REGULATORY OBSERVATION

REGULATOR TO COMPLETE

RO unique no.:	RO-ABWR-0024
Date sent:	13 November 2014
Acknowledgement required by:	4 December 2014
Agreement of Resolution Plan Required by:	*To be defined by Hitachi-GE Resolution Plan*
Resolution of Regulatory Observation required by:	*To be defined by Hitachi-GE Resolution Plan*
TRIM Ref.:	2014/419242
Related RQ / RO No. and TRIM Ref. (if any)**:**	RQ-ABWR- 0141, 0147 and 0149.
Observation title:	Hitachi-GE Nuclear Energy Ltd. Human Reliability Analysis – Error of Commission / misdiagnosis
Technical area(s) Human Factors	**Related technical area(s)** PSA Fault Studies

Regulatory Observation

Summary

The UK ABWR makes potentially important safety claims related to human reliability, which require substantiation in a modern standards safety case. Amongst other human factors matters, ONR expects the safety case to identify and proportionately analyse all reasonably foreseeable human actions and omissions that might impact on safety. During ONR's Step 2 assessment of the UK ABWR, Regulatory Queries (RQ) were raised related to Human Reliability Analysis (HRA) [Ref.1]. Three of these were focussed on the requesting party's approach to the treatment of Errors of Commission (EOC) and their impacts on safety. ONR has assessed the RPs responses to the RQs [Ref. 1] and whilst we welcome the commitment given by Hitachi-GE to identify, understand and qualitatively analyse EOC, and that quantification will be provided '*if appropriate'*, ONR does not consider the entirety of the responses to be sufficiently justified and fully reflective of HRA relevant good practice and UK regulatory expectations in this area. Hitachi-GE has also stated that '*additional negative impacts that cause new accident sequence are not modelled in the PSA because of the complexity of the impact on the sequence*'. This is not consistent with the UK legal requirement to reduce all risks so far as is reasonably practicable.

Without appropriate analysis of important EOC an unknown risk gap can exist, resulting in an inadequate safety case, design and the UK ABWR risk estimates being optimistic. Left unresolved, inadequate treatment of EOC is a potentially significant project risk for Hitachi-GE delivering a successful GDA safety case within the desired timescale. The RP should consider the matters identified in this Regulatory Observation (RO), furnish responses to the actions raised, and subsequently provide in the UK ABWR safety case, suitable and sufficient justification and analysis for the treatment of EOC and their impacts within the UK ABWR safety case.

Background and Discussion

1. In the response to RQ-ABWR-0141, the RP stated that '*additional negative impacts that cause new accident sequence are not modelled in the PSA because of the complexity of the impact on the sequence*'. This is not consistent with the UK legal requirement to reduce all risks as far as is reasonably practicable, produce an adequate safety case and suitable and sufficient risk assessment. Complexity is not a valid argument for not attempting to identify and analyse all reasonably foreseeable risks. The safety case and its PSA need to be complete and include all reasonably foreseeable risks (hence faults) and their impacts (i.e. material risks that are not trivial or fanciful – UK Case Law e.g. *R v Chargot Limited, R v EGS Limited*).

EOC in the form of slips and lapses as well as diagnostic failures are reasonably foreseeable; their impacts on safety and risk should therefore be analysed if they can aggravate a fault scenario, change its trajectory or inspire new faults. In addition to the dominant failure path, probabilities should be assigned to those important EOC with potential to create any significant new / divergent fault sequences that are not already bounded and protected. This is necessary to be confident that plant protection is suitable and sufficient to defend against faults and their variants, and demonstrate that the system design has reduced EOC potential to ALARP. This analysis should also provide evidence that there are robust recovery mechanisms in place should misdiagnosis and other significant EOC occur, and that the potential for recovery errors to exacerbate a situation has also been considered.

2. The RP's response to RQ-ABWR-0147 (and 0149) [Ref. 1] states that Hitachi-GE is considering appropriate modern practice with regards to treatment of EOC, which is welcomed. However, ONR does not consider the full response to fully reflect modern practice and latest understanding in this area. The reasons for this are discussed below.

   Hitachi-GE states that "*most current HRA material does not support the accurate and credible quantification of cognitive errors, and additional quantification and modelling in the PSA will be included in future revision if appropriate and valid tools can be found".* Appropriate and valid tools can be found to model cognitive errors and misdiagnosis. It is relevant good practice for modern HRA to consider the likelihood of misdiagnosis both qualitatively and quantitatively and to model this in the PSA. ONR expects such modelling to be explicit in the UK ABWR PSA. There are HRA techniques (e.g. SPAR-H is mentioned in the RP's response to RQ-0149), which if underpinned by thorough task analysis to give suitable task decomposition, correctly interpret the quality of performance shaping factors (PSF) and crew response actions, that have the ability to predict crew performance and yield error probabilities similar to empirical HEP distributions for cognitive /diagnosis failure reported in published literature.

   ONR refers Hitachi-GE to the Step 4 Human Factors Assessment Reports for the UK EPR and AP 1000 regarding this area (www.onr.org.uk/new-ractors/apl000/reports.htm; www.onr.org.uk/new-reactors/uk-epr/reports.htm). Also of relevance is the work of the US NRC, Paul Scherrer Institute (PSI) and Halden Reactor Project. This involved extensive international HRA studies, which used as their basis real-time empirical simulator scenarios of post-fault crew performance. This work provides the latest and credible insights into the use and accuracy of many HRA techniques. ONR considers this work to be relevant good practice information following an independent evaluation and peer review of its impacts for UK HRA practice.

   Use of the Standardised Plant Analysis Risk-HRA (SPAR-H) [Ref. 2] method will require justification based on latest knowledge in this area. SPAR-H tends to yield optimistic results. It has a nominal (baseline) probability for diagnostic HEP of 1E-02, which tends to lie towards the 5th centile end of empirical HEP distributions derived in published literature. Whilst a SPAR-H assessment can degrade the nominal HEP, it can also improve it by up to a factor of 100. This would be too optimistic for more complex diagnosis HFE encountered in nuclear power plant. Moreover, as a simplified HRA method, SPAR-H has inherent modelling and analysis limitations that need to be clearly understood. SPAR-H does not require assessors to make significant judgements about the state of factors affecting human performance other than rating them against set criteria. Its fixed approach to PSF multipliers suffers from a lack of flexibility and tends to be too rigid. Assessors need to be able to use more graduations of PSF than are offered in SPAR-H, particularly for more difficult or complex HFE often encountered in post-fault scenarios. ONR therefore has reservations regarding the use of SPAR-H without appropriate sensitivity analysis using another technique that allows for more graduated PSF assessment. Whichever HRA method is used for quantification ONR expects it to be underpinned and informed by sound qualitative analysis.

UK regulatory expectations relating to the above are set out in the ONR Technical Assessment Guides (TAG) on HRA and Probabilistic Safety Analysis (PSA) [Ref. 3]. These state that [inspectors may consider whether]:

"*the dutyholder has considered plausible deviations from normal plant conditions or fault sequences that might cause additional human errors leading to exacerbated or additional fault sequences."*

"PSA should be a systematic analysis to identify all important fault sequences which can lead to radiological

consequences and to evaluate their contribution to the risk. The PSA should set out to identify all the significant contributions to the risk since, otherwise the analysis is not complete and conclusions drawn from the analysis may thus be incorrect"

"The general approach used for the inclusion of post-accident human failure events (detection, decision errors, omission errors, commission errors, etc, and common cause human failures) into the system models is clear and adequate. All relevant human failure events have been correctly included in the fault tree"

"HFEs resulting from identified credible mis-diagnosis have been modelled correctly (e.g. human actuations due to mis-diagnosis that change the course of an accident sequence will normally be modelled in the event trees. Un-required switching off of systems due to mis-diagnosis will normally be modelled in the fault trees)"

References

[1] *ONR Electronic Document Management System TRIM Folder 5.1.3.9389 ONR – New Nuclear Reactor Build.* GDA 2013 – 2017 (Hitachi-GE) – RQs (Regulatory Queries and Responses)

[2] The SPAR-H Human Reliability Analysis Method. NUREG/CR – 6883, INL/EXT – 05 – 00509. September 2004.

[3] ONR Technical Assessment Guides: www.hse.gov.uk/nuclear/operational/tech_asst_guides/index.htm.http://www.hse.gov.uk/nuclear/operational/tech_asst_guides/index.htm

Regulatory Observation Actions

Action # 1 : Hitachi-GE is requested to consider the matters identified in this RO and furnish a Resolution Plan by 20 December 2014.

Action # 2: Hitachi-GE needs to provide suitable and sufficient justification and analysis in the UK ABWR safety case for the treatment of important EOC and their impacts. This should include systematic assessment and modelling (qualitatively and quantitatively) of important EOC, including those EOC that have the potential to aggravate fault sequences and lead to new situations that are not modelled in the PSA. The PSA should quantify these errors (and sequences) and fully incorporate them to provide a best-estimate of the risk. Resolution required in line with the UK ABWR PSA programme timescales.

Action # 3: Hitachi-GE is expected to provide a robust justification for the choice of its HRA methods and HEP data, taking into account the above and noting UK regulatory expectations in the regards as cited in SAP EHF.10 (paragraph 390: "The selection and application of probability data for human errors should be……..justified and its relevance for the task and context demonstrated"). If SPAR-H is to be used, sensitivity studies using another HRA method should be conducted. Alternatively, Hitachi-GE may wish to justify why EOC have no significant safety impacts and that tasks with decision-making and diagnosis do not have a cognitive error potential with an impact on safety. Resolution required in line with the UK ABWR PSA programme timescales.

Action # 4: Given the intricacies and simplistic nature of SPAR-H and its lack of application in UK NPP safety cases to date, Hitachi-GE should explain the familiarity and experience of its assessors regarding use and application of SPAR-H in this context and its technical basis. Resolution required by 20 December 2014.

REQUESTING PARTY TO COMPLETE

Actual Acknowledgement date:	
RP stated Resolution Plan agreement date:	