

REGULATORY OBSERVATION	
REGULATOR TO COMPLETE	
RO unique no.:	RO-ABWR-0008
Date sent:	5th June 2014
Acknowledgement required by:	26th June 2014
Agreement of Resolution Plan Required by:	4th July 2014
Resolution of Regulatory Observation required by:	<i>To be determined by the Hitachi-GE Resolution Plan</i>
TRIM Ref.:	2014/138772
Related RQ / RO No. and TRIM Ref. (if any):	
Observation title:	Common cause failure of electrical distribution systems
Technical area(s) Fault Studies	Related technical area(s) Electrical PSA
Regulatory Observation	
Summary	
<p>Electrical power supplies on a nuclear power plant (NPP) are dependent on the source of power. For the UK Advanced Boiling Water Reactor (ABWR) these can be the national grid, emergency diesel generators, battery systems and the diverse back-up building diesel generators. However, they are also dependent on the transmission and distribution of electrical power within the NPP site.</p> <p>ONR has produced a Regulatory Observation asking Hitachi-GE to undertake design basis analysis of a range of major common cause failures (CCFs) of key systems involved in the distribution of power within the generic UK ABWR site. Hitachi-GE will need to analyse the impact of the CCF of switchboards and static conversion equipment (an example of the latter is equipment that converts alternating current to direct current). This work, which is referred to as the CCF of electrical distribution systems, complements another Regulatory Observation on the UK ABWR which focuses on the source of generation.</p>	
Background	
<p>Electrical power supplies on a nuclear power plant (NPP) are dependent on the source of power. For the UK Advanced Boiling Water Reactor (ABWR) these can be the national grid, emergency diesel generators, battery systems and the diverse back-up building diesel generators. However, they are also dependent on the transmission and distribution of electrical power within the NPP site.</p> <p>The challenges and consequences from a loss of important functions of NPP distribution systems are not necessarily the same as those from a loss of the sources of generation of electrical power. A good example is the three-divisional safety Class 1 6.9 kV switchboards labelled on Hitachi-GE's single line diagram (SLD) 310RC06-522 SH 1/E Rev 0 as safety bus 1C (Div I), 1D (Div II) and 1E (Div III). A CCF of these three switchboards as an infrequent design basis event would not be the same as loss of offsite power (LOOP) event and the CCF of the three emergency diesel generators. The reason for this is that with the switchboards remaining available for the LOOP event, the operators can still provide power to the safety Class 1 loads by directing power from the back-up building diesel generators to the safety Class 1 loads using the 6.9 KV switchboards.</p> <p>For the purpose of this Regulatory Observation, the CCF relates to all items of common technology. For example (see SLD 310RC06-522 SH 1/E Rev) the nuclear island 6.9 KV switchboards labelled non-safety bus (1A-1, 1A-2, 1B-1 and 1B-2) employ identical switchboard technology to that on those labelled safety buses (1C, 1D and 1E) and therefore the CCF would apply to all 7 switchboards simultaneously. The CCF will apply to all common equipment (see the above example of the 6.9KV ac supply) used across different safety classes for all switchboards and static conversion equipment (i.e. rectifiers, invertors and uninterruptible power supply</p>	

systems).

The CCF of Safety Class 1 equipment should be considered in the design basis safety case as an infrequent event. The CCF of Safety Class 2 and 3 equipment should be considered as a frequent event. Where common technology covers different safety classes then the CCF is to be applied to the highest safety class.

The bases for these event frequencies are derived from ONR's technical assessment guide on Safety Systems, T/AST/003 Issue 6 (http://www.onr.gov.uk/operational/tech_asst_guides/tast003.pdf). This document gives guidance on the limits which should be applied to the CCF of any single technology regardless of the degree of redundancy and is given in the following table:

System Class	Failure Frequency/yr (<i>ff</i>)
Class 1	$10^{-3}/\text{yr} \geq ff \geq 10^{-5}/\text{y}$
Class 2	$10^{-2}/\text{yr} \geq ff > 10^{-3}/\text{y}$
Class 3	$10^{-1}/\text{yr} \geq ff > 10^{-2}/\text{y}$

(Note, these figures assume all sources of CCF including internal and external hazards. Therefore, they may appear unduly pessimistic compared any notionally similar failure frequencies used in an internal events PSA).

Hitachi-GE needs to show through new or pre-existing transient analysis that a sustainable safe state can be reached, after applying the appropriate deterministic rules for the event frequency. Claims on the requirements of batteries and diesel tanks need to be clearly identified. It is expected that batteries remain available to deliver any required functions for at least 24 hours while diesel generators have sufficient stocks for at least 72 hours.

ONR gave a presentation to Hitachi-GE 4 March 2014 (TRIM 2014/114395) on how the above could potentially be applied using the following SLDs:

- 310RC06-522 SH 1/E Rev 0
- 310RC06-520 SH 1/E Rev 0
- 310RC06-521 SH 1/E Rev 0
- Extracts of diagrams for UK ABWR uninterruptible power supply systems.

ONR's 4 March 2014 presentation was based on preliminary information on the UK ABWR submitted by Hitachi-GE. This preliminary information does not provide, at this stage, sufficient details for ONR to provide a complete set of expectations on this topic and this is the reason for the first action on Hitachi-GE to provide its proposals for the set of electrical CCFs based on its detailed understanding of the proposed technology for the UK ABWR.

This is a cross cutting regulatory observation led by fault studies but supported by electrical engineering and PSA.

Regulatory Observation Actions

RO-ABWR-0008.A1: List of electrical distribution CCFs

Hitachi-GE to provide a complete list of electrical distribution CCFs to be analysed as design basis events based on the principle that the failure will apply to all common electrical distribution and static conversion equipment proposed for the UK ABWR.

The complete list of CCFs to be analysed is to be provided. The outcome of this work should be reflected in the UK ABWR fault schedule.

Resolution required by: To be determined by the Hitachi-GE Resolution Plan

RO-ABWR-0008.A2: Design basis analysis of electrical distribution CCFs

Hitachi-GE to provide a design basis safety case for the electrical distribution CCFs identified in Action 1, demonstrating that a sustainable safe state can be achieved. This is likely to require transient analysis to be performed, showing that the appropriate acceptance criteria can be met and that there is sufficient engineered diversity for the assumed CCF frequency. Mission times for batteries and diesel generators need to be clearly identified.

Resolution required by: To be determined by the Hitachi-GE Resolution Plan

RO-ABWR-0008.A3: PSA modelling of initiating events triggered by electrical distribution CCFs

Hitachi-GE to provide the following information (this information can be included in a relevant PSA topic report or in a dedicated topic report):

- Initiating events that are triggered by the failure of the electrical distribution equipment are to be identified, defined and characterised so that they can be modelled in the Level 1 UK ABWR PSA. These initiating events shall include CCFs of the electrical distribution equipment and the combination of independent failures with these CCFs.
- An explanation of how these initiating events will be modelled in the UK ABWR Level 1 PSA. This shall include the justification for potential initiating event groups (if relevant) and how the proposed model will address dependencies between these initiating events and the mitigating systems.
- A justification of the initiating event frequencies associated with the failure of the electrical distribution equipment to be used in the UK ABWR Level 1 PSA. Fault trees or other models used to calculate the initiating event frequencies shall be provided.

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: