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Civil Nuclear Reactors Programme

NNB GenCo: Hinkley Point C Pre-Construction Safety Report 2012 – Assessment Report for Mechanical Engineering Work Streams (B15, 21 & 22)

Assessment Report ONR-CNRP-AR-14-077
Revision 0
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EXECUTIVE SUMMARY

This mechanical engineering Assessment Report reviews those sub-chapters of the Hinkley Point C Pre-Construction Safety Report 2012 (HPC PCSR 2012) that are either new or modified from those in the Pre-Construction Safety Report (PCSR) provided for the Generic Design Assessment (GDA) of the UK EPR™ design. The scope of my assessment covers the following systems and mechanical engineering Work Streams:

- B15: Balance of Nuclear Island (BNI)
- B21: Balance of Plant (BOP), and
- B22: Conventional Island (CI).

The sub-chapters included in my assessment are 9.2 'Water Systems', 9.4 'Heating Ventilation and Air Conditioning Systems' (HVAC), 10.2 'Presentation of the Turbogenerator Set' and 10.4 'Other Features of the Steam and Power Conversion Systems'.

A final version of the GDAPCSR issued in November 2012 formed the basis for issue by the Office for Nuclear Regulation (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 PCSR 2012 addresses the whole Hinkley Point C (HPC) 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 PCSR 2012. 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generic documentation has been copied into HPC PCSR 2012 from an earlier March 2011 GDA PCSR but this has now been superseded by the November 2012 GDA PCSR report.

It is important to note that HPC PCSR 2012 alone is not sufficient to inform a future ONR decision on whether to grant permission to construct HPC. New Nuclear Build Generation Company Limited (NNB GenCo) intends to submit a major revision to HPC PCSR 2012 (to be known as PCSR3) before seeking consent for nuclear island construction (referred to as First Nuclear Island Concrete (FNIC)). The HPC PCSR3 will fully integrate the final GDA PCSR and will be supported by other documentation.

The changes to sub-chapter 9.2 'Water Systems' mainly reflect the adoption of the open circuit design for the heat sink. The material is consistent with that included in the site specific Heat Sink Summary Document (HSSD) produced by NNB GenCo in support of the HPC nuclear site licence application. My earlier assessment of the HSSD concluded that the open issues were unlikely to challenge the ability to provide an acceptable heat sink capability; some of these issues have subsequently been progressed giving further confidence in the proposed design.

NNB GenCo is progressing cooling chain sizing studies which will confirm the adequacy of the proposed heat exchangers and provide confidence in the sizing of the main cooling system pipework. The latter will support Construction Safety Justification-01 (CSJ-01) required to inform ONR's decision as to whether to grant permission for the construction of the technical galleries in advance of FNIC. I will be following this up as part of the on-going mechanical engineering intervention.

Sub-chapter 9.4 describes the various HVAC systems that provide confinement of radioactive material and maintain acceptable ambient conditions for structures, systems and components important to nuclear safety. The changes are limited to the section addressing the ventilation of the pumping station which has been rewritten although the general intent and approach has not altered.

During GDA a number of design changes were introduced to the HVAC systems to address the concerns raised by ONR regarding failure of the essential support systems; the key changes were to the safeguard building HVAC. The Responsible Designer has progressed a conceptual design to address the associated GDA Assessment Findings (AF), however ONR has raised concerns with the evolving design and as a result a task force has been established to reach an acceptable position. At this point in time I am satisfied that the project is taking appropriate measures to mitigate the risk and to be in a position to include sufficient material in PCSR3 to support FNIC.

The material in sub-chapters 10.2 'Presentation of the Turbogenerator Set' and 10.4 'Other Features of the Steam and Power Conversion Systems' is limited since the preferred bidder for the turbine hall turnkey contract had not been selected at the time that HPC PCSR 2012 was prepared. On the basis of the information presented I am satisfied that the approach proposed for the turbogenerator and support systems is broadly consistent with established practices.

For each of the sub-chapters my assessment has identified a number of items to be considered in HPC PCSR3. Depending upon the significance of these items they will either be raised as Issues in the ONR database or progressed as part of routine regulatory business. Some of these items have already been identified in the PCSR Forward Work Activities document and as such are not raised as ONR Issues.

I am satisfied with the current status of the resolution plans associated with the mechanical engineering GDA AFs required to be complete prior to FNIC and will be reviewing progress against the implementation of the plans during routine regulatory interactions.

I consider that NNB GenCo has put in place the means by which it can provide oversight of the mechanical engineering aspects of the HPC project and there is adequate evidence from level 4 regulatory meetings that key decisions are made at the appropriate level within the project.

Regular level 4 meetings have been held with NNB GenCo's Design Authority (DA) since the granting of the HPC site licence. As a result I consider that NNB GenCo has put in place the means by which it can fulfil its Intelligent Customer role in the BNI, BOP and CI areas. The resource levels within the DA continue to be of concern, however I am satisfied that the situation is beginning to improve. I am aware that preferred bidders have been selected for a number of contracts with arrangements in place to facilitate early contractor involvement with a focus on further de-risking the project in advance of signing the main contracts.

My assessment concludes that the on-going work within the BNI, BOP and CI areas demonstrates suitable progress towards meeting ONR's requirement for an adequate PCSR to be available to support FNIC.

No recommendations have arisen from my assessment.

LIST OF ABBREVIATIONS AND ACCROYNMS

AF	Assessment Finding
ALARP	As Low As Reasonably Practicable
APG [SGBS]	Steam Generator Blowdown System
AR	Assessment Report
ASG [EFWS]	Emergency Feed Water System
BDR	Basic Design Reference
BMS	(ONR) How2 Business Management System
BNI	Balance of Nuclear Island
BOP	Balance of Plant
CFI [CWFS]	Circulating Water Filtration System
CI	Conventional Island
CMF	Change Management Form
CRDM	Control Rod Drive Mechanism
CRF	Circulating Water System
CSJ	Construction Safety Justification
DA	Design Authority
DAC	Design Acceptance Confirmation
DEL [SCWS]	Safety Chilled Water System
DOP	Dispersed Oil Particle
DVL_{new}[$SBVSE_{new}$]	Diverse Safeguard Building Ventilation System Electrical (Division)
DVP [CWPSVS]	Circulating Water Pumping Station Ventilation System
EBA [CSVS]	Containment Sweep Ventilation System
ECI	Early Contractor Involvement
FA3	Flamanville 3
FNIC	First Nuclear Island Concrete
GCT [MSB]	Main Steam Bypass
GDA	Generic Design Assessment
HEPA	High Efficiency Particulate Air (filters)
HOJ	Fire Fighting Water Building
HOR	Raw Water Storage Building
HPC	Hinkley Point C
HPC PCSR 2012	Hinkley Point C Pre-Construction Safety Report 2012
HSSD	Heat Sink Summary Document
HVAC	Heating, Ventilation and Air Conditioning
IAEA	International Atomic Energy Agency

IC	Intelligent Customer
IDR	Implemented Design Reference
IIS	Integrated Intervention Strategy (Rating) – an ONR metric on submission
JAC [FFWSS]	Fire Fighting Water Supply System
MCR	Main Control Room
NNB GenCo	New Nuclear Build Generation Company Limited
NRC	Nuclear Regulatory Commission
NSDAP	Nuclear Safety Design Assessment Principle(s)
NSL	Nuclear Site Licence
NVF	Nuclear Ventilation Forum
ONR	Office for Nuclear Regulation
PCSR	Pre-Construction Safety Report
PTR	Fuel Pond Purification (and Cooling) System
RC1	Reference Configuration 1
RD	Responsible Designer
RP	Resolution Plan
RRI [CCWS]	Component Cooling Water System
SAPs	Safety Assessment Principles (ONR)
SBO	Station Blackout
SDA [DPS]	Demineralised (water) Production System
SDM	System Design Manual
SEC [ESWS]	Essential Services Water System
SEP [PWS]	Potable Water System
SRU [UCWS]	Ultimate Cooling Water System
SZB	Sizewell B
TAGs	Technical Assessment Guides (ONR)
UKAEA	United Kingdom Atomic Energy Authority
UK EPR™	The generic design of pressurised water reactor submitted for GDA
VDA [MSRT]	Main Steam Relief Train

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1 INTRODUCTION

1.1 Background

1. This mechanical engineering Assessment Report reviews those sub-chapters of the Hinkley Point C Pre-Construction Safety Report 2012 (HPC PCSR 2012) (Ref. 1) that are either new or modified from those in the Pre-Construction Safety Report (PCSR) provided for the Generic Design Assessment (GDA) of the UK EPR™ design. The scope of my assessment covers the following systems and mechanical engineering Work Streams:

   - B15: Balance of Nuclear Island (BNI)
   - B21: Balance of Plant (BOP), and
   - B22: Conventional Island (CI).

2. Assessment was undertaken in accordance with the requirements of the Office for Nuclear Regulation (ONR) How2 Business Management System (BMS) guide NS-PER-GD-014 (Ref. 2). The ONR Safety Assessment Principles (SAPs) (Ref. 3), together with supporting Technical Assessment Guides (TAGs) (Ref. 4) have been used as the basis for this assessment.

3. This Assessment Report (AR) has been written to address whether HPC PCSR 2012 demonstrates suitable progress towards meeting ONR's requirement for an adequate Pre-Construction Safety Report (PCSR) to inform a future decision on whether to grant permission to commence construction of the Hinkley Point C (HPC) nuclear island.

1.2 Scope

4. A final version of the Generic Design Assessment (GDA) 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.

5. In contrast HPC PCSR 2012 addresses the whole HPC 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 PCSR 2012. 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 the HPC PCSR 2012 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.

6. It is important to note that HPC PCSR 2012 alone is not sufficient to inform a future ONR decision on whether to grant permission to construct HPC. New Nuclear Build Generation Company Limited (NNB GenCo) intends to submit other supporting documentation and HPC PCSR 2012 will be superseded by a further site-specific revision to be known as PCSR3. HPC PCSR3 will inform the ONR decision as to whether to grant permission for the commencement of nuclear island construction referred to as First Nuclear Island Concrete (FNIC). PCSR3 is intended to fully reflect the final GDA PCSR and other design changes from Flamanville 3 (FA3) which is the reference design for HPC.

7. It should also be noted the approach to safety function categorisation and safety system classification agreed during GDA is not fully reflected in HPC PCSR 2012

which largely uses the approach employed on FA3. The integration of the methodology agreed during GDA will be demonstrated in HPC PCSR3.

1.3 Methodology

8. The methodology for the assessment follows the requirements of the ONR How2 BMS guide NS-PER-GD-014 (Ref. 2), in particular in relation to mechanics of assessment.

9. The mechanical engineering intervention Task Sheet (Ref. 5) was prepared to support the overarching ONR intervention for the construction phase of the HPC project. Reference 5 includes the requirement to review the development of the HPC PCSR to establish whether it adequately supports FNIC.

10. In addition to considering the various HPC PCSR 2012 sub-chapters, my assessment has also considered NNB GenCo's on-going work and organisational capability to further develop the PCSR. This has been achieved by holding a number of level 4 meetings with NNB GenCo.

2 ASSESSMENT STRATEGY

11. 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.

2.1 Standards and Criteria

12. The relevant standards and criteria adopted within this assessment are principally the SAPs (Ref. 3), internal ONR TAGs (Ref. 4), 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.

2.1.1 Safety Assessment Principles

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

2.1.2 Technical Assessment Guides

14. The following TAGs have been referred to as part of the assessment (Ref. 4):

- NS-TAST-GD-022: Ventilation, Revision 3, June 2014
- NS-TAST-GD-036: Diversity, Redundancy, Segregation and Layout of Mechanical Plant, Revision 3, April 2014
- NS-TAST-GD-049: Licensee Use of Contractors & Intelligent Customer Capability, Revision 4, April 2013
- TAST/057: Design Safety Assurance, Issue 2, November 2010
- NS-TAST-GD-079: Licensee Design Authority Capability, Revision 2, April 2013

2.1.3 National and International Standards and Guidance

15. The following international standards and guidance have been used as part of this assessment (Ref 6):

- International Atomic Energy Agency (IAEA) Safety Standard SSR-2/1 (2012) – Safety of Nuclear Power Plants: Design
- IAEA International Nuclear Safety Advisory Group Report 19 (INSAG-19): Maintaining the Design Intent of Nuclear Installations throughout their Operating Life, 2003

2.2 Use of Technical Support Contractors

16. Technical Support Contractors have not been used in undertaking this assessment.

2.3 Integration with Other Assessment Topics

17. My assessment has not required any interactions with other work streams.

2.4 Out of Scope Items

18. The following items are outside the scope of the assessment:

- consideration of those sub-chapters where there has been no change to the material presented in the GDA PCSR; for example Chapter 5 'Reactor

Coolant System and Associated Systems', Chapter 6 'Containment and Safeguard Systems' and sub-Chapter 9.1 'Fuel Handling and Storage'.

- consideration of the adoption of the 2008, 2009 and 2010 addenda to the Technical Code for Mechanical Equipment (RCC-M) code edition 2003 as this relates to the integrity of the pressure boundary of mechanical equipment and is addressed by ONR's structural integrity inspectors.

3 LICENSEE'S SAFETY CASE

19. A review of the HPC PCSR 2012 Head Document (Ref. 7) identified a number of sub-chapters of relevance to my mechanical engineering assessment that are either new for the HPC PCSR 2012 or have been modified since the GDA PCSR. These sub-chapters are discussed in section 3.1.

20. As noted in section 1.2, the equipment safety classifications presented in HPC PCSR 2012 are largely those adopted for FA3 and are not based on the methodology agreed during GDA. In particular, the approach adopted for FA3 did not require the CI equipment to be classified; this will not be the case for HPC. In some instances the classifications presented are based on de-risking studies undertaken to support early procurement activities in advance of the output from application of the agreed classification methodology.

21. At the time of HPC PCSR 2012 NNB GenCo prepared a support document (Ref. 8) identifying the PCSR forward work activities to be addressed in a subsequent version of the HPC PCSR.

3.1 Chapter 9 Auxiliary Systems

22. The auxiliary systems have been divided into the categories of fuel handling systems, water systems, primary auxiliary systems, heating and ventilation systems, other systems and chemistry control. For HPC PCSR 2012 the following sub-chapters have been updated of which the first two are of relevance to my mechanical engineering assessment:

- Sub-chapter 9.2 'Water Systems'
- Sub-chapter 9.4 'Heating, Ventilation and Air Conditioning (HVAC)', and
- Sub-chapter 9.6 'Chemistry'

23. Sub-chapter 9.2 describes the various water systems including the Essential Services Water System (SEC [ESWS]), the Component Cooling Water System (RRI [CCWS]), the various demineralised water systems, the Circulation Water Filtration System (CFI [CWFS]), the Potable Water Systems (SEP [PWS]) and the Ultimate Cooling Water System (SRU [UCWS]).

24. HPC PCSR 2012 Head Document (Ref. 7) notes that additional information on the proposed HPC heat sink design is provided in the site specific Heat Sink Summary Document (HSSD) (Ref. 9) produced to support the HPC Nuclear Site Licence (NSL) application. The heat sink comprises both safety classified cooling systems that perform nuclear safety functions and non-classified systems for power production. The HSSD includes details of the optioneering undertaken, describes the proposed open circuit system design and how it satisfies both functional requirements and site-specific constraints. The protection provided by the heat sink design against internal and external hazards is also presented.

25. The HPC PCSR 2012 head document notes that GDA Out-of-scope item 4 'Heat sink characteristics' is relevant to Chapter 9 and that it will be addressed during detailed design.

26. Upon closer examination of sub-chapter 9.2 it is apparent that changes since the GDA PCSR 2011 of a technical and/or nuclear safety perspective are very limited including:

- changes to reflect the adoption of the open circuit system design for the heat sink in line with the concept design in the HSSD. The GDA PCSR covered both open and closed circuit heat sink options recognising that the final choice is site specific.

- deletion of the seawater Demineralised (Water)Production System (SDA [DPS]) along with additional descriptive material for the remaining demineralised water systems.

27. Sub-chapter 9.4 describes the various HVAC systems that provide confinement of radioactive material and maintain acceptable ambient conditions for structures, systems and components important to nuclear safety. For each system an outline description is provided along with the normal role, nuclear safety role, normal operational conditions, transient conditions and a preliminary safety analysis. The preliminary safety analysis includes consideration of hazard withstand requirements.

28. Upon closer examination of sub-chapter 9.4 it is apparent that changes since GDA PCSR 2011 are limited to Section 12 'Ventilation of the Pumping Station' which has been rewritten although the general intent and approach has not altered.

29. The consolidated GDA PCSR 2012 included a number of changes that are not reflected in the HPC PCSR 2012; namely a description of the static and dynamic containment of the fuel building and reactor building, inclusion of metallic pre-filters upstream of the iodine lines and isolation dampers in the Containment Sweep Ventilation System (EBA [CSVS]), and operation during a number of additional accident conditions. I understand that this material is to be included in HPC PCSR3.

30. The HPC PCSR 2012 Head Document (Ref. 7) notes that the material presented for the Circulating Water Pumping Station Ventilation System (DVP [CWPSVS]) has not considered extreme high air temperatures. The PCSR forward work activities document (Ref. 8) notes that this will be addressed in a future version of the HPC PCSR.

31. During the GDA Step 4 fault studies assessment it became apparent that the GDA PCSR did not provide a design basis safety case for loss of essential support system faults which included the HVAC and the cooling water systems. For example, loss of the safeguard building HVAC system can result in the loss of cooling to Instrumentation and Control (I&C) systems and essential electrical systems with consequential loss of the frontline systems that these systems support. As a result GDA Issue GI-UKEPR-FS-05 was raised and the requesting party undertook further studies to consider the implications of failure of the support systems leading to a significant number of design changes.

32. Reference 10 presents the ONR close-out assessment of GDA Issue GI-UKEPR-FS-05 concluding that sufficient progress had been made to justify its closure subject to a number of Assessment Findings (AF) to be addressed by any future licensee; some of these AFs are of relevance to the mechanical engineering assessment area.

33. Chapter 9 of the consolidated GDA PCSR 2012 introduced the relevant design changes for the HVAC and cooling water systems but they were not integrated into the various sub-chapter sections. Chapter 9 of the HPC PCSR 2012 does not refer to these design changes; however the Head Document notes that the resolution of the GDA Issue will be incorporated in the next revision of the HPC PCSR.

3.2 Chapter 10 Steam and Power Conversion System

34. For HPC PCSR 2012 the following sub-chapters have been updated of which the first two are of relevance to my mechanical engineering assessment:

- Sub-chapter 10.2 'Presentation of the Turbogenerator Set'
- Sub-chapter 10.4 'Other Features of the Steam and Power Conversion Systems', and
- Sub-chapter 10.7 'Secondary System Chemistry'

35. Sub-chapter 10.2 is new due to its site specific nature. At the time of HPC PCSR 2012 the preferred bidder for the turbine hall contract had not been selected, as such detailed information is not presented. The sub-chapter is limited to a high level description of the turbine and generator with limited consideration of the measures to be taken to prevent turbine disintegration, explosion and fire.

36. Sub-chapter 10.4 has been modified to include information on systems not covered by the GDA PCSR (i.e. condenser, condensate extraction system, some of the feedwater supply systems and the turbine gland system). The section covering the Main Steam Bypass system (GCT [MSB]) has been modified to include additional descriptive material and to clarify the system roles. A site specific update has been included for the Circulating Water System (CRF) to reflect the fact that HPC is a coastal site. The section addressing the Steam Generator Blow Down System (APG [SGBS]) has not changed.

37. The sub-chapter presents the safety requirements and main design features for the various systems. Information is also provided as to whether the systems are safety classified, however this is in advance of the detailed HPC classification studies and may change in HPC PCSR3.

4 ONR ASSESSMENT

38. This assessment has been carried out in accordance with HOW2 guide NS-PER-GD-014, “Purpose and Scope of Permissioning” (Ref. 2).

4.1 Scope of Assessment Undertaken

39. My assessment has been limited to the new and/ or modified material presented in the HPC PCSR 2012 sub-chapters identified in sections 3.1 and 3.2, progress on relevant GDA AFs and NNB GenCo’s on-going work and organisational capability to further develop and implement the HPC PCSR to support FNIC.

40. As noted in both the GDA Step 4 and HPC licensing mechanical engineering ARs (Refs. 11 & 12), the information presented in the PCSR is at a high level and more detailed information will only become available following the placement of the equipment procurement contracts. An important suite of evidential information from a mechanical engineering assessment perspective comes from factory acceptance tests and site acceptance tests which will not be available until later in the project.

41. I understand that HPC PCSR3 will be supported by Stage 1 System Design Manuals (SDMs); these will be sampled as part of the ONR mechanical engineering intervention to gain confidence that system functional requirements and classifications are adequately reflected.

4.2 Assessment

4.2.1 HPC PCSR 2012 Chapter 9 – Auxiliary Systems

4.2.1.1 Sub-Chapter 9.2 – Water Systems [modified]

42. As noted in section 3.1, the extent of the revisions to sub-chapter 9.2 is limited with the majority of the changes made to reflect the adoption of the open circuit design for the CRF heat sink and associated changes to the Circulating Water Filtration System (CFI [CWFS]). The material presented for the SEC [ESWS] and CFI [CWFS] is consistent with that presented in the HSSD which I reviewed as part of my assessment to support the granting of the HPC NSL (Ref. 12). At the time it was noted that there were a number of open issues to resolve, however I considered that these did not challenge the ability to provide an acceptable heat sink capability.

43. Since granting of the HPC NSL in December 2012 I have attended a number of level 4 regulatory meetings with NNB GenCo in support of the construction phase of the project. As a result I am aware that the Responsible Designer (RD) has progressed the various HSSD open issues and undertaken additional studies to gain further confidence in the proposed design for the heat sink. The studies have included an investigation into the system configurations to manage the unavailability of the various heat sink structures during exceptional maintenance activities (tunnels, forebays and outfall ponds). These studies have resulted in further developments of the concept design that are reflected in Reference Configuration 1 (RC1) (Ref. 13) to be used as the basis for HPC PCSR3 and detailed design activities.

44. The HPC PCSR 2012 Head Document (Ref. 7) states that the HSSD will be updated to support future versions of the HPC PCSR. Following the BOP level 4 regulatory meeting held in November 2013 (Ref. 14) I understand this is no longer the case. NNB GenCo’s preference is to include the relevant material in specific PCSR chapters. If this approach is adopted I consider it important that the various As Low As Reasonably Practicable (ALARP)/ optioneering studies are either included or clearly referenced so that visibility is not lost. This will be will raised as an issue in ONR’s Issues database and progressed as part of my on-going intervention.

45. I understand that the HPC site specific extreme sea water temperatures presented in Chapter 2 of the HPC PCSR 2012 have not been considered in terms of the performance of the cooling systems important to nuclear safety. This shortfall is included in the PCSR forward work activities document (Ref. 8) under Chapter 13 and will need to be addressed in HPC PCSR3.

46. NNB GenCo had intended a cooling chain sizing study to be included as a Basic Design Reference (BDR) deliverable at the end of 2013. However, following the BOP level 4 regulatory meeting held in July 2014 (Ref. 15) I understand that completion of the study will now be an Implemented Design Reference (IDR) deliverable. I would expect the outcome of these studies to provide the necessary confidence in the sizing of the cooling chain pipework to support Construction Safety Justification-01 (CSJ-01) required to inform ONR's decision as to whether to grant permission for the construction of the technical galleries in advance of FNIC. I will be following this up as part of the on-going mechanical engineering intervention.

47. In the event of clogging upstream of the cooling water system pumps due to the massive intake of seaweed or marine organisms the non-safety related pumps providing cooling water to the turbine condensers are tripped. The tripping of the non-safety related pumps ensures sufficient flow of water to those pumps important to nuclear safety. GDA PCSR 2011 included the requirement to trip the pumps should the head drop across the drum screens and/ or band screens reach a certain threshold in the event of clogging. Section 4.5 of HPC PCSR 2012 includes additional requirements to trip the pumps when there is:

- low level of filtered water downstream of the screens, due for example to clogging of a pre-filtering grid;
- low level in the forebay due to clogging of an offshore water intake head.

48. I consider that the provision of these additional trip parameters will increase the certainty of identifying clogging issues that if undetected could challenge the availability of cooling water to those systems important to nuclear safety.

49. As explained in section 3.1, as a result of GDA Issue GI-UKEPR-FS-05 a number of design changes were introduced to address the concerns regarding failure of the essential support systems. In terms of the cooling water systems the main change from a mechanical engineering perspective is covered by Change Management Form (CMF) #76. This change introduced the requirement for a common header on the RRI [CCWS] system to allow cooling of the thermal barriers on all four reactor coolant pumps in the event of loss of one train of cooling to provide increased resilience against pump seal failure.

50. The ONR close out report for GDA Issue GI-UKEPR-FS-05 (Ref. 10) raised AF-UKEPR-FS-95 requiring future licensees to provide a full justification for CMF#76 including consideration of the safety dis-benefits resulting from a break in the common header. I will be following this up as part of the on-going mechanical engineering intervention and would expect it to be addressed in HPC PCSR3.

51. Section 3 of sub-chapter 9.2 contains new material describing the demineralised water systems, however I understand that the safety case makes no claims on these systems. Those systems important to nuclear safety that are supplied with demineralised water (the Emergency Feed Water System (ASG [EFWS]) and the Fire Fighting Water Supply System (JAC [FFWSS])) have their own reserves allowing them to fulfil their safety functions independently. As such my assessment has not considered the new material presented.

52. The filter panels on the drum screens and band screens are cleaned by two washing stations each provided with a low pressure and high pressure pump. GDA PCSR 2011

noted that only the low pressure pumps were classified as this is sufficient when the screens are operating at low speed (the high pressure pumps are required for high speed operation of the screens which is not claimed in the safety case). Section 4.4.1 of sub-chapter 9.2 has been amended such that whilst the high pressure pumps are still non-classified for operability they need to be classified to ensure the integrity of the overall washing circuit. The HPC categorisation and classification studies are on-going; however it is encouraging to see evidence that the early de-risking classification studies have given consideration to the potential for non-safety related equipment to effect equipment important to nuclear safety.

53. HPC PCSR 2012 notes that the potable water system has no nuclear safety role which is consistent with the position at the time of GDA. During the BOP level 4 regulatory meeting held in November 2013 (Ref. 14) NNB GenCo provided an update on enhancements proposed in response to the Fukushima incident. I understand that design modifications have been proposed by the RD to extend the function of the raw water storage building (HOR) to support various beyond design basis functions and water reserves. The conceptual design of the enhancements makes use of temporary flexible hoses to be deployed should the need arise. I consider such an approach to be reasonable when it is recognised that the modifications are intended for beyond design basis events.

54. As noted in the PCSR forward work activities document (Ref. 8), future versions of HPC PCSR should include the modifications to the HOR building. In addition consideration should be given to the following:

- justification that any temporary hoses can be readily connected in the available time recognising the hostile nature of conditions likely to be prevailing at the time, and
- secure storage of the hoses and any tools required in a location that can be readily accessed following a range of beyond design basis events.

This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

55. Section 6.6.2.2 of sub-chapter 9.2 notes that whilst the single failure criterion does not apply to the SRU [UCWS], redundancy is in fact available 15 days after the start of RRC-B situations since after this time only one of the two SRU trains is required. It is unclear as to whether this applies to the cooling of the 3rd train of the Fuel Pond Purification (and Cooling) System (PTR [FPPS/ FPCS]) as this would require the ability to connect the PTR train to train 2 of the SRU [UCWS] for which there is currently no provision. I will seek clarification on this matter during future regulatory interactions.

56. HPC PCSR 2012 makes no mention of the classified lifting equipment in the pumping station building; I consider that this needs to be addressed in HPC PCSR3. Particular attention should be given to the ALARP measures with respect to dropped loads noting that the following GDA AFs are relevant: AF-UKEPR-ME-14 and AF-UKEPR-ME-18. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

57. Whilst not part of sub-chapter 9.2 the following observation is made in relation to the allocation of safety functions to pumps in the fire fighting water building (HOJ). At the time of GDA the JAC [FFWSS] system pumps supplied both the fire fighting systems and the spent fuel pool make-up and this has not changed in HPC PCSR 2012. I understand from the BOP level 4 regulatory meeting held in November 2013 (Ref. 14) that FA3 feedback has shown that combining these two functions resulted in a complex system in terms of both design studies and operability with few benefits. For HPC it is now proposed to separate these functions allowing the fire fighting pumps to be assigned a lower safety classification. I consider this to be a good example of the

HPC project modifying the HPC design to address lessons learned from FA3. I consider that HPC PCSR3 should include this modification along with details of the associated optioneering. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

58. On the basis of a number of BOP level 4 regulatory meetings since the granting of the HPC NSL I am satisfied that NNB GenCo will be in a position to further develop sub-chapter 9.2 to meet ONR's requirement for an adequate PCSR to be available to support FNIC.

4.2.1.2 Sub-Chapter 9.4 – Heating, Ventilation and Air Conditioning Systems [modified]

59. As noted in section 3.1, the extent of the changes to sub-chapter 9.4 is limited to Section 12 'Ventilation of the Pumping Station'. Whilst a number of the sub-sections of Section 12 have been largely rewritten I am satisfied that the general intent and approach has not changed from that presented at the time of GDA.

60. The GDA PCSR 2011 design basis for the Circulating Water Pumping Station Ventilation System (DVP [CWPSVS]) system included the requirement to maintain the minimum temperature in the SEC [ESWS] technical galleries. HPC PCSR 2012 states that this requirement is no longer considered necessary on the basis that the galleries are adequately buried underground. Whilst this would appear reasonable I will be seeking the supporting evidence as part of the on-going mechanical engineering intervention.

61. There are some instances in which information presented in the GDA PCSR 2011 is not included in the HPC PCSR 2012 (for example, the provision of heating elements on the chain filters) and it is not clear whether this reflects changes in the design intent or is simply a manifestation of the section rewrite. I am satisfied that such issues do not present a risk to the project at this point in time and will be resolved as part of the detailed design studies and reflected as appropriate in HPC PCSR3.

62. The consolidated GDA PCSR 2012 included a number of changes that are not reflected in the HPC PCSR 2012; namely a description of the static and dynamic containment of the fuel building and reactor building, inclusion of metallic pre-filters upstream of the iodine lines and isolation dampers in the EBA [CSVS] system, and operation during a number of additional accident conditions. I understand that this material is to be included in HPC PCSR3.

63. Section 12.5.2.5 of sub-chapter 9.4 currently states that during Station Black Out (SBO) a number of the DVP [CWPSVS] actuators could be backed up by the SBO diesel generators. I consider that HPC PCSR3 needs to identify the actual requirements for backing up of HVAC equipment during loss of offsite power and SBO noting the AFs associated with the closure of GDA Issue GI-UKEPR-FS-05. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

64. AECP 1054 (Ref. 16) was regarded as the industry standard for the design of ventilation of radioactive areas. The document was owned by the United Kingdom Atomic Energy Authority (UKAEA) and supported by a committee within the industry. The last revision of the document was produced in 1989. Following the recent resurgence of the nuclear industry, a Nuclear Ventilation Forum (NVF) was convened in 2007 to review the principles of AECP 1054 and apply relevant good practice. The forum represents the views of industry and a new guide for the design of ventilation of radioactive areas has been developed. In January 2009, the forum issued NVF/DG 001 (Ref. 17) which effectively supersedes AECP 1054. NVF/DG001 has been endorsed by the Safety Directors' Forum and is accepted within the nuclear industry as representing relevant good practice. I will seek confirmation during the routine

regulatory interactions that the HPC HVAC design is compliant with the principles of NVF/DG 001.

65. I am aware that Sizewell B (SZB) is addressing a number of issues with the HVAC systems via a HVAC Station Enhancement Programme. I consider that HPC PCSR3 should confirm that due account has been taken of relevant operating experience from SZB along with a summary of any measures taken to avoid similar issues at HPC. This will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

66. I consider that HPC PCSR3 should clarify the intentions for testing to verify that the Main Control Room (MCR) will be habitable post fault taking due account of relevant good practice on US power plant as identified by the Nuclear Regulatory Commission (NRC) in 2003 (GL03-001 Control Room Habitability). This will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

67. I would expect the following topics associated with the use of High Efficiency Particulate Air (HEPA) filters in the ventilation of radioactive areas to be addressed in HPC PCSR3:

- the use of pre-filters in HEPA filter trains noting that their use is now considered to be by exception requiring appropriate justification, and
- the proposed methodology for in-situ HEPA testing along with appropriate justification if not in accordance with the UK practice of Dispersed Oil Particle (DOP) testing.

This will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

68. As explained in section 3.1, as a result of GDA Issue GI-UKEPR-FS-05 a number of design changes were introduced to address the concerns regarding failure of the essential support systems. In terms of the HVAC systems the key changes were to the safeguard building as proposed in CMF#41 and summarised below:

- upgrade of the safeguard building chilled water system to Class 1;
- upgrade of the safeguard building ventilation system to Class 1;
- creation of a new Class 2 safeguard building diverse chilled water system allocated to divisions 1 and 4 of the 400V AC essential electrical system that will be housed in an extra single storey to be added to safeguard buildings 1 and 4;
- creation of a new Class 1 safeguard building diverse ventilation system allocated to divisions 1 and 4 of the 400V AC essential electrical system;
- upgrade of the automatic switchover from the safeguard building ventilation system to the safeguard building new diverse ventilation system on loss of normal systems to Class 1;
- upgrade of the automatic switchover from the safeguard building chilled water system to the safeguard building new diverse chilled water system on loss of normal systems to Class 2, and
- upgrade of the main control room air conditioning system to Class 1.

69. With the exception of the MCR and the pump house HVAC systems, the GDA requesting party (EDF and Areva) concluded that failure of the other HVAC systems will result in reactor transients that are already covered by pre-existing design basis faults. In the case of the MCR and the pump house HVAC systems a series of design changes (CMF#77 and CMF#80 respectively) were proposed during GDA to provide additional protection against common mode failure.

70. The consolidated GDA PCSR 2012 notes that the various design changes associated with the above CMFs will need to be fully developed by a future licensee as part of the detailed design. In support of the HPC BDR the RD has progressed the conceptual design of the safeguard building HVAC systems and the output was presented during the BNI level 4 meeting held in October 2014 (Ref.19). During the meeting it was explained that a task force has been established to resolve the outstanding issues. I understand that the specification for the task force is to be released soon and will cover the following:

- Heat loads and margins – detailed system design work;
- Diversification/ reliability of local cooling units;
- Cooling when the Safety Chilled Water System (DEL [SCWS]) is un-available (T ambient <25°C) - detailed calculation to substantiate GDA assumption, and
- I&C work stream – removal of Class 2 I&C from the new diverse Safeguard Building Ventilation System (DVL_{new} [$SBVSE_{new}$]).

A further workshop with the ONR is planned for early 2015 to ensure that an acceptable position is reached to de-risk the project.

71. An area of particular interest from a mechanical engineering perspective will be how the project meets the requirements for mechanical diversity particularly with respect to the safeguard building HVAC system. I recognise that achieving conceptual and component diversity may be impractical; however NNB GenCo needs to demonstrate prior to FNIC that various alternatives have been considered before relying solely on manufacturing diversity. The final solution will need to be revisited to confirm that the assumptions made in the fault studies supporting closure of GDA Issue GI-UKEPR-FS-05 remain valid. I will be following this up as part of the on-going mechanical engineering intervention and would expect it to be addressed in HPC PCSR3 noting the AFs associated with the closure of GDA Issue GI-UKEPR-FS-05.

72. Both NNB GenCo and ONR recognise that resolution of the shortfalls associated with the HVAC systems remains one of the key design risks to the project. At this point in time I am satisfied that the project is taking appropriate measures to mitigate the risk and be in a position to include sufficient material in sub-chapter 9.4 to meet ONR's requirement for an adequate PCSR to be available to support FNIC.

4.2.2 HPC PCSR 2012 Chapter 10 – Steam and Power Conversion Systems

4.2.2.1 Sub-Chapter 10.2 – Presentation of the Turbogenerator Set [new]

73. At the time of HPC PCSR 2012 the preferred bidder for the turbogenerator set had not been selected; as such detailed HPC specific design information was not available. The information provided in the sub-chapter is therefore limited. The HPC PCSR forward work activities document (Ref. 8) notes that further detail will be included in a future version of the PCSR which I support.

74. The HPC design is for a single turbogenerator set (approximately 1750MWe) per reactor which represents a considerable increase in size compared with the sets previously installed in UK nuclear power plant (maximum of 660MWe). Whilst there is limited experience of such equipment within the UK, there is considerable international experience including within EDF's fleet in France. As such I judge the risks associated with introducing such equipment at HPC to be manageable and have not pursued this aspect of the design. I consider that HPC PCSR3 should include discussion of operational experience associated with similarly rated turbogenerator sets. This will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

75. The role of the turbogenerator set is to transform the thermal energy contained in the steam into electrical power. Section 1 of the sub-chapter notes that this function is not safety related which I accept. However, I would expect some of the equipment to be classified due to the nuclear safety related roles they need to perform, for example the turbine stop valves need to prevent turbine overspeed and reactor overcooling faults. As noted in section 0.1 of the sub-chapter and the HPC PCSR forward work activities document (Ref. 8) the safety classification work was on-going at the time of HPC PCSR 2012. On the basis of discussions at CI level 4 regulatory meetings I am satisfied that progress is being made in this area. A number of sub-systems have been identified as performing safety functions and needing to be classified; this is being progressed as part of the cross cutting categorisation and classification work.

76. Section 4 of the sub-chapter presents the preliminary safety analysis identifying measures to be taken to prevent the turbine causing internal hazards (projectiles, fire and explosions) which I consider to be adequate from a mechanical engineering perspective. The sub-chapter also refers to the role of the turbine protection system and steam valves in protecting the turbine against events which could adversely affect its integrity, however little detail is provided.

77. I would have expected some consideration of the internal hazards that could affect the turbine protection system and steam valves and the measures taken to mitigate against them. Internal flooding and dropped load are of particular relevance; this should be covered in HPC PCSR3. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

78. The turbine has the potential to overcool the reactor therefore as stated in Section 10.1.1 of the HPC PCSR 2012 Head Document (Ref. 7) the turbine trip system needs to support the following plant level safety function:

- maintain core criticality control by limiting primary circuit cooling

79. Sub-chapter 10.2 fails to clearly address this requirement; I consider that this needs to be addressed in HPC PCSR3. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

80. In addition to the ONR Issues identified above, a number of areas for improvement have been identified that I will share with NNB GenCo during future CI level 4 regulatory meetings, these include:

- the turbine governor system and its function should be discussed in the sub-chapter;
- Section 3.2 'Loading factored into Design Basis' should be clearer as to the full extent of the loading capability of the set and be consistent with the information presented in sub-chapter 1.2, and
- ONR SAPs should not be referred to directly; reference should be to NNB GenCo's Nuclear Safety Design Assessment Principles (NSDAP).

81. Subsequent to HPC PCSR 2012 a preferred bidder has been selected who has extensive experience of designing turbo generator sets and will be providing what is essentially a proven design with no novel features. The design has evolved over many years taking due cognisance of operating experience from diverse applications. In advance of the HPC final investment decision an Early Contractor Involvement (ECI) contract has been signed with the preferred bidder enabling key areas, including equipment classification, to be progressed to de-risk the project.

82. The on-going studies to classify the turbo generator equipment (referred to in the HPC PCSR forward work activities document (Ref. 8)) present a risk to the project in terms of the supply chain's ability to meet the more rigorous requirements associated with

supplying Class 1 and 2 equipment. This is an area that I will continue to monitor during routine regulatory interactions.

83. On the basis of information shared at level 4 meetings I consider that the on-going work within the CI area demonstrates that NNB GenCo will be in a position to further develop sub-chapter 10.2 to meet ONR's requirement for an adequate PCSR to be available to support FNIC.

4.2.2.2 Sub-Chapter 10.4 – Other Features of Steam and Power Conversion Systems [modified]

84. The new sections covering the condenser, condensate extraction system and turbine gland system provide brief descriptions and identify the roles of the systems. Whilst the level of detail provided is limited, I am satisfied from a systems and mechanical engineering perspective that the proposed approach is consistent with established practices for turbine support systems.

85. The sub-chapter does not identify any specific nuclear safety claims for these systems and proposes that they are not safety classified. However, it is noted that the HPC safety classification work, which includes consideration of duty systems, is on-going and this may identify the need for classification of certain equipment and components.

86. At the CI level 4 meeting in July 2014 (Ref. 18) there was some discussion about the use of industrial/ manufacturers standards for certain safety classified equipment in the turbine hall as opposed to nuclear standards. If this is to be pursued then I consider that HPC PCSR3 needs to address the issue and provide sufficient justification. As a minimum I would expect a fit-for-purpose review to identify differences with nuclear standards and the need, or otherwise, for any additional measures to bridge any gaps. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

87. The preliminary safety analysis for the Main Steam Bypass (GCT [MSB]) system identifies that it is fail safe in that the pressure reducing valves close on loss of supplies thereby preventing overcooling of the reactor which I consider to be good practice. I also note that should the valves fail to open the pressure in the steam header is controlled by the Main Steam Relief Train (VDA [MSRT]) and ultimately the steam generator safety relief valves; as such the sub-chapter states that there are no nuclear safety claims on the turbine bypass system and the system is not safety classified.

88. The sub-chapter makes no mention of the GCT [MSB] valves failing to close following a genuine demand to open or inadvertently opening due to an I&C fault; both scenarios have the potential to overcool the reactor and will be bounded by excess steam demand faults in the HPC fault studies. I consider that a future version of sub-chapter 10.4 should address these scenarios with respect to claims on the GCT [MSB]. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

89. Similarly, I consider that HPC PCSR3 needs to address other steam consumers that have the potential to overcool the reactor resulting in reactor trip and/ or challenge to the fuel cladding stress criterion. Consideration of the latter for SZB led to a number of changes in the classification of certain control systems on the conventional plant. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

90. In recognition of the potential contribution to overcooling faults I would expect the on-going safety classification studies for HPC to identify the need to classify certain equipment within the GCT [MSB] system (e.g. I&C associated with steam dump

prevention). ONR will continue to monitor the safety classification work during routine level 4 regulatory meetings.

91. I note that section 4.4.2 of the sub-chapter recognises the potential for reactor overcooling due to the inadvertent operation of the steam support valves to the feedwater tank. I am satisfied that the classification requirements for this equipment will be determined from the on-going classification studies.

92. The sub-chapter includes the Circulating Water System (CRF), however the amount of information is limited in terms of a system description with additional information presented in the HSSD (Ref. 9) referred to in section 3.1 of this report.

93. The role of the CRF system is stated in sub-chapter 10.4 as cooling the condenser and meeting the Environment Agency's requirements on discharge temperature, as such there are no direct nuclear safety claims on the system. The sub-chapter does however identify the tripping of the non-safety related cooling system pumps as a safety related function to maintain sufficient margin for operation of those cooling water systems important to nuclear safety and prevent flooding in the turbine hall due to pipe breaks. The detailed implementation of the pump trip is outside the mechanical engineering scope and will be addressed as appropriate by ONR I&C inspectors.

94. HPC PCSR 2012 makes no mention of the lifting equipment in the turbine hall; I consider that this needs to be addressed in HPC PCSR3. Particular attention should be given to the ALARP measures with respect to dropped loads noting that the following GDA AFs are relevant: AF-UKEPR-ME-14 and AF-UKEPR-ME-18. This will be will be raised as an issue in ONR's Issues database and progressed as part of my on-going intervention.

95. On the basis of information shared at level 4 regulatory meetings I consider that the on-going work within the CI area demonstrates that NNB GenCo will be in a position to further develop sub-chapter 10.4 to meet ONR's requirement for an adequate PCSR to be available to support FNIC.

4.2.2.3 GDA Assessment Findings

96. A total of 35 mechanical engineering AFs were identified during GDA to be addressed as part of normal regulatory business by any future licensees in support of site licensing and permissioning activities.

97. As part of the HPC site licensing mechanical engineering assessment (Ref. 12) I considered the approach adopted by NNB GenCo to address the AFs in the BNI topic area. It was evident that the NNB GenCo procedure for the management of AFs was being complied with.

98. AFs have been assigned NNB GenCo owners and, as appropriate, leads within the RD organisation. Following a stakeholder meeting in April 2012, the mechanical engineering AFs required for completion prior to FNIC (Group 1) were identified. NNB GenCo shared the output of the prioritisation at the April 2012 BNI level 4 progress meeting (Ref. 20) and I was generally satisfied.

99. During the BNI level 4 meeting held in July 2012 (Ref. 21) draft Resolution Plans (RP) for a number of AFs relating to the specification of ALARP load paths for lifts of nuclear safety significance (AF-UKEPR-ME-14 and AF-UKEPR-ME-18) were handed over and discussed. I subsequently reviewed these draft plans and was satisfied that they met the intent of the original ONR findings.

100. A number of the Group 1 AFs have the potential to impact on procurement contracts and therefore need to be completed, or mitigation identified, prior to the signing of contracts. At the time of site licensing NNB GenCo seemed to be well aware of this in

the BNI topic area and a spreadsheet was in preparation identifying which BNI contracts are affected by which AF. I understand that the spreadsheet was populated during workshops attended by the NNB GenCo Topic Lead for mechanical engineering AFs, the RD Topic Lead and the RD BNI Contracts Project Coordinator. I consider this to be strong evidence that NNB GenCo is seeking to de-risk the procurement process; at the time I understood that similar spreadsheets were in preparation for other topic areas. This is an area that I will revisit in future level 4 regulatory meetings to gain confidence that detailed design activities are progressed with appropriate awareness of relevant AFs.

101. Since site licensing NNB GenCo and the RD have been completing the RPs for the Group 1 AFs. This exercise has been more protracted than anticipated and progress has been regularly reviewed at the various mechanical engineering level 4 meetings. At the time of preparing this report NNB GenCo has issued RPs for the majority of the Group 1 AFs with the remainder in various stages of production. A recent exercise has been completed in which the following RPs have been sampled by an ONR mechanical engineering inspector (Ref. 22):

- NNB-202-PLN-000137 (2014/202345) **AF-UKEPR-ME-08:** The licensee shall generate evidence to demonstrate that the CRDMs meet their seismic design intent.
- NNB-202-PLN-000192 (2014/202370) **AF-UKEPR-ME-10:** The design code identification of “n.a.” (assumed to mean “not applicable”) to the Control Rod Drive Mechanism (CRDM) and the displacement limiter is not to my expectations. The licensee shall generate evidence that the CRDM and its constituent components are assigned with appropriate Mechanical Engineering design / material codes, which are commensurate to their importance to safety.
- NNB-202-PLN-000147 (2014/149450) **AF-UKEPR-ME-14:** The licensee shall ensure the design of all rigging equipment associated with lifts of nuclear safety significance is completed, and in doing so shall systematically review these rigging arrangements to identify faults, and review and implement reasonably practicable improvements to either eliminate such faults by design, or limit their frequency by the provision of engineered protection systems.
- NNB-202-PLN-000146 (2014/104256) **AF-UKEPR-ME-18:** The licensee shall ensure that all lifts of nuclear safety significance are identified, and safe load paths are specified through appropriate design and safety documentation, and procedures.
- NNB-OSL-PLN-006544 (2014/104278) **AF-UKEPR-ME-21:** The licensee shall ensure that the proposed modification to the nuclear ventilation system, described as CMF#20 (Confinement – Modification of Ventilation Systems) is fully incorporated into the UK EPR design and safety documentation.

102. The assessment has not identified any significant issues in regards to the contents of the sampled RPs and concludes that the AFs have been interpreted in line with the GDA inspector’s expectations. Two observations are made in that:

- the RPs do not present the details of what documentation will be included in the closure packs, this would assist ONR in targeting certain documents for assessment, and
- the RPs do not consistently identify the various work areas that need to considered in closing the AFs, i.e. the need to consider the impact on the BOP and CI areas is not always made clear.

The conclusions of the assessment will be discussed with NNB GenCo during future level 4 meetings as part of normal regulatory business.

103. NNB GenCo have recently reviewed the GDA fault studies AFs and have proposed that a number of them should be re-allocated to other work streams including mechanical engineering. On the basis of an initial review I support the proposed re-allocation and when finally agreed will progress the associated RPs and subsequent work through the appropriate level 4 meetings.

104. A number of the fault studies AFs to be re-allocated to mechanical engineering are associated with the closure of GDA Issue GI-UKEPR-FS-05. For example AFs FS-101, 102 and 106 are related to the implementation of CMFs#41, 77 and 80 proposed during GDA for the HVAC systems and referred to in section 4.2.1.2.

105. To conclude, I am satisfied with the current status of the RPs associated with the mechanical engineering GDA AFs required to be complete prior to FNIC and will be reviewing progress against the implementation of the plans during routine regulatory interactions.

4.2.3 Further Development and Implementation of HPC PCSR

106. In support of my HPC site licensing mechanical engineering assessment the opportunity was taken to examine the capability and competence of NNB GenCo's Design Authority (DA). Reference 12 concluded that in the BNI, BOP and CI areas the DA had established adequate mechanical engineering capability and competency for the pre-construction phase. Resource requirements were regularly reviewed against the Nuclear Baseline with a number of routes in place for securing future resource. Role profiles and associated competency requirements had been developed in accordance with company procedures, assessments had been completed against the various role profiles identifying individuals' development needs and the staff appraisal process was being implemented.

107. Since the HPC site licence was granted in December 2012 I have arranged a number of level 4 meetings with NNB GenCo DA to support my mechanical engineering intervention in the BNI, BOP and CI areas. These meetings have provided confidence that NNB GenCo is taking the necessary measures to ensure that HPC PCSR3 is adequate to support FNIC. Some examples include:

- NNB GenCo is actively engaged with the RD through topical meetings and working groups to ensure that the necessary work is completed to underpin the developing HPC PCSR. Through these engagements and the on-going surveillance of deliverables NNB GenCo is challenging the RD and influencing decisions.
- detailed Chapter specifications have been prepared by NNB GenCo for HPC PCSR3 and formally reviewed and accepted by NNB GenCo. I have sampled the specification for Chapter 9 'Auxiliary Systems' (Ref. 23) and am satisfied that it captures the issues that I would expect to be addressed in HPC PCSR3.
- the establishment of ECI contracts with preferred bidders (e.g. turbine hall contract) in advance of signing the full scope contracts. This has allowed NNB GenCo and the RD to work closely with the preferred bidders in certain key areas to technically de-risk the project.
- the capability of NNB GenCo's Safety Directorate is being strengthened with evidence that it is now adding value to the project via independent assessment of key project decisions and deliverables. At the BNI level 4 meeting held in October 2014 (Ref. 19) an overview was provided of the independent assessment of the BDR HVAC work. This assessment is understood to have included a review of the deliverables associated with

achieving functional diversity; this was a key requirement identified during the closure of GDA Issue GI-UKEPR-FS-05.

108. Due to delays in securing the final investment decision for the project NNB GenCo has not been able to recruit at the rate previously anticipated and over the summer of 2013 the project went through a re-organisation that resulted in the release of some resource. The re-organisation was addressed by a Management of Change paper that was considered by ONR.

109. In light of the reduced staffing levels within the DA I have sought evidence during level 4 meetings that NNB GenCo is continuing to fulfil its Intelligent Customer (IC) role. On a number of occasions I have noted that I consider the DA staffing levels to be of some concern recognising the volume of work being progressed by the RD and the intent to restart procurement activities; for example, the BNI level 4 meeting held in November 2013 (Ref. 24).

110. Notwithstanding the reduced staffing levels I have been satisfied that NNB GenCo has managed to undertake adequate surveillance of the RD's work and is involved in key project decisions (Refs. 14 & 25). In some instances the project has obtained the necessary competencies and capabilities through a combination of embedded and non-embedded contractors; for example, in the BNI area a specialist HVAC contractor is being used.

111. I am aware that over the recent months the resourcing situation is beginning to improve; for example, during the BNI level 4 meeting held in October 2014 (Ref. 19) it was apparent that a number of vacancies had been filled including the BNI team leader. I also understand that recruitment plans for additional resource are under review with increased use of framework support as work ramps up. I am supportive of these improvements and consider that they will help to secure an acceptable HPC PCSR to support FNIC.

112. I consider that NNB GenCo has put in place the means by which it can provide oversight of the mechanical engineering aspects of the HPC project and there is adequate evidence that key decisions are made at the appropriate level within the project. The resource levels within the DA continue to be of concern, however I am satisfied that the situation is beginning to improve. This will need to continue as the project pace increases in the coming months and I will regularly monitor the position against the Nuclear Baseline and project requirements through routine regulatory interactions.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

113. This mechanical engineering Assessment Report reviews those sub-chapters of the Hinkley Point C Pre-Construction Safety Report 2012 (HPC PCSR 2012) that are either new or modified from those in the Pre-Construction Safety Report (PCSR) provided for the Generic Design Assessment (GDA) of the UK EPR™ design. The scope of my assessment covers the following systems and mechanical engineering Work Streams:

- B15: Balance of Nuclear Island (BNI)
- B21: Balance of Pant (BOP), and
- B22: Conventional Island (CI).

I have also considered progress on relevant GDA AFs along with NNB GenCo's on-going work and organisational capability to further develop and implement the mechanical engineering aspects of the HPC PCSR to support FNIC.

114. I recognise that NNB GenCo has further work to do in a number of key areas including the HVAC system architecture and cooling chain sizing studies to de-risk the project ahead of FNIC. However, on the basis of the material presented at various level 4 meetings I am satisfied from a mechanical engineering perspective that the necessary work is being scoped and progressed.

115. On the basis of my mechanical engineering assessment of the identified sub-chapters of HPC PCSR 2012 along with the earlier ONR mechanical engineering assessment of the UK EPR^{TM} GDA PCSR (Ref. 11) I am satisfied with the material presented. A number of issues have been identified to be addressed in HPC PCSR3; these are listed in Annex A and will be added to the ONR Issues database.

116. I am satisfied with the current status of the RPs associated with the mechanical engineering GDA AFs required to be complete prior to FNIC and will be reviewing progress against the implementation of the plans during routine regulatory interactions.

117. I consider that NNB GenCo has put in place the means by which it can provide oversight of the mechanical engineering aspects of the HPC project and there is adequate evidence that key decisions are made at the appropriate level within the project. The resource levels within the DA continue to be of concern, however I am satisfied that the situation is beginning to improve.

118. I consider that the on-going work since HPC PCSR 2012 demonstrates suitable progress towards meeting ONR's requirement for an adequate PCSR to be available to support FNIC.

119. An Integrated Intervention Strategy (IIS) rating (an ONR metric on submission quality) of 3 'Adequate' is judged to be appropriate.

5.2 Recommendations

120. No recommendations have arisen from my assessment; the need for future updates of the HPC PCSR as described in this report will be progressed as routine regulatory business.

6 REFERENCES

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3. Safety Assessment Principles for Nuclear Facilities, 2006 Edition, Revision 1, HSE, January 2008
   http://www.onr.org.uk/saps/saps2006.pdf.

4. ONR Technical Assessment Guides:

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   - NS-TAST-GD-036: Diversity, Redundancy, Segregation and Layout of Mechanical Plant, Revision 3, April 2014
   - NS-TAST-GD-049: Licensee Use of Contractors & Intelligent Customer Capability, Revision 4, April 2013
   - TAST/057: Design Safety Assurance, Issue 2, November 2010
   - NS-TAST-GD-079: Licensee Design Authority Capability, Revision 2, April 2013

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5. ONR-NNB-TS-14-024, Intervention Task Sheet: HPC Mechanical Engineering and System Design – Topic Stream B15, B21, B22, Issue A [TRIM 2014/275324]

6. International Atomic Energy Agency documents:

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   - International Nuclear Safety Advisory Group Report 19 (INSAG-19): Maintaining the Design Intent of Nuclear Installations throughout their Operating Life, IAEA, 2003

   www.iaea.org

7. HPC-NNBOSL-U0-000-RES-000076, HPC Pre-Construction Safety Report 2012 Head Document, Version 1.0, December 2012 [TRIM 2013/16152]

8. HPC-NNBOSL-U0-000-RES-000082, HPC Pre-Construction Safety Report Version 2 Forward Work Activities, Version 1.0, November 2012 [TRIM 2013/16159]

9. HPC-NNBOSL-U0-000-RET-000011, HPC PCSR2 Heat Sink Summary Document, Version 2.0, January 2012 [TRIM: 2012/61317]

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11. ONR-GDA-AR-11-026, Step 4 Mechanical Engineering Assessment of the EDF and AREVA UK EPR™ Reactor, Revision 0, November 2011 [TRIM: 2010/581505]

12. ONR-CNRP-AR-12-075, Hinkley Point C Nuclear Site Licensing - Mechanical Engineering Topic Report, Revision 1, January 2013 [TRIM 2012/339862]

13. NNB GenCo, HPC-ECUKXX-XX-000-NOT-000720, RC1 Reference Configuration (engineering design standards/methodologies) [TRIM 2014/24617]

14. ONR-NNB-IR-13-093, NNB GenCo Level 4 Balance of Plant Systems and Mechanical Engineering Progress Meeting - 20 November 2013, Revision 0, December 2013 [TRIM 2013/464420]

15. ONR-NNB-CR-14-113, NNB BoP Mechanical Level 4 Progress Meeting - 29th July 2014, Revision 0, July 2014 [TRIM 2014/283586]

16. AECP 1054, AEA Technology Code of Practice, Ventilation of Radioactive Areas, March 1993

17. NVF/DG001, An Aid to the Design of Ventilation of Radioactive Areas, Issue 1, January 2009

18. ONR-NNB-CR-14-125, NNB GenCo Hinkley Point C Level 4 Mechanical Engineering Progress Meeting - Conventional Island Systems: 23 July 2014, Revision 0, July 2014 [TRIM 2014/278556]

19. ONR-NNB-CR-14-180, Balance of Nuclear Island Mechanical Engineering and System Design Level 4 Meeting – 7 October 2014, Revision 0, October 2014 [TRIM 2014/371696]

20. ONR-NNB-IR-12-048, Hinkley Point C Level 4 BNI Systems and Mechanical Engineering Progress Meeting No. 3, Revision 0, April 2012 [TRIM: 2012/218546]

21. ONR-NNBGenCo-IR-12-160, Hinkley Point C Level 4 BNI Systems and Mechanical Engineering Progress Meeting No. 4, Revision 0, July 2012 [TRIM 2012/311894]

22. ONR File Note: Sample Review of GDA AF Resolution Plans - October 2014 [TRIM 2014/372492]

23. HPC-NNBOSL-XX-000-SPE-000022, HPC PCSR3 Chapter 9 Specification – Auxiliary Systems, [TRIM 2014/267458]

24. ONR-NNB-IR-13-090, Level 4 Balance Nuclear Island and Mechanical Engineering - 8 November 2013, Revision 0, December 2014 [TRIM 2013/451567]

25. ONR-NNB-IR-13-100, NNB GenCo – Level 4 Mechanical Engineering Progress Meeting on Conventional Island Systems - 16 January 2014, Revision 0, February 2014 [TRIM 2014/64210]

Table 1

Relevant Safety Assessment Principles Considered During the Assessment

SAP No	SAP Title	Description
MS.1	Leadership and management for safety: Leadership	Directors, managers and leaders at all levels should focus the organisation on achieving and sustaining high standards of safety and on delivering the characteristics of a high reliability organisation.
MS.3	Leadership and management for safety: Decision Making	Decisions at all levels that affect safety should be rational, objective, transparent and prudent.
MS.4	Leadership and management for safety: Learning from Experience	Lessons should be learned from internal and external sources to continually improve leadership, organisational capability, safety decision making and safety performance.
SC.4	The regulatory assessment of safety cases: Safety case characteristics	A safety case should be accurate, objective and demonstrably complete for its intended purpose.
SC.8	The regulatory assessment of safety cases: Safety case ownership	Ownership of the safety case should reside within the dutyholder's organisation with those who have direct responsibility for safety.
EES.1	Engineering principles: essential services: Provision	Essential services should be provided to ensure the maintenance of a safe plant state in normal operation and fault conditions.
EHT.2	Engineering principles: heat transport systems: Coolant inventory and flow	Sufficient coolant inventory and flow should be provided to maintain cooling within the safety limits for operational states and design basis fault conditions.
EHT.3	Engineering principles: heat transport systems: Heat sinks	A suitable and sufficient heat sink should be provided.
EHT.4	Engineering principles: heat transport systems: Failure of heat transport system	Provisions should be made in the design to prevent failure of the heat transport system that could adversely affect the heat transfer process, or safeguards should be available to maintain the facility in a safe condition and prevent any release in excess of safe limits.
FA.16	Fault analysis: severe accident analysis: Use of severe accident analysis	The severe accident analysis should be used in the consideration of further risk-reducing measures.

Annex 1

Issues Raised During Assessment of HPC PCSR 2012

Issue Number	Issue Title	Issue	Milestone (by which this item should be addressed)
1	Incorporation of Heat Sink Summary Document in to PCSR3	If NNB GenCo chooses to include the relevant material from the Heat Sink Summary Document (HPC-NNBOSL-U0-000-RET-000011) in specific PCSR3 chapters rather than update the document the various ALARP/ optioneering studies should be either included or clearly referenced so that visibility is not lost.	PCSR3
2	Use of temporary flexible hoses in the raw water storage building (HOR)	If temporary flexible hoses are to be used to extend the functions of the raw water storage building (HOR) to support beyond design basis functions then consideration should be given to: • justification that any temporary hoses can be readily connected in the available time recognising the hostile nature of conditions likely to be prevailing at the time, and • secure storage of the hoses and any tools required in a location that can be readily accessed following a range of beyond design basis events.	PCSR3
3	Lifting equipment in the turbine hall and pumping station building	PCSR3 should include consideration of classified lifting equipment in the turbine hall and pumping station building. Particular attention should be given to the ALARP measures with respect to dropped loads noting that the following GDA AFs are relevant: AF-UKEPR-ME-14 and AF-UKEPR-ME-18.	PCSR3
4	Separation of fire fighting and spent fuel make-up functions of the Fire Fighting Water Supply System (JAC [FFWSS])	PCSR3 should reflect the proposal to separate the fire fighting and spent fuel pool make-up functions provided by the Fire Fighting Water Supply System (JAC [FFWSS]) and include details of the associated optioneering.	PCSR3
5	Backing up of HVAC electrical supplies	PCSR3 needs to identify the requirements for the backing up of electrical supplies to the HVAC equipment during loss of offsite power and Station Black Out noting the assessment findings associated with the closure of GDA Issue GI-UKEPR-FS-05.	PCSR3

6	HVAC operating experience from Sizewell B	PCSR3 should reflect that due consideration has been given to Sizewell B's HVAC operating experience/ enhancement programme along with a summary of any measures taken to avoid similar issues at HPC.	PCSR3
7	Testing of the Main Control Room HVAC to verify habitability post faults	PCSR3 should clarify the intentions for testing to verify that the Main Control Room (MCR) will be habitable post fault taking due account of relevant good practice on US power plant as identified by the Nuclear Regulatory Commission.	Active commissioning
8	Use of High Efficiency Particulate Air (HEPA) filters	The following topics associated with the use of High Efficiency Particulate Air (HEPA) filters in the ventilation of radioactive areas should be addressed in PCSR3: • the use of pre-filters in HEPA filter trains noting that their use is now considered to be by exception requiring appropriate justification, and • the proposed methodology for in-situ HEPA testing along with appropriate justification if not in accordance with the UK practice of Dispersed Oil Particle (DOP) testing.	PCSR3
9	Turbogenerator operational experience	PCSR3 should include discussion of operational experience associated with similarly rated turbogenerator sets to that proposed for HPC.	PCSR3
10	Internal hazards affecting turbine hall equipment	PCSR3 should consider the internal hazards that could affect the turbine protection system and steam valves and the measures taken to mitigate against them. Internal flooding and dropped load are of particular relevance.	PCSR3
11	Turbine trip system support to plant level safety functions	PCSR3 sub-chapter 10.2 should reflect that the turbine trip system needs to support the following plant level safety function: • maintain core criticality control by limiting primary circuit cooling	PCSR3
12	Use of manufacturers' standards for safety classified turbine hall equipment	If the use of industrial/ manufacturers standards for certain safety classified equipment in the turbine hall is pursued as opposed to nuclear standards then PCSR3 needs to provide sufficient justification. The justification should as a minimum include a fit-for-purpose review to identify differences to nuclear standards and the need, or otherwise, for additional measures to bridge any gaps.	PCSR3

13	Main Steam Bypass (GCT [MSB]) valves leading to overcooling of the reactor	PCSR3 sub-chapter 10.4 should recognise the potential for overcooling the reactor due to the Main Steam Bypass (GCT [MSB]) valves failing to close following a genuine demand to open or inadvertently opening due to an I&C fault.	PCSR3
14	Identification of turbine hall steam consumers with potential to overcool the reactor	PCSR3 needs to identify all turbine hall steam consumers that have the potential to overcool the reactor resulting in reactor trip and/ or challenge to the fuel cladding stress criterion.	PCSR3