Office for Nuclear Regulation

An agency of HSE

Civil Nuclear Reactors Programme

NNB GenCo Ltd: Hinkley Point C Pre-Construction Safety Report 2012 – Assessment Report for Work Stream Spent Fuel and Storage

Assessment Report: ONR-CNRP-AR-13-082
Revision 3
Version 2
March 2014

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EXECUTIVE SUMMARY

This assessment report (AR) reviews that portion of the Hinkley Point C (HPC) pre-construction safety report 2012 (HPC PCSR 2012) falling within the scope of the spent fuel and storage work stream. The material I have reviewed lies in HPC PCSR 2012 sub-chapter 11.5 (i.e. those portions of this sub-chapter relating solely to the interim spent fuel storage facility - ISFS).

My assessment has been conducted to inform my judgment as to the licensee's progress in constructing an adequate safety case (in the above technical area) and in defining suitable limits and conditions to maintain safety within that safety case (i.e. compliance with Licence Condition LC 23 – "Operating Rules").

A final version of the Generic Design Assessment (GDA) PCSR, 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. Certain matters were also deemed to be outside the scope of the GDA PCSR (including interim spent fuel storage, i.e. fuel storage post the fuel's first 10 years of cooling after discharge from the reactor), as the licensee had made no decision at that time whether to pursue a wet or dry interim spent fuel storage option.

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 also addressed. 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generic documentation has been copied into HPC PCSR 2012 from an earlier March 2011 GDA PCSR, but this has now been superseded by the November 2012 GDA PCSR report.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 permission construction of HPC. Nuclear New Build Generating Company (NNB GenCo Ltd) i.e. the licensee intends to submit a major revision to HPC PCSR 2012 before seeking consent for nuclear island construction, which will fully integrate the final GDA PCSR and will be supported by other documentation.

The information presented in HPC PCSR 2012 sub-Chapter 11.5 (as stated in the HPC PCSR 2012 Head Document) is entirely new information, since at the time of the GDA no decision had been taken on the future interim spent fuel management strategy. Accordingly, I have performed a formal assessment of the new information presented in sub-chapter 11.5 of HPC PCSR 2012 relating to the interim spent fuel store (ISFS).

In addition since HPC PCSR 2012 was issued, I have monitored the licensee's progress with the development of the conceptual design of the ISFS and its supporting safety case via routine level 4 meetings with key licensee personnel. I also accompanied the licensee on a technical visit to the Goesgen nuclear power plant in Switzerland, to view the interim wet spent fuel store, constructed and operational on that site, which NNB GenCo Ltd intends to use to inform its design process (i.e. this is a valuable source of operational experience - OpEx for the licensee). From my assessment of HPC PCSR 2012 sub-chapter 11.5 and my ongoing dialogue with the licensee, it is my judgment that the licensee is making suitable progress (given the currently immature stage of the ISFS

design) in the production of a sound safety case for the ISFS. I am broadly content with the licensee’s forward work proposals in this area. Accordingly, I am presently content that the licensee will ultimately fully meet the requirements of LC 23.

However, my assessment of the HPC PCSR 2012 has resulted in a total of 3 new ONR Level 3 Issues and 5 Level 4 Issues i.e. in addition to the original GDA Assessment Findings - AFs. All of these new Issues (i.e. items requiring actions from the licensee) are detailed in the body of the report and following internal ONR review, I will record these Issues on ONR’s ‘Issues Database’ and I will track the licensee’s progress against resolution of the Issues, via my routine ongoing routine interactions with the licensee and I will ensure that in due course the Issues are closed via the defined ONR processes for Issue closure.

The licensee expects to proceed to basic design (although it is recognised that it may not be complete prior to issue of the safety case to inform the first ONR consent issue i.e. PCSR 3). I judge that no regulatory action in this area is currently required.

The GDA exercise on the EPR design resulted in AFs being recorded by ONR. Of these: Some of these GDA AFs are not specific to the ISFS: some will need specific information from the ISFS design in order to allow them to be closed: and a third category is recognised to have a generic impact upon the ISFS design. The licensee has hence conducted what I judge to be a thorough exercise to look at all the GDA AFs and identify all findings having a bearing upon the ISFS design. These identified AFs have then been categorised and all findings that are ISFS specific (three of) will be taken forward by the ISFS working group. High level work plans have been developed and the findings have been prioritised to ensure that the greatest effort is applied to the two findings requiring closure before the nuclear island concrete ONR hold point.

Likewise eight GDA AFs have been identified as requiring ISFS design information to permit closure. Whilst the ISFS working group will not be responsible for resolution of these AFs they will, nevertheless, be intimately involved in resolution. Once again, high level work plans are already in place for resolution of these findings.

In the case of AFs having a generic impact upon the ISFS design, these AFs have been sub-split into three categories i.e. resolution of the AF does not need ISFS specific input (but there is recognition that an ISFS deliverable may be required post finding closure). The second category is where the AF can be closed with reference to ISFS data or studies. The final category is where resolution of the AF will in turn inform the ISFS design. In the case of all these three categories, there is no requirement for a GDA AF resolution forward work plan as activities arising from category-three GDA AFs can be completed post resolution of the GDA AFs. In addition, no prioritisation has yet been done by the licensee against these AFs, although the work is in hand.

I am content with the current position with respect to the GDA AFs relating to the ISFS.

The ISFS conceptual design is being conducted by a French design team and I am content at this juncture that the NNB GenCo Ltd ISFS project team in the UK is exercising an appropriate intelligent customer (IC) role with respect to these design activities. This has been evidenced by members of the French design team attending level 4 meetings with the NNB GenCo Ltd staff. A contract is to be let for the basic design of the ISFS and as a part of the contract; the chosen contractor will be required to specify the contract deliverables. NNB GenCo Ltd intends to exercise its IC role by monitoring the quality of these defined deliverables. I will be examining the interfaces between the chosen contractor and NNB GenCo Ltd and NNB GenCo Ltd’s oversight of this contractor in due course.

LIST OF ABBREVIATIONS

BAT	Best Available Technology
BMS	(ONR) How2 Business Management System
CIDAS	Criticality Incident Detection and Alarm System
DAC	Design Acceptance Confirmation
FA3	Flamanville 3
GDA	Generic Design Assessment
GDF	Geological Disposal Facility
HSE	Health and Safety Executive
HPC PCSR 2012	Hinkley Point C Pre-Construction Safety Report 2012
IAEA	International Atomic Energy Agency
IC	Intelligent Customer
IPR	Intervention Project Record
ISFS	Interim Spent Fuel Store
LC	Licence Condition
NDT	Non-Destructive Testing
ONR	Office for Nuclear Regulation (an agency of HSE)
OpEx	Operational Experience
PCSR	Pre-Construction Safety Report
RD	Responsible Designer
RP	Resolution Plan
SAP	Safety Assessment Principle(s)
SQEP	Suitably Qualified and Experienced Person
SZB	Sizewell B
TAG	Technical Assessment Guide(s)

TABLE OF CONTENTS

Tables

Annexes

1 INTRODUCTION

1.1 Background

1 A Generic Design Assessment (GDA) was conducted by the Office for Nuclear Regulation (ONR) on the generic features of the EPR^{TM} design and a final GDA pre-construction safety report (PCSR), produced in November 2012, formed the basis of ONR issuing a design acceptance confirmation (DAC) for the design. However, the safety submissions, assessed during GDA, were purposely for the key elements of the design of a single EPR unit (i.e. the generic features of the "nuclear island") and took no account of site specific features and ancillary buildings (including those related to interim spent fuel storage).

2 Nuclear New Build Generating Company Ltd (NNB GenCo Ltd) i.e. the licensee has since further developed the EPR design for the UK context and has also further developed the extant safety case to address issues specific to construction of twin EPRs at Hinkley Point C (HPC), including all required associated ancillary buildings to be constructed on the site. This revised safety case was presented in HPC PCSR 2012 (Reference 1), which also considers a number of matters which were deemed to be outside the scope of the GDA exercise (including interim spent fuel storage).

3 This report presents the findings of my assessment of sub-chapter 11.5 of the HPC PCSR 2012, (Reference 1) i.e. those parts of sub-chapter 11.5 falling within the scope of the spent fuel and storage work stream. The "Head Document" i.e. Reference 2 for HPC PCSR 2012 defines which HPC PCSR 2012 chapters present new data/analysis and which chapters are unchanged from GDA PCSR 2011. Sub-chapter 11.5 is an entirely new chapter added since GDA PCSR 2011 and hence I have conducted a formal assessment of those parts of the sub-chapter relating to interim spent fuel store (ISFS).

4 This assessment report (AR) has been written, as one of a set of technical ARs, to support a Summary Assessment Report that addresses whether HPC PCSR 2012 demonstrates suitable progress (i.e. against Licence Condition LC 23) towards meeting ONR's requirement for an adequate PCSR (to be known as PCSR 3) to permit ONR to release the first construction hold-point i.e. for the pouring of first nuclear island concrete. In addition this AR summarises the licensee's progress towards closure of a number of GDA assessment findings (AFs), which are either of direct relevance to the ISFS, or which will need ISFS specific design information to allow closure of the findings, or which impact generically upon the ISFS design.

5 It is important to note that HPC PCSR 2012 alone is not sufficient to inform a future ONR decision on whether to permission construction of HPC. NNB GenCo Ltd intends to submit a major revision to HPC PCSR 2012 i.e. PCSR 3 before seeking consent for nuclear island construction, which will fully integrate the final GDA PCSR and will be supported by other documentation.

6 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 Flamanville 3 (FA3). The integration of the methodology agreed during GDA will be demonstrated in the next revision of HPC PCSR.

1.2 Scope

7 The scope of this AR covers the spent fuel and storage work stream. The material constituting the licensee's current safety case, for the interim storage of spent fuel, lies within sub-chapter 11.5 of HPC PCSR 2012 (Reference 1), which were hence the focus of my assessment. Since the design of the ISFS is currently very immature (i.e. is at the conceptual design stage only), I have not sought to sample any of the supporting references. However, prior to and following the production of HPC PCSR 2012, I have routinely been engaging with the licensee and their responsible designer (RD) (via level 4 meetings) to oversee their progress in continuing to develop their safety case in the spent fuel interim storage technical area. I have also accompanied the licensee on a technical visit to the Goesgen nuclear power plant, where a facility similar to the proposed HPC ISFS has already been constructed and is operating. NNB GenCo Ltd intends to use the operational experience (OpEx) from this facility to inform their design (a decision I fully support). Accordingly, I have reported some of my key findings from this ongoing work in this AR.

8 I have also reported the licensee's progress in constructing resolution plans (RP) to provide ONR with appropriate information to permit closure of all GDA assessment findings relating to the ISFS.

1.3 Methodology

9 My assessment (which was conducted against my intervention project record – IPR see TRIM 2013/141116) was undertaken in accordance with the requirements of the ONR How2 Business Management System (BMS) procedure AST/003 (Reference 3) and "Guidance on the Mechanics of Assessment".

2 ASSESSMENT STRATEGY

10 My assessment strategy was primarily to assess the new information presented in chapter 11.5 of HPC PCSR 2012 of relevance solely to the ISFS, although as noted previously I have also provided commentary on the licensee's work since HPC PCSR 2012 and the licensee's progress in the closure of GDA AFs of relevance to the ISFS. The following sections identify the standards and criteria that have been applied in my assessment work.

2.1 Standards and Criteria

11 The relevant standards and criteria, adopted within this assessment, are principally the ONR safety assessment principles (SAP) (Reference 4) and internal ONR technical assessment guides (TAG), Reference 5. No relevant national standards or other relevant good practice has been used within this assessment. However, I have also consulted appropriate International Atomic Energy Agency (IAEA) guidance (Reference 6) in constructing this AR. The key SAPs and relevant TAGs and the IAEA guidance employed are detailed below.

2.2 Safety Assessment Principles

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

2.2.1 Technical Assessment Guides

13 The following Technical Assessment Guide has been used as part of this assessment (Reference 5):

- NS-TAST-GD-081 – "Safety Aspects Specific to Storage of Spent Nuclear Fuel," Revision 1, June 2013

2.2.2 National and International Standards and Guidance

14 I also consulted the following IAEA guidance (Reference 6) in conducting this assessment i.e.

- Specific Safety Guide No. SSG-15 – "Storage of Spent Nuclear Fuel", IAEA, Vienna, 2012.

2.3 Use of Technical Support Contractors

15 I did not employ technical support contractors to assist in my assessment work.

2.4 Integration with other Assessment Topics

16 Particularly in the area of GDA AFs which impinge upon the design of the ISFS, it has been recognised that ONR oversight of closure of many of the GDA findings will be the responsibility of other ONR assessors. Accordingly, ONR is presently considering internal systems to allow effective and comprehensive management of this process.

2.5 Out-of-scope Items

17 Final disposal of the spent fuel.

3 LICENSEE'S SAFETY CASE

3.1 HPC PCSR 2012 Material Assessed

18 The licensee's safety case for the spent fuel and storage work stream is located within sub-chapter 11.5 of HPC PCSR 2012 (i.e. Reference 1). Reference 2 confirms that the information in this sub-chapter is new compared to GDA PCSR 2011.

19 The licensee has conducted optioneering (I have previously sampled this and consider it to have been a thorough and robust exercise) to arrive at their choice of wet interim spent fuel storage at HPC. However, the current design of the ISFS is only at a conceptual stage and accordingly, there is significantly less detail available than for other HPC site facilities e.g. the reactors themselves. Accordingly, the information presented in Reference 1, rather than presenting the safety case for the ISFS, indicates the licensee's forward work programme for the basic design, detailed design and construction of the ISFS.

20 The information presented in Reference 1 provides:-

- The ISFS design philosophy and assumptions,
- The functional requirements,
- An overview of the ISFS

21 Reference 1 also presents the preferred design options for the ISFS including:-

- Cask unloading,
- The storage rack design,
- Pool design,
- Heat sink – primary cooling,
- Heat sink – secondary cooling.

22 Finally, Reference 1 also recognises the maintenance activities which will have to be carried out in respect of the ISFS, recognises the interfaces that the ISFS will have with the rest of the site, describes the strategy for dealing with the wastes produced by the ISFS and describes how the fuel will be transferred to the ISFS. Construction timing and the future design work is outlined, although presently it is my understanding that the licensee is re-considering construction timings for the ISFS i.e. construction may not now occur whilst the reactors themselves are under construction. This is an open point within NNB GenCo Ltd and its Responsible Designer with a decision pending.

23 Whilst the material presented in Reference 1 appears to be comprehensive in its recognition of the main work required going forward, the information is more of a statement of intent, together with future work areas, rather than the actual complete safety case for the ISFS. It was always the intention of the licensee to continue to develop the

safety case in this technical area in later safety submissions i.e. beyond PCSR 3. I have, therefore, reported progress towards the generation of this developed safety case in my assessment (see following Sections).

24 I have also reported the licensee's progress with respect to addressing GDA AFs which relate to the ISFS, or which impact upon the ISFS.

4 ONR ASSESSMENT

25 This assessment has been carried out in accordance with ONR HOW2 BMS procedure AST/003 (Reference 3) and the "Guidance on the Mechanics of Assessment."

4.1 Scope of Assessment Undertaken

26 The information provided by NNB GenCo Ltd to date is mainly at the level of concept design and does not include identification of specific safety claims relating to the operating limits for the ISFS and a fault schedule for the plant has yet to be developed.

27 There is some information on the civil design and this is assessed in the Civil Structures work stream (Reference 12). My own assessment is limited to consideration of the functional requirements for the system and examination of the current information on the design, to satisfy myself that it does not preclude the development of an adequate safety case.

4.2 Assessment

28 I note that wet storage of spent nuclear fuel is not a novel concept globally and wet storage of fuel has been the preferred method of storage since the inception of nuclear power in the UK. In addition, I note that longer term storage concepts for wet storage of spent nuclear fuel have been developed in several countries e.g. Switzerland (see below).

29 I assessed sub-chapter 11.5 of Reference 1, producing a series of questions from my assessment which I communicated to the licensee in Reference 7. My questions to the licensee are summarised in Annex 1.

30 In addition, I have looked at the licensee's summary of its forward work areas to ensure good alignment with both ONR TAG 81 (Reference 5) and the IAEA guidance provided in Reference 6 (i.e. to ensure that the licensee has adequately captured the full spectrum of study and design work it will need to execute moving forward in the ISFS design and safety case development). I am content that the licensee is closely following the guidance provided by both Reference 5 and 6.

31 The licensee has since provided informal responses to my questions – Reference 8 and in many cases (Annex 1); I am content with the responses provided by the licensee. However, where I have judged that further action is still required from the licensee i.e. during the basic or detailed design phase of the ISFS, I have utilised ONR's issues management process on its HOW 2 Business Management System (depending upon whether I judge that lack of satisfactory response has the potential to inhibit ONR's ability to issue a required Licence Instrument (LI) to release a key hold point in the construction

process – i.e. a Level 3 Issue, or not – i.e. a Level 4 Issue). These Level 3 and 4 Issues (see later in text), after internal review within ONR, will be recorded on ONR's 'Issues Database' and I will track the licensee's progress with resolution of the Issues via my ongoing routine regulatory interactions. I will ensure that, in due course, the Issues are closed via the defined ONR processes for Issue closure.

32 My three new Level 3 Issues and 5 Level 4 Issues are summarised in the table below i.e.

Issue No.	Issue Title	Issue	Issue Level	Completion/Review Date
2049	Peak Heat Loadings in ISFS	The licensee shall justify the assumptions in the safety case with regards to fuel loadings in the ISFS which result in the peak heat loading in the ISFS pond and will demonstrate how the thermal challenges to the pond civil structures change with time as more fuel is loaded, decay heats reduce etc.	3	First fuel on Site
2050	Spent Fuel Capacity of ISFS	The licensee shall quantify and justify any margins in the ISFS design for the accommodation of additional spent fuel (i.e. above the assumed total fuel arisings from the operation of 2x EPRs at HPC for 60 years).	3	First fuel on Site
2056	Heat Stressing of Pond Structure and Facilitation of Repair Work	The licensee shall demonstrate how the normal operations (i.e. during loading of the pond) will stress the pond structure and will also demonstrate that any assumed in service remedial work on the pond structures is facilitated by the design of the ISFS.	3	First fuel on Site
2044	Fuel Utilisation Strategy	The licensee shall finalise its in-core fuel utilisation strategy and evaluate and demonstrate the impacts of the chosen strategy on spent fuel isotopics, heat loadings etc.	4	First fuel on Site
2045	Engineering of Valves/Filters on Failed Fuel Containers	The licensee shall develop their proposals for valves and filters on containers of failed fuel to be stored in ISFS and shall submit these proposals to ONR for scrutiny.	4	First fuel on Site
2046	Engineering of Fuel Rack Locks	The licensee shall develop the details of the proposed device, for locking the fuel storage racks to the floor of the ISFS pond and shall clarify the safety case claims being made on the device.	4	First fuel on Site

Issue No.	Issue Title	Issue	Issue Level	Completion/Review Date
2047	Pond Measurement Systems	The licensee shall provide detailed information on its pond measuring systems and shall ensure that systems are provided to enable remote visual pond condition monitoring.	4	First fuel on Site
2048	Pond Temperatures	The licensee shall justify their models of temperature profiles in the ISFS as a function of time and shall provide details of the proposed temperature measuring devices and the safety claims being made on these devices.	4	First fuel on Site

33 From my assessment of sub-chapter 11.5 of HPC PCSR 2012 I judge that despite the immaturity of the ISFS design, the licensee is making satisfactory progress in the production of a sound safety case for the ISFS (as evidenced by the licensee's forward planned work areas, which address the requirements of the relevant IAEA guidance and the licensee's use of global OpEx). I am presently content that the licensee will ultimately meet the requirements of LC 23.

34 Since HPC PCSR 2012 was produced, I held a level 4 meeting with the licensee (Reference 9) to oversee progress with both the safety case and design since HPC PCSR 2012 was issued. My conclusions from this level 4 meeting were that relatively little progress has been made with respect to the design since the last level 4 meeting. Given the potential long lead time for the construction of the ISFS (since there is an open point within NNB GenCo Ltd and its Responsible Designer with a decision pending regarding a decision to delay construction of the ISFS i.e. rather than construction proceeding as a part of the up-front building work), I do not necessarily see this as representing a threat to the project or as being an area for potential further regulatory action.

35 I also attended a technical tour (Reference 10) of a similar facility i.e. to that envisaged for HPC which has been constructed and is operating at the Goesgen nuclear power plant in Switzerland. This tour was interesting and as the Goesgen personnel were very open about their operational experiences with the facility, it provided a valuable source of OpEx for the NNB GenCo Ltd personnel. This willingness on NNB GenCo Ltd's part to actively seek out suitable OpEx and to consider this within their design process I consider gives me further confidence in their progression of the design and safety case going forward.

36 ONR's GDA process for the EPR produced several hundred AFs and it is of importance that the licensee has plans in place to address any of those AFs where they relate to the ISFS. The licensee has duly conducted what, in my opinion, was a very thorough exercise to review (Reference 11) all the GDA AFs and to place them into four categories i.e.

- GDA AF is not relevant to the ISFS (no further action required by ISFS project) e.g. AF-UKEPR-FD-02 – ***"The licensee shall review the results of available EPR physics testing and confirm uncertainty allowances in the safety case."***
- GDA AF is ISFS specific (resolution will be led by the ISFS working group) e.g. UK EPR-AF16 – ***"The future operator shall, before the commissioning phase, propose techniques for the interim storage of spent fuel following a period of initial cooling in the pool. The future operator shall provide an assessment to show that the techniques proposed are Best Available Technology – BAT."***
- GDA AF requires ISFS specific information for its resolution (the ISFS working group will not lead resolution, but will be consulted as a part of resolution of the AF) e.g. AF-UKEPR-CE-15 – ***"The licensee shall provide details of the waterproof membrane for safety critical structures in terms of its effectiveness, practicability and longevity."***
- GDA AF has a generic impact upon the ISFS design (this has been spilt into 3 sub-categories i.e. the resolution of the GDA AF does not need ISFS specific input but a specific ISFS deliverable will be required, the ISFS finding resolution will include reference to existing ISFS studies or data and the resolution of the AF will inform the ISFS design). No ISFS working group input to the resolution of this latter category of AFs is required e.g. AF-UKEPR-CE-17 – ***"The licensee shall develop a hypothesis note for the pool liner design at the site specific stage."*** [This AF falls into the category of requiring a specific deliverable to be produced].

37 High level plans have subsequently been put in place for the resolution of the AFs in the first two categories and the plans have been prioritised according to the permissioning milestone at which the AF must be closed. The third category of AFs (i.e. those that have been sub-split) do not require a resolution forward work plan, as any activities arising from these AFs can be completed post resolution of the AF.

38 I am content with the licensee's progress to date in this area but will continue to monitor progress with closure of AFs via routine level 4 meetings with the licensee.

39 The concept design of the ISFS is being progressed in France by NNB GenCo Ltd's RD in this area i.e. CIDEN and hence it is important that the NNB GenCo Ltd team in the UK has the ability to function as an intelligent customer (IC) for this design service. From my observations made to date at level 4 meetings (where representatives of the RD have attended), I am content that the UK team has a good working relationship with the French RD and is maintaining close over-sight and control of their work. It is hence my judgement that NNB GenCo Ltd is currently adequately discharging its IC obligations in this design area. A contract will be let for a designer to conduct the basic design of the ISFS. The contract will specify a number of design deliverables and NNB GenCo Ltd intend to monitor the timeliness and quality of these deliverables. I shall monitor this work on a routine basis to ensure the licensee continues to adequately exercise its IC role.

4.3 Comparison with Standards, Guidance and Relevant Good Practice

40 From my assessment of HPC PCSR 2012, sub-chapter 11.5 and from the information I have obtained from my level 4 meeting (Reference 9) as to licensee's progress since HPC PCSR 2012, I have made some judgments below as to the licensee's compliance with the guidance provided by the key ONR SAPs listed in Table 1, with the guidance provided by the relevant TAGs and with the relevant IAEA guidance.

41 **SAPs** – ENM.1 – The licensee has a clear strategy (i.e. for long term wet storage of all the spent fuel from the 2x EPR reactors at HPC, prior to fuel disposal to a future geological disposal facility). The strategy has been produced from an optioneering process which I judge to be robust. Accordingly, I judge the licensee to be in compliance with the guidance provided by SAP ENM.1.

ENM.2 – The licensee is designing sufficient (i.e. to take the total spent fuel arisings from the operation of 2x EPRs at HPC over 60 years generation) and suitable (as this wet storage option has been used at multiple other nuclear sites globally) arrangements for the safe management of its spent fuel. Accordingly I judge the licensee to be in compliance with the guidance provided by ENM.2.

ENM.6 – One of the licensee's key principles in the design of the ISFS is that the spent fuel should be stored in a facility that is designed to provide passive cooling for the fuel. Accordingly, I judge that the licensee is endeavouring to ensure compliance with the guidance of ENM.6.

ENM.7 – The licensee's chosen option of wet fuel storage will facilitate both fuel retrieval and inspection and hence I am content that the licensee will be compliant with the guidance provided by with ENM.7.

42 **TAG 81** – The licensee was briefed on the contents and requirements of this TAG by my ONR predecessor and hence should be well familiar with the TAG. From the topic areas covered by the licensee in Reference 1 for future work (see Section 3.1), I am content that the licensee is adequately addressing the guidance of TAG 81 in its design process, although I will continue to monitor the design as it develops against the TAG.

43 **IAEA SSG-15** – I am content that the licensee is actively engaged in the development of its safety case for the ISFS (although noting the current very early stage in the design). In the construction of this safety case the licensee is showing clear evidence of being cognisant of issues such as the importance of passive safety, retrievability, support facilities for the autonomous phase, climate change etc. Accordingly, from the evidence presented by the licensee to date, I judge that it is applying the guidance of Reference 6.

5 CONCLUSIONS AND RECOMENDATIONS

5.1 Conclusions

44 I have assessed the new information presented in sub-chapter 11.5 of HPC PCSR 2012 on spent fuel and storage. My assessment resulted in a series of questions to the licensee (see Annex 1), to which the licensee has provided informal responses. The responses provided have, however, allowed me to judge that several of my questions can effectively be closed off (subject to the licensee meeting the commitments it has made in its responses). Some of the questions will require the licensee to conduct additional work (which it has made suitable commitments to do) as the design reaches the detail design phase. For those areas where further work is required of the licensee I have recorded my questions as ONR Level 3 (3 of) or Level 4 Issues (5 of), which in due course I expect to be added to ONR's 'Issues Database' following internal ONR review. I will track the licensee's progress to resolution of the Level 3 and 4 Issues via my routine ongoing interactions with the licensee and in due course expect to close the Issues via the approved ONR procedures for Issue closure. However, from the assessment I have made of the licensee's safety case for the ISFS as presented in HPC PCSR 2012, the licensee's informal responses to my questions plus the information I have obtained from the level 4 meetings I have conducted with the licensee and from the technical tour to Goesgen, I judge that the licensee is making adequate progress in constructing a sound safety case for construction, operation and maintenance of the ISFS and hence ultimately I judge that the licensee will fully meet the requirements of LC 23.

45 In the area of GDA AFs relating to the ISFS, I am also content that the licensee fully understands the full scope of those AFs relating to the ISFS which it must address, and has already prioritised the more urgent work. Again I am content with progress in this area.

46 The conceptual design has been undertaken by an external RD and the basic design stage will also be conducted in a similar manner. Currently I am content that the licensee is exercising their IC role in a satisfactory manner, but will be scrutinising arrangements in this area as the design moves into the basic design stage.

47 I note that since this AR was written a number of questions on Chapter 11.5 (ISFS) have been forwarded to the licensee by the ONR civil engineering specialist assessor. I have agreed with the licensee that it will respond to these questions via a formal letter from the licensee to the assessor, routed through me as the ONR topic lead.

48 As I am content that the licensee continues to make an adequate level of progress in defining the design and safety case in the spent fuel and storage area I hence consider that an IIS rating of **3** i.e. **"Adequate"** is appropriate.

5.2 Recommendations

49 With the exception of a number of new ONR Level 3 and Level 4 Issues (see paragraph 32), no other Recommendations have arisen from my assessment of HPC PCSR2012.

6 REFERENCES

1. Letter NNB-OSL-RIO-000322, ONR-HPC-20337N – “NNB GenCo Submission of PCSR 2012,” 6 December 2012, TRIM 2013/16143 (see TRIM 2013/23292 for full HPC PCSR 2012 documents).

2. 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).

3. AST/003 – “Guidance on Production of Reports,” Revision 7, September 2013 (TRIM 2013/324703).

4. “Safety Assessment Principles for Nuclear Facilities,” 2006 Edition, Revision 1, HSE January 2008, www.hse.gov.uk/nuclear/SAP/SAP2006.pdf

5. “Technical Assessment Guides” (TAGs) www.hse.gov.uk/nuclear/tagsrevision.htm

NS-TAST-GD-081 – “Safety Aspects Specific to Storage of Spent Nuclear Fuel, Revision 1, June 2013

6. Specific Safety Guide SSG-15 – “Storage of Spent Nuclear Fuel,” IAEA Vienna, 2012

7. E-mail – “Comments on Chapter 11.5 of PCSR 2012,” 26/6/2013 (TRIM 2013/378009).

8. Presentation Given by NNB GenCo to ONR on ISFS Design/Safety Case Progress (Bootle 13/11/2013), TRIM 2013/425740.

9. ONR-NNB-IR-13-085 – “Office for Nuclear Regulation (ONR) Bootle. Progress Update by Nuclear New Build Generating Company (NNB GenCo) on the Design and Safety Case for the Hinkley Point C (HPC) Interim Spent Fuel Storage Facility (ISFS) – Level 4 Meeting,” 13/11/2013 (TRIM 2013/450995).

10. ONR-CNRP-OV2-13-219 – “Technical Tour of External Wet Spent Fuel Storage Facility – Goesgen NPP,” 10/4/2013, TRIM 2013/142311.

11. HPC-NNBBOSL-U0-HHK-SOW-000002 – “NNB Generation Company Ltd – ISFS Related GDA Findings Scoping Document,” Version 1.0, 25/9/2013 (TRIM 2013/388975)

12. ONR-CNRP-AR-13-080 – “NNB GenCo: Hinkley Point C Pre-Construction Safety Report 2012 – Assessment for Work Stream Civil Engineering,” (TRIM 2014/19012).

Table 1

Relevant Safety Assessment Principles Considered During the Assessment

SAP No.	SAP Title	Description
ENM.1	Strategies for Nuclear Matter	A strategy (or strategies) should be made and implemented for the management of nuclear matter.
ENM.2	Provisions for Nuclear Matter Brought onto, or Generated on, the Site	Nuclear matter should not be generated on site, or brought onto the site, unless sufficient and suitable arrangements are available for its safe management.
ENM.6	Storage in a Condition of Passive Safety	When nuclear matter is to be stored on site for a significant period of time it should be stored in a condition of passive safety and in accordance with good engineering practice.
ENM.7	Retrieval and Inspection of Stored Nuclear Matter	Storage of nuclear matter should be in a form and manner that allows it to be retrieved and, where appropriate, inspected.

Annex 1

ONR Questions on HPC PCSR 2012 (Sub-Chapter 11.5), Licensee Informal Responses and Commentary

No.	Question	Licensee Informal Response	Commentary
1	Section 2.3.1 (last bullet) refers to "future autonomous operation"), which I take to mean the period post generation, when the ISFS will not be able to rely on previous site infrastructure systems. However, it would be useful if this could be explained to make the meaning crystal clear.	Agreed – modification to sub-chapter envisaged.	I am content with the licensee's response.
2	Section 2.3.2 refers to a peak thermal power of 8 kW from the spent fuel pool. I am unclear as to what fuel inventory and fuel cooling results in this assumption and this section should be clarified accordingly i.e. how much 10 years plus aged fuel and how much 3 years aged fuel is assumed in determining the figure?	The peal thermal power of approx 8 MW (not 8 kW – error in PCSR), which will occur after 60 years loading, was obtained during the conceptual design stage by considering a specified inventory of spent fuel assemblies, among which: The bulk of the assemblies are cooled for 10 years in HK pond before transfer to the ISFS. A much smaller number of assemblies are cooled for 3 years in HK pond before transfer to the ISFS. We are currently performing studies in order to consolidate the input data related to the inventory and the cooling time in HK pond. The basic design stage will use the revised and consolidated input data and therefore the peak thermal power could be different to 8 MW. The update to this sub-chapter in PCSR 3 will reflect this.	This question and question No. 3 are related. I have informed the licensee (Reference 9) that the margins in terms of fuel storage capacity in the pond need to be evaluated and this is likely to require a number of different fuel management strategies to be studied. This in turn will influence the peak thermal power that will have to be shown to have been adequately defined in the ISFS design. This work will proceed into the detailed design phase.

No.	Question	Licensee Informal Response	Commentary
3	Section 2.3.2 – it is clear that the facility has been sized to accommodate 60 years of fuel arisings from the operation of 2x EPR units. However, given that there is a drive globally to look at extending Pressurised Water Reactor (PWR) life spans beyond 60 years, i.e. to circa 80 years; will there be sufficient contingency in the ISFS design to allow for expansion in the future if this is required? Will the design implications of potential extensions be looked at?	As stated during the Level 4 meeting on 24/5/2012, lifetime extension of the EPR units has, to date, not been considered in the design of the ISFS because UK fuel disposal plans and options for spent fuel will likely change/develop over the next 60 – 70 years. The ISFS is, however, conservative (as it stands in its conceptual design state), in particular regarding the inventory and the burn-up considered. It is therefore practical to consider that a lifetime extension could be possible.	The licensee has been informed (Reference 9) that at release of the first hold point (i.e. pouring of nuclear island concrete – which will be supported by PCSR 3), ONR will require confidence in the chosen plot plan for the ISFS on the HPC site and hence the margins in the design with respect to spent fuel storage capacity must be understood.
4	Section 2.3.2 – Fuel isotopic compositions appear to have been based upon an assumed average burn-up of 65 GWd/te, is a higher average possible in the future and what would be the implications on the current design of potentially moving to a higher average burn-up?	We are currently performing studies in order to consolidate the input data related to fuel isotopic composition and burn-up. The basic design stage will use these revised and consolidated input data and consequently highlight the implications on the design.	This relates to questions 2 and 3 i.e. in providing an under-pinned understanding of the margins in spent fuel storage capacity for the present ISFS plot plan.
5	Section 2.3.2 – there is a statement that the design lifetime of the ISFS is at least 100 years with lifetime extension a possibility. Will an understanding be built during the design process as to what are the ultimate life limiting factors and what therefore the ultimate design life may be?	The operational life of the ISFS is assumed to be around 100 years but the facility can be adapted and refurbished to meet the need for duration of storage prior to disposal in the Geological Disposal Facility (GDF). Regarding civil engineering topics, the ISFS building is designed according to ETC-C so according to Eurocodes taking into account 100 years design life. The degradation mechanisms of civil engineering structures are well known (for example corrosion and degradation due to chlorine attack). Thus it is possible to extend the ultimate design life at the design stage by using an appropriate concrete formulation and/or by increasing the concrete cover.	The licensee received a lot of challenge in this area during the discussions in Reference 9. A number of important pieces of advice were provided by ONR specialist civil engineering inspectors e.g. The licensee must demonstrate a good understanding as to how the normal operations (i.e. during loading of the pond) will stress the structure, since these stresses and any damage resulting will be important as the pond enters the autonomous phase of operation.

No.	Question	Licensee Informal Response	Commentary
5 -Cont	See previous page	Moreover the civil engineering will be inspected throughout the life of the facility (visual inspection, structural concrete specimens stored in the facility, monitoring, determination of depth of penetration of chlorides etc.) If necessary the facility lifetime will be increased by preventative maintenance or by treatment (for example – electrochemical treatment to remove chlorides and/or concrete surface treatment).	If pond treatment is being actively considered during its operational life then provision should be made at the design stage to facilitate such operations. The ONR inspectors noted that this civil structure of the pond would represent an area for intense ONR scrutiny moving into the detail design stage.
6	Section 2.3.3 – the facility will accept failed fuel and will accommodate conditioning and safe storage of this fuel. Failed fuel will apparently be stored in storage bottles – careful thought will be required at the detailed design stage as to how these bottles will be sealed and what consequent requirements there will be on inspection/future remediation of the sealing requirements on these bottles.	Storage bottles will not be sealed so that they will permit through-flow of pool cooling water. They will be fitted with valves and filters for retention of particulate fission products while permitting the circulation of liquids and gases. This system has the advantage of permitting effective decay heat removal from the fuel while minimising the release of activity to the pool and its associated cooling and purification systems. A strategy for maintenance and inspection of bottles will be defined at a later stage.	The licensee was advised (Reference 9) that this was the first time ONR had been made aware of a proposal for filters and valves on the failed fuel storage bottles and that this would receive more ONR scrutiny in due course.
7	Any criticality safety implications of failed fuel will need to receive adequate attention within the criticality safety case.	Agreed – modification to sub-chapter envisaged.	I am content with the licensee’s response.

No.	Question	Licensee Informal Response	Commentary
8	Section 2.3.3 – reference is made to the provision of "reserve areas" in the design (e.g. to accommodate waste treatment post EPR closure). Such forward thinking is commended but experience from Goesgen indicated that there may be other drivers that force use of such contingency space (e.g. at Goesgen the subsequent need to install an air filtration plant). It would be prudent to ring fence some appropriate amount of contingency space at HPC to accommodate later as yet unexpected requirements.	The needs for reserve areas will be quantified at the basic design stage. A reasonable margin will be included in order to allow the ISFS to accommodate both expected and unexpected requirements.	I am content with the licensee's response.
9	Section 2.3.3 – fuel failures during transfer to the ISFS are mentioned. How will such failures be detected at ISFS	Such failures will be detected by checking the radiological inventory of the internal cavity (Krypton-85 analysis) of every incoming transfer cask prior to opening.	I am content with the licensee's response.
10	Section 2.3.4 – Protection against algal growth and the large volume of water loss from evaporation (with no current way of capturing the lost water and recycling it) were two important messages from the Goesgen visit. I would expect these messages to be considered and if possible acted on as the detailed design proceeds.	Both of these very important feedbacks from Goesgen will be considered at basic design stage and within the PCSR 3 ISFS sub-chapter.	I am content with the licensee's response.
11	Section 2.3.4 – The use of non-borated water in the pool is a design intent but it must be shown that criticality safety will be maintained during both normal operations and under postulated accident conditions (e.g. dropped loads, impacts with the storage racks etc.). Goesgen seems t have relied upon an incredibility of failure argument for the crane for these accident scenarios, such arguments would be likely to attract intense regulatory scrutiny in the UK.	At basic design stage, penalising situations regarding criticality will be identified and design measures will be implemented to ensure that criticality safety is maintained during these situations. The reliability of the crane will not be a part of the demonstration.	I am content with the licensee's response.

No.	Question	Licensee Informal Response	Commentary
12	Section 2.3.4- how will the Reserve Halls be sized to ensure that they have sufficient capacity for the autonomous phase operations?	During basic design stage, the various systems of the facility will be studied for both the “attached mode” (when the EPR units are in operation) and the “autonomous mode” (when the EPR units are no longer available). The reserve halls will be sized to ensure that there will be enough space for all the phases of the facility lifecycle. A reasonable margin will also be considered in order to allow the ISFS to accommodate unexpected requirements.	I am content with the licensee’s response.
13	Section 2.3.4 – what is known about the long term corrosion resistance of borated stainless steel in demin water? Will there be any Boron sampling of the pond water that would give early indications of any potential Boron leaching problems?	This topic will be considered at basic design stage; available operational experience of degradation of neutron absorber materials will be used to select and justify the choice of rack materials.	I am content with the licensee’s response.
14	Section 2.3.4 – the racks are purposely designed to be mobile but how would this affect their stability in a seismic event i.e. could a domino topple type event occur (if so then the impact upon criticality safety will need to be assessed)?	The mobile racks will be designed in order to remain stable even in a seismic event. At conceptual design stage, the solution envisaged is a system to lock the racks to the bottom of the pool.	This is the first time ONR has been made aware of this proposed locking system. I have advised the licensee that further scrutiny will be applied e.g. as to how the licensee will guarantee to integrity of the locking system and how it will be maintained and inspected in service.
15	Section 2.3.4 – Presumably the strength of the building structure will be shown to be sufficient to withstand any potential collapse of the air-water heat exchanger towers onto it?	A collapse of the cooling towers will likely to be bounded by more penalising loads taken into account in the design of the very robust external civil engineering structures. A check will nevertheless be made to ensure this is the case.	I am content with the licensee’s response.

No.	Question	Licensee Informal Response	Commentary
16	Section 2.3.4 – will there be a demonstration that the potential effects of climate change (especially climate warming) have been considered in the design of the pond cooling capabilities?	The large amount of water contained by the ISFS pool has a significant thermal inertia. For this reason an outdoor temperature of 31ºC is used in the design, which is bounding of high 24-hourly (and over) mean temperatures. The 31ºC temperature was defined by EDF Research and Development and corresponds to a 10,000 year return period 24 hour mean temperature computed for the period 2070 – 2100 with climate change taken into account. The 10,000 year return period levels after 21000 are not defined because climate models are not able to reliably distinguish between the different ending years of the systems (2085 or 2125). However, the peak thermal power to evacuate from the pool will occur prior to 2100. In addition at basic design stage, the additional margin in heat sink capacity will be evaluated.	The licensee was advised, at the meeting in Reference 9 that ONR would scrutinise the licensee's modelling of temperature profiles in the pond during both normal and incident conditions as well as the choice of technology chosen for the monitoring systems and the reliability claims made upon them.
17	Section 2.3.4 (last but one para on Page 23) – how extendable will the building footprint be (see earlier question on lifetime extension of the reactors and hence increasing the amount of fuel consigned to the ISFS)?	The ISFS is not designed to be extendable. It is currently considered that we will be able to consider an extension of the HPC design lifetime with the conservatisms considered, in particular regarding the inventory and burn-ups considered.	See response to Question No. 3

No.	Question	Licensee Informal Response	Commentary
18	Section 2.3.4 – I do not believe pond level measurement at Goesgen is via diverse systems and would expect this to be addressed in the HPC design. In addition at Sizewell B (SZB) I believe the level measurement is only to the top of the fuel storage racks and it is now recognised that this would present problems for the operators in knowing how successful remote filling has been in an extreme Fukushima type event. Again I would expect this to be addressed in the HPC design.	In order to monitor the water level in the pool, there will be instrumentation across the entire depth of the pool associated to water-level alarms. The choices related to technologies and diversification will be made at a later design stage. In the event of an accident or incident, the ISFS will have the capability to connect to an external water make-up device.	I am content with the licensee's response. [However, I note that at the meeting in Reference 9, ONR advised the licensee that we would also seek an ability to remotely view the pool in a severe accident scenario].
19	Section 2.3.5 – will inspections of the civil structure of the semi-embedded pond design still be possible (e.g. is it intended to build the pond on stilts at Goesgen)?	The semi-embedded pond is designed not to rest directly on the slab of the structure i.e. it has been specified that an inspection space shall be left between the pool base slab and the building foundation (as at Goesgen).	I am content with the licensee's response.
20	Section 2.3.5 – presumably the installed leak detection system will facilitate leak tracing and location?	Yes it will. A drainage system will be implemented between the liner and the concrete structure of the pool (similarly to what is proposed for the HK pool). This system will comprise channels located under liner welds in order to collect water in case of leakage. The channels will be grouped in separate networks, in order to be able to roughly identify the location of a leak.	I am content with the licensee's response.
21	Section 2.3.6 – I note that rack maintenance is an opportunity to conduct Non-Destructive Testing (NDT) to demonstrate the Boron content of the racks remains unchanged – has this been considered?	The rack materials will be selected by using available operational experience of degradation of neutron absorber materials. A strategy for maintenance and inspection will be defined at a later design stage, taking into account this operational experience.	I am content with the licensee's response.

No.	Question	Licensee Informal Response	Commentary
22	Section 2.3.7 – mention is made of liquid effluent collection and treatment systems – what systems are envisaged here?	The radioactive liquid effluents produced in the ISFS will mainly originate from:- Package preparation effluents. Leak recuperation system. Purges or draining of cooling, purification or skimming systems. Decontamination of packages. Ventilation system. Floor drains. Contaminated zone of the changing rooms. These effluents will be collected in tanks. Following chemical and radiological measurements of the effluents, the content of these tanks will be transferred either towards a tank intended for discharge into the environment, or directed towards a “treatment tank” equipped with a recirculation system allowing the effluents to be treated.	I am content with the licensee’s response.
23	Section 2.3.8 – “ion exchange resins will be encapsulated within ISFS,” – will they also be stored in the ISFS? If so then due consideration needs to be given for the sizing of the storage facility, any associated shielding requirements and an ultimate disposal route must be demonstrated.	The resins will be encapsulated in the ISFS with the MERCURE process. The MERCURE process mixes the resins with an epoxy polymer inside a concrete container. To perform this process, a mobile MERCURE unit will periodically come to the ISFS in order to encapsulate a batch of resins (this is a so called MERCURE campaign). The ISFS will be designed in order to allow performing this process with buffer storage before transit to a dedicated interim storage. The ultimate disposal route of encapsulated resins from the ISFS will be the same as the one of encapsulated resins from the EPR units which will also use the MERCURE process.	I am content with the licensee’s response.

No.	Question	Licensee Informal Response	Commentary
24	Section 2.3.9 –how will the temperature of the fuel be controlled during dry transfers to ISFS (especially with the anticipated 3 year cooled fuel at the end of generation). Temperature control will be of importance for limiting any potential delayed hydride cracking of the fuel.	Usually there is no temperature control during dry transfer because the maximum thermal power to be dissipated is taken into account in the design of the transfer cask, considering also a margin on the transfer time. The maximum acceptable temperature of the spent fuel cladding is a criterion for the design of the cask. In France, dry transport of spent fuel assemblies with a cooling time of 2 – 3 years is a common practice.	I am content with the licensee's response. [NB – there should then be no further gross temperature transients that the fuel will experience once if has been loaded into the ISFS pool, as the large amount of water in the pool will provide for large thermal inertia].
25	Section 2.5.1 (internal hazards – fuel clad failure). The dose estimate presented seems to be based upon 10 failed rods, but no justification is presented for the use of such a figure and what consequent proportion of radioactive inventory escapes from the failed rods. It is also unclear as to whether this is a worker or public dose?	The value of 10 failed rods was considered as a bounding value, taking into account the available operational experience. The bounding release fractions considered for all design basis events are:- NB The dose stated is a public dose **Noble Gases And Volatile Fission Products** / **Release Fractions Burnup Greater Than 47 GWd/t** Kr-85: 25% Other Noble: 8% I, Cs: 8%	I am content with the licensee's response.
26	Similarly, for the dropped rack scenario all fuel rods are assumed to have fractured but no indication is given as to what fraction of their radioactive inventory is assumed to have escaped? Again it is not clear whether the dose stated is worker or public?	The same bounding release fractions were considered for all design basis events, including dropped rack events (see list against previous question)	I am content with the licensee's response.

No.	Question	Licensee Informal Response	Commentary
27	The facility will need a Criticality Incident Detection and Alarm System (CIDAS) Omission argument as a part of its safety case.	Agreed – modification to sub-chapter envisaged.	I am content with the licensee's response.
28	How have the lessons learned from Fukushima been implemented?	Annex A of NNB-OSL-STR-000034 – "The Choice of Interim Spent Fuel Management Storage Technology for the Hinkley Point C UK EPRs" Issue 1, 26/10/2011	I am content with the licensee's response.

NB The questions where further action is required from the licensee will be recorded and tracked as ONR Issues on the ONR Issues database.