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ENGINEERING ADVICE NOTE

TITLE: Screening to determine whether a Transboundary Consideration Assessment is required for Hunterston A's proposed variation to authorisation limits **AUTHOR:** [redacted] **FUNCTION:** Technical Department, Process & Environment Section	**EAN NO:** HNA/8100/PG/PR/1071 **DATE: June**, 2023
DISTRIBUTION: [redacted]	**QA STATEMENT:** All work has been carried out in accordance with the relevant Company Quality Assurance procedures as recorded in the Task File. **QA GRADE: 3** **SITE: Hunterston A**
	ATTACHMENTS:

1 Introduction

Following the gaseous discharge assessment for the retrieval and encapsulation of discharges from Solid Active Waste Bunkers (SAWB) ILW waste in the SILWE facility, it has been determined that Hunterston A (HNA) will need to increase its authorised limits for gaseous releases.

The site will be submitting an application to the Scottish Environment Protection Agency (SEPA) to vary the current authorisation [1].

As part of this it needs to be determined whether a Transboundary Consideration Assessment is required.

1.1 Proposed Annual Site Limits

The proposed Annual Limits for Gaseous releases, which will be proposed to SEPA as part of the site variation are presented below in Table 1.

Table 1 Proposed Site Annual Limits for the SILWE Site Authorisation Variation Application (Gaseous)

Radionuclide or Group of Radionuclides	Current Annual Limit (GBq)	Proposed Annual Limit (GBq)
Tritium	20	40
Carbon- 14	2	10
All other nuclides (excluding Tritium and Carbon- 14)	0.003	0.003

This provides doses associated with proposed limits (Table 1) and existing authorised limits presented in Table 2. These existing limits presented in Table 2 will **not** be changing in the EASR18 authorisation variation application.

Table 2 Current Site Annual Limits (Aqueous)

Radionuclide or Group of Radionuclides	Current Annual Limit (GBq)	Proposed Annual Limit (GBq)
H-3	30	No change
Cs-137	160	No change
Pu-241	2	No change
Total Alpha	2	No change
Non-Alpha	60	No change

1.2 Guidance

The Transboundary Radioactive Contamination (Scotland) Direction 2021 [2] is the direction under which SEPA must consider the transboundary impacts of radioactive waste disposal.

Under this direction SEPA must consider whether plans are liable to result in radioactive contamination, significant from the point of view of health, of water, soil or airspace of any of the notifiable countries [2].

However, if the proposed activities, considered in their entirety, amount to be "trivial operations" then transboundary considerations are not necessary. In the Directive "trivial operations" are defined as "operations that have no or negligible radiological impact in notifiable countries". "Notifiable countries" in the Directive are defined as the EU member states and Norway [2].

This requirement is defined further in the Environmental Authorisations (Scotland) Regulations 2018, Guidance on the Application Form for a permit for the management of Radioactive Substances not involving Sealed Sources, V5 [3]. This new guidance sets the "trivial operations" criteria as "*if the assessed maximum exposure levels from releases in normal conditions to adults, children and infants in the vicinity of the operation are below 10μSv per year and there are no exceptional pathways of exposure, e.g., involving the export of foodstuffs, to notifiable countries*".

2 Purpose

The purpose of this EAN is to carry out screening to determine if disposals of radioactive waste at proposed discharge limits in Table 1and Table 2 meets the criteria of "trivial operations" as set out in the *Transboundary Radioactive Contamination (Scotland) Direction 2021* and SEPA guidance [2,3].

The scope of the assessment covers the dose consequences to the most exposed person in the vicinity of the Hunterston A site if aqueous and gaseous discharges were made at the new proposed authorisation limits (maximum exposure) in one year.

3 Assumptions

For these assessments, the below assumptions were made:

- To provide the most conservative approach, it was assumed disposals to the environment are at the proposed annual limits, as given in Tables 1 & 2 were discharged in their entirety over the period of one year.
- Therefore, for specific named radionuclides in Tables 1 & 2, the proposed annual limit releases were assumed (found in Table 1 & Table 2).
- For the "All other nuclides" and "Alpha/ Non-Alpha" groups in Tables 1 & 2 (i.e., where no specific radionuclide is listed) the following approach was taken:
  - The representative radionuclides for aqueous releases were based on recent lab analysis results of HNA liquid effluent samples [4]
  - The representative radionuclides for gaseous releases were based on the most dominating, and high dose consequence radionuclides in the Pond and SAWB fingerprints [5, 6].
  - It is assumed the total site gaseous releases are heavily weighted (84%) to the Pond fingerprint with the remainder (16%) to the SAWB wastes. This assumption is explained in more detail in section 4.1.
- Calculated doses are to local resident and fishing families.
- Calculated doses are assumed to be from ground level release and so no account is made for stack heights.

These assumptions are discussed further in the methodology.

4 Method

The Environment Agency's (EA) Initial radiological assessment tool 2 (IRAT2) was used to assess the maximum dose for the most exposed individual in the vicinity of HNA in line with the SEPA guidance, this provides a cautious assessment of doses, however although the SEPA report references the older version of the IRAT, the new IRAT2 has been used to ensure an up to date assessment [7,8].

The dose consequence of HNA releases was assessed at the proposed new gaseous limits and existing aqueous limits, as presented in Table 3.

Table 3 Site authorisation limits in relation to the data input into IRAT2 to generate the dose information. For the actual input data see Tables 4 & 5.

	Radionuclide or Group of Radionuclides	Site authorisation limit	IRAT input data
New limits	Gaseous	GBq/y	Bq/y
	H-3	40	4.00E+10
	C-14	10	1.00E+10
	All Others[1]	0.003	3.00E+06
Existing Limits (no change)	Aqueous	GBq/y	Bq/y
	H-3	30	3.00E+10
	Cs-137	160	1.60E+11
	Pu-241	2	2.00E+09
	Total Alpha[2]	2	2.00E+09
	Non- alpha[3]	60	6.00E+10

4.1 Gaseous Dose Assessment Method

For the gaseous assessment, the dose consequence of HNA releases was calculated at the proposed new limits. H-3, and C-14 were all input into the IRAT2 at the maximum release, as seen in

[1] This total was a contribution of representative radionuclides from HNA waste fingerprints as discussed in 4.1
[2] This total was a contribution of representative radionuclides from HNA aqueous waste lab analysis as discussed in 4.2
[3] This total was a contribution of representative radionuclides from HNA aqueous waste lab analysis as discussed in 4.2

Table 3.

For "All Others" the contribution of representative radionuclides in the Hunterston waste streams were identified. To do this a representative fingerprint was taken from the Ponds, and the Solid Active Waste Bunkers (SAWB) [5,6].

From these representative fingerprints, alphas with the highest activity were selected. For non-alpha, all three non-alphas from Ponds were selected. For SAWBR the non-alpha, is dominated by Co-60 which has a high dose consequence and therefore this was selected. This was to enable a more conservative assessment. The percentage weighting of each of these nuclides was then calculated by dividing the activity amount per nuclide by the total activity of the fingerprint. This was then multiplied by the proposed authorisation limit (3Mbq). A weighting was given across the two fingerprints to give the GBq amount for each selected nuclide.

There is a total of 18 authorised[4] discharge outlets on site, of which 15 are expected to release gaseous waste corresponding to the Ponds fingerprint. The remaining 3[5] are assumed to relate to the SAWB waste fingerprint. Based on this, the weighting of 83.3% (Ponds fingerprint) / 16.7% (SAWB fingerprint) was used in the calculation. The Reactors were excluded, as they only emit H-3, and C-14 and therefore could not provide representative radionuclides for "All others". These radionuclides and their amounts can be seen in

Table 4.

Table 4 Representative Alphas and Beta for Gaseous Releases (Bq)

Emitter Type	Radionuclide	Bq/y
Non- Alpha	Co-60	5.00E+05
	Cs-137	8.20E+05
	Sr-90	1.07E+06
	Pu-241	4.54E+05
Alpha	U-234	2.35E+02
	U-235	2.70E+01
	U-236	3.74E+01
	U-238	2.29E+02
	Pu-238	2.11E+04
	Pu-239	1.83E+04
	Pu-240	2.12E+04
	Am-241	9.43E+04
	Cm-243	1.15E+02
	Cm-244	1.91E+03
	Cm-242	5.19E-01
Total		3.00E+06

[4] For the purposes of this assessment this is assumed to include the new proposed SILWE stack which will be included in the authorisation application.
[5] SAWB building, SAWBR building, and a temporary stack for miscellaneous work

To add further conservatism, the total of the alphas in Table 4 input as Plutonium 239 in the IRAT2. This is because Pu-239 has the highest dose consequence per unit discharge in the IRAT2 model. The data that inputted into IRAT 2 for gaseous releases is given in Table 5.

Table 5 IRAT 2 Input Data for Gaseous Releases

Input Data		Bq/y
H-3		4.00E+10
C-14		1.00E+10
Non-Alpha	**Co- 60**	5.00E+05
	Cs- 137	8.20E+05
	Sr-90	1.07E+06
	Pu-241	4.54E+05
Alpha[6]	**Pu -239**	1.57E+05

4.2 Aqueous Dose Assessment Method

For the aqueous assessment, the dose consequence of HNA releases was assessed at the current site authorisation limits, as there is no proposed change to these limits. H-3, Cs-137, and Pu-241 were all input into the IRAT2 at the current annual maximum release, as presented in

[6] This value Is the sum of all the Alphas in Table 4.

Table 3.

For "Total Alpha" and "Non-Alpha" the representative radionuclides were taken from recent HNA liquid effluent analysis results [4]. It was decided to use the most recent lab analysis results, as these are more relevant, however, lab analysis from the last 5 years were taken and averaged as well. These can be found in Appendix B but were not used in the report.

For Beta, Strontium 90 is the major non-alpha emitting nuclide present in the liquid effluent that isn't subject to a nuclide specific limit (i.e., Cs-137, Pu-241, H-3 all have their own limits), so this was taken as the full Beta amount. For Alphas, similar to the method for gaseous releases, the percentage share of each nuclide was calculated from the effluent sample, then multiplied by the existing site limit in

Table 3. The data that was entered into the IRAT2 as presented in .

Table 6.

Table 6 IRAT 2 Input Data for Aqueous Releases

Input Data		Bq
H-3		3.00E+10
Cs-137		1.60E+11
Pu-241		2.00E+09
Non-Alpha	**Sr-90**	6.00E+10
Alpha	**Am241**	5.59E+08
	Cm 242	4.05E+06
	Cm 243	1.00E+07
	Cm 244	1.00E+07
	Pu-238	2.78E+08
	Pu 239	5.70E+08
	Pu-240	5.70E+08
Total		**2.00E+09**

For coastal/estuary releases the IRAT2 tool uses a default coastal exchange rate of 30 m3/s [7]. This is the net volume of water transferred between the local and regional compartments in unit time and affects how the discharge is dispersed in the environment [7]. However, this figure was determined to be unrealistic for HNA, therefore, a coastal exchange rate of 633 m^3/ s was used. The figure of 633 m^3/ s is based on the figure of 2 10^{10} m^3 /y from the Public Health England, Review of local compartment parameter values for use with UK sites in the DORIS marine dispersion model, exchange rate calculation for HNA [9].

5 Results

Table 7 IRAT 2 Results all predicted Doses [10]

	Radionuclide or Group of Radionuclides	Permit limit	IRAT input data	Local Resident dose
New limits	**Gaseous**	**GBq/y**	**Bq/y**	**µSv/y**
	H-3	40	4.00E+10	3.9E-02
	C-14	10	1.00E+10	7.0E-01
	All Others	0.003	3.00E+06	2.01E-01

	Gaseous Total Dose			**9.40E-01**
Existing Limits (no change)	**Aqueous****	**GBq/y**	**Bq/y**	**µSv/y**
	H-3	30	3.00E+10	4.27E-06
	Cs-137	160	1.60E+11	4.96E+00
	Pu-241	2	2.00E+09	8.72E-03
	Total alpha	2	2.00E+09	3.43E-01
	Non-Alpha	60	6.00E+10	5.9E-02
	Aqueous Total Dose			**5.4E+00**
Total	**Total site emissions Local resident dose**			**6.3E+00**

As shown in Table 7 with the proposed site authorised limits, the total Gaseous dose is 0.94µSv/y, with the highest contributing dose of 0.7µSv/y coming from C-14. Additionally, at the existing site authorisation limits the total Aqueous dose is 5.4µSv/y, with the highest contributing dose of 4.96µSv/y coming from Cs-137 at current limits.

Combining these two doses gives an overall total site emissions Local resident dose of 6.3µSv/y. It is important to note that all these doses have been calculated at ground level, and stack height has not been considered. This provides further conservatism to the assessment.

This total dose is lower than the "trivial" criteria of 10µSv/y laid as set out in the *Transboundary Radioactive Contamination (Scotland) Direction 2021* and SEPA guidance [2,3].

5.1 Exceptional Pathways of exposure to Notifiable Countries

As aforementioned, in the new EASR guidance to define an operation as "trivial" there is also the criteria that "there are no exceptional pathways of exposure, e.g., involving the export of foodstuffs, to notifiable countries" [3] Exposure pathways involving exported foodstuffs were examined in the 2002 Article 37 submission for HNA [11,11]. This considered that food and fish exports as potential pathways but concluded that such pathways were insignificant.

The 2002 Article 37 submission noted that "Commercial fish species landed from the Clyde to UK ports in 1999 totalled 1100 tonnes. The main species were cod, haddock and hake. Commercial vessels landed crustaceans from the Clyde in 1999. Two thousand tonnes of crustaceans were landed, mainly nephrops." [11] Since this time there has been a significant decline in fish landed in the Clyde while the nephrops catch has fluctuated but is typically around 4000 tonnes. Overall, there has been a significant drop in total landings and so the original conclusion of the 2002 Article 37, which was that there were no pathways associated with the Clyde fishery, remains valid [12].

The 2002 Article 37 also noted that "In terms of land area, agriculture is the principal land use on the Hunterston Peninsula. The dominant agricultural activity is grazing of cattle (for milk and beef) and sheep. Some barley and potatoes are grown." This document also rules out any pathways from agriculture, noting that food for exports is mixed together from different regions as part of the supply-chain network. The region around Hunterston remains primarily agricultural. The broad pattern of Scotland's agriculture is largely unchanged since

2002, although there has been a long-term decline in cattle numbers, driven by a fall in their profitability, which is linked to increased production costs [14].

Additionally, as food is consumed in the vicinity of the site as well as being exported there are no pathways of exposure which exist solely to notifiable countries [13]. As shown in Table 8 the IRAT dose considers local consumption of seafood, and terrestrial food, this combined dose is very low with only 1.5µSv/y. This dose is negligible and therefore exported doses to notifiable countries would be lower. Additionally for most types of food, the material produced in the Hunterston area would be mixed with material produced elsewhere in the UK before being exported. Although there are speciality foods produced near Hunterston that could be exported without mixing, the quantities of such food consumed by an individual in a notifiable country would be negligible. This applies to radioactivity in aerial and in aquatic discharges [11]. Therefore, foodstuffs are not being considered as an exceptional pathway.

Table 8 IRAT Food Dose for Gaseous and Aqueous releases

Food Dose	µSv/y
Gaseous	3.5E-01
Aqueous	1.1E+00
Total	**1.5E+00**

5.2 Comparison with HNA 2002 Article 37

An assessment was produced in 2002 [11] to satisfy the requirement of Article 37 of the Euratom Treaty as recommended by the Commission of the European Communities (Annex 2 of Commission Recommendation 1999/829/Euratom of 6 December 1999).

This was submitted to the Commission and they provided an opinion in October 2002 [EUR-Lex - 32002A1016(01) - EN (europa.eu)] concerning the plan for the disposals of radioactive waste arising from the dismantling of HNA, which is summarised below:

In conclusion, the Commission is of the opinion that the implementation of the plan for the disposal of radioactive waste in whatever form arising from the dismantling of the Hunterston A power station in the United Kingdom, both in normal operation and in the event of an accident of the type and magnitude considered in the general data, is not liable to result in radioactive contamination, significant from the point of view of health, of the water, soil or airspace of another Member State.

A direct comparison of the calculated doses given in Table 8 of this report against those calculated in the 2002 Article 37 submission [11] is not possible because the annual limits assessed in 2002 were much higher than those in this report. The limits, assumptions and calculated doses from the 2002 submission are presented in Appendix A.

The results in this report are likely to be more conservative, and the dose higher than what would have been produced in a more in-depth assessment such as that carried out for the 2002 Article 37. However, for this reason the results of this assessment are considered to be worst case and bounding for the dose consequences associated with the proposed gaseous limit increases. This report presents a high level and cautious assessment is considered bounding for the proposed Gaseous and Aqueous limits to be included in the authorisation variation application.

Additionally, the aqueous discharge limits assessed in this report are different to those assessed in the 2002 Article 37 submission [11]. Therefore, the aqueous dose will be different than what was presented in the 2002 Article 37.

6 CONCLUSIONS

This screening shows that the proposed HNA gaseous authorisation limits and the existing aqueous limits meet the criteria for trivial operations, as the total predicted dose is 6.3 μSv/y which is less than the 10 μSv/y laid out in the guidance. This assessment assumes releases at the limits in one year. Only 0.94 μSv/y of the total maximum exposure is attributable to gaseous radioactive waste, which is the media relevant to the proposed application for variation.

This is a cautious assessment with some conservatisms applied to input data and takes no account of stack height in the releases. Additionally, this assessment is considered bounding for the proposed Gaseous and Aqueous limits to be included in the authorisation variation application.

It is concluded there will be no exceptional pathways of exposure to notifiable countries from the proposed increase in gaseous limits.

Based on these conclusions, in line with SEPA guidance, Magnox Ltd concludes a transboundary consideration assessment for this variation application is not required.

7 REFERENCES

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Appendix A 2002 Article 37 Assessment Comparison with Current and Proposed Limits

Table 9 Aqueous Discharge Limits in Article 37 and current limits [1,11]

Radionuclide or Group of Radionuclides	2002 Article 37 Submission (GBq)	Current Annual Limit (GBq)
H-3	700	30
Cs-137	Not listed	160
Pu-241	1000	2
Total Beta	600	60
Total Alpha	40	2

Table 10 Gaseous Discharge Limits in Article 37, current limits, and proposed limits [1, 11]

Radionuclide or Group of Radionuclides	Article 37 Annual limit (GBq)	Current Annual Limit (GBq)	Proposed Annual Limit (GBq)
Tritium	20	20	40
Carbon- 14	2	2	10
All other nuclides (excluding Tritium and Carbon- 14)	0.06 (Defined as beta particulate in Article 37)	0.003	No change from Current

Appendix B Aqueous dose using alphas average from last 5 years

Table 11 IRAT Input Data Using Average Alpha Activity from the Last 5 Years of Lab Analysis [10,16]

Input Data		Bq
H-3		3.00E+10
Cs-137		1.60E+11
Pu-241		2.00E+09
Non-Alpha	**Sr-90**	6.00E+10
Alpha	**Am241**	1.13E+09
	Cm 242	1.99E+05
	Cm 243	3.51E+07
	Cm 244	3.51E+07
	Pu-238	2.33E+08
	Pu 239	2.81E+08
	Pu-240	2.81E+08
Total		**2.00E+09**

Table 12 Coastal Dose using Data in Table 11 [10,16]

Radionuclide	Fishing family (coastal) dose µSv/y
H-3	0.00
Sr-90	0.06
Cs-137	4.96
Pu-238	0.05
Pu 239	0.07
Pu-240	0.07
Pu-241	0.01
Am241	0.01
Cm 242	0.00
Cm 243	0.00
Cm 244	0.00
Total dose	**5.22**