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OPTIMISATION (BPM) SUMMARY FOR IMPLEMENTATION OF THE SAWB WASTE MANAGEMENT STRATEGY
ISSUE 4

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June 2023 issue 3	[redacted]	[redacted]	Minor update(highlighted in grey) to include revised SILWE/ILWS radioactive gaseous discharge estimates
September 2023 issue 4	[redacted]		Updated to include ILWS discharge grill to be discharge point, additional FAP to check ILWS ventilation condensate for radioactivity, update to includes FAPs that have been completed. Changes shaded in grey.

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OPTIMISATION (BPM) SUMMARY FOR IMPLEMENTATION OF THE SAWB WASTE MANAGEMENT STRATEGY

EXECUTIVE SUMMARY

Radioactive waste has accumulated at Hunterston 'A' Power Site (HNA) over its operating life and during initial decommissioning. These wastes include solid Intermediate Level Waste (ILW) comprising fuel element component debris which accumulated in the Solid Active Waste Bunkers (SAWB). The management strategy for these wastes is to retrieve and package them for encapsulation and interim storage on-site pending final management off-site [1].

The HNA Solid Active Waste Bunker Retrieval (SAWBR) facility has been developed to provide the safe retrieval, processing and packaging of these solid ILW streams. The Solid Intermediate Level Waste Encapsulation (SILWE) facility has been developed to provide immobilisation of these solid ILW waste streams. The Intermediate Level Waste Store (ILWS) has been developed for the safe interim storage of packaged and immobilised ILW.

Since 2014 these wastes have been retrieved and packaged within the purpose-built SAWBR into 3m^3 boxes. These boxes are being buffer stored in the ILWS awaiting availability of SILWE. When it becomes available, the boxes will be transferred to SILWE for immobilisation of the wastes. The boxes will be transferred back to and be stored on site in the ILWS until a final management solution becomes available.

This report summarises how Best Practicable Means (BPM) are being applied during implementation of the SAWB waste management strategy. It does so by considering the three stages of its on-site implementation: retrieval, encapsulation, and storage. It does so by assessing the potential waste arising from these stages and the techniques applied to prevent or minimise discharges to the environment and minimise the radioactivity in any waste being discharged.

This assessment concludes that the retrieval, encapsulation and storage processes identified as the chosen option [1] have been optimised and represent BPM. Air emissions are controlled by a number of optimisation and abatement techniques to minimise emissions. Liquid discharges are not produced during the primary processing of the wastes, although small quantities will be produced during hand washing and showering by operatives following entry to radioactively contamination-controlled areas for maintenance activities, these liquid discharges will be controlled through abatement using the sites Active Effluent Treatment Plant to minimise emissions.

Triggers for Review

This optimisation (BPM) assessment shall be reviewed when:

- A waste estimate is produced that details the secondary solid low level waste and flushing water/grout plant non-radioactive waste that will be produced during active operations of SILWE. This BPM shall then include ways of optimising that waste.
- When any FAP actions are completed
- If there are any fundamental changes to the chosen option or associated facilities
- As a minimum every 5 years [33]

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OPTIMISATION (BPM) SUMMARY FOR IMPLEMENTATION OF THE SAWB WASTE MANAGEMENT STRATEGY

1 INTRODUCTION

A recent strategic options assessment has been carried out to determine the management strategy for waste originating from the Solid Active Waste Bunkers (SAWB) at the Hunterston A (HNA) site. The "proposed option", herein referred to as the SAWB Waste Strategy, from this strategic options assessment is to manage all intermediate level waste (ILW) from the SAWB by encapsulation for interim storage pending final management (envisaged to be off-site disposal) [1].

This report summarises how Best Practicable Means (BPM) are being applied during implementation of the SAWB Waste Strategy. It does so by considering the three stages of its on-site implementation: retrieval, encapsulation, and storage.

1.1 BPM Requirement

The Environmental Authorisations (Scotland) Regulations 2018 (EA(S)R18) [2] standard condition B.2.2 states that those involved in authorised radioactive substances activities "must optimise the approach to the management of radioactive waste taking account of all waste streams and disposals expected from current and future operations." Standard condition G.1.4 requires BPM to be used "to minimise the quantity of radionuclides that are discharged." Standard condition G.1.5 requires BPM to be used to "dispose of radioactive waste in a manner that minimises public exposure and impact on the environment."

In addition, the Scottish Environment Protection Agency (SEPA) impose [3] the following BPM requirements on those carrying out radioactive substances activities:

1. *Use BPM to minimise the activity and volume of radioactive waste generated*
2. *Use BPM to minimise the total activity of radioactive waste that is discharged to the environment*
3. *Use BPM to minimise the radiological effects of radioactive discharges on the environment and members of the public*

SEPA note that applying these three requirements as absolute requirements would not only be impossible but would also be disproportionate; therefore these requirements need to be supplemented to take account of what is both reasonable and practicable. SEPA do this by requiring those carrying on radioactive substances activities to use BPM to achieve each of the above three goals [3].

2 APPLICATION OF BPM TO IMPLEMENTATION OF THE SAWB WASTE STRATEGY

The demonstration of the application of BPM will apply the claim, argument, evidence structure for each of the SAWB on-site waste management stages (retrieval, encapsulation, and storage). The definition of each element of the structure is provided below:

Table 1: Claim, Argument, Evidence Structure

Element	Definition
Claim	A statement as to what we believe we have achieved. In this context such a BPM claim would typically demonstrate compliance with a specific condition requirement of the EASR18 Permit.
Argument	A series of considerations that, when taken together, demonstrate that all 'claims' are valid.

Evidence	Information that demonstrates that the arguments are underpinned with comprehensive data that can be readily examined and challenged where necessary. Evidence can be broadly categorised as supposition, knowledge, or fact: • *Supposition* (I think): Evidence that is based on the views of individuals. • *Knowledge* (I know): Evidence based on individuals' qualifications and experience. • *Fact* (I can show): Evidence that can be validated and is from a reputable, auditable source). To demonstrate that the BPM arguments are robust, supporting evidence must be identified / developed and the links with the BPM arguments recorded.

These elements have been applied to assess whether BPM is being applied during implementation of the SAWB Waste Strategy. The following sections set out the arguments and evidence supporting the claim that EA(S)R18 standard conditions relating to BPM are being met during each waste management stage.

1.2 Retrieval

1.2.1 SAWBR Facility Description

Solid ILW has been produced during operation of the twin Magnox reactors at Hunterston A Site. This waste was stored within the five bunkers in the SAWB. Bunkers 1, 2 and 3 were constructed as part of the station build in the 1960's with bunkers 4 and 5 added in the 1980's to provide additional storage. The bunkers are above ground and approximately 8m x 9.5m x 10m high with a total capacity of approximately 3800 m^3. The bunkers contained approximately 2500 m^3 of waste in total. The waste comprises:

- Fuel Element Debris (FED) – consisting mainly of Magnox splitters (removed from the fuel elements before the elements were sent to Sellafield for reprocessing) and graphite.
- Miscellaneous Contaminated Items (MCI) – consisting mainly of filters, vacuum cleaner debris, incinerator ash, graphite dust and decontaminating material.
- Miscellaneous Activated Components (MAC) – consisting mainly of absorber bars, thermocouple and support cables, redundant desplittering equipment and Fuel Support Members (FSM's).

The Solid Active Waste Building Retrieval (SAWBR) facility has been operational since 2014. It is a reinforced concrete structure located in the Radiological Controlled Area (RCA) directly adjoining the east end of the SAWB, adjoining bunker 5. Located on the ground floor is the Import / Export Bay, the Box Preparation Area and the Process Area. Located on the first floor is the Box Transfer Area. Heating Ventilation Air Conditioning (HVAC) plant and fans is housed on the second floor and the structure above this floor forms the building external envelope and roof.

During operation, the waste retrieval process includes the following steps (extracted from [4]):

- Breakthrough – Breakthrough into the Bunkers has been achieved by a combination of diamond wire cutting techniques, primarily to separate and release the bulk of the concrete mass from bunker wall, followed by final breakthrough into the bunker compartment using a Remotely Operated Vehicle (ROV), starting with Bunker 5.
- Box import – 3m^3 boxes are delivered to the Import / Export Bay by a vehicle with a weatherproof system. The box is hoisted, and transferred via crane, through the Box Transfer Area and lowered into the Box Preparation Area onto a bogie. The lid bolts are removed and stored in the

Box Preparation Area prior to the box being driven, on the bogie, through to the Process Area. At this point its lid is removed.

- Waste retrieval – An ROV enters the Bunker and fills a bucket with waste following sorting to the requirements of the Letter of Compliance (LoC) which includes visually inspecting for the presence of uranium fuel rods (and segregating them if any are found). The bucket is then be transported by a conveyer to the box location in the Process Area.
- Box filling – The box is raised and the waste emptied through a waste chute into the box using an elevator / tipper arrangement. This process is repeated until the operator deems that the box is ready for lid replacement.
- Box closure and export checks – When the box is deemed full, the waste chute is retracted and the lid located back on the box. The box is then be transferred to the Box Preparation Area. Here the box has the lid bolts replaced and secured. The box is then swabbed on all sides and contamination readings taken from the swabs (this was carried out during active commissioning until confidence was gained in relation to the containment system, following that box swabbing was reduced to just swabbing the box top). If acceptable the box is then raised on the export hoist to the Box Transfer Area and a multi point dose rate survey undertaken.
- Box export – The Cross Site Transporter (XST) is raised by adjustable suspension until the top of the shielded overpack is inside the concrete docking snout attached to the Import / Export Bay roof. The filled box is then lowered into the overpack and the overpack closed. The XST can then leave the Import / Export Bay for its onward journey to the ILWS / SILWE.
- In addition to bulk waste retrieval, "fines" will also be retrieved. These are particulate dry graphite and dry sludge which remain on the SAWB bunker floors after bulk waste is retrieved. The fines are vacuumed into $3m^3$ boxes which contain special liners to allow the Fines to be processed.

All routine operations are performed remotely, without personnel being present within the areas, except for the import / export area where the XST driver returns to his vehicle once the $3m^3$ box is imported into the XST shielded overpack. In addition, access to other low radiation dose rate areas is permitted during processing.

Note 1 - A Cross Site Transporter 2 (XST2) was introduced during 2016. The XST2 concept was for a simplified design over the XST 1 system, incorporating a standard 'off the shelf' forklift truck (FLT) designed to carry a fit for purpose shielded over pack containing waste packages. The intent was to build on experience gained from use of XST1 to reduce the level of complexity of the system, increasing reliability, reducing maintenance burden and ultimately increasing availability of the system [5].

Note 2 – Retrievals of SAWB wastes from bunkers 2-5 is complete. The LoC from Radioactive Waste Management Ltd (now Nuclear Waste Services – (NWS)) for these wastes accepted the probability of fuel debris from these wastes was very low and no additional measures for fuel detection were specified when retrieving the waste into final packages. Based on experience from other sites and the perceived higher probability of fuel debris in Bunker 1, agreement was reached with NWS that a fuel detection system (FDS) would be installed within the in-line waste recovery process in SAWBR to supplement visual identification and reduce the likelihood of undetected fuel debris being carried over within the Bunker 1 waste packages [6].

1.2.2 SAWBR BPM Assessment Summary

For this BPM assessment (gaseous radioactive waste production and release, solid waste production, and liquid radioactive waste production and release):

- the **claim** is that EASR18 standard conditions relating to BPM have been met,

- the **arguments** relating to optimisation and abatement are set out in the tables below,
- the **evidence** is referenced, where applicable.

Table 2: BPM Arguments and Evidence for Retrieval of SAWB Waste

Solid Radioactive Waste	
Existing Assessments (Primary ILW)	The primary wastes within SAWB bunkers have been deemed ILW and the preferred option for their management has been detailed in [1] and the optimisation argument made in this report when taken together with [1] constitutes BPM. Several process improvements were made to improve packing efficiencies etc to minimise the number of packages produced. • The process control system was altered to allow for additional levelling operations of the waste within the boxes. • The optimum levelling robot path was identified • The option of repeating the final sweep of the levelling robot tool was added, following operational experience, this will deal with any waste "flip up" or surface to be "ploughed." Thiese above improvements has allowed wastes to be "pushed" into the free ullage space internal to the box tops. This has reduced the number of boxes from 1578 to 1220 [7]. HEPA filters from the SAWBR ventilation plant have also been categorised as ILW, it had been anticipated that these would be categorised as LLW once the filters reached a certain dose rate [8], but it was found that this would have resulted in an increased volume of waste as the filters would have been changed more frequently. Therefore a judgement was made on the balance of many LLW filters against a few ILW filters (approximately 2 filter changes per year).
Existing Assessments (Secondary LLW)	An assessment for secondary solid LLW was produced in 2009 and reviewed in 2018 [9]. This did not estimate volumes of solid LLW (ie general soft wastes from maintenance etc), however from bunker wall breakthrough (to access each bunker), 7m^3 of VLLW/LLW concrete was estimated to have been produced (this has not been documented, this is based on knowledge from the Nominated Responsible Engineer). See above for HEPA filters, these have been added to the primary ILW inventory hence the presence in the box above although technically they are secondary wastes.
Optimisation	**Facility Design** • the design and construction of the SAWBR facility considered the most suitable surfaces and coatings, which may be subject to possible contamination, in order to facilitate decontamination and therefore minimise the generation of secondary wastes. • All equipment shall utilise sealed components, where possible, with surfaces which facilitate their decontamination. • Areas identified as contamination controlled areas have their walls and floors treated with a smooth, painted impervious surface that can be easily wiped clean if particulate matter settles on surfaces.

	• ILW processing is carried out remotely with operators working in non-radioactive contamination controlled (clean) areas (therefore normal ILW retrieval operations does not create secondary solid LLW - only normally created during maintenance activities). **Facility Operations** • ILW processing efficiencies have been implemented to minimise the number of ILW 3m³ boxes produced, therefore minimising maintenance activities, required for box handling equipment, for the lifetime of the project and therefore minimising secondary wastes. • During box filling with ILW, the boxes are sealed to the filling chute, the purpose of the seals are to prevent the spread of contamination both within the facility and onto the box. Once the box is full of ILW the top of the box is vacuum cleaned before the lid of the box is replaced and the box is lowered from the filling chute. Operational experience has been used to reduce the number of swabs used to clear each box (4 swabs per box now used instead of 63) which also shortens the operational cycle per box). Swabs are also re-used where they are found to be free of radioactive contamination. • Breakthrough into each of the bunkers was achieved through a combination of diamond wire cutting and use of the ROVs as an ALARP measure. The wall surfaces were vacuum cleaned to remove the loose contamination from the walls and surrounding area prior to break through to reduce dust generation. The concrete is currently being held in the bunkers and will undergo stringent monitoring and segregation to remove VLLW from LLW where possible. • In addition, any secondary solid waste will be minimised and managed in line with Site Procedures, for example through minimising packaging materials taken into radiological controlled areas, segregation of Out of Scope wastes, VLLW and LLW, in drum compaction, appropriate disposal processes. • Personal protective equipment (PPE) and respiratory protective equipment (RPE) used in contamination controlled area is minimised as the ILW retrievals are conducted remotely, with operators working in non-contamination controlled (clean) areas. Where PPR/RPE is used (during maintenance work) it is laundered (at an off-site contractor's facility) for re-use. It should be noted that an estimate of volumes of secondary waste produced during retrievals was not made and a record of actual secondary wastes produced is not made. ***Note*** – other optimisation options that were previously considered but discounted were: • Coating the SAWBR process area floor as this coating was expected to be damaged by the ROV tracks during operations. Applying a coating to this surface would not provide any advantage with regards to decontamination and would likely generate unnecessary secondary waste. • Compaction of ILW as well as LLW, however this would have significantly increased secondary radioactive gaseous waste which would have challenged the limits in the environmental permit, and incurred extra cost for introduction of a compactor for ILW.

	The optimisation options were assessed in Ref [9] (and see sub reference within this reference).
Abatement	Does not apply to solid LLW transferred off site, but plants on site used to process LLW are fitted with appropriate gaseous discharge abatement equipment. Ref [10] recognises that HEPA filter for the ventilation of radiological containments is industry best practice. Although not directly relevant to this section on solid waste, it should be noted that during 2023 HEPA filtration in terms of demonstrating BPM for the whole of the Hunterston A Site will be reviewed (see forward action plan 1).
Secondary Liquid Radioactive Wastes	
Existing Assessments	No radioactive liquid waste production was anticipated as there was no liquid waste expected in the SAWB bunkers [4], and none has been discovered during retrievals Therefore, this aspect cannot be optimised and abatement cannot be applied. Note – Personnel entry into radioactive contamination controlled areas of SAWBR shall take place in the event of either fault conditions or as part of planned maintenance. The personnel entering these areas shall be required to wash their hands and shower upon exit in accordance with the radiological safety rules [11]. This will take place within the sites change facility, which is located on another part of the site. Water generated through these routes is treated by the sites active effluent treatment plant. An assessment of volume and activity of liquid waste from showers and sinks (based on historical data and future decommissioning work) was carried out Ref [12], this estimated that miscellaneous arisings would be 1114m^3 over 7 years, between 2022 and 2027 (159 m^3 per year) The radioactivity associated with that would be 0.006MBq/y total alpha and 64 MBq/y total beta/gamma (per year pre abatement). These estimates are for the whole site, so SAWBR operations would only contribute a small percentage of this. These arisings are covered by a separate BPM assessment [13] (and sub reference). It should be noted that a review of radioactive liquid waste abatement in terms of demonstrating BPM will be reviewed during 2023 for the whole of the Hunterston A Site, see forward action plan 2. It is expected that post abatement radioactive liquid discharges from the whole site will result in public doses of < 20uSv/y [14], "below which then no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment. ")). This statement shall be confirmed in a subsequent revision of this BPM report.
Optimisation	n/a
Abatement	n/a to SAWBR but applicable to the effluent treatment plant [13].
Secondary Gaseous Radioactive Wastes	
Existing Assessments	An assessment for secondary radioactive gaseous waste was produced in 2009 and reviewed in 2018 [9]. In summary the retrieval of solid ILW produces radioactive gaseous waste (in the form of dust particulate). This is the only gaseous waste produced during SAWBR operations.
Optimisation	**Facility Design** • The SAWBR facility is designed to prevent the loss of radioactive material to the occupied building and external environment, this is achieved through the physical containment of the facility and is aided by a ventilation system.

	• The ventilation system, employed to prevent spread of contamination, creates a depression gradient to ensure that, at points where physical structural containment is broken there is a net inward flow of air, the ventilation system also ensures that air flows from lower to a higher potential contamination controlled areas, minimising the spread of contamination within the plant. • The ventilation plant was originally designed to recirculate 95% of the air within the SAWBR facility contamination controlled areas to facilitate a reduced oxygen atmosphere that was required within the work area to prevent the initiation of a hydrocarbon fire. Therefore, only the volume discharged will be approximately 5% of a conventional ventilation system, therefore both the volume and activity content discharged to the environment was minimised. Note – following justification that there was no risk of a bunker fire, the recirculation system was isolated (electrically and mechanically) in 2017 towards the end of bunker 3 retrievals [15]. Therefore, 95% recirculation ceased at that point. **Facility Operation** • In order to minimise the re-suspension of radioactive surface contamination during bunker breakthrough, box closure and manned entries into both the process area and emptied bunkers, HEPA filtered vacuum cleaners (both remotely and manually operated) have been employed to remove loose surface contamination. Vacuuming the internals of emptied bunkers has minimised the re-suspension of radioactive surface contamination during breakthrough into the adjoining bunker. • Vacuuming the area around the box flange and lid seal (after filling the box with ILW) during box closure has also minimised the spread of contamination. • Vacuuming the process area prior to manned entries has minimised the re-suspension of radioactive surface contamination generated during personnel entries in the event of fault or planned maintenance (Note- the dust levels in the bunkers could not be reduced as they come from how the waste has been stored. A small proportion may have arisen from mechanical handling of the wastes, but this is necessary for sorting purposes). Note – other optimisation options that were considered but discounted were: • The use of suppressant such as paint or water (to coat the ILW prior to retrieval) to minimise the re-suspension of loose surface radioactive contamination was considered impractical, and therefore not BPM, as any reduction in gaseous discharges to the environment would be far outweighed by the increase in processing time, the cost of the paint, limited coverage of the waste and increase in secondary waste. Use of water would have increased the conditions required to produce Uranium Hydride which could spontaneously combust and act as an initiator for a fire. Water also promotes a Magnox fire to burn more vigorously. The optimisation options were assessed in Ref [9] and see sub reference within this reference).
Abatement	The use of HEPA filtration (primary and secondary in series(with duty and standby filters) for SAWBR, as the SAWBR process is a dry process there is no requirement for a coalescer prior to HEPA filtration)), has been deemed as meeting BPM in terms of radioactive gaseous particulate abatement [9]. The estimated activity to be discharged

	was 2.4E-4GBq/y beta/gamma (post optimisation/abatement). (5.0E-2 GBq/y (Pre-optimisation/abatement). During the review in 2018 it was determined that the maximum actual discharge between 2014 and 2018 was 6E-5GBq/y, which was 2% of the RSA'93 Authorisation limit at the time of the review and less than was forecast. From Ref [9], dose to the public from SAWBR gaseous discharges (post optimisation/abatement) is 0.001uSv/y, which is below the level of 20uSv/y [14], "below which then no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment." This further underpinned that HEPA filtration represented BPM and Ref [10] recognising that HEPA filter for the ventilation of radiological containments is industry best practice. It should be noted that during 2023 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 retrievals shall be updated at the same time (see forward action plan 1). SAWBR Stack/Discharge Point – 19m above ground level Ref [10] gives guidance on heights) Ref [14] requires a two stage calculation; • Stage 1 calculation of dose to the public from inhalation and dose from external radiation at boundary to the site (see radiation dose summary section below) therefore 1.3 + 0.001 = 1.301 uSv/y (assumes a ground level release). • Stage 2 requires a scaling factor application (based on stack height) in this case the scaling factor is 0.03, if the result from Stage 1 is >20uSv/y. However, in this case the Stage 1 calculation is below this level therefore the Stage 2 calculation is not required, according to Ref [14] Therefore, no further assessment is required. Note – BPM is applied to gaseous sampling through the adoption of [31].
Non-Radioactive Discharges/Waste	
Existing Assessments	Not been assessed for SAWBR apart from the non radioactive elements associated with the ILW solid wastes, which has been assessed by the NWS LoC Process [16], ie chemical properties -not relevant to this BPM report)
Summary of Expected Doses and Discharges	
Radiation dose summary	Radiation Dose Summary for SAWBR Operations: • Highest dose to operator – 2mSv/y [17] • Highest dose to public (from dose rate at fence) – 1.3uSv/y [17] • Highest dose to public (discharges) – 0.001uSv/y [9]
Radioactive discharge summary	Radioactive Discharge from SAWBR Comparison to EASR 18 Permit Limit: • Gaseous – 2% of EASR18 limit *(actual discharges of 0.06MB/y beta/gamma) (Predicted discharges from SAWBR were 2.4E-4 GBq/y beta/gamma) highest actual annual discharge between 2014 and 2018 was 6E-5GBq/y* beta/gamma) [9]

	• Highest dose to public (gaseous discharges from SAWBR) – 0.001uSv/y [9] which is below the level of 20uSv/y [14], "below which no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment." • Liquid – N/A

This BPM summary is represented graphically in Figure1 below, inventory is detailed in [37]

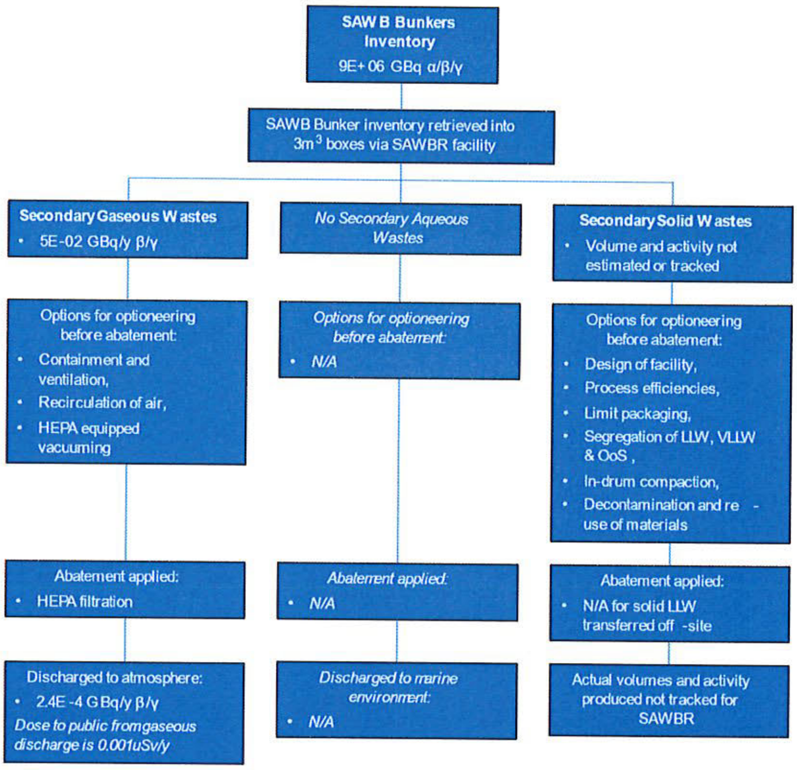

Figure 1: BPM Summary for Retrieval Process

1.3 Encapsulation

1.3.1 SILWE Facility Description

The following text is from Ref [18]:

The main purpose of SILWE is to grout 3m^3 boxes which have been filled with solid ILW recovered from SAWB. Waste boxes will be filled with loose waste in SAWBR, and then exported. The boxes need to be filled with grout before they can be consigned to interim term storage in the ILWS, to be in accordance with LoC requirements. SILWE will receive ungrouted waste boxes, fill the boxes with grout to meet the LoC requirements, hold the grouted box in quarantine until hydrogen evolution is acceptably low, and then return the grouted waste box to the XST for interim storage in the ILWS.

SILWE is also intended to provide a remediation facility and a fines grouting facility, as these functional requirements cannot be delivered at SAWBR, the ILWS or the Wet ILW and Resins Encapsulation Plant (WILWREP). For this reason SILWE has the capability to handle Secondary Containment Vessels (SCVs).

The purpose of the remediation facility is to provide HNA with a facility which is able to resolve problems with a filled waste box or drum. There are no specific scenarios identified for remediation, so the requirement is to provide a configurable facility with the means to remotely operate suitable tools.

Detail of the design

The basic components of SILWE will be the Import/Export (I/E) facilities, the grouting stations, and a quarantine area where boxes will be held until the hydrogen generation rate reduces to a level low enough to meet the acceptance criteria for the ILWS. Supporting the main facilities will be a system for moving boxes between the facilities, a grout preparation and delivery plant and a facility ventilation system. The box remediation and fines handling facility will be provided in a separate room attached to the main facility. A control room will also be provided.

All of the plant areas where active packages will be present will be shielded by means of being contained within a reinforced concrete building, including a reinforced concrete ceiling. The minimum thickness of the building has been determined to provide the appropriate shielding. Access doors will be required for maintenance, which will be shielded and normally locked and interlocked.

Import/Export Facilities

The I/E facilities consist of the I/E Bay and the I/E Cell. The I/E Bay is where the XST interfaces with the SILWE facility to allow boxes or SCVs to be received from the XST and returned to the XST. The design of this bay will closely match the comparable bays in the ILWS and the SAWBR and the design of the crane which lifts the box out of the XST will closely match the comparable crane in the SAWBR.

The I/E Cell will be the location where the overhead crane sets down the package taken from the cross site transporter. This facility will be provided with a turntable and a Kuka robot to allow removal/replacement of the box grouting port plugs plus box swabbing for monitoring and cleaning purposes. The box set-down location will also be able to accommodate a SCV lifted from the XST; and this is where the SCV lid will be unbolted by the Kuka robot and removed by the crane, and the non-conforming package within lifted out and placed onto a platen for transfer to the Remediation Cell.

The I/E Bay and Cell will also be required to import empty drums from a flatbed lorry for the fines encapsulation process. For this operation the usual XST interlocks will be overridden and, once in the facility, the empty drum will be moved into the Remediation Cell in the same way as the fines box. Export of the filled drum, containing encapsulated fines, will be the same as the export of a box onto the XST.

The I/E Cell will also be provided with a shielded door to permit Operator entry for maintenance or plant reconfiguration whilst the main facility still contains waste boxes.

Process Cell

To meet the peak operating rate required, the plant requires eight separate grouting stations, although grout delivery will only be needed for one station at a time. To meet the quarantining requirements, eight quarantine locations are also required within the Process Cell. The basic layout of the facility is shown in Figure 1 of Ref [18], which shows that the eight grouting stations will be located off eight separate spurs from a conveyor. The eight quarantine stations will be eight nominally allocated locations on the return conveyor, with the conveyor making a full loop as it passes the grouting stations then returns through the quarantine area.

Each grouting station will consist of a fixed grouting head, with grout delivery pipe, box ventilation pipe and there will be laser level detection devices which are located out-cell on the cell roof. The box will be transferred under the grout head and raised to make contact as part of the conveyor mechanism action. The grout supply, ventilation and level measurements will all be managed from facilities on the cold side of the shielding.

The conveyor system consists of a set of roller conveyor sections, each with its own separate motor and control. The waste boxes will be placed onto platens, so that it is the platens which actually get carried by the rollers. The use of separate sections to make up the full conveyor loop permits separation of the task of delivering a box to a selected grout station from the indexing of the boxes in the quarantine line, improving operational flexibility.

Located off two other spurs from the main conveyor loop in the Process Cell are the I/E Cell and the Remediation Cell.

Remediation Cell

The Remediation Cell will house the fines encapsulation equipment and provide the facilities for remediation of non-conforming packages. It will be provided with a conveyor, turntable and Kuka robot, much like the I/E Cell. These basic tools will be supplemented with bespoke tools, brought in and installed when a defined remediation activity is identified. The cell will also contain a shielded door to allow it to be separated from the main process area during man entries.

The fines encapsulation equipment will provide the ability to move the fines from a fines box into a drum and then encapsulate the fines. The equipment will be located within the Remediation Cell and connections will be made between the fines box, a cyclone vessel and the empty drum. The fines are moved from the box to the cyclone vessel under vacuum. In the cyclone vessel the fines are separated from the airflow using candle filters and they then fall into a hopper before being discharged to the drum. The air used to convey the fines passes through a HEPA filter located in-cell and will be recycled back into the cell via the out-cell extract fan, which will be located on the cell roof. No box ventilation pipework will be required for the fines encapsulation process due to the low hydrogen evolution rate.

Ventilation Systems

Two separate ventilation systems have been installed. The first system will be a 'box extract' system, which will automatically become coupled to a box raised at a grouting station. The system will draw air out of the box, thereby removing any hydrogen being generated following addition of grout. The air is replenished by air drawn from the cell, through a separate port on the box. The extract rate will be sufficiently high that the extracted air will remain below the Lower Flammable Limit (LFL) for hydrogen in air. The extracted air is likely to contain a small amount of particulate contamination, so will be passed through double HEPA filtration (with a coalescer in place prior to HEPAs to protect them from potential moisture from grouting process), in series (with duty and standby filters - note there will be no pre -filter as it is wet grout that is used for grouting the waste - therefore not dusty) before being exhausted to a stack with a discharge outside the SILWE building. The exhaust will be installed and monitored routinely. The box extract system will also remove water vapour so will tend to dry the surface of the grout, which will help to ensure that there is minimal bleed-water on the surface of the main pour of grout when the final capping grout is poured.

A second ventilation system will be provided which will maintain the air within the shielded facility in appropriate conditions to maintain the integrity of the boxes and the plant within the facility. In particular, the temperature of the facility will be managed appropriately and the humidity will be controlled to prevent condensation on sensitive plant. To achieve this, air will be provided to the facility through appropriate air conditioning plant, and extracted through an extract plant. As the extracted air could contain some level of particulate contamination, the extracted air will be discharged through double HEPA filtration, in series (with duty and standby filters) to an exhaust stack external to the facility, and will be installed and monitored routinely. This ventilation system will ensure air movement is always into an area of higher contamination.

Note - there is an interim containerised storage stage of 3m^3 boxes of ILW in the ILWS prior to encapsulation as SILWE construction/commissioning is not complete. However, during containerised storage within the ILWS there will be no solid, liquid or gaseous radioactive waste discharges from the ILWS [34].

1.3.2 SILWE BPM Assessment Summary

For this BPM assessment (gaseous radioactive waste production and release, solid waste production, and liquid radioactive waste production and release):

- the **claim** is that EASR18 standard conditions relating to BPM have been met,
- the **arguments** relating to optimisation and abatement are set out in the tables below,
- the **evidence** is referenced, where applicable.

Table 3: BPM Summary for Encapsulation of SAWB Waste

Solid Radioactive Waste	
Existing Assessments (Primary ILW)	The encapsulation process will not produce any additional solid ILW, it will just import the existing 3m^3 boxes of ILW from the retrieval process and add grout to them for encapsulation purposes [18].
Existing Assessments (Secondary LLW)	The actual encapsulation operations will take place remotely with operators working outwith contamination controlled areas [19]. Therefore no secondary radioactive solid waste shall be produced during normal operations. However, secondary solid low level waste is likely to be produced during maintenance activities. This is an assumption at this stage as a solid waste estimate has not been produced yet for SILWE active operations (see forward action plan 3).
Optimisation	**Facility Design** • The design and construction of the SILWE facility has considered the best surfaces finishes of all equipment and structure, where subject to possible contamination, in order to facilitate the decontamination and therefore minimise the generation of secondary waste.

	• All equipment shall utilise sealed components, where possible, with surfaces which facilitate their decontamination from particulate matter, ie contamination, which settles on the surfaces. • Areas identified as contamination controlled areas have their walls and floors treated with a smooth, painted impervious surface that can be easily wiped clean if particulate matter settles on surfaces. • Encapsulation is carried out remotely with operators working in non-radioactive contamination controlled areas (therefore normal processing operations does not create secondary solid LLW - only normally created during maintenance activities). **Facility Operation** • In addition, any secondary solid waste will be minimised and managed in line with Site Procedures, for example through minimising packaging taken into radiological areas, segregation of Out of Scope wastes, VLLW and LLW, in drum compaction, appropriate disposal processes. • Personal protective equipment (PPE) and respiratory protective equipment (RPE) used in contamination controlled area is minimised (as mentioned above) as the encapsulation operations are conducted remotely, with operators working non-contamination controlled areas and therefore, there is less use of PPE and RPE than if they were not. Where PPR/RPE is used (during maintenance work) it is laundered (at an off site contractors facility - this will produce secondary wastes – which is outwith the control of Magnox) for re-use. The above optimisation is detailed in [20]. It should be noted that an estimate of volumes of secondary waste produced during retrievals was not made and a record of actual secondary wastes produced is not made. Further optimisation of secondary solid wastes to be assessed once a solid waste estimate has been complete (see forward action plan).
Abatement	Does not apply to solid LLW transferred off site, but does apply to those plants on site used to process LLW (however this relates to abatement of gaseous discharges from those LLW plants). Ref [10] recognises that HEPA filtration for the ventilation of radiological containments is industry best practice. Although not directly relevant to this section on solid waste, it should be noted that during 2023 HEPA filtration in terms of demonstrating BPM for the whole of the Hunterston A Site will be reviewed (see forward action plan 1).
Secondary Liquid Radioactive Wastes	
Existing Assessments	No radioactive liquid waste production is anticipated for SILWE operations. There are no wet operations within contamination controlled areas of the facility and the facility is not connected to any active drainage system [18,21]. Therefore, this aspect cannot be optimised and abatement cannot be applied. **Note 1** – Based on the experience of using coalescers at HNA site to date, when they are drained no liquor is ever found (this is based on the Wet Intermediate Level Waste Retrieval and Encapsulation Plant operational experience - this is based on knowledge

	from the Plant Operators – this is not documented)). So it is not expected that liquor will be collected from the coalescers in the SILWE plant. However, this will be monitored during active commissioning and operation. ***Note2*** – Personnel entry into radioactive contamination controlled areas of SILWE shall take place in the event of either fault conditions or as part of planned maintenance. The personnel entering these areas shall be required to wash their hands and shower upon exit in accordance with Ref [11]. This will take place within the sites change facility, which is located on another part of the site. Water generated through these routes is treated by the sites active effluent treatment plant. An assessment of volume and activity of liquid waste from showers and sinks (based on historical data and future decommissioning work) was carried out [12], this estimated that miscellaneous arisings would be 1114 m^3 over 7 years, between 2022 and 2027 (59 m^3 per year) The radioactivity associated with that would be 0.006 MBq/y total alpha and 64 MBq/y total beta/gamma (per year pre abatement). These estimates are for the whole site, so SILWE operations would only contribute a small percentage of this. These arisings are covered by a separate BPM assessment [13]. It should be noted that a review of radioactive liquid waste abatement in terms of demonstrating BPM will be reviewed during 2023 for the whole of the Hunterston A Site, see forward action plan 2. It is expected that post abatement radioactive liquid discharges from the whole site will result in public doses of < 20uSv/y [14], "below which then no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment. ")). This statement shall be confirmed in a subsequent revision of this BPM report.
Optimisation	n/a
Abatement	n/a
Secondary Gaseous Radioactive Wastes	
Existing Assessments	An assessment for secondary gaseous radioactive waste was produced in 2023 [22]. This predicts that the highest annual discharges will be 7.62 GBq/y of H-3 and 2.0 GBq/y of C-14 will be discharged from SILWE facility during active operations. The predicted particulate discharges would be 2.16E-2 GBq/y beta/gamma and 1.69E-4 GBq/y alpha (prior to optimisation/abatement) and 2.33E-6GBq/y beta/gamma and 2.62E-8 GBq/y alpha (following optimisation/abatement) [22]. From [22], dose to the public from gaseous discharges (post optimisation/abatement) is 0.148 uSv/y, which is below the level of 20 uSv/y [14], "below which then no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment."
Optimisation	**Facility Design** • The SILWE facility is designed to prevent the loss of radioactive material to the occupied building and external environment, this is achieved through the physical containment of the facility and is aided by a ventilation system. • The ventilation system, employed to prevent spread of contamination, creates a depression gradient to ensure that, at points where physical structural containment is broken there is a net inward flow of air, the ventilation system

	shall also ensure that air flows from lower to a higher potential contamination controlled areas, minimising the spread of contamination, within the plant. • During encapsulation, the grout is added to the container through the grout station fill head to an internally fixed stainless steel perforated pipe (which has 10mm holes at 15mm intervals) allowing the containers to fill from the bottom up. The container perforated pipe also prevents fouling of the ports and false level indication and prevents the grout from splattering on to the waste and potentially suspending fine particulate matter. Because of this, the only waste displaced from the container (to the ventilation system) is that already suspended or in a gaseous form; this is expected to be minimal as the containers will be packed with larger pieces of waste. The extraction gasket and pressure setting ensure that any release from the container is extracted to the ventilation system. The container houses an anti-flotation mesh (AFM) that will ensure the waste is fully encapsulated below the grout. • During curing, there will continue to be evolution of H-3 and C-14, further optimisation of this curing process could not be determined. • There will also be some containers arriving at SILWE from SAWBR which are Fines containers. These Fines are particulate dry graphite and dry sludge which remain on the SAWB bunker floors after bulk waste is retrieved. The fines are vacuumed into 3m^3 boxes which contain special liners to allow the Fines to be processed. The Fines boxes will arrive at SILWE externally uncontaminated and will be emptied and reused when and if required. • During fines encapsulation (to produce a compliant package that is fully encapsulated), this aspect considers the release of particulate and gaseous activity during the encapsulation of graphite/sludge fines which will take place in the Remediation Cell. The Fines will be managed differently to the FED; unlike the FED waste which arrives pre-packed from the SAWB, the Fines arrive at the SILWE facility in a temporary package and are transferred to a container, modified to encapsulate the fines.Once transferred to a drum, fines will be mixed with water to generate a homogenous paste / slurry to which the reference grout mix is added; the container (3m^3 drum – note the waste volume will not increase 1 box of Fines will results in 1 drum of Fines) is fitted with a stirring paddle that will be grouted in with the waste referred to as a "lost paddle". The lost paddle rotates at a speed of 30 revolutions per minute (RPM). Trials using a graphite stimulant demonstrated this to be the optimum speed to mix the slurry without causing splashing or unnecessary agitation and without putting the mixing equipment under stress. Though an unquantified amount of dust was visible during the trials, this preferred approach is considered to be the optimum method of encapsulating the Fines. Water will be added to the empty container prior to the graphite powder/dry sludge with a target ratio of 1:1:14 (calculated on the fines hopper weight). The generation of the graphite slurry ensures that all of the graphite is incorporated into a fluid solution without potential for non-wetted or poorly immobilised graphite in the final product. Mixing the Fines into a slurry also avoids the addition of graphite powder/dry sludge to the grout (or vice versa) which the trials found to give visible dust arisings. The addition of Fines to grout also highlighted problems with mixing in the Fines to obtain a homogenous solution.

	Note - no other optimisation options were identified that were disregarded [25]. During the scope setting of this optimisation report it was agreed that [25] be reviewed due to the passage of time since its production, there is an opportunity to explore potential additional optimisation of the SILWE plant prior to active operation, see forward action plan 7.
Abatement	Ref [22] also assessed different abatement technologies for H-3 and C-14, and the conclusion was the adoption of abatement on the SILWE facility was not BPM. As the annual H-3 and C-14 discharges exceeds (or there is no limit) the discharge limit for the specified routes and the discharge point is not specified (in the EA(S)R18 permit)) an application for a variation will be required to utilise the site limits in the EA(S)R 18 permit and to add the discharge point, see forward action plan below. Radioactive gaseous particulate emissions were also considered [22]. These predicted that the particulate discharges would be 2.16E-2 GBq/y beta/gamma and 1.69E-4 GBq/y alpha (prior to optimisation/abatement), 2.33E-6GBq/y beta/gamma and 2.62E-8 GBq/y alpha (post optimisation/abatement). HEPA filtration abatement for gaseous particulate represents BPM and Ref [10] recognising that HEPA filter for the ventilation of radiological containments is industry best practice. It should be noted that during 2023 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 encapsulation shall be updated at the same time (see forward action plan 1). From [22], dose to the public from gaseous discharges (post optimisation/abatement) is 0.148 uSv/y, which is below the level of 20 uSv/y [14], "below which then no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment." SILWE Stack/Discharge Point – 21 m above ground level (Ref [10] gives guidance on stack heights) Ref [14] requires a two stage calculation • Stage 1 calculation of dose to the public from inhalation and dose from external radiation at boundary to the site (see radiation dose summary section below) therefore 5 + 0.148 = 5.148 uSv/y (assumes a ground level release). • Stage 2 requires a scaling factor application (based on stack height) in this case the scaling factor is 0.02, if the result from Stage 1 is >20uSv/y. However, in this case the Stage 1 calculation is below this level therefore the Stage 2 calculation is not required, according to Ref [14]. Therefore, no further assessment is required. In addition in [22] an assessment of varying the stack height to determine if this had any significant dose benefit was carried out, this concluded that increasing the stack height above 21m does not generate a significant dose reduction (reduction from 2.97E-02 uSv/y to 2.18E-02 uSv/y) and would not represent BPM. Note – BPM is applied to gaseous sampling through the adoption of [31]. The associated Ref 31 BPM forms for gaseous sampling require reviewing (see forward action 9) For gaseous discharges, environmental performance criteria to be determined and management of these criteria to be established (see forward action 8)

Non-Radioactive Discharges/Waste	
Existing Assessments	The SILWE facility has a grout plant and any non radioactive dust emitted as a result of this is managed by the Pollution Prevention Control (Scotland) Regulations 2012 [26], through the permit [27] issued by SEPA. No dust will enter the radiological ventilation plant, as it will be wet grout that enters the boxes/drums for grouting. There will also be non-radioactive waste grout and washings produced as a result of the operations of the grout plant. The sequencing of filling and plant washdowns will be optimised once the plant is operating to ensure minimisation of waste grout and water usage (see forward action 5). Hydrogen gas will also be produced during the grouting process. The production and management of this is described in [35]. This will not result in any environmental consequence. No other non-radioactive emissions will occur when the cement chemically reacts with the solid ILW [39]
Summary of Expected Doses and Discharges	
Radiation dose summary	Radiation Dose Summary for SILWE Operations: • Highest dose to operator – 0.1mSv/y [20] • Highest dose to public (from dose rate a fence) – 5uSv/y [20] • Highest dose to public (discharges) – 0.148 uSv/y [22]
Radioactive discharge summary	Predicted radioactive discharges from SILWE Comparison to EASR 18 Permit Limit: • Gaseous – 0.001 % of EASR 18 permit limit (particulate), predicted H-3 discharges have been assessed as 7620% of the specified route limit (all site gaseous discharge stacks taken together), which would be 38.1% of the site limit. C-14 100% of the site limit. These estimates do no take account of existing discharges from HNA Site. As a comparison the 2021 twelve month rolling total for discharges from all HNA gaseous discharge stacks was 0.3MBq H-3 (limit 100MBq), 0.383MBq All others (limit 3MBq) [28]. Note – there are currently no gaseous C-14 discharges from ventilation stacks at HNA and no specified route permit limit. This potential exceedance of the specified route limit has been addressed through application for a variation to the EA(S)R18 permit. • Highest dose to public (gaseous discharges from SILWE) – 0.148uSv/y [22] which is below the level of 20uSv/y [14], "below which no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment." • Liquid – N/A

This BPM summary is represented graphically in 2 below.

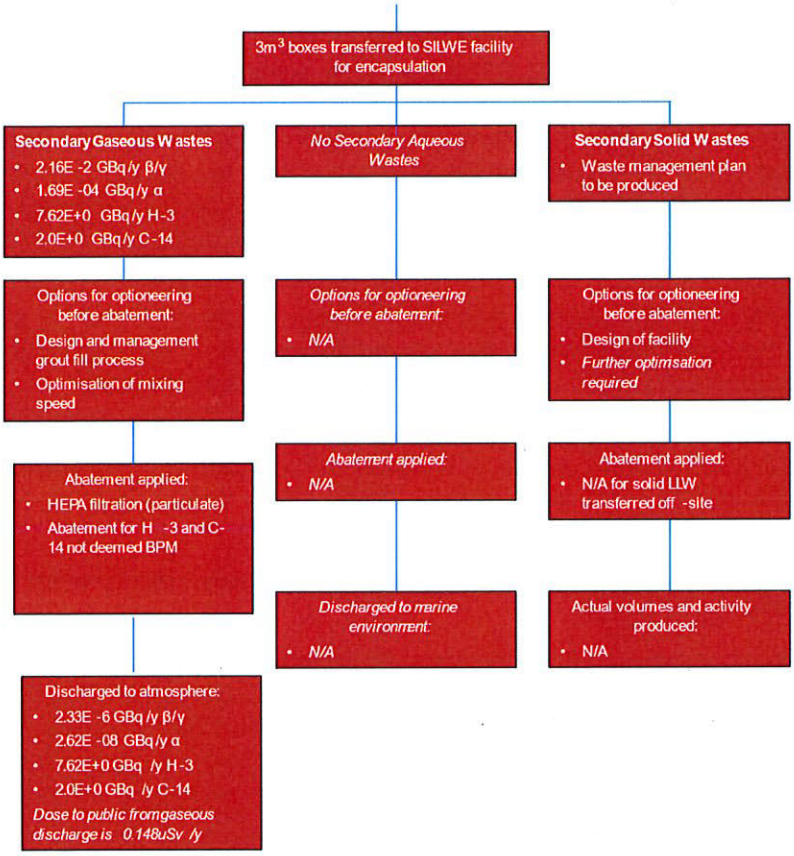

Figure 2: BPM Summary for Encapsulation Process

1.4 Storage

1.4.1 ILWS Facility Description

The following text is from [29]:

Once the 3m³ boxes of solid ILW are encapsulated in SILWE, they will be transferred to the ILWS. The sealed ILW 3m³ packages (i.e. boxes which are radioactively clean externally) generated on the Hunterston A site will be transported to the ILWS in a shielded overpack container. Once within the receipt cell of the ILWS, the packages will be removed from the overpack using the store crane (known as the Package Handling Machine (PHM)), logged on a computer system and transferred to a designated set down location within the store. Facilities will also exist to inspect packages, either upon receipt or at a later time and to perform routine or breakdown maintenance on the PHM.

The store will contain approximately 1500 (1200 solid ILW, 300 wet ILW) packages when the site enters the care and maintenance phase in the year 2030 (as per the current lifetime plan [36]) and remain in place during the care and maintenance phase (which will last for approximately 50-60 years).*

The vault ventilation system is designed to maintain the environmental conditions (temperature and humidity) within the ILW storage vault. The system consists of a supply and extract system (resulting in the vault being at a slight negative depression) with airflows from areas with potentially lower contamination to areas of potentially higher contamination.

The vault ventilation supplies conditioned air to the storage vault as well as the crane maintenance area, shield door maintenance area and the inspection cell.

The combined Air Handling Unit (AHU) incorporates a mixing box and automatic balancing damper that blends the extract with a proportion of fresh air (90% of the air from the vault is re-circulated - this recirculation system limits the loads imposed upon the heating and cooling plant whilst maintaining the minimum quantity of fresh air required to dilute the gases evolved from the waste packages). The fresh air is drawn through into the mixing box via a louvre recessed into the cladding and ducted to the AHU. The air is then pre-filtered, via a coalescing pre-filter, bag filter and HEPA filter to remove coarse suspended particulate and minimises chloride concentration in the ILWS vault. An electric pre-heater shall protect the filters from frost. A direct expansion cooling coil removes excess water from the air with a second electric battery heater, comprising of multi-staged heating elements, to boost the supply air to the required supply temperature to maintain the +4°C differential to dewpoint temperature. The cooling coil is manufactured for a marine environment and comprises a copper coil with copper fins to enhance its longevity in a saline environment. Condensate from the cooling coil is collected in an Intermediate Bulk Container (IBC).

As discussed above, the ventilation rate for fresh air is 0.05 air changes per hour. As such, the vault area of the store will effectively experience a complete fresh air change (20850m³) every 20 hours (assumed to be once per day for simplicity). Ex-filtered air is discharged to atmosphere via a vertical extract grill in the building cladding. *The system is designed to ensure there is laminar flow, ensure there are no pockets of H_2, no microclimates that affect corrosion rates and maintain a relative humidity of approximately 65%.*

The design of the system allows for the provision of HEPA filters in the extract, should this be required at a later date. It should be noted that HEPA filtration is only suitable for abating particulate and not gaseous emission such as tritium and carbon-14.

Monitoring of discharges for particulate activity, from the HVAC extract system, is not currently required and hence is not within the scope of this system. However, provision is made within the design of the extract to allow such instruments to be installed in future, should the requirement arise.

The capability also exists to install a monitoring system to monitor gaseous activity in air (H-3 and 1C-14) in the vault ventilation system extract ductwork, to provide an indication of radiological conditions within the vault, should this be required.

It should be noted that there is not a discharge stack on the ILWS, only an extract grill on the west end of the facility.

The ventilation system will be switched off during the care and maintenance phase, and then switched back on when packages are exported at some future date.

***Note** – ILW packages are sealed and the only discharges from them would be gaseous tritium, carbon-14 and hydrogen.*

**- Due to strategy change, the numbers will now be 1300 solid ILW packages and 250 liquid ILW packages.*

1.4.2 ILWS BPM Assessment Summary

For this BPM assessment (gaseous radioactive waste production and release, solid waste production, and liquid radioactive waste production and release):

- the **claim** is that EASR18 standard conditions relating to BPM have been met,
- the **arguments** relating to optimisation and abatement are set out in the tables below,
- the **evidence** is referenced, where applicable.

Solid Radioactive Waste	
Existing Assessments (Primary ILW)	Operation of the ILWS will not produce solid ILWS, it is merely a storage location for the retrieved and encapsulated ILW. (Ref [29])
Existing Assessments (Secondary LLW)	None of the areas of the ILWS are radioactive contamination controlled areas [19]. Therefore, none of the operations within the ILWS will produce secondary radioactive solid LLW, Therefore, this aspect cannot be optimised and abatement cannot be applied.
Optimisation	n/a
Abatement	n/a
Secondary Liquid Radioactive Wastes	
Existing Assessments	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). See non-radioactive waste/discharges section below. This will be assessed during the active commissioning and operation of SILWE (see forward action 11 and 12). Note - the facility is not connected to any active drainage system [9, 21]. When the ILWS ventilation system is operating 24hrs per day, 365 days per year, it is assumed, (based only on operational experience, that 1 IBC of condensate will be produced each week (52 IBCs per year), therefore 52m^3 per year.
Optimisation	Once the assessment of the H-3 and C-14 levels in the condensate has been assessed, the optimisation of the production of this condensate will be determined (see forward action 12)

Abatement	Once the assessment of the H-3 and C-14 levels in the condensate has been assessed, the abatement of this condensate will be determined and dose to the public from discharging this liquid radioactive waste to the marine environment calculated (see forward action 12). Note - if it the condensate pessimistically contained all the H-3 and C-14 (see page 27 below), this would result in a concentration of 42Bq/ml H-3 and 6.15 Bq/ml C-14 in the condensate. These levels do not exceed any of the limits in the acceptance criteria for the existing and future liquid effluent treatment plants, therefore this waste can be processed through the Hunterston A effluent treatment plants. [42,43,44]
Secondary Gaseous Radioactive Wastes	
Existing Assessments	An assessment for secondary radioactive gaseous waste was produced in 2023 [22]. This predicts that the highest annual discharges of 2.19GBq/y of H-3 and 0.32 GBq/y of C-14 will be discharged from ILWS facility during active operations on receipt of packages from SILWE. No particulate gaseous discharges were assessed as being likely. The dose to public (from these discharges) is 0.025uSv/y [22] which is below the level of 20uSv/y [14], "below which no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment."
Optimisation	**Facility Design** Though not considered from a BPM/optimisation perspective air changes in the ILWS vault have been designed to minimise chloride import whilst ensuring no build up of hydrogen exists. No other options were considered that were ruled out.
Abatement	Ref [22] also assessed different abatement technologies for H-3 and C-14, and the conclusion was the adoption of abatement on the ILWS facility was not BPM. As the annual H-3 and C-14 discharges exceeds (or there is no limit) the discharge limit for the specified routes and the discharge point is not specified (in the EA(S)R18 permit) an application for a variation has been made to utilise the site limits in the EA(S)R 18 permit and to add the discharge point. ILWS Discharge Point – 5.3m above ground level (Ref [10] gives guidance on stack heights - noting that the ILWS discharge point is not a stack. Ref [14] requires a two stage calculation; • Stage 1 calculation of dose to the public from inhalation and dose from external radiation at boundary to the site (see radiation dose summary section below) therefore 0.004 + 0.025 = 0.029 uSv/y (assumes a ground level release). • Stage 2 requires a scaling factor application (based on stack height) in this case the scaling factor is 0.4, if the result from Stage 1 is >20uSv/y. However, in this case the Stage 1 calculation is below this level therefore the Stage 2 calculation is not required, according to Ref [14]. Therefore, no further assessment is required. In addition in [22] an assessment of varying the discharge point height (and whether the installation of a discharge stack would be BPM) to determine if this had any significant dose benefit was carried out, this concluded that increasing the discharge point height

	above 5.3m (and installation of stack) does not generate a significant dose reduction (reduction from 1.53E-2 uSv/y to 9.72E-03 uSv/y) and would not represent BPM. Note – BPM is applied to gaseous sampling through the adoption of [31]. The associated Ref 31 BPM forms for gaseous sampling require reviewing (see forward action 9)
Non-Radioactive Discharges/Waste	
Existing Assessments	The storage vault air inlet (including 90% of the vault extract, which is re-circulated) is heated and conditioned, producing liquid condensate which is currently treated as trade effluent. Once active packages from SILWE are placed in the vault this condensate is assumed to contain small amounts of the tritium or carbon-14 from the off-gassing of the SILWE packages. This will be confirmed during active commissioning (see forward action 11 and 12).
Summary of Expected Doses and Discharges	
Radiation dose summary	Radiation Dose Summary for ILWS Operations: • Highest dose to operator – 0.2mSv/y [30] • Highest dose to public (from dose rate a fence) – 0.004uSv/y [30] • Highest dose to public (discharges) – 0.025uSv/y [22]
Radioactive discharge summary	Predicted radioactive discharges from ILWS Comparison to EA(S)R 18 Permit Limit: • Gaseous – H-3 2190% of the specified route limit (all site gaseous discharge stacks taken together), 10.9% of the site limit)). C-14 16% (Site Limit). These estimates do not take account of current discharges from the HNA site. As a comparison the 2021 twelve month rolling total for discharges from all HNA gaseous discharge stacks was 0.3MBq H-3 (limit 100MBq) [28]. Note – there are currently no C-14 discharges from ventilation stacks at HNA and no specified route permit limit. This potential exceedance of the specified route limit has been addressed through an application for a variation to the EA(S)R18 permit. • Highest dose to public (gaseous discharges from ILWS) – 0.025uSv/y [22] which is below the level of 20uSv/y [14], "below which no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment." However, this may be lower if some the H-3 and C-14 transfers to the ILWS ventilation system condensate, see below. • Liquid - from the secondary liquid waste section above it is assumed that a small amount of the H-3 and C-14 gaseous discharges will transfer into the liquid condensate, even if all the annual gaseous discharges transferred to the condensate (2.19GBq/y of H-3 and 0.32 GBq/y of C-14) [22] this would equate to 7.3% and 0.5% of the permit limits (30GBq/y H-3 and 60GBq/y non-alpha emitting radionuclides) respectively. It can be seen that by adding the additional radioactivity from the condensate to typical annual aqueous discharges (0.007GBq/y H-3 and 0.039 GBq/y non-alpha emitting radionuclides) [41] the activity discharged remains significantly below the permit limits. • Highest dose to the public (aqueous radioactive discharges from the ILWS), [40] assessed the aqueous discharge dose assessment where the dose consequence was assessed at the current site permit limits concluded that the dose to local residents would be 5.4 uSv/y. As discussed above, if all the H-3 and C-14 gaseous discharges transferred to the condensate the discharges would be significantly below the EA(S)R 18 permit aqueous discharge limits and therefore

		the dose to the public would be a number of orders of magnitude below 5.4uSv/y and therefore the total dose would be significantly lower than the trivial criteria of 10uSv/y as set out in the 'Transboundary Radioactive Contamination (Scotland) Direction 2021.'

This BPM summary is represented graphically in 3 below.

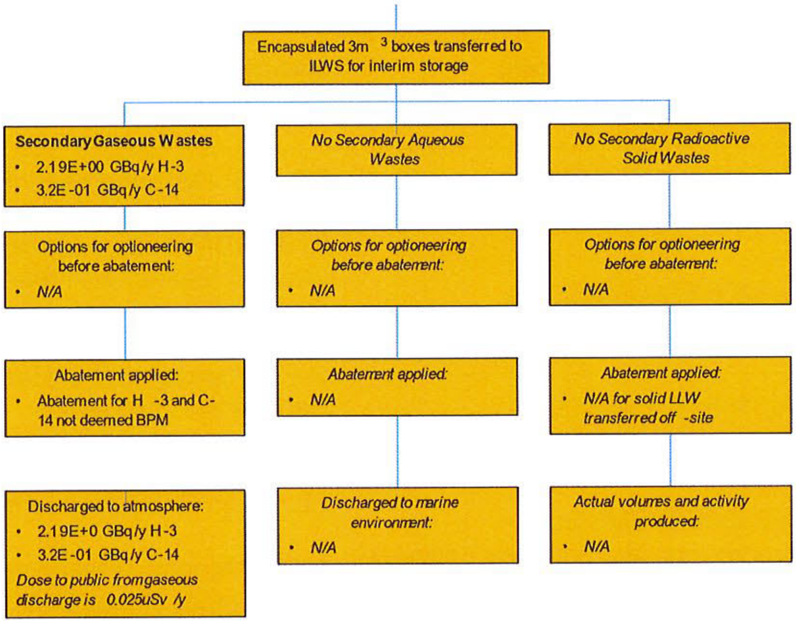

Figure 3: BPM Summary for Interim Storage

SUMMARY OF ENVIRONMENTAL, ENGINEERING, AND MANAGEMENT CONTROLS

TABLE below provides a summary of environmental, engineering and management controls for gaseous releases, solid wastes, and aqueous releases.

Table 4: Summary of Environmental, Engineering and Management Controls

Engineering controls (Gaseous Releases)	**Maintenance and Testing Arrangements**	**Management Controls (Gaseous Releases)**
SAWBR HEPA Filters	HNA/3306/ED/CMS/002 – Environmental Maintenance Schedule	PD-026 – Management of Waste HNA/SID/PD-026 – Management of Waste (Hunterston A Site Interface Document) S-070 Assessment of Gaseous Radioactive Discharges PRO-EHSSQ-002 Provision of Advice on Compliance with RSL S-035 Magnox Training and Competency Requirements PD-012 Environmental Management
SAWBR C2/C3 extract system	HNA/3306/ED/CMS/002 – Environmental Maintenance Schedule	
SAWBR C3/C4 extract system	HNA/3306/ED/CMS/002 – Environmental Maintenance Schedule	
SAWBR Ventilation system	HNA/3306/ED/CMS/002 – Environmental Maintenance Schedule	
SAWBR Stack Sampler system	HNA/3306/ED/CMS/002 – Environmental Maintenance Schedule	
SILWE Controls TBC – see forward action plan 6	TBC – see forward action plan	
Engineering controls (Solid Waste)	**Maintenance and Testing Arrangements**	**Management Controls (Solid Waste)**

N/A for this optimisation assessment	N/A for this optimisation assessment	PD-026 – Management of Waste HNA/SID/PD-026 – Management of Waste Hunterston Site Interface Document PD-012 Environmental Management S-078 Management of LLW S-136 Assessment of Radioactivity in LLW S-152 – Supervision of activities associated with the disposal of solid radioactive waste PRO-EHSSQ-002 Provision of Advice on Compliance with RSL S-035 Magnox Training and Competency Requirements
Engineering controls (Aqueous Releases)	**Maintenance and Testing Arrangements**	**Management Controls (Aqueous Releases)**
N/A for this optimisation assessment	N/A for this optimisation assessment	N/A for this optimisation assessment

3 CONCLUSION

By following the principles of BPM optimisation and conditions within EASR18, Magnox Ltd have developed arrangements and a design that should ensure:

- the volume and activity of secondary waste from processing solid ILW processing is minimised,
- any discharges to the environment are minimised,
- any exposures to ionising radiation of the public are optimised (Note the highest annual dose to the public when assessing retrieval, immobilisation and storage holistically is 5.17uSv/y – this is below the level of 20uSv/y [14], "below which then no further assessment would be warranted for the purpose of authorising the discharge of radioactive waste to the environment."

4 FORWARD ACTION PLAN

The optimisation summaries above note the following aspects needing further work. These will be tracked on site using the QPulse system.

1. 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.

2. A review of radioactive liquid waste discharges abatement for the whole site to be carried out.
3. 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.
4. Complete – application for a variation to the EA(S)R18 permit has been made.
5. 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.
6. Develop list of SILWE Engineering Controls (gaseous releases) and maintenance and testing arrangements
7. SILWE Project Team to review [25] for SILWE plant, there is an opportunity to explore potential additional optimisation of the SILWE plant prior to active operation.
8. Environmental Performance Criteria to be determined and management of these criteria to be established.
9. Review gaseous sampling BPM forms [31] for SILWE and ILWS
10. Complete - an assessment of non-radioactive gaseous emissions from grouting the ILW has been completed
11. Sample and assess ILWS ventilation system condensate prior to active commissioning of SILWE to establish baseline H-3 and C-14 levels.
12. 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 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

5 TRIGGERS FOR REVIEW

This Optimisation (BPM) assessment shall be reviewed when:

- A Waste Management Plan is produced that details the secondary solid low level waste and flushing water/grout plant non-radioactive waste that will be produced during active operations of SILWE. This BPM shall then include ways of optimising that waste.
- When any FAP actions are completed
- If there are any fundamental changes to the chosen option or associated facilities
- As a minimum every 5 years [32]

6 REFERENCES

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3. RS-POL-001 – SEPA - Satisfying the optimisation requirement and the role of Best Practicable Means
4. HNA/2941/2014/SS/1208 Issue 1, Stage Submission 7: Operation of the SAWBR Facility including Waste Retrieval and Cross-site Transport from Bunkers 4, 3 and 2, December 2014
5. ARC-033-352-R02 - SQEP Review Report HNA XST2
6. HNA/2941/2018/1377 – DPAF – SAWBR, Installation of Fuel Detection System
7. HNA/2941/2015/1245 – DPAF SAWBR Waste Processing Improvements
8. HNA/3812/PJ/HP/1101 - SAWBR Ventilation Plant Routine Survey

9. HNA/8200/PJ/PR/824 Review of the management of waste generated during the retrieval of ILW from the SAWB bunkers
10. ES_0_1738 – Ventilation System For Radiological Facilities, Design Guide
11. S-139 Radiological Safety Rules
12. HNA/2860/PJ/PR/758 – Effluent Demands Report
13. HNA/2911/TC/REP/1441 - BPM Review of Radioactive Liquid Effluent Discharges
14. RS-JG-016 PRINCIPLES FOR THE ASSESSMENT OF PROSPECTIVE PUBLIC DOSES ARISING FROM AUTHORISED DISCHARGES OF RADIOACTIVE WASTE TO THE ENVIRONMENT (and sub reference - Initial Radiological Assessment Methodology – Part 1 User Report)
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16. S-448 Arrangements for the Production and Maintenance of Higher Activity Waste Disposability Cases
17. L3/SAWBR/2015/001 – SAWBR L3 Risk Assessment/ALARP report
18. HNA/2981/PE/DR/457 – SILWE Process Description
19. HNA/3805/EH/HP/427 – Hunterston A Schedule of Designated Areas
20. HNA/2981/PJ/DR/872 – SILWE L3 Radiological Risk Assessment and ALARP Report
21. HAD.HDO.2960.000002 - Hunterston A Active Drains Drawing
22. HNA/2981/PG/REP/1223 – Assessment of SILWE Gaseous Discharges
23. HNA/1002/TC/ERA/155 – Sampling Frequency Assessment for SILWE
24. HNA/2981/PJ/PR/856 – BPM Assessment SILWE H-3 and C-14 Discharges
25. HNA/2981/PE/DR/518 - SILWE Environmental Assessment Report
26. Pollution Prevention and Control (Scotland) Regulations 2012
27. PPC/B/1169293 – PPC Permit SILWE Grout Plant
28. HNA/3805/EH/HP/407 – HNA Monthly Gaseous Discharge Report
29. HNA/5300/2015/SS/1237 – ILWS Operational Safety Report
30. HNA/5300/PR/DR/149 – ILWS Normal Operations Dose Assessment
31. S-070 - The Assessment of Radioactive Gaseous Discharge
32. S-391 - Options Assessment for Radioactive Substances Legislation BAT / BPM Compliance
33. The Scottish Government, "Scotland's Higher Activity Radioactive Waste Policy," January 2011.
34. HNA/5300/PJ/PR/460 – ILWS Estimated Aerial Discharges.
35. P0539A–CALC-003 P3 – Hydrogen Dilution Calculation (System 742 Box Ventilation Extract)
36. HNA MSS-P – Hunterston A Management MSS
37. M/EF/HNA/EAN/0002/21 - A Solid Active Waste Bunker (SAWB) Inventory Review
38. 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).
39. M/EF/HNA/EAN/0005/23 - Assessment of the Non-Radioactive Gaseous Discharges during Grouting of Hunterston Solid Active Waste Bunker and Spent Skip Cleaning Acid.
40. 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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