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Civil Nuclear Reactor Build - Generic Design Assessment

Step 2 Assessment of the Conventional Fire Safety of Hitachi-GE Nuclear Energy Ltd.'s UK Advanced Boiling Water Reactor (UK ABWR)

Assessment Report ONR-GDA-AR-14-017
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EXECUTIVE SUMMARY

This report presents the results of my assessment of the Conventional Fire Safety of Hitachi General Electric Nuclear Energy Ltd (The requesting party) UK Advanced Boiling Water Reactor (UK ABWR) undertaken as part of Step 2 of the Office for Nuclear Regulation's (ONR) Generic Design Assessment (GDA).

The GDA process calls for a step-wise assessment of the Requesting Party's (RP) safety submission with the assessments getting increasingly detailed as the project progresses. Step 2 of GDA is an overview of the acceptability, in accordance with the regulatory regime of Great Britain, of the design fundamentals, including review of key nuclear safety, nuclear security and environmental safety claims with the aim of identifying any fundamental safety or security shortfalls that could prevent the proposed design from being licensed in Great Britain. Therefore during GDA Step 2 my work has focused on the assessment of the key claims in the area of Conventional Fire Safety to judge whether they could satisfy UK expectations for fire safety in building design.

For Conventional Fire Safety, "UK expectations" are interpreted as being: the design principles contained in appropriate published national standards and current relevant standards of industry good practice for the design and management of buildings.

The standards I will use to judge the adequacy of the claims in the area of fire safety have been primarily legislative requirements of the Regulatory Reform (Fire Safety) Order 2005 and supporting fire risk assessment guidance documents and relevant building design codes of practice including Approved Document 'B' to the Building Regulations, British Standard 9999 and other British Standards as appropriate.

My GDA Step 2 assessment work has involved an initial meeting with the RP in the form of a technical exchange workshop and an assessment of the RP's Preliminary Safety Report (PSR) and its references relevant to Conventional Fire Safety. A visit to Japan took place in June 2014, to meet the Hitachi design team, strengthen mutual understanding of expectations, view a three dimensional model of the ABWR and tour a plant under construction. The RP's preliminary safety claims related to Conventional Fire Safety, as presented in the PSR, can be summarised as follows:

- To comply with UK guidance and standards of fire safety, mainly contained within BS 9999 for building design and comply with other relevant industry good practice, as far as reasonably practicable.
- Identify departures in the ABWR design from UK established Building codes and fire safety expectations due to nuclear safety requirements and other design features.
- Provide an equivalent level of fire safety for each of the departures through a process of optioneering and selection based on a robust ALARP justification.

During my GDA Step 2 assessment of the UK ABWR aspects of the safety case related to Conventional Fire Safety, I have identified the following areas of strength:

- The PSR document clearly identifies relevant UK legislative requirements and makes reference to the appropriate guidance and relevant good practice which forms the benchmark for assessing compliance with the law. A good understanding of the largely functional requirements of the legislation and guidance is evident in the submission. It is also positive that the RP has identified, at an early stage, that there will be areas where adherence to the prescriptive sections of guidance will be challenging. The RP has documented a proposal to manage departures from code compliance by a risk assessed optioneering process combined with an ALARP justification for the chosen solution, to ensure risk gaps are minimised.



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During my GDA Step 2 assessment of the UK ABWR aspects of the safety case related to conventional Fire Safety I have identified the following areas that require follow-up:

- Although the RP has described the means to resolve areas of departure from UK fire safety expectations in the PSR, there is an absence of detail in the proposed methodology. A strategy document is required, which adequately describes a consistent process for identifying, recording, prioritising and managing departures. The strategy should include sufficient detail to describe the fire safety optioneering and ALARP justification for the chosen solution. The absence of this detail in step 2 is not critical but the departure management strategy should be progressed early within step 3.

Overall, I see no reason, on Conventional Fire Safety grounds, why the UK ABWR should not proceed to Step 3 of the GDA process.



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LIST OF ABBREVIATIONS

ABWR	Advanced Boiling Water Reactor
ALARP	As Low As Reasonably Practicable
BAT	Best Available Technique
BMS	Business Management System
BS	British Standard
BSL	Basic Safety Level (in SAPs)
BSO	Basic Safety Objective (in SAPs)
DAC	Design Acceptance Confirmation
EA	Environment Agency
GEP	Generic Environmental Permit
The requesting party	Hitachi General Electric Nuclear Energy Ltd
IAEA	International Atomic Energy Agency
JPO	(Regulators') Joint Programme Office
MSIV	Main Steam Isolation Valve
NPP	Nuclear Power Plant
ONR	Office for Nuclear Regulation
PCSR	Pre-construction Safety Report
PSR	Preliminary Safety Report
RGP	Relevant Good Practice
RHWG	Reactor Harmonization Working Group (of WENRA)
RI	Regulatory Issue
RIA	Regulatory Issue Action
RO	Regulatory Observation
ROA	Regulatory Observation Action
RP	Requesting Party
RPV	Reactor Pressure Vessel
RQ	Regulatory Query
RRP	Resource Review Panel



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LIST OF ABBREVIATIONS

SAP(s)	Safety Assessment Principle(s)
SFAIRP	So far as is reasonably practicable
SME	Subject Matter Expert
TAG	Technical Assessment Guide(s)
TSC	Technical Support Contractor
TSF	Technical Support Framework
WENRA	Western European Nuclear Regulators' Association



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1 INTRODUCTION

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1.1 Background

1. The Office for Nuclear Regulation's (ONR) Generic Design Assessment (GDA) process calls for a step-wise assessment of the Requesting Party's (RP) safety submission with the assessments getting increasingly detailed as the project progresses. Hitachi General Electric Nuclear Energy Ltd's (The requesting party) is the RP for the GDA of the UK Advanced Boiling Water Reactor (UK ABWR).
2. During Step 1 of GDA, which is the preparatory part of the design assessment process, the RP established its project management and technical teams and made arrangements for the GDA of its ABWR design. Also, during Step 1 the requesting party prepared submissions to be evaluated by ONR and the Environment Agency (EA) during Step 2.
3. Step 2 of GDA is an overview of the acceptability, in accordance with the regulatory regime of Great Britain, of the design fundamentals, including review of key nuclear safety, nuclear security and environmental safety claims with the aim of identifying any fundamental safety or security shortfalls that could prevent the proposed design from being licensed in Great Britain.
4. This report presents the results of my assessment of the Conventional Fire Safety of The requesting party's UK ABWR as presented in the UK ABWR Preliminary Safety Report (PSR) (Ref.9).

1.2 Methodology

5. My assessment has followed my GDA Step 2 Assessment Plan for Conventional Fire Safety (Ref 6) prepared in February 2014 and shared with the requesting party to maximise openness and transparency. Occasionally, during GDA Step 2, there have been reasons why my assessment work had to depart from the plan established in Ref. 6; the main discrepancies are explained here and in Ref. 7
6. A variation from the assessment plan has occurred which relates to my request to review an example of how the RP will resolve departures from UK fire safety expectations. Although the RP did not provide a demonstration of their process in Step 2; this issue was discussed in detail with the RP's design team during a visit to Japan and it was clarified that examples of managing departures would be a key feature of the Step 3 conventional Fire Safety assessment.

2 ASSESSMENT STRATEGY

7. This section presents my strategy for the GDA Step 2 assessment of the Conventional Fire Safety of the UK ABWR (Ref 6). It also includes the scope of the assessment and the standards and criteria that I have applied.

2.1 Scope of the Step 2 Conventional Fire Safety Assessment

8. The objective of my GDA Step 2 Conventional Fire Safety assessment for the UK ABWR was to review and judge whether the claims made by the RP related to Conventional Fire Safety provide an equivalent level of fire safety in building design to UK expectations.
9. For Conventional Fire Safety "safety claim" is interpreted as being:



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- To comply with UK guidance and standards of fire safety, mainly BS 9999, in building design and other established UK standards as far as reasonably practicable.
 - To comply with UK Fire Safety legislation.
 - Identification of departures from compliance with UK fire safety expectations due to nuclear safety requirements and other design features.
 - To provide an equivalent level of fire safety for areas which depart from established Building codes, through a process of optioneering and selection based on a robust ALARP justification.
10. During GDA Step 2, I have also evaluated whether the safety claims related to Conventional Fire Safety are supported by reference to established national building design standards and codes of practice sufficient to allow me to proceed with GDA work beyond Step 2.
11. Finally, during Step 2, I have undertaken the following preparatory work for my Step 3 assessment:
- Assessed Hitachi GE's UK ABWR GDA Preliminary Safety Report on Conventional Safety and Fire.
 - Identified issues to prioritise within Step 3
 - Attended a workshop in Japan, reviewed the 3D model and toured an ABWR in construction

2.2 Standards and Criteria

12. The goal of the GDA Step 2 assessment is to reach an independent and informed judgment on the adequacy of a nuclear safety, security and environmental case. For this purpose, ONR will assess the building design for conventional fire safety against legislative requirements, established national standards and published relevant industry good practice.
13. The Regulatory Reform (Fire Safety) Order 2005 applies during the construction phase, normal operation and periods of maintenance of the project and constitutes the regulatory requirements against which duty holders' compliance is assessed. In addition, the Construction (Design and Management) Regulations 2007 also apply during the design and build of the project, which include requirements for planning and implementing fire safety provisions.
14. Furthermore, ONR is a member of the Western Regulators Nuclear Association (WENRA). WENRA has developed Reference Levels, which represent good practices for existing nuclear power plants, and Safety Objectives for new reactors.

2.2.1 National and International Standards and Guidance

- The following national and international standards and guidance have also been used as part of this assessment:

Legislative requirements of:-

- Regulatory Reform (Fire Safety) Order 2005
 - Construction (Design and Management) Regulations 2007
- Relevant UK standards for fire safety in building design and management



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- Approved Document 'B' Fire Safety to the Building Regulations 2010
ISBN 978 1 85946 489 2
- British Standard 9999: 2008 Code of Practice for Fire Safety in the design, management and use of buildings
- British Standard 7974; - Application of fire safety engineering principles to the design of buildings. Code of practice ISBN 0 580 38447 0.
- Communities and Local Government fire risk assessment guidance for achieving compliance with the requirements of the Regulatory Reform (Fire Safety) Order 2005.
 - Factories and Warehouses ISBN-13: 978 1 85112 8167
 - Offices and Shops ISBN-13: 978 1 85112 8150
- Published Fire Safety Guidance and Relevant Good Practice
 - Fire Safety in Construction Work, HSG 168. Health & Safety Executive ISBN 978 0 7176 6345 3
 - Various relevant British Standards for the selection, installation, operation management and maintenance of fire safety equipment and fire safety systems.

2.3 Integration with Other Assessment Topics

15. Early in GDA I recognised that during the project there would be a need to consult with other assessors as part of the Conventional Fire Safety assessment process. Similarly, other assessors will seek input from my assessment of the conventional Fire Safety for the UK ABWR. I consider these interactions very important to ensure the prevention of assessment gaps and duplications, and, therefore, are key to the success of the project. Thus, from the start of the project, I made every effort to identify as many potential interactions as possible between the Conventional Fire Safety and other technical areas, with the understanding that this position would evolve throughout the UK ABWR GDA.
16. Also, it should be noted that the interactions between the Conventional Fire Safety and some technical areas need to be formalised since aspects of the assessment in those areas constitute formal inputs to the Conventional Fire Safety assessment, and vice versa. These are:
 - Security: provides input to the means of escape aspects of the conventional fire safety. This formal interaction has not commenced during GDA Step 2. This work will be led by the Security Inspector in co operation with Fire Safety Team.
 - Internal Hazards provides input to the building fire compartmentation and protective fire systems aspects of the conventional fire safety assessment. This work will be led by the Internal Hazards team in coordination with the Fire Safety Inspectors.
17. In addition to the above, during GDA Step 2 there have been interactions between Conventional Fire Safety and the rest of the technical areas, ie, Security etc. Although these interactions, which are expected to continue thorough GDA, are mostly of an informal nature, they are essential to ensure consistency across the technical assessment areas.



3 REQUESTING PARTY'S SAFETY CASE

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18. This section presents a summary of the RP's preliminary safety case in the area of Conventional Fire Safety. It also identifies the documents submitted by the requesting party which have formed the basis of my assessment of the UK ABWR Conventional Fire Safety during GDA Step 2.

3.1 Summary of the RP's Preliminary Safety Case in the Area of conventional Fire Safety

19. The aspects covered by the UK ABWR preliminary safety case in the area of Conventional Fire Safety can be broadly grouped under 3 headings which can be summarised as follows

- To comply with UK guidance and standards of fire safety, mainly BS 9999, in building design and comply with other relevant industry good practice, as far as reasonably practicable.
- Identify departures in the ABWR design from established UK Building codes and UK fire safety expectations due to nuclear safety features and other design requirements.
- To achieve an equivalent level of fire safety for each of the departures through a process of optioneering and selection based on a robust ALARP justification.

3.2 Basis of Assessment: RP's Documentation

20. The RP's documentation that has formed the basis for my GDA Step 2 assessment of the safety claims related to the Conventional Fire Safety for the UK ABWR is:

- UK ABWR PSR Chapter on conventional Fire Safety "Preliminary Safety Report on Conventional Safety and Fire GA91-9901-0044-00001" (Ref. 9). This document presents / describes how the RP proposes to meet UK expectations for fire safety in building design and how they will achieve an equivalent level of safety using alternative methods in cases where there are departures from established guidance.



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21. My assessment has been carried out by referencing the RP's high level conventional fire safety strategy contained within Preliminary Safety Report on Conventional Safety and Fire, against legislative requirements, established guidance and relevant industry good practice.
22. My GDA Step 2 Conventional Fire Safety assessment has followed the strategy described in Section 2 of this report.
 - My Step 2 assessment work has involved an initial meeting with the RP's conventional fire safety Subject Matter Experts (SME) a subsequent meeting at a workshop in Japan, and assessment of their Preliminary Safety Report on Conventional Safety and Fire.
23. Details of my GDA Step 2 assessment of the UK ABWR preliminary safety case in the area of conventional Fire Safety including the areas of strength that I have identified, as well as the items that require follow-up and the conclusions reached are presented in the following sub-sections.

4.1 Fire Safety

4.1.1 Assessment

24. Within the 'Preliminary Safety Report on Conventional Safety and Fire', the RP has correctly identified the requirements of fire safety legislation, demonstrated an understanding of relevant guidance and selected BS9999 as the code of practice for fire safety in the design and management of buildings. Referencing the design of the ABWR against these documents provides an appropriate benchmark for achieving acceptable standard of fire safety in the final building. Similarly, during the construction phase, compliance with appropriate guidance has been specified including HSG 168 and other relevant industry good practice.
25. At this step in the GDA process the RP has provided an adequate strategic overview of the standards of conventional fire safety that will be employed to confirm and satisfy UK expectations for building design.

4.1.2 Strengths

26. The requesting party understands that UK laws in relation to conventional fire safety are different to those in Japan and have stated that they are 'adapting their existing design processes and design decisions as required to meet UK requirements'. The 'Preliminary Safety Report' also states that the RP will obtain support to facilitate understanding of and provide competent advice on UK requirements. Understanding of ONR's expectations in the application of goal setting legislation will be greatly assisted by the use of subject matter experts
27. The RP has also recognised that full compliance with the design code will be challenged by nuclear safety considerations and they have identified a suitable methodology to achieve an equivalent level of safety through alternative methods

4.1.3 Items that Require Follow-up

28. During my GDA Step 2 assessment of Conventional Fire Safety I have identified the following areas that require development that I will follow-up during Step 3:

The following points relate to improvements to the processes for resolving areas of departure from UK fire safety expectations in building design.



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- Although the RP has described a basic system of resolving departures in the PSR, there is an absence of detail in the methodology which should be further developed into a process that can be used consistently.
- A strategy document for recording and managing the process of departures, optioneering and ALARP justification is required.
- In areas where compliance with guidance is not achievable, The RP will need to demonstrate, by means of an example, that they take a strategic approach in the optioneering process and take full account of practical fire engineering measures to produce an integrated and balanced solution.
- The RP will need to demonstrate, by means of an example, that their ALARP justification in the selection of an alternative fire engineered solution is robust and could withstand legal challenge.

4.1.4 Conclusions

29. Based on the outcome of my assessment of Conventional Fire Safety I have concluded that overall, the RP has provided an adequate high level statement of their approach to meet UK expectations for Conventional Fire Safety.

4.2 Out of Scope Items

30. The following items have been left outside the scope of my GDA Step 2 assessment of the UK ABWR Conventional Fire Safety.
- Detailed fire strategies for individual buildings. The reason for leaving this matter out of the scope of my GDA Step 2 assessment is this level of scrutiny will be developed in later steps and as final design is confirmed.
 - Detailed construction phase fire safety strategies have not been included in Step 2 because these will developed in steps 3 and 4.
31. It should be noted that the above omissions do not invalidate the conclusions from my GDA Step 2 assessment. During my GDA Step 3 assessment I will follow-up the above out-of-scope items as appropriate; I will capture this within my GDA Step 3 Assessment Plan.

4.3 Comparison with Standards, Guidance and Relevant Good Practice

32. In Section 2.2 above I have listed the standards and criteria I have used during my GDA Step 2 assessment of the UK ABWR Conventional Fire Safety to judge the adequacy of the preliminary safety case. My overall conclusions in this regard can be summarised as follows:
- The RP has correctly identified appropriate established standards of fire safety in building design which will satisfy UK expectations both for the final building and during the construction phase.



5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

33. The requesting party has provided a PSR for the UK ABWR for assessment by ONR during Step 2 of GDA. The PSR and its references to supporting documents, present, at a high level, the claims in the area of Conventional Fire Safety.
34. During Step 2 of GDA I have conducted an assessment of the parts of the PSR and its references that are relevant to the area of conventional Fire Safety against UK expectations for building design. From the UK ABWR assessment done so far I conclude the following:
- The RP has selected and confirmed compliance, as far as reasonably practicable, with appropriate established standards of fire safety to apply in the ABWR design which will satisfy UK expectations for the final building.
 - Appropriate references have also been identified for Fire Safety during the construction phase of the project which provides an adequate overview to satisfy the requirements of Step 2 GDA assessment. During step 3, the RP will be expected to develop more detail for the construction phase.
 - The RP has recognised that certain features of nuclear power plants challenge UK expectations in building design and to resolve this issue they have documented a strategy for addressing departures. Whilst the high level elements of the strategy represent industry good practice, there is an absence of detail in the procedure and no account of a recording and management process. These shortfalls do not impact on the Step 2 assessment but development of a management strategy for dealing with departures from UK standards and guidance will become a key aspect of my assessment, early in Step 3.
 - The engagement of subject matter experts to assist in the implementation of UK guidance represents a significant advantage in achieving acceptable solutions particularly in areas of design that challenge implementation in the requirements of prescriptive guidance.
35. Overall, I see no reason, on conventional fire safety grounds, why the UK ABWR should not proceed to Step 3 of the GDA process.

5.2 Recommendations

36. My recommendations are as follows
- Recommendation 1: The UK ABWR should proceed to Step 3 of the GDA process.
 - Recommendation 2; All the items identified in Step 2 as important to be followed up should be included in ONR's GDA Step 3 Assessment Plan for the UK ABWR conventional fire safety.
 - Recommendation 3: All the relevant out-of-scope items identified in sub-section 4.2 of this report should be included in ONR's GDA Step 3 Assessment Plan for the UK ABWR conventional fire safety.



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6 REFERENCES

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