REGULATORY OBSERVATION

REGULATOR TO COMPLETE

RO unique no.:	RO-ABWR-0022
Date sent:	17 October 2014
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Agreement of Resolution Plan required by:	7 November 2014
Resolution of Regulatory Observation required by:	*To be determined by the Hitachi-GE resolution plan*
TRIM Ref.:	2014/340906
Related RQ / RO No. and TRIM Ref. (if any)**:**	RO-ABWR-0006 RO-ABWR-0019
Observation title:	Demonstration that the Primary Cooling System Operating Chemistry reduces risks SFAIRP
Technical area(s) Reactor Chemistry	**Related technical area(s)** Fuel Design Radiation Protection & (Level 3 PSA) Structural Integrity Radwaste & Decommissioning Project Generic Environmental Permitting

Regulatory Observation

SUMMARY

The choice of operating chemistry for a given system can be a complex decision and there is a need to show that the chosen regime adequately balances the different benefits and detriments that this choice infers and therefore reduces risks So Far As Is Reasonably Practicable (SFAIRP).

Chemistry control of the primary cooling system can be particularly important given the potential risks posed by its inadequate execution on the integrity of fuel and structural materials and the generation and transport of radioactivity, amongst others. In addition to the reactor chemistry topic, the decision on the primary cooling system operating chemistry will have impacts on many other areas of the UK ABWR safety case (for example, fuel, structural integrity, radiation protection and radwaste), and submissions already provided or scheduled to be submitted to ONR.

Hitachi-GE have already committed to producing a demonstration that justifies the chosen operating chemistry for the primary cooling system of UK ABWR reduces risks SFAIRP. The objective of this Regulatory Observation (RO), therefore, is to clearly define ONR's expectations for that demonstration and also to clarify our expectation that a robust demonstration should be submitted to ONR by 31 December 2014.

The scope of the As Low As Reasonably Practicable (ALARP)[1] justification required by this RO covers at power operations for UK ABWR. By definition, therefore, it does not include other phases of normal operations, for example start-up and shutdown.

Regardless of the outcome of the ALARP justification for the primary cooling system operating chemistry regime for UK ABWR, ONR needs to be satisfied that:

(1) The option chosen reduces risks SFAIRP;
(2) A process of optimisation has been followed, this process can be demonstrated to ONR in a transparent manner, and forms part of the safety case for UK ABWR.

[1] The terms ALARP and SFAIRP can be used interchangeably. The outcome of reducing risks SFAIRP is that the level of risk is ALARP *i.e.* the outcomes are the same.

To do this Hitachi-GE need to provide a demonstration that their choice reduces risks SFAIRP, clearly identifying:

(1) What the risks are that are being mitigated, including likelihood and consequences;
(2) What measures are in place to mitigate these risks, including the adoption of relevant good practice measures;
(3) What options, or range of options, could be applied to further mitigate these risks; and
(4) A demonstration of whether these options are reasonably practicable to implement or not.

Until this robust demonstration has been provided, which takes account of all relevant risks, ONR cannot form a judgement on whether the legal duty of controlling risks and reducing risks SFAIRP will be met by the primary cooling system operating chemistry regime for UK ABWR.

BACKGROUND

ONR's reactor chemistry assessment during Step 2 of GDA of UK ABWR concluded that Hitachi-GE had presented an adequate basis to proceed to Step 3. The Step 2 assessment was almost entirely based upon the reactor chemistry PSR [1], which provided a set of safety claims for the main chemistry related systems, including claims on the primary system water chemistry regime. The PSR stated that the primary system water chemistry regime for UK ABWR, including an option to change the material for the Reactor Water Clean Up-system (RWCU), was yet to be finalised, but the claims made in the PSR were made on the assumption that UK ABWR would implement Hydrogen Water Chemistry (HWC), On Line Noble metal Chemistry (OLNC) and zinc addition. During Step 2 of GDA this position was accepted by ONR on the understanding that the supporting evidence would be provided as GDA progresses. The PCSR, submitted in August 2014 (but not assessed during GDA Step 2), further confirmed the chemistry choice as HWC, OLNC and zinc addition.

For reactor chemistry, the selection of an appropriate operating chemistry regime requires a detailed holistic assessment of all of the relevant risks and a demonstration that on balance, they are reduced SFAIRP for the plant as a whole. Without that robust demonstration ONR is unable to judge whether the legal duty of controlling risks and reducing risks SFAIRP, also referred to, interchangeably, as ALARP, will be met.

This RO has therefore been raised to make clear ONR's expectations regarding the quality, content and timing of the ALARP justification.

ONR has issued another RO concerning the strategy, plan and delivery of the reactor chemistry aspects of the UK ABWR safety case, RO-ABWR-0019 [2]. Resolution of that RO requires Hitachi-GE to identify the times at which submissions will be made to ONR during Steps 3 and 4 of GDA. In developing their response to RO-ABWR-0019, ONR would expect Hitachi-GE to take account of ONR's expectations highlighted in this RO and vice versa.

REGULATORY EXPECTATIONS.

The primary system water chemistry regime which UK ABWR will operate is an example of an area where Hitachi-GE are able to influence and control the magnitude of the radiological hazards and their resultant risks posed by the UK ABWR design.

For Boiling Water Reactors (BWRs) there is a relatively broad spectrum of options available to choose from when deciding on the primary system water chemistry regime to operate the plant to. For example:

- Some BWRs inject hydrogen to varying degrees, whilst others inject none at all;
- Some BWRs add zinc in the form of depleted zinc oxide (DZO), others add none at all;
- Some BWRs inject noble metals (either platinum or rhodium) either during at power operations or during shut down operations, others do not; and
- There are a number of methods available to control feedwater iron levels.

All of the above options, or combination of options either have been, or are being utilised by BWRs that are currently operating. This provides a strong indication that there are a number of options for UK ABWR which are reasonably practicable to implement. ONR's expectation is that the option, or combination of options which achieves the lowest level of residual risk and which is reasonably practicable, should be implemented.

While this RO is concerned with the choice of chemistry regime, the impacts and options available to mitigate the identified risks may be outside of the operating chemistry area (for example, shielding provisions). ONR would expect the demonstration to be based on the overall plant risks being reduced SFAIRP, by whatever appropriate means.

Further guidance on ONR's expectations is provided below.

More specific detailed guidance on ONR's expectations in relation to reactor chemistry is given in NS-TAST-GD-088 [3]. ONR's expectations with respect to demonstrating ALARP are also given in NS-TAST-GD-005 [4]. The Health and Safety Executive (HSE) have also published (online) a suite of guidance on ALARP [5-10]:

ONR expect Hitachi-GE to take due account of the principles and guidance set out in these documents when preparing their ALARP demonstration for the primary system water chemistry regime for UK ABWR. More specifically, ONR would expect Hitachi-GE to include the following:

a) **Relevant Good Practice (RGP):** ONR expects Hitachi-GE to apply RGP as a minimum. 'Relevant' means it should be appropriate to the activity and associated risks, and should be up to date. ONR will form a judgement by comparing Hitachi-GE's proposed approach for the primary cooling system water chemistry regime against RGP and good design principles. The use of good practice at the design stage is essential to demonstrating the achievement of ALARP.

   As a guide, Hitachi-GE should aim and compare against levels of safety that are known to have been achieved in other designs. ONR expect that UK ABWR would not give rise to a risk level greater than that achieved by the best of existing practice for comparable functions. Where others are achieving a higher standard, ONR will challenge Hitachi-GE whether this standard is, in effect, good practice.

   A universal practice adopted for BWR and ABWR operating chemistries may not necessarily be good practice or reduce risks to ALARP and Hitachi-GE should not assume that it is. What is good practice may cease to be relevant with the passage of time and new technology may make a higher standard reasonably practicable.

b) **Options and optioneering:** For UK ABWR a selection amongst options for the primary system water chemistry will be needed.

   An effective approach for demonstrating that risks are ALARP is to start with the safest option within the range of practicable solutions. This option should be chosen by Hitachi-GE unless they can show it is not reasonably practicable; in which case attention should pass to the next safest option. There should also be a comparison of the chosen option with the 'best' current practice to confirm that residual risks are no greater than the best of existing BWRs or ABWRs.

   ONR will form a judgement as to whether the design and primary system water chemistry option presented for UK ABWR reduces risks to ALARP based on our knowledge as a regulator, including: knowledge of relevant good practice in the area, ONR's knowledge of other possible options, and our judgement of the arguments and evidence presented in Hitachi-GE's case.

   To aid transparency in the ALARP demonstration, ONR would expect Hitachi-GE to record the range of options considered and discarded. ONR expect the ALARP demonstration to be made in an appropriate place in the safety case for UK ABWR.

c) **Known problem areas:** The ALARP demonstration should set out how known problem areas (e.g. identified from Operational Experience Feedback (OEF), improved analysis, or improving standards) have been addressed and how and why the particular option, or solution chosen, was arrived at.

d) **Proper balancing of all risks:** ONR expects Hitachi-GE to use good practice which will be relevant to the risks from operating UK ABWR and to cover all risks.

   The ALARP argument needs to consider all types of risk that are relevant and where these conflict with one another, ensure that an appropriate overall balance is achieved in regard to the their management. Risk should be considered over the life of the facility and all affected groups taken account of. The potential scale and nature of risks considered needs to be clearly presented.

e) **Taking cognisance of all relevant legislation:** Hitachi-GE will have to select an option taking account of legislation regulated by ONR and also the Environment Agency, where the requirement to apply Best Available Techniques (BAT) to discharges and disposals of radioactive waste applies. ONR would therefore expect Hitachi-GE to arrive at an 'optimised' solution, where the UK ABWR design will be capable of best meeting the requirements of all relevant legislation.

f) **Uncertainties and the precautionary principle:** Where the potential radiological consequences are high, ONR would expect Hitachi-GE to take a precautionary approach by giving more weight to the use of sound engineering and operational practice rather than arguments about the probability of failure. The essence of the precautionary approach is essentially that precautions should be taken unless there is a good reason to think that the risk is insignificant.

Thought should also be given to the robustness of the conclusions of the ALARP demonstration with respect to uncertainties and to any assumptions employed in the demonstration. Where a case uses quantitative methods sensitivity studies to test the robustness of the arguments should be provided.

References:

[1] XE-GD-0152 – UK ABWR GDA – Preliminary Safety Report on Reactor Chemistry, Revision B, Hitachi-GE, May 2014
[2] Regulatory Observation RO-ABWR-0019 – UK ABWR Reactor Chemistry Safety Case: Strategy, Plan and Delivery, ONR, September 2014, TRIM 2014/305447.
[3] Technical Assessment Guides. Chemistry of operating civil nuclear reactors, NS-TAST-GD-088, Revision 0, ONR, April 2014.
[4] Technical Assessment Guides, Guidance on the Demonstration of ALARP, NS-TAST-GD-005, Revision 6, ONR, September 2013.
[5] Principles and Guidelines to Assist HSE in its Judgements that Dutyholders have Reduced Risk as Low as Reasonably Practicable.
[6] Assessing Compliance with the Law in Individual Cases and the use of Good Practice.
[7] Policy and Guidance on Reducing Risks as Low as Reasonably Practicable in Design.
[8] HSE Principles for Cost Benefit Analysis in Support of ALARP Decisions.
[9] HSE – Risk Management: ALARP at a Glance.
[10] HSE – Risk Management: Cost Benefit Analysis (CBA) Checklist.

Regulatory Observation Actions

RO-ABWR-0022.A1 – Hitachi-GE to provide a robust demonstration to show that the primary cooling system operating chemistry reduces risks SFAIRP

Hitachi-GE should provide a robust demonstration for the primary cooling system operating chemistry choice for UK ABWR which demonstrates that:

(1) The option chosen reduces risks SFAIRP;
(2) A process of optimisation has been followed, this process can be demonstrated to ONR in a transparent manner, and forms part of the safety case for UK ABWR.

ONR would expect such a response to include a clear description of:

(1) What the risks are that are being mitigated, including likelihood and consequences;
(2) What measures are in place to mitigate these risks, including the adoption of relevant good practice measures;
(3) What options, or range of options, could be applied to further mitigate these risks; and
(4) A demonstration of whether these options are reasonably practicable to implement or not.

ONR expect that the expectations given above, in addition to that given in relevant ONR guidance, as referenced in this RO, will be included in the submission provided in response to this Action.

The scope of the ALARP justification required by this RO covers at power operations for UK ABWR. By definition, therefore, it does not include other phases of normal operations, for example start-up and shutdown.

While this RO is concerned with the choice of chemistry regime, the impacts and options available to mitigate

the identified risks may be outside of the operating chemistry area (for example, shielding provisions). ONR would expect the demonstration to be based on the overall plant risks being reduced SFAIRP, by whatever appropriate means.

ONR recognise that some of the detailed supporting evidence that underpins the conclusions of this demonstration may not be available in a timescale compatible with this RO, however we would expect details of key supporting evidence (i.e. those which could materially change the conclusions) to be available, where reasonably practicable, along with details of what other supporting evidence will be made available during later steps in GDA.

There are a number of overlaps with other ROs, noteably RO-ABWR-0006 and 0019 which need to be considered as part of this response.

RESOLUTION REQUIRED BY*:* 31 December 2014.

REQUESTING PARTY TO COMPLETE	
Actual Acknowledgement date:	
RP stated Resolution Plan agreement date:	