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ASSESSMENT REPORT

Civil Nuclear Reactors Programme

**NNB Genco: Hinkley Point C Pre-Construction Safety Report 2012 – Assessment
Report for Work Stream B16 Human Factors**

Assessment Report: ONR-CNRP-AR-13-078

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EXECUTIVE SUMMARY

This assessment report (AR) reviews that portion of the Nuclear New Build Generating Company (NNB GenCo) Hinkley Point C Pre-Construction Safety Report 2012 (HPC PCSR2012) that falls within the scope of Work Stream B16 Human Factors (HF). Most of this material lies in HPC PCSR2012 Chapter 18.1 and 18.3 but other material potentially relevant to the HF safety case found in sub-Chapters 3, 7, 9.4, 11, 13.1 and elsewhere has also been reviewed. I have also provided an update on NNB GenCo's progress in addressing those Generic Design Assessment (GDA) HF Assessment Findings (AFs) that are linked to First nuclear safety-related Structural Concrete; the first permissioning hold point.

A final version of the GDA Pre-Construction Safety Report (PCSR) issued in November 2012 formed the basis for issue by ONR on 13 December 2012 of a Design Acceptance Confirmation (DAC) for the UK EPR™ design. The GDA PCSR addressed only the key elements of the design of a single UK EPR™ unit (the generic features on "the nuclear island") and excluded ancillary installations that a potential purchaser of the design could choose after taking the site location into account. Certain matters were also deemed to be outside the scope of the GDA PCSR.

In contrast HPC PCSR2012 addresses the whole Hinkley Point C licensed site comprising the proposed twin UK EPR units and all ancillary installations. Some matters that were outside the scope of GDA PCSR are also addressed in HPC PCSR2012. As the generic features were addressed in the GDA process, my focus is on site-specific documentation that has not been formally assessed by ONR previously. The remaining, generic documentation has been copied into PCSR2012 from an earlier March 2011 GDA PCSR but this has now been superseded by the November 2012 GDA PCSR report.

For the HF topic sub-chapters 18.1 and 18.3 of this March 2011 GDA PCSR were extensively re-written for the final November 2012 GDA PCSR in order to incorporate the very extensive HF safety case that was developed in response to a GDA Issue on Human Factors. Consequently my assessment of this HPC PCSR2012 has focussed on either new material that may alter any of the final GDA HF safety case, or new site specific aspects that are additional to the final GDA HF safety case.

It is important to note that HPC PCSR2012 alone is not sufficient to inform a future ONR decision on whether to permission construction of Hinkley Point C. NNB Genco intends to submit a major revision to HPC PCSR2012 before seeking consent for Nuclear Island construction which will fully integrate the final GDA PCSR and will be supported by other documentation

The main conclusions from my assessment are as follows:

- Chapter 18.1 and 18.3 present the HF safety case that was superseded by the final HF safety case at the end of GDA. This updated the HF safety case to reflect the very considerable HF work done to close out the HF GDA Issue.
- Chapter 15 presents some minor changes to the HF aspects of the PSA but nothing that significantly alters the final GDA HF safety case. The PSA and supporting HRA will need to be updated for PCSR3 to reflect the reference design prior to construction.
- None of the other chapters in the HPC PCSR2012 contain new material that impacts the HF safety case at this point. There are aspects related to maintenance, inspection and operational practices that will need to be considered in the future post-PCSR.

Overall I consider that the HPC PCSR2012 requires updating to reflect the final GDA HF safety case and any changes to it arising from the incorporation of design changes for the reference design, and resolution of any relevant GDA Assessment Findings that impact the final GDA HF safety case.

There are eight HF GDA AFs that are linked to the first structural concrete hold point. Of these I consider that three have been adequately addressed. Progress is being made against all the remaining AFs, and I judge that all should be satisfactorily addressed by the required milestone.

I have one recommendation arising from this assessment which is that the HPC PCSR2012 should be updated by the licensee to accommodate the final GDA HF safety case and any changes arising to it from the consolidated reference design and from the HPC operating philosophy. This will include consideration on the changes to claimed human based safety claims arising from design changes and resolution of relevant GDA AFs. It will also include updating to reflect the associated changes to the PSA model for the reference design.

LIST OF ABBREVIATIONS

AF	Assessment Finding
AR	Assessment Report
BMS	(ONR) How2 Business Management System
DAC	Design Acceptance Confirmation
FA3	Flammanville 3
FV	Fussel-Vesely
GDA	Generic Design Assessment
HBSC	Human Based Safety Claim
HF	Human Factors
HPC	Hinkley Point C
HSE	Health and Safety Executive
HPC PCSR2012	Hinkley Point C Pre-Construction Safety Report 2012
LC	Licence Condition
ONR	Office for Nuclear Regulation (an agency of HSE)
PCSR	Pre-construction Safety Report
PSA	Probabilistic Safety Analysis
RIF	Risk Increase Factor
SAP	Safety Assessment Principle(s)
SOA	State Orientated Approach
SSC	System, Structure and Component
TAG	Technical Assessment Guide(s) (ONR)

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1 INTRODUCTION

1.1 Background

1 This assessment report (AR) presents the findings of the assessment of that portion of the Nuclear New Build Generating Company (NNB GenCo) Hinkley Point C Pre-Construction Safety Report 2012 (HPC PCSR2012, Ref.1) that falls within the scope of Workstream B16 Human Factors (HF).

2 Assessment was undertaken in accordance with the requirements of the Office for Nuclear Regulation (ONR) How2 Business Management System (BMS) procedure AST/003 (Ref.2). The ONR Safety Assessment Principles (SAP), Ref.3, together with supporting Technical Assessment Guides (TAGs), Ref. 4, have been used as the basis for this assessment.

3 This AR has been written to support a Summary Assessment Report that addresses whether HPC PCSR2012 demonstrates suitable progress towards meeting ONR's requirement for an adequate Pre-Construction Safety Report. To this end this AR provides guidance on matters that need to be addressed in the next revision of HPC PCSR

1.2 Scope

4 The scope of this report covers Work Stream B16 Human Factors. Most of this material lies in HPC PCSR2012 Chapter 18 (18.1 primarily but also 18.2 and 18.3) but other potentially relevant material found in the sub-Chapters listed in section 4.2.1 has also been reviewed. I have also provided an update on NNB GenCo's progress in addressing those GDA HF Assessment Findings (AFs) that are linked to First Structural Concrete; the first permissioning hold point.

5 A final version of the Generic Design Assessment (GDA) Pre-Construction Safety Report (PCSR) issued in November 2012 formed the basis for issue by ONR on 13 December 2012 of a Design Acceptance Confirmation (DAC) for the UK EPR design. The GDA PCSR addressed only the key elements of the design of a single UK EPR unit (the generic features on "the nuclear island") and excluded ancillary installations that a potential purchaser of the design could choose after taking the site location into account. Certain matters were also deemed to be outside the scope of the GDA PCSR.

6 In contrast HPC PCSR2012 addresses the whole Hinkley Point C licensed site comprising the proposed twin UK EPR units and all ancillary installations. Some matters that were outside the scope of GDA PCSR are addressed in HPC PCSR2012. As the generic features were addressed in the GDA process, attention has been concentrated here on site-specific documentation that has not been formally assessed by ONR previously. The remaining, generic documentation has been copied into PCSR2012 from an earlier March 2011 GDA PCSR but this has now been superseded by the November 2012 GDA report. The generic documentation has only been revisited if recent developments have materially affected the case being made.

7 It is important to note that HPC PCSR2012 alone is not sufficient to inform a future ONR decision on whether to permission construction of Hinkley Point C and NNB Genco intends to submit other supporting documentation. Note also that HPC PCSR2012 will be superseded by a further site-specific revision intended to fully reflect the final GDA PCSR and other design changes from Flammanville 3 (FA3) which is the reference design for Hinkley Point C. This updated version is termed as PCSR3 in this AR.

8 It should also be noted the approach to safety function categorisation and safety system classification agreed during GDA is not fully reflected in HPC PCSR2012 which largely uses the approach employed on Flammerville 3. The integration of the methodology agreed during GDA will be demonstrated in the next revision of HPC PCSR.

1.3 Methodology

9 The methodology for the assessment follows the requirements of the ONR BMS 'produce assessments' step in the nuclear safety permissioning process and Ref. 2 in particular in relation to mechanics of assessment.

2 ASSESSMENT STRATEGY

10 My assessment strategy is set out in this section. This identifies the scope of the assessment and the standards and criteria that have been applied.

11 The final November 2012 GDA PCSR incorporated a completely revised sub-chapter 18.1 and minor amendments to 18.3 from the March 2011 PCSR version in order to reflect the very substantial HF safety case that had been developed in response to the GDA Issue raised on HF at the end of Step 4 (see Ref. 5). In consequence my assessment has focussed on new site specific material in the HPC PCSR 2012 that may alter any part of the final HF safety case presented in the November 2012 GDA PCSR. The specific aspects I have considered are:

- Has the HPC 2012 PCSR incorporated the final GDA HF safety case?
- Is there any new material presented related to the HPC site specific aspects that have HF implications – if so these are assessed.
- Is there anything in the HPC 2012 PCSR that may impact or alter the final GDA HF safety case presented in the November 2012 PCSR – if so these are assessed.

12 In addition I have provided an update of NNB GenCo's progress on the HF AFs raised in the GDA HF Step 4 assessment report (Ref.5). Eight AFs were raised that were linked to First Structural Concrete (listed in Table 2). No additional AFs linked to this first hold point were raised in the Close-out assessment (Ref. 6). This update is based on the routine monitoring of the workstream I have taken via Level 4 meetings over the last 18 months.

2.1 Standards and Criteria

13 The relevant standards and criteria adopted within this assessment remain those used for both the HF Step 4 assessment (Ref. 5) and the GDA HF Issue close out report (Ref. 6). There are principally the Safety Assessment Principles (SAP), Ref. 2, internal ONR Technical Assessment Guides (TAG), Ref. 3, relevant national and international standards and relevant good practice informed from existing practices adopted on UK nuclear licensed sites. The key SAPs and relevant TAGs are detailed within this section. National and international standards and guidance have been referenced where appropriate within the assessment report. Relevant good practice, where applicable, has also been cited within the body of the assessment

2.2 Safety Assessment Principles

14 The key SAPs applied within the assessment are included within Table 1 of this report.

2.2.1 Technical Assessment Guides

15 The following Technical Assessment Guides have been used as part of this assessment (Ref. 3):

- T/AST/058 HF Integration
- NS/-TAST-GD-059 Human Machine Interface
- T/AST/061 Staffing Levels and Task Organisation
- T/AST/062 Workplaces and Work Environment
- NS/-TAST-GD-063 Human Reliability Analysis

- T/AST/064 Allocation of Function between Humans and Engineered Systems

2.2.2 National and International Standards and Guidance

16 No national/international standards and guidance have been utilised in the construction of this AR.

2.3 Use of Technical Support Contractors

17 No technical support contractors have been used in the construction of this assessment.

2.4 Integration with other Assessment Topics

18 Although HF interfaces with many other safety report topics, this assessment has not impacted with any of them. This is due to the lack of change on the presented HF safety case position (see section 4 below).

2.5 Out-of-scope Items

19 There are no items are outside the scope of the assessment.

3 LICENSEE'S SAFETY CASE**3.1 HPC PCSR2012 Material Assessed**

20 The majority of material relating to Work Steam B16 HF is located in Chapter 18.1 on Human-Machine Interface; 18.2 on Normal Operation; and 18.3 Abnormal Operation, Many other chapters are potentially relevant to HF especially chapter 7 (Control and Instrumentation) and Chapters 15 (Probabilistic Safety Analysis, PSA) and 16 (Risk Reduction and Severe Accident Analysis).

21 NNB GenCo's HPC PCSR2012 Head document (Ref. 7) indicates that sub-chapters 18.1 and 18.3 have not changed from the March 2011 GDA PCSR version, and sub-chapter 18.2 has limited changes. It also indicates that chapters 7 and 16 are unchanged from the March 2011 PCSR. Chapter 15 on the Probabilistic Safety Analysis (PSA) contains some new material.

4 ONR ASSESSMENT

22 This assessment has been carried out in accordance with ONR HOW2 BMS policy (Ref. 2).

4.1 Scope of Assessment Undertaken

23 The scope of the assessment is outlined in section 1.2. It focuses on new material presented in this PCSR and the impact on the final HF safety case presented at GDA Close-out in the GDA November 2012 PCSR.

4.2 Assessment

4.2.1 Assessment of PCSR 2012

24 As described in Section 0.3 of Reference 2, the information presented in Reference 1 (sub-chapters 18.1, 18.3, chapter 7 and 16) is consolidated GDA PCSR 2011 data, which has been assessed by ONR previously (see References 5 and 6). I have hence not sought to reassess this information, but I have sampled these sub-chapters from the GDA PCSR 2011 and have compared these directly with the information presented in the corresponding sub-chapters in PCSR 2012. My findings from this exercise confirm that these have been directly lifted from PCSR 2011 with no changes.

25 I have reviewed sub-Chapter 18.2 and compared it with both the March 2011 PCSR sub-chapter and the revised sub-chapter 18.2 presented at the final GDA November 2012 PCSR. My conclusion is that the HPC 2012 sub-chapter amendments reflect changes to operational parameters related to reactor chemistry. None of the changes impact the HF safety case.

26 Overall this means that the HPC 2012 PCSR has yet to accommodate the final HF safety case from the GDA HF issue close-out programme of work that is encompassed within Chapter 18 of the November 2012 GDA PCSR (Refs. 8 and 9).

27 I have also conducted a review of other sub-chapters that have changed from the 2011 PCSR to determine if they are likely to have an impact on the final GDA HF safety case (see chapter 18 of Ref. 8). The sub-chapters reviewed are:

- Sub-chapter 1.2 General Description of the Units - Introduction and General Description
- Sub-chapter 3.6 General Design & Safety Aspects - Qualification of Electrical & Mechanical Equipment for Accident Conditions
- Sub-chapter 5.5 Reactor Coolant Systems & Associated Systems - Reactor Chemistry
- Sub-chapter 9.2 Auxiliary Systems - Water Systems
- Sub-chapter 9.4 Auxiliary Systems - HVAC
- Sub-chapter 11.2 Discharges & Waste/Spent Fuel - Radioactive Waste Management Process & Strategy
- Sub-chapter 11.3 Discharges & Waste/Spent Fuel - Waste Generation, Discharges & Disposal for HPC
- Sub-chapter 11.4 Discharges & Waste/Spent Fuel - Effluent & Waste Treatment Systems Design Architecture

- Sub-chapter 11.5 Discharges & Waste/Spent Fuel -Interim Storage Facilities & Disposability
- Sub-chapter 13.1 Hazards Protection - External Hazards Protection
- Sub-chapter 13.2 Hazards Protection - Internal Hazards Protection
- Sub-chapter 15.0 Probabilistic Safety Assessment (PSA) - Safety Requirements & PSA Objectives
- Sub-chapter 15.1 PSA Level 1
- Sub-chapter 15.2 PSA Internal & External Hazards
- Sub-chapter 15.7 PSA Discussion & Conclusions
- Sub-chapter 19.1 Commissioning
- Sub-chapters 20.1-3 Decommissioning

- 28 My review of the chapter 15 sub-chapters reveals that some details of the human based safety claims (HBSC) are altered from the March 2011 PCSR. The most significant operator actions on combined Risk Increase Factor (RIF) and Fussel-Vesely (FV) values alter slightly. In the GDA 2011 PCSR there were 7 identified operator actions - one of these has disappeared for the HPC PSA due to a known intended design change (automation of local to plant valves). The remaining top 6 operator actions are the same as those in the 2011 GDA sub-chapter although their RIF and FV values change slightly and the order of significance changes slightly.
- 29 All these actions were assessed qualitatively as part of the GDA HF Issue close-out work. The HF Step 4 report (Ref. 5) raised an assessment finding that required the HRA for HPC to be generally revisited and updated. Additionally the GDA HF close-out report raised an AF requiring consideration of a very extensive number of issues that potentially affect the HBSCs modelled in the PSA. Consequently I consider that the HPC PCSR3 will need to accommodate the PSA and HRA revisions stemming from resolution of these AFs and any other additional design or operational changes that impact the final GDA HF safety case. This will be part of ONR's general expectations for PCSR3.
- 30 My review of the other sub-chapters has not identified anything that adds to, amends or challenges explicitly the final GDA HF safety case presented in the November 2012 GDA PCSR. I have identified several aspects that relate to future inspection, maintenance and operational requirements that will need to be considered further as the design and corresponding safety case develops. I consider that this forms part of future project development and normal regulatory business post-PCSR.
- 31 The updated PCSR (PCSR3) will be produced after a consolidated design has been developed for HPC; the reference design. This will include design modifications arising from FA3 and from work in response to AFs produced at both GDA Step 4 and the GDA Close-out work programme. For the HF topic the resolution of many AFs is likely to lead to changes in detailed aspects of the final GDA HF safety case. Consequently I consider that the HPC PCSR3 will need to determine and present an HF safety case that includes consideration of these AF resolution impacts.

4.2.2 HPC Operating Philosophy and Staffing

- 32 The HPC 2012 PCSR does not consider any detailed aspects of HPC operating philosophy. The final GDA PCSR HF safety case is based on key expectations of staffing

roles and on the use of both state orientated approach (SOA) procedures and on a severe accident management strategy approach. I consider that the updated PCSR should provide further details as to the envisaged operational philosophy, and confirmation that it is consistent with the final GDA HF safety case, or provide appropriate justification of any changes that affect it. It should also provide information on any issues arising from the HPC double unit site on the final GDA HF safety case.

4.2.3 Progress on GDA Human Factors Assessment Findings

- 33 Table 2 provides a summary of progress against the eight GDA HF AFs that are linked to First Structural Concrete. Three of these AFs have been fully addressed, namely a user description document and logs to track both HF issues and assumptions. I have reviewed these and found them to be satisfactory. The tracking logs have both been established and are being routinely used.
- 34 Progress on the outstanding five AFs is progressing and I am continuing to monitor progress. I am generally satisfied with the progress that is being made against all these AFs and judge that all should be achieved by the required milestone.

5 CONCLUSIONS AND RECOMENDATIONS

5.1 Conclusions

35 This report presents the findings of my HF assessment of the HPC PCSR2012 for workstream B16. My main conclusions are as follows:

- Chapter 18.1 and 18.3 present the HF safety case that was superseded by the final HF safety case at the end of GDA. This updated the HF safety case to reflect the very considerable HF work done to close out the HF GDA Issue.
- Chapter 15 presents some minor changes to the HF aspects of the PSA but nothing that significantly alters the final GDA HF safety case. The PSA and supporting HRA will need to be updated for PCSR3 to reflect the reference design prior to construction.
- None of the other chapters in the HPC PCSR2012 contain new material that impacts the HF safety case at this point. There are aspects related to maintenance, inspection and operational practices that will need to be considered in the future post-PCSR.

36 Overall I consider that the HPC PCSR2012 requires updating to reflect the final GDA HF safety case and any changes to it arising from the incorporation of design changes for the reference design, and resolution of any relevant GDA Assessment Findings.

5.2 Recommendations

37 I have one recommendation arising from this assessment:

- Recommendation 1: The HPC PCSR2012 should be updated by the licensee to accommodate the final GDA HF safety case and any changes arising to it from the consolidated reference design. This will include consideration on the changes to claimed HBSCs arising from design changes and resolution of relevant GDA AFs. It will also include updating to reflect the associated changes to the PSA model for the reference design.

6 REFERENCES

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 5. *GDA Step 4 Human Factors Assessment of the EDF and AREVA UK EPR™ Reactor*. ONR Assessment Report ONR-GDA-AR-11-028 Revision 0. TRIM Ref. 2010/581503
 6. *GDA Close-out for the EDF and AREVA UK EPR™ Reactor – GDA Issue GI-UKEPR-HF-01 Revision 0 – Identification & Substantiation of Human Based Safety Claims*. ONR Assessment Report ONR-GDA-AR-12-009 Revision 0. TRIM Ref. 2012/9
 7. HPC-NNBOSL-U0-000-RES-000076 – “NNB Generation Company Ltd – Hinkley Point C Pre-Construction Safety Report 2012 – Head Document,” December 2012, TRIM 2013/23292
 8. *PCSR Sub-Chapter 18.1 - Human Factors*. UKEPR-0002-181, Issue 06. TRIM Ref. 2012/450490
 9. *PCSR Sub-Chapter 18.3 – Abnormal Operations*. UKEPR-0002-181, Issue 03. TRIM Ref. 2012/450492
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Annex 1

Table 1

Relevant HF Safety Assessment Principles Considered During the Assessment

SAP No.	SAP Title	Description
EHF.1	Integration with design, assessment and management	A systematic approach to integrating human factors within the design, assessment and management of systems should be applied throughout the entire facility life-cycle.
EHF.2	Allocation of safety actions	When designing systems, the allocation of safety actions between humans and technology should be substantiated and dependence on human action to maintain a safe state should be minimised.
EHF.3	Identification of actions impacting safety	A systematic approach should be taken to identifying human actions that can impact on safety.
EHF.4	Identification of administrative controls	Administrative controls used to remain within the safe operating envelope should be systematically identified.
EHF.5	Task Analysis	Analysis should be carried out of tasks important to safety to determine demands on personnel in terms of perception, decision making and action.
EHF.6	Workspaces	Workspaces in which plant operations and maintenance are conducted should be designed to support reliable task performance, by taking account of human perceptual and physical characteristics and the impact of environmental factors.
EHF.7	User interfaces	User interfaces, comprising controls, indications, recording instrumentation and alarms should be provided at appropriate locations and should be suitable and sufficient to support effective monitoring and control of the plant during all plant states.
EHF.9	Procedures	Procedures should be produced to support reliable human performance during activities that could impact on safety.
EHF.10	Human Reliability	Risk assessments should identify and analyse human actions or omissions that might impact on safety.

Annex 1

Table 2

TTHuman Factors GDA Assessment Findings to be Addressed Prior to First Structural Concrete

Assessment Finding Number	Assessment Finding	Timescale	Progress
AF-UKEPR-HF-06	The licensee shall establish and maintain a log of current assumptions from the safety case, including consideration of those identified in Annex 3, Table A3.1. Additional assumptions should be added as they emerge from subsequent HF analysis work. All assumptions shall be substantiated as part of the forward work programme for HF.	Prior to First structural concrete.	Completed
AF-UKEPR-HF-24	The licensee shall develop and submit a HFIP for UK EPR construction.	Prior to First structural concrete.	On-going
AF-UKEPR-HF-25	The licensee shall ensure that sufficient SQEP HF resource is identified and deployed to meet the demands of the on-going design and safety case work for the UK EPR.	Prior to First structural concrete.	On-going
AF-UKEPR-HF-26	The licensee shall produce a user definition document that contains relevant anthropometric details and has considered the impact of secular trends in the operating community.	Prior to First structural concrete.	Completed
AF-UKEPR-HF-27	The licensee shall establish and maintain a consolidated HF Issues Register for the future design and safety case development beyond PCSR. This will incorporate all outstanding HF Issues and requirements that have arisen from the work to the end of GDA.	Prior to First structural concrete.	Completed
AF-UKEPR-HF-28	The licensee shall ensure that there is full integration between the remaining HFE programme, the HRA and the overall safety case,	Prior to First structural concrete.	On-going
AF-UKEPR-HF-29	The licensee shall establish a process for addressing ALARP requirements for HF aspects of the design and safety case for the UK EPR.	Prior to First structural concrete.	On-going
AF-UKEPR-HF-36	The licensee shall provide a HMI style guide (or equivalent); using recognised modern standards to guide detailed design and justification of the interfaces and displays for the UK EPR.	Prior to First structural concrete.	On-going