STATION REPORT - HNA/1002/TC/SR/1267
Hunterston A Site Environmental Authorisations (Scotland) Regulations 2018 Permit EAS/P/1173609 Variation Supporting Report for Solid Intermediate Level Waste Encapsulation (SILWE).
ISSUE 2

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Completed report retention period	Lifetime of HNA Site or until EA(S)R permit surrendered or revoked.
Legislation requirement/Reason for retention	EA(S)R permit EAS/P/1173609.
Trigger	EA(S)R permit EAS/P/1173609 variation.
Referenced in DPAF/Safety Submission No.	N/A

Published in the United Kingdom by Magnox Limited, Hunterston A Site, West Kilbride, Ayrshire, KA23 9RA.

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REVISION/REVIEW REGISTER

A REVIEW/CHANGE OF THIS DOCUMENT WAS CARRIED OUT AS FOLLOWS:

DATE/ ISSUE NO.	CARRIED OUT BY	SIGNATURE	AMENDMENT AND BRIEF REASON
June 23, Issue 1	[redacted]		First Issue
Sep 23, Issue 2		[redacted]	To include ILWS discharge grill as an authorised discharge point. Changes shaded in grey

1 INTRODUCTION

Solid Intermediate Level Waste (ILW) arisings from operational fuel route activities were stored in five purpose-built bunkers at the sites Solid Active Waste Building (SAWB). This waste consists of graphite (primarily discharged to bunkers 2 -5) and Magnox fuel element debris (FED; primarily discharged to bunker 1). A number of other wastes were also discharged to the bunkers and became intimately mixed with the graphite and Magnox FED. This mixed waste is currently being retrieved and stored in stainless steel $3m^3$ boxes, in line with the site's Baseline Decommissioning Strategy HNA/2981/PJ/SR/1131 (*Ref. 2*) as amended by M/WF/GEN/REP/0003/15 (*Ref. 3*) with encapsulation planned to passively store the waste on site until a final disposal route became available. The site Lifetime Plan (LTP) allows these encapsulated wastes to be stored on site for up to 300 years (*Ref. 4*). Retrieval of these wastes is scheduled to be completed in 2023.

Hunterston A Site is authorised under the Environmental Authorisations (Scotland) Regulations 2018 to dispose of radioactive gaseous waste via "Authorised gaseous outlets", specified in Table 2 of Hunterston A Site Environmental Authorisations (Scotland) Regulations 2018 permit EAS/P/1173609 (*Ref. 1*). In 2019, an application to vary the permit was made to support this work, however this was subsequently withdrawn. Since then, additional work has been carried out to further underpin the BPM study.

In brief, the options assessment, inventory, estimated gaseous discharges and optimisation report have all been reviewed. Data from similar work undertaken at a sister Magnox site has been utilised to underpin both the gaseous discharge assessment and demonstration that the selected option – to encapsulate the waste in $3m^3$ stainless steel boxes - is the BPM option (*Ref. 8*). The timeline for this work has also been refined and is now anticipated to take 6 years (previously this was 2 years).

2 SCOPE

This report will detail the variations required to be made to the Hunterston A Site EA(S)R permit EAS/P/1173609 to enable the authorised discharge of gaseous waste from the SILWE facility and the Intermediate Level Waste Store (ILWS). Namely, the addition of this new discharge locations to Table 2, and an amendment to annual activity limits for gaseous disposal outlets in Table 1 and gaseous discharge site limits in Table 3 of the permit (Ref 1).

3 METHOD

In order to underpin this application, various reports have been produced to support the selected BPM option. These look at the different aspects of radioactive gaseous waste evolution in both the encapsulation plant (SILWE), where the gaseous wastes will be produced, and at the Intermediate Level Waste Store (ILWS) where the grouted, passively safe waste will go for interim storage prior to final disposal.

3.1 Bunker Waste Inventory

The bunker waste inventory was reviewed with further characterisation work performed in 2021 (*Ref. 6 & 7*). In brief, modern modelling tools were employed utilising less conservative 'best estimate element precursors' for neutron activation and bunker filling histories were utilised to refine decay times and irradiations experienced by waste materials in the bunkers. A summary of the bunker waste inventory is detailed in section 1.3 of the review of options assessment (Ref 11). This data was used as the basis for determining gaseous discharges (Ref 8).

3.2 BPEO Options Assessment

The Options Assessment report was initiated to determine if the existing strategy for management of the bunker waste remained the preferred option (Ref 11). The site aims to encapsulate these wastes in a purpose-built facility, the Solid Intermediate Level Waste Encapsulation (SILWE) Plant before returning them to the Intermediate Level Waste Store (ILWS) to await a final management solution, in line with Scottish Policy. The Scottish Higher Active Waste policy is near site, near surface with facilities to store, treat and dispose of HAW located as close to the source of the waste as practicable (*Ref. 5*).

The options report aimed to determine if this 'baseline option' remained the optimal management strategy for wastes from all bunkers. Separate options are listed for wastes from bunker one (primarily Magnox FED; Section 5 of Ref 11) and bunkers two to five (primarily graphite; Section 4 of Ref 11). Figure 2 (of Ref 11) provides an overview of the shortlisted options considered in this report. The report concludes that encapsulation followed by storage (Option G1) remained the preferred option for Graphite as gasification (the only alternative option) scored more poorly in each attribute (Section 4.3 of Ref 11). The six options shortlisted for managing the Magnox waste from bunker One are detailed in Section 5.2 (of Ref 11). Several treatments were selected as options however as these options had health & safety risks from construction of new facilities, additional radioactivity discharged to the environment, technical/development challenges & cost (i.e. vitrification, dissolution). Therefore, they were not preferred. Option M1 - encapsulation followed by storage performed best overall (Section 5.4 of Ref 11). The next best option identified was to sort and decay store the Magnox waste (Option M2). The advantages of this approach are clearly demonstrated in the 'weighted average activity per waste stream/item' table shown in Appendix F with the accompanying text stating that segregated Magnox waste in its raw form could be considered low level waste by 2035. The benefits and risk of pursuing this alternative option are provided in section 6.3.4 (of Ref 11) titled 'would another option be preferable?'. In brief, there is likely to be an amount of Magnox which cannot be adequately segregated for the LLW route. The additional waste handling would result in increased operator and public dose and existing facilities are not suited to sorting this waste so a new facility would be required with associated costs. There would also be greater uncertainty with management of the segregated non-Magnox wastes.

Foreclosure of future options following encapsulation of the bunker waste was also addressed. Currently, the majority of the bunker waste has been retrieved into $3m^3$ stainless steel boxes, with completion anticipated later in 2023. The stainless-steel boxes were designed to safely contain encapsulated waste in accordance with the baseline option, rendering this waste passively safe for interim storage on site until a disposal strategy was available. Continuing to store the un-passivated waste in these boxes i.e. do nothing, to safe guard future options, is unproven as that is not the design intent of these receptacles, see Section 6.3.2 (of Ref 11) for further details. This report (Ref 11) provides additional information on potential foreclosure of future options in Section 6.2 'Risks Associated with the Lead Options'.

3.3 SILWE Facility

The primary purpose of the SILWE facility is to encapsulate radioactive solid waste that has been retrieved from the Solid Active Waste Bunkers on the Hunterston A Site. There is expected to be approximately 1200 boxes of ILW encapsulated in the SILWE facility over a 6-year period. The waste is contained in $3m^3$ stainless steel boxes (currently stored unencapsulated at the ILWS) and will be transported into SILWE where the boxes of waste will be filled and capped using grout.

3.4 Estimated Gaseous Discharges

The process of mixing and curing of the grout with the waste results in a temperature elevation within the boxes and a chemical reaction (of the grout mixture with the waste) which promote the evolution of hydrogen gas, tritium and carbon-14 radioactive gaseous emissions. Radioactive gaseous particulate will also be produced when the grout is initially poured into the boxes. The exact mechanisms for the generation of gaseous emissions, the concentrations, volumes, and total activities of gaseous emissions, and consequences of these gaseous emissions, are all assessed and detailed in Magnox report HNA/2981/PG/REP/1223 – "Assessment of Hunterston A SILWE Gaseous Radioactive Discharges in relation to Best Practicable Means requirement" (Ref.8). This report was revised to include recent live data from another Magnox site, also utilising this process.

In addition to the assessment of gaseous radioactive discharges, a separate assessment was carried out to look at possible abatement technologies that could be utilised within the facility to mitigate any environmental impact arising from the discharge of radioactive gaseous emissions from SILWE. Details of abatement technologies considered and the reasoning behind either their inclusion or exclusion from utilisation within the SILWE grouting process can be found in Magnox report HNA/2981/PG/SR/1229 – "A review of abatement technology for tritium and carbon-14 at Hunterston A SILWE facility & Intermediate Level Waste Store" (Ref.9).

3.5 Optimisation/BPM Assessment

The findings of the aforementioned reports (Ref. 8, 9 and 11) have been used to carry out an optimisation/Best Practicable Means (BPM) assessment of the chosen option. Details of the optimisation carried out and reasoning behind the conclusions arrived at are detailed in, HNA/2940/TC/SR/1261 Issue 3 June 2023, Optimisation (BPM) Summary for Implementation Of The SAWB Waste Management Strategy (Ref 10). There is a forward action (in Ref 10) to review and update the optimisation arguments specifically for the SILWE facility.

It is a requirement of the site EA(S)R permit that gaseous discharges from the site are adequately assessed and reported to the regulator on a monthly basis. The methodology of how the assessment is carried out is determined through guidance issued by the Scottish Environment Protection Agency (SEPA), Radiological Monitoring Technical Guidance Note 1 "Standardised Reporting of Radioactive Discharges from Nuclear Sites" (Ref.12). The content of this guidance is incorporated into Magnox company standard S-070 (Ref.13) which requires sites to make an assessment of the gaseous discharges from each of its authorised outlets and determine the appropriate method of assessing and reporting its discharges to the regulator, through which it can be demonstrated from a company level that BPM is being applied. There is a forward action (in Ref 10) to review and update the gaseous discharge sampling BPM forms (from Ref 13).

There will be no radioactive liquid discharges from SILWE and it is assumed that minimal secondary solid radioactive waste will be produced, this assumption requires further assessment and is captured as a forward action in Ref 10. The details of this are given in the optimisation/BPM report (Ref 10).

3.6 ILW Store

The primary purpose of the ILWS is the interim long term storage of packages of Intermediate Level Waste generated on the Hunterston A Site prior to final disposal. This is in accordance with Scottish Government policy which requires the long-term management of higher activity radioactive waste be in near-surface facilities and that these facilities should be located as near to the site where the waste is produced as possible. Grouted waste packages from the SILWE facility are transferred to the store after an initial period of curing. The majority of off gassing from the grouted packages is envisaged to take place within SILWE

as the boxes are held within the grouting stations for the first 56 hours after grouting, they are then transferred to the quarantine line for a further period of curing. After the initial grout-curing period, the boxes are transferred to the ILWS for final storage, during this time off gassing of hydrogen, tritium, and carbon-14 will continue, albeit at greatly reduced levels compared to off gassing during their presence in SILWE (which will be no less than 168 hours). An assessment of the levels of tritium and carbon-14 that will arise within the store and consequently be discharged from the store has been carried out, the details of which can also be found in (Ref.8).

Due to the nature of radioactive gaseous arisings within the ILWS, particulate abatement on the store ventilation system would not be effective due to the fact that tritium and carbon-14 will be in the gaseous form and will not be abated by conventional filtration type abatement. As the case has been made that gaseous discharges from SILWE will be of such levels that tritium and carbon-14 abatement would not represent BPM (Ref.9), the same case can be applied to the ILWS as discharges from here will be a lower than those from SILWE. It is not envisaged that there will be any particulate emissions from the store as the waste will be bound in a grout matrix within the boxes.

Optimisation/BPM assessment of the storage of encapsulated boxes within the ILWS, is also detailed in Ref 10.

In addition, a BPM assessment (Ref.14) was written to assess the need for a discharge stack at the ILWS compared to the existing discharge grill. It concluded that the installation of a discharge stack at the ILWS would not be BPM.

As with SILWE the techniques for assessment and reporting of gaseous wastes from the ILWS is detailed in Magnox company standard S-070 (Ref.13), through which it can be demonstrated from a company level that BPM can be applied. As with SILWE there is a forward action (in Ref 10) to review and update the gaseous discharge sampling BPM forms (from Ref 13).

It is assumed that a small amount of H-3 and C-14 from the off gassing from packages received from SILWE may transfer into the condensate (from the heated and dried re-circulated ILWS vault ventilation air). There will be no secondary solid radioactive waste produced in the ILWS. The details of this are given in the optimisation/BPM report (Ref 10).

4 RESULTS SUMMARY

- Discharge assessment reports for SILWE and ILWS (Ref.8) give estimates of peak annual gaseous discharges to be :-

Table 1

		Peak Annual Discharges (GBq)			
SILWE Facility				ILWS	
Tritium	Carbon-14	Alpha Particulate	Beta Particulate	Tritium	Carbon-14
7.62	2.0	2.62E-8	2.33E-6	2.19	0.32

- SILWE and ILWS review of abatement technology report (Ref.9) and subsequent Optimisation assessment for the SILWE facility (Ref.10) conclude that it would not represent best practicable means to install abatement technology for gaseous tritium and carbon-14 emissions, however particulate abatement will be applied on the SILWE ventilation system.

- The discharges from SILWE and the ILWS would represent an annual dose to the public of 0.148uSv/y and 0.025uSv/y respectively.

- Discharge assessments for the purpose of regulatory reporting will be carried out through the use of sampling and analysis for tritium, carbon-14, and radioactive particulates in the SILWE facility. A standard reporting value will be used tritium and carbon-14 for the ILW store.
(Ref.13) which requires sites to make an assessment of the gaseous discharges from each of its authorised outlets and determine the appropriate method of assessing and reporting its discharges to the regulator, through which it can be demonstrated from a company level that BPM is being applied.

- All forward action actions from the BPM/optimisation report (Ref 10) are tracked on site using the QPulse system.

5 CONCLUSIONS

Based on the information presented in this report, it is the intention of Hunterston A Site to apply for a variation to its current EA(S)R Permit, EAS/P/1173609, that will extend the list of authorised gaseous outlets (Table 2 of the permit) to include SILWE and the ILWS and to increase the subsidiary limits for authorised gaseous outlets (Table 1 of the permit) and increase the site limits (Table 3 of the permit), as determined by Ref 15, which takes into account extant discharges and future discharges from other decommissioning project work . This would effectively change the limits for gaseous discharges from authorised gaseous outlets and site limits as per Table 2 and 3 (respectively) below:-

Table 2

Authorised Outlet, Group of Outlets or other discharge route.	**Radionuclide or Group of Radionuclides**	**Current Annual Limit**	**Proposed Annual Limit**
All authorised outlets specified taken together.	Tritium	0.1GBq	20 GBq
	Carbon-14	N/A	5 GBq
	All other radionuclides (excluding tritium and gaseous carbon-14)	0.003GBq	0.003 GBq
Discharges made as a consequence of reactor breathing.	Tritium	3GBq	3 GBq
	Gaseous Carbon-14	0.2 GBq	0.2 GBq

These new proposed sub limits are intended to give sufficient "headroom."

Table 3

Radionuclde or Group of Radionuclides	**Current Annual Limit**	**Proposed Annual Limit**
Tritium	20 GBq	40 GBq
Carbon-14	2 GBq	10 GBq
All other radionuclides (excluding tritium and carbon-14)	0.003GBq	0.003GBq

The proposed site limits comfortably accommodate the combined sub limits for reactor breathing, gaseous outlets and any potential future decommissioning projects.

- **Transboundary Assessment**

The Transboundary Radioactive Contamination (Scotland) Direction 2021 [16] is the direction under which SEPA must consider the transboundary impacts of radioactive waste disposal. Under this directive SEPA must consider whether these plans (outlined in this station report) 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.
[17] assessed whether a Transboundary Consideration Assessment is required. The report concluded 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 [18]. It is concluded there will be no exceptional pathways of exposure to notifiable countries from the proposed increase in gaseous limits.
Magnox Ltd concludes a transboundary consideration assessment for this variation application is not required

6 REFERENCES

1. EAS/P/1173609 - Hunterston A Site Radioactive Substances Permit under the Environmental Authorisations (Scotland) Regulations 2018.
2. E. Sales, "Hunterston A Solid Active Waste Building Bunkers Waste (9J18-9J30 / 9J35-9J42 / 9J44), Best Practicable Environmental Option (BPEO) / Strategic Options Assessment," HNA/2981/PJ/SR/1131, Issue 1, November 2012"
3. E. Bridgewater, "LC35 Change Justification, Scottish Sites Long-term Storage Strategy," M/WF/GEN/REP/0003/15, Issue 1, September 2015.
4. HNA lifetime plan (LTP) - HNA MSS-P – Hunterston A Management MSS
5. Scottish Government, "Implementation strategy for Scotland's policy on higher activity radioactive waste," December 2016
6. J. Weatherill, Hunterston A Solid Active Waste Bunker (SAWB) Inventory Review, M/EF/HNA/EAN/0002/21: Issue 1, April 2021.
7. J. Weatherill, "Calculation of Radiological Inventories for the Hunterston A Solid Active Waste Bunkers (SAWB)," M/EF/HNA/EAN/0003/21, Issue 1, June 2021.
8. HNA/2981/PG/REP/1223 Issue 3, June 2023 – "Assessment of Hunterston A SILWE Gaseous Radioactive Discharges in relation to Best Practicable Means requirement"
9. HNA/2981/PG/SR/1229 Issue 1, June 2018 – "A review of abatement technology for tritium and carbon-14 at Hunterston A SILWE facility & Intermediate Level Waste Store"
10. HNA/2940/TC/SR/1261 Issue 3 June 2023, Optimisation (BPM) Summary For Implementation Of The SAWB Waste Management Strategy
11. WD/REP/0032/21 Issue 2, May 2023 – 'Review of Options for Managing Waste from the Hunterston A Solid Active Waste Bunkers given its Status at May 2021'.
12. Radiological Monitoring Technical Guidance Note 1 "Standardised Reporting of Radioactive Discharges from Nuclear Sites"
13. S-070, Issue 3, Mar 2017 – "The Assessment of Radioactive Gaseous Discharges"
14. HNA/2865/PJ/PR/1072 – Options assessment for radioactive gaseous discharges from SAWB encapsulated waste in the ILW Store'
15. HNA/3800/TC/CS/1534 Issue 4, June 2023 – Impact of SILWE Gaseous Discharges on Site Permit Limits
16. *The Transboundary Radioactive Contamination (Scotland) Direction 2021*
17. HNA/8100/PG/PR/1071 Screening to determine whether a Transboundary Consideration Assessment is required for Hunterston A's proposed variation to authorisation limits
18. Environmental Authorisations (Scotland) Regulations 2018, Guidance on the Application Form for a PERMIT for the management of Radioactive Substances not involving Sealed Sources, V5, March 2023

Appendix A
Forward Actions for EASR Permit Application

Forward Action	Reference Document	Q Pulse Action Reference
HEPA filtration in terms of demonstrating BPM for the whole of the Hunterston A Site will be reviewed and the maximum gaseous discharges as a result of solid ILW processing shall be updated(if required) at the same time.	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION11199/1
A review of radioactive liquid waste discharges abatement for the whole site to be carried out.	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION11199/2
An estimate of secondary solid radioactive wastes is to be produced (as per normal site procedures) for SILWE active operations and optimisation of this waste production assessed.	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION11199/3
An application to SEPA for a variation to the EASR18 permit (EAS/P/1173609), is required before active operation of the SILWE facility (and storage of grouted packages in the ILWS), to increase the Site Limits (table 3 of the permit) in table 1 (authorised disposals)	HNA/2940/TC/SR/1261 (SAWB Wastes BPM) & HNA/2981/PG/REP/1223 (SILWE/ILWS gaseous discharge assessment	ION11199/4) **COMPLETE**
SILWE grout plant; sequence is to be reviewed prior to start of operations and then again once there is some experience on the plant to ensure minimisation of waste grout and water usage.	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION11199/5
Develop list of SILWE Engineering Controls (gaseous releases) and maintenance and testing arrangements	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION11199/6

SILWE Project Team to review for SILWE plant, there is an opportunity to explore potential additional optimisation of the SILWE plant prior to active operation.	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION11199/7
Environmental Performance Criteria to be determined and management of these criteria to be established.	HNA/2940/TC/SR/1261 (SAWB Wastes BPM) & HNA/2981/PG/REP/1223 (SILWE/ILWS gaseous discharge assessment	ION11199/8 & ION11199/9
Review gaseous sampling BPM forms for SILWE and ILWS	HNA/2940/TC/SR/1261 (SAWB Wastes BPM) & HNA/2981/PG/REP/1223 (SILWE/ILWS gaseous discharge assessment	ION12229/1
Develop a processing philosophy for the sequence of boxes to be processed from Bunkers 2-5 across the 4.5 years. This needs to address the potential variations in discharges between the bunker wastes.	HNA/2981/PG/REP/1223 (SILWE/ILWS gaseous discharge assessment.	ION12229/2
Review the release estimates in the ILWS once data is obtained during active commissioning of SILWE. Review also the BPM and any SRV's.	HNA/2981/PG/REP/1223 (SILWE/ILWS gaseous discharge assessment	ION12229/3
Monitor releases from SILWE in the three phases set out in the recommendations. This will inform a review of the estimated release fractions and discharges presented in this report. Phase 1: Request to Central Engineering should be made by October 2024(via PF-001 form), EAN to be produced by end of January 2025 prior to active commissioning commencing in October 2025.	HNA/2981/PG/REP/1223 (SILWE/ILWS gaseous discharge assessment	ION12229/4

Waste Manager to confirm that the ILWS Standard Reporting Value recorded in HNA/1002/TC/REP/157 'F-016 Part D - Application of Standard Reporting Value – Intermediate Waste Store (ILWS)' has been reviewed and amended as required during SILWE Active Commissioning and the Outcome has been reported to the EHSS&Q Environment Advisor (Rad).	HNA/2865/PJ/PR/1072	ION12229/5
EHSS&Q Environment Advisor (Rad) to review report 'HNA/2865/PJ/PR/1072 – "Options assessment for management of radioactive gaseous discharges from encapsulated waste packages processed through the Solid Intermediate Level Waste Encapsulation facility (SILWE) and stored within the Intermediate Level Waste Store (ILWS)." following SILWE Active Commissioning and Amend as Required.	HNA/2865/PJ/PR/1072	ION12229/6
Non-radioactive releases from chemical reaction between cement and solid ILW to be assessed	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION12229/7 **COMPLETE**
Monitor releases from SILWE in the three phases set out in the recommendations. This will inform a review of the estimated release fractions and discharges presented in this report. Phase 2 - Request to Central Engineering should be made by January 2026 (via PF-001 form), EAN to be produced by end of March 2026 prior to active operations of	References:HNA/2981/PG/REP/1223 (SILWE/ILWS gaseous discharge assessment)	ION12229/8

bunker 1 encapsulation commencing in June 2026.		
Monitor releases from SILWE in the three phases set out in the recommendations. This will inform a review of the estimated release fractions and discharges presented in this report. Phase 3: Request to Central Engineering should be made by January 2027(via PF-001 form), EAN to be produced by end of May 2027 prior to active operation of bunker 2-5 waste encapsulation, commencing in January 2028	HNA/2981/PG/REP/1223 (SILWE/ILWS gaseous discharge assessment	ION12229/9
Ensure all Forward actions within the following document have been closed out, HNA/1002/TC/SR/1267: Hunterston A Site Environmental Authorisations (Scotland) Regulations 2018 Permit EAS/P/1173609 Variation Supporting Report for Solid Intermediate Level Waste Encapsulation (SILWE)	HNA/1002/TC/SR/1267	ION12229/10
Sample and assess ILWS ventilation system condensate prior to active commissioning of SILWE to establish baseline H-3 and C-14 levels.	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION12229/11
Sample and assess ILWS ventilation system condensate during active commissioning and operation of SILWE to determine if the H-3 and C-14 off-gassing from the SILWE packages in the ILWS transfers to the condensate. If confirmed H-3	HNA/2940/TC/SR/1261 (SAWB Wastes BPM)	ION12229/12

and/or C-14 is present in the condensate, review and amendment of HNA/2940/TC/SR/1261 'Optimisation (BPM) Summary for Implementation of the SAWB Waste Management Strategy' shall be performed.		