	Standard	Nuclear Operating Unit
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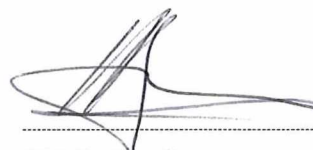
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1. INTRODUCTION

This standard specifies the radiological environmental surveillance 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 environmental surveillance 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 procedure 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] 238-35: Radiation Protection Dose and Risk Limits.
- [3] 238-36: Operational Radiation Protection Requirements.
- [4] 238-43: Requirements for Radiation Workers.
- [5] 32-226: Eskom Standard, Radiation Protection and safety of radiation sources.
- [6] 32-227: Eskom Policy, Radiation Protection and safety of radiation sources.

3.2 INFORMATIVE

- [7] 238-1: Nuclear Division Integrated Management System.

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4. DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITIONS

- 4.1.1 **Contamination:** The presence of radioactive substances in, or on a material or the human body or other place where they are undesirable or could be harmful.
- 4.1.2 **Dose:** A measure of the radiation received or absorbed by a target.
- 4.1.3 **Dosemeter(s):** Instrument to detect and measure accumulated radiation exposure. Used for personal monitoring such as a TLD intended to be worn on the body.
- 4.1.4 **Electronic product:** Any electronic product that emits ionising electro-magnetic, particulate radiation or any sonic, infrasonic or ultrasonic wave.
- 4.1.5 **Employee:** A person who has entered into or works under a contract of service or of apprenticeship or learnership, with an employer, whether the contract is express or implied, oral or in writing, and whether the remuneration is calculated by time or by work done, or is in cash or in kind, and includes:
- a) a casual employee employed for the purpose of the employer's business;
 - b) a person who has entered into a contract of service or of apprenticeship or learnership with the employer;
 - c) a person provided to Eskom by a Temporary Employment Service (Labour Broker) and who works under the control, instruction and supervision of an Eskom employee;
 - d) a casual employee;
 - e) a part-time worker;
 - f) a temporary worker;
 - g) an occasional employee;
 - h) an unattached learner;
 - l) a bursar.

Note: In the event of an injury to persons in the above categories it will be regarded as arising out of and in the course of duty, if the injured person worked under the instruction and supervision of an Eskom employee.

- 4.1.6 **Eskom:** Is used for Eskom Holdings SOC Limited, its divisions and wholly owned subsidiaries.
- 4.1.7 **Exposure:** The act or condition of being subject to irradiation externally or internally. The term also expresses the amount of ionization produced in air by ionising radiation.
- 4.1.8 **External Exposure:** Irradiation by sources outside the body.
- 4.1.9 **Group III Hazardous Substance:** Any electronic product that emits ionising and non-ionising radiation.
- 4.1.10 **Group IV Hazardous Substance:** Any fabricated radio-isotopes.
- 4.1.11 **Ionising Radiation:** Radiation capable of producing ion pairs in biological material(s).

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- 4.1.12 **Occupational Exposure:** All exposures of radiation to employees incurred during work.
- 4.1.13 **Potential Exposure:** Exposure to radiation that is not expected with certainty to be delivered, but that may result from an incident at a source or owing to an event or sequence of events of a probabilistic nature, including equipment failures and operating errors.
- 4.1.14 **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.
- 4.1.15 **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.
- 4.1.16 **Public Exposure:** Exposure incurred by members of the public from radiation sources.
- 4.1.17 **Radiation Workers:** The requirements for radiation workers in Eskom employment are defined in Eskom Standard, 238-43:Requirements for Radiation Workers.
- 4.1.18 **Radiation:** See ionising radiation.
- 4.1.19 **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.
- 4.1.20 **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
EP	Emergency Planning
ESKOM	Eskom Holdings SOC Limited, it's divisions and wholly owned subsidiaries
MDA	Minimum Detectable Activity
RP	Radiation Protection
SAR	Safety Analysis Report
TLD	Thermoluminescent Dosimeter

5. REQUIREMENTS

5.1 MONITORING OF PUBLIC EXPOSURE

- 5.1.1 Eskom shall provide for the establishment, implementation and maintenance of an appropriate environmental monitoring and surveillance programme to ensure that the storage, disposal or effluent discharge of radioactive waste, does not result in unacceptable contamination of the

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environment and complies with the ALARA principle and public dose limits prescribed in Eskom standard, 238-35: Radiation Protection Dose and Risk Limits.

- 5.1.2 Eskom shall establish and carry out a monitoring programme, sufficient to ensure that the requirements of this standard regarding public exposure to sources of external irradiation, be satisfied and to assess such exposure.
- 5.1.3 Eskom shall establish and carry out a monitoring programme sufficient to ensure that the requirements of this standard for discharges of radioactive substances to the environment and the requirements established by the relevant regulatory authority in granting the discharge Authorisation are satisfied, and that the conditions assumed in deriving the Authorised discharge limits remain valid and sufficient to enable the exposures to critical groups to be estimated.
- 5.1.4 Eskom shall keep appropriate records of the results of the monitoring programmes.
- 5.1.5 Eskom shall report a summary of the monitoring results to the relevant regulatory authority at approved intervals.
- 5.1.6 Eskom shall report promptly to the relevant regulatory authority any significant increase in environmental radiation fields or contamination that could be attributed to the radiation or radioactive discharges emitted by sources under Eskom control.
- 5.1.7 Eskom shall establish and maintain a capability to carry out emergency monitoring, in case of unexpected increases in radiation fields, or radioactive contamination due to accidental or other unusual events, affecting sources under Eskom control.
- 5.1.8 Eskom shall, if appropriate, verify the adequacy of the assumptions made for the prior assessment of radiological consequences of the discharges.
- 5.1.9 Eskom shall, if appropriate, demonstrate the possible detection of any long-term radiological changes or trends in the environment resulting from plant operation.

5.2 PRE-OPERATIONAL ENVIRONMENTAL SURVEILLANCE PROGRAMME

- 5.2.1 A pre-operational environmental surveillance programme shall be fully operational two years prior to the operation of an Eskom nuclear installation.
- 5.2.2 The duration of the pre-operational programme, for specific media, presented in Appendix A shall be followed.

5.3 OPERATIONAL ENVIRONMENTAL SURVEILLANCE PROGRAMME

- 5.3.1 An operational Eskom nuclear installation shall collect and analyse environmental samples as specified in Appendix B and the associated footnotes specified in Appendix C.
- 5.3.2 An Eskom nuclear installation shall prepare a map listing for all the sampling sites and a sampling schedule.
- 5.3.3 Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons.

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- 5.3.4 If specimens are unobtainable due to sampling equipment malfunction, every effort should be made to complete corrective action before the end of the next sampling period. All deviations from the sampling schedule shall be documented in the annual report.
- 5.3.5 If milk samples become unavailable from any of the sample locations required by the programme, Eskom shall prepare and submit to the relevant regulator a special report stating the cause of the unavailability of samples and the locations for obtaining replacement samples. The locations from which samples were unavailable may then be deleted from the programme, provided the locations from which the replacement samples were obtained are added to the programme as replacement locations.

5.4 DISPOSAL OF SAMPLES

- 5.4.1 Samples must be disposed in an appropriate manner in accordance with documented criteria.
- 5.4.2 The specific activity limit for each radionuclide is 0.2 Bq/g.

5.5 LAND USE CENSUS

- 5.5.1 A land use census shall be conducted at a frequency specified by the relevant regulator.
- 5.5.2 Requirements for a land use census shall be defined in local rules and procedures.

5.6 LOCAL RULES, PROCEDURE AND SUPERVISION

- 5.6.1 Local radiological environmental surveillance rules and procedures shall be enforceable.
- 5.6.2 Local radiological environmental surveillance rules and procedures shall be reviewed routinely.
- 5.6.3 Local radiological environmental surveillance rules and procedures shall be made available and the requirements should be made known to those workers to whom they apply, and to other persons who may be affected by them.
- 5.6.4 The local rules and procedures should reflect the appropriate requirements contained in the Eskom policy, directive, regulation and associated standards.
- 5.6.5 The local rules and procedures should reflect the ALARA principles.
- 5.6.6 Any work involving public exposure shall be adequately supervised and all reasonable steps shall be taken to ensure that the radiological environmental surveillance rules, procedures, protective measures and safety provisions are being applied.

5.7 INTER-LABORATORY COMPARISON

- 5.7.1 Eskom radiological environmental surveillance programmes shall participate in appropriate inter-laboratory comparison programmes as required.
- 5.7.2 The results of the inter-laboratory comparison programme should be made available to the regulatory authority.

5.8 NOTIFICATIONS, RECORDS AND REPORTS

- 5.8.1 Radiological environmental surveillance records shall be maintained in accordance with the requirements prescribed by the regulator.

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- 5.8.2 Samples in excess of the reporting levels in Appendix D and Appendix E shall be investigated, recorded and reported to the regulator.
- 5.8.3 Radiological environmental surveillance reports shall be compiled and distributed in accordance with the requirements prescribed by the relevant regulator.

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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- K Featherstone
- MV Moduka

10. APPENDICES

A: Duration of Pre-Operational Sampling Programme

B: Operational Radiological Environmental Monitoring Programme

C: Operational Radiological Environmental Monitoring Programme: Footnotes

D: Reporting Levels of Radioactivity in Environmental Media: Liquid Pathway

E: Reporting Levels of Radioactivity in Environmental Media: Gaseous Pathway

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APPENDIX A: DURATION OF PRE-OPERATIONAL SAMPLING PROGRAMME**Duration of Pre-Operational Sampling Programme**

Six months	One year	Two years
<ul style="list-style-type: none">• airborne iodine• iodine in milk products [while animals are in pasture]	<ul style="list-style-type: none">• airborne particulates• milk [remaining analysis]• surface water• ground water• drinking water	<ul style="list-style-type: none">• direct radiation• fish and food• invertebrates• sediment from shore-line

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APPENDIX B: OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMME

Exposure pathway and/or sample	Number of samples ^a and locations	Sampling and collection frequency ^a	Type, frequency and analysis
Radioiodine and particulate	Samples from five locations: Three samples from off-site locations [in different sectors] of the highest calculated annual average ground level (χ/Q) χ/Q . One sample from the vicinity of a community having the highest calculated annual average ground level χ/Q . One sample from a control location 30 km distant and in the least prevalent wind direction ^d	Continuous sampler operation with sample collection weekly ^e	Radioiodine Canister: analyse weekly for I-131. Particulate Sampler: gamma isotopic activity following filter change ^{bc}
Direct Radiation^f	Forty stations with two or more dosimeters or one instrument for measuring and recording dose rate continuously, to be placed as follows: an inner ring of stations in the general area of the site boundary and an outer ring in the 6 to 8 km range from the site with a station in each section of each ring [16 sectors x 2 rings = 32 stations]. The balance of the stations, 8, should be placed in special interest areas such as population centres, nearby residences, schools and in two or three areas to serve as control stations, 15 to 30 km distant.	Monthly on public exclusion boundary, with the rest quarterly.	Gamma exposure: Analyse monthly or quarterly.
Sea Water^j	One sample on each side of discharge within 500 m.	Composite sample over a one-month period from weekly grab sample	Gamma isotopic analysis: monthly. Composite for tritium analysis: quarterly.
Soil^j	Samples from four locations within 5 km and one from 30 km.	Annually	Gamma isotopic analysis

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Exposure pathway and/or sample	Number of samples ^a and locations	Sampling and collection frequency ^a	Type, frequency and analysis
Drinking or surface fresh water^g	One sample of each of the two nearest water supplies. If not used for drinking, surface fresh water shall be sampled. One sample 30 km distance for control	Weekly samples for monthly composite Monthly	Composite for gamma isotopic analysis: monthly. Composite for tritium analysis: quarterly.
Sediment from shoreline	One sample each side of discharge within 500 m at low tide.	Semi-annually	Gamma isotopic analysis semi-annually.
Milk^h	Samples from three locations within 5 km [nearest to the reactor] having the highest dose potential. If there are none, then one sample from milk producing animals in each of three areas between 5 to 8 km distance, having the highest dose potential based on meteorological data. One sample from milk producing animals at a control location [15 to 30 km distant and in the least prevalent wind direction].	Semi-monthly animals are on pasture, monthly at other times.	Gamma isotopic and I-131 analysis: semi-monthly when animals are on pasture; monthly at other times
Fish and Invertebratesⁱ	One sample of each commercially and recreationally important species in vicinity of discharge point influenced by plant discharges One sample of same species in areas not influenced by plant discharge.	Sample semi-annually.	Gamma isotopic analysis: On edible portions.
Food products^j	One sample of each principal class of food products from the nearest area within 15 km of the reactor.	At time of harvest ⁱ	Gamma isotopic analysis: On edible portions.
Broad Leaf Vegetation^j	Three samples of broad leaf vegetation grown nearest off-site locations of highest calculated annual average ground level χ/Q . One sample of each of the similar vegetation grown 15 to 30 km distant in the least prevalent direction.	Monthly when available	Gamma isotopic analysis: On leaves.
Sewage	Sample the off-site sewage system which receives sewage effluent from the station	Monthly sample	Gamma isotopic analysis of sludge: Monthly. H-3 analysis of liquid: Quarterly composite.

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APPENDIX C: OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAMME: FOOTNOTES**Footnote (a)**

The number, media, frequency and location of sampling may vary from site to site. It is recognized that, at times, it may not be possible or practical to obtain samples of the media of choice at the most desired location or time. In these instances suitable alternative media and locations may be chosen for the particular pathway in question and submitted for acceptance. Actual locations [distance and direction] from the site shall be provided.

Footnote (b)

If Cs-137 activity in air is detected, Sr-90 analysis shall be performed.

Footnote (c)

Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

Footnote (d)

The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites that provide valid background data may be substituted.

Footnote (e)

Canisters for the collection of radioiodine shall be carefully checked before operation in accordance with the quality assurance programme of the manufacturer.

Footnote (f)

One or more instrument(s), such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purpose of this table, a thermo-luminescent dosimeter may be considered to be one phosphor, and two or more phosphors in a packet may be considered as two or more dosimeters. The 40 stations are not an absolute number. This number may be reduced according to geographical limitations, for example, at an ocean site; some sectors may be over the sea so that the number of dosimeters may be reduced accordingly.

Footnote (g)

Ground water samples shall be taken when this source is tapped for drinking or irrigation purposes in areas where the hydraulic gradient or recharge properties are suitable for contamination.

Footnote (h)

The dose shall be calculated for using the methodology prescribed by the National Nuclear Regulator and the actual parameters particular to the site.

Footnote (i)

If harvest occurs more than once a year, sampling shall be performed during each discrete harvest. If harvest occurs continuously, sampling shall be monthly. Attention shall be paid to including samples of tuberous and root food products if available.

Footnote (j)

If gamma isotopic analysis indicates Cs-137, an analysis for Sr-90 shall be performed

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APPENDIX D: REPORTING LEVELS OF RADIOACTIVITY IN ENVIRONMENTAL MEDIA: LIQUID PATHWAY

Nuclide	Fish	Invertebrate	Beach sand Sea sediment	Sea water
	Bq/kg	Bq/kg	Bq/kg	Bq/kg
H-3	2.51E+03	2.51E+03	2.51E+02	2.51E+03
Cr-51	5.88E+01	2.94E+02	1.01E+00	1.47E-01
Mn-54	1.50E+01	1.09E+01	2.12E+00	2.72E-02
Fe-59	2.09E+01	1.40E+02	7.74E-02	
Co-57	3.24E-02	3.24E-01		
Co-58	2.48E+01	2.48E+02	4.37E+00	2.48E-01
Co-60	1.18E+01	1.18E+02	5.25E+01	1.18E-01
Zn-65	1.72E+01	4.31E+02	5.23E-01	
Y-90	3.20E-02	1.28E+01	9.46E-01	
Y-91	7.68E-02	3.07E+01	4.48E-02	
Zr-95	3.01E-01	1.20E-01	2.40E-02	
Nb-95	4.31E+01	1.44E-01	1.26E-02	
Mo-99	1.26E+01	1.26E+01	8.65E-01	1.26E+01
Tc-99m	1.11E+01	5.56E+01	8.26E-01	1.11E+01
Ru-103		1.71E+01	1.67E-02	
Ru-106	2.84E-04	9.47E-02	8.86E-02	9.47E-05
Ag-110m	1.10E+01	2.21E+02	1.37E+01	2.20E-02
Sb-125	9.85E-01	1.18E+0	2.47E-01	
Te-132	3.79E+01	3.79E+01	3.08E-01	3.79E-01
I-131	7.25E+01	3.62E+02	1.45E+01	7.25E+01
I-132	3.95E+01	1.97E+01	3.17E-01	3.95E-01
I-133	4.54E+01	2.27E+01	9.80E-02	4.54E-01
I-134		1.94E-01		
I-135	6.34E-01	3.17E+01		6.34E-02
Cs-134	2.68E+02	1.67E+02	1.25E+03	6.69E+01
Cs-136	7.40E+01	4.46E+01	5.82E+01	1.78E+01
Cs-137	1.32E+02	8.25E+01	3.34E+03	3.30E+01
Ba-140	1.13E-01	1.13E+0	3.59E-02	1.13E-02
La-140	3.38E-01	1.35E+01	4.15E-02	1.35E-02
Ce-141	1.48E-02	8.86E-01	1.20E-02	
Ce-144	1.37E-02	8.20E-01	9.68E-02	
Nd-147	1.62E-02	6.50E-01		

Note: The reporting levels derived in the Spreadsheet SAR.XLS and supplied in this standard, places no requirement on the sensitivity of the instruments and detection methods used to quantify the specific activity for the nuclides listed. Where the Minimum Detectable Activity (MDA) exceeds these figures, any activity detected in excess of MDA shall be reportable to the relevant Regulatory Authority

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APPENDIX E: REPORTING LEVELS OF RADIOACTIVITY IN ENVIRONMENTAL MEDIA: LIQUID PATHWAY

Pathway

Nuclide	AIR	MILK	MEAT	FRUIT, VEG, GRAIN	LEAFY VEGETABLES	WATER
	Bq/m ³	Bq/l	Bq/kg	Bq/kg	Bq/kg	Bq/l
H-3	1.88E02	4.85E03	1.37E04	2.89E03	2.35E04	2.05E03
C-14						
Cr-51	4.37E01	1.61E03	4.55E03	9.62E02	7.81E03	6.84E02
Mn-54	2.50E00	1.13E02	3.18E02	6.73E01	5.48E02	4.81E01
Co-57	1.36E00	4.85E02	1.37E03	2.89E02	2.35E03	2.05E02
Co-58	1.88E00	1.13E02	3.18E02	6.73E01	5.48E02	4.81E01
Co-60	6.29E02	3.23E01	9.10E01	1.92E01	1.56E02	1.37E01
Zn-65	6.25E-01	1.61E01	4.55E01	9.62E02	7.81E01	6.84E00
Sr-89	1.88E00	3.23E01	9.10E01	1.92E01	1.56E02	1.37E01
Sr-90	4.37E02	1.61E00	4.55E00	9.62E01	7.81E00	6.84E01
Zr-95	6.25E01	8.07E01	2.27E02	4.81E01	3.92E02	2.70E01
Nb-95	2.50E00	4.85E01	1.37E02	2.89E01	2.35E02	2.05E01
Tc-99m	1.22E03	1.13E04	3.18E04	6.73E03	5.48E04	4.81E03
Ru-103	3.74E00	1.13E02	3.18E02	6.73E01	5.48E02	4.81E01
Ru-106	1.88E-01	1.13E01	3.18E01	6.73E00	5.48E01	4.81E00
Ag-110m	3.13E-01	3.23E01	9.10E01	1.92E01	1.56E02	1.37E01
I-131	1.25E-01	1.61E00	4.55E00	1.00E01	7.81E00	6.84E01
I-132	1.88E01	1.61E02	4.55E02	9.62E01	7.81E02	6.84E01
I-133	6.25E-01	9.69E00	2.73E01	5.77E00	4.70E01	4.11E02
I-134	6.25E01	1.45E03	4.09E03	8.65E02	7.03E03	6.16E02
I-135	3.74E00	4.85E01	1.37E02	2.89E01	2.35E02	2.05E01
Te-132	6.25E-01	4.85E01	1.37E02	2.89E01	2.35E02	2.05E01
Cs-134	2.50E-01	4.85E00	1.37E01	2.89E00	2.35E01	2.05E00
Cs-137	3.74E-01	6.44E00	1.82E01	3.85E00	3.13E01	2.74E00
Ba-140	3.13E00	3.23E01	9.10E01	1.92E01	1.56E02	1.37E01
La-140	2.50E00	3.23E01	9.10E01	1.92E01	1.56E02	1.37E01
Ce-141	1.88E00	9.69E01	2.73E02	5.77E01	4.70E02	4.11E01
Ce-144	3.13E-02	1.29E01	3.64E01	7.70E00	6.25E01	5.48E00

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