Hinkley Point B Power Station

Technical and Safety Support Report

Justification for EPR CB3735DT variation

Originated by:	[redacted] Environmental Safety Group Head	Date:	March 2025
Reviewed by:	[redacted] Environmental Safety Engineer	Date:	April 2025
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Report issue

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March 2025	[redacted]	000	First issue

Glossary

Word, Phrase or Acronym	Description
AETP	Active Effluent Treatment Plant
AGR	Advanced Gas Cooled Reactor
AL	Annual Limit
Ar-41	Argon 41
BAT	Bets Available Techniques
C-14	Carbon 14
CEARAS	Compilation of Environment Agency Requirements, Approvals and Specifications
CO_2	Carbon Dioxide
EA	Environment Agency
EoG	End of Generation
EPR	Environmental Permitting Regulations
ESPEC	Environmental Specification
GBP	Gas Bypass Plant
H-3	Tritium
HPB	Hinkley Point B
I-131	Iodine 131
MDA	Minimum Detectable Activity
NRS	Nuclear Restoration Services
QNL	Quarterly Notification Level
S-35	Sulphur 35
t1/2	Half Life
TSPEC	Technical Specification
WAL	Weekly Advisory Level

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1 Overview

Hinkley Point B Power station (HPB) began generating electricity from two Advanced Gas Cooled Reactors (AGR) in 1976. Both Reactor 3 and Reactor 4 reached the End of Generation (EoG) in 2022 with the reactors being shutdown and isolated. The Station then entered a defueling phase with Reactor 4 completing defueling in September 2024 and Reactor 3 on target for completion by October 2025.

Once a reactor is defueled, the carbon dioxide (CO_2) coolant is no longer required and the reactor can be purged to an air atmosphere at equilibrium with its surroundings. The reactor remains in this condition until the final site clearance is undertaken. This activity was completed for Reactor 4 in November 2024 and is expected to be completed on Reactor 3 in November 2025.

With both reactors defueled, the Station will enter a formal verification period to confirm no radioactive fuel remains on site. Preparations will then begin for the transfer to Nuclear Restoration Services (NRS) in October 2026 and commencement of the decommissioning phase.

The station holds an Environmental Permitting Regulations permit (EPR) [Ref 1] to undertake radioactive substances activities and in preparation for the phase changes at the station, workshops have been held with the Environment Agency (EA) and NRS to discuss appropriate amendments to the permit and Compilation of Environment Agency Requirements, Approvals and Specifications (CEARAS) to demonstrate the monitoring undertaken aligns with Best Available Techniques (BAT) principles.

1.1 Background Information on Source of Radioactivity

Tritium (H-3):

H-3 has a $t_{1/2}$ of 12.32 years, emitting very low energy beta radiation. It arises from the ternary fission process inside the fuel followed by diffusion through the fuel pin cladding into the coolant gas where is reacts with oxygen to form water. The mechanism and reaction rate is mainly dependant on reactor power.

The water content in the coolant requires minimising to prevent steel corrosion within the reactor vessel and this is achieved through gas dryers containing silica gel desiccant in the gas bypass plant (GBP). Any water adsorbed is removed from the desiccant during a drying cycle and is condensed into aqueous form for discharge via the Active Effluent Treatment Plant (AETP). Liquid discharges are less radiologically significant than gaseous discharges and so external exposure to H-3 and consequential radiation doses to members of the public are of low significance due to the very weak radiation emitted.

Carbon 14 (C-14):

C-14 has a $t_{1/2}$ of 5700 years, emitting low energy beta radiation. It occurs naturally in the environment, being produced by the action of cosmic rays on nitrogen in the upper atmosphere. In an AGR reactor there are two mechanisms for producing additional C-14:

- Neutron activation of carbon, nitrogen and oxygen in the CO2 coolant;
- Neutron activation of carbon and nitrogen in the graphite core which is then released into the CO_2 coolant as the graphite slowly corrodes.

Over years of operation, the proportion of C-14 in the graphite core gradually increases because of the ongoing neutron activation. As a result, an increasing proportion of C-14 is discharged from radiolytic corrosion of the graphite core and therefore C-14 discharges increase over time irrespective of coolant chemistry control.

The primary route of C-14 discharge is through the coolant as either reactor blowdowns or general leakage. Some of this CO_2 may be absorbed by plants with the C-14 transferring to humans via the consumption of crops or indirectly by transfer from these crops into meat or diary products which is the most significant exposure pathway for this radionuclide.

Sulphur 35 (S-35):

S-35 has a half-life ($t_{1/2}$) of 87.51 days, emitting low energy beta radiation. It is produced by activation of impurities in the graphite core followed by release into the coolant by radiolytic corrosion of the core. Some S-35 remains within the gas whilst some deposits on surfaces inside the reactor vessel and GBP.

During operation at power, methane was injected into the coolant circuit to reduce the core corrosion rate and control S-35 evolution, however levels of S-35 were also affected by impurities in materials entering the pressure vessel such as feed gases and circulator lubricating oil. Through processing of the gas in the GBP, S-35 had the potential for adsorption in the recombination unit catalyst and dryer tower desiccant. Some S-35 compounds dissolved in the water vapour of the coolant were condensed in the GBP and discharged in aqueous form via the AETP, the gaseous S-35 was discharged via the GBP through reactor blowdowns and leakage.

Argon 41 (Ar-41):

Ar-41 has a $t_{1/2}$ of 109.61 minutes, emitting both beta and gamma radiation. It is produced in the reactor by neutron activation of naturally occurring, non-radioactive Ar-40 which is present in the CO_2 coolant gas as a contaminant both from residual air and other feed gases. Ar-41 is a noble gas which means it does not react chemically with other material and there is no mechanism by which it can become concentrated in the environment, people or animals. Consequently, it does not result in any exposure as a result of consumption of foodstuffs. There is a small relative contribution from inhalation but most exposure from Ar-41 is due to external irradiation. During the operational period, Ar-40 impurities in the coolant were controlled to minimise discharges.

Iodine 131 (I-131):

I-131 has a $t_{1/2}$ of 8 days, emitting both beta and gamma radiation. It is a fission product generated inside the fuel where it remains so that it is not significant in discharges during normal operation. If I-131 escaped through failure of the fuel cladding it would be detected by the nuclear safety and environmental safety instrumentation and steps taken to minimise discharges.

The reactor design and operation minimise the likelihood of damage to fuel or fuel cladding however, should a fuel failure occur, fuel pins could release I-131. Additionally, I-131 can be produced from any traces of uranium contamination on the outside of the fuel cladding (tramp uranium). The station has iodine adsorption beds on the reactor coolant blow down discharge route which trap greater than 99.5% iodine.

The main pathway leading to possible radiation dose to people is by the deposition of I-131 onto grass which is consumed by cows and then transferred to humans via the consumption of milk. I-131 discharges are therefore tightly controlled by Technical Specifications (TSPEC) and Environmental Specifications (ESPEC).

1.2 Historical Gaseous Discharge Data

Gaseous discharge data are presented below showing the reduction in discharges against the permitted levels and limits. Tabulated QNL and AL rolling totals are also provided to show further context on the very low percentage totals the Station is currently operating to.

1.2.1 Tritium

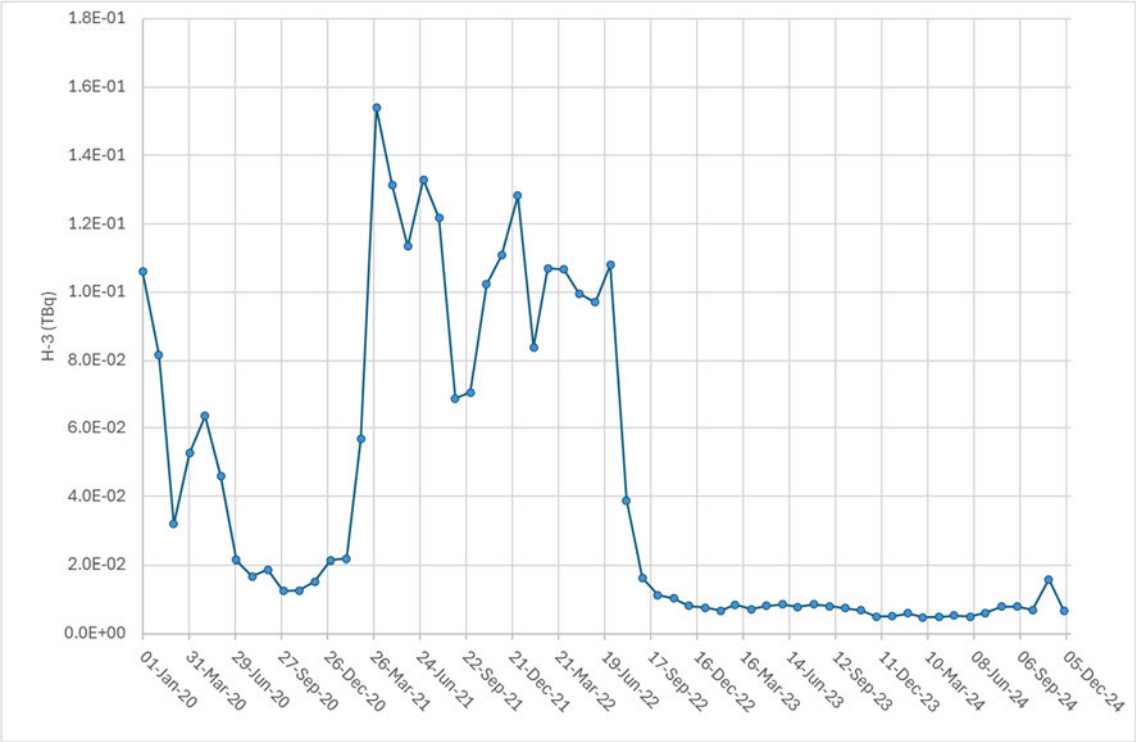

Figure 1: Monthly gaseous H-3 discharges from January 2020 to December 2024.

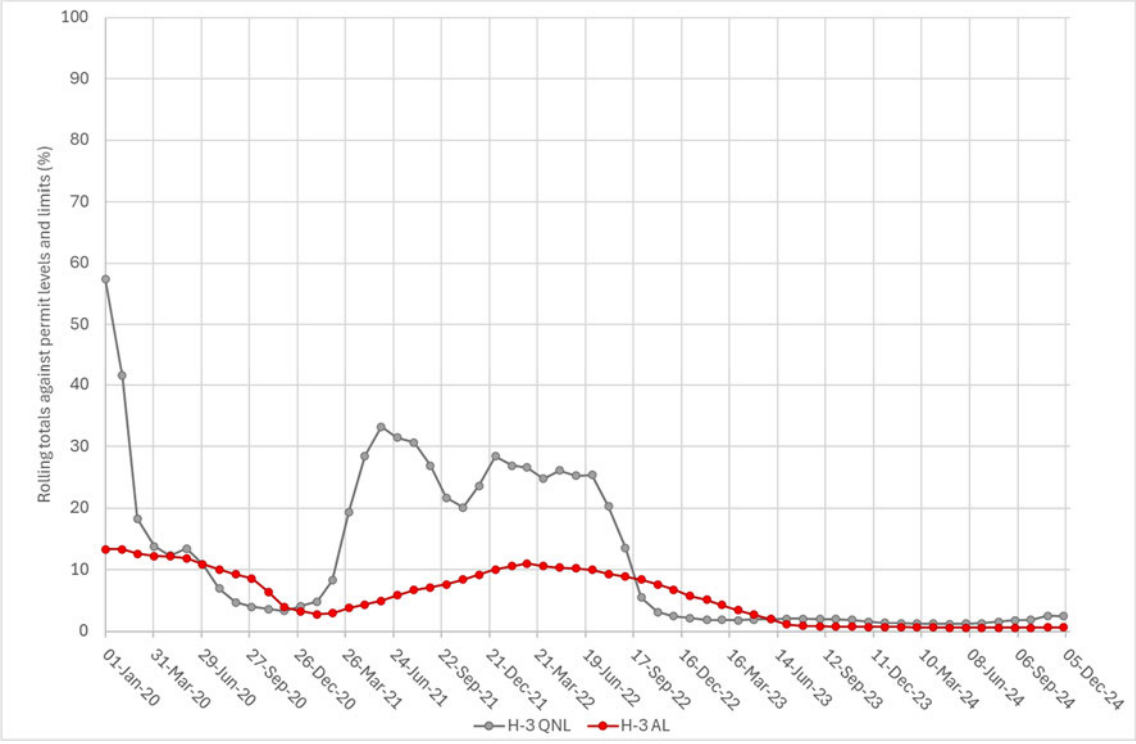

Figure 2: Rolling gaseous H-3 quarterly and annual totals against permitted QNL and AL.

1.2.2 Sulphur-35

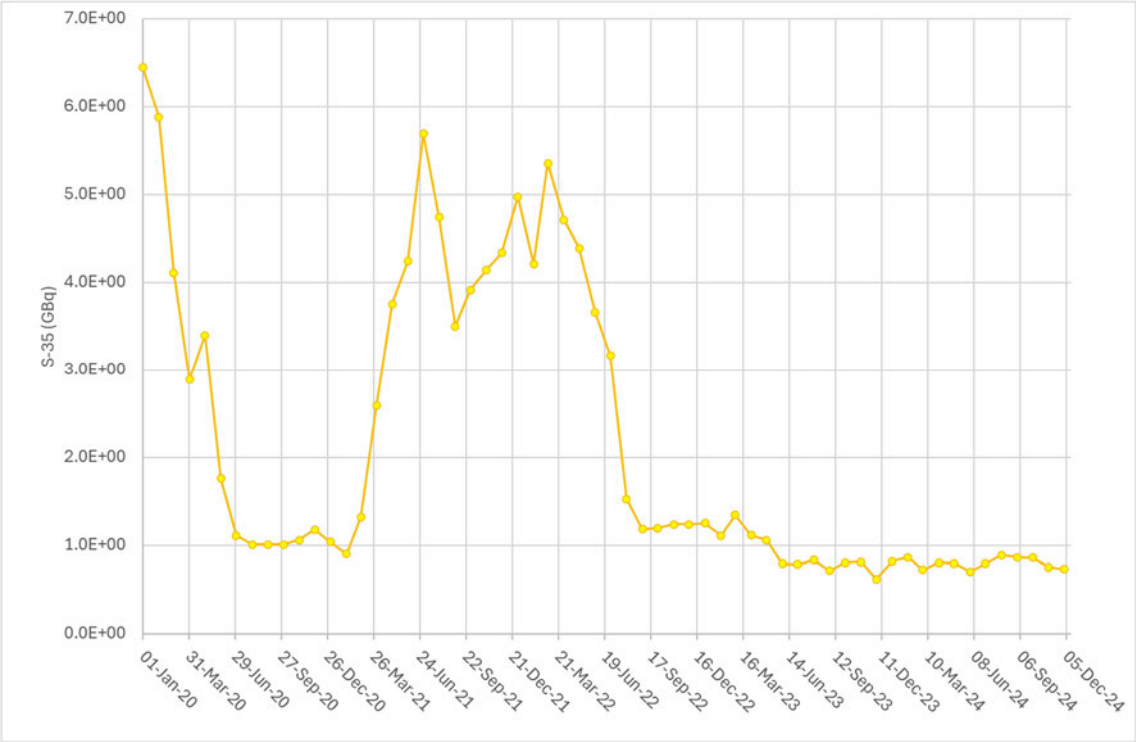

Figure 3: Monthly gaseous S-35 discharges from January 2020 to December 2024.

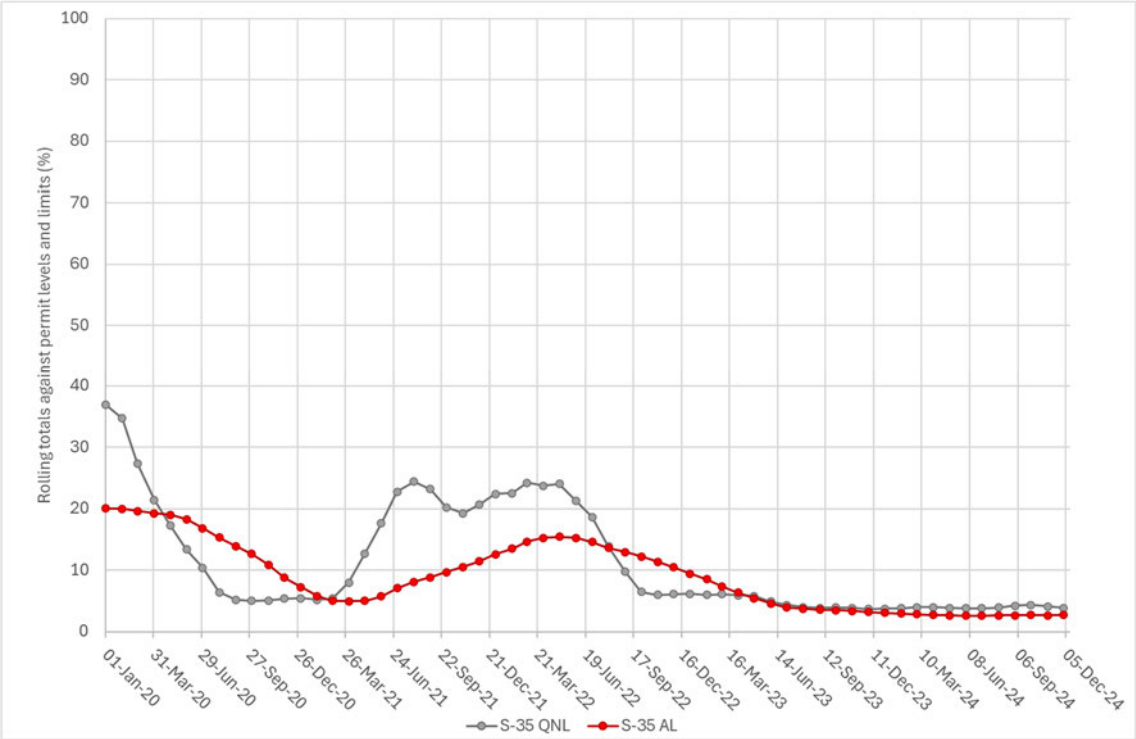

Figure 4: Rolling gaseous S-35 quarterly and annual totals against permitted QNL and AL.

1.2.3 Carbon-14

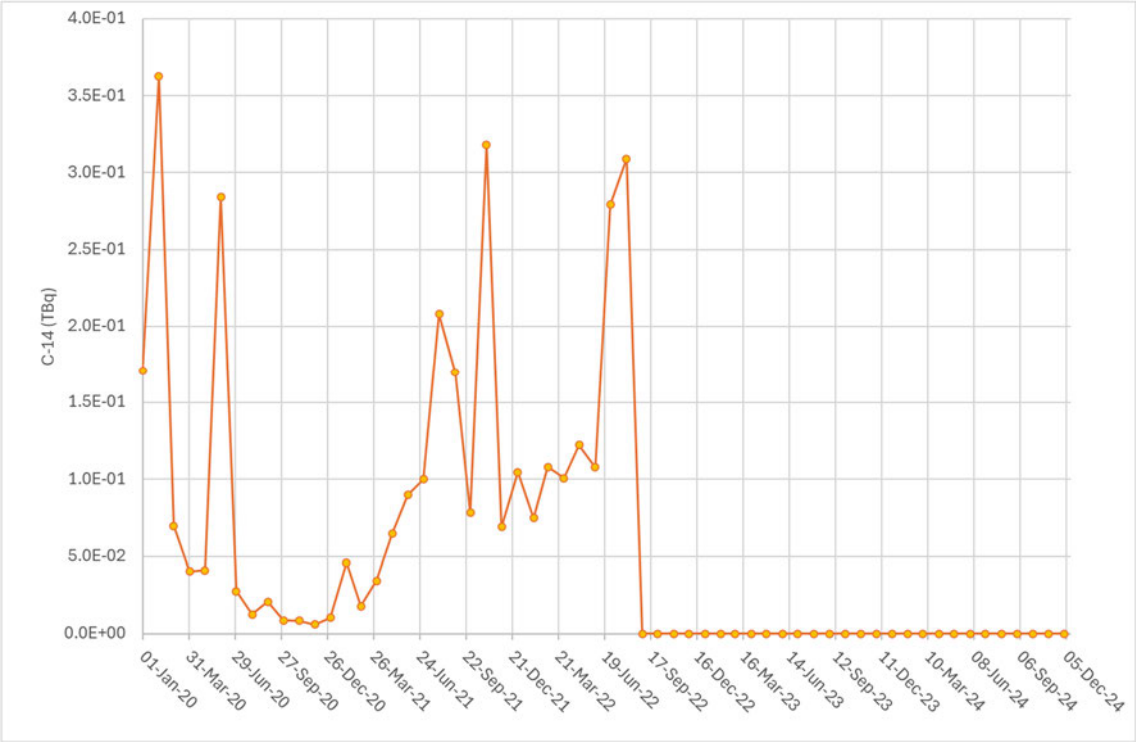

Figure 5: Monthly gaseous C-14 discharges from January 2020 to December 2024.

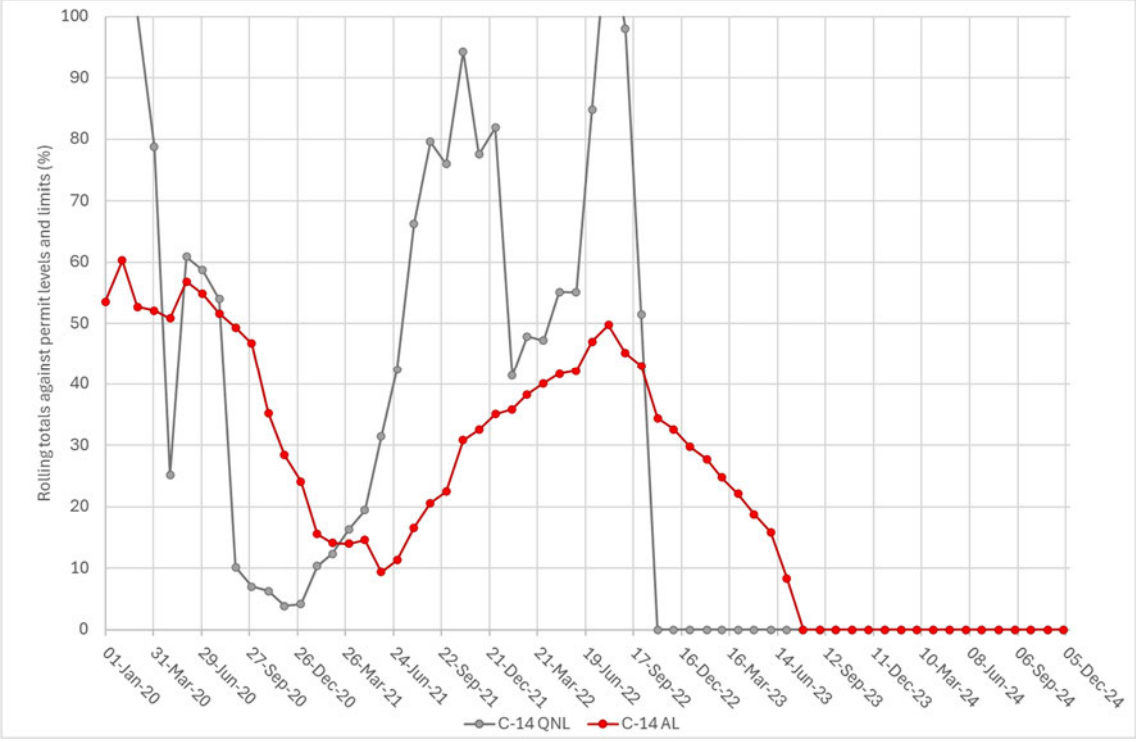

Figure 6: Rolling gaseous C-14 quarterly and annual totals against permitted QNL and AL.

1.2.4 Cobalt-60

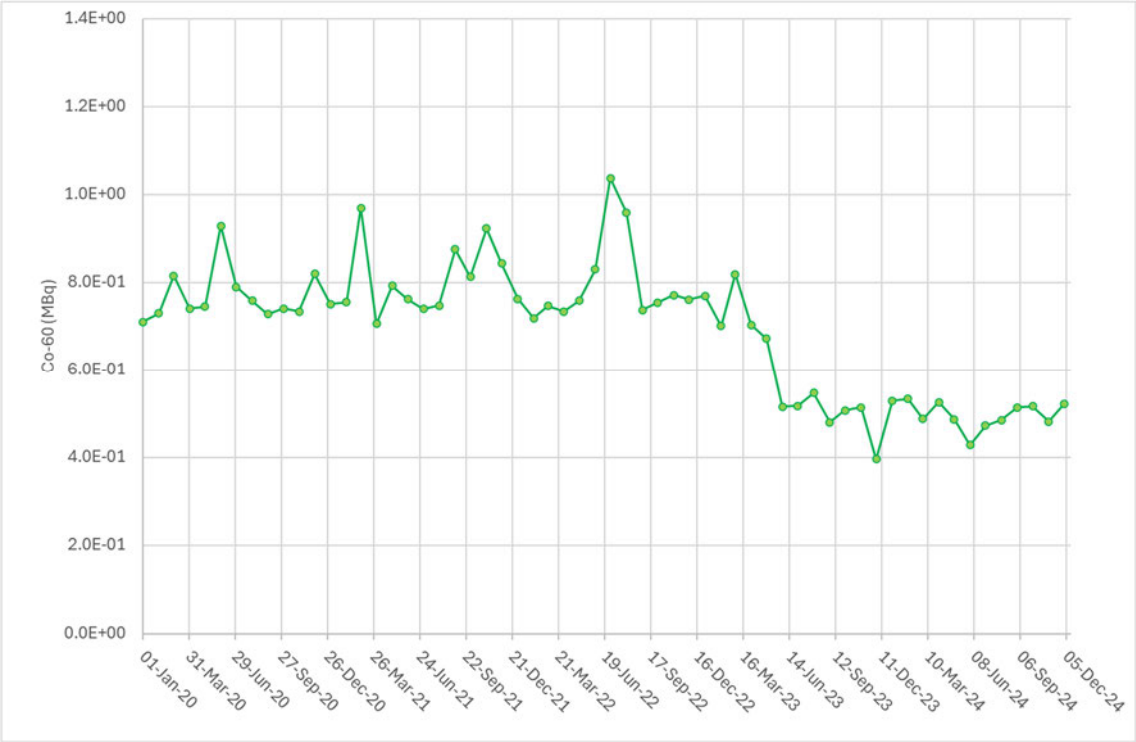

Figure 7: Monthly gaseous Co-60 discharges from January 2020 to December 2024.

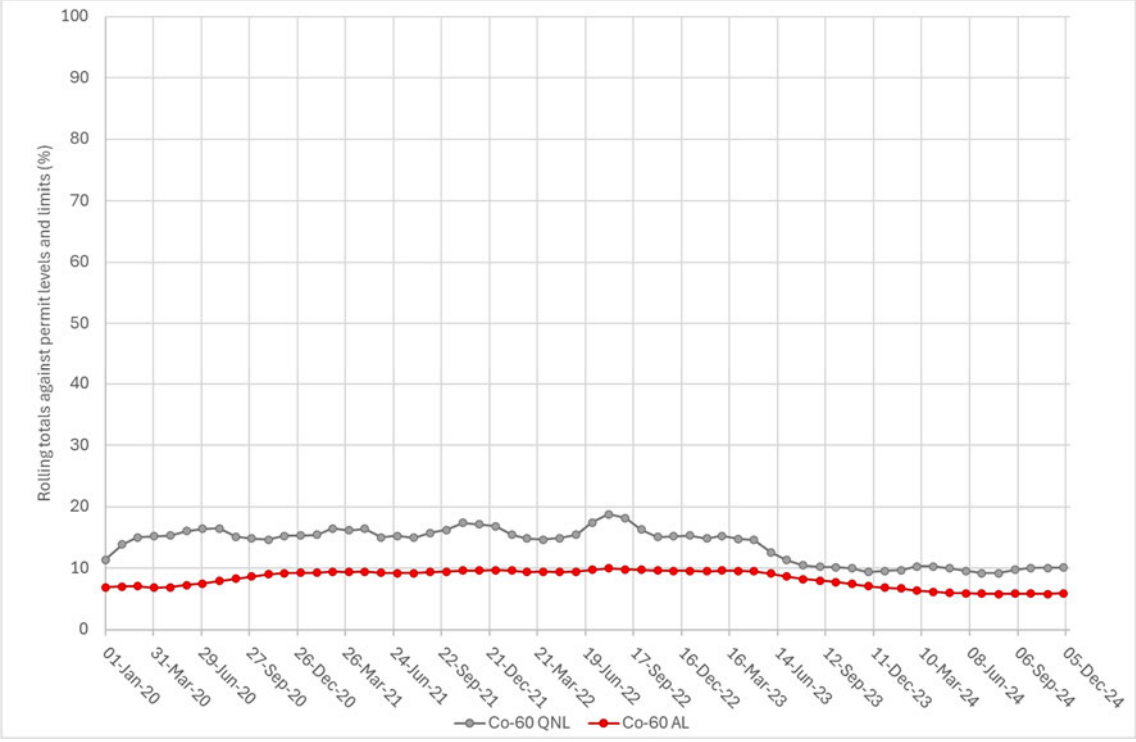

Figure 8: Rolling gaseous Co-60 quarterly and annual totals against permitted QNL and AL.

1.2.5 Iodine-131

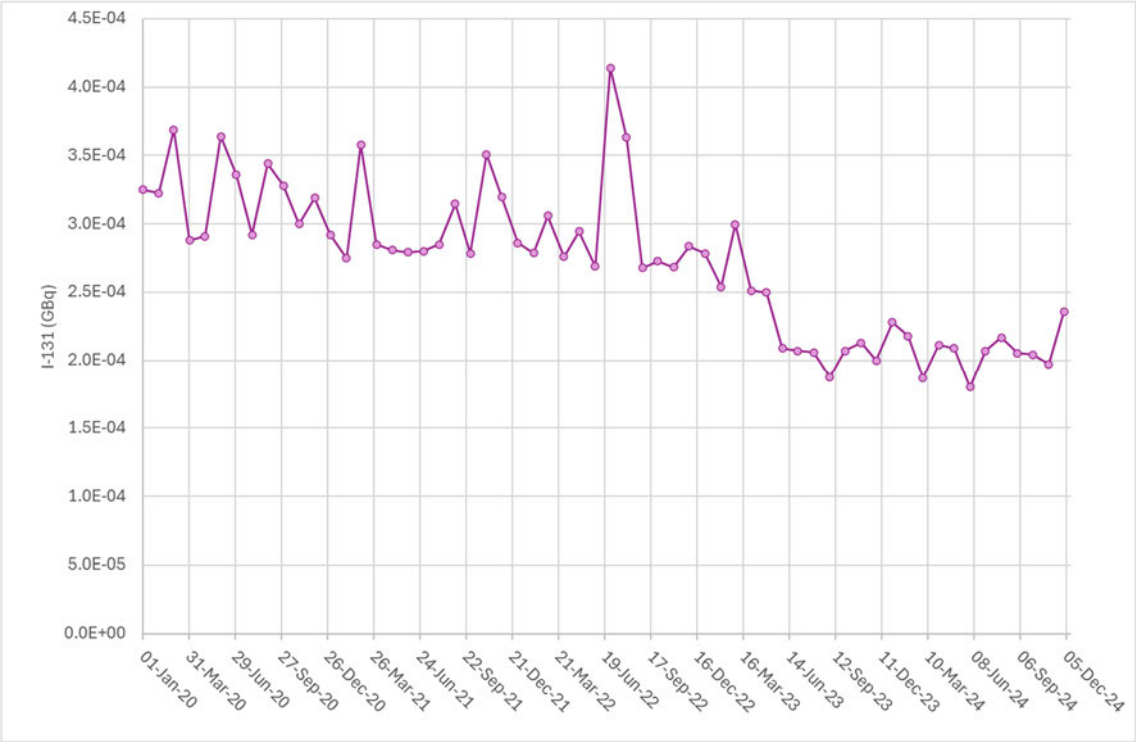

Figure 9: Monthly gaseous I-131 discharges from January 2020 to December 2024.

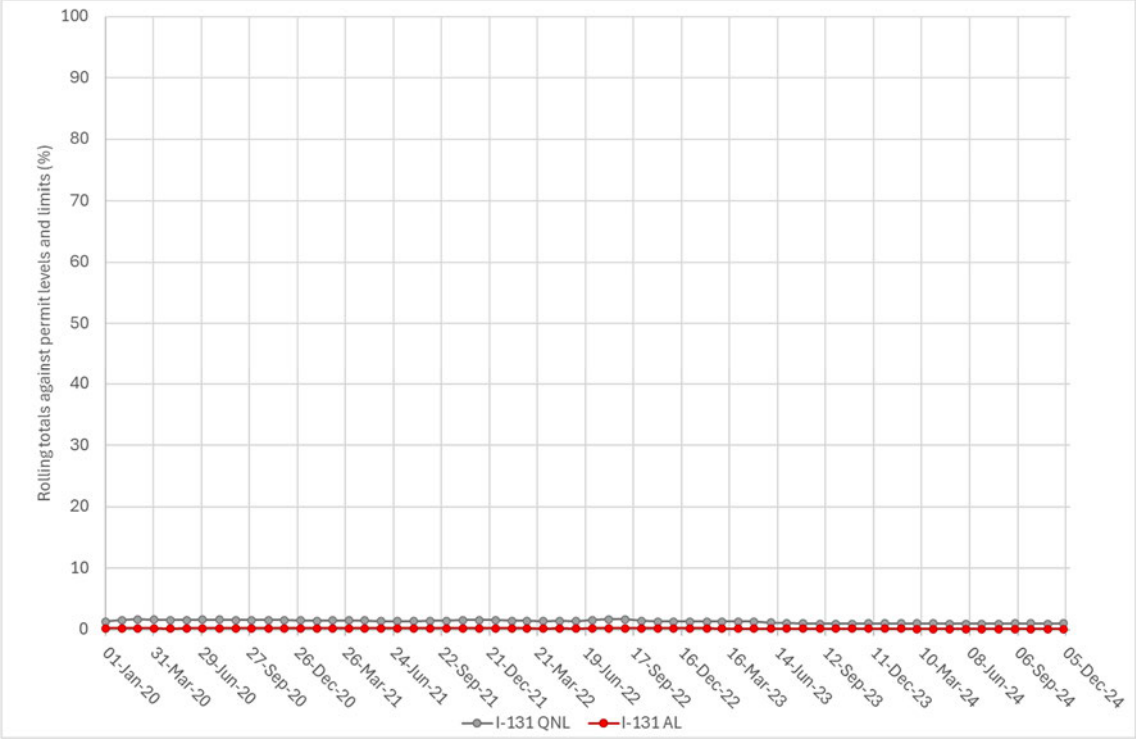

Figure 10: Rolling gaseous I-131 quarterly and annual totals against permitted QNL and AL.

1.2.6 Argon-41

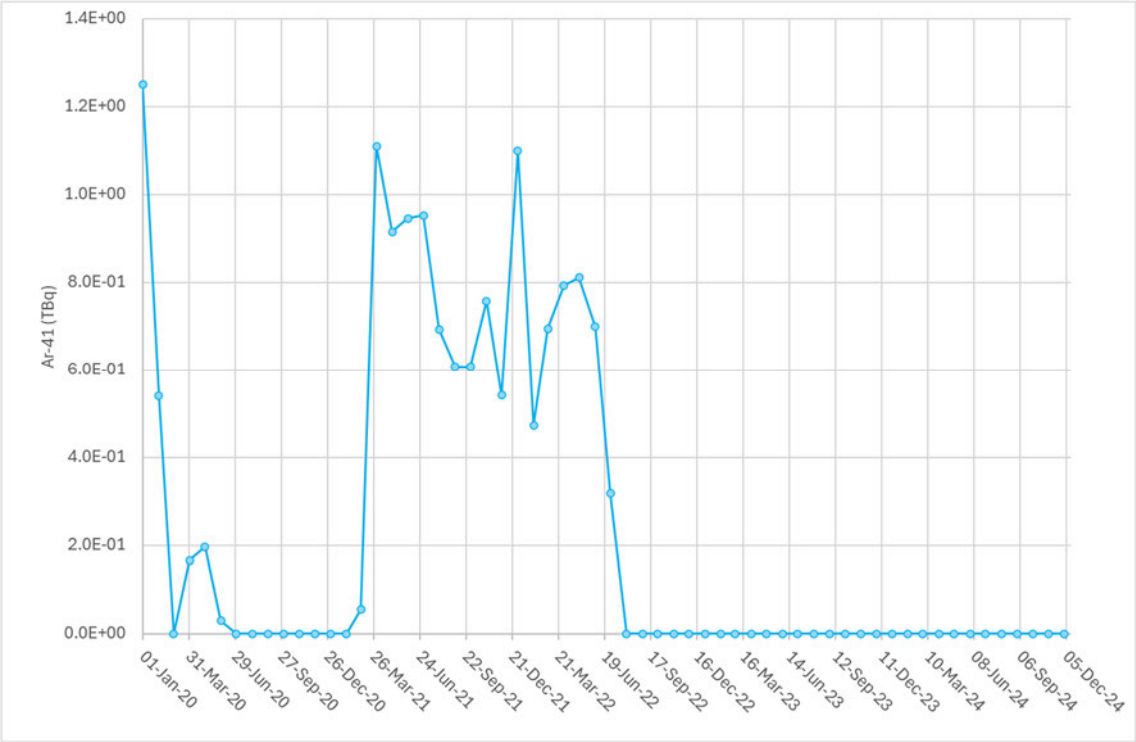

Figure 11: Monthly gaseous Ar-41 discharges from January 2020 to December 2024.

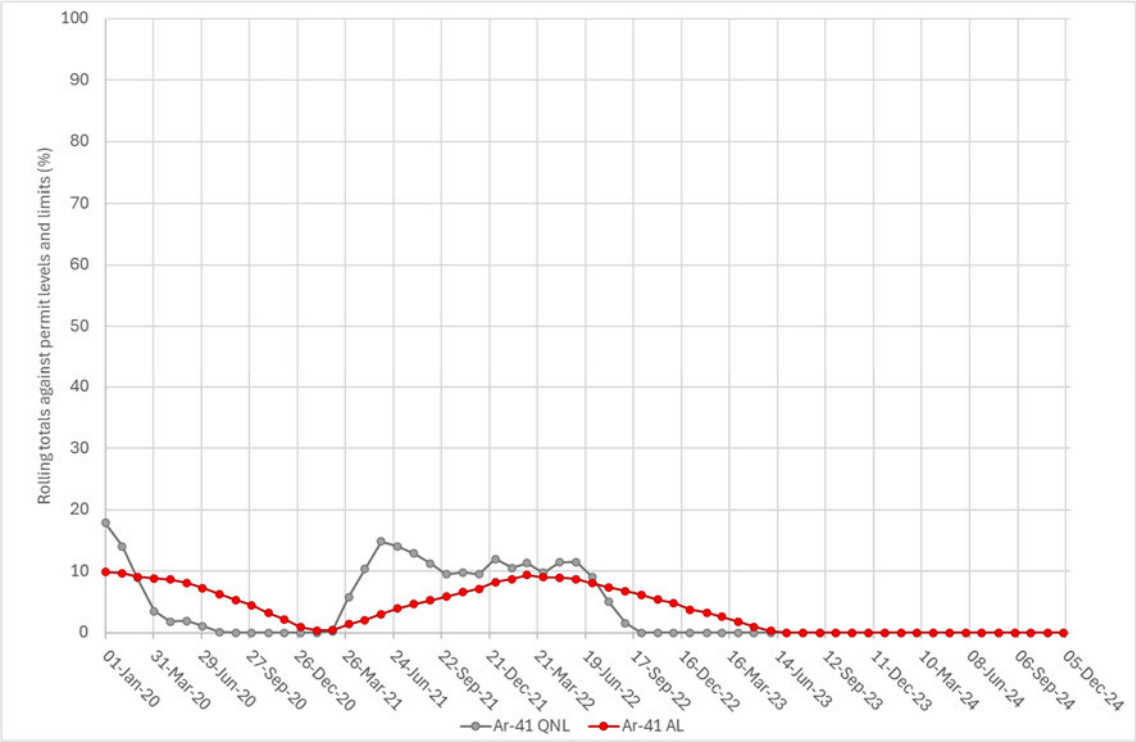

Figure 12: Rolling gaseous Ar-41 quarterly and annual totals against permitted QNL and AL.

1.3 Historical Aqueous Discharge Data

Aqueous discharge data are presented below showing the reduction in discharges against the permitted levels and limits. Tabulated QNL and AL rolling totals are also provided to show further context on the very low percentage totals the Station is currently operating to.

1.3.1 Tritium

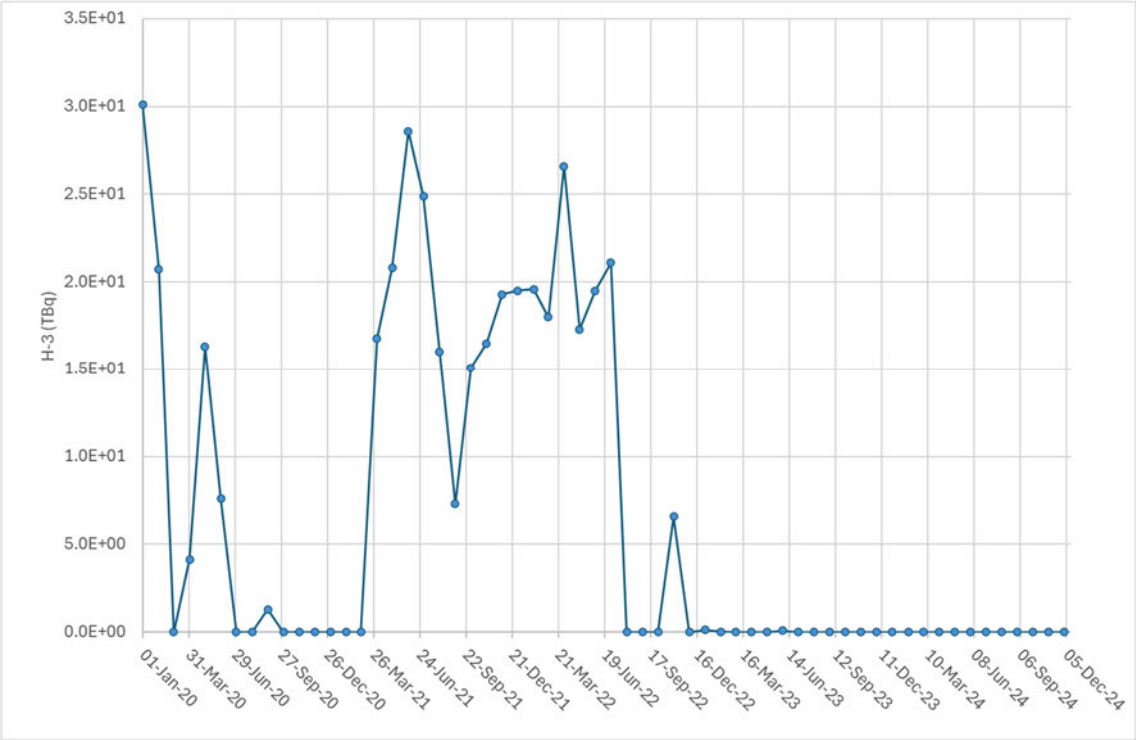

Figure 13: Monthly aqueous H-3 discharges from January 2020 to December 2024.

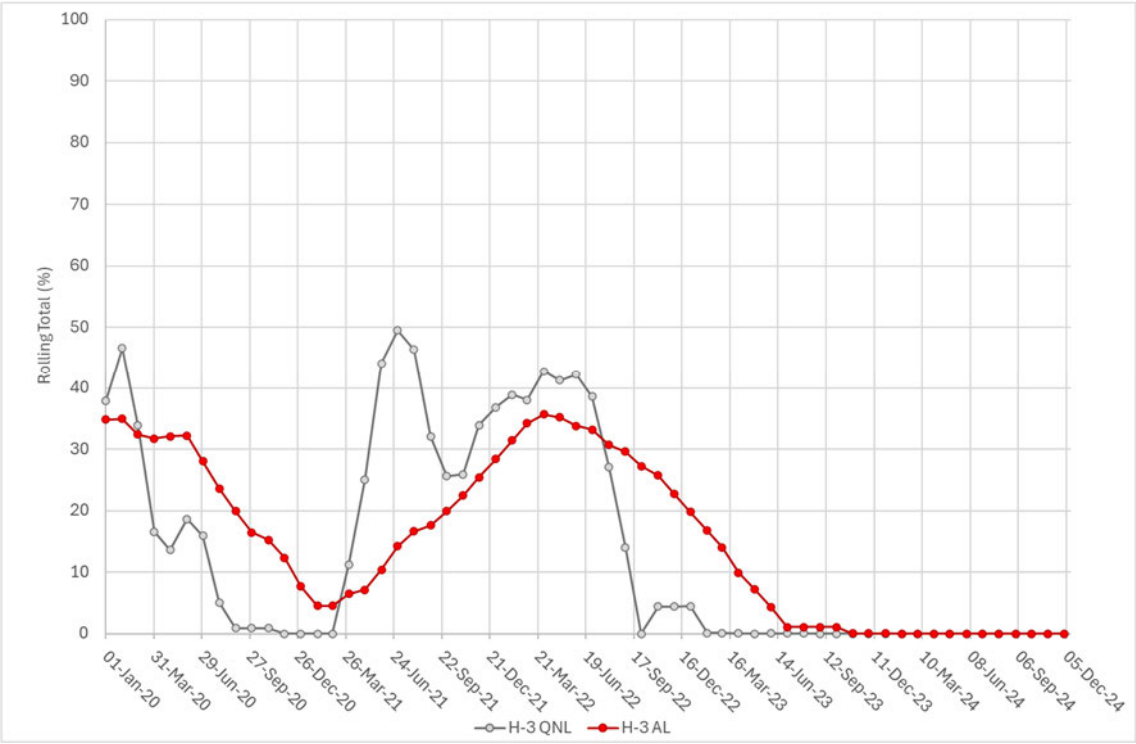

Figure 14: Rolling aqueous H-3 quarterly and annual totals against permitted QNL and AL.

1.3.2 Sulphur-35

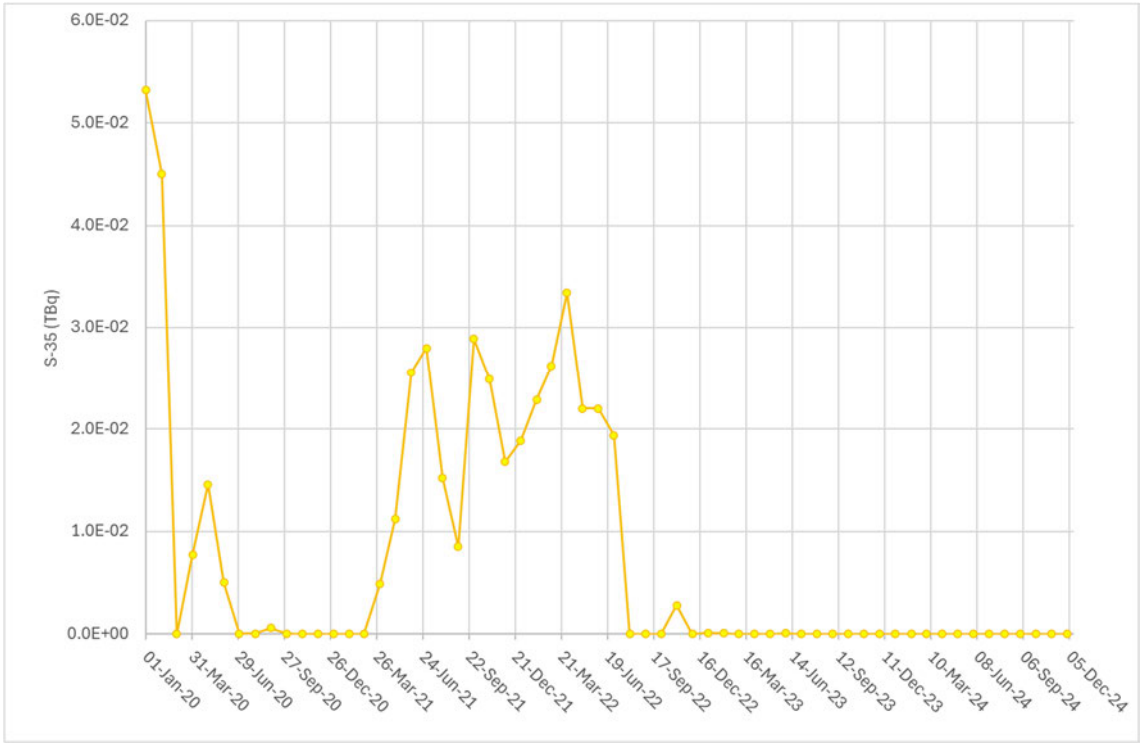

Figure 15: Monthly aqueous S-35 discharges from January 2020 to December 2024.

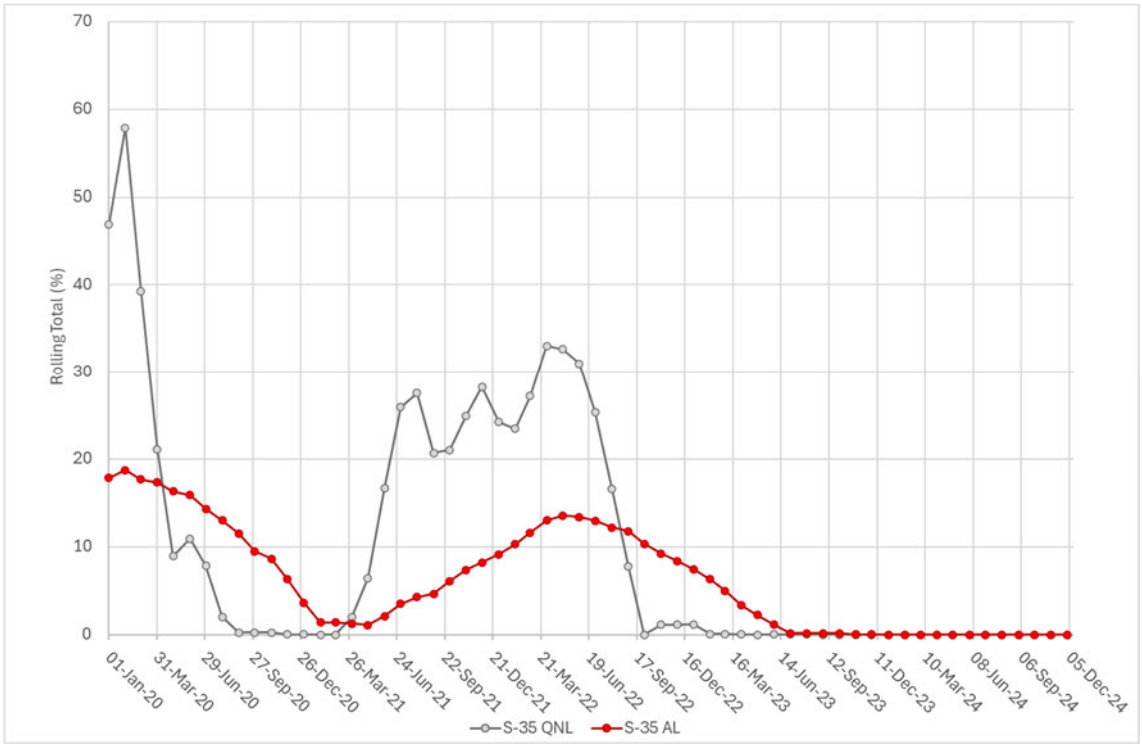

Figure 16: Rolling aqueous S-35 quarterly and annual totals against permitted QNL and AL.

1.3.3 Others

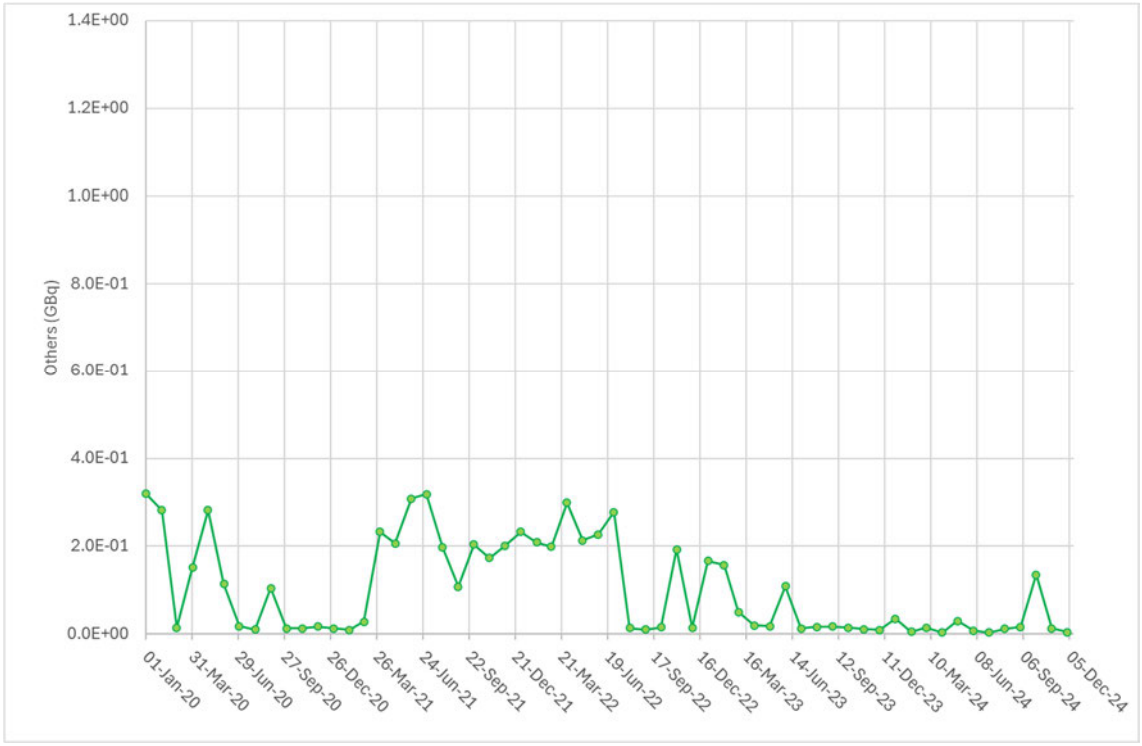

Figure 17: Monthly aqueous Others discharges from January 2020 to December 2024.

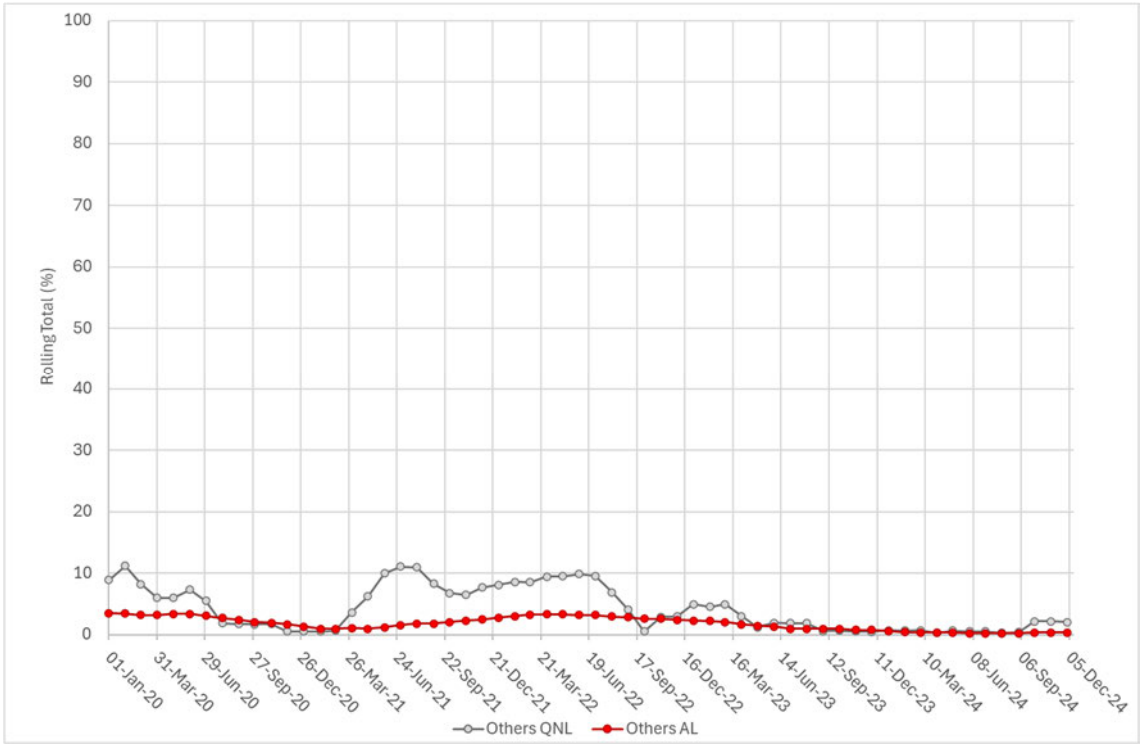

Figure 18: Rolling aqueous Others quarterly and annual totals against permitted QNL and AL.

1.3.4 Cobalt-60

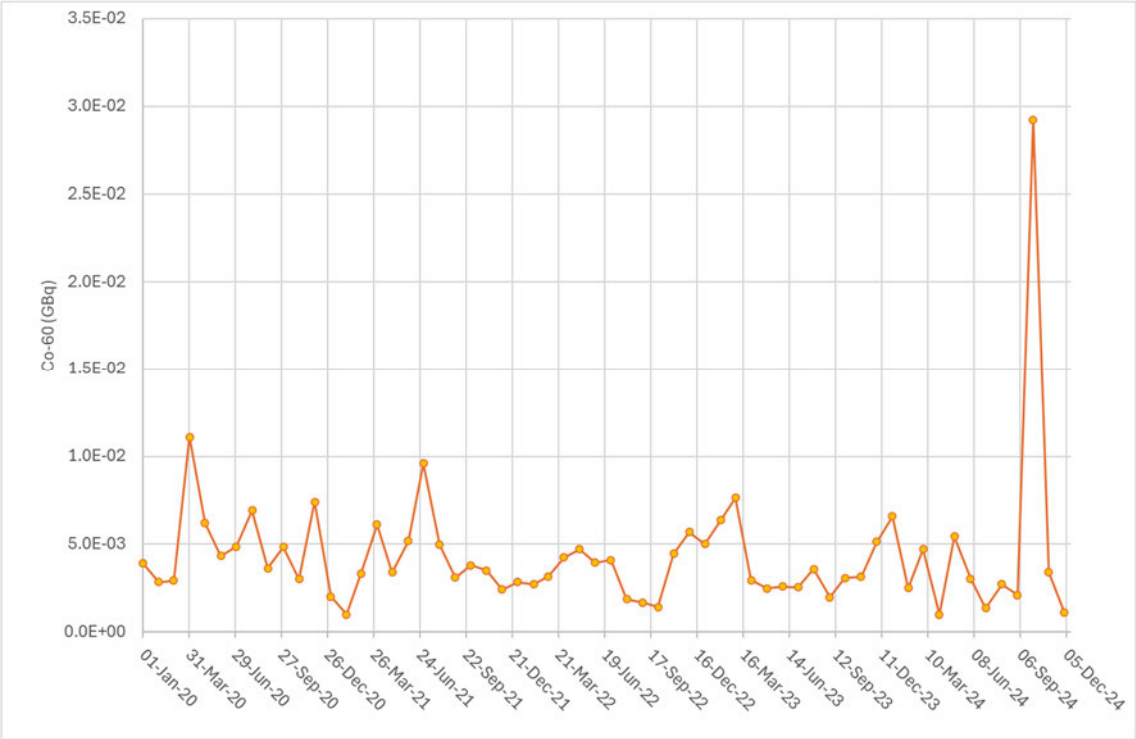

Figure 19: Monthly aqueous Co-60 discharges from January 2020 to December 2024.

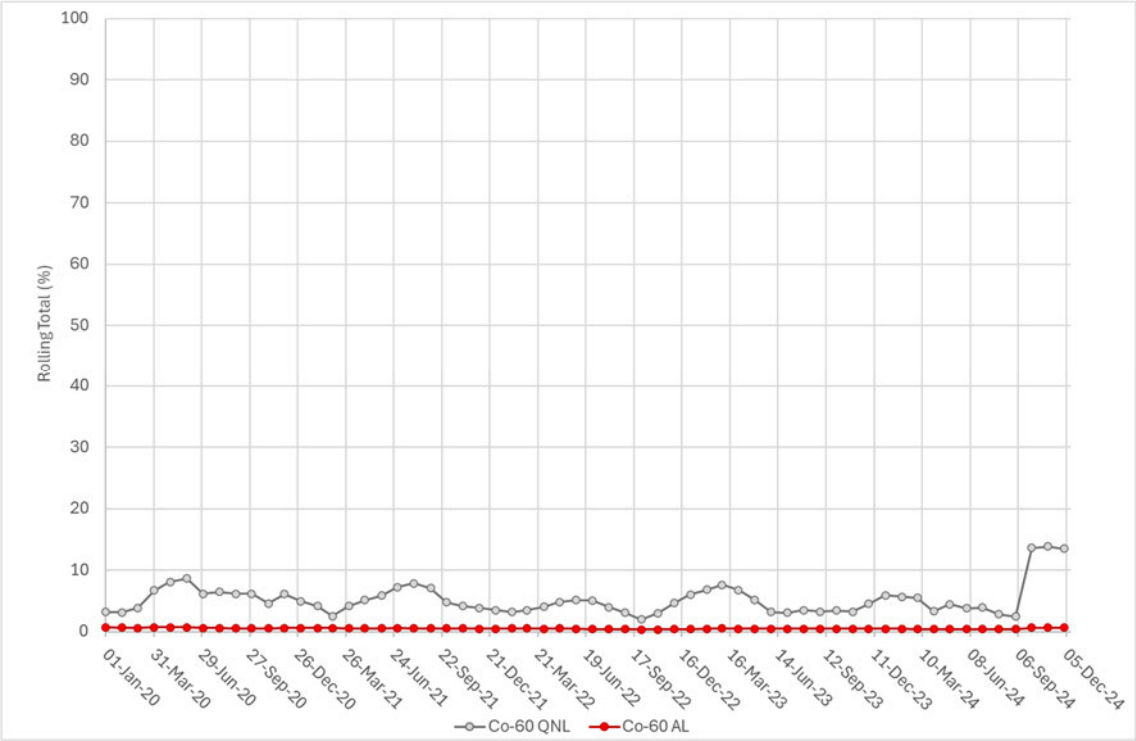

Figure 20: Rolling aqueous Co-60 quarterly and annual totals against permitted QNL and AL.

1.3.5 Caesium-137

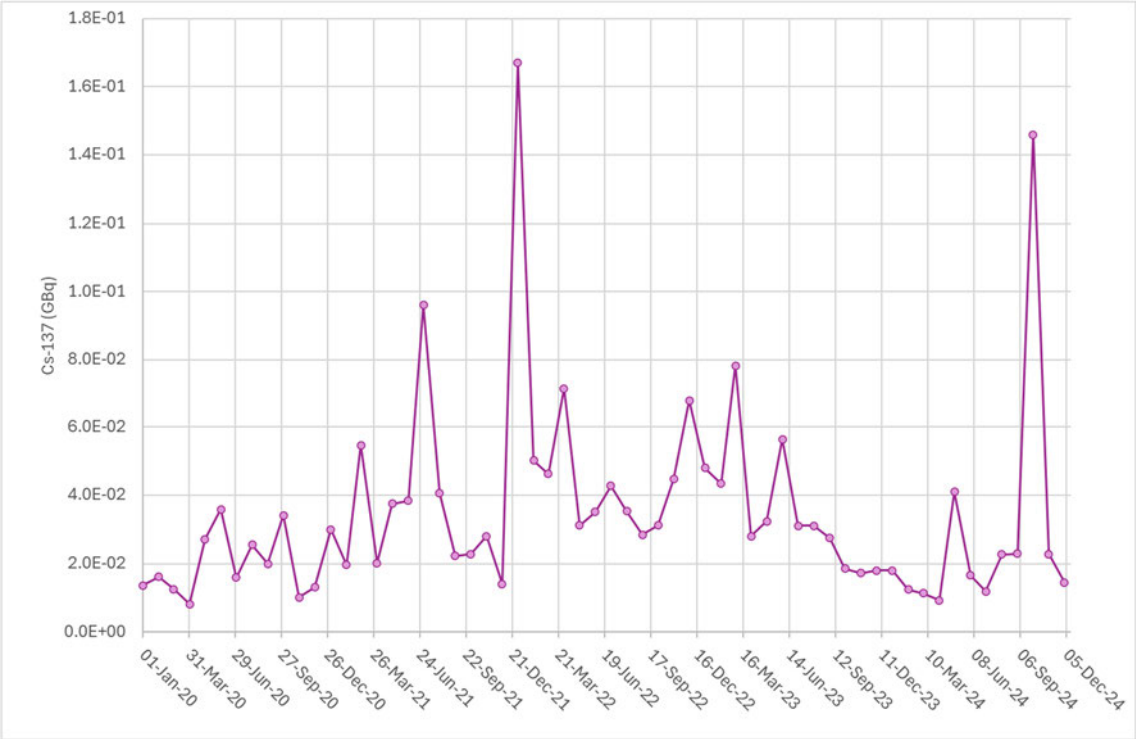

Figure 21: Monthly aqueous Cs-137 discharges from January 2020 to December 2024.

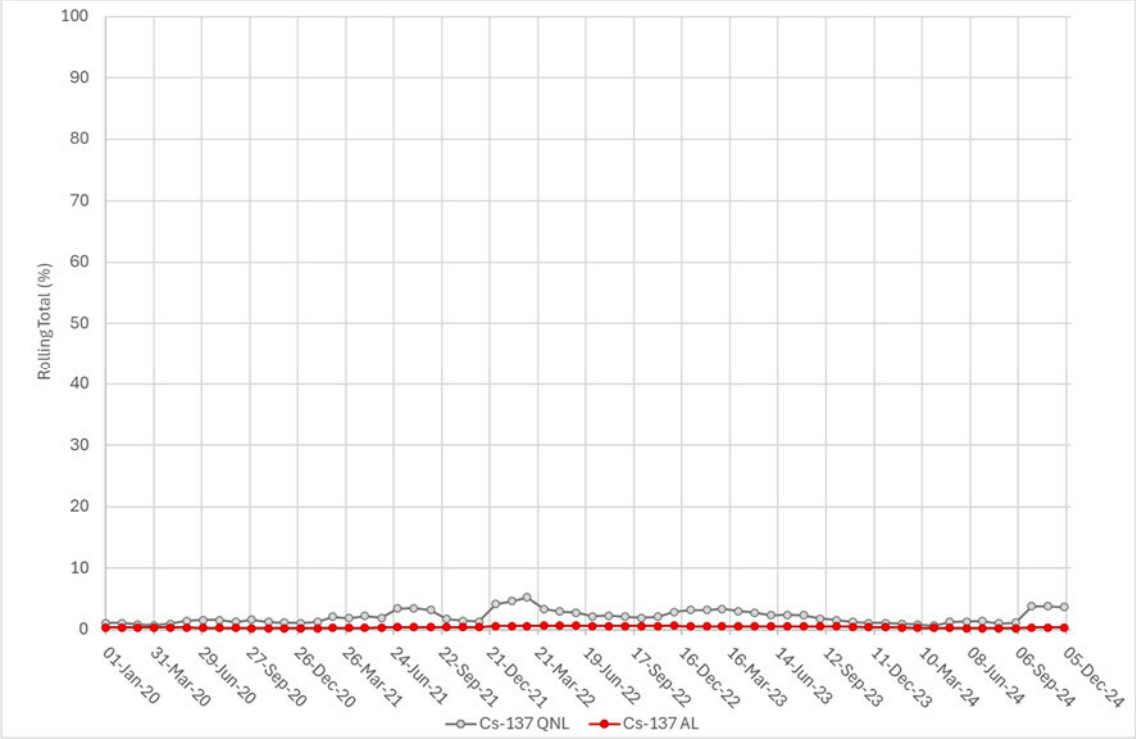

Figure 22: Rolling aqueous Cs-137 quarterly and annual totals against permitted QNL and AL.

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2 Proposed Changes

2.1 EPR/CB3735DT Permitted Limits and Levels

The changes to the permit discussed at workshops with the EA and NRS are detailed below and are all related to the removal of radionuclides or removal of Weekly Advisory Levels (WAL), Quarterly Notification Levels (QNL) or Annual Limits (AL):

Table 1: Requested changes to disposals to water.

Discharge Route	Radionuclide	Change Required	Justification Reference
Aqueous	S-35	Removal of S-35 radionuclide from Table S3.2 of the Permit	2
		Removal of S-35 QNL from Table S3.2 of the Permit	2
		Removal of S-35 AL from Table S3.2 of the Permit	2
		Removal of S-35 from Outlets W2 – W5 of Table S3.2 of the Permit	2
		Removal of references to S-35 within the monitoring techniques described in Table S3.6 of the Permit.	2
		Removal of S-35 as a mandatory radionuclide for the annual bulk analysis within Requirement number 3.2.5 (a)/v004 Section 3 of the CEARAS.	2

Table 2: Requested changes to disposals to air.

Discharge Route	Radionuclide	Change Required	Justification Reference
Gaseous	H-3	Removal of WAL from Table S3.1 of the Permit	3
	C-14	Removal of WAL from Table S3.1 of the Permit	4
	S-35	Removal of S-35 radionuclide from Table S3.1 of the Permit	2
		Removal of S-35 WAL from Table S3.1 of the Permit	2
		Removal of S-35 QNL from Table S3.1 of the Permit	2
		Removal of S-35 AL from Table S3.1 of the Permit	2
		Removal of S-35 from Outlets A14 – A29 of Table S3.1 of the Permit	2
		Removal of S-35 from annual witnessed reactor in-circuit analysis within Requirement number 3.2.5 (a)/v004 Section 1, Table 1 of the CEARAS	2
	Ar-41	Removal of Ar-41 radionuclide from Table S3.1 of the Permit	1
		Removal of Ar-41 QNL from Table S3.1 of the Permit	1
		Removal of Ar-41 AL from Table S3.1 of the Permit	1
		Removal of Ar-41 from Outlets A14 – A29 of Table S3.1 of the Permit	1
	I-131	Removal of I-131 radionuclide from Table S3.1 of the Permit	5
		Removal of I-131 QNL from Table S3.1 of the Permit	5
		Removal of I-131 AL from Table S3.1 of the Permit	5
		Removal of I-131 from Outlets A14 – A29 of Table S3.1 of the Permit	5

2.1.1 Justification 1

Following EoG, the production mechanism for gaseous Ar-41 is no longer possible. Residual Ar-41 in the reactor vessels at the time of shutdown has gone through more than 12 $t_{1/2}$, the decay of initial activity reaching 0.00% within a few days.

2.1.2 Justification 2

Following EoG, the production mechanism for S-35 in the reactor no longer exists. Residual S-35 in the reactor vessels at the time of shutdown has gone through more than 11 $t_{1/2}$, the decay of initial activity currently being less than 0.03% of the activity at shutdown.

Discharges through the gaseous route cannot occur through blowdowns as the reactors are either at low pressure CO_2 or in ambient air. A reactor in air may still undergo leakage depending on external pressure conditions, however this is approximately 10kg/day.

Discharges via the liquid route no longer occur following the isolation of the GBP which previously would have condensed S-35 species into the aqueous phase before transferring to the AETP for discharge.

2.1.3 Justification 3

Following EoG, the production mechanism for H-3 is no longer possible, with residual radioactivity levels remaining in the vessel following reactor purging post shutdown. With the GBP isolated, no further aqueous discharges arising from conditioning of reactor gas can be generated or discharged. A reactor in air may still undergo leakage depending on external pressure conditions, however this is approximately 10kg/day, therefore there is no radioactive inventory or plant operation that would challenge a gaseous WAL for H-3.

2.1.4 Justifications for Change 4

Following EoG, the production mechanism for C-14 in the reactor no longer exists, with residual radioactivity levels remaining in the vessel following reactor purging post shutdown. The GBP is currently isolated, and apart from the final purge to air of Reactor 3 when defueling is complete, no further blowdowns or large-scale gaseous discharges will occur. A reactor in air may still undergo leakage depending on external pressure conditions, however this is approximately 10kg/day, therefore there is no radioactive inventory or plant operation that would challenge a gaseous WAL for C-14.

2.1.5 Justifications for Change 5

Following EoG, the production mechanism for I-131 no longer exists, with residual radioactivity levels remaining in the vessel following reactor purging post shutdown being below the Minimum Detectable Activity (MDA). Both reactors were also declared failed fuel free following the final shutdown in 2022.

2.2 EPR/CB3735DT CEARAS Requirement Number 3.1.1/v002

Under Section B of Requirement number 3.1.1/v002 of the CEARAS, the Environment Agency agrees for spent desiccant to be transferred to Tradebe Fawley Ltd, Charleston Road, Hardley, and Southampton, SO45 3NX for direct incineration in line with the strategic BAT assessment ERO/REP/0185/GEN [Ref 2]. Following an update of this document to Revision 002 in March 2023, the BAT now includes catalyst from the GBP recombination unit to this disposal route following conclusion of incineration trials at Tradebe Fawley Ltd.

The Station requests that Part 2 of Section B of Requirement number 3.1.1/v002 of the CEARAS is updated to specify spent desiccant and catalyst.

2.3 Update to IC5

Within Table S1.2, improvement and information requirements of the Permit, IC5 which requires the operator to:

To enable the effective use of the VLLW and LLW permitted disposal routes and to ensure that arrangements are robust enough to sentence wastes via these routes the accuracy in characterisation required to ensure compliance with the permit requirements should be reviewed, any shortfalls identified should addressed within management and governance arrangements. A report of this review should be submitted to the Environment Agency for approval. 1st July 2022.

was completed by an agreed date with the EA of 31/03/2023 and confirmed within Requirement number 2.4.1/v002 of the CEARAS.

The Station requests that IC5 of the Permit and Requirement number 2.4.1/v002 of the CEARAS are updated and aligned to reflect the condition being complete.

2.4 Assessment of Dose Impact

In 2005, during the review of authorisations to dispose of radioactive waste issued under the Radioactive Substances Act 1993 [Ref 3], a radiological assessment of dose was made at the proposed authorised limits. These limits were at the least the same or greater than the limits in the current EPR CB3735DT permit. The individual doses calculated were the dose to an individual, integrated to 50 years arising from one year's discharge and are shown in Table 3.

Table 3: Calculated exposures to members of the public [Ref 3].

Discharge Route	Infant Exposure (µSv/y)	Child Exposure (µSv/y)	Adult Exposure (µSv/y)
Gaseous	21	10	10
Liquid	n/a	n/a	0.5

The hypothetical most exposed person is an infant member of the critical group for gaseous discharges with a calculated annual exposure of 21µSv. This exposure at the proposed authorised limits, by comparison, is an order of magnitude less than the average exposure of a member of the public in the UK calculated in 2010 by Public Health England [Ref 4].

From the changes proposed in this report, there would be no impact on the dose to the public from either aqueous or gaseous outlets and the public dose stated in Table 3 remains the bounding limit.

The last annual BAT report on “Efforts to Reduce Radioactive Waste Disposals to Meet the Radioactive Substances Regulation Permit Improvement and Information Requirement Reference I1” [Ref 5] submitted to the EA on 27th March 2025 recorded that the maximum dose to the public in 2024 was 0.24μSv. Additional data in Reference 5 show an observable decrease in public dose following EoG supporting the justifications in this permit change proposal.

3 Conclusion

This report details the changes that have occurred to radiological discharges since HPB has moved from being a generating nuclear power station to a defueling station. As part of the continued application of BAT, the proposed changes and justifications supporting this variation will assist the Station in taking a proportionate approach to the management of discharges for the post operational phase of its lifecycle.

4 References

Ref.	Document Identifier	Document Title
1.	EPR/CB3735DT	Environmental Permitting (England & Wales) Regulations 2016 Permit and Compilation of Environment Agency Requirements, Approvals and Specifications
2.	ERO/REP/0185/GEN	Strategic Best Available Techniques (BAT) Assessment for the Management of Spent Advanced Gas-Cooled Reactor (AGR) Desiccant and Catalyst
3.	HINB/R/TET/790	Submission of information to the Environment Agency to enable review of Radioactive Substances Act 1993 Authorisations
4.	Ionising radiation: dose comparisons	https://www.gov.uk/government/publications/ionising-radiation-dose-comparisons/ionising-radiation-dose-comparisons
5.	HINB/R/TET/1163	Annual Report on Efforts to Reduce Radioactive Waste Disposals to Meet the Radioactive Substances Regulation Permit Improvement and Information Requirement Reference I1 for 2024

Appendix A Gaseous Discharges Rolling QNL and AL Percentages

Table 4: Rolling quarterly gaseous discharge totals against QNL.

	Co-60 (%)	H-3 (%)	S-35 (%)	I-131 (%)	C-14 (%)	Ar-41 (%)
Jan-20	11.4	57.5	37.0	1.4	143.5	17.9
Feb-20	13.9	41.6	34.7	1.6	132.0	14.1
Mar-20	15.0	18.3	27.4	1.7	100.6	9.0
Apr-20	15.2	13.9	21.5	1.6	78.8	3.5
May-20	15.3	12.3	17.3	1.6	25.2	1.8
Jun-20	16.1	13.5	13.4	1.6	60.9	2.0
Jul-20	16.4	10.9	10.5	1.7	58.8	1.1
Aug-20	16.5	7.0	6.5	1.7	54.0	0.1
Sep-20	15.2	4.8	5.2	1.6	10.2	0.0
Oct-20	14.9	4.0	5.1	1.6	7.0	0.0
Nov-20	14.7	3.7	5.1	1.6	6.3	0.0
Dec-20	15.3	3.4	5.4	1.6	3.9	0.0
Jan-21	15.4	4.1	5.5	1.5	4.2	0.0
Feb-21	15.5	4.9	5.2	1.5	10.4	0.0
Mar-21	16.5	8.3	5.4	1.5	12.4	0.3
Apr-21	16.2	19.4	8.0	1.5	16.3	5.8
May-21	16.5	28.5	12.8	1.5	19.5	10.4
Jun-21	15.1	33.2	17.6	1.4	31.5	14.9
Jul-21	15.3	31.5	22.8	1.4	42.4	14.1
Aug-21	15.0	30.7	24.5	1.4	66.3	13.0
Sep-21	15.8	26.9	23.2	1.5	79.6	11.3
Oct-21	16.2	21.7	20.3	1.5	76.0	9.5
Nov-21	17.4	20.1	19.3	1.6	94.3	9.9
Dec-21	17.2	23.6	20.7	1.6	77.5	9.5
Jan-22	16.9	28.5	22.4	1.6	81.9	12.0
Feb-22	15.5	26.9	22.5	1.5	41.4	10.6
Mar-22	14.9	26.6	24.2	1.5	47.9	11.3
Apr-22	14.7	24.8	23.8	1.4	47.2	9.8
May-22	14.9	26.1	24.1	1.5	55.1	11.5
Jun-22	15.5	25.3	21.3	1.4	55.1	11.5
Jul-22	17.5	25.4	18.7	1.6	84.9	9.1
Aug-22	18.8	20.3	13.9	1.7	116.0	5.1
Sep-22	18.2	13.6	9.8	1.7	98.0	1.6
Oct-22	16.3	5.5	6.5	1.5	51.5	0.0
Nov-22	15.1	3.2	6.0	1.3	0.00345	0.0
Dec-22	15.2	2.5	6.1	1.4	0.00412	0.0
Jan-23	15.4	2.2	6.2	1.4	0.00132	0.0
Feb-23	14.9	1.9	6.0	1.4	0.01365	0.0
Mar-23	15.3	1.9	6.2	1.4	0.01722	0.0
Apr-23	14.8	1.9	5.9	1.3	0.02157	0.0
May-23	14.6	2.0	5.9	1.3	0.00932	0.0
Jun-23	12.6	2.0	4.9	1.2	0.00687	0.0
Jul-23	11.4	2.1	4.4	1.1	0.00600	0.0
Aug-23	10.5	2.1	4.0	1.0	0.00670	0.0
Sep-23	10.3	2.0	3.9	1.0	0.00753	0.0
Oct-23	10.2	2.0	3.9	1.0	0.00619	0.0
Nov-23	10.0	1.9	3.9	1.0	0.00643	0.0
Dec-23	9.4	1.6	3.7	1.0	0.00399	0.0
Jan-24	9.6	1.4	3.8	1.1	0.00323	0.0
Feb-24	9.7	1.3	3.8	1.1	0.00230	0.0

	Co-60 (%)	H-3 (%)	S-35 (%)	I-131 (%)	C-14 (%)	Ar-41 (%)
Mar-24	10.3	1.3	4.0	1.1	0.00220	0.0
Apr-24	10.3	1.3	4.0	1.0	0.00024	0.0
May-24	10.0	1.3	3.9	1.0	0.00024	0.0
Jun-24	9.6	1.3	3.8	1.0	0.00024	0.0
Jul-24	9.2	1.4	3.8	1.0	0.00024	0.0
Aug-24	9.2	1.6	4.0	1.0	0.00024	0.0
Sep-24	9.8	1.8	4.2	1.0	0.00024	0.0
Oct-24	10.1	1.9	4.4	1.0	0.00024	0.0
Nov-24	10.1	2.6	4.1	1.0	0.00279	0.0
Dec-24	10.1	2.5	3.9	1.1	0.00279	0.0

Table 5: Rolling annual gaseous discharge totals against AL.

	Co-60 (%)	H-3 (%)	S-35 (%)	I-131 (%)	C-14 (%)	Ar-41 (%)
Jan-20	6.9	13.4	20.1	0.3	53.6	9.9
Feb-20	7.1	13.4	20.0	0.3	60.3	9.7
Mar-20	7.1	12.6	19.6	0.3	52.8	9.1
Apr-20	6.9	12.2	19.3	0.2	52.1	8.9
May-20	6.9	12.2	19.1	0.2	50.9	8.7
Jun-20	7.3	11.9	18.3	0.2	56.8	8.1
Jul-20	7.5	10.9	16.9	0.2	54.9	7.3
Aug-20	8.0	10.1	15.4	0.2	51.7	6.3
Sep-20	8.3	9.3	13.9	0.2	49.3	5.3
Oct-20	8.7	8.6	12.7	0.3	46.7	4.5
Nov-20	9.1	6.5	10.9	0.3	35.3	3.2
Dec-20	9.2	4.0	8.8	0.3	28.5	2.2
Jan-21	9.3	3.3	7.3	0.3	24.1	0.9
Feb-21	9.3	2.8	5.9	0.3	15.6	0.4
Mar-21	9.5	3.0	5.1	0.3	14.2	0.4
Apr-21	9.4	3.8	5.0	0.3	14.0	1.4
May-21	9.5	4.4	5.1	0.3	14.6	2.1
Jun-21	9.3	5.0	5.8	0.2	9.4	3.0
Jul-21	9.3	5.9	7.1	0.2	11.3	4.0
Aug-21	9.2	6.8	8.2	0.2	16.6	4.7
Sep-21	9.4	7.2	8.9	0.2	20.6	5.3
Oct-21	9.5	7.7	9.7	0.2	22.5	5.9
Nov-21	9.7	8.4	10.6	0.2	30.9	6.6
Dec-21	9.7	9.2	11.5	0.2	32.6	7.2
Jan-22	9.7	10.1	12.6	0.2	35.1	8.3
Feb-22	9.7	10.6	13.6	0.2	35.9	8.8
Mar-22	9.4	11.0	14.7	0.2	38.3	9.4
Apr-22	9.5	10.6	15.3	0.2	40.1	9.1
May-22	9.4	10.4	15.5	0.2	41.7	9.0
Jun-22	9.5	10.2	15.3	0.2	42.2	8.7
Jul-22	9.8	10.0	14.6	0.2	47.0	8.1
Aug-22	10.0	9.3	13.7	0.3	49.8	7.4
Sep-22	9.9	8.9	13.0	0.2	45.2	6.8
Oct-22	9.8	8.4	12.2	0.2	43.1	6.2
Nov-22	9.7	7.7	11.4	0.2	34.5	5.4
Dec-22	9.6	6.8	10.5	0.2	32.6	4.9
Jan-23	9.6	5.8	9.5	0.2	29.8	3.8

	Co-60 (%)	H-3 (%)	S-35 (%)	I-131 (%)	C-14 (%)	Ar-41 (%)
Feb-23	9.6	5.1	8.6	0.2	27.8	3.3
Mar-23	9.6	4.3	7.4	0.2	24.8	2.6
Apr-23	9.6	3.5	6.4	0.2	22.1	1.8
May-23	9.5	2.7	5.5	0.2	18.8	1.0
Jun-23	9.2	2.0	4.6	0.2	15.9	0.3
Jul-23	8.7	1.2	4.0	0.2	8.4	0.0
Aug-23	8.3	0.9	3.8	0.2	0.0054	0.0
Sep-23	8.0	0.8	3.6	0.2	0.0058	0.0
Oct-23	7.8	0.8	3.5	0.2	0.0057	0.0
Nov-23	7.5	0.8	3.4	0.2	0.0059	0.0
Dec-23	7.1	0.8	3.2	0.2	0.0058	0.0
Jan-24	6.9	0.7	3.1	0.2	0.0060	0.0
Feb-24	6.7	0.7	3.0	0.2	0.0040	0.0
Mar-24	6.4	0.7	2.8	0.2	0.0033	0.0
Apr-24	6.2	0.7	2.8	0.2	0.0025	0.0
May-24	6.0	0.7	2.7	0.2	0.0025	0.0
Jun-24	5.9	0.6	2.7	0.2	0.0023	0.0
Jul-24	5.9	0.6	2.7	0.2	0.0016	0.0
Aug-24	5.8	0.6	2.7	0.2	0.0015	0.0
Sep-24	5.9	0.6	2.7	0.2	0.0011	0.0
Oct-24	5.9	0.6	2.7	0.2	0.0006	0.0
Nov-24	5.9	0.7	2.7	0.2	0.0009	0.0
Dec-24	6.0	0.7	2.7	0.2	0.0009	0.0

Appendix B Aqueous Discharges Rolling QNL and AL Percentages

Table 6: Rolling quarterly aqueous discharge totals against QNL.

	H-3 (%)	S-35 (%)	Others (%)	Co-60 (%)	Cs-137 (%)
Jan-20	37.92	46.87	8.93	3.23	1.09
Feb-20	46.61	57.88	11.19	3.12	1.05
Mar-20	33.88	39.28	8.22	3.87	0.85
Apr-20	16.57	21.11	5.98	6.74	0.74
May-20	13.63	8.95	5.97	8.08	0.96
Jun-20	18.68	10.96	7.31	8.65	1.43
Jul-20	15.93	7.86	5.52	6.15	1.58
Aug-20	5.06	2.03	1.89	6.44	1.55
Sep-20	0.87	0.24	1.76	6.16	1.23
Oct-20	0.86	0.24	1.69	6.16	1.59
Nov-20	0.86	0.24	1.73	4.60	1.29
Dec-20	0.00	0.02	0.56	6.11	1.15
Jan-21	0.00	0.01	0.56	4.98	1.06
Feb-21	0.00	0.01	0.51	4.17	1.25
Mar-21	0.00	0.01	0.67	2.53	2.09
Apr-21	11.20	1.97	3.61	4.17	1.89
May-21	25.07	6.45	6.23	5.13	2.25
Jun-21	44.13	16.69	9.96	5.88	1.92
Jul-21	49.53	25.92	11.09	7.27	3.44
Aug-21	46.33	27.52	10.97	7.90	3.50
Sep-21	32.13	20.68	8.31	7.06	3.18
Oct-21	25.60	21.04	6.79	4.74	1.71
Nov-21	25.93	24.92	6.47	4.16	1.46
Dec-21	33.93	28.24	7.71	3.89	1.30
Jan-22	36.87	24.24	8.09	3.51	4.18
Feb-22	38.93	23.44	8.57	3.19	4.63
Mar-22	38.07	27.20	8.55	3.49	5.27
Apr-22	42.80	33.00	9.43	4.05	3.36
May-22	41.27	32.64	9.48	4.85	2.98
Jun-22	42.27	30.96	9.85	5.16	2.75
Jul-22	38.60	25.36	9.57	5.10	2.18
Aug-22	27.07	16.56	6.92	3.97	2.27
Sep-22	14.07	7.77	4.02	3.06	2.13
Oct-22	0.00	0.01	0.52	1.98	1.90
Nov-22	4.38	1.13	2.91	3.02	2.09
Dec-22	4.38	1.13	2.97	4.62	2.88
Jan-23	4.47	1.17	4.98	6.06	3.21
Feb-23	0.11	0.08	4.50	6.83	3.19
Mar-23	0.11	0.08	4.98	7.61	3.39
Apr-23	0.02	0.04	3.03	6.78	3.00
May-23	0.00	0.01	1.17	5.23	2.77
Jun-23	0.05	0.03	1.95	3.21	2.34
Jul-23	0.05	0.03	1.86	3.05	2.40
Aug-23	0.05	0.03	1.84	3.49	2.37
Sep-23	0.00	0.01	0.60	3.24	1.79
Oct-23	0.0001	0.0076	0.62	3.46	1.54
Nov-23	0.0001	0.0076	0.56	3.28	1.27
Dec-23	0.00004	0.0076	0.46	4.54	1.08
Jan-24	0.0001	0.0084	0.73	5.95	1.07
Feb-24	0.0001	0.009	0.65	5.69	0.97
Mar-24	0.0001	0.008	0.73	5.52	0.84

	H-3 (%)	S-35 (%)	Others (%)	Co-60 (%)	Cs-137 (%)
Apr-24	0.0001	0.006	0.31	3.29	0.66
May-24	0.0004	0.004	0.63	4.46	1.24
Jun-24	0.0005	0.003	0.54	3.79	1.34
Jul-24	0.0004	0.003	0.54	3.93	1.39
Aug-24	0.0001	0.003	0.31	2.84	1.02
Sep-24	0.00005	0.003	0.41	2.47	1.15
Oct-24	0.00005	0.003	2.16	13.61	3.83
Nov-24	0.00004	0.003	2.18	13.88	3.83
Dec-24	0.00003	0.0034	2.03	13.48	3.67

Table 7: Rolling annual aqueous discharge totals against AL.

	H-3 (%)	S-35 (%)	Others (%)	Co-60 (%)	Cs-137 (%)
Jan-20	34.86	17.87	3.48	0.70	0.36
Feb-20	34.95	18.74	3.42	0.62	0.35
Mar-20	32.41	17.68	3.18	0.61	0.33
Apr-20	31.77	17.34	3.21	0.69	0.32
May-20	32.12	16.33	3.36	0.73	0.33
Jun-20	32.22	15.90	3.38	0.72	0.36
Jul-20	28.04	14.33	3.05	0.61	0.31
Aug-20	23.65	13.00	2.70	0.61	0.32
Sep-20	19.91	11.52	2.41	0.56	0.27
Oct-20	16.45	9.51	2.07	0.56	0.25
Nov-20	15.27	8.64	1.95	0.56	0.24
Dec-20	12.33	6.31	1.67	0.62	0.23
Jan-21	7.70	3.65	1.29	0.60	0.25
Feb-21	4.51	1.40	0.95	0.58	0.25
Mar-21	4.51	1.40	0.97	0.59	0.29
Apr-21	6.46	1.26	1.07	0.54	0.31
May-21	7.15	1.09	0.97	0.51	0.32
Jun-21	10.38	2.12	1.21	0.52	0.32
Jul-21	14.21	3.52	1.59	0.56	0.40
Aug-21	16.68	4.28	1.82	0.54	0.41
Sep-21	17.60	4.67	1.83	0.54	0.42
Oct-21	19.92	6.12	2.07	0.53	0.41
Nov-21	22.46	7.36	2.27	0.53	0.42
Dec-21	25.43	8.20	2.50	0.48	0.42
Jan-22	28.43	9.15	2.77	0.49	0.56
Feb-22	31.45	10.29	3.02	0.51	0.59
Mar-22	34.22	11.60	3.24	0.51	0.58
Apr-22	35.72	13.03	3.32	0.49	0.635
May-22	35.18	13.57	3.33	0.50	0.628
Jun-22	33.78	13.39	3.23	0.49	0.625
Jul-22	33.20	12.96	3.18	0.44	0.57
Aug-22	30.74	12.20	2.95	0.40	0.57
Sep-22	29.62	11.77	2.82	0.39	0.57
Oct-22	27.29	10.33	2.59	0.37	0.58
Nov-22	25.77	9.22	2.61	0.38	0.60
Dec-22	22.80	8.38	2.38	0.41	0.65
Jan-23	19.82	7.44	2.30	0.43	0.53
Feb-23	16.81	6.30	2.23	0.47	0.53

	H-3 (%)	S-35 (%)	Others (%)	Co-60 (%)	Cs-137 (%)
Mar-23	14.04	4.99	2.05	0.51	0.56
Apr-23	9.94	3.32	1.70	0.50	0.51
May-23	7.28	2.22	1.45	0.48	0.52
Jun-23	4.29	1.13	1.31	0.46	0.54
Jul-23	1.05	0.16	0.97	0.45	0.53
Aug-23	1.05	0.16	0.98	0.46	0.52
Sep-23	1.05	0.16	0.99	0.47	0.52
Oct-23	1.05	0.16	0.98	0.48	0.51
Nov-23	0.04	0.02	0.76	0.47	0.48
Dec-23	0.04	0.01	0.75	0.47	0.43
Jan-24	0.02	0.01	0.59	0.48	0.40
Feb-24	0.01	0.01	0.40	0.44	0.37
Mar-24	0.01	0.01	0.35	0.41	0.30
Apr-24	0.01	0.01	0.33	0.39	0.28
May-24	0.01	0.01	0.34	0.42	0.29
Jun-24	0.0002	0.003	0.22	0.43	0.25
Jul-24	0.0002	0.003	0.21	0.42	0.23
Aug-24	0.0002	0.003	0.20	0.41	0.22
Sep-24	0.0001	0.003	0.20	0.41	0.22
Oct-24	0.0001	0.003	0.35	0.67	0.35
Nov-24	0.0001	0.002	0.35	0.67	0.35
Dec-24	0.0001	0.002	0.35	0.63	0.35

5 Distribution List

Name	Position / Location	User ID
[redacted]	Environmental Safety Group Head / HPB	[redacted]
[redacted]	Environmental Safety Engineer / HPB	[redacted]
[redacted]	Environmental Safety Engineer / HPB	[redacted]
[redacted]	Environmental Safety Engineer / HPB	[redacted]
[redacted]	Environmental Safety Engineer / HPB	[redacted]
[redacted]	Environmental Safety Engineer / HPB	[redacted]
[redacted]	Technical & Safety Support Manager / HPB	[redacted]