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**Sizewell C Licensing**

**Internal hazards assessment of an application by NNB Generation Company (SZC) Ltd for a nuclear site licence**

Assessment Report Ref.: ONR-NR-AR-21-035

Issue No.: 1

Date: 26 April 2023

Executive Summary

On 30 June 2020, NNB Generation Company (SZC) Limited (NNB GenCo (SZC)) applied to the Office for Nuclear Regulation (ONR), under the Nuclear Installations Act 1965 (as amended), for a nuclear site licence to install and operate a nuclear power station at its site located at Sizewell on the coast of Suffolk.

This report presents the findings of my assessment of the internal hazards aspects of NNB GenCo (SZC)’s application for a nuclear site licence for Sizewell C (SZC).

The objective of my assessment was to provide a judgement, from an internal hazards perspective, on ONR’s overall decision on whether to grant a nuclear site licence for the development of a new twin UK EPRTM, at Sizewell in Suffolk.

NNB GenCo (SZC)’s justification on the suitability of the site for licencing was based on several key claims. My assessment focused on the following claims:

* Claim 1 – The site is of sufficient size (to accommodate all necessary systems to ensure safe operation).
* Claim 3 – There is adequate cooling capability for all normal fault conditions.
* Claim 6 – Operations at the site will not adversely affect the safety case for any adjoining nuclear licensed site.

Regarding Claim 1, from an internal hazards perspective, I am satisfied that the proposed SZC site is adequate to accommodate all the necessary systems to ensure safe operation. However, I note that there are several matters that remain to be addressed at detailed design.

In terms of Claim 3, I am satisfied that the changes to the design (compared to Hinkley Point C) do not undermine NNB GenCo (SZC)’s claim to demonstrate that there is adequate cooling for all normal and fault conditions. However, I recognise that SZC’s bulk water cooling systems introduce internal hazards into specific buildings and I am content they can be adequately addressed during the detailed design.

For Claim 6, I considered turbine disintegration, explosion and construction hazards and their impact on Sizewell B.

Regarding turbine disintegration there remains work to be done to demonstrate that the risk will be reduced to as low as reasonably practicable (ALARP). This is because the positioning of the SZC turbines presents a possible missile hazard to Sizewell B in the event of a turbine disintegration. NNB GenCo (SZC) has committed in writing to demonstrate that a rigorous review of the options for introduction of a passive safety measure has been undertaken, to select appropriate solutions and demonstrate that the risks to Sizewell B from turbine disintegration are ALARP. Based on the level of risk, options are not foreclosed and the commitments made by NNB GenCo (SZC), I judge that it is appropriate for the work to be progressed at the detailed design stage post-licensing. ONR is tracking NNB GenCo (SZC)’s progress with optioneering to a satisfactory resolution through a level 3 regulatory issue linked to the next appropriate construction hold point (commencement of construction of the cut-off wall).

I have assessed the risk from explosion hazards on the Sizewell B site and I am satisfied that overall, the SZC site proposed may be configured to ensure it will not adversely affect the safety case for Sizewell B.

Although there are several outstanding issues and work is ongoing I judge that, from an internal hazards perspective, the future operation of the plant at SZC can be shown not to adversely affect the safety case for the adjoining nuclear licensed site (Sizewell B).

At this early stage of the SZC project, a complete construction safety case is not available. I sampled documentation which demonstrates the working arrangements in place at a senior and working level to identify hazards which may arise on one site but where the risk may manifest itself on the adjacent site and, to ensure that all parties are aware of these hazards so that they can be managed. I consider that the potential for hazards to arise at Sizewell B from SZC construction is understood and is being communicated and controlled by suitable arrangements to ensure that decision-making is informed, rational and objective. On this basis, I judge the arrangements controlling construction hazards are adequate for nuclear site licensing purposes.

To conclude, I consider the claims, arguments and evidence presented by NNB GenCo (SZC) to be adequate to support a nuclear site licence. Where outstanding matters have been identified I have confidence that these can be resolved after the granting of a nuclear site licence, and they therefore do not prevent our recommendation to grant a nuclear site licence. Regulatory issues have been raised to monitor NNB GenCo (SZC)’s resolution of the outstanding matters.

I have given NNB GenCo (SZC)’s submission a rating of ‘Amber’ in accordance with ONR’s Guidance on Mechanics of Assessment (NS-TAST-GD-096) as there has been significant regulatory intervention and guidance needed with many technical issues being raised requiring regulatory follow-up.

I recommend that from an internal hazards perspective a nuclear site licence should be granted to NNB GenCo (SZC) to construct and operate a nuclear power station at Sizewell C.

List of Abbreviations

ALARP As Low As Reasonably Practicable

BDHPS Basic Design Hazard Protection Schedule

BSL Basic Safety Level

BSO Basic Safety Objective (in SAPs)

CCW Component Cooling Water system

CI/BOP Conventional Island/Balance of Plant

CNEPE Centre National d'Équipement de Production d'Électricité

DBA Design Basis Analysis

DFSS Dry Fuel Storage System

DMG Delivery Management Group

ESW Essential Service Water system

HDB Emergency diesel generator buildings\*

HDU Emergency response energy centre\*

HEG National grid substation\*

HF CI electrical building\*

HGF Essential Service Water Gallery Train 1\*

HGG Essential Service Water Gallery Train 2\*

HHA Warehouse\*

HHD Contaminated tool storage\*

HHE Back-up emergency equipment store\*

HHI Intermediate level waste store\*

HHK Interim spent fuel store\*

HHL Transit area for very low and low level waste\*

HHP Operational store\*

HHW Conventional waste store\*

HHX Equipment storage building\*

HJA Auxiliary transformer platform\*

HOJ Fire-fighting water distribution building\*

HOR Raw and portable water supply and storage\*

HOW2 ONR’s management system platform

HP Pumping station\*

HPC Hinkley Point C

HPH Chlorination plant\*

HTE Gas insulated switchgear\*

HTP Main transformer platform\*

HTS Unit transformer platform\*

HUB Secondary access control building\*

HUC Auxiliary administration building\*

HUD Security administration centre\*

HUM Emergency response centre\*

HXE Sewage treatment plant\*

HZC Chemical products storage\*

HZG Oil and grease storage\*

HZH Hydrogen storage building\*

HZN Hydrazine Storage Building

HZO Oxygen storage building\*

IAEA International Atomic Energy Agency

IEF Initiating Event Frequency

JSSR Justification of Site Safety Report

KITs Keep In Touch meetings

LRF Large Release Frequency

NCC No Change Committee

NI Nuclear Island

NNB GenCo (SZC) Nuclear New Build Generation Company

NSL Nuclear Site Licence

ONR Office for Nuclear Regulation

OPA Operational Protections Agreement

PAR Project Assessment Report

PCSR Pre-Construction Safety Report

PSA Probabilistic Safety Analysis

RC Reference Configuration

RD Responsible Designer

RGP Relevant Good Practice

RUHS Reserve Ultimate Heat Sink

SAP Safety Assessment Principle(s)

SZB Sizewell B

SZC Sizewell C

TAG Technical Assessment Guide(s) (ONR)

UK EPR™ UK reference design of the EPR™

WENRA Western European Nuclear Regulators’ Association

\* denotes acronym taken from prospective licensee’s documentation.

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Introduction

NNB Generation Company (SZC) Ltd (NNB GenCo (SZC)) applied to the Office for Nuclear Regulation (ONR) on 30 June 2020 for a nuclear site licence to construct and operate a nuclear power station comprising two UK EPR™ reactors at Sizewell C (SZC) in Suffolk.

The outcome of ONR’s activities from the nuclear site licence (NSL) assessment will be a project assessment report (PAR), which will draw together the views of ONR’s specialist assessors on NNB GenCo (SZC)’s readiness to become a nuclear site licensee. This will result in a recommendation to the Chief Nuclear Inspector on granting a licence. This licensing assessment report, focusing on internal hazards, is one of several that will inform the PAR.

ONR’s licensing assessment has followed the guidance in Licensing Nuclear Installations [1]. The approach to this assessment project was elaborated in the ONR SZC assessment strategy [2], with guidance on the production of licensing assessment reports set out in the SZC Assessment Framework [3].

Background

This report presents the findings of the assessment of internal hazards as presented in the Justification of Site Safety Report (JSSR) [4] and supporting documentation provided by NNB GenCo (SZC). Assessment was undertaken in accordance with the requirements of the ONR management system (How2). The ONR Safety Assessment Principles (SAPs) [5], together with supporting Technical Assessment Guides (TAGs) [6], have been used as the basis for this assessment.

Scope

The scope of this report covers the findings of the assessment of internal hazards as presented in the JSSR for SZC [4] and supporting documentation provided by NNB GenCo (SZC).

Methodology

The methodology for assessment follows ONR’s guidance on the mechanics of assessment, NS-TAST-GD-096 [6].

Due to the wide scope of internal hazards and in order to perform an effective assessment, the scope for this assessment has been targeted. The approach taken to achieve this is outlined in ONR guidance [9], which advises adoption of a sampling approach focusing on the key hazards and management thereof, where, if the hazard was realised, it could challenge the site's principal safety measures.

NNB GenCo (SZC) produced the JSSR to seek a nuclear site licence for the SZC site. The JSSR considered the design and layout of the SZC site and the capability for it to be constructed and to operate safely. In addition, the JSSR addressed the impact of the construction and operation of SZC on the neighbouring nuclear site (specifically Sizewell B (SZB)) and the ability for the neighbouring site to continue to operate safely during the construction and operation of SZC.

In summary, this assessment has focused primarily on the key hazards which may affect the location, layout and design of the facility proposed at this stage and for which issue of a nuclear site licence is being sought, namely:

* fire
* building collapse
* turbine disintegration
* explosion
* construction activities

Assessment Strategy

The intended assessment strategy for internal hazards is set out in this section. This identifies the scope of the assessment and the standards and criteria that have been applied.

Standards and Criteria

The relevant standards and criteria adopted within this assessment are principally the SAPs [5], ONR TAGs [6], relevant national and international standards and relevant good practice. 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.

Safety Assessment Principles (SAPs)

The key SAPs applied within this assessment are included within Table 2 of this report.

Technical Assessment Guides (TAGs)

The following TAGs have been used as part of this assessment [6]:

* NS-TAST-GD-014 (Rev 7) – Internal hazards
* NS-TAST-GD-005 (Rev 11) – Demonstration of as low as reasonably practicable (ALARP)
* NS-TAST-GD-051 (Rev 7) – The purpose, scope and content of safety cases.

National and International Standards and Guidance

National and international standards and guidance were used within ONR as part of the processes of preparing and reviewing the ONR TAGs. This includes key International Atomic Energy Agency (IAEA) design standards and those covering internal hazards [8]. The relevant TAGs also reference the relevant reactor Reference Safety Levels as published by the Western European Nuclear Regulators’ Association (WENRA) [7].

These international standards are secondary references and are not directly referenced in my assessment report.

Integration with Other Assessment Topics

Aspects of this internal hazard assessment are related to other technical areas such as probabilistic safety analysis (PSA), external hazards and civil engineering. Each technical area has a defined scope of assessment as presented in their specific assessment report and agreed with the Delivery Management Group (DMG) Lead. Assessment from each technical area will be combined as part of the project assessment report (PAR) and it is advised that this assessment is read in conjunction with the reports produced by other technical areas.

The PSA specialist inspector has reviewed aspects of the turbine disintegration safety submission and has provided a section in this report which considers the validity of the reliability figures used and the acceptability of the arguments made relating to the resultant risk.

Out of Scope Items

NNB GenCo (SZC)’s JSSR [4] focussed on six specific claims which address ONR key questions on licensing. This assessment has focused primarily on Claims 1, 3 and 6. Claims 2, 4 and 5 do not relate specifically to internal hazards considerations and, therefore, have not been considered.

NNB GenCo (SZC) Submission

The key documents from the prospective licensee which have addressed the internal hazards aspects of the safety case for SZC licensing are as follows:

* The Justification of Site Suitability Report (JSSR) [4]
* The Claim 6 Report [10]
* The Preliminary ALARP Report for SZC Turbine Disintegration on SZB [11]
* SZC Project Plot Plan Summary Report [12]

Justification of Site Suitability Report

Ahead of assessment for SZC licensing, ONR developed seven key questions based on *Licencing Nuclear Installations* [1] and ONR’s SAPs [5]. NNB GenCo (SZC) addressed these questions as specific claims in the JSSR [4].

Previous versions of the JSSR were shared with ONR to facilitate early engagement. However, for licensing, NNB GenCo (SZC) submitted revision 3, which captured the latest work that had been undertaken.

The JSSR is split into sections, each addressing a specific claim and pointing to further supporting ‘primary’ references. The sections are as follows:

* Section 2 - Claim 1: The site is of sufficient size to accommodate all necessary systems to ensure safe operation;
* Section 3 - Claim 2: The site can be connected to electricity grid supplies;
* Section 4 - Claim 3: Adequate cooling capability can be provided for all normal and fault conditions;
* Section 5 - Claim 4: There are no external hazards that would preclude the use of the site (including the external hazards presented by SZB to SZC);
* Section 6 - Claim 5: The geology of the site provides secure long-term support to the necessary structures, systems, components; and
* Section 7 - Claim 6: Operations on the SZC site will not adversely affect the ability to maintain an adequate safety case for the adjoining nuclear licensed site (SZB).

Figure 1 is taken from the JSSR which shows the layout of the claims and the key primary references.

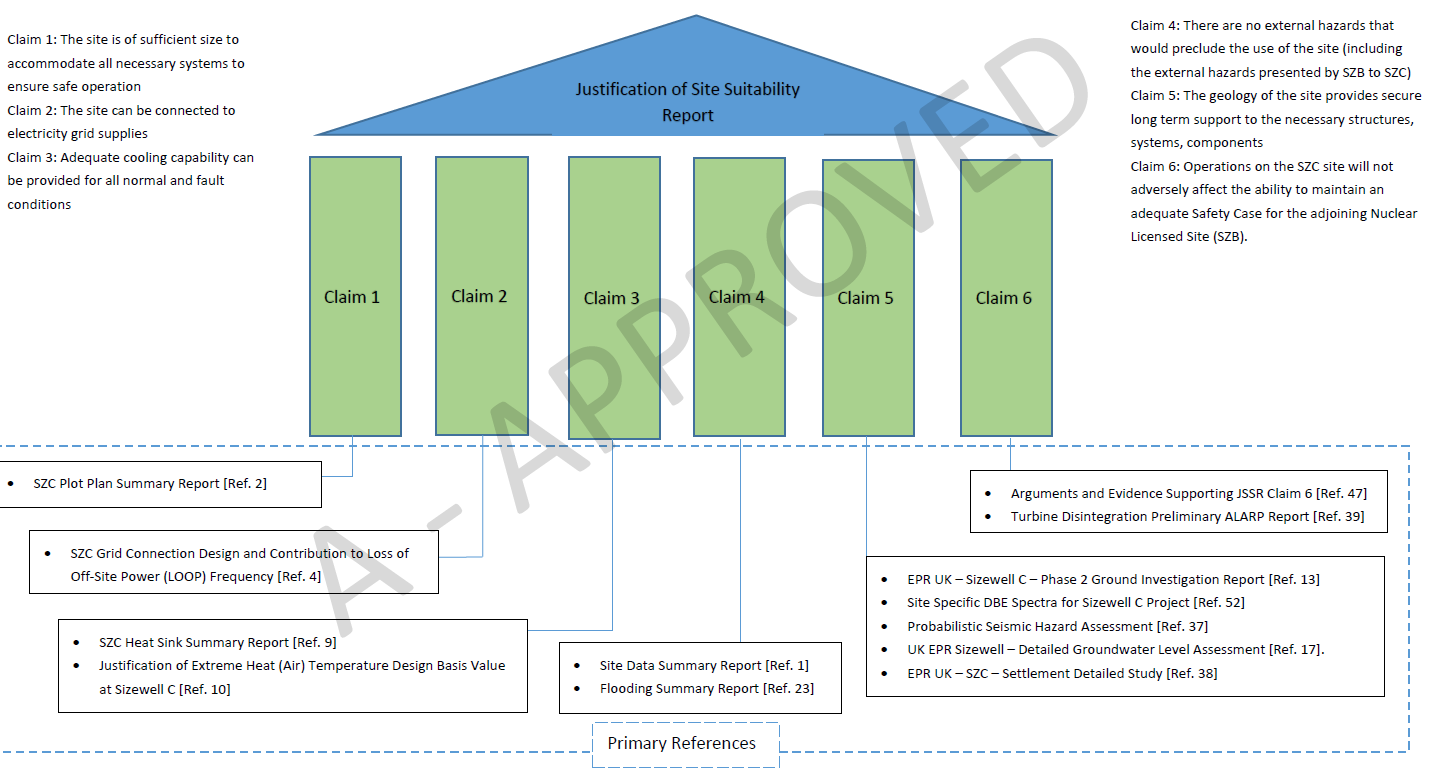


Figure : Diagram taken from JSSR summarising the claims, and the primary references

Primary References

The Justification of Site Suitability Report (JSSR) [4]

See above.

Arguments and Evidence Supporting JSSR Claim 6 [10]

This report specifically focuses on the operations on the SZC site which could potentially adversely affect the ability to maintain an adequate safety case for the adjoining nuclear licensed site (SZB). The key areas of interest within this document from an internal hazards perspective relate to turbine disintegration, location of specific buildings on the SZC site and how they relate to the neighbouring SZB site and control of construction activities.

The Preliminary ALARP Report for SZC Turbine Disintegration on SZB [11]

This report describes the output of the ALARP process that NNB GenCo (SZC) applied to address the hazard of SZC turbine disintegration missiles impacting the SZB site. The scope of the report was limited to this specific missile hazard. The report describes the ALARP process applied, summarising the optioneering programme delivered in support of this. The report describes how NNB GenCo (SZC) narrowed down the list of options from an initial long list through several stages of expert review and refinement, with several options retained for further development in support of implementation.

The intent of the report was for the analysis and optioneering presented to support the preliminary development of an ALARP case. NNB GenCo (SZC) claims that the report demonstrated that options and forward actions had been identified such that there is a high degree of confidence that the risk of turbine disintegration can be reduced to ALARP. NNB GenCo (SZC) stated that this gives confidence in the ability of SZB nuclear licenced site to maintain an adequate safety case.

SZC Project Plot Plan Summary Report [12]

This report was written to support the Justification of Site Suitability Report (JSSR) in its claim that:

* “The site is of sufficient size to accommodate all necessary systems to ensure safe operation”.

The key conclusions of this report were that the majority of the plot plan remains unchanged between Hinkley Point C (HPC) and SZC. The inter-unit distance is identical and the nuclear island (NI) buildings, and key conventional island/balance of plant (CI/BOP) buildings remain in the same position. As a knock-on effect, the plot plan for many of the technical galleries which connect the services of these facilities also remains largely unaffected, and where a small amount of re-routing may be needed as a part of the ongoing design work, NNB GenCo (SZC) considered that there is high level of confidence that this can be achieved with respect to both safety and design requirements.

Where SZC buildings have a changed position relative to HPC, this report provided the preliminary arguments and evidence to give confidence that the change in position will not have a significant effect on the ability to make a safety case (and demonstrate risks are ALARP) in the SZC pre-construction safety report (PCSR).

The overall conclusion of this report was that, in principle, the site is of sufficient size to accommodate all necessary systems and to ensure safe operation.

ONR Assessment

Scope of Assessment Undertaken

As discussed in paragraph 21, ONR developed seven key questions to support the assessment for licensing. NNB GenCo (SZC) used these questions to develop the claims stated in the JSSR. In order for the assessment to cover all aspects important to licensing, but to also be targeted and proportionate, the questions were linked to specific topic streams. This alignment was outlined in the ONR SZC assessment framework [3]. This assessment report addresses only those questions relevant to the internal hazards topic stream. Table 1 below shows the questions and their alignment to the relevant topic streams.

|  |  |
| --- | --- |
| Licensing Question | Topic Stream |
| The site is of a sufficient size [to accommodate all necessary systems to ensure safe operation] | Civil Engineering  External Hazards  Internal Hazards |
| The site can be connected to [electricity] grid supplies. | Electrical |
| There is adequate cooling capability for all normal and fault conditions | Mechanical Engineering  Civil Engineering  Internal Hazards  External Hazards |
| The environmental conditions would not preclude the use of the site with respect to external hazards. | External Hazards |
| The geology of the site will provide a secure long-term support to the necessary structures, systems and components. | Civil Engineering  External Hazards |
| The [NSL] submission would also need to provide a schedule for submission of further PCSR updates or revisions to support subsequent construction milestones | Safety Case |
| That operations of the site will not adversely affect the safety case for any adjoining nuclear licensed site | Internal Hazards (main)  External Hazards |

**Table 1: ONR expectations and relevant assessment disciplines/topic streams**

Claim 1 - The Site Is of a Sufficient Size [to Accommodate All Necessary Systems to Ensure Safe Operation]

This section presents the findings of my assessment of NNB GenCo (SZC)’s claims, arguments and evidence to support its claim that the SZC site is of sufficient size to accommodate all necessary systems to ensure safe operation.

My assessment has been undertaken in line with ONR expectations related to hazard analysis and site layout optimisation to minimise the impact of hazards across the site as described in ONR SAPs [5] and ONR TAG-014 [6].

|  |  |  |
| --- | --- | --- |
| Relevant Parts of NNB GenCo (SZC)’s Safety Case  Section 3 highlights the key documents that form the body of evidence in support of licensing the SZC site. The most relevant parts of the safety case in support of Claim 1 are the Justification of Site Suitability Report (Reference [4]) and the Plot Plan Summary Report (Reference [12]). These reports have been assessed along with other relevant supporting documents and my findings are presented below.  Assessment of General Layout of Site   |  |  | | --- | --- | | The general layout of the SZC site is described within NNB GenCo (SZC)’s plot plan summary report [12] and the JSSR [4]. These reports provided an overview of the SZC plant and its building locations. From my assessment of these documents, I note the following key points which I consider relevant to this assessment:   * The SZC layout and design is based on replication of the reference plant Hinkley Point C (HPC) at its current design reference configuration (RC) 2.0. * The SZC site footprint is significantly smaller than HPC. The SZC footprint is 30.2 ha, compared to 66.1 ha for HPC. Notwithstanding this, the main nuclear island (NI) buildings, the conventional island (CI) buildings and balance of plant (BOP) buildings have an identical footprint to the reference plant HPC. This includes the spacing between both reactor units and the key nuclear safety buildings. * The reduction in the SZC footprint has required NNB GenCo (SZC) to deviate from the reference HPC layout primarily for ancillary buildings. NNB GenCo (SZC) undertook optioneering to relocate the various ancillary buildings within the SZC footprint. NNB GenCo (SZC) considered four options and selected option D [12]. * Buildings affected by option D included the emergency equipment store (HHE), warehouse (HHA), emergency response centre (HUM), emergency response energy centre (HDU), emergency response centre (HUC), raw and portable water supply and storage (HOR), intermediate level waste store (HHI) and the transit area for very low and low level waste (HHL).   NNB GenCo (SZC) has further modified the SZC layout in addition to option D above. This includes different positions for the two hydrogen storage (HZH) buildings. NNB GenCo (SZC) recognised in [12] that the design layout is still undergoing changes as further analysis is undertaken. In that reference, NNB GenCo (SZC) also stated that it has a process in place to review and manage the implications of any additional layout changes. This process consists of reviews by multiple committees and working groups which should ensure that any changes in layout are co-ordinated, understood and documented within the appropriate design documentation. From my assessment of the process, I am satisfied that this is a reasonable approach with evidence of an appropriate, multi-layered decision-making process being in place. This should ensure that safety-informed decisions are made as part of normal business and, in my view, satisfies SAP MS.3.  As stated in paragraph 38, NNB GenCo (SZC) highlighted in [12] that the NI, CI and BOP buildings at SZC are sited on the same footprint as HPC with the same claimed building separation distances. NNB GenCo (SZC) stated in [4] that confidence can be drawn from a hazard analysis perspective based on the justification of the HPC plot plan given the replication approach applied. I am satisfied with this because the NI, CI and BOP buildings are comparable to HPC’s equivalents both in size, location, and separation. It is in my view appropriate for SZC to take credit for the relevant HPC safety case analyses.  However, I have previously reported within my assessment of the replication strategy [13] that although I judged replication to be an adequate approach, HPC is still progressing its safety case work and the detailed hazard verification studies used to demonstrate that the risks across the site are ALARP are still being developed [14]. These studies remain to be assessed by ONR. Thus, there is a potential for further modifications to the current HPC design being required and these modifications could impact SZC. Furthermore, where replication cannot be applied because of SZC site constraints, the assumptions applied within the HPC analysis may not be valid for SZC. However, I judge that this is a matter for detailed design as such issues need to be identified through the detailed analysis work yet to be completed. The plot plan summary report [12] stated that further detailed hazard and safety analysis is being undertaken and that many of the ancillary buildings are not yet designed for HPC, and therefore the outputs cannot readily be transferred to SZC at this stage.  Therefore, it is my view that recommendation 2 which I raised within my replication assessment note [13] also remains valid for this assessment. This recommendation states that “A clear process should be implemented by SZC with HPC to identify, capture and review the shortfalls identified through the HPC hazard analysis studies. The process should demonstrate, through optioneering, if alternative measures could be adopted within the SZC design to eliminate or reduce risks so far as is reasonably practicable.”  It is my expectation that the SZC safety case should demonstrate that, where opportunities for improvements in the design are identified at HPC (such as through completion of the hazard verification process), adequate optioneering should be undertaken by SZC to determine if these improvements are appropriate for SZC to demonstrate that the risks are ALARP. Given the differences in plot plans between HPC and SZC, I recognise that the ability for SZC to move or relocate buildings is limited. Notwithstanding this, if reasonably practicable improvements are identified during the HPC design, consideration should be given to implementation within the SZC design if appropriate. | The general layout of the SZC site is illustrated in figure 1 of this report and described within NNBs Plot Plan Summary Report [12] and the Justification of Site Suitability Report [4]. These reports provide a overview of the SZC plant and building locations. From my assessment of these documents, I note the following key points which are relevant to this assessment:  The SZC layout and design is based on replication of the reference plant Hinkley Point C (HPC) at its current design reference configuration (RC)2.0.  The SZC site footprint is significantly smaller than HPC. The SZC footprint is 30.2ha, compared to 66.1ha for HPC. Notwithstanding this the main nuclear island (NI) buildings, the conventional island buildings (CI) and balance of plant buildings (BOP) have an identical footprint to the reference plant HPC. This includes the spacing between both reactor units and the key nuclear safety buildings.  The reduction in SZC footprint has required NNB to deviate from the reference HPC layout primarily for ancillary buildings. Optioneering has been undertaken by NNB to relocate the various ancillary buildings within the SZC footprint. Four options were considered by NNB of which Option D was selected [12].  Option D resulted in changes to the following buildings when compared to HPC; Emergency equipment store (HHE), Warehouse (HHA), Emergency response Centre (HUM), Emergency response Energy Centre (HDU), Emergency response centre (HUC), Raw and portable water supply and storage (HOR), Intermediate level waste store (HHI) and the Transit area for very low and low level wate (HHL).  In addition to the changes to buildings highlighted above as part of option D, the SZC layout has been further modified by NNB. This includes movement of the two Hydrogen store (HZH) buildings. It is recognised by NNB [12] that the current design layout is still undergoing changes as further analysis is undertaken. Therefore, to manage the implications of any additional layout changes NNB [12] have in place a process to review modifications. This review process consists of a number of committees and working groups to ensure any changes in the layout are co-ordinated, understood and documented within appropriate design documentation. From my assessment of the process, I am satisfied that this is a reasonable approach and demonstrates that an appropriate decision-making process is in place with multiple layers which in my view should ensure an informed decisions are made as part of normal business and thereby satisfies SAP MS.3.  As stated above NNB highlight [12] that the principle nuclear significant buildings at SZC are sited on the same footprint as HPC with the same claimed building separation distances. NNB state [4], that confidence can be drawn from a hazard analysis perspective based on the justification of the HPC plot plan given the replication approach applied. I am satisfied that because the principle nuclear safety buildings are comparable to HPC both in size, location, and separation and I consider it appropriate for SZC to take credit for the relevant safety case analysis work. However, I have previously reported [13] that although replication is an adequate approach, HPC are still progressing their safety case work and the detailed hazard verification studies are still being developed [14] and remain to be assessed by ONR thus further changes might be required to the current HPC design that could impact SZC. Furthermore, where replication cannot be applied because of SZC constraints, the assumptions applied due to replication may also not be valid. However, I consider this a matter for detailed design as such issues need to be identified through the detailed analysis work yet to be completed. The Plot Plan Summary Report [12] states that further detailed hazard and safety analysis is being undertaken and that many of the ancillary buildings are not yet designed for HPC and therefore the outputs cannot readily be transferred to SZC at this stage.  Therefore, it is my view that recommendation 1 which I raised within my replication assessment note [13] also remains valid for this assessment. It is my expectation that the SZC safety case should demonstrate that where opportunities for improvements in the design are identified at HPC (e.g. through completion of the hazard verification process), adequate optioneering should be undertaken by SZC to determine if these improvements are appropriate for SZC to demonstrate that the risks are ALARP. Given the differences in plot plans between the HPC and SZC I recognise that the ability for SZC to move or relocate buildings is limited. Notwithstanding this, if reasonably practicable improvements are identified over the HPC design consideration should be given for implementation as far as is reasonably practicable. |   Assessment of the Changes to the SZC Plot Plan from an Internal Hazard’s Perspective   1. To determine the adequacy of the current site layout, I have assessed the individual building changes identified by NNB GenCo (SZC) within the SZC plot plan [12] from an internal hazards perspective to gain confidence that the proposed layout is adequately justified in line with SAPs ST.5, ST.6 and ELO.4. The buildings that have had changes identified can be broadly categorised as:  * buildings that contain radioactive inventory; * buildings that present hazards to the site; and * buildings that provide an emergency response function.   In total, NNB GenCo (SZC) highlighted 19 building changes from the HPC design [12]. I note that not all the analysis for these buildings has been completed at this stage. Further work is required by NNB GenCo (SZC) to consider the analysis through the plot plan change management process. As stated previously, I am satisfied that the plot plan changes are being managed through an adequate process, but as further detailed information is required to underpin these decisions, the current SZC layout may be subject to further change.  To address the above point, NNB GenCo (SZC) undertook a review of each of the plot plan changes identified in [12] with respect to hazards. I note that the building classifications on the nuclear island, conventional island and ancillary buildings are consistent with the HPC designations within PCSR3 [15]. This provides me with some confidence that, at this stage, the proposed changes (subject to further detailed design) are unlikely to impact the overall safety functional requirements.   * + - 1. Facilities Containing Radioactive Inventory   NNB GenCo (SZC) highlighted changes to the following buildings as compared to HPC that handle, store, or contain radioactive material: interim spent fuel store (HHK), intermediate level waste store (HHI), transit area for very low and low-level waste (HHL) and contaminated tool storage (HHD). The plot plan summary report [12] presents NNB GenCo (SZC)’s analysis of the potential conflicts and impacts of the listed building modifications which include internal hazard aspects.  NNB GenCo (SZC) highlighted [12] that the HHK building is not to be replicated from the HPC reference plant and an alternative but similar design would be developed to deliver the required nuclear safety functions. The HHK building contains the dry fuel storage system (DFSS) to store fuel. NNB GenCo (SZC) stated in [12] that, as the safety claims are on the DFSS, it was appropriate to qualitatively review its analysis within the relevant basic design hazard protection schedule (BDHPS) for the HHK within HPC by comparing the hazards related to locational changes.  NNB GenCo (SZC) stated in [12] that the new position of the HHK on the SZC site is more optimally placed as it would be outside of the turbine low trajectory missile zone. It stated that it is also further away from the nearest largest explosion hazard source, which is the unit 1 hydrogen store, when compared to HPC. NNB GenCo (SZC) also stated that the HHK steel clad super structure covering the class 1 foundation slab where the DFSS is integrated would not be seismically qualified. Therefore, there is a potential that this structure could collapse in a seismic event. The design of the structure and SSCs to address this hazard is a matter of detailed design. In line with this and SAP EHA.14, further justification is expected as the design progresses to demonstrate that the risks from collapse of the HHK on the DFSS are ALARP. However, I judge that this is a matter that can be resolved during detailed design as the building design develops and I have captured it in a level 4 regulatory issue (10936). I consider this does not impact the suitability of the actual building location as the hazard is building specific.  Noting that in [12] NNB GenCo (SZC) had only considered structural collapse within the building’s footprint, I checked the potential impacts of the HHK collapsing beyond its footprint by considering the immediate adjacent buildings. The adjacent buildings to HHK listed by NNB GenCo (SZC) are the equipment storage building (HHX), fabrication area, and the secondary access control building (HUB). None of these buildings are safety classified and were described by NNB GenCo (SZC) as having limited hazard sources [12]. I am satisfied, based on the building descriptions provided by NNB GenCo (SZC), that there is little impact to the site’s nuclear safety claims if these buildings were impacted by a collapse of HHK. Wider consequences on the nuclear island beyond the immediate adjacent buildings (such as the HUC) are more difficult to ascertain at this stage in the absence of detailed information such as building height. I judge that this is a potential shortfall against SAP ST.6. Subsequently NNB GenCo (SZC) has confirmed [16] that an initial review of building offsets has been carried out to check for interaction hazards posed by the non-classified buildings to classified building. The offset was taken as to be a minimum of two thirds the height of the building. However, further evidence is not currently available to confirm the potential impacts.  NNB GenCo (SZC) acknowledged that the SZC PSCR will be developed further along with the plot plan and that this did not preclude enhancement of building classifications if the impact of building collapse was to be more significant than previously assumed [12]. I am satisfied that the above potential shortfall could be addressed by seismically qualifying the HHK building super-structure to eliminate the collapse hazard. On this basis, I judge that the current building location for the HHK is not a barrier to licensing, however I expect further consideration of the above potential shortfall in the SZC PCSR.  The HHI consists of vaults for storage of intermediate waste and an adjacent service building which are both classified structures. The vaults were claimed by NNB GenCo (SZC) [12] to be safety class 1 and SC 1 seismically qualified, with the adjacent service building being a safety class 2 and SC 2 seismically qualified. I note that the design of the HHI at HPC is ongoing [12] but its proposed location at SZC is further away from the nearest hydrogen store explosion hazard when compared to HPC. I concur with NNB GenCo (SZC)’s conclusion that the different location for this building when compared with the layout at HPC does not increase nuclear safety risks.  For the HHL building move, I am content that the proposed new location is unlikely to increase nuclear safety risk compared to the building location at HPC. This is because the type of waste the building contains presents a limited nuclear safety hazard.  I note HHD is still undergoing design and the height of the building has not yet been finalised. HHD is a non-classified building and in proximity to the back-up emergency equipment store (HHE). The HHD, therefore, could present a collapse hazard to the HHE, following a seismic event. NNB GenCo (SZC) highlighted within the plot plan report [12] that the HHE building is a class 1 structure and SC1 seismically qualified, therefore, I have confidence that this building will be able to withstand a seismic event, however, how this translates to its specific withstand to impact from a structural collapse of HHD impact should be confirmed at detailed design.  I acknowledge that NNB GenCo (SZC) has stated that further analysis work is planned, and that the HHD building height could change to demonstrate that risk is reduced to ALARP [12]. This analysis has not yet been completed. Given that the building’s classification could be changed as already acknowledged by NNB GenCo (SZC) [12], and the design is undergoing review to reduce risks from HHD, I am content that engineering measures can be implemented during detailed design. However, until resolved, I judge this remains a shortfall in the current safety justification against ONR SAP EHA.3 and is captured in a level 4 regulatory issue (10936).  In summary, I have assessed from an internal hazard perspective the claims and arguments for the individual building changes identified by NNB GenCo (SZC) that contain a radioactive inventory. I am satisfied that the proposed plot plan changes from the HPC layout to SZC are unlikely to change the nuclear risk profile and therefore the expectations in SAP ST.4 are largely met, subject to detailed design considerations.  Where I identified issues that should be addressed at detailed design, I have captured them within a level 4 regulatory issue (10936). It should also be noted that the HPC detailed hazard analysis, which is relevant to building layout and design decisions for SZC, has not yet been completed. I am, however, content there are sufficient engineered options available for NNB GenCo (SZC) to address the potential shortfalls to demonstrate that risks are reduced ALARP. As the assessment is not on a final site plan, there is a risk that further building movements may be required or additional engineering measures above what is presented as part of the HPC design may also be required. However, I am satisfied that these can be addressed at detailed design and do not preclude the issuing of a nuclear site licence.   * + - 1. Facilities That are a Source of Internal Hazards to Other Buildings   NNB GenCo (SZC) reported the move of several buildings that present hazards to surrounding buildings [12]. These buildings are unit 1 and unit 2 hydrogen storage (HZH), chemical products storage (HZC), oil and grease storage (HZG), conventional waste store (HHW), National Grid substation (HEG), sewage treatment plant (HXE), operational store (HHP) and the chlorination plant (HPH).  The HZH buildings store hydrogen and nitrogen gas required for various chemical processes [4]. Both reactor units have associated HZH buildings designated unit 1 and unit 2 HZH respectively. NNB GenCo (SZC) highlighted in Reference [12] that both buildings present explosion, missile and fire hazards within the SZC site.  Each HZH building is designed to hold [REDACTED] hydrogen cylinders each [10]. The dominant hazard from these buildings is an explosion following an uncontrolled release of hydrogen gas. NNB GenCo (SZC)’s analysis [17] calculated the explosion overpressures and the minimum distances to which nuclear significant buildings could be sited. NNB GenCo (SZC) calculated a [REDACTED] distance [12]. At such distance NNB GenCo (SZC) estimated that the side-on overpressure would be [REDACTED], which is the withstand value of SZC safety classified buildings. However, I note that NNB GenCo (SZC)’s analysis has assumed the failure of [REDACTED] packs within the trailer. This point was also reported by NNB GenCo (SZC) [12] which stated that further analysis work is to be undertaken to determine the potential domino effects from failure of [REDACTED] hydrogen cylinders.  The outputs from the revised NNB GenCo (SZC) explosion analysis have not yet been provided for assessment. I acknowledge NNB GenCo (SZC)’s intent to review the available explosion analysis, as stated within its plot plan report [12]. Any changes to the derived explosive loads following this analysis will need to be adequately justified. From an explosion effects point of view, I consider any increase in explosion source term is likely to increase the distances applied to maintain the [REDACTED] design requirement which may present additional challenges within the SZC footprint due to the limited site footprint. I have reviewed the locations of the HZH buildings along with the surrounding buildings to ascertain the suitability of the current locations and potential impacts following any increases in blast radius.  For [REDACTED], the plot plan summary report [12] and site plan [18] highlighted that the [REDACTED] has been moved further away from the nearest safety classified building [REDACTED] when compared to HPC. The current SZC plot plan illustrates that [REDACTED] is located next to the [REDACTED], [REDACTED] and [REDACTED] buildings, all of which have also been moved compared to HPC, as well as the [REDACTED].  The plot plan report highlighted that [REDACTED] presents a significant source of explosion and fire. [REDACTED] also present significant fire hazards. These buildings are all [REDACTED] and, from the scaled site plan [18], I judge the distances to be less than the calculated [REDACTED] building separation distance for the [REDACTED] withstand criterion. Therefore, if an explosion was to occur in [REDACTED], there is the potential for [REDACTED] and I judge that this is a potential shortfall against SAPs ELO.4, ST.5 and ST.6. Noting that [REDACTED] are both next to the [REDACTED], there is also a potential impact to a safety classified building. I have captured this potential shortfall within a level 4 regulatory issue (10936).  NNB GenCo (SZC) stated that it had undertaken fire [REDACTED] effects analysis, but further work is required to demonstrate that the risks from fire hazards in the buildings are ALARP [12]. Notwithstanding this, I am content that there is space available to enable additional engineering measures which if required can be progressed at engineering design to reduce the risks ALARP from explosion and fire for all the hazardous buildings [REDACTED]. Progress will be tracked through a level 4 regulatory issue (10936).  [REDACTED], when compared to HPC, is closer to the conventional island (CI) and nuclear island (NI) buildings. The plot plan report [12] claimed that these buildings are located at sufficient distances so as to not exceed the design basis explosion loadings for the [REDACTED], [REDACTED] and [REDACTED]. I have reviewed the scaled drawings [18] and I am satisfied that the [REDACTED] are adequately spaced. However, I am not satisfied that NNB GenCo (SZC)’s claim regarding the [REDACTED] building is fully justified as a review of the site plan [18] indicates that it is within the [REDACTED] radius of the explosion as well as the [REDACTED]. Furthermore, there are [REDACTED] coming into these [REDACTED]. Thus, in my view, an [REDACTED] explosion could result in [REDACTED]. I judged that there was a potential shortfall against SAPs ST.5, ST.6 and ELO.4.  NNB GenCo (SZC) assessed the above scenario within its [REDACTED], which recognised that there is a relatively high risk due to a design base explosion in [REDACTED]. I note that this issue is yet to be resolved and is captured in the document’s open points register [REDACTED]. As highlighted previously, NNB GenCo (SZC) is yet to quantify the potential increase in explosion loads from larger hydrogen releases and [REDACTED] effects. This is due to be reported in future NNB GenCo (SZC) analysis. The overpressure effects could impact the closest [REDACTED] and other buildings such as [REDACTED], in turn affecting emergency response activities. In addition, it was also highlighted by NNB GenCo (SZC) [12] that [REDACTED]. NNB GenCo (SZC) acknowledged in [12] that this is also subject to further analysis to determine the potential impact to the site safety case.  [REDACTED]. Thus, it is my view that additional work is required to demonstrate that the risks to other buildings and nuclear safety from hazards arising from [REDACTED] are ALARP. Therefore, based on the information available, I judge that the current position of [REDACTED] does not satisfy SAPs ELO.4 and ST.6 and represents a potential safety case shortfall, which I have captured within a level 4 regulatory issue (10936). Notwithstanding this, I am satisfied that this shortfall can be addressed during detailed design, with either additional engineering measures being implemented, the building being relocated or minimising the hazard, such as [REDACTED].  NNB GenCo (SZC) also highlighted that SZC requires a chlorination plant (HPH) to be installed for the management of marine biological growth [12]. This is a SZC site specific requirement and is not replicated from HPC, as HPC does not require it. The plot plan summary report [12] highlighted that the HPH building will produce and distribute sodium hypochlorite. As the details of this plant have not been finalised, the quantities of chemicals are not yet defined. However, the basic design document [20] for the HPH indicated that the facility presents both a fire and an explosion hazard as the process generates hydrogen. NNB GenCo (SZC) stated within its plot plan report that these hazards are being assessed as part of the building design process. I am content that the hazards have been identified by NNB GenCo (SZC) thus satisfying SAP EHA.1 and that there are plans to address them. I note that the electrolysis process will also produce chlorine gas that presents a toxic gas hazard and this will need to be addressed during detailed design, when the process technology is chosen, in order to meet SAP EHA.14. However, in my view, the hazards above and the location for HPH proposed by NNB GenCo (SZC) do not present additional hazards other than those associated with the building. I am therefore satisfied that the current location is adequate subject to further detailed assessment, satisfying SAP ST.6.  I have also assessed NNB GenCo (SZC)’s justification of the movement of the following buildings: National Grid substation (HEG), sewage treatment plant (HXE) and operational store (HHP) as described within the plot plan report [12]. I am content that the identified building and plant moves do not present significant increases in risks and further detailed design analysis will be undertaken, thereby satisfying SAP ST.6.  In summary, I have assessed the significant plot plan changes for the facilities that are considered a source of hazards to other buildings. The most significant of these changes is the location of the [REDACTED], as this building could impact [REDACTED] and safety functions. It is my opinion that further analysis work is required to demonstrate that risks associated with the current layout are ALARP and I have captured this potential shortfall within a level 4 regulatory issue (10936). However, I am satisfied that further measures are available and can be adopted during detailed design to reduce risks further if necessary.  For all of the other facilities, further detailed analysis is required to understand the hazard loads, however, I consider this is a safety case development matter rather than a significant site constraint issue. I recognise that the current site layout is aligned with HPC and therefore the potential shortfalls identified do not undermine the claim that the site is of sufficient size.   * + - 1. Changes for Facilities with Emergency Response Functions   NNB GenCo (SZC) highlighted that there are two principal changes to buildings with an emergency response function; these are the auxiliary administration building (HUC) and the back-up emergency equipment store (HHE) [12]. I have already discussed the main hazards to the HHE from HHD collapse and [REDACTED] in the previous section and they are therefore not repeated here.  NNB GenCo (SZC) modified SZC’s HUC to incorporate functions that on the HPC site are in separate buildings. These are the security administration centre (HUD), the emergency response centre (HUM) and the emergency response energy centre (HDU). The plot plan summary report [12] stated that the combination of these facilities was undertaken to increase the available space on the SZC site. The new location of HUC is between the raw and portable water supply and storage building (HOR) and the HHK building. The plot plan summary report [12] highlighted that the HOR building is safety class 1 and class 1 seismically qualified and therefore I consider collapse of the HOR impacting the HUC a low risk, however, as stated earlier (paragraph 48) HHK is not currently seismically qualified and its potential impact on HUC needs to be assessed. I judge that this is a potential shortfall against SAP ST.5 and is captured within a level 4 regulatory issue (10936).  Furthermore, I note that the HDU facility in HPC contains diesel fuel, and it is expected that this will be the same at SZC. The quantities and location of diesel inventories is unclear at this stage, however, the implications of the co-location of these facilities should be understood if one facility could result in the others not being available. It is my expectation that these facilities should have a level of independence, such that one centre does not impact the other, enabling the emergency functions to be maintained and to demonstrate the risks from hazards are reduced ALARP. I consider this a potential shortfall against SAPs EHA.1 and ELO.4 which can be resolved during part of detailed design, and I have captured it within a level 4 regulatory issue (10936).  Summary  As part of its site licensing justification, NNB GenCo (SZC) made the claim that the SZC site is of a sufficient size to accommodate all necessary systems to ensure safe operation. I have assessed the evidence associated with this claim, which includes NNB GenCo (SZC)’s justification of various building moves.  I am satisfied that, overall, the SZC site as proposed is adequate to accommodate all the necessary systems to ensure safe operation. This has been evidenced by the fact that all buildings and their functions have been replicated to some extent at SZC from the HPC reference site. However, I note that there are several matters that remain to be addressed during detailed design. These relate to explosion, fire and building collapse which I have captured within a level 4 regulatory issue (10936). A number of these matters have been identified by NNB GenCo (SZC) and they are currently being progressed. I also acknowledge NNB GenCo (SZC)’s commitment [12] to reconsider positions, locations and building classifications subject to the findings from its reviews. Although this is positive it needs to be recognised that the SZC site is limited in size, thus the actual ability to move buildings is limited, and further engineered measures may be required. However, I consider that it will be possible for such measures to be identified during the detailed design phase and, therefore, these matters do not preclude granting a nuclear site licence.  I have made my judgements based on the information available at this stage prior to detailed design. Notwithstanding this, I judge that from an internal hazards perspective, the site is of sufficient size to accommodate all necessary systems to ensure safe operation thereby satisfying SAPs ST.5 and ST.6. |

Claim 3 – There Is Adequate Cooling Capability for All Normal and Fault Conditions

This section presents the findings of my assessment of NNB GenCo (SZC)’s claims, arguments and evidence to support that there is adequate cooling capability for all normal and fault conditions.

Relevant Parts of NNB GenCo’s (SZC) Safety Case

The key documents to support the claim are the JSSR [4], the plot plan summary report [12] and the heat sink summary report [21]. I have sampled these reports and my assessment findings are documented below.

Assessment of Claim 3

I have assessed NNB GenCo (SZC)’s claims to form a judgement on whether there is adequate cooling for all normal and fault conditions. The Plot Plan Summary Report [12] stated that total replication of the HPC heat sink design for SZC is not possible and ultimately not economical, and therefore the depths to which some of the key technical galleries are constructed will be different to that of HPC. NNB GenCo (SZC) stated that this is not considered a barrier to safety and that the galleries plot plan footprint will be largely unchanged [12].

I have assessed the changes presented by NNB GenCo (SZC) within the plot plan report [12] and the site justification report [4]. I am satisfied that the changes to the design identified under Claim 3 do not undermine NNB GenCo (SZC)’s claim to demonstrate that there is adequate cooling for all normal and fault conditions. This is because the design has multiple trains. However, I do recognise that the systems have a potential impact on the internal hazards case for SZC as they present hazard sources such as flooding (from pipe breaks or leaks) and missiles (from failures of rotating equipment such as pumps). NNB GenCo (SZC)’s heat sink summary report [21] analysed the impact of these on the internal hazards case. Overall, I consider that these hazards will be building-specific and can be addressed during the detailed design hence I have not assessed them further in this report.

As highlighted in my assessment for Claim 1 (Section 4.2.3), I have identified potential shortfalls related to explosion hazards with the siting of the [REDACTED]. In this case there is a potential impact to the provision of [REDACTED]. This has been captured within a level 4 regulatory issue (10936).

Summary

I have assessed NNB GenCo (SZC)’s arguments and evidence available to underpin the claim that there is adequate cooling for all normal and fault conditions. The level of evidence available at this stage is limited but commensurate with the stage in the design process, and further analysis is required at detailed design to understand the impact of the identified internal hazards such as flooding and missiles, which I consider normal business. The most significant finding relates to the siting of [REDACTED] and this potential shortfall is captured within a level 4 regulatory issue (10936).

Claim 6 – Operations of the Site Will Not Adversely Affect the Safety Case for Any Adjoining Nuclear Licensed Site

The SZC site is located adjacent to the SZB site and, therefore, introduces new external hazards or changes existing external hazards considered in the SZB safety case. The external hazards environment around SZB will change throughout the construction period for SZC and then reach a relatively stable / permanent state as SZC becomes operational. There are a number of hazards which could be initiated at SZC and have the potential to impact operations on the SZB site. NNB GenCo (SZC) has reviewed the hazards it has identified as relevant to this claim in both the JSSR [4] and the Arguments and Evidence Supporting JSSR Claim 6 Report [10]. I have considered such potential hazards and determined that the following hazards are those with greatest risk or are least controlled:

* missiles
* explosions
* construction hazards

NNB GenCo (SZC)’s identification and consideration of these hazards are assessed further below.

Relevant Parts of NNB GenCo (SZC)’s Safety Case

NNB GenCo (SZC) addressed the potential to adversely affect the safety case of the adjoining nuclear licensed site under Claim 6 within the JSSR [4] which considered this issue at a relatively high level. The arguments and evidence supporting JSSR Claim 6 report [10]) discussed the hazards in turn in much greater detail and the turbine disintegration hazard was specifically considered within the preliminary ALARP report for SZC turbine disintegration missile impact on SZB [11]. NNB GenCo (SZC) stated [10] that the SZC site is located adjacent to the SZB site and would, therefore, introduce new hazards or change existing hazards considered in the SZB safety case. NNB GenCo (SZC) also stated that a comprehensive review had been undertaken to identify the potential risks that SZC would pose to SZB and that this would provide confidence that the SZC site will not adversely affect the ability to maintain an adequate safety case for SZB. NNB GenCo (SZC) claimed in [10] that, for all of the hazards covered by the analysis, the report demonstrated that there is a high degree of confidence in the ability of the SZB nuclear licenced site to maintain an adequate safety case and that the SZC site would not adversely impact this. The hazards are discussed in turn below.

* + - 1. Missiles – Turbine Disintegration

The key missile hazard which could be generated at SZC and which has the potential to result in significant consequences at SZB, albeit very unlikely, arises as a result of turbine disintegration. The chosen orientation of the turbines in the context of the SZC twin reactor units and the nuclear island (NI) is such that, in a SZC turbine disintegration event, the missiles generated would preferentially be ejected towards the SZB site in general and the SZB reactor building in particular.

NNB GenCo (SZC) identified this hazard initially in the preliminary arguments supporting JSSR Claim 6 report [22]. Subsequent to this document being issued, NNB GenCo (SZC) commenced a multi-phase optioneering programme to consider several options. This is summarised in the preliminary ALARP report for SZC turbine disintegration missile impact on SZB [11], the update to the ALARP report [23] and the SZC turbine disintegration safety case support optioneering record [24].

[11] and [24] provided a detailed explanation of the optioneering process adopted for SZC. Following three workshops, NNB GenCo (SZC) reduced the options to five options which would be progressed for further consideration. Following the third workshop, NNB GenCo (SZC) reviewed the remaining options with stakeholders and they reduced the list to four preferred options:

* Option #2 – improve the reliability of the overspeed protection system;
* Option #2a – improve turbine rotor integrity such that ductile failure speed is not reached in an overspeed event;
* Option #18a – install a partial height deflector plate/shield within the turbine hall itself; and
* Option #33 – advanced control and instrumentation by increasing the use of analysis, operational experience and quality/inspection requirements or monitoring options (to improve brittle failure Initiating Event Frequency (IEF)).

NNB GenCo (SZC) continued to develop the various options and prepared a proposal for the options to be taken forward into detailed design (Reference [25]). The proposed options were presented to the No Change Committee (NCC) which is the key design change approval committee within NNB GenCo (SZC). Following on from the NCC, NNB GenCo (SZC) reconsidered the proposed way forward. It parked the preferred option and instead committed to reviewing the previously discounted options (for introduction of a passive barrier) to examine if there are any other reasonably practicable passive safety options that could be developed to reduce risks from the hazard to ALARP. NNB GenCo (SZC) proposed the way forward to the NCC in May 2022 [26].

* + - 1. Explosions

NNB GenCo (SZC) identified in Section 7 of the JSSR [4] and in the arguments and evidence supporting the Claim 6 report [10] that there are potential explosion hazards on the SZC site which could impact nuclear safety on the SZB site. In [10] NNB GenCo (SZC) argued that the explosion sources that are of most interest are those which are closest to the SZB northern boundary and that these sources are generally from ancillary buildings associated with SZC unit 1 reactor which is closest to SZB. [10] identified the relevant buildings to be:

* hydrogen and nitrogen storage (HZH)
* oxygen storage (HZO)
* chemical products storage (HZC)
* hydrazine storage (HZN)

The claims, arguments and evidence for the above buildings generally rely on a combination of the following arguments:

* the distance between the building in question and the safety classified buildings on the SZB site is such that the overpressure arising from an explosion at SZC would not challenge the SZB building withstand;
* SZB facilities which might be damaged by an explosion at SZC are not deemed important to safety; and
* explosion hazards have been minimised by the removal of hazardous inventory to other facilities.

However, I note that [10] explained that as for Claim 1 for the unit 1 hydrogen and nitrogen storage (1HZH) building, work is ongoing by the Responsible Designer (RD) to assess whether [REDACTED] effects (that is [REDACTED] hydrogen cylinder explosions) can occur as a result of the explosion of a [REDACTED], and if so, quantify the maximum explosion overpressure and the resultant effects on nearby buildings and structures. Depending on the results of the analysis, NNB GenCo (SZC) will consider measures to address the updated definition of the hazard to ensure that the effect of the explosion hazard is still below the design basis withstand of nearby safety classified buildings.

* + - 1. Construction Hazards

NNB GenCo (SZC) explained in the Claim 6 report [10] that the main construction phase at SZC will take place following the enabling works (work required on site to be carried out before main construction works can commence). NNB GenCo (SZC) stated that the contractor performing the main civil construction is, at the time of writing this report, working on the construction of HPC and the companies that make up the main contractor have also been involved in the construction of Flamanville 3 and Olkiluoto 3. At Flamanville 3, the construction site was immediately adjacent to the Flamanville 2 reactor just like SZC will be immediately adjacent to SZB. Similarly, HPC unit 2 will be constructed alongside unit 1 when it is going through commissioning and once nuclear fuel has been delivered to the site.

NNB GenCo (SZC) noted that additional safety provisions will be adopted where necessary to further control the risks to the adjacent SZB site further. NNB GenCo (SZC) considers that this approach has been embodied within the operational protections agreement (OPA) [27] with the overall aim of preventing SZC construction having a detrimental effect on SZB. NNB GenCo (SZC) also considers that mechanisms are in place via the OPA to ensure that SZC construction activities are shared with SZB to identify potential risks, with the level of operational protection agreed between the two parties being commensurate to the amount of risk posed.

Assessment of Claim 6

* + - 1. Turbine Disintegration

My assessment of turbine disintegration hazards at SZC was informed by RGP and interactions with several technical disciplines as described below.

**Relevant Good Practice**

Relevant good practice (RGP) with respect to the hazard of turbine disintegration is summarised in ONR TAG 14 [6] which references out to IAEA guidance [8] and states that the layout of the main turbine generator should be such that potential critical targets (such as the control room) lie within the area least susceptible to direct strikes from the turbine.

The SZC position and proposed layout is such that several SZB buildings (including the reactor building) lie within the zone most susceptible to missile strikes for the SZC turbines [23]. Hence, the SZC location and layout do not meet ONR initial expectations for a favourable layout or SAP ELO.4.

SAPs EKP.3 and EKP.5 expect that nuclear facilities should be designed and operated so that defence in depth against potentially significant faults or failures is achieved by the provision of multiple independent barriers to fault progression, and that safety measures should be identified to deliver the required safety function(s). In addition, paragraph 155 of the SAPs lays out the hierarchy of safety measures. This is further supported by TAG 14 [6] which states that a probabilistic argument alone, for example, to support unfavourable layouts and lack of design provision against turbine disintegration, would not be acceptable and risk should be demonstrated to be ALARP. TAG 14 [6] identifies suitable passive safety measures such as civil structures which would be expected to protect plant from missiles arising from turbine disintegration and which should be suitably substantiated against relevant turbine missile strikes. In the absence of a favourable layout and noting that a probabilistic argument alone is not considered acceptable, ONR has clarified to NNB GenCo (SZC) that passive safety measures should be preferentially considered and progressed unless they are demonstrated to be grossly disproportionate versus the risks averted [28] [29] [30].

Target 4 of the SAPs ‘Design Basis Fault Sequences – any person’ [5] provides ONR numerical targets for design basis analysis (DBA) and explains that “the DBA should demonstrate that adequate robust safety measures are in place, including the presence of at least one intact barrier at sequence termination”.

Consistent with ONR expectations in SAP ST.5 (the safety case should take account of any hazardous installations on or off the site that might be affected by an incident at the nuclear facility), NNB GenCo (SZC) identified the risk posed to SZB from turbine disintegration at SZC. The related ALARP report [11] and optioneering report [24] considered several possible options across numerous workshops applying various criteria at each stage. The reports identified several possible passive features which could provide physical protection to SZB in the event of a SZC turbine disintegration. Of these options, NNB GenCo (SZC) had put forward one option for development into concept and detailed design: a steel barrier to be located within the turbine building, which NNB GenCo (SZC) considered would prevent a large proportion of the normal overspeed low trajectory missiles from being ejected outside the turbine hall building in the direction of SZB. However, this option is a partial solution which, alone, does not satisfy SAP ELO.4.

I assessed the ALARP report to understand why other options had not been progressed. In my view, the report showed that some options had been discounted on perceived high costs, but these would not necessarily be grossly disproportionate (for example the free-standing barrier) in the context of the risk averted. Also, NNB GenCo (SZC) discounted several options on the perception of a better option being available (integrated concrete or steel wall to turbine building). I therefore concluded that NNB GenCo (SZC) had not demonstrated at that stage that the time, trouble and cost of discounted options were grossly disproportionate to the benefits gained.

I raised the above considerations in engagements with NNB GenCo (SZC) held in December 2021 [28], February 2022 [29] and March 2022 [30]. My aim was to ensure that NNB GenCo (SZC) further reviewed options, including options already discounted, to demonstrate that risks will be reduced to ALARP. This included identification of other possible passive options which could, when combined, provide a more comprehensive solution (which would ensure that a larger range of missiles would be mitigated by the passive barrier) consistent with the expectations of SAP ELO.4. This was supported by an email sent by the ONR Delivery Lead to NNB GenCo (SZC) on 5 April 2022 [31] clarifying ONR’s expectations. Following NCC 34c held on 4 March, where the NCC questioned the underpinning of the detriment costs identified for the preferred passive option, NNB GenCo (SZC) decided to broaden and further develop its search for a passive solution. NNB GenCo (SZC) confirmed in [32] and [26] that it intends to review a number of passive options with the aim to develop a passive measure into detailed design.

Since NNB GenCo (SZC) has accepted the need to progress the SZC turbine safety case with passive options being a key element, I am content that the prospective licensee has acknowledged the importance of passive measures and that a commitment has been made [32] to develop the design of several passive safety features in order to demonstrate that risks will be reduced to ALARP. I expect NNB GenCo (SZC) to follow the commitment letter with a plan for the identification and implementation of all reasonably practicable measures, with due consideration and preference being given to passive measures in line with paragraph 155 of ONR SAPs. I have captured the extant gap within the current safety case against SAPs ST.5 and EHA.14 in a level 3 regulatory issue (10940).

**Reliability and Risk**

The SZC safety submission [26] made claims about the IEFs of a turbine disintegration and potential reliability improvements which might be achieved by the proposed changes [26] to the turbine control systems and overspeed controls.

The ONR PSA and control and instrumentation specialist inspectors have assessed the claims on the proposed active measures [33]. The conclusions of their assessment are that NNB GenCo (SZC)’s normal overspeed and runaway overspeed frequency estimates are not supported by statistical analysis of wider population data (including turbine control protection system reliability improvement) for the claimed reduction in frequency. The specialist inspector’s advice is documented in [34].

Regarding the overall risk and, specifically, for comparison against targets 8 and 9 of SAP NT.1 [5], the PSA inspector advised that the current large release frequency (LRF) for SZB excluding the SZC turbine event is between the basic safety objective (BSO) and basic safety level (BSL) of target 8; this is consistent with NNB GenCo (SZC)’s claims [11]. The PSA inspector clarified that the inclusion of the SZC event would mean that the frequency would increase but would remain within the same region. Regarding target 9, the PSA inspector advised that it would be reasonable to assume target 9 would likely be below the BSO.

Notwithstanding the advice regarding target 9 (below the BSO), the levels of risk at SZB (both extant and increased from a turbine disintegration event) put the onus on SZC to demonstrate that the risk will be reduced to ALARP and hence I expect consideration and implementation of all reasonably practicable options.

**Conclusions**

NNB GenCo (SZC) has recognised the importance of providing a passive safety measure to protect SZB in the event of an unlikely turbine disintegration at SZC and has provided a commitment to deliver this [32], unless it can be shown not to be reasonably practicable, that is the related time, trouble and costs of such measure(s) being grossly disproportionate to the risk reduction.

I am content that, at this point, a nuclear site licence may be granted to NNB GenCo (SZC) for SZC whilst recognising that there is a significant amount of work to be carried out during detailed design, for NNB GenCo (SZC) to demonstrate implementation of all reasonably practicable options. Given NNB GenCo (SZC) has not foreclosed options and there are several technically feasible options to reduce risk ALARP, I have sufficient confidence that this can be resolved post the grant of any nuclear site licence. Notwithstanding this, I have raised a level 3 regulatory issue (10940) requiring NNB GenCo (SZC) to complete the optioneering of the passive safety features, to implement all reasonably practicable measures and to provide a robust justification for the rationale applied in either discounting or selecting options for implementation.

Implementation of measures should give due consideration of the hierarchy of safety measures, as per paragraph 155 of ONR SAPs. It should be noted that NNB GenCo (SZC)’s desire to achieve replication should not be the sole basis of NNB GenCo (SZC)’s justification of options as the legal test is ‘so far as is reasonably practicable’. It is my view that, as NNB GenCo (SZC) considers optioneering further, it should consider options which adopt more than one passive feature, an expectation that is not currently reflected in the letter of commitment [32].

In order to ensure that ONR has suitable sight of the optioneering work and final option justification I consider that the closure of the proposed level 3 regulatory issue should be tied to the release of the hold point for the start of construction of the cut-off wall, when the position of buildings and space available will become physically fixed at the site (and, therefore, this is the most relevant hold point ahead of key build activities).

* + - 1. Explosions

I have assessed the layout of SZC in comparison to SZB [18] and have considered the buildings likely to present an explosion hazard to SZB. I consider that the buildings identified by NNB GenCo (SZC) [10] are the buildings which present the most significant explosion hazard to SZB; these are discussed below.

**Hydrogen and Nitrogen Storage (HZH)**

I have assessed the key claims and arguments NNB GenCo (SZC) made regarding the potential for explosions from the 1HZH building to affect the SZB site. NNB GenCo (SZC) claimed that the size of the potential explosion would not be sufficient to result in damage to the key SZB buildings given their withstand and their distance from the source of explosion [10]. [20] detailed the overpressure arising from an unconfined vapour cloud explosion following a release from [REDACTED] packs of hydrogen cylinders at their maximum operating pressure on a trailer within the facility. NNB GenCo (SZC) calculated the resulting explosion overpressure to be [REDACTED]. [18] provided a scale diagram of the SZB and SZC sites and showed that the SZB site is at least 75 m from the 1HZH building. [10] claimed that the SZB safety-classified buildings would be exposed to overpressures of [REDACTED] as a result of a similar explosion from the SZB hydrogen building and that these buildings would withstand such pressures. This was confirmed by SZB [35]. Therefore, even if overpressure was compounded by blast wave reflection, I would expect the overpressure experienced by the SZB safety classified buildings to be bounded by that of an explosion involving a release from the SZB hydrogen plant.

However, as explained in the assessment of Claim 1, [10] considered the overpressure arising from the release of hydrogen from [REDACTED] hydrogen canisters [REDACTED] and there is ongoing work to determine the potential [REDACTED] effects from failure of [REDACTED] hydrogen cylinders. Any increase in the explosion source term is likely to increase the separation distance requirements between buildings not to exceed the [REDACTED] overpressure threshold required by NNB GenCo (SZC) as the basis of design. This may present additional challenges, however, as for Claim 1, I consider that Claim 6 should be revisited once the output of this work has been reported to determine the potential effect of the conclusions on the SZB site as captured within a level 4 regulatory issue (10936). As for Claim 1, I am satisfied that this potential shortfall could be addressed during detailed design, with either additional engineering measures being implemented, the building being relocated or minimising the hazards, such as reducing the quantities of hydrogen stored. Hence, I am satisfied that further measures are available and can be adopted during detailed design to reduce risks further if necessary.

NNB GenCo (SZC) claimed in [10] that loss of the safety function provided by the reserve ultimate heat sink (RUHS) in isolation is not a safety issue, as cooling would also have to be simultaneously lost from the SZB sea water pumps which are housed in the SZB seawater pump house. This is a safety classified building on the SZB site. SZB confirmed that loss of the RUHS alone would not result in radiological consequences [36]. However, SZB clarified that the RUHS provides the back-up supply of cooling water to the component cooling water (CCW) system when the essential service water (ESW) system is unavailable.

The above considerations are particularly significant as the cooling water pumphouse (part of the ESW) is not seismically qualified and the RUHS would be expected to remain available following a seismic event within the design basis. I note that [10] stated that 1HZH will be seismically qualified, however, to ensure continued availability of the RUHS, it is important to ensure that there are no releases of hydrogen and consequential explosion hazards and damage to the RUHS. In my view, the submission has not adequately considered the following points, thus representing a potential shortfall against SAP ST.5:

* seismic qualification requirements of equipment supporting the operation of the 1HZH building to ensure that there would not be a release of hydrogen in a seismic event;
* potential for [REDACTED] 1HZH building to present a hazard to 1HZH or equipment addressed by bullet point 1 by the mechanism of collapse or other internal hazard such as fire; and
* potential requirement for defence in depth measures [REDACTED] to protect key infrastructure on the SZB site from a hydrogen explosion emanating from 1HZH.

I have captured the above points within a level 4 regulatory issue (10936) for the prospective licensee to address as the ongoing review of explosion hazards informs detailed design considerations. It is my view that engineered solutions to the hazard loadings remain available and are a matter appropriate to future detailed design considerations.

**Oxygen Storage (HZO)**

I have assessed the claims relating to an explosion in the oxygen storage building and am content that the size of the explosion overpressure is bounded by that arising from hydrogen explosion hazards at 1HZH [17] and that the distance from SZC’s HZO to SZB as shown in [18] is similar to 1HZH’s hence limiting potential detrimental effects.

**Chemical Products Storage (HZC)**

I have assessed the claims relating to an explosion in the chemical products storage building at SZC and the potential threat to SZB [10]. I am aware that the main inventory posing this explosion hazard at HPC would be nitric acid mixing with other chemicals in HZC and that, at HPC, nitric acid has been removed to a separate building on the HPC site [37]. I expect the same layout arrangements to be implemented at SZC. I have considered the remaining hazardous inventories which could lead to explosion hazards as detailed in the synthesis of HZC and HZG hazard studies [38] and am content that the explosion hazards have been further controlled by splitting inventories across several locations and/or are not sufficiently large to present a hazard to the SZB site. Therefore, I judge that the HZC building does not present a significant explosion hazard to the SZB site.

**Hydrazine Storage (HZN)**

NNB GenCo (SZC) considered that hydrazine is only explosive when mixed with other chemicals [10]. I am content with this claim and as [10] stated that incompatible chemicals will not be stored within HZN; I judge that NNB GenCo (SZC) has demonstrated that it understands and will control the threat to SZB from explosions involving the HZN inventory, in line with ONR SAPs EHA.13 and EHA.14.

**Conclusions**

I have assessed the risk from explosion hazards on the SZB site and I am satisfied that overall, the SZC site proposed can be configured to ensure it will not adversely affect the safety case for SZB. NNB GenCo (SZC) has demonstrated that buildings and their functions have been replicated to some extent at SZC from the HPC reference site and that the HPC hazard information has been used to underpin the potential magnitude of hazards which might affect SZB.

However, I note that there is a specific risk to the RUHS system at SZB from explosion, fire and building collapse hazards which needs to be considered further during detailed design as NNB GenCo (SZC) progresses work on the explosions source term. As for Claim 1, I also acknowledge NNB GenCo (SZC)’s commitment [12] to reconsider building orientations, locations and building classifications subject to the findings from the reviews. As for Claim 1, I note that the size of the SZC site may limit the potential for resolving shortfalls through additional separation distance or relocation of buildings, and therefore further engineered measures may be required during detailed design.

Notwithstanding the above, I judge that, from an internal hazards perspective and with the further planned work, the operation of the plant at SZC can in the future be shown not to adversely affect the safety case for the adjoining nuclear licensed site (SZB) thereby satisfying SAP ST.5.

* + - 1. Construction Hazards

[26] provides the framework agreement for cooperation between NNB GenCo (SZC) and EDF Energy Nuclear Generation Limited (NGL). The document explains the responsibilities and the requirements of the two parties and how this will change as the operations on the two sites evolve. The document further details the working arrangements between the two organisations to facilitate communication of the operations on one site which may affect the operations on the adjacent site. I consider that this communication should allow the identification of hazards arising at one site which may be potentially realised on the other and that, when such hazards are identified, suitable safety measures are mutually agreed.

NNB GenCo (SZC) has also provided the terms of reference for two committees which will further facilitate the communication between the two adjacent sites and their operating organisations. The SZB/C Joint Project Board [39] oversees the engineering, consents and licensing, procurement, construction and commissioning, and SZB support for all the elements of the SZC development. This includes resolution of any potential impacts on the operations of the SZB station. This committee is further supported by the SZB/C Interface Technical Forum [40] whose primary purpose is technical oversight and governance during the design and planning phase of the SZC project to ensure:

* identification of aspects of the SZC development that could impact SZB (and vice versa);
* collaborative working to identify solutions to manage those impacts; and
* safe implementation of the of the identified solutions.

NNB GenCo (SZC) noted that the strategic aim of this committee is to ensure that robust controls (operational protections) are established to maintain SZB’s operational safety, security, and licensing obligations, and that these controls support SZC’s construction programme.

At this stage of the SZC project, a complete construction safety case is not available. I have therefore sampled the documentation provided by NNB GenCo (SZC) to demonstrate that there are working arrangements in place at a senior and working level to identify hazards which may arise on one site but where the risk may manifest itself on the adjacent site and, to ensure that all parties are aware of these hazards so that they can be managed. Based on the information provided by NNB GenCo (SZC) at this stage of the SZC project [27] [39] [40], I consider that the potential for hazards to arise at SZB from SZC construction is understood and is being communicated and controlled by suitable arrangements to ensure that decision-making is informed, rational and objective and satisfies SAP MS.3.

* + - 1. Summary

As part of its site licensing justification for SZC, NNB GenCo (SZC) made the claim that operations on the site will not adversely affect the safety case for the adjoining nuclear licensed site. I have sampled the evidence associated with this claim, which has addressed a number of potential hazards to the SZB site.

I am satisfied that, overall, the SZC site as proposed may be configured to reduce the risk to the adjoining nuclear site, which is SZB. This has been evidenced by the proposed layout and the fact that, in general, buildings and their functions have been replicated at SZC from the HPC reference site. This has enabled reference to the HPC safety case for the estimation of hazard magnitude and consequences.

However, I note that there are several shortfalls to be addressed during detailed design, relating to missile, explosion, fire and building collapse. The most significant of these is the consideration and provision of suitable passive measures to protect SZB against a turbine disintegration at SZC, subject to reasonable practicability. I acknowledge NNB GenCo (SZC)’s commitment [32] to continue to study passive safety measures which could be used for protection against the turbine disintegration hazard, and to continue to develop the ALARP case for this hazard. Although this commitment is positive, I expect it to be further developed by NNB GenCo (SZC) to recognise that the solution may involve implementing more than one passive feature, a consideration that is not currently reflected in the letter of commitment [32].

I am content to support granting a nuclear site licence to NNB GenCo (SZC) for SZC from an internal hazards perspective recognising that the outstanding matters, while requiring significant effort, are appropriate for resolution at detailed design. I have raised a level 3 regulatory issue (10940) requiring NNB GenCo (SZC) to complete the optioneering of the passive safety options, providing a robust justification for the chosen options noting that the desire to achieve replication is not in itself an argument for dismissing potential options. In order to ensure that ONR has suitable sight of the optioneering work and final option justification, I consider that the closure of this regulatory issue should be tied to the release of the most relevant hold point ahead of key build activities.

Notwithstanding this, from an internal hazards perspective and with the further planned work, I consider that future operations of the site can be shown to not adversely affect the safety case of the adjoining nuclear licensed site, thereby satisfying SAP ST.5. I have drawn this conclusion acknowledging the PSA specialist’s judgement that the risks to SZB from the turbine disintegration hazard is between the BSO and BSL of SAP numerical target 8, and the risk when compared against target 9 would be below the BSO.

Comparison with Standards, Guidance and Relevant Good Practice

This assessment has been carried out in accordance with ONR’s HOW2 Guide NS PER GD 001, “The Purpose and Use of Permissioning” [41].

The standards and criteria adopted within my assessment are principally ONR’s SAPs [5], ONR’s TAGs , relevant standards [8] [7] and previous experience of good practice from other UK nuclear assessments. Relevant SAPs considered in this assessment sample are listed in Table 2.

I have sampled the prospective licensee’s submissions and assessed them against the expectations set out in this guidance and RGP. In my view, the submissions provided to support the request for granting a nuclear site licence are in line with the guidance. There are some aspects of the submission where NNB GenCo (SZC) is required to provide further confidence and deliverables; these will be tracked by regulatory issues. However, I judge that these do not preclude the granting of the SZC nuclear site licence.

Interface with Other Topic Areas

The interface with other topic areas has been managed through:

* weekly SZC specific keep in touch meetings (KITs);
* involvement of relevant specialists at turbine disintegration specific internal ONR and external meetings with NNB GenCo (SZC) including during the site visit/intervention at Sizewell held in September 2021 [42];
* regular KITs with the operating facilities DMG Lead and relevant specialist inspectors to ensure that they are kept up-to-date with the progress and to seek their views on the way forward; and
* contributions from specific specialists to sections of this assessment report.

These interactions have resulted in regular communication with specialists from external hazards, civil engineering, electrical engineering, PSA and mechanical engineering working across ONR New Reactors and Operating Facilities Divisions. Through the mechanisms described above, I have ensured regular communications between the affected specialist areas within ONR, that relevant learning is applied from other specialist areas and that the ONR team has provided a consistent approach to the internal hazards posed by the construction and operation of SZC.

ONR Assessment Rating

I have given NNB GenCo (SZC)’s GenCo’s submission a rating of ‘Amber’ in accordance with ONR’s Guidance on Mechanics of Assessment (NS-TAST-GD-096) as there has been significant regulatory intervention and guidance needed with many technical issues being raised requiring regulatory follow-up. In the case of the turbine disintegration hazard, and pending NNB GenCo (SZC)’s development and consideration of passive options, currently there is a notable shortfall against RGP or established standards when compared with appropriate benchmarks. Notwithstanding this, the shortfalls all relate to matters to be developed and closed out as detailed design progresses, these will be subject to formal tracking and close out through a regulatory issue tied to an appropriate regulatory hold point and, in my judgement, do not preclude the granting of a nuclear site licence from an internal hazards perspective.

Conclusions and Recommendations

Conclusions

This report presents the findings of the ONR assessment of internal hazards relating to the NNB GenCo (SZC) application for a NSL for a new nuclear power plant at SZC.

As part of its site licensing justification, NNB GenCo (SZC) made the claims that the SZC site is of a sufficient size to accommodate all necessary systems to ensure safe operation and that there is adequate cooling capability for all normal and fault conditions. I have seen sufficient evidence to demonstrate that the intent of these claims has been satisfied in line with relevant good practice, including justification of various building moves when compared with the layout at HPC. Several minor matters remain outstanding, which I judge appropriate to be taken forward as part of the detailed design process. These matters are outlined below and captured in a level 4 regulatory issue (10936). In my judgement, these matters do not undermine the application for a nuclear site licence, as they are predominantly concerned with detailed design and safety case evidence development.

During the development of the detailed design NNB GenCo (SZC) should address the following:

* review the potential for [REDACTED] to determine the need for additional safety measures;
* review the potential consequences of a hydrogen explosion at [REDACTED] and consider whether this might impact the location of affected plant [REDACTED] or the amount of hydrogen to be stored in [REDACTED];
* assess the potential impact of the interim spent fuel store (HHK) collapsing on to the auxiliary administration building (HUC) in a seismic event;
* review the co-location of facilities in the emergency response energy centre (HDU) to determine whether a hazard in one part of the facility could result in loss of the entire facility;
* review the hydrogen explosion source term review work being carried out for the hydrogen storage buildings (HZH) to determine whether the results affect the conclusions of Claim 6;
* provide justification on the seismic qualification of the interim spent fuel store building (HHK) with respect to its potential impact to the dry fuel storage system; and
* review the following issues in relation to the potential to cause damage to the reserve ultimate heat sink at SZB:
* seismic qualification requirements of equipment supporting the operation of the unit 1 hydrogen storage building (1HZH) to ensure the risk of consequential hydrogen releases from a seismic event has been reduced ALARP;
* potential for [REDACTED] the unit 1 hydrogen storage building (1HZH) to present a hazard to unit 1 hydrogen storage building (1HZH) or seismically qualified equipment supporting the operation of unit 1 hydrogen storage building (1HZH) by the mechanism of collapse or other internal hazard such as fire; and
* potential requirement for defence in depth measures [REDACTED] to protect key infrastructure on the SZB site from hydrogen explosion hazards arising from unit 1 hydrogen storage building (1HZH).

NNB GenCo (SZC) has also made the claim that operations on the site will not adversely affect the safety case for the adjoining nuclear licensed site. Assessment of NNB GenCo (SZC)’s turbine missile case has been the principal focus of ONR’s internal hazards assessment, as this is the most significant internal hazard related to the site licence application. This has sought to ensure that NNB GenCo (SZC) demonstrates that all reasonably practicable measures, including passive barriers (considered as relevant good practice) have been considered and adopted. Whilst NNB GenCo (SZC) has undertaken various optioneering studies in this context, it is yet to confirm that passive barriers will be implemented and demonstrate that the risks from turbine missiles to SZB are ALARP.

NNB GenCo (SZC) has committed to undertake further work to pursue additional measures including consideration of passive features. Based on the levels of risk and the commitments made by NNB GenCo (SZC), I judge that it is appropriate for the work to be progressed during the detailed design stage post-licensing. To track progress with the appropriate level of regulatory scrutiny, I have raised a level 3 regulatory issue (10940). This matter will need to be adequately resolved prior to commencement of construction of the cut-off wall, when the position of buildings and space available will become physically fixed at the site. The level 3 regulatory issue requires NNB GenCo (SZC) to continue to develop and implement options including passive measures where necessary to reduce the risks from turbine disintegration to ALARP, specifically:

* identify suitable passive measures to mitigate the effects of missiles which might be generated during a turbine disintegration event from impacting safety significant areas of the SZB nuclear power plant;
* provide a robust ALARP justification for the options selected, with due consideration to passive measures; and
* provide a robust ALARP justification for any measures not progressed into detailed design on the basis of gross disproportion.

Recommendations

My recommendation is as follows:

* I recommend that from an internal hazards perspective a nuclear site licence should be granted to NNB GenCo (SZC) to construct and operate a nuclear power station at Sizewell C.

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Table 2: Relevant Safety Assessment Principles (SAPs) considered during the assessment

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| SAP No. | SAP Title | Description |
| EHA.1 | Identification and characterisation | An effective process should be applied to identify and characterise all external and internal hazards that could affect the safety of the facility. |
| EHA.14 | Fire, explosion, missiles, toxic gases etc – sources of harm | Sources that could give rise to fire, explosion, missiles, toxic gas release, collapsing or falling loads, pipe failure effects, or internal and external flooding should be identified, quantified and analysed within the safety case. |
| EKP.3 | Defence in depth | Nuclear facilities should be designed and operated so that defence in depth against potentially significant faults or failures is achieved by the provision of multiple independent barriers to fault progression. |
| EKP.5 | Safety measures | Safety measures should be identified to deliver the required safety function(s). |
| ELO.4 | Minimisation of the effects of incidents | The design and layout of the site, its facilities (including enclosed plant), support facilities and services should be such that the effects of faults and accidents are minimised. |
| MS.3 | Decision making | Decisions made at all levels in the organisation affecting safety should be informed, rational, objective, transparent and prudent. |
| ST.4 | Suitability of the site | The suitability of the site to support safe nuclear operations should be assessed prior to granting a new site licence. |
| ST.5 | Effect on other hazardous installations | The safety case should take account of any hazardous installations on or off the site that might be affected by an incident at the nuclear facility. |
| ST.6 | Multi-facility sites | On multi-facility sites, the safety case should consider the site as a whole to establish that hazards from interactions between facilities have been taken into account. |

1. CM9 revision to be identified upon completion of activity and incorporation of any changes to document. [↑](#footnote-ref-1)
2. Where required in accordance with [NS-PER-GD-016](https://how2.prod.onr.gov.uk/CtrlWebIsapi.dll/D2B97868F9C04F9F97117C7B56DFC8B7.cwl?__id=webFile.save&doc=3B55AFB1AFAC46B48A5EF6D7C306666C&dpt=1&save=1). [↑](#footnote-ref-2)
3. Hard-copy of document signed-off, CM9 version updated with authors / approver / acceptor names and dates and record finalised [↑](#footnote-ref-3)