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| **GDA Regulatory Observation** |
| **REGULATOR TO COMPLETE** |
| **RO unique no.:** | RO-BWRX300-002 |
| **Revision:** | 0 |
| **Date sent:** | 20/06/2025 |
| **Acknowledgement required by:** | 11/07/2025 |
| **Resolution Plan Agreement Required by:** | 08/08/2025 |
| **Record Reference:** | ONRW-2126615823-7699 |
| **Related RQ / RO No. and CM9 Ref:** (if any)**:** | RQ-01810 Segregation  |
| **Observation title:** | Segregation of waste |
| **Lead technical topic:**Environment  | **Related technical topic(s):**Nuclear Liabilities Regulation |
| **REGULATORY OBSERVATION:** |
| **Background**The EA’s Generic Developed Principle (GDPs) RSMDP8 [1] – segregation of wastes states “*The best available techniques should be used to prevent the mixing of radioactive substances with other materials, including other radioactive substances, where such mixing might compromise subsequent effective management or increase environmental impacts or risks*”. Principle RSMDP3 [1] – use of BAT to minimise waste also states, “*BAT should be used to ensure that production of radioactive waste is prevented and where that is not practicable minimised with regard to activity and quantity.”*Additionally, the ONR’s Safety Assessment Principles (SAPs) [2] state that radioactive waste should be *“…minimised in terms of quantity and activity*” [RW.2], *“…segregated to facilitate its subsequent safe and effective management*”, and that any decisions to mix waste streams must be *“…properly justified and provide a net benefit in favour of safety or environmental factors including the later safe management of the waste through to disposal*” [RW.4].We have observed from the submissions provided for our GDA Step 2 assessment that there are several waste streams generated from the BWRX-300 design which will not be segregated prior to onwards management and subsequent disposal. Interactions with the Requesting Party (RP) concerning the management of these waste streams include the Regulatory Query (RQ) RQ-01810 on segregation. Further information is provided below. **Segregation of non-radioactive, lower activity and higher activity wet solid wastes prior to processing for disposal** The submissions refer to the transfer of spent bead resins from the Liquid Waste Management System (LWMS), the Isolation Condenser Pool Cooling & Cleanup System (ICC), the Condensate Filter and Demineraliser System (CFD) and Fuel Pool Cooling and Cleanup System (FPC) to a spent resin tank for decay storage, prior to onwards transfer for processing, once tank capacity has been reached [3][4][5]. The bead resins generated from the LWMS, CFD and FPC are currently identified as ILW [4], whereas those generated from the ICC are not expected to be radioactive. Furthermore, the submissions state that following refinement of the End User Source Term (EUST), the ILW bead resins may be re-categorised as a mixture of lower and higher activity wastes [3]. The submissions therefore suggest that non-radioactive and radioactive **spent bead resins with potentially different waste categories will be mixed in the spent resin tank prior processing.** **This approach does not align with our regulatory expectations as it may prevent a future operator from:*** **segregating non-radioactive and radioactive wastes prior to onwards management**
* **segregating radioactive wastes with different waste categories prior to onwards management**
* **minimising the volume and activity of radioactive waste generated and disposed of**
* **selecting an optimised disposal route when disposing of radioactive waste**

We raised an RQ-01810 in relation to this issue to seek further clarity. The RP responded that “*The BWRX-300 wet solid waste process design would enable processing of waste resins from each demineraliser on a batch-by-batch basis…They can therefore be segregated from other waste resins on the basis of the batch’s radiological characteristics, before the next batch of spent resin is transferred into the tank”.* The RP concludes that “*It would be the responsibility of the future operator to determine their management strategy and demonstrate that their management arrangements are demonstrably BAT and ALARP*”. We have identified the following issues with the proposed approach to managing the spent bead resins on a ‘batch by batch’ basis:* it does not align with the design intent for the tank as stated in the submissions, which is to decay store the spent bead resins prior to transfer for processing
* it introduces the risk of cross contamination between non-radioactive and radioactive waste streams with different waste categories
* it introduces constraints on a future operator which may result in the future operator being able to justify that operating the spent resin tank on a batch by batch basis is a disproportionate amount of effort, and it should be operated as per the original design intent, resulting in the mixing of non-radioactive and radioactive waste streams with different waste categories.

On this basis, we consider there to be a shortfall in the BWRX-300 design whereby there is a risk that wastes of dissimilar categories will be mixed. This includes the mixing of non-radioactive and radioactive wastes, as well as dissimilar categories of radioactive wastes, compromising their subsequent effective management and increasing the environmental impact associated with their disposal. We therefore require the RP to provide a robust demonstration that best available techniques have been used to prevent the unnecessary mixing of non-radioactive and radioactive spent bead resins with different waste categories, or that it is necessary to facilitate subsequent waste management, as per our generic developed principle RSMDP8 – Segregation of wastes [1].The RP’s response to RQ-01810 stated that it is deemed grossly disproportionate to provide a separate system for the management of 0.7m3 of ICC resin a year. We recognise that as part of the optimisation process the RP will need to consider both the benefits and detriments of a particular technique. Techniques may be rejected as BAT and ALARP if the costs are grossly disproportionate to the environmental and safety benefits. In this instance, we would expect a robust demonstration that alternative options for the management of these resins have been identified and substantiated to be grossly disproportionate, with robust underpinning information provided. **Segregation of radioactive liquid wastes prior to processing in the Liquid Waste Management System** **The submissions refer to radioactive liquid wastes generated from floor, equipment and process drains in the radiation controlled area as being stored in common collection tanks and processed together on a batch basis [3]. The submissions therefore suggest that radioactive liquid wastes with different physical, chemical and radiological characteristics will be mixed in the LWMS collection tanks prior processing.** We observed that liquid wastes are typically segregated based on physical, chemical and radiological characteristics prior to treatment, to ensure treatment is optimised and secondary waste arisings are minimised.We raised an RQ-01810 in relation to this observation to seek further clarity. The RP responded that floor, equipment and process drains are all treated as high conductivity waste (HCW). The RP stated a number of benefits associated with the use of common treatment plant for liquid wastes in the RQ response. However, we require the RP to provide a robust demonstration that the mixing of floor, equipment and process drains prior to treatment does not compromise effective management of these wastes or increase environmental impacts or risks, as per our generic developed principle RSMDP8 – Segregation of wastes [1].This Regulatory Observation (RO) has therefore been raised to ensure the RP: * provides a robust demonstration that best available techniques have been used to prevent the unnecessary mixing of spent bead resins with different waste categories, or that it is necessary to facilitate subsequent waste management, as per our generic developed principle RSMDP8 – Segregation of wastes [1].
* provides a robust demonstration that the mixing of floor, equipment and process drains prior to treatment does not compromise effective management of these wastes or increase environmental impacts or risks, as per our generic developed principle RSMDP8 – Segregation of wastes [1].

**Relevant Legislation, Standards and Guidance**Relevant Environment Agency guidance includes GDPs [1] RSMDP3 Use of BAT to minimise waste and RSMDP8 Segregation of wastes, defined as follows: RSMDP3 Use of BAT to minimise waste“*BAT should be used to ensure that production of radioactive waste is prevented and where that is not practicable minimised with regard to activity and quantity.”*RSMDP8 Segregation of wastes“*The best available techniques should be used to prevent the mixing of radioactive substances with other materials, including other radioactive substances, where such mixing might compromise subsequent effective management or increase environmental impacts or risks.”.*Principle RSMDP8 goes onto state a series of considerations which are relevant to this RO, as follows:* *“The requirements of subsequent radioactive substance management steps through to disposal should be considered before mixing radioactive substance streams, including with other materials. Such steps include the ability to store, characterise, retrieve, treat, condition, and dispose.*
* *Segregation of radioactive substances should be addressed when designing new facilities.*
* *Mixing of radioactive substances should be prevented where the mixing is with other substances or materials with incompatible physical or chemical properties.*
* *Mixing of radioactive substances, including with other materials, may be undertaken where this facilitates subsequent management.”*

Relevant ONR guidance includes SAPs [2] RW.2 and RW.4, defined as follows:RW.2: Generation of radioactive waste*“The generation of radioactive waste should be prevented or, where this is not reasonably practicable, minimised in terms of quantity and activity.”**“796. Process and materials selection, construction methods, and commissioning,* *operational and decommissioning arrangements should be such so as to avoid the* *creation of radioactive waste, or reduce to the minimum radioactive waste generated* *throughout the facility’s lifetime.”**797. Factors to be considered in assessment against this principle should include:* *(a) the facility layout and service infrastructure;* *(b) secondary waste generation;* *(c) recycling and re-use of materials; and* *(d) decontamination of materials.* *Note: The choice between re-use, decontamination and direct disposal of waste should take account of relevant factors, including the form and disposability of the resultant waste, the benefits (or otherwise) of waste segregation, doses to operators, other wastes generated and resultant discharges.*RW.4: Characterisation and segregation*“Radioactive waste should be characterised and segregated to facilitate its subsequent safe and effective management*.”*“807. Decisions to mix waste streams need not be precluded if it can be properly justified and provide a net benefit in favour of safety or environmental factors including the later safe management of the waste through to disposal. Where radioactive waste is to be mixed with other wastes or materials, their mutual compatibility should be established in the safety case. Mixing of incompatible wastes should be prevented. Dilution of wastes solely to reduce their category should be avoided.”*Relevant IAEA guidance [6] includes the following recommendations:*6.9. Pretreatment operations, including segregation of waste, should be carried out so as to minimize the amount of radioactive waste to be further treated, conditioned, stored and disposed of**6.22. The categorization and classification of radioactive waste contributes to the development of management strategies and the operational management of the waste. Segregation of waste with different properties will also be helpful at any stage between the arising of the raw waste and its processing, storage, transport and disposal…**6.33. Pretreatment includes operations such as waste collection, segregation, chemical adjustment and decontamination, and is performed to reduce the amount of waste needing further treatment and conditioning, storage and disposal, to adjust the characteristics of the waste, to make the waste more amenable to further processing, and to reduce or eliminate certain hazards posed by the waste owing to its radiological, physical and chemical properties.**6.34. The first operation in the pretreatment of radioactive waste is generally the collection of waste, and segregation as necessary on the basis of its radiological, physical and chemical properties. The segregation of radioactive waste into appropriate categories should be carried out as near to the point of generation of the waste as practicable. Written procedures should be drawn up for the segregation of the waste. Radioactive waste containing predominantly short lived radionuclides should not be mixed with waste containing long lived radionuclides. In the segregation of waste, it should be taken into account whether the waste can be cleared from regulatory control or whether it can be recycled or discharged, either directly or after allowing for a period of storage for radioactive decay**6.96. Measures to be considered in the design of the nuclear power plant or research reactor for the management of liquid radioactive waste and liquid effluents (including waste arising from ion exchange resins) should include the following:…(f) Provisions for segregation of liquid waste by radioactivity (radionuclide half-life, specific activity), composition (organic and aqueous waste, low and high salt-containing aqueous waste) and phase status (ion exchange resins, sludge)….(j) Provisions for avoiding the combining of liquid waste that would result in a mixed waste or an undesirable chemical reaction (e.g. hydrogen generation).**6.97. Measures to be considered in the design of the nuclear power plant or research reactor for the management of solid radioactive waste should, as far as applicable, include the following: (a) Provisions for segregation of waste by type (i.e. by mass, physical form, volume, isotopic composition and activity concentration)…* *(h) Provisions for avoiding the combining of waste types that would result in a mixed waste.***Regulatory Expectations**Based on the expectations from the standards and guidance listed above, the Environment Agency expects the RP to provide a robust demonstration that:* the best available techniques have been used to prevent the unnecessary mixing of non-radioactive and radioactive spent bead resins with different waste categories, or that it is necessary to facilitate subsequent waste management, as per our generic developed principle RSMDP8 – Segregation of wastes [1].
* the mixing of floor, equipment and process drains prior to treatment does not compromise effective management of these wastes or increase environmental impacts or risks, as per our generic developed principle RSMDP8 – Segregation of wastes [1].

In addition to this, we have observed that there is some ambiguity associated with the waste classification of the spent bead resins generated from the ICC, in both the RQ response and the GDA Step 2 submissions. The RQ-01810 response does not clearly state what the waste classification for the ICC resins will be. In response to question 1, the RP states that the ICC spent resins are “*anticipated to be free from radioactivity under normal operating conditions*”. However, in response to question 2, there is an assumption stated that “*the ICC resin is radioactive and managed through the spent resin tank as a bounding conservatism*”. This doesn’t state whether the ICC resins are assumed to be LLW or ILW. Clarity therefore needs to be provided in the GDA Step 2 submissions on the assumed waste classification of the spent bead resins generated from the ICC during normal operations (including Anticipated Operational Occurrences (AOOs)), including the identification of any uncertainties, assumptions and further work required to address them.Furthermore, we have also observed that there is an inconsistency within the GDA Step 2 submissions regarding the design intent and proposed operation of the spent resin tank. In PER Chapter E05 [4] and PSR Chapter 11 [5] the spent resin tank is referred to as being used for the collection and decay of spent bead resins, prior to onwards processing once tank capacity has been reached. In PER Chapter E06 [3] Argument 1.5.6 also refers to the spent resin tank being used for the collection and decay storage of bead resins. However, Argument 1.1.9, Argument 1.4.3 and Argument 1.5.2 refers to the processing of bead resins on a batch-by-batch basis similarly to the response provided to RQ-01810. Clarity therefore needs to be provided across the submissions regarding the design intent of the spent bead resin tank, as it cannot be used for both decay storage and the batch processing of wastes.As part of the resolution of this RO, the RP will need to undertake and document the following activities during GDA Step 2:1. Define the assumed waste classification of the ICC bead resins generated from the BWRX-300 design during normal operations (including AOO) within the PER and PSR submissions.
2. Clarify the design intent of the spent bead resin tank within the PER and PSR submissions and ensure consistency in how this is presented in the BAT Claims, Arguments and Evidence (CAE) model [3].

As part of the resolution of this RO, the future developer/operator will need to undertake and document the following activities following completion of GDA Step 2:1. Define the waste classification of all spent bead resins generated from the BWRX-300 design, following refinement of the EUST (Forward Action PER5-113 [4]).
2. Evaluate the options for managing spent bead resins with different waste categories within the BWRX-300 design, with supporting narrative.
3. Demonstrate that the selected option is BAT and ALARP in preventing the unnecessary mixing of spent bead resins with different waste categories, or that it is necessary to facilitate subsequent waste management.
4. Define the waste classification of all other wet solid wastes generated from the BWRX-300 design, following refinement of the EUST (Forward Action PER5-113 [4]) and identify whether there are other waste streams with different waste categories (for example, LLW sludges and ILW sludges). If so, activities 2 and 3 above will need to be completed for these wastes.
5. Evaluate whether the mixing of floor, equipment and process drains prior to treatment in the LWMS compromises subsequent effective management of these wastes
6. Evaluate whether the mixing of floor, equipment and process drains prior to treatment in the LWMS increases environmental impacts or risks (for example, increased volume of secondary wastes).
7. Demonstrate that the mixing of floor, equipment and process drains prior to treatment in the LWMS is BAT

**References**[1] Radioactive substances management: generic developed principles, Environment Agency, May 2024[2] Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 1, Office for Nuclear Regulation, January 2020.[3] GEH Topical Report NEDC-34223P, Revision A, BWRX-300 UK GDA Chapter E06 Demonstration of Best Available Techniques Approach [4] GEH Topical Report NEDC-34223P, Revision A, BWRX-300 UK GDA Chapter E05 Radioactive Waste Management Arrangements  [5]GEH Topical Report NEDC-34174P, Revision A, BWRX-300 UK GDA Chapter 11 – Management of Radioactive Waste[6] IAEA Predisposal Management of Radioactive Waste from Nuclear Power Plant and Research Reactors, Specific Safety Guide No. SSG-40, 2016 |
| **REGULATORY OBSERVATION ACTIONS** |
| RO-BWRX300-002 **A1 – Define the assumed waste classification of the ICC bead resins generated from the BWRX-300 design during normal operations** In response to this Action, the RP should:* Identify the assumed waste classification of the bead resins generated from the ICC during normal operations
* Clearly state any uncertainties or assumptions in defining this waste classification and further work required to address them
* Provide an indication of whether the waste classification is likely to change following completion of this work.

RO-BWRX300-002 **A2 – Clarify the design intent of the spent bead resin tank within the PER and PSR submissions and ensure consistency in how this is presented within the BAT CAE model [3].**RO-BWRX300-002 **A3 – Define the waste classification of all spent bead resins generated from the BWRX-300 design, following refinement of the EUST (Forward Action PER5-113 [4]).**In response to this Action, the RP should:* Identify the waste classification of the bead resins generated from the ICC, LWMS, CFD and FPC during normal operations
* Clearly state any uncertainties or assumptions in defining this waste classification and further work required to address them
* Provide an indication of whether the waste classification is likely to change following completion of this work.

RO-BWRX300-002 **A4 – Evaluate the options for management of spent bead resins with different waste categories within the BWRX-300 design, with supporting narrative.** In response to this Action, the RP should:* Identify a comprehensive set of options for the management of spent bead resins with different waste categories.
* Evaluate these options using a systematic decision-making process and involving suitable qualified and experienced persons.
* Clearly state any uncertainties or assumptions used during the options evaluation process and further work required to address them.

RO-BWRX300-002 **A5 – Demonstrate that the selected option is BAT and ALARP in preventing the unnecessary mixing of spent bead resins with different waste categories,** or that it is necessary to facilitate subsequent waste managementIn response to this Action, the RP should:* Identify the preferred option for the management of spent bead resin with different waste categories, following completion of Action RO-BWRX300-002 A4.
* Provide a justification that the selected option is BAT and ALARP.
* Provide a justification that the selected option does not introduce the risk of unnecessary cross-contamination or unnecessary constraints on a future operator

RO-BWRX300-002 **A6 – Define the waste classification of all other wet solid wastes generated from the BWRX-300 design, following refinement of the EUST (Forward Action PER5-113 [4]). Identify whether there are waste streams with different waste categories (for example, LLW sludges and ILW sludges). If so, actions** RO-BWRX300-002 **A4 and** RO-BWRX300-002 **A5 will need to be repeated for these wastes.**RO-BWRX300-002 **A7 – Evaluate whether the mixing of floor, equipment and process drains prior to treatment in the LWMS compromises subsequent effective management of these wastes**In response to this Action, the RP should:* Evaluate whether the mixing of floor, equipment and process drains prior to treatment in the LWMS compromises subsequent effective management of these wastes
* Evaluate whether the mixing of floor, equipment and process drains prior to treatment in the LWMS facilitates the subsequent effective management of these wastes
* Identify and include where appropriate any relevant OPEX or RGP

RO-BWRX300-002 **A8 – Evaluate whether the mixing of floor, equipment and process drains prior to treatment in the LWMS increases environmental impacts or risks (for example, increased volume of secondary wastes).**In response to this Action, the RP should:* Provide information on the volume of secondary waste expected to be generated from the LWMS and how this compares to wastes generated from LWMS on comparable power stations across the world
* Evaluate whether there are any other environmental impacts or risks associated with the mixing of floor, equipment and process drains prior to treatment in the LWMS
* Identify and include where appropriate any relevant OPEX or RGP

RO-BWRX300-002 **A9 – Demonstrate that the mixing of floor, equipment and process drains prior to treatment in the LWMS is BAT** In response to this Action, the RP should:* Provide a justification that the approach to mixing floor, equipment and process drains prior to treatment is BAT, taking into consideration the outputs from Actions RO-BWRX300-002 A7 and RO-BWRX300-002 A8.

Resolution required by '*to be determined by GE Hitachi Resolution Plan*' |

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| **REQUESTING PARTY TO COMPLETE** |
| **Actual Acknowledgement date** (dd/mm/yy)**:** |  |
| **RP stated Resolution Plan agreement date** (dd/mm/yy)**:** |  |