

REGULATORY OBSERVATION	
REGULATOR TO COMPLETE	
RO unique no.:	RO-ABWR-0034
Date sent:	16th December 2014
Acknowledgement required by:	9th January 2015
Agreement of Resolution Plan Required by:	6th February 2015
Resolution of Regulatory Observation required by:	<i>To be determined by the Hitachi-GE resolution plan</i>
TRIM Ref.:	2014/460897
Related RQ / RO No. and TRIM Ref. (if any):	RQ-ABWR-0082, TRIM 2014/118089
Observation title:	Demonstrating the inclusion of a 'bottom drain line' in the UK ABWR design achieves inherent safety and reduces risks SFAIRP
Technical area(s) 9. Reactor Chemistry	Related technical area(s) 10. Radiation Protection & (Level 3 PSA) 12. Structural Integrity
<i>Regulatory Observation</i>	
SUMMARY	
<p>The United Kingdom Advanced Boiling Water Reactor (UK ABWR) currently includes a design feature referred to as the 'bottom drain line'. The line is located at the bottom of the Reactor Pressure Vessel (RPV) and is connected to the Reactor Water Clean-up System (RWCU).</p> <p>During Step 2 of the Generic Design Assessment (GDA) of UK ABWR, a Regulatory Query (RQ), (RQ-ABWR-0082 [1]), was raised in the reactor chemistry area which requested Hitachi-GE to explain the functions and justification for this design feature. The reason for this query was that such features are known to be the cause for significant worker dose during outages.</p> <p>Hitachi-GE's response [2] provided the high-level claims associated with this feature. ONR informed Hitachi-GE the inclusion of a 'bottom drain line' in the UK ABWR design would be subject to further regulatory scrutiny as GDA progressed. ONR has subsequently undertaken further assessment work related to this aspect of the UK ABWR design, the outcome of which challenges the claims made by Hitachi-GE in their response.</p> <p>This Regulatory Observation (RO) has therefore been raised to make clear ONR's expectations regarding Hitachi-GE's justification for the inclusion of a 'bottom drain line' in the UK ABWR design, specifically whether this achieves an inherently safe design which avoids radiological hazards rather than controlling them, and whether its presence reduces risks SFAIRP.</p>	
BACKGROUND	
<p>The UK ABWR currently includes a design feature referred to as the 'bottom drain line'. The line is located at the bottom of the RPV and is connected to the RWCU, as depicted in Figure 1 below as the line appearing as an arrow at the bottom of the RPV:</p>	

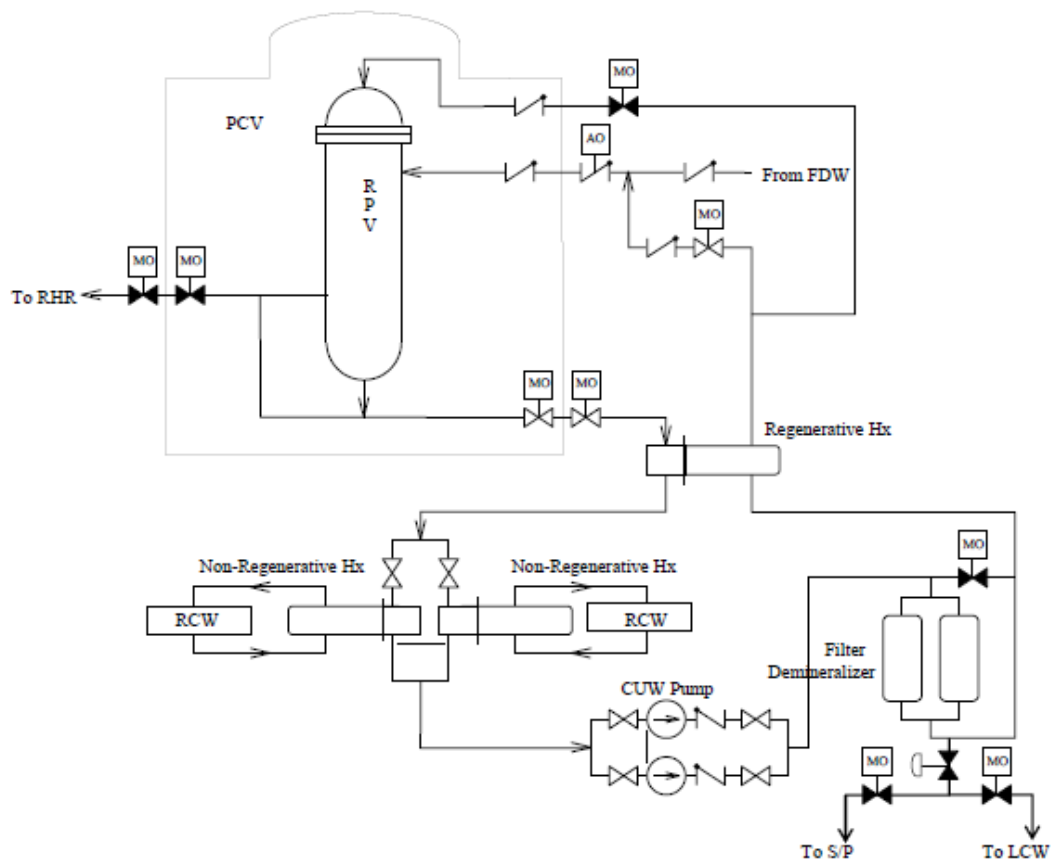


Figure 1: Depiction of the RWCU for UK ABWR [3]

During Step 2 of GDA of UK ABWR, RQ-ABWR-0082 was raised in the reactor chemistry area which requested Hitachi-GE to explain:

- What the function(s) of the ‘bottom drain line’ in the UK ABWR design is(are), and based on their response to question 1, to provide:
- A justification that the presence of a ‘bottom drain line’ in the UK ABWR design reduces risks SFAIRP.

The reason for this RQ was that ONR understood that the drain line is a significant contributor to operator dose during outages, and at that time Hitachi-GE were considering material changes to this line as a measure to mitigate the dose.

Hitachi-GE provided a response to RQ-ABWR-0082 during Step 2. The underlying reasons given for inclusion of this feature in the design relate to corrosion product accumulation and thermal effects in the RPV. During the close-out of the reactor chemistry Step 2 assessment, ONR accepted Hitachi-GE’s response to RQ-ABWR-0082 as being commensurate with the level of detail and justification expected at that stage of the GDA process, but informed Hitachi-GE the inclusion of a ‘bottom drain line’ in the UK ABWR design would be subject to further regulatory scrutiny as GDA progressed.

ONR has subsequently undertaken further assessment work related to this aspect of the design, the outcome of which confirms that such features are significant sources of dose and also challenges the reasons originally put forward for the inclusion of the ‘bottom drain line’ for UK ABWR. In summary, ONR has found that:

- a. All German Boiling Water Reactors (BWRs) have permanently closed the drain openings at the RPV bottom [4];
- b. All Swedish BWRs that were originally designed with a ‘bottom drain line’ have now permanently closed them, principally because;
 - Operating Experience Feedback (OPEX) has shown the line was not required in practice and

- was a large contributor to worker dose uptake during the outage;
- The line was originally intended to drain CRUD (Chalk River Un-identified Deposit) which may accumulate in the bottom of the RPV, but OPEX showed CRUD accumulation did not prove problematic [5].
- c. The design of all Swedish internally pumped BWR plants (similar to the UK ABWR design) does not include a 'bottom drain line' [5];
- d. Some BWRs in the United States of America (USA) have also permanently closed the drain openings at the RPV bottom;
- e. Water chemistry control for the UK ABWR is claimed to minimise the formation of CRUD [6].

This RO has therefore been raised to make clear ONR's expectations regarding Hitachi-GE's justification for the inclusion of a 'bottom drain line' in the UK ABWR, specifically whether this achieves an inherently safe design which avoids radiological hazards rather than controlling them, and whether its presence reduces risks SFAIRP.

REGULATORY EXPECTATIONS.

One of the main sources of standards and guidance ONR use in assessing the UK ABWR are the Safety Assessment Principles (SAPs) [7].

As outlined in SAP EKP.1, the engineering key principle covering inherent safety, ONR's preference is for an inherently safe design, which avoids radiological hazards rather than controlling them. The application of this principle is particularly important for a new facility at the design stage.

ONR expect Hitachi-GE to provide a robust demonstration that the inclusion of a 'bottom drain line' in the UK ABWR design achieves inherent safety and reduces risks SFAIRP. ONR expect first and foremost, the safest option to be selected, unless it can be shown it is not reasonably practicable for that option to be implemented. ONR would expect Hitachi-GE to demonstrate:

- whether other options have been considered;
- to identify and document those options;
- to provide robust evidence of the criteria used in decision making and option selection, and;
- to provide evidence of gross disproportion in terms of cost (time, trouble or money) for options not selected.

In order to be able to undertake the above demonstration ONR would expect Hitachi-GE to:

- Take account of all relevant, Worldwide OPEX, regarding the purpose and function of the 'bottom drain line' in other BWRs;
- Clearly state the applicability, or otherwise, of the above Worldwide OPEX to the UK ABWR design;
- Clearly state all of the operational and safety functions of the 'bottom drain line' in the UK ABWR, including the consequences for its removal;
- Take due account of the claims being made on water chemistry control, or in other technical areas, for UK ABWR;
- Provide supporting evidence to demonstrate that the selected option has reduced risks SFAIRP.

Although this RO has been raised by the reactor chemistry topic, ONR's Radiation Protection (RP) discipline will lead the assessment of the response, with support from reactor chemistry and structural integrity, as required and as a minimum. ONR expect a similar coordinated approach to be adopted by Hitachi-GE in response to this RO.

References:

- [1] GDA Regulatory Query RQ-ABWR-0082 – RPV Bottom Drain Line, ONR, March 2014, TRIM 2014/118089.
- [2] GA91-9201-0003-00100 – UK ABWR GDA – Reactor water clean-up system design: RPV Bottom Drain Line (response to RQ-ABWR-0082), Hitachi-GE, May 2014, TRIM 2014/193308.
- [3] XE-GD-0126 – UK ABWR GDA – ABWR General Description – Revision 2, Hitachi-GE, 2014.
- [4] Compilation of Boiling Water Reactors (BWR) operational experience (OpEx) to inform ONR's ABWR GDA assessment work during GDA – Final Report, GRS, July 2014.

[5] ONR-GDA-CR-14-202 - Level 4 Information Exchange Meeting with the Swedish Nuclear Safety Regulator (SSM) and Swedish Utilities on Boiling Water Reactor (BWR) Chemistry and Design, ONR, November 2014, TRIM 2014/427110.

[6] XE-GD-0152 – UK ABWR GDA – Preliminary Safety Report on Reactor Chemistry, Revision B, Hitachi-GE, May 2014.

[7] Safety Assessment Principles for Nuclear Facilities – Revision 1, HSE, 2006.

Regulatory Observation Actions

RO-ABWR-0034.A1 – Hitachi-GE to provide a robust demonstration to show the inclusion of a 'bottom drain line' in the UK ABWR design achieves inherent safety and reduces risks SFAIRP

RESOLUTION REQUIRED BY: To be determined by the Hitachi-GE resolution plan

REQUESTING PARTY TO COMPLETE

Actual Acknowledgement date:	
RP stated Resolution Plan agreement date:	