Eskom	Standard	Nuclear Operating Unit

Title: **Liquid and Gaseous Effluent Management Requirements for Koeberg Nuclear Power Station.**

Document Identifier:	**238-49**
Alternative Reference Number:	**NSN-049**
Area of Applicability:	**Nuclear Operating Unit**
Functional Area:	**Radiation Protection**
Revision:	**1**
Total Pages:	**19**
Next Review Date:	**April 2024**
Disclosure Classification:	**Controlled Disclosure**

Compiled by	Functional Responsibility	Authorized by
M Maree	**KG Featherstone**	**MR Bakardien**
Corporate Specialist Radiation Protection	**Senior Manager Nuclear Strategy and Regulation**	**Chief Nuclear Officer Nuclear Operating Unit**
Date: 29.04.2022	Date: 23/05/2022	Date: 27-05-2022

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**

CONTENTS

Page

1. INTRODUCTION

This standard specifies the liquid and gaseous effluent management requirements for Koeberg Nuclear Power Station in terms of the Eskom Radiation Protection Policy 32-227 and Standard 32-226. The Eskom Generation Division 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 the liquid and gaseous effluent management requirements employed at the Koeberg Nuclear Power Station 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 radioactive material 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: Nuclear Division Radiation Protection Manual.

[2] 238-35: Radiation Protection Dose and Risk Limits.

[3] 238-43: Requirements for Radiation Workers.

[4] 32-226: Eskom Standard, Radiation Protection and Safety of Radiation Sources.

[5] 32-227: Eskom Policy, Radiation Protection and Safety of Radiation Sources.

[6] KSH-010: Functional Responsibilities for Radiation Protection at Koeberg Nuclear Power Station.

3.2 INFORMATIVE

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

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

4. DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITIONS

4.1.1 **Authorised Person (RP):** An Authorised Person (Radiation Protection) is a member of the radiation protection organisation who has been authorised to release radioactive effluent to the environment within prescribed limits.

4.1.2 **Exposure:** The act or condition of being subject to irradiation. Exposure

4.1.3 **Eskom:** is used for Eskom Holdings SOC Limited, its divisions and wholly owned subsidiaries.

4.1.4 **Ionising Radiation:** Radiation capable of producing ion pairs in biological material(s).

4.1.5 **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.

4.1.6 **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.

4.1.7 **Radiation:** See ionising radiation.

4.1.8 **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.

4.1.9 **Senior Authorised Person (RP):** A Senior Authorised Person (Radiation Protection) is a person authorised to act as or on behalf of the Manager (RP) in technical matters requiring input.

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

4.2 ABBREVIATIONS

Abbreviation	Description
AADQ	Annual Authorised Discharge Quantity
ACP2	Access Control Point Number 2
Bq/m^3	Becquerel per cubic meter
CAS	Central Alarm System
CRF	Circulating Water system
CSIR	Council for Scientific and Industrial Research
CVI	Condenser vacuum system
DVN	Nuclear Auxialliary Building ventilation system
EBA	Containment scavenging ventilation system
Eskom	Eskom Holdings SOC Limited, its Divisions and wholly owned subsidiaries

Abbreviation	Description
ETY	Containment atmosphere control system
KER	Monitoring and discharge of nuclear island liquid effluents
KRT	Plant radiation monitoring system
LLD	Lower Limit of Detection
MBq/m^3	Mega Becquerel per cubic meter
MDC	Minimum Detectable Concentration
RRI	Component cooling system (Nuclear)
SAR	Safety Analysis Report
SEC	Essential service water system
SEK	Monitoring and discharge of conventional island liquid waste

5. REQUIREMENTS

5.1 RESPONSIBILITIES

The responsibilities for management of the liquid and gaseous effluent programme at Koeberg Nuclear Power Station shall be implemented in accordance with requirements specified in the Koeberg standard, KSH-010.

5.2 REQUIREMENTS FOR MONITORING INSTRUMENTATION

5.2.1 Suitable radioactive liquid and gaseous effluent monitoring instrumentation shall be provided. The equipment shall be designed to indicate the following parameters:

5.2.1.1 An alarm in the Control Room if a preset threshold is reached for threshold one (warning alarm) and threshold two (alarm/system trip), if applicable.

5.2.1.2 Indicate the measured level above the alarm trip set point.

5.2.1.3 The threshold two alarm trip set points shall be set in accordance with Appendix A.

5.2.1.4 The initial instrumentation calibration for radioactivity measurements shall be performed using calibrated sources traceable to the national standards maintained by the CSIR or standards traceable to international standards recognized by the CSIR. These standards shall permit calibration of the system over its intended range of energy and dose rate capabilities.

5.2.1.5 Subsequent channel calibration sources that have been related to the initial calibration, should be used at intervals of at least once every eighteen months or during refuelling outages.

5.2.1.6 A suitable programme shall be established to perform radioactive source checks on the instrumentation at regular intervals.

5.2.1.7 When a monitoring channel alarm trip set point or calibration is found to be out of tolerance, the release of all radioactive effluents monitored shall be managed in accordance with the requirements of Appendix A.

5.3 REQUIREMENTS FOR CONTINUOUS DISCHARGES

5.3.1 If the effluent discharge system is to be used for the continuous discharge of liquid or gaseous effluents, a radiation monitor shall be placed at the discharge line to measure gross activity.

5.3.2 A continuous flow meter shall also be installed and the readings of the radiation monitor and flow meter shall be recorded continuously when releases are in progress.

5.3.3 Fallback requirements shall be documented for when this equipment is inoperable.

5.3.4 Provision shall further be made to take grab samples for isotopic analysis.

5.3.5 A facility to terminate the release shall be provided if the activity of the release exceeds the trip set point of the radiation monitor.

5.3.6 A procedure to document the above actions shall be established.

5.3.7 The monitoring instruments on the discharge line shall have a detection capability of 3.7×10^4 Bq/m^3.

5.4 REQUIREMENTS FOR LIQUID EFFLUENT DISCHARGES

5.4.1 Requirements for liquid effluent batch discharges

5.4.1.1 Each batch of liquid effluent shall be sampled prior to discharge in accordance with Appendix C.

5.4.1.2 If gross gamma activity is less than or equal to 3.7×10^6 Bq/m^3, the effluent may be discharged without further analysis.

5.4.1.3 Any batch of liquid containing activity greater than 3.7×10^6 Bq/m^3 shall be analysed by gamma spectrometry, prior to discharge, and the activity per radionuclide present in the sample shall be applied to assess the total activity present in the batch of liquid.

5.4.1.4 Prior to discharging tanks of liquid effluent, authority shall be obtained from a Senior Authorised Person (RP) or an Authorised Person (RP) if the release does not exceed 5 % of the AADQ for a specific radionuclide.

5.5 REQUIREMENTS FOR LIQUID EFFLUENT CONTINUOUS DISCHARGES

5.5.1 Continuous discharges of liquid effluent shall be monitored and or sampled in accordance with Appendix C.

5.5.2 The detection capability of the instruments used shall be 3.7×10^4 Bq/m^3.

5.6 REQUIREMENTS FOR LIQUID EFFLUENT COMPOSITE SAMPLES

5.6.1 A weekly composite sample shall be made up from all batches discharged during the week and analysed by gamma spectrometry.

5.6.2 The composition of the composite sample shall be used to assess the quantity of radionuclides released during that period.

5.6.3 The assessment of activity in composite samples shall account for radioactive decay.

5.6.4 A quarterly composite sample shall be made of the liquid effluent batches discharged during that quarter, and analysed for strontium-89, strontium-90 and tritium.

5.6.5 A daily grab sample, or continuous sampling (to sample at least one litre of water per day from the SEC system) downstream of the RRI heat exchangers must be undertaken. A quarterly composite must be made of this sample and analysed by gamma spectrometry and analysis for Sr-89, Sr-90 and tritium.

5.6.6 The requirements for sampling and analysis, with the required Lower Limit of detection are listed in Appendix C.

5.7 REQUIREMENTS FOR GASEOUS EFFLUENT DISCHARGES

5.7.1 Requirements for gaseous effluent batch discharges

Each batch of gaseous effluent shall be sampled prior to discharge in accordance with Appendix C.

5.7.2 Requirements for gaseous effluent continuous discharges

5.7.2.1 A continuous measurement must be made of radioactive gases released, in accordance with Appendix C.

5.7.2.2 The detection capability of the instrument used shall be 7.4×10^3 Bq/m^3.

5.8 REQUIREMENTS FOR GASEOUS EFFLUENT COMPOSITE SAMPLES

5.8.1 The radioactive composition of gases released shall be determined.

5.8.2 Composite samples of aerosols in gaseous effluent discharges shall be collected and monitored. The sample shall be analysed weekly by gamma spectrometry. The quantity of nuclides discharged in the form of aerosols shall be made from this analysis, correcting for radioactive decay as necessary.

5.8.3 Iodine shall be collected from an iodine filter with a minimum collection efficiency of 90 % for organic iodine compounds. The filter shall be monitored continuously and analysed weekly using gamma spectrometry to estimate the quantity of iodine released.

5.8.4 Tritium release shall be measured by continuous sampling of water vapour in the discharge gases and analysed.

5.8.5 A quarterly composite sample shall be made of the gaseous effluent batches discharged during that quarter and analysed for strontium-89, strontium-90 and tritium.

5.8.6 The requirements for sampling and analysis, with the required Lower Limit of detection are listed in Appendix C.

5.9 ANNUAL AUTHORISED DISCHARGE QUANTITIES

5.9.1 The annual authorised discharge quantities specified in Appendix B shall be complied with.

5.9.2 If projected that the authorised discharge quantities will be exceeded, the NNR must be requested to provide special release authorisation.

5.10 OFF-SITE DOSE LIMIT

5.10.1 Koeberg Nuclear Power Station shall comply with the public dose limit prescribed in Eskom standard, 238-35: Radiation Protection Dose and Risk Limits.

5.10.2 Effective dose to the critical group resulting from liquid and gaseous effluent shall be determined and documented.

5.11 ADMINISTRATIVE CONTROLS

Local rules and procedures shall be based on requirements contained in this standard and in the relevant Koeberg Safety Analysis Report.

5.12 REPORTING REQUIREMENTS

5.12.1 Quarterly radioactive effluent report

5.12.1.1 A report, covering the operation of the plant during the previous three months of operation, shall be submitted to the NNR within thirty days after January st1, April st1, July st1, and October st1, of each year. This report shall include the following:

a. A summary of the quantities of radioactive liquid and gaseous effluents released from the plant.

5.12.1.2 The following information for all unplanned releases of radioactive materials in liquid and gaseous effluents:

a. a description of the events and equipment involved.

b. cause(s) for the unplanned release.

c. actions taken to prevent recurrence.

d. consequences of the unplanned release.

5.12.1.3 An assessment of effective doses from the radioactive liquid and gaseous effluents released.

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.

Name	Designation
Anari van Greuning	Hendrina Acting Power Station Manager
Avi Singh	Peaking Cluster General Manager
Bonga Mashazi	Kusile Power Station Manager
Douglas Woodhall	Corporate Consultant
Jurie Pieterse	Komati Acting Power Station Manager
Justice Bore	Camden Power Station Manager
Londi Mthembu	Majuba Power Station Manager
Lourence Chauke	Duvha Power Station Manager
Lukhanyo Ndube	Kendal Power Station Manager
Marcus Nemadodzi	Arnot Power Station Manager
Maserati Lesolang	Matla Power Station Manager
Morongwe Raphasha	Kriel Power Station Manager
Nomawethu Mtwebana	Koeberg Nuclear Power Station Manager (Acting)
Obakeng Mabotja	Matimba Power Station Manager
Refilwe Langa	Koeberg Nuclear Power Station Radiation Protection Manager
Riedewaan Bakardien	Nuclear Cluster Chief Nuclear officer
Sello Mametja	Tutuka Power Station Manager
Solly (Yangaphe) Ngcashi	Lethabo Power Station Manager
Tertius Karsten	Chief Physicist
Tshepiso Temo	Grootvlei Power Station Manager
Zweli Witbooi	Medupi Acting Power Station Manager

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

- E Flanagan
- K Featherstone
- MV Moduka

10. APPENDICES

A: Actions for Trip setpoint or monitoring channel out of tolerance.

B: Annual Authorised Discharge Quantities

C: Radioactive Effluent Sampling and Analysis Programme

APPENDIX A: TRIP SETPOINTS AND ACTIONS FOR MONITORING CHANNELS OUT OF TOLERANCE.

Radioactive Liquid Effluent Monitoring Instrumentation						
Instrumentation Channel		**Minimum Channels Operable**	**Application**	**Parameter**	**Trip Setpoint Bq per m^3**	**Action**
1.	Gross Radioactivity Monitors providing automatic termination of release					
(a)	KER Discharge Line KRT 901 MA	1 (Common to both units)	During releases via this pathway	Gamma activity	7.4×10^8 Bq/m^3	1
(b)	SEK Discharge Line KRT 904 MA	1 (Common to both units)	During releases via this pathway	Gamma activity	7.4×10^8 Bq/m^3	1
(c)	SEK Bypass Line KRT 902/903 MA	1 (Common to both units)	At all times	Gamma activity	4.3×10^5 Bq/m^3 When APG is diverted to the SEK bypass, the applicable trip setpoint may be set up to 3.7×10^7 Bq/m^3.	2

Action 1: With the number of channels operable less than required by the minimum channels operable requirement, releases may be resumed for up to 14 days, provided that:

(a) one sample is taken and analysed (as per Appendix C) prior to release, and

(b) another sample from the normal sampling point is taken during release and analysed.

Otherwise, suspend releases of radioactive effluents via this pathway.

Action 2: With the number of channels operable less than required by the minimum channels operable requirements, effluent release via the SEK bypass line will be suspended and routed to the appropriate SEK discharge tank.

Radioactive Gaseous Effluent Monitoring Instrumentation						
Instrumentation Channel		**Minimum Channels Operable**	**Application**	**Parameter**	**Trip Setpoint**	**Action**
1. DVN Stack						
(a)	KRT 016 MA (Manual trip)	1 (from either unit)	At all times	Beta activity aerosols	7.4×10^2 Bq/m^3	3
(b)	KRT 017 MA (Automatic trip on own unit)	*	At all times	Beta activity gases (Low)	8.5×10^7 Bq/m^3	3
(c)	KRT 021 MA	1 (from either unit)	At all times	Beta activity gases (High)	6.1×10^2 MBq/m^3	3
(d)	KRT 025 MA (Manual trip)	1 (from either unit)	At all times	Gamma activity of iodine	5.2×10^2 Bq/m^3	3
2. Containment						
(a)	KRT 009 MA (Automatic trip)	#		Beta activity gases (Low)	9.0×10^6 Bq/m^3	3

Note:	*	Both KRT 017MA channels or either KRT 017MA PLUS KRT 009MA of the other unit. If neither KRT 017MA channels are available the CAS and ACP2 must be informed that the change over to iodine train ventilation is now only a manual operation.
	#	Either KRT 009 or 017 MA of the same unit (KRT 009 MA is shown as an effluent monitor because it is used as an alternative to KRT 017 MA for ETY/EBA isolation).
Action	3	With the number of channels operable less than required by the minimum channels operable requirement, releases via this pathway may continue provided that EBA/ETY and TEG are isolated, primary coolant oxygenation of either unit is prohibited, and auxiliary monitoring equipment is installed within 12 hours. With auxiliary monitoring equipment not installed within 12 hours releases via this pathway may continue provided that the following programme is initiated. A grab sample must be taken every 1 hour for analysis for noble gases and continuous sampling with daily analysis for iodine, particulates and tritium. Otherwise, suspend releases of radioactive effluents through this pathway and report to the National Nuclear Regulator.

APPENDIX B: ANNUAL AUTHORISED DISCHARGE QUANTITIES

	Liquid AADQ	Liquid DCF	Liquid Dose	Gaseous AADQ	Gaseous DCF	Gaseous Dose
Isotope	**Bq**	**Sv / Bq**	**Sv**	**Bq**	**Sv / Bq**	**Sv**
H-3	5.73E+14	1.19E-21	6.82E-07	5.72E+14	1.54E-20	8.81E-06
Be-7	1.04E+10	2.12E-16	2.20E-06	9.72E+06	3.39E-19	3.30E-12
Na-24	1.39E+09	0.00E+00	0.00E+00	1.01E+08	7.55E-20	7.63E-12
Ar-41	0.00E+00	2.93E-25	0.00E+00	4.79E+13	1.49E-20	7.14E-07
Cr-51	3.09E+10	6.38E-17	1.97E-06	3.05E+07	3.52E-19	1.07E-11
Mn-54	5.72E+09	6.79E-18	3.88E-08	5.09E+06	7.11E-17	3.62E-10
Mn-56	1.04E+08	1.83E-20	1.90E-12	1.48E+07	2.94E-20	4.35E-13
Fe-59	1.46E+09	2.76E-16	4.03E-07	1.38E+06	1.73E-19	2.39E-13
Co-57	1.26E+08	4.15E-17	5.23E-09	1.12E+05	2.81E-17	3.15E-12
Co-58	5.22E+10	2.95E-16	1.54E-05	4.82E+07	2.54E-17	1.22E-09
Co-60	2.47E+10	3.72E-17	9.19E-07	2.19E+07	1.14E-15	2.50E-08
Zn-65	1.81E+09	9.41E-16	1.70E-06	1.61E+06	2.21E-16	3.56E-10
Br-82	1.29E+09	2.25E-20	2.90E-11	1.02E+08	7.99E-20	8.15E-12
Br-84	2.64E+07	1.25E-35	3.30E-28	9.67E+07	1.77E-20	1.71E-12
Kr-85m	0.00E+00	0.00E+00	0.00E+00	1.39E+13	3.25E-20	4.52E-07
Kr-85	0.00E+00	0.00E+00	0.00E+00	3.57E+14	1.44E-21	5.14E-07
Kr-87	0.00E+00	0.00E+00	0.00E+00	9.71E+12	1.81E-19	1.76E-06
Kr-88	0.00E+00	0.00E+00	0.00E+00	2.30E+13	4.56E-19	1.05E-05
Rb-88	2.55E+08	3.34E-44	8.52E-36	2.30E+13	8.65E-21	1.99E-07
Rb-89	6.22E+06	1.12E-48	6.97E-42	1.21E+06	1.88E-20	2.27E-14
Sr-89	8.96E+08	2.98E-18	2.67E-09	8.40E+05	7.22E-18	6.06E-12
Sr-90	1.97E+08	6.02E-17	1.19E-08	1.77E+05	8.32E-16	1.47E-10
Sr-91	2.73E+06	9.70E-20	2.65E-13	3.68E+05	3.65E-20	1.34E-14
Sr-92	5.65E+05	7.80E-22	4.41E-16	7.97E+04	2.94E-20	2.34E-15
Y-92	1.56E+05	2.12E-19	3.31E-14	0.00E+00	1.40E-20	0.00E+00
Zr-95	3.16E+08	3.94E-18	1.25E-09	2.92E+05	1.91E-17	5.58E-12
Zr-97	6.35E+07	2.93E-18	1.86E-10	1.60E+05	6.62E-20	1.06E-14
Nb-94	4.62E+06	2.74E-14	1.27E-07	0.00E+00	0.00E+00	0.00E+00
Nb-95	3.02E+08	2.93E-18	8.85E-10	2.91E+05	2.47E-17	7.19E-12
Mo-99	2.66E+11	2.25E-19	5.99E-08	7.35E+08	6.88E-20	5.06E-11
Tc-99m	2.35E+11	3.34E-21	7.85E-10	9.72E+08	8.80E-21	8.55E-12
Ru-103	3.60E+08	3.43E-17	1.23E-08	3.43E+05	3.69E-17	1.27E-11
Ru-105	2.53E+05	2.93E-19	7.41E-14	0.00E+00	2.12E-20	0.00E+00
Rh-105	2.84E+07	2.17E-17	6.16E-10	2.08E+05	2.58E-20	5.37E-15
Ag-110m	4.62E+09	1.28E-15	5.91E-06	4.12E+06	2.02E-16	8.32E-10
Sn-113	1.05E+07	1.72E-15	1.81E-08	0.00E+00	1.69E-19	0.00E+00
Sb-122	2.05E+09	7.34E-17	1.50E-07	5.77E+06	9.11E-20	5.26E-13
Sb-124	1.92E+09	1.44E-16	2.76E-07	1.78E+06	2.89E-17	5.14E-11
Sb-125	7.68E+08	6.65E-17	5.11E-08	6.78E+05	7.78E-19	5.27E-13
I-130	7.64E+08	9.38E-19	7.17E-10	4.36E+08	1.78E-19	7.76E-11
I-131	1.52E+12	3.74E-17	5.68E-05	2.37E+10	6.14E-17	1.46E-06
I-132	8.36E+10	3.55E-22	2.97E-11	4.38E+09	4.88E-20	2.14E-10
I-133	9.90E+10	3.67E-18	3.63E-07	2.49E+10	3.54E-19	8.81E-09
I-134	8.38E+08	9.38E-28	7.86E-19	4.00E+09	5.74E-19	2.30E-09
I-135	1.47E+10	1.36E-19	2.00E-09	1.08E+10	9.29E-20	1.00E-09

	Liquid AADQ	Liquid DCF	Liquid Dose	Gaseous AADQ	Gaseous DCF	Gaseous Dose
Isotope	**Bq**	**Sv / Bq**	**Sv**	**Bq**	**Sv / Bq**	**Sv**
Xe-131m	0.00E+00	0.00E+00	0.00E+00	7.75E+13	2.67E-21	2.07E-07
Xe-133	0.00E+00	0.00E+00	0.00E+00	5.42E+15	8.03E-21	4.35E-05
Xe-133m	0.00E+00	0.00E+00	0.00E+00	6.50E+13	6.76E-21	4.39E-07
Xe-135m	0.00E+00	0.00E+00	0.00E+00	5.80E+13	1.00E-19	5.80E-06
Xe-135	0.00E+00	0.00E+00	0.00E+00	8.24E+13	5.33E-20	4.39E-06
Xe-138	0.00E+00	0.00E+00	0.00E+00	7.23E+12	2.17E-19	1.57E-06
Cs-134	1.40E+12	3.17E-17	4.44E-05	1.24E+09	9.60E-16	1.19E-06
Cs-136	3.75E+11	4.08E-18	1.53E-06	4.20E+08	3.10E-19	1.30E-10
Cs-137	6.94E+11	1.56E-17	1.08E-05	6.10E+08	1.43E-15	8.72E-07
Cs-138	7.20E+07	4.87E-33	3.51E-25	1.37E+07	2.51E-20	3.44E-13
Ba-139	2.72E+05	1.90E-24	5.17E-19	0.00E+00	4.00E-21	0.00E+00
Ba-140	2.37E+09	7.82E-18	1.85E-08	2.68E+06	2.40E-18	6.43E-12
La-140	2.84E+09	3.48E-17	9.88E-08	5.33E+06	9.19E-19	4.90E-12
Ce-141	3.10E+08	1.08E-17	3.35E-09	3.01E+05	1.83E-18	5.51E-13
Ce-144	2.87E+08	8.11E-17	2.33E-08	2.56E+05	2.96E-17	7.58E-12
Pr-144	2.83E+08	1.09E-43	3.08E-35	2.62E+05	1.49E-21	3.90E-16
Nd-147	1.36E+08	2.57E-17	3.50E-09	1.60E+05	1.68E-19	2.69E-14
W-187	5.48E+08	4.42E-19	2.42E-10	1.04E+07	2.15E-20	2.24E-13
U-237	2.49E+07	1.27E-18	3.16E-11	0.00E+00	1.33E-19	0.00E+00
Np-239	1.39E+08	2.83E-19	3.93E-11	4.64E+05	7.37E-20	3.42E-14
Totals	**5.78E+14**		**1.44E-04**	**6.76E+15**		**8.24E-05**
Another	5.00E+05	2.74E-14		1.00E+06	8.90E-16	

The effluent releases associated with the above liquid AADQ's require operation of at least two CRF pumps.

If the CRF release pathway is unavailable, liquid effluent releases must be terminated.

Noble gases appearing in liquid effluent may be disregarded.

Nuclides with a zero gaseous AADQ may be released up to the figure for "Another" nuclide. The Dose Conversion Factor for "Another" nuclide must be used.

For any other nuclides detected in effluent streams, each nuclide may be released up to the figure for "Another" nuclide for liquid and gaseous releases. The Dose Conversion Factor for "Another" nuclide must be used. Any such release must be approved by a Senior Authorised Person (RP) based on consideration of the SAR-modelled release value for that specific nuclide.

APPENDIX C: RADIOACTIVE EFFLUENT SAMPLING AND ANALYSIS PROGRAME

Radioactive Liquid Sampling and Analysis Programme				
Liquid Waste Release Type	**Sampling Frequency**	**Minimum Analysis Frequency**	**Type of Activity Analysis**	**Lower Limit of Detection (LLD) Bq/m^3 (a)**
Liquid Waste Tanks (b)	Each Batch	Each Batch	Principal Gamma Emitters (e)	1.85E4(f)
			I-131	1.85E4
		Monthly	H-3	3.7E5
		Composite (c)	Gross Alpha	3.7E3
		Once every 3 months (Quarterly)	Sr-89	1.85E3
		Composite (c)	Sr-90	
Continuous Release (d) (SEK Bypass)	Daily	Weekly	Principal Gamma Emitters (e)	1.85E4
		Composite	I-131	1.85E4
		Monthly	H-3	3.7E5
		Composite	Gross Alpha	3.7E3
		Once every 3 months (Quarterly)	Sr-89	1.85E3
		Composite	Sr-90	
Continuous Release (d) (SEC Downstream of the RRI heat exchangers)	Daily	Weekly	Principal Gamma Emitters (e)	1.85E4
		Composite	I-131	1.85E4
		Monthly	H-3	3.7E5
		Composite	Gross Alpha	3.7E3
		Once every 3 months (Quarterly)	Sr-89	1.85E3
		Composite	Sr-90	

Table Notation

(a) The LLD is defined for the purpose of these controls as the smallest concentration of radioactive material in a sample that will yield a net count above system background, that will be detected with 95% probability with only a 5% probability of falsely concluding that a blank observation represents a “real” signal. It should be recognised that the LLD is defined as a limit representing the intrinsic capability of a measurement system and not as a limit for a particular measurement. LLD determinations for gamma spectrometry are based on background counts for the same duration as those applied to real samples, and no decay correction is to be applied. Instrument compliance to the required LLD’s shall be reconfirmed at least once per quarter. When unusual circumstances result in LLD’s higher that required, the reasons as well as the appropriate corrective actions, shall be documented in the Quarterly Radioactive Effluent Report.

The minimum detectable concentrations (MDC's) which are calculated for non-detected nuclides during actual analyses of real samples are not to be confused with the LLD requirements which apply to pure background counts. Nuclides which are below their MDC for an analysis should be reported as being present at the MDC level.

(b) A batch release is the discharge of liquid wastes of a discrete volume.

(c) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite to be representative of the effluent release.

(d) A continuous release is the discharge of liquid wastes of a non-discrete volume; e.g. from a volume of a system that has an input flow during the continuous release.

(e) The principal gamma emitters for which the LLD specification will apply are exclusively the following nuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Ag-110m, Cs-134, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other nuclides which are measurable and identifiable shall also be reported.

(f) The LLD for Ce-144 shall be 3.7E4 Bq/m^3.

Radioactive Gaseous Sampling and Analysis Programme				
Gaseous Waste Release Type	**Minimum Sampling Frequency**	**Minimum Analysis Frequency**	**Type of Activity Analysis**	Lower Limit of Detection (LLD) Bq/m^3 (a)
Waste Gas Storage Tanks (TEG)	Each tank	Each Tank	Particulate Principal Gamma Emitters (b)	1.85E3
			Gaseous Principal Gamma Emitters (b)	1.85E6
			I-131	1.85E3
			H-3	1.85E4
Containment Atmospheric Control and Purge (ETY/EBA)	Each purge	Each purge	Particulate Principal Gamma Emitters (b)	3.7E0
			Gaseous Principal Gamma Emitters (b)	3.7E4
			I-131	3.7E0
			H-3	1.85E4
Continuous release through the Nuclear Auxiliary Building ventilation (DVN)	Weekly	Weekly (Gas Grab Sample)	Gaseous Principal Gamma Emitters (b)	1.85E4
	Continuous	Weekly (Particulate Sample) (c)	Particulate Principal Gamma Emitters (b)	1.85E-1
		Weekly (Charcoal Sample)	I-131, I-133	1.85E-2
		Monthly Composite (Particulate Sample)	Gross Alpha	3.7E-3
		Once every 3 months (Quarterly) Composite (Bubbler Sample)	H-3	3.7E2
		Every 3 Months (Quarterly) Composite (Particulate Sample)	Sr-89 Sr-90	3.7E-3
Downstream TEG Delay Line	Weekly When in service	Weekly When in service	Gaseous Principal Gamma Emitters (b)	1.85E6
Condenser Air Ejectors (CVI)	Weekly	Weekly	Gaseous Principal Gamma Emitters (b)	1.85E4

(a) The LLD is defined for the purpose of these controls as the smallest concentration of radioactive material in a sample that will yield a net count above system background that will be detected with 95% probability with only a 5% probability of falsely concluding that a blank observation represents a “real” signal.
It should be recognised that the LLD is defined as a limit representing the intrinsic capability of a measurement system and not as a limit for a particular measurement. LLD determinations for gamma spectrometry are based on background counts for the same duration as those applied to real samples, and no decay correction is to be applied. Instrument compliance to the required LLD’s shall be reconfirmed at least once per quarter. When unusual circumstances result in LLD’s higher that required, the reasons as well as the appropriate corrective actions, shall be documented in the Quarterly Radioactive Effluent Report.
The minimum detectable concentrations (MDC’s) which are calculated for non-detected nuclides during actual analyses of real samples are not to be confused with the LLD requirements which apply to pure background counts. Nuclides which are below their MDC for an analysis should be reported as being present at the MDC level.

(b) The principal gamma emitters for which the LLD specification will apply are exclusively the following nuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Ag-110m, Cs-134, Ce-141, and Ce-144. In particulate analysis and Ar-41, Kr-85m, Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 in gas analysis. This list does not mean that only these nuclides are to be detected and reported. Other nuclides which are measurable and identifiable shall also be reported.

(c) Analysis shall also be performed at least one per twenty-four hours following and alarm or trip set point being exceeded.