

Hitachi-GE Nuclear Energy, Ltd.
UK ABWR GENERIC DESIGN ASSESSMENT
Resolution Plan for RO-ABWR-0081
UK ABWR Sampling Capabilities

RO TITLE:	UK ABWR Sampling Capabilities
REVISION :	0
Overall RO Closure Date (Planned):	27 September 2017
REFERENCE DOCUMENTATION RELATED TO REGULATORY OBSERVATION	
Regulatory Queries	RQ-ABWR-0957, RQ-ABWR-0970, RQ-ABWR-1038, RQ-ABWR-1198, RQ-ABWR-1351, RQ-ABWR-1352
Linked ROs	-
Other Documentation	UE-GD-0602 Rev. 0, WPE-GD-0232 Rev. 1, WPE-GD-0358 Rev.0

Scope of work :
<p>Background</p> <p>Hitachi-GE delivered the topic report on “Sampling and Monitoring Philosophy for Chemical and Radiochemical Parameters” [1], “Design Justification in Chemistry Aspect for Primary Water Systems” [2] and “System Design Description for Sampling System” [3] to show the sampling system design and its justification for normal operation, and “Monitoring Parameters in DBF” [4] to show the all sampling and monitoring parameters needed for a control to establish stable cooling after initiating the Design Basis Faults (DBF).</p> <p>In the former reports sampling and monitoring design philosophy, sampling system design description and justification of the sampling system are provided. However, the level of detail did not meet the ONR expectations to perform meaningful assessment during GDA and this RO (Action 1 and Action 2) was raised. Hitachi-GE understand the ONR expectations for normal operations sampling as follows:</p> <ul style="list-style-type: none"> • To provide suitable and sufficient information of the specific UK ABWR sampling system design including: <ul style="list-style-type: none"> - Sample schedule required to support operation of UK ABWR; - Design information of sampling and monitoring system for all types of sampling lines; and - Identification of any changes to the reference design in light of chemistry changes for UK ABWR. • To justify the adequacy of the UK ABWR sampling and monitoring design to support normal operation considering: <ul style="list-style-type: none"> - Specific features of the UK ABWR design; - The effect of any design changes to the sampling system - The operator safety in collection and transport of samples - The approach to recycle all sample effluent in the reactor <p>In the latter report sampling and monitoring parameters necessary to control the accident are mainly physical ones such as neutron flux, temperature, flow rate, water level and radiation level, while chemistry related parameters are limited for this purpose until stable cooling is established. The ONR have identified potential gaps against their expectations for example the requirements for reactor water sampling and use of sources other than the NRC regulatory guide [5] and Action 3 and Action 4 were raised. Hitachi-GE understand the ONR expectations for post-accident sampling as follows:</p> <ul style="list-style-type: none"> • To define and identify and identify RGP and perform a comparison with UK ABWR:

- Not only NRC guidance [5] and IEEE standard [6], but also IAEA [7] and WENRA [8] guidance to be considered
- Other operating BWR post-accident sampling and monitoring arrangements to be considered
- Radiation protection measures for personnel who carry out sampling and analysis to be considered
- Regular checks of the PASS to be included
- Specification of chemistry parameters to be monitored
- Identification and justification of parameters to be monitored:
 - ONR (SAP and TAG), IAEA and WENRA guidance to be considered
 - Specific parameters regarding reactor water to be identified
 - Chemistry parameters for Spent fuel pool, suppression pool, FCV and SLC to be considered
 - Monitoring parameters during DBA to be justified and categorised commensurate to their importance including the reasons of selection and categorisation
- Demonstration the SAM is capable of fulfilling its safety function in Design Basis Accident:
 - Adequate justification that SAM is capable of sampling and monitoring chemistry related parameters to be provided

This Resolution Plan is prepared to respond to the RO-ABWR-0081: UK ABWR Sampling Capabilities.

Scope of Work

This RO is consisted of two main parts; Normal operations sampling and Post-accident sampling. For normal operations sampling this Resolution Plan demonstrates what kinds of the detail design information will be provided and how the UK ABWR sampling and monitoring system design will be justified to be adequate to support normal operations.

For Post-accident sampling this Resolution Plan demonstrates how chemistry parameters to be sampled and monitored during DBA will be defined and justified and how the capability of sampling and monitoring system will be justified for the UK ABWR Reactor Chemistry Safety Case. Chemistry parameters will be identified for not only reactor water, but also other all plant systems relevant to DBA except for liquid and solid radwaste system. The sampling and monitoring period will cover from the initiating event of the DBA to the next normal operation when full recovery has been made from the DBA. The period of sampling and monitoring will be divided into before and after the stable cooling is established based on the difference of safety requirements.

Description of work:

ACTION 1 - *Presentation of suitable and sufficient information to enable a meaningful assessment of the sampling and monitoring systems*

Hitachi-GE will provide suitable and sufficient design information for the UK ABWR specific sampling and monitoring system. The design information includes; (1) a sample schedule required to support operation of UK ABWR, (2) design information of the sampling and monitoring system, for all types of sampling lines, and (3) identification of any changes to the reference design in light of chemistry changes for UK ABWR.

Regarding (1) Hitachi-GE will provide the UK ABWR specific sample schedule with considering:

- All modes of operation;
- Type of sampling line for the most significant chemistry parameters to nuclear safety;
- Discharge destination;
- Parameters to be measured from which location and the frequency of sampling;
- link back to the safety case (OR/LCO);
- Representativeness (e.g. nozzle insertion and titanium piping application);
- Places of sample collection; and

This sampling schedule will cover at least CUW, RHR, CFDW, HD and not limited to these systems.

Regarding (2) Hitachi-GE will provide design information of the sampling and monitoring system, for all types of sampling lines related to systems with the greatest nuclear safety significance. Additionally, systems are selected on their importance to chemistry control and potential impact from the change to UK ABWR operating chemistry. This will include P&ID (piping and instrument diagrams) or diagrammatical presentation for conceptual system of

sampling lines which includes sample line length/diameter, containment penetrations, cooling measures (and source), pressure reduction measures, isolation valves, flushing measures, sumps, sample hoods, sample sinks, sample filter racks and online meters and a description of how the UK ABWR sampling and monitoring system will work in practice.

Regarding (3) Hitachi-GE will provide the identification results of any differences to the reference J-ABWR design considering the water chemistry change such as hydrogen, platinum and depleted zinc injection for UK ABWR in an impact assessment, identifying any necessary design changes.

In response to Action 1, Hitachi-GE will provide Sampling System P&IDs and a Topic Report on Design Justification in Chemistry Aspect for Primary Water Systems Rev.3 by 27 June 2017.

ACTION 2 - *Justification that the UK ABWR sampling and monitoring design is adequate to support normal operations*

Hitachi-GE will provide an appropriate justification that the sampling and monitoring system design described under A1 of this RO is capable of providing timely and representative sampling to support safe normal operations. To achieve this RGP and guidance for sampling system will be reviewed, considering international plant experience along with international and industry guidance.

Then UK ABWR sampling system will be compared to these RGP and guidance considering:

- Specific features of the UK ABWR design, such as the location of cooling provisions and the maintenance of high pressure lines;
- The effect of any design changes (material and chemical) to the sampling system;
- The operator safety (both radiological and conventional) in collection and transport of samples including a brief description of operating procedures for grab sampling and handling of a filter folder;
- The approach to recycle all sample effluent in the reactor, with specific consideration on generation of secondary waste; and
- OPEX data or other evidences to justify the configurations above and representativeness of samples especially for Zn.

In response to Action 2, Hitachi-GE will provide Sampling System P&IDs and a Topic Report on Design Justification in Chemistry Aspect for Primary Water Systems Rev.3 by 27 June 2017.

ACTION 3 - *Definition and justification for chemistry-related parameters required in design basis post-accident sampling*

Hitachi-GE will identify and justify all chemistry parameters required to be monitored in a design basis accident in line with ONR's SAPs, TAGs and IAEA guidance. To achieve this the work will include:

- To define the sampling and monitoring period (before establishing stable cooling and thereafter) in DBA;
- To align the DBA management strategy, and then identify specific chemistry parameters to be measured for reactor water, which is described in the topic report on monitoring parameters in DBF [4];
- To align the DBA management strategy, and then identify all chemistry parameters for all plant systems such as spent fuel pool, suppression pool, pressure containment vessel etc for 14 fault groups described in Table 3 of the topic report on monitoring parameters in DBF [4]. Liquid and solid radwaste systems will be excluded due to no monitoring requirements against accident control;
- To describe monitoring timing for each parameter against the corresponding DBA sequences;
- To gather worldwide information on DBA sampling and monitoring requirements and arrangements;
- To justify identified chemistry parameters adequately with consideration of the above gathered information, and to make clear the safety role for each monitoring function.

In response to Action 3, Hitachi-GE will provide a topic report on Sampling Capabilities of Chemistry-related Parameters in Design Basis Faults Revision 0 by 23 June 2017.

ACTION 4 - Demonstration that the UK ABWR design is adequate to support post-accident sampling

Hitachi-GE will demonstrate that the UK ABWR sampling and monitoring system is capable to deliver monitoring chemistry parameters in Design Basis Accident. To achieve this the work will consider:

- Categorisation and Classification of the sampling and monitoring system to be used in DBA;
- Sample condition (e.g. temperature, pressure, activity) at the sampling timing and scenario identified in ROA1;
- Supporting system (e.g. power supply, cooling water) availability at the sampling timing and scenario identified in ROA1;
- SAM availability;
- Representativeness of sampling and monitoring;
- Comparison of the UK ABWR to identified RGP and other BWR designs; and
- Operator safety in terms of safe collection, handling and return of samples.

Hitachi-GE will also describe which systems perform normal operations and post-accident sampling function within the safety case.

In response to Action 4, Hitachi-GE will provide Sampling System P&IDs and a topic report on Sampling Capabilities of Chemistry-related Parameters in Design Basis Faults Revision 0 by 23 June 2017.

Summary of impact on GDA submissions:

The GDA submissions that will be affected by the actions to resolve this RO are summarised below. These documents will be originated and/or revised in accordance with the corresponding actions as necessary.

GDA Submission Documents	C/U	Related GDA RO Action(s)	Submission Date to ONR
Topic Report on Design Justification in Chemistry Aspect for Primary Water Systems Revision 3	U	A1, A2	June 2017
Sampling System P&IDs	C	A1, A2, A4	June 2017
Topic Report on Sampling Capabilities of Chemistry-related Parameters in Design Basis Faults	C	A3, A4	June 2017

Programme Milestones/ Schedule:

See attached Gantt Chart (Table 1)

Reference:

- [1] Hitachi-GE Nuclear Energy, Ltd., "Topic Report on Sampling and Monitoring Philosophy for Chemical and Radiochemical Parameters", GA91-9201-0001-00264 (WPE-GD-0358) Revision 0, March 2017

- [2] Hitachi-GE Nuclear Energy, Ltd., “Topic Report on Design Justification in Chemistry Aspect for Primary Water Systems”, GA91-9201-0001-00199 (WPE-GD-232) Revision 2, March 2017
- [3] Hitachi-GE Nuclear Energy, Ltd., “Sampling System System Design Description”, GP91-1001-0001-00001 (SD-GD-0024) Revision 1, September 2016
- [4] Hitachi-GE Nuclear Energy, Ltd., “Monitoring Parameters in DBF”, GA91-9201-0003-01577 (UE-GD-0602) Revision 0, February 2017
- [5] US Nuclear Regulatory Commission, “Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident”, Regulatory Guide. 1.97 Revision 3, December 1983
- [6] IEEE Power Engineering Society, “IEEE Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations”, IEEE Std 497™-2002, September 2002
- [7] IAEA, “Safety of Nuclear Power Plants: Design, Specific Safety Requirements”, No. SSR-2/1, 2012
- [8] Western European Nuclear Regulators’ Association. Reactor Harmonization Group. WENRA Reactor Reference Safety Levels for Existing Reactors, WENRA. September 2014.

Table 1 RO-ABWR-0081 Gantt Chart

Resolution Plan for RO-ABWR-0081		«Legend»								
		■ ... Plan ←→ ... Actual		3	4	5	6	7	8	9
Level	Action Title	Start(Plan)	Finish(Plan)							
1	Regulator's issue of RO	27-Mar-17	19-Jun-17		█	█	█			
1.1	ONR Issue RO	27-Mar-17	12-May-17		█	█				
1.2	Hitachi-GE Acknowledge RO & Issue Resolution Plan	15-May-17	05-Jun-17			█				
1.3	Regulator's confirm credibility of Resolution Plan	06-Jun-17	12-Jun-17				█			
1.4	Regulator's publish RO and Resolution Plan	13-Jun-17	19-Jun-17				█			
2	Preparation of Submissions and Closure of RO Action	03-Apr-17	27-Sep-17		█	█	█	█	█	█
2.1	ROA1	24-Apr-17	27-Jun-17			█	█			
2.2	ROA2	24-Apr-17	27-Jun-17			█	█			
2.3	ROA3	03-Apr-17	23-Jun-17		█	█	█			
2.4	ROA4	17-Apr-17	23-Jun-17			█	█			
2.5	Regulator's assesment of submission	28-Jun-17	27-Sep-17					█	█	█
3	Regulator's Closure of RO									
3.1	Regulator's publication of RO closure letter	27-Sep-17	27-Sep-17							█

Glossary

Glossary follows definition of this RO.

BAT – *Best Available Techniques*

BWR – *Boiling Water Reactor*

CRUD – *Chalk River Unidentified Deposit*

Expected event – *events that are expected to occur over the lifetime of the plant. This does not include events that are inconsistent with the use of BAT such as accidents, inadequate maintenance and inadequate operation.*

GEP – *Generic Environmental Permit*

Operational States – *Including “normal operations” and “anticipated operational occurrences”.* For a nuclear power plant, this includes start-up, power operation, shutting down, shutdown, maintenance, testing and refuelling.

ORE – *Operational Radiation Exposure*

PCSR – *Pre-construction Safety Report*

RO – *Regulatory Observation*

ROA – *Regulatory Observation Action*

RPV – *Reactor Pressure Vessel*

Severe accident - *As defined in the SAPs. A fault sequence which leads either to consequences exceeding the highest radiological doses given in the BSLs of Target 4, or to a substantial unintended relocation of radioactive material within the facility which places a demand on the integrity of the remaining physical barriers*

SFAIRP – *So Far as is Reasonably Practicable*

Source term – *The types, quantities, and physical and chemical forms of the radionuclides present in a nuclear facility that have the potential to give rise to exposure to radiation, radioactive waste or discharges*

SSCs – *Systems, Structures and Components*

UK ABWR – *UK Advanced Boiling Water Reactor*