

Hunterston A Site ENVIRONMENT CALCULATION SHEET			SHEET 1 OF 8 SHEETS
TITLE: IMPACT OF SILWE GASEOUS DISCHARGES ON SITE PERMIT LIMITS.			DATE: 15/06/23
CALCULATED BY: NAME: [REDACTED] SIGNATURE: [REDACTED] DATE: 19/06/23	CHECKED BY: NAME: [REDACTED] SIGNATURE: [REDACTED] DATE: 17/6/23	APPROVED BY: NAME: [REDACTED] SIGNATURE: [REDACTED] DATE: 19/6/23	CALC. REF: HNA/3800/TC/C S/1534 Issue 4
PURPOSE OF CALCULATION:			
<p>This calculation sheet combines the estimated gaseous discharges from the Solid Intermediate Level Waste Encapsulation (SILWE) facility with estimated gaseous discharges from all other known site activities over the anticipated operation period of this facility (2025 – 2031). This information is required to determine and justify proposed changes to the annual activity limits (sub-limits) and annual site limits (site limits) for gaseous discharges, listed within the sites permit issued by SEPA (Ref 1), required to support the SILWE permit variation application.</p>			
BASIS OF CALCULATION:			
<i>Assumptions:</i>			
<ul style="list-style-type: none"> SILWE gaseous waste shall be discharged over a six-year period, 2025 – 2031, as detailed in HNA/2981/PG/REP/1223. Pond Purge Sump Retrieval and Encapsulation Project (PPSREP) gaseous waste shall be discharged over a three-year period, 2023 – 2026, as detailed in HNA/3800/TC/CS/1529. Wet Intermediate Level Waste Retrieval Encapsulation Plant (WILWREP) gaseous waste shall be discharged over a one-year period, 2024 – 2025, as detailed in M/EF/HNA/EAN/0005/22. Gaseous Discharges from all other site activities will broadly align with 2022 site discharges. Organically bound Carbon-14 from other site decommissioning activities conservatively accounts for 1.23% of 'All other' activity reported for 2022 site discharges. 			
REFERENCES:			
<i>Insert list of references used</i>			
<ol style="list-style-type: none"> EAS/P/1173609SEPA, Environment Authorisations (Scotland) Regulations 2018, March 2019. M/EF/HNA/EAN/0005/22 – Gaseous Discharge Assessment for the Neutralisation of Acid Waste (9J61) with Lime. HNA/3800/TC/CS/1529 – Impact of PPSREP Gaseous Discharges on Site Permit Limits. HNA/2981/PG/REP/1223 – “Assessment of Hunterston A SILWE Gaseous Radioactive Discharges in relation to Best Practicable Means requirement”. HNA/1050/PG/PR/895 – Assessment of Gaseous Discharges and Justification of Ventilation Arrangements for the Pond Purge Sump Intermediate Level Waste Retrieval and Encapsulation Project. HNA/3805/EH/HP/407 – Monthly Gaseous Discharges Reporting Form for December 2022. WD/REP/0132/18 - Reactor Waste Fingerprint. HNA/8100/PG/PR/1071 - Screening to Determine Whether a Transboundary Consideration Assessment is Required for Hunterston A’s Proposed Variation to Authorisation Limits 			

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Checklist:						
Is the basis of the calculation clear?		Yes / No *				
Is the basis of the calculation correct?		Yes / No *				
Are all the reference documents available?		Yes / No *				
Are all the reference documents valid?		Yes / No *				
Is the arithmetic correct?		Yes / No *				
Is the calculation technically correct?		Yes / No *				
Are the results valid?		Yes / No *				
Are the conclusions valid?		Yes / No *				
Are alternative calculations required?		Yes / No *				
* Delete where appropriate						

NOTES:

- Calculations should either be printed or completed in ink.

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1.0 Current Site Discharges and Permit Limits

Table One, below, details the level of radioactivity within annual gaseous waste discharges from authorised gaseous outlets (Table Two, Ref 1) at Hunterston A Site over the last six years. These discharges, coupled with gaseous waste discharges from reactor breathing, constitute the monthly compliance reporting required by the site permit (Ref 1).

There is a decreasing trend in the level of radioactivity discharged from authorised gaseous outlets following completion of key decommissioning activities on site. It should be noted that radioactivity discharged during 2020 is lower than the other years shown mainly due to a four-month period when there was no gaseous waste discharged from authorised gaseous outlets during the initial stages of the Covid pandemic.

Table One: Annual Gaseous Waste Discharges from Authorised Gaseous Outlets 2017 – 2022.

	2022	2021	2020	2019	2018	2017
Tritium (GBq)	0.0003	0.0003	0.01423	0.0564	0.0564	0.0564
All Other (GBq)	0.000441	0.000383	0.000271	0.000449	0.000573	0.001043

With regards to authorised gaseous outlets, annual activity limits (referred to herein as 'sub-limits') listed within the sites permit are 0.1 GBq and 0.003 GBq for 'Tritium' and 'All Other' activity, respectively. 'All other' activity includes activity from all radionuclides except Tritium and currently includes Carbon-14. The site is held accountable against these sub-limits which are listed on Table One of the sites permit (Ref 1).

The site permit also lists Annual Site Limits for Gaseous Discharges (Table Three, Ref 1; referred to herein as 'Site Limits'). These site limits are 20, 2 and 0.003 GBq for Tritium, Carbon-14 and 'All Other' activity excluding Tritium and Carbon-14, respectively. A key difference between the sub-limits and site limits is that Carbon-14 is reported as 'all other' activity for the sub-limit whereas annual limits state an individual limit for Carbon-14. The site is held accountable against the sub limits. The site limits are the maximum activity the site can request to discharge without a mandatory public consultation and transboundary assessment.

2.0 Estimated Gaseous Discharges from Future Decommissioning Project Activities

The current decreasing trend of activity discharged from authorised gaseous outlets will inverse as new decommissioning projects commence which will generate Tritium and Carbon-14 gaseous activity in addition to particulate gaseous activity (including organically bound Carbon-14). A significant proportion of these gaseous discharges will be generated from the encapsulation of solid Intermediate Level Waste at the SILWE facility and storage of the encapsulated packages within the Intermediate Level Waste Store (ILWS).

Operation of the SILWE facility, planned for six years between 2025 and 2031, will overlap with two other decommissioning projects which will discharge gaseous waste:

- the PPSREP project, currently scheduled from 2023 until 2026; and
- encapsulation of acid within the WILWREP facility, currently scheduled from 2024 until 2025

To assess the impact of these projects on total gaseous discharges from authorised gaseous outlets at site and understand the implications on the site permit sub-limits and site limits, the gaseous activity from all decommissioning projects is assumed to discharge concurrently, as detailed in Table Two, below.

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Table Two: Estimated Annual Gaseous Discharges from Planned Decommissioning Activities, 2025 – 2031.

Source of Discharge	Tritium (GBq)	Carbon-14 (GBq)	All Other (GBq)	Ref:
WILWREP	0.0017	8.30E-10	2.24E-04	Ref: 2
PPSREP	0.0086	0.0021	8.68E-06	Ref: 3 / Appendix A
*SILWE – bunkers 2 – 5 estimates	7.62	2.0	2.36E-06	Ref: 4
ILWS – SILWE Discharges	2.19	0.32	N/A	Ref: 4
ILWS – PPSREP Discharges	0.0098	0.0025	N/A	Ref: 5
Site Discharges 2022	0.0003	**5.51E-06	**4.35E-04	Ref: 6
Total	9.83	2.32	0.00067	

*The gaseous estimates included for SILWE are the bunker 2 – 5 plus fines estimates as these are higher than the gaseous estimate from bunker 1 plus fines and therefore have the biggest impact on site permit limits.

** To estimate the organically bound C-14 component of 'all other' 2022 site activity this report conservatively assumed that 1.23% of all activity (beta and alpha) is Carbon-14 – this is based on the waste fingerprint for reactors (Ref 7).

3.0 Impact on Current Site Permit Sub-limits and Site Limits

Comparing the estimated discharges from authorised gaseous outlets, from Table Two above, against current site annual limits demonstrates that the site limits are not sufficient to support planned work activities, as can be seen in Table Three below.

Table Three: Comparison of Estimated Annual Gaseous Discharges from Authorised Gaseous Outlets with Current Site Limits for Site Gaseous Discharges.

	Tritium (GBq)	Carbon 14 (GBq)	All Other (GBq)
Total Estimated Annual Gaseous Discharges from Authorised Gaseous Outlets	9.83	2.32	0.00067
Site Limits – Gaseous Discharges	20	2	0.003
% of Site Limits	49.15 %	116 %	22.3 %

Annual Site Limits for Gaseous Discharges (Table Three, Ref 1), as shown in Table Three above, apply to the cumulative gaseous discharges from both authorised gaseous outlets and from reactor breathing. The table above does not consider gaseous waste arising from reactor breathing. For completeness, Table Four, below, has been produced to compare the combined estimated annual discharges from both authorised gaseous outlets and from reactor breathing against the site limits. The table uses annual gaseous waste discharge results from 2022 for reactor breathing which are consistent with previous years.

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Table Four: Comparison of Estimated Annual Gaseous Discharges from Authorised Gaseous Outlets and Annual Gaseous Waste Arising from Reactor Breathing with Current Site Limits for Site Gaseous Discharges.			
	Tritium (GBq)	Carbon 14 (GBq)	All Other (GBq)
Total Estimated Annual Gaseous Discharges from Authorised Gaseous Outlets	9.83	2.32	0.00067
Annual Gaseous waste arising from reactor breathing	0.43	0.006	N/A
Site Limits – Gaseous Discharges	20	2	0.003
% of Site Limits	51.3 %	116 %	22.3 %
<p>From both Table Three and Table Four, above, it can be demonstrated that to enable planned decommissioning projects to run concurrently a variation to both the sub-limits and site limits contained within the current site permit (Ref 1) is required. In addition, it is recommended that the SILWE enabling permit variation should request Carbon-14 as an additional sub-limit. This will mirror the three site limit categories, shown above in Tables Three and Four.</p> <p>4.0 Recommendations <u>Changes to Table One: Authorised Disposals (Ref 1).</u></p> <p>It can be seen within Table Two of this calculation sheet that the estimated annual gaseous discharges from waste encapsulated within the SILWE facility, and subsequently stored within the ILWS, are by far the most significant contributors to the estimated total annual discharges from authorised gaseous outlets, i.e. greater than 99.8% of the total for both Tritium and Carbon-14.</p> <p>The estimated discharges are taken directly from Table 14 within report HNA/2981/PG/REP/1223 (Ref 4). It is recognised within the report (Ref. 4) that the estimates are based on a relatively limited data set, i.e. results from sixteen encapsulated boxes of solid ILW at Trawsfynydd. Also, section 5 of the report (Ref. 4) details a number of limitations and assumptions on which the estimates are based.</p> <p>It is reasonably foreseeable that actual discharges from both SILWE and the ILWS could be greater than the estimates used in this calculation sheet if any of the assumptions or limitations on which the estimates are based are shown to be invalid. In recognition of the relatively limited data set as well as the uncertainties regarding the limitations and assumptions on which the estimated annual gaseous discharges are based, and the potential for actual discharges from both SILWE and the ILWS to exceed the estimates it is recommended that the sub limits requested within the permit variation are approximately double the total estimated annual gaseous discharges in Table Four to accommodate discharges above the estimated values as a result of the assumptions and limitations on which the estimates are based being shown to be invalid.</p> <p>It is worth noting that in recognition of the uncertainties, there is a forward action (Ref. 4) to review the ILWS release estimate assumptions, BPM assessment and any Standard Reporting Values (SRV's) once monitoring data is gathered during the active commissioning of SILWE.</p>			

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This calculation sheet therefore recommends that the variation to enable the SILWE decommissioning project activities should request the following changes to Table One of the site permit (Ref 1).

- Increase the gaseous discharge outlets Tritium annual activity limit from 0.1 to 20 GBq.
- Introduce a new gaseous discharge outlets Carbon-14 annual activity limit of 5 GBq.
- The gaseous discharge outlet 'all other' annual activity limit to remain unchanged at 0.003 GBq.

The proposed new sub-limits for gaseous discharge outlets are shown in Table Five.

Table Five: Proposed Annual Activity Limits for the SILWE Permit Variation Application.

Description of Authorised Radioactive Waste	Specified Disposal Routes	Discharge Limits for each Specified Route	
		Radionuclide or Group of Radionuclides	Annual Activity Limit (GBq)
Gaseous	Gaseous Disposal Outlets specified in Table 2 of Permit	Tritium	20
		Carbon-14	5
		The total activity of all radionuclides excluding tritium and carbon-14	0.003

This table is a replicate of the Gaseous Disposal Outlets section in Table One of the site (Ref 1). Additional sub limits (not shown) are listed for gaseous discharges from reactor breathing which state an annual activity limit of 3 and 0.2 GBq for Tritium and Carbon-14, respectively. Sub-limits associated with reactor breathing are outwith the scope of this calculation sheet.

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<u>Changes to Table Three: Gaseous Discharge – Site Limits (Ref 1).</u>											
<p>Due to the uncertainties discussed above, Appendix B of the report HNA/2981/PG/REP/1223 (Ref 4) includes a more conservative annual estimate for both Tritium and Carbon-14 using the 95th percentile of the release fractions. This conservative estimate is summarised in the table below</p>											
<p>Table Six: Annual Gaseous Discharge Using 95th Percentile Release Fractions</p>											
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 70%;"></th> <th style="width: 15%;">Tritium (GBq)</th> <th style="width: 15%;">Carbon 14 (GBq)</th> </tr> </thead> <tbody> <tr> <td>Total Estimated Annual Gaseous Discharges from SILWE and ILWS Combined</td> <td style="text-align: center;">28.6</td> <td style="text-align: center;">6.5</td> </tr> </tbody> </table>					Tritium (GBq)	Carbon 14 (GBq)	Total Estimated Annual Gaseous Discharges from SILWE and ILWS Combined	28.6	6.5		
	Tritium (GBq)	Carbon 14 (GBq)									
Total Estimated Annual Gaseous Discharges from SILWE and ILWS Combined	28.6	6.5									
<p>It is recommended that the site limits requested within the permit variation are approximately one third greater than the total estimated annual gaseous discharges in Table Six to accommodate both the conservative annual estimate as well as gaseous discharges from potential emergent future decommissioning projects, including those that may result from changes in the sites decommissioning strategy, which may take place between the same period of 2025 to 2031.</p>											
<p>This calculation sheet therefore recommends that the variation to enable the SILWE decommissioning project activities should request the following changes to Table Three of the site permit (Ref 1).</p>											
<ul style="list-style-type: none"> • Increase the Gaseous Discharges Tritium Annual Limit from 20 to 40 GBq. • Increase the Gaseous Discharges Carbon-14 Annual Limit from 2 to 10 GBq. • The gaseous discharge outlet 'all other' annual activity limit to remain unchanged at 0.003 GBq. 											
<p>The proposed site limits accommodate the combined sub-limits for both reactor breathing and authorised gaseous outlets.</p>											
<p>Table Seven: Proposed Site Annual Limits for the SILWE Permit Variation Application</p>											
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 70%;">Radionuclide or Group of Radionuclides</th> <th style="width: 30%;">Annual Limit</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Tritium</td> <td style="text-align: center;">40 GBq</td> </tr> <tr> <td style="text-align: center;">Carbon-14</td> <td style="text-align: center;">10 GBq</td> </tr> <tr> <td style="text-align: center;">All other nuclides (excluding Tritium and Carbon-14)</td> <td style="text-align: center;">3 MBq</td> </tr> </tbody> </table>				Radionuclide or Group of Radionuclides	Annual Limit	Tritium	40 GBq	Carbon-14	10 GBq	All other nuclides (excluding Tritium and Carbon-14)	3 MBq
Radionuclide or Group of Radionuclides	Annual Limit										
Tritium	40 GBq										
Carbon-14	10 GBq										
All other nuclides (excluding Tritium and Carbon-14)	3 MBq										
<p>This table is a replicate of the Gaseous Discharges – Site Limits detailed in Table Three of the site permit (Ref 1). These limits accommodate the sub-limits detailed in Table Five.</p>											
<p>If other decommissioning projects which have not been captured in this calculation sheet are scheduled to be undertaken during the proposed six-year SILWE project duration period, then a new calculation sheet should be produced to assess the impact of these activities on the limits listed within the site permit.</p>											
<p><u>Review Requirement</u> This calculation sheet should be reviewed if the estimated gaseous discharges referenced in this report are revised.</p>											

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5.0 Dose Assessment

An assessment has been performed (Ref 8) to determine the maximum dose for the most exposed individual in the vicinity of Hunterston A Site based on the proposed site limits in Table Seven of this report. Section 5 of the assessment (Ref 8) concluded that the maximum total dose from gaseous discharges would be $0.94\mu\text{Sv/y}$. Despite a level of conservatism being applied to the proposed increased sub-limits and site limits, it can be seen that the dose consequence to the public based on annual discharges at a level equal to the site limits are very low.

Appendix A: PPSREP Annual Discharges

The PPSREP calculation sheet (Ref 3) estimates discharges against current site sub-limits, namely Tritium and 'All Other' activity so a direct comparison with the new C-14 proposed sub-limit is not possible.

The total activity generated from the PPSREP project is $4.98\text{E-}03$ GBq Carbon-14 and $2.09\text{E-}5$ GBq combined alpha and beta particulate activity (Table One; Ref 3). The more conservative activity (130 L sludge per can) is utilised for comparison of discharges against site sub-limits.

Carbon-14:

$4.98\text{E-}03 / 462$ cans = $1.08\text{E-}05$ discharges per can.

Process 16 cans per month over 12-month calendar year = $1.08\text{E-}05 \times 16 \times 12 = 2.07\text{E-}03$ GBq per year.

Alpha & Beta Particulate:

$2.09\text{E-}05 / 462$ cans = $4.52\text{E-}08$ discharges per can.

Process 16 cans per month over 12-month calendar year = $4.52\text{E-}08 \times 16 \times 12 = 8.68\text{E-}06$ GBq per year.