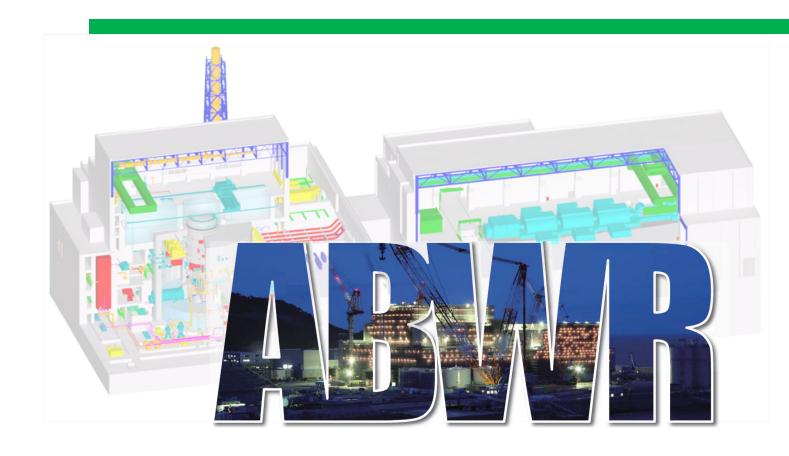


Document ID	:	GA91-9101-0101-00000
Document Number	:	XE-GD-0225
Revision Number	:	С

## **UK ABWR Generic Design Assessment**

Generic PCSR: Master Table of Contents of Generic PCSR





Page ii/ii

#### **DISCLAIMERS**

#### **Proprietary Information**

This document contains proprietary information of Hitachi-GE Nuclear Energy, Ltd. (Hitachi-GE), its suppliers and subcontractors. This document and the information it contains shall not, in whole or in part, be used for any purpose other than for the Generic Design Assessment (GDA) of Hitachi-GE's UK ABWR. This notice shall be included on any complete or partial reproduction of this document or the information it contains.

### **Copyright**

No part of this document may be reproduced in any form, without the prior written permission of Hitachi-GE Nuclear Energy, Ltd.

Copyright (C) 2017 Hitachi-GE Nuclear Energy, Ltd. All Rights Reserved.

#### **Master Table of Contents**

#### **PART I: GENERAL ISSUES**

#### **Chapter 1** Introduction

**Executive Summary** 

- 1.1 Introduction
- 1.2 Purpose and Scope of Chapter 1
- 1.3 Purpose of the Generic Design Assessment (GDA)
- 1.4 Structure and Contents of the UK ABWR Generic PCSR
- 1.5 PCSR User Guide and Route Map
- 1.6 Safety Assessments and Achievements of the ABWR Design Prior to the UK ABWR
- 1.7 Abbreviations and Acronyms List
- 1.8 Conclusions
- 1.9 References

Appendix A: Abbreviations and Acronyms List

#### **Chapter 2** Generic Site Envelope

**Executive Summary** 

- 2.1 Introduction
- 2.2 Purpose and Scope
- 2.3 General Approach for Generic Site Envelope
- 2.4 Generic Site Envelope
- 2.5 Conclusions
- 2.6 References

Appendix A: Document Map

#### **Chapter 3** Site Characteristics (Not Included in Generic PCSR)

#### **Chapter 4** Safety Management throughout Plant Lifecycle

Executive Summary

- 4.1 Introduction
- 4.2 Purpose and Scope
- 4.3 Hitachi-GE Safety and Quality Philosophy
- 4.4 Hitachi-GE Construction Experience and Safety Record (Including radiological safety)
- 4.5 Relationship between PCSR and GEP-RSR
- 4.6 Safety Management Framework
- 4.7 Safety in the Design Phase
- 4.8 Safety in the Construction Phase
- 4.9 Safety in the Commissioning Phase
- 4.10 Safety in the Operational Phase
- 4.11 Safety in the Decommissioning Phase
- 4.12 Assumptions, Limits and Conditions for Operation
- 4.13 Conclusions

i

Generic Pre-Construction Safety Report

Revision C

4.14 References

Appendix A: Document Map

Appendix B: List of Specific Legal Requirements

#### **Master Table of Contents (Cont.)**

#### **Chapter 5** General Design Aspects

Executive Summary

- 5.1 Introduction
- 5.2 Purpose and Scope
- 5.3 General Safety Design Bases
- 5.4 Definition of Operating Stages, Modes and Conditions
- 5.5 Definition of Design Basis Faults and Beyond Design Basis Faults
- 5.6 Categorisation of Safety Functions and Classification of Structures, Systems and Components (SSCs)
- 5.7 Qualification of SSCs
- 5.8 Applied Regulations, Code and Standards
- 5.9 Examination, Maintenance, Inspections and Testing
- 5.10 Conclusions
- 5.11 References

#### **Chapter 6** External Hazards

**Executive Summary** 

- 6.1 Introduction
- 6.2 Purpose and Scope
- 6.3 Identification of Individual External Hazards
- 6.4 Identification of Combined External Hazards
- 6.5 The Relationship between Safety Functions and External Hazards
- 6.6 Hazard Definition and General Protection
- 6.7 Margin Evaluation for Beyond Design Basis Events
- 6.8 Assumptions, Limits and Conditions for Operation
- 6.9 Summary of ALARP Justification
- 6.10 Conclusion
- 6.11 References

Appendix A: Route Map from External Hazards to Related Safety Functions

Appendix B: Document Map

#### **Chapter 7** Internal Hazards

**Executive Summary** 

- 7.1 Introduction
- 7.2 Purpose and Scope
- 7.3 General Principles
- 7.4 Internal Fire and Explosions
- 7.5 Internal Flooding
- 7.6 Pipe Whip and Jet Impact
- 7.7 Dropped and Collapsed Loads
- 7.8 Internal Missile
- 7.9 Internal Blast
- 7.10 EMI / RFI

ii

## **Master Table of Contents (Cont.)**

- 7.11 Miscellaneous Internal Hazards
- 7.12 Primary Containment Vessel (PCV)
- 7.13 Main Control Room (MCR)
- 7.14 Main Steam Tunnel Room (MSTR)
- 7.15 Turbine Disintegration
- 7.16 Internal Combined Hazards
- 7.17 Assumptions, Limits and Conditions for Operation
- 7.18 Summary of ALARP Justification
- 7.19 Overall Conclusions
- 7.20 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C : Document Map

#### **Chapter 8 Structural Integrity**

**Executive Summary** 

- 8.1 Introduction
- 8.2 Purpose and Scope
- 8.3 Safety Functional Claims
- 8.4 Structural Integrity Classification
- 8.5 Topic Reports
- 8.6 Load Condition
- 8.7 Assumptions, Limits and Conditions for Operation
- 8.8 Summary of ALARP Justification
- 8.9 Conclusions
- 8.10 References

Appendix A : Safety Functional Claims Table

Appendix B: Safety Properties Claims Table

Appendix C: Document Map

Appendix D: Topic Report Summary – Reactor Pressure Vessel (RPV)

Appendix E: Topic Report Summary - Main Steam Piping

Appendix F: Topic Report Summary - Main Steam Isolation Valve (MSIV)

Appendix G: Topic Report Summary – Feedwater Piping

Appendix H: Topic Report Summary – Reactor Internals

Appendix I: Topic Report Summary – SLC Storage Tank

Appendix J: Topic Report Summary - HP Turbine Casing

#### **PART II: TECHNICAL SYSTEMS**

#### **Chapter 9 General Description of the Unit (Facility)**

**Executive Summary** 

- 9.1 Introduction
- 9.2 Purpose and Scope
- 9.3 Basic Technical Characteristics

iii

## **Master Table of Contents (Cont.)**

- 9.4 Facility Layout
- 9.5 Conclusions
- 9.6 References

#### **Chapter 10** Civil Works and Structures

- **Executive Summary**
- 10.1 Introduction
- 10.2 Purpose and Scope
- 10.3 General Principles for Civil Structures
- 10.4 Safety Claims and Design Principles for Civil Structures
- 10.5 Codes and Standards
- 10.6 Beyond Design Basis Conditions
- 10.7 Assumptions, Limits and Conditions for Operation
- 10.8 Summary of ALARP Justification
- 10.9 Conclusions
- 10.10 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C : Document Map

Appendix D: Internal and External Hazard Mapping

#### **Chapter 11** Reactor Core

**Executive Summary** 

- 11.1 Introduction
- 11.2 Purpose and Scope
- 11.3 Summary Description
- 11.4 Design Basis
- 11.5 Design Description
- 11.6 Design Evaluation
- 11.7 Assumptions, Limits and Conditions for Operation
- 11.8 Summary of ALARP Justification
- 11.9 Conclusions
- 11.10 References

Appendix A: Safety Functional Claims Table

Appendix B: Document Map

# Chapter 12 Reactor Coolant Systems, Reactivity Control Systems and Associated Systems

**Executive Summary** 

- 12.1 Introduction
- 12.2 Purpose and Scope
- 12.3 Reactor Coolant Systems and Associated Systems
- 12.4 Reactivity Control Systems
- 12.5 Summary of ALARP Justification
- 12.6 Assumptions, Limits and Conditions for Operation

iν

## **Master Table of Contents (Cont.)**

	lusions

12.8 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C : Document Map

#### **Chapter 13 Engineered Safety Features**

**Executive Summary** 

- 13.1 Introduction
- 13.2 Purpose and Scope
- 13.3 Containment System
- 13.4 Emergency Core Cooling System
- 13.5 Assumptions, Limits and Conditions for Operation
- 13.6 Summary of ALARP Justification
- 13.7 Conclusions
- 13.8 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C: Document Map

#### **Chapter 14** Control and Instrumentation

**Executive Summary** 

- 14.1 Introduction
- 14.2 Purpose and Scope
- 14.3 Safety Principles and Development Practice
- 14.4 Claim Architecture
- 14.5 C&I Architecture
- 14.6 Control and Instrumentation Systems
- 14.7 Sensors Pre-Processing Actuators
- 14.8 Embedded C&I Systems
- 14.9 C&I Support Systems
- 14.10 Management Systems
- 14.11 Hardware and Software Development and System Justification
- 14.12 Assumptions, Limits and Conditions for Operation
- 14.13 Summary of ALARP Justification
- 14.14 Conclusions
- 14.15 References

Appendix A1: Safety Functional Claims Table

Appendix A2: FS and Initiating Fault / Event ID Linkage Table

Appendix B : Safety Properties Claims Table

Appendix C : Document Map

#### **Chapter 15** Electrical Power Supplies

**Executive Summary** 

- 15.1 Introduction
- 15.2 Purpose and Scope

Master Table of Contents of Generic PCSR Ver. 0  $\nu$ 

## **Master Table of Contents (Cont.)**

- 15.3 Safety Claims Claims, Arguments and Evidence (CAE) and approach to protection against Common Cause Failure (CCF)
- 15.4 Architecture power supply and power distribution
- 15.5 Electrical Equipment and Systems
- 15.6 Electrical Protection and Earthing
- 15.7 Panel and Raceway Layout
- 15.8 Quality Assurance and Management Systems
- 15.9 SMART Devices, Software Development and System Justification
- 15.10 Assumptions, Limits and Conditions for Operation
- 15.11 Summary of ALARP Justification
- 15.12 Conclusions
- 15.13 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C : Document Map

#### **Chapter 16** Auxiliary Systems

**Executive Summary** 

- 16.1 Introduction
- 16.2 Purpose and Scope
- 16.3 Water Systems
- 16.4 Process Auxiliary Systems
- 16.5 Heating Ventilating and Air Conditioning System
- 16.6 Other Auxiliary Systems
- 16.7 Severe Accident Mechanical Systems
- 16.8 Assumptions, Limits and Conditions for Operation
- 16.9 Summary of ALARP Justification
- 16.10 Conclusions
- 16.11 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C : Document Map

#### **Chapter 17** Steam and Power Conversion Systems

**Executive Summary** 

- 17.1 Introduction
- 17.2 Purpose and Scope
- 17.3 Turbine Generator
- 17.4 Turbine Main Steam, Turbine Auxiliary Steam and Turbine Bypass System
- 17.5 Extraction Steam System
- 17.6 Turbine Gland Steam System
- 17.7 Feedwater Heater Drain and Vent System
- 17.8 Condenser
- 17.9 Circulating Water System
- 17.10 Condensate and Feedwater System

vi

### **Master Table of Contents (Cont.)**

- 17.11 Condensate Purification System
- 17.12 Assumptions, Limits and Conditions for Operation
- 17.13 Summary of ALARP Justification
- 17.14 Conclusions
- 17.15 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C: Document Map

# PART III: SYSTEMS AND PROCESSES TO SUPPORT OPERATION, AND ENGINEERING SUBSTANTIATION

#### **Chapter 18** Radioactive Waste Management

**Executive Summary** 

- 18.1 Introduction
- 18.2 Purpose and Scope
- 18.3 Safety Claims
- 18.4 OPEX
- 18.5 Liquid Waste Processing in the Radwaste Building
- 18.6 Wet-solid Waste Processing in the RadWaste Building
- 18.7 Off-Gas System
- 18.8 Heating Ventilating and Air Conditioning System
- 18.9 Tank Vent Treatment System
- 18.10 High Level Waste Processing
- 18.11 Intermediate Level Waste store
- 18.12 Low Level Waste Processing
- 18.13 Transportation of Waste
- 18.14 Radioactive Waste Management Arrangements
- 18.15 Assumptions, Limits and Conditions for Operation
- 18.16 Summary of ALARP justification
- 18.17 Conclusions
- 18.18 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C: Document Map

#### **Chapter 19** Fuel Storage and Handling

**Executive Summary** 

- 19.1 Introduction
- 19.2 Purpose and Scope
- 19.3 Description of Fuel Route Operations
- 19.4 New Fuel Inspection Stand
- 19.5 Fuel Preparation Machine
- 19.6 Fuel Handling Machine
- 19.7 Reactor Building Overhead Crane
- 19.8 Spent Fuel Storage Facility

vii

## **Master Table of Contents (Cont.)**

19.9	Fuel Poo	l Cooling,	Clean up	and Ma	keup Systems
------	----------	------------	----------	--------	--------------

- 19.10 Spent Fuel Export Systems
- 19.11 Claims and Links to High Level Safety Functions
- 19.12 Assumptions, Limits and Conditions for Operation
- 19.13 Summary of ALARP Justification
- 19.14 Conclusions
- 19.15 References

Appendix A : Safety Functional Claims Table Appendix B : Safety Properties Claims Table

Appendix C : Document Map

#### **Chapter 20** Radiation Protection

**Executive Summary** 

- 20.1 Introduction
- 20.2 Purpose and Scope
- 20.3 Definition of Radioactive Sources
- 20.4 Strategy to Ensure that the Exposure is ALARP
- 20.5 Protection and Provisions against Direct Radiation and Contamination
- 20.6 Radiation and Contamination Monitoring of Occupational Exposure
- 20.7 Dose Assessment for Public from Direct Radiation
- 20.8 Worker Dose Assessment
- 20.9 Post Accident Accessibility
- 20.10 Assumptions, Limits and Conditions for Operation
- 20.11 Summary of ALARP Justification
- 20.12 Conclusions
- 20.13 References

Appendix A: Document Map for Supporting Evidence

Appendix B: Links with Other PCSR Chapters

Appendix C: Representative Safety Functional Claims in relation to Radiation

Protection

#### **Chapter 21** Human-Machine Interface

**Executive Summary** 

- 21.1 Introduction
- 21.2 Purpose and Scope
- 21.3 Requirements and Claims for HMIs
- 21.4 HMIs in the Main Control Room
- 21.5 HMIs in the Remote Shutdown System Panel Rooms
- 21.6 HMIs in the Back-up Building Control Panel Room
- 21.7 HMIs in the Radwaste Facilities
- 21.8 HMIs in the Local Control Locations
- 21.9 Assumptions, Limits and Conditions for Operation
- 21.10 Summary of ALARP Justification
- 21.11 Conclusions
- 21.12 References

Appendix A : Safety Functional Claims

Appendix B: Safety Properties Claims Table

viii

#### **Master Table of Contents (Cont.)**

Appendix C: Document Map

#### **Chapter 22 Emergency Preparedness**

Executive Summary

- 22.1 Introduction
- 22.2 Purpose and Scope
- 22.3 Legislation, Guidance and Requirements
- 22.4 UK ABWR Design, Safety and Emergency System
- 22.5 Insights from OPEX and post Fukushima Learning
- 22.6 Emergency Organisation, Facilities and Response
- 22.7 Accident Management
- 22.8 Consideration of Lifecycle Aspects
- 22.9 Conclusions
- 22.10 References

Appendix A: Document Map

#### **Chapter 23** Reactor Chemistry

**Executive Summary** 

- 23.1 Introduction
- 23.2 Purpose and Scope
- 23.3 Reactor Chemistry Safety Claims
- 23.4 Reactor Coolant System and Associated Systems Chemistry
- 23.5 Spent Fuel Storage Pool Chemistry Control
- 23.6 Suppression Pool Chemistry Control
- 23.7 Standby Liquid Control System Water Chemistry
- 23.7 Make-Up Water Condensate System Chemistry
- 23.8 Make-up Water, Treatment and Storage
- 23.9 Component Cooling Water Systems Chemistry
- 23.10 Back-up Building- FLSS Water Chemistry Control
- 23.11 Sampling and Monitoring
- 23.12 Radioactive Waste Management Impact from System Chemistry Regimes
- 23.13 Summary of ALARP Justification
- 23.14 Conclusions
- 23.15 References

Appendix A: Reactor Chemistry Claims Table

Appendix B : Document Map

#### **PART IV: ASSESSMENT**

## **Master Table of Contents (Cont.)**

Chapter 24	Design Basis Analysis
•	Executive Summary
24.1	Introduction
24.2	Purpose and Scope
24.3	Safety Case Relation to Faults
24.4	Fault Identification and Grouping and Fault Schedule
24.5	Design Basis Analysis for UK ABWR
24.6	Analysis Results and Fault-based View – Non-Isolation Events
24.7	Analysis Results and Fault-based View – Isolation Events
24.8	Analysis Results and Fault-based View – Loss of Coolant Events
24.9	Analysis Results and Fault-based View – Common Cause and Multiple Failures
24.10	Analysis Results and Fault-based View – Reactor Faults Other Than at Full Power
24.11	Analysis Results and Fault-based View – Non-Reactor Faults
24.12	Performance of Class 2 SSCs in Frequent Faults
24.13	Post-Accident Management for Safe Shutdown Following Design Basis Faults
24.14	Assumptions, Limits and Conditions for Operation
24.15	Summary of ALARP Justification
24.16	Conclusions
24.17	References
	Appendix A: Table of SFC Claims
	Appendix B : Table of SPC Claims
	Appendix C : Document Map

#### **Chapter 25** Probabilistic Safety Assessment

**Executive Summary** 

- 25.1 Introduction
- 25.2 Purpose and Scope of PSA
- 25.3 PSA Study Approach for UK ABWR PSA
- 25.4 Level 1 PSA for Internal Events at Power
- 25.5 Level 2 PSA for Internal Events at Power
- 25.6 Level 3 PSA for Internal Events at Power
- 25.7 Internal Events at Power PSA (Results and Insights)
- 25.8 Shutdown PSA
- 25.9 Spent Fuel Pool PSA
- 25.10 PSA for Internal Hazards
- 25.11 PSA for External Hazards
- 25.12 Fuel Route PSA
- 25.13 PSA for Events Not Leading to a Core or Fuel Melt
- 25.14 Worker Risk Assessment
- 25.15 Summary of PSA Results and Key Insights
- 25.16 Summary of Use of PSA in ALARP Assessment
- 25.17 Conclusions
- 25.18 References

 $\boldsymbol{x}$ 

### **Master Table of Contents (Cont.)**

Appendix A: Document Map

#### **Chapter 26** Beyond Design Basis and Severe Accident Analysis

**Executive Summary** 

- 26.1 Introduction
- 26.2 Purpose and Scope
- 26.3 Beyond Design Basis Analysis
- 26.4 Severe Accident Analysis
- 26.5 Fukushima Accident Learning and Stress Test Assessment
- 26.6 Assumptions, Limits and Conditions for Operation
- 26.7 Summary of ALARP Justification
- 26.8 Conclusions
- 26.9 References

Appendix A : Safety Functional Claims Table

Appendix B : Safety Properties Claims Table

Appendix C : Document Map

Appendix D: System Claims and SAA Assumptions

#### **Chapter 27** Human Factors

**Executive Summary** 

- 27.1 Introduction
- 27.2 Purpose and Scope
- 27.3 UK ABWR Integrated HF Programme
- 27.4 Baseline HF Position
- 27.5 Human Factors in GDA: Activities and Results
- 27.6 Structure and Substantiation of HBSCs
- 27.7 Assumptions, Limits and Conditions for Operation
- 27.8 Summary of ALARP Justification
- 27.9 Conclusions
- 27.10 References

Appendix A: List of Functional HBSCs

Appendix B: HF Property Claims and Engineering Reference Documents

Appendix C: Document Map

## **Chapter 28** ALARP Evaluation

**Executive Summary** 

- 28.1 Introduction
- 28.2 Purpose and Scope
- 28.3 Development of the Standard ABWR
- 28.4 Development of ABWR after Kashiwazaki-Kariwa Units 6 and 7
- 28.5 Response to the Fukushima Accident
- 28.6 Strategy for the Demonstration of ALARP in GDA
- 28.7 The development of the UK ABWR Design during GDA
- 28.8 Conclusions
- 28.9 References

Appendix A: Example of the use of MADA in ALARP Assessments

хi

Generic Pre-Construction Safety Report

Revision C

# PART V : FRAMEWORK OF DEALING WITH ISSUES SPECIFIC TO PLANT LIFE PHASE

## **Master Table of Contents (Cont.)**

Chapter 29	Commissioning Executive Summary
29.1	Introduction
29.2	Purpose and Scope
29.3	Commissioning Programme Principles
29.4	Commissioning Programme Objectives
29.5	Commissioning Programme Organization
29.6	Conduct of Commissioning
29.7	Commissioning Programme
29.8	Managing Safety during Commissioning
29.9	Assumptions, Limits and conditions for Operation
29.10	Summary of ALARP Justification
29.11	Conclusions
29.12	References
Chapter 30	Operation
_	Executive Summary
30.1	Introduction
30.2	Purpose and Scope
30.3	Operational Strategy
30.4	Operating System
30.5	Plant Status Control
30.6	UK ABWR Operations Personnel Description
30.7	Assumptions, Limits and Conditions for Operation
30.8	Summary of ALARP Justification
30.9	Conclusions
30.10	References
	Appendix A: Document map
Chapter 31	Decommissioning
	Executive Summary
31.1	Introduction
31.2	Safety Claims
31.3	Operational Experience
31.4	Design for Decommissioning - Principles and Techniques
31.5	Key Decommissioning Operations and Design Features
31.6	Decommissioning Strategy
31.7	Decommissioning Plan
31.8	Decommissioning Wastes and Wastes Remaining on Site
31.9	Decommissioning Management Arrangements
31.10	Assumptions, Limits and Conditions for Operation
31.11	Summary of ALARP Justification

31.12 Conclusions

Generic Pre-Construction Safety Report

Revision C

## **Master Table of Contents (Cont.)**

31.13 References

Appendix A: Document Map

Appendix B: Interactions with other PCSR chapters Appendix C: Decommissioning Safety Claims

#### **Chapter 32** Spent Fuel Interim Storage

**Executive Summary** 

- 32.1 Introduction
- 32.2 Purpose and Scope
- 32.3 Spent Fuel Storage Strategy
- 32.4 System Description
- 32.5 System Performance and Safety Features
- 32.6 Spent Fuel Management at the end of Generation
- 32.7 Spent Fuel Management Arrangements for SFIS
- 32.8 Assumptions, Limits and Conditions for Operation
- 32.9 Summary of ALARP Justification
- 32.10 Conclusions
- 32.11 References

Appendix A: Document Map