



New Reactors Division

Step 4 Assessment of Fire Safety for the UK Advanced Boiling Water Reactor

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EXECUTIVE SUMMARY

Hitachi-GE Nuclear Energy Ltd is the designer and GDA Requesting Party for the United Kingdom Advanced Boiling Water Reactor (UK ABWR). Hitachi-GE commenced Generic Design Assessment (GDA) in 2013 and completed Step 4 in 2017.

This assessment report is my Step 4 assessment of the Hitachi-GE UK ABWR reactor design in the area of conventional fire safety.

The scope of the Step 4 assessment is to review the safety, security and environmental aspects of the UK ABWR in greater detail, by examining the evidence, supporting the claims and arguments made in the safety documentation, building on the assessments already carried out for Step 3.

My assessment conclusion is:

- Hitachi has conducted a suitable and sufficient assessment of the risks to life safety from fire.

My judgement is based upon the following factors:

- Fire Safety Strategy GA91-9201-0001-00144 revision 3 and the Topic Report on Departures from Conventional Fire Regulation GA91-9201-0001-00001 revision 6 provide sufficient evidence to demonstrate that Hitachi has conducted a suitable and sufficient assessment of the risks to life safety from fire
- For areas of design which depart from British Standard 9999, Fire Safety in the Design and Management of Buildings, Hitachi has applied a rigorous process, which adequately evaluates risk and provides suitable ALARP justifications for alternative fire engineered measures which achieve an equivalent standard of life safety protection from fire.

Overall, based on the samples undertaken, I am broadly satisfied that the claims, arguments and evidence laid down within the Fire Safety Strategy and supporting documentation submitted as part of the GDA process present an adequate justification for the protection of life safety for the generic UK ABWR design in the area of conventional fire safety. For this reasoning the UK ABWR should be awarded a DAC at this present time.

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
BS	British Standard
BSL	Basic Safety Level
BSO	Basic Safety Objective
GDA	Generic Design Assessment
IAEA	The International Atomic Energy Agency
MDEP	Multi-national Design Evaluation Programme
ONR	Office for Nuclear Regulation
PCSR	Pre-construction Safety Report
PSA	Probabilistic Safety Assessment
PSR	Preliminary Safety Report
RGP	Relevant Good Practice
RP	Requesting Party
SAPs	Safety Assessment Principles
SFAIRP	So Far As Is Reasonably Practicable
SSC	System, Structure (and) Component
SSER	Safety, Security and Environmental Report
TAG	Technical Assessment Guide
TSC	Technical Support Contractor
US NRC	United States (of America) Nuclear Regulatory Commission
UK ABWR	United Kingdom Advanced Boiling Water Reactor
WEC	Westinghouse Electric Company
WENRA	Western European Nuclear Regulators' Association

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1 INTRODUCTION

1.1 Background

1. Information on the GDA process is provided in a series of documents published on our website (<http://www.onr.org.uk/new-reactors/index.htm>). The expected outcome is a Design Acceptance Confirmation (DAC) for ONR and a Statement of Design Acceptability (SoDA) for the Environment Agency (EA) and Natural Resources Wales (NRW).
2. The GDA Step 3 summary report is published on our website (<http://www.onr.org.uk/new-reactors/uk-abwr/reports/step3/uk-abwr-step-3-summary-report.pdf>). Further information on the GDA process in general is also available on our website (<http://www.onr.org.uk/new-reactors/index.htm>).
3. Hitachi-GE commenced GDA in 2013 and completed Step 4 in 2017. The Step 4 assessment is an in-depth assessment of the safety, security and environmental evidence. Through the review of information provided to ONR, the Step 4 process should confirm that Hitachi-GE:
 - Has properly justified the higher-level claims and arguments.
 - Has progressed the resolution of issues identified during Step 3.
 - Has provided sufficient detailed assessment to allow ONR to come to a judgment of whether a DAC can be issued.
4. During the step 4 assessment I have undertaken a detailed assessment, on a sampling basis of the fire safety strategy for buildings on the nuclear island. The full range of items that might form part of the assessment is provided in ONR's GDA Guidance to Requesting Parties (<http://www.onr.org.uk/new-reactors/ngn03.pdf>). These include:
 - Consideration of issues identified in Step 3.
 - Judging the design against the Safety Assessment Principles (SAPs) and whether the proposed design reduces risks to ALARP.
 - Reviewing details of the Hitachi-GE design controls, procurement and quality control arrangements to secure compliance with the design intent.
 - Establishing whether the system performance, safety classification, and reliability requirements are substantiated by the detailed engineering design.
 - Assessing arrangements for ensuring and assuring that safety claims and assumptions are realised in the final as-built design.
 - Resolution of identified nuclear safety and security issues, or identifying paths for resolution.
5. This is my report from the ONR's Step 4 assessment of the Hitachi-GE UK ABWR design in the area of conventional fire safety.
6. All of the regulatory issues (RIs) and regulatory observations (ROs) issued to Hitachi-GE as part of my assessment are also published on our website, together with the corresponding Hitachi-GE resolution plan.

1.2 Scope

7. The scope of my assessment is detailed in assessment plan (TRIM 2015/341044).
8. The scope of my assessment focused on; -
 - Resolving significant departures from the expectations of BS9999 outstanding from Step 3

- Addressing late design changes introduced by other safety & security disciplines.
 - Samples of the detailed fire safety strategies of a number of areas, particularly locations with challenging means of escape provisions which do not meet code compliance; to assess that the fire engineering optioneering process results in solutions that are supported by a convincing and robust ALARP justification.
9. The scope of my assessment is appropriate for GDA because the structural requirements to meet the expectations of the Regulatory Reform (Fire Safety) Order 2005, which apply during the normal occupied phase of the building, can only be addressed most efficiently at design stage.

1.3 Method

My assessment considered the measures to protect life safety from the risk of fire in a building. The effectiveness of these arrangements is primarily affected by the structural design; particularly the internal layout and the number and arrangement of exit routes and fire protection provided by the elements of structure. The assessment also evaluated other, non-structural provisions, where they are used as a component in the overall fire escape strategy; examples include fire loading assessments, ventilation conditions and fire detection systems.

The documents which support conventional fire safety for the ABWR were assessed for compliance against the benchmark provided by British Standard 9999. The two main documents are the 'Fire Safety Strategy' GA91-9201-0001-00144 revision 3 and the 'Topic Report on Departures from Conventional Fire Regulation' GA91-9201-0001-00001 revision 6.

For design areas which departed from compliance with the code of practice, the fire engineering justification was examined to ensure a suitable and sufficient assessment of the risks to life safety from fire had been conducted.

In addition to a review of the fire strategies included in the documents, a series of workshops were also undertaken for those areas where fire engineered solutions were necessary. In the workshops, subject matter experts were challenged to give an in-depth walkthrough explanation and justification of all preventative and protective fire safety arrangements including life safety measures, property protection and emergency fire response. Examples were assessed against the needs of other safety and security disciplines to determine a holistic and balanced ALARP solution was achieved.

2 ASSESSMENT STRATEGY

2.1 Standards and criteria

10. The standards and criteria adopted within this assessment are principally the; -
- Legislative requirements of;-
 - Regulatory Reform (Fire Safety) Order 2005
 - Construction (Design and Management) Regulations 2015
 - Relevant UK standards for fire safety in building design and management
 - 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.

2.2 Use of Technical Support Contractors (TSCs)

11. Not applicable

2.3 Integration with other assessment topics

12. GDA requires the submission of an adequate, coherent and holistic generic safety case. Regulatory assessment cannot therefore be carried out in isolation as there are often safety issues of a multi-topic or cross-cutting nature. The following cross-cutting issues have been considered within this assessment:

13. Internal Hazards

14. Security

2.4 Sampling strategy

15. It is seldom possible, or necessary, to assess a fire safety strategy for every compartment in a building in its entirety, therefore sampling is used to limit the areas scrutinised, and to improve the overall efficiency of the assessment process. Sampling is done in a focused, targeted and structured manner with a view to revealing any topic-specific, or generic, weaknesses.
16. The sampling strategy for this assessment was to prioritise the most significant departures from compliance with fire safety design codes of practice and require an increasingly robust challenge and in-depth justification for areas of greatest departure.

2.5 Out of scope items

Table 1 sets out the items have been agreed with Hitachi-GE as being outside the scope of GDA.

1	Buildings on the Nuclear Licensed Site which are not included in the GDA process	Site specific non-nuclear buildings will be assessed during the Nuclear Site Licensing process. Buildings subject to the Building Regulations (mainly offices and canteens) are required to obtain approval
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		from a Building Inspector. In this case, ONR, as the Fire Enforcing Authority, is a statutory consultee.
2	Specifications of active fire protection systems where no claim is made upon enhanced performance of active measures to provide mitigation for shortfalls in other areas of fire protection.	<p>Detailed specifications of systems are not necessary in GDA process, where the Fire Strategy specifies compliance with generic guidance with appropriate British Standards.</p> <p>Where necessary, ONR will enhance regulatory oversight of relevant active fire protection systems during the nuclear site licensing process</p>
3	Specification of passive fire protection measures where no claim is made upon enhanced performance of active measures to provide mitigation for shortfalls in other areas of fire protection.	<p>Detailed specifications of systems are not necessary in GDA process, where the Fire Strategy specifies compliance with generic guidance with appropriate British Standards.</p> <p>Where necessary, ONR will enhance regulatory oversight of relevant passive fire protection measures during the nuclear site licensing process</p>
4	Detailed fire safety management arrangements where no claim is made upon enhanced management supervision to provide mitigation for shortfalls in other areas of fire protection.	<p>Reasonable expectations for the management of fire safety are assessed against current industry good practice.</p> <p>Claims on management arrangements will be examined in more detail during the Nuclear Site Licensing Process.</p>
5	Construction fire safety arrangements	During nuclear site licensing, ONR will establish a separate dedicated workstream to evaluate measures to protect the workforce during the construction phase of the facility.

3 REQUESTING PARTY'S SAFETY CASE

The Hitachi-GE safety case for conventional fire safety is documented in; -

- Fire Safety Strategy GA91-9201-0001-00144 revision 3.
- Topic Report on Departures from Conventional Fire Regulation GA91-9201-0001-00001 revision 6.

4 ONR STEP 4 ASSESSMENT

17. This assessment has been carried out in accordance with the principles of good practice involving Fire Authority consultation in major new construction projects.

4.1 Scope of Assessment Undertaken

18. The scope of the assessment is limited to aspects of building design which have an impact on the ability of occupants to leave the building in safety and for firefighters to enter, should a fire occur. The assessment considered the internal layout of compartments, the number and arrangement of exit routes, the fire protection provided by the elements of structure and other arrangements to provide adequate defence in depth.

Other, non-structural provisions were assessed, when they are claimed as a component in the overall fire escape strategy; examples include measures to control fire loading, ventilation conditions and fire detection systems.

4.2 Assessment

Hitachi-GE's two main conventional fire safety documents, 'Fire Safety Strategy' and the 'Topic Report on Departures from Conventional Fire Regulation', were assessed against published UK standards for fire safety in the design and management of new buildings.

In the majority of cases, the documents indicate that the design achieves compliance with guidance.

In some areas the design departs from code compliance and my assessment has mainly considered these design issues. The Topic Report on Departures from Conventional Fire Regulation presents an agreed, structured procedure for the identification, management and prioritisation of departures from code compliance. ONR has assessed the procedure and challenged samples of the fire engineering which supports the claims for alternative fire protection arrangements to ensure each case has a robust ALARP justification.

Over a series of interventions and revisions to the design or enhancements to the fire engineering justification, the dutyholder provided evidence that the risk to life safety from fire in the UK ABWR, had been subject to a suitable and sufficient assessment to ensure compliance with legislation and satisfy ONR's expectations.

4.3 Comparison with standards, guidance and relevant good practice

19. British Standard 9999: "The code of practice for fire safety design, management and construction of buildings" is used as the basis for design in UK ABWR to meet the structural design expectations of the Regulatory Reform (Fire Safety) Order 2005.
20. Where departures from compliance with prescriptive building codes has been necessary, Hitachi-GE has used fire engineering principals to produce alternative fire safe designs, following relevant good practice by producing a robust ALARP justification; the method used, achieves adequate protection for life safety and maintains legal compliance.

5 CONCLUSIONS

21. This report presents the findings of my Step 4 Conventional Fire Safety assessment of the Hitachi-GE UK ABWR.
22. To conclude, I am broadly satisfied with the claims, arguments and evidence laid down within the Fire Safety Strategy and supporting documentation for conventional fire safety and I consider that from a conventional fire safety view point, the Hitachi-GE UK ABWR design is suitable for construction in the UK.

5.1 Key Findings from the Step 4 Assessment

23. I consider that from a Conventional Fire Safety view point, the UK ABWR design is suitable for construction in the UK, at this present time.

6 REFERENCES

Regulatory Reform (Fire Safety) Order 2005

Construction (Design and Management) Regulations 2015

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
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