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| ONR Assessment Report  Internal hazards proportionate reassessment of an application by Sizewell C Limited (SZC Ltd) for a Nuclear Site Licence |



ONR Assessment Report

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**Report Title**: Internal hazards proportionate reassessment of an application by Sizewell C Limited (SZC Ltd) for a Nuclear Site Licence

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# Executive Summary

This report presents the findings of the internal hazards aspects of the Sizewell C Limited (SZC Ltd) application for a nuclear site licence to construct and operate two UK EPR™ reactors at Sizewell C (SZC).

An initial assessment was completed in June 2022. This report presents the findings of a proportionate reassessment, focused on matters that have changed, and does not repeat the earlier assessment. This proportionate reassessment has examined new information that has been shared through meetings and engagements which warrants interim 'review' to give confidence in the progress on resolution of outstanding internal hazard issues. These issues were identified either within the original internal hazards assessment report for SZC Ltd licensing and captured within Regulatory Issues 10936 and 10940 or during engagements on progress on the general safety case for turbine disintegration.

The assessment is based on evidence obtained during interactions with SZC Ltd, on specific topics and arrangements, including key project enabling activities. It also draws on the significant cross cutting work carried out by the Office for Nuclear Regulation (ONR) as part of the delivering the proportionate reassessment.

The main points from this work are:

* SZC Ltd is still in the process of developing and writing its safety case for turbine disintegration. At this point no issues have been identified by myself or other inspectors involved in the engagements with SZC Ltd which would significantly undermine the safety case being developed by SZC Ltd for turbine disintegration. There are a number of unresolved issues which are yet to be communicated to ONR:
  + design of the passive protection;
  + underpinning of the initiating event frequencies for runaway overspeed (ROS); and
  + demonstration that risk from all missiles (generated by a turbine disintegration) is as low as reasonably practicable (ALARP).

However, SZC Ltd will address these areas in the safety case for turbine disintegration which will take the form of a Licence Summary Statement and these issues can be resolved post-licensing. ONR will assess this safety case to ensure that risks from turbine disintegration are reduced ALARP.

Key to the safety case is that SZC Ltd must demonstrate that the risks to Sizewell B from all missiles need to be reduced to ALARP including progression of the optioneering, design and implementation of all reasonably practicable measures, as agreed by ONR and SZC Ltd which SZC Ltd will address in the safety case.

* I have reviewed the progress made by SZC Ltd on the eight actions raised under Regulatory Issue 10936 and am content that work is ongoing to address the issues addressed therein. SZC Ltd’s updates to the actions provide me with assurance that work is progressing and that my review of SZC Ltd’s progress is that it is in line with the assessment scopes and the timelines for resolution are adequate. Where issues have not yet been resolved, I am content that alternative options are available to mitigate the risk which, if required, can be progressed at engineering design to reduce the risks ALARP.

Taking these points into account, the overall judgement for internal hazards is that SZC Ltd is ready to be granted a NSL for the proposed development at Sizewell C, noting that future permissioning hold points will provide ONR with the opportunity to assess the adequacy of the internal hazards case, once it has been further developed by SZC Ltd. From an internal hazards perspective, it is recommended that a nuclear site licence is granted to SZC Ltd for the proposed development at Sizewell C.

# List of Abbreviations

|  |  |
| --- | --- |
| ALARP | As Low As Reasonably Practicable |
| BSL | Basic Safety Level |
| BSO | Basic Safety Objective |
| C&I | Control and Instrumentation |
| CNEPE | Centre Nationale d’Equipment de Production d'électricité |
| EASL | Engineering Analysis Services Limited |
| EDF NGL | Electricité de France Nuclear Generation Limited |
| EPR | European Pressurised Water Reactor |
| FST | Full Stroke Test |
| GE | General Electric |
| HDU | Emergency Response Energy Centre |
| HGF | Essential Service Water Gallery Train 1 |
| HGG | Essential Service Water Gallery Train 2 |
| HHD | Contaminated Tool Storage |
| HHE | Back-up Emergency Equipment Store |
| HHK | Interim Spent Fuel Store |
| HHW | Conventional Waste Storage |
| HJA | Auxiliary Transformer Platform |
| HP | High Pressure |
| HPC | Hinkley Point C |
| HTE | Gas Insulated Switchgear |
| HTP | Main Transformer Platform |
| HTS | Unit Transformer Platform |
| HUC | Auxiliary Administration Building |
| HUD | Security Administration Building |
| HUM | Emergency Response Centre |
| HZC | Chemical Products Storage |
| HZG | Oil and Grease Storage |
| HZH | Hydrogen Storage |
| HZN | Hydrazine Storage |
| IAEA | International Atomic Energy Agency |
| IP | Intermediate Pressure |
| LRF | Large Release Frequency |
| NGL | EDF Nuclear Generation Limited |
| NOP | Normal Operation |
| NOS | Normal Overspeed |
| NSL | Nuclear Site Licence |
| OEM | Original Equipment Manufacturer |
| ONR | Office for Nuclear Regulation |
| OPEX | Operational Experience |
| PAR | Project Assessment Report |
| PFD | Probability of Failure on Demand |
| PSA | Probabilistic Safety Analysis |
| RGP | Relevant Good Practice |
| RI | Regulatory Issue |
| ROS | Runaway Overspeed |
| SAPs | Safety Assessment Principles |
| SFR | Safety Functional Requirements |
| SFRN | Safety Functional Requirements Note |
| SZB | Sizewell B site |
| SZC | Sizewell C site |
| SZC Ltd | Sizewell C Limited |
| TAG | Technical Assessment Guide |
| TPCS | Turbine Protection and Control System |

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# Introduction

1. This report presents ONR’s findings from its proportionate reassessment of the internal hazards aspects of an application by Sizewell C Limited (SZC Ltd) for a nuclear site licence (NSL) to install and operate a twin EPR™ nuclear power station at Sizewell C (SZC) in Suffolk.

## Background

1. On 30 June 2020, SZC Ltd (then known as NNB Generation Company (SZC) Ltd) applied to ONR for a NSL to install and operate a nuclear installation at a site located at Sizewell on the east coast of England, near Leiston, Suffolk.
2. ONR’s assessment of the evidence provided with the licence application was undertaken during the period from July 2020 to May 2022. That assessment is set out in a series of ONR assessment reports and summarised in a Project Assessment Report (PAR). These reports are all published on ONR’s website ([Sizewell C Licensing Assessment](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c.htm)) and are listed in Appendix 1 of this document.
3. A statement issued on the ONR website on 11 July 2022, noted that:

* the licence assessment concludes that the application has met almost all the regulatory requirements set out in regulatory guidance; and
* there are two outstanding matters which require resolution prior to the formal granting of a licence.

1. The first of those matters related to the ownership (security of tenure) of the land intended for the licensed site area. Our regulatory guidance [Licensing Nuclear Installations](https://www.onr.org.uk/licensing-nuclear-installations.pdf) [1] states that a nuclear site licensee is expected to have ‘full rights of access to and control of’ the site upon which the nuclear site will operate. At that time SZC Ltd did not have such rights to the land proposed for the SZC development and this therefore needed to be resolved prior to licence grant.
2. The second issue relates to the then current shareholder agreement. As the licensee should be able to exercise effective day-to-day control over all activities on the licensed site, it is essential there is clarity on how that responsibility can be exercised. The then current shareholder agreement for the development phase of the SZC project placed control of key policies relating to safety and security with NNB Holding Company (SZC) Ltd, rather than the licence applicant. This is inconsistent with our regulatory expectations, and we would require control of such policies to rest with the applicant prior to the granting of a licence. Consequently, SZC Ltd provided ONR with a commitment letter, which sets out how it intends to address this shortfall [2].
3. The ONR statement went on to note that when those matters are resolved, ONR would carry out a proportionate reassessment of the application, focused on the two outstanding matters and any other relevant matters relating to licensing that may emerge during the intervening period. The internal hazards assessment report for licensing [3] identified a number of issues which needed to be resolved after licensing but prior to commencement of particular construction activities. Since this reassessment is being carried out two years after the original licensing assessment was completed, I conducted an assessment of internal hazards to report on progress and confidence gained in resolution of these issues. Ultimately, the aims are to confirm whether these matters are being progressed adequately and to ensure that there are no new issues which would now preclude licensing of SZC.
4. This report sets out ONR’s findings from its reassessment of the internal hazards area. The report’s findings will inform the PAR which will summarise ONR’s conclusions from its reassessment work and will make a recommendation to the Chief Nuclear Inspector on whether the licence should be granted.

## Scope

1. The reassessment scope for internal hazards is limited to:

* progress made on Regulatory Issue 10940 – development and implementation of options including passive measures to reduce the risks from turbine disintegration to ALARP; and
* progress made on Regulatory Issue 10936 – identification, characterisation and consequences of hazards with the potential to propagate to or impact nearby buildings and facilities.

# Assessment Standards and Interfaces

1. ONR has a range of internal guidance to enable inspectors to undertake a proportionate and consistent assessment of nuclear safety cases.   
   This section identifies the standards which have been considered in this assessment. This section also identifies the key interfaces with other technical topic areas.

## Standards

1. The relevant standards and criteria adopted within this assessment are principally the Safety Assessment Principles (SAPs) [4], Technical Assessment Guides [5], relevant national and international standards and relevant good practice informed from existing practices adopted on UK nuclear licensed sites. The key guidance is identified below and referenced where appropriate within Section 4 of this report. Relevant good practice (RGP), where applicable, has also been cited within the body of this report.

### Safety Assessment Principles (SAPs)

1. The following SAPs were used as part of this assessment:

* EKP.3 – 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 should be identified to deliver the required safety function(s).
* ELO.4 – 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.
* SC.4 – A safety case should be accurate, objective and demonstrably complete for its intended purpose.

### Technical Assessment Guides (TAGs)

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

* NS-TAST-GD-014 (Rev. 7.1) – Internal hazards.
* NS-TAST-GD-051 (Rev. 7.1) – The purpose, scope and content of safety cases.
* NS-TAST-GD-005 (Rev. 12) – Regulation of duties to reduce risks to ALARP.
* NS-TAST-GD-096 (Rev. 0) – Guidance on mechanics of assessment.
* NS-TAST-GD-108 (Rev. 1) – Guidance on the production of reports for permissioning and assessment [7].

### National and International Standards and Guidance

1. National and international standards and guidance have been referenced where appropriate within the assessment report.

### Integration with Other Assessment Topics

1. The following specialisms have supported my assessment:

* control and instrumentation
* civil engineering
* probabilistic safety analysis (PSA)
* structural integrity
* mechanical engineering.

1. The outcomes of each of these assessments are either reported separately and will be summarised in the PAR or are reported within the relevant sections of this document.

## Use of Technical Support Contractors

1. No technical support contractors have been used in this assessment.

# Applicant’s Submission

1. This assessment has focused on the new work that has been carried out by SZC Ltd to resolve the issues identified within the original internal hazards assessment report for SZC Ltd licensing [3] and captured within Regulatory Issues 10936 and 10940. The information provided to ONR by SZC Ltd and considered is detailed within Section 4. No documents submitted as part of SZC Ltd’s NSL original application dossier have been submitted as new revisions to ONR in relation to the internal hazards safety case. However, SZC Ltd has submitted a safety case strategy [8] and documents supporting the two confidence building reviews [9] [10] held to-date. I have reviewed these documents as part of this reassessment for licensing.

# ONR Assessment

## Assessment Strategy

1. ONR’s strategy for the proportionate reassessment of SZC Ltd’s licence application [11] affirms that the principles by which ONR would undertake and reach a conclusion on its reassessment would be the same as those applied during the original assessment during 2020-22 [12]. It notes that as we have already undertaken a robust and extensive assessment of SZC Ltd’s case for licence grant, in undertaking a reassessment we will target our re-examination only on the outstanding matters and those areas of the application where we consider that there are or may be:

* changes in the applicant company impacting the basis for aspects of our previous licensing judgement (e.g., resource, capability, arrangements, tools etc); and/or
* new information that may warrant a re-examination of relevant areas of the application, including relevant operational experience (OPEX) from other EPR™ or relevant new reactor projects.

1. The reassessment strategy is supplemented by a licensing assessment plan [13]. This document provides information and guidance to ONR’s specialist inspectors involved in the assessments, including a timetable for production of reports required to inform the PAR.
2. This report covers the proportionate reassessment of the internal hazards area.

## Assessment outcomes

1. As explained above this assessment has focused on new information that has been shared through meetings and engagements which warrants interim 'review' to give confidence in the progress on resolution of outstanding internal hazard issues. These issues were identified either within the original internal hazards assessment report for SZC Ltd licensing [3] and captured within Regulatory Issues 10936 and 10940 or during engagements on progress on the general safety case for turbine disintegration as captured within presentations [9] [14] and contact records [15] [16].

### Turbine Disintegration – Regulatory Issue 10940

1. In my assessment report for licensing SZC Ltd I assessed SZC Ltd’s consideration of the turbine disintegration hazard, which presents an additional risk to the neighbouring Sizewell B (SZB) site. My assessment concluded that SZC Ltd had not yet demonstrated that the risks to SZB will be reduced to as low as reasonably practicable (ALARP). As a result of this I raised a regulatory issue which comprised two specific actions:

Action 1 – SZC Ltd to 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.

Action 2 – SZC Ltd to provide a robust ALARP justification for the options selected, with due consideration to passive measures and for any measures not progressed into detailed design on the basis of gross disproportion.

1. The progress made on these two actions is considered below along with general development of the safety case for turbine disintegration.
2. RGP with respect to the hazard of turbine disintegration is summarised in ONR TAG 14 [6] which references out to International Atomic Energy Agency (IAEA) guidance [17] 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.
3. 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 [18]. Hence, the SZC location and layout do not meet ONR initial expectations for a favourable layout or SAP ELO.4.
4. SZC Ltd claims that the increased risks to SZB from the turbine disintegration hazard lie between the Basic Safety Level and the Basic Safety Objective [19], i.e. the risks are tolerable if shown to be ALARP.
5. 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 [4] 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 SZC Ltd that passive safety measures should be preferentially considered and progressed unless they are demonstrated to be grossly disproportionate versus the risks averted [20] [21] [22].
6. Since [3] was issued and Regulatory Issue 10940 raised, SZC Ltd has issued a safety case strategy [8] explaining how the turbine disintegration issue will be addressed and has held two confidence building reviews with ONR [15] [16] detailing how the safety case will be built. These confidence building reviews explained how the safety case will be multi-legged (comprised of four legs) as follows:
7. Integrity of Turbine Rotor
8. Turbine Failure Mode Analysis
9. Reduction in Runaway Overspeed Initiating Event Frequency
10. Provision of passive protection mechanisms.
11. The two confidence building reviews held to-date have addressed the following topics:

* missile characterisation, high-level update and review of risks – July 2023 [15]; and
* structural integrity and failure mode review – January 2024 [16].

1. These reviews have focused predominantly on the structural integrity safety case being developed for SZC turbine disintegration but have included information on the other legs of the multi-legged safety case. Since the safety case approach covers multiple specialist areas within ONR, I have involved a number of specialist inspectors in the related confidence building reviews and sought their views regarding the direction and development of the safety case so far.
2. SZC Ltd’s intent is to demonstrate that the potential risk to SZB from a turbine disintegration event (at SZC) has been reduced to ALARP. Fundamental to SZC Ltd’s approach is work being carried out on its behalf by the manufacturer of the turbine, General Electric (GE). A key aspect of the turbine disintegration safety case is identification of the bounding missile which for previous turbine disintegration safety cases has been considered to be a 1/3 disc missile. SZC Ltd and GE explained in the first confidence building review [15] that due to modern manufacturing techniques, materials of manufacture and inspection during commissioning and outages, modern turbines are much more resilient and robust than older turbines resulting in the bounding missile [23] now being a rotor shaft end (which is significantly lower in energy than the previous bounding missile). SZC Ltd stated [23] that it is designing the passive protection measures on this revised bounding missile.
3. The structural integrity aspects of the SZC turbine disintegration safety case are predominantly addressed by legs a) and b) of the strategy and are focused on the structural integrity arguments being made by the turbine manufacturer GE. The ONR structural integrity inspector was a key party involved in both confidence building reviews held so far and has provided a summary of the work done to-date by GE and SZC Ltd on turbine disintegration and its own understanding of the issue [24] [25].
4. The structural integrity inspector noted that SZC Ltd is yet to provide any safety case for the turbine and the passive barrier; hence the discussion below is purely based on interactions held with SZC Ltd/GE during early engagements and a review of relevant supporting references.
5. The structural integrity inspector noted that the scope of the second confidence building review [16] was restricted to the turbine integrity aspects only, which directly supports the structural integrity leg of the overarching safety case. The main objective was for SZC Ltd to demonstrate to ONR that it has sufficient confidence in the work undertaken by itself as well as GE as the original equipment manufacturer (OEM), to judge that whilst the “legacy” disc failure (1/3rd) is “extremely unlikely”, it is “more likely” that the rotor support end would fail.
6. The structural integrity inspector understood from the workshop that SZC Ltd supported by GE and Engineering Analysis Services Ltd (EASL) is confident on the integrity and most likely failure mode of the Arabelle turbine. From the sampling and review of the documents and discussion with GE experts, the structural integrity inspector obtained clarity on GE’s current integrity arguments for the turbine and its probable failure mechanism, and noted that whilst there is no safety classification for the turbine, GE et al have however undertaken a substantial amount of work to produce evidence which is largely aligned with the regulatory expectations for a highest reliability component.
7. Overall, whilst GE will be providing further information on realistic failure progression, based on the available information/assessment work etc and discussion held with GE SMEs on turbine behaviour, the structural integrity inspector concluded that GE’s judgment on “low likelihood” of the legacy missile seems credible at this point when compared with the rotor shaft end failure [26] [27].
8. Leg c) of the safety case relates to changes being made to the turbine protection and control system (TPCS). This system contains both control and instrumentation (C&I) and mechanical elements for which I have engaged with both the C&I and mechanical engineering ONR inspectors assigned to the SZC project. The C&I inspector states [28] that “a high level outline of the C&I changes was provided at the first confidence building review. The C&I changes are part of leg c) of the safety case, “reduction in runaway overspeed initiating frequency”; SZC Ltd’s intention is to upgrade the TPCS in order to increase the reliability of the overspeed prevention and protection and hence reduce the likelihood of a runaway overspeed of the turbine.”
9. The C&I inspector stated that the details on how the reliability claims will be increased is not yet clear. However, this will be followed up at the next planned confidence building review that will provide the opportunity for SZC Ltd to provide more details on its planned approach to the C&I systems which provide turbine protection at SZC.
10. The ONR mechanical engineering inspector stated that [29] it initially held a level 4 meeting [30] with SZC Ltd in August 2023 which provided an overview of the mechanical engineering related modifications being proposed to align with its claims in relation to turbine disintegration. These were summarised as:

* on-load full stroke testing of the steam admission system will be performed weekly to demonstrate that the systems function as per the safety case requirements;
* additional hydraulic trip circuit within the turbine governor system design (Class 1 / Class 2) to provide diversity, redundancy and segregation / separation claims; and
* electrical building heating, ventilation and air-conditioning system modifications (Class 2) may be required to mitigate additional heat loads from the C&I cabinets and cubicles.

1. The mechanical engineering inspector sampled documentation related to the on-load stroke testing and requested additional information from SZC Ltd. The mechanical engineering inspector will be following up its queries at the next confidence building review, which considers the turbine protection and control system.
2. At this point, the mechanical engineering inspector stated that it has not identified any aspects that it considers to be of concern. The questions asked by the mechanical engineering inspector are around clarification rather than significant shortfalls identified. The mechanical engineering inspector noted that it has a suitable level of confidence at this time, that SZC Ltd should be able to demonstrate that the mechanical engineering related changes are in line with regulatory requirements, modern standards and reduce risk so far as is reasonably practicable.
3. The probabilistic safety analysis (PSA) inspector also attended the first confidence building review and noted that subsequently [31], of the completed underpinning analysis for leg c), it has looked at two references made available to ONR [32] [33].
4. The PSA inspector notes that the runaway overspeed initiating event frequency is based on the failure of high pressure (HP) valve set (stop valve and control valve). The reliability claims will apply to only the HP valve set. There is no requirement of stringent claims on the intermediate pressure (IP) value set as these valves do not contribute to a runaway overspeed possibility. The justification of the claims above is presented in [32]. An underpinning calculation to support the reliability calculations based on the full stroke test (FST) cycle for the HP valve set is presented in [33].
5. The PSA inspector advised that it looked at the basis of evaluation of the probability failure on demand (PFDs) for 1oo2 HP admission lines and 1oo2 IP admission lines not closing [33].
6. The PSA inspector performed an independent sample check of the calculations for IP valves, and its results tallied with those in the paper [33]. The calculations are aimed at demonstrating that the FST interval does not significantly impact the reliability of the valve set functionality. The PSA inspector agrees with this view based on the reliability calculations.
7. Additionally, the PSA inspector performed a sensitivity study to see the impact of changes to the dangerous failure rate. The PSA inspector concluded that the conclusion on FST is not dependent on value of dangerous failure rate which is based on field experience (OPEX) and was, therefore, content with the underpinning calculations to support leg c) of the safety case strategy. In summary, the PSA inspector has reviewed the available reliability data but notes that the higher level claim on runaway overspeed (ROS) initiating event frequency of the leg c) still remains to be justified.
8. The ROS failure rate considered by the PSA inspector noted below from [19] includes an initiating event frequency of 10-5 per turbine per year. This is consistent with the expected failure rate provided by SZC Ltd [23] where SZC Ltd considers failure of the rotor shaft end to be the bounding missile (from a frequency perspective). The normal overspeed (NOS) failure rate quoted in [19] is 2.5x 10-5 per turbine per year. SZC Ltd notes [23] that potential failure mechanisms at normal speeds (up to 120%) would all terminate in ejection of shaft ends (at worst). As before, SZC Ltd considers the bounding missile to be the rotor shaft end and expects the frequency of failure to be in the 10-5 – 10-6 range [23]. Thus all frequencies expected by SZC Ltd are bounded by those proposed previously by SZC Ltd in its preliminary ALARP analysis which is the basis for the PSA inspector’s conclusions shown below. The structural integrity inspector was content that for NOS/ROS, the “10-5 per turbine year” claim by SZC Ltd has been underpinned based on recorded operating hours and is, therefore, deemed to be acceptable from structural integrity considerations [27].
9. The PSA inspector noted [34] that with the previously considered ROS frequency, the large release frequency (LRF) for SZB due to the SZC turbine disintegration nearly doubles the baseline LRF [19] for SZB.  SZC Ltd has not formally shared updated probabilistic risk estimates with ONR, however SZC Ltd expects that the additional risk to SZB will be significantly reduced in comparison to these initial estimates [35]. Based upon information presented within EC367290 [36] the SZB societal risk (SAPs Target 9) is above the basic safety objective (BSO), but below the basic safety level (BSL), at 2.95E-6 per year without the SZC turbine disintegration effects. The PSA inspector noted that it would expect the SZB societal risk to remain below the BSL when SZC turbine missiles are included, but with a significantly reduced margin to the BSL. Therefore, the advice remains the same, i.e. the risk to SZB must be reduced ALARP.
10. Leg d) of the safety case relates to the provision of passive protection mechanisms. The design for the passive protection measures is still being developed by SZC Ltd. SZC Ltd has presented preliminary considerations during the first confidence building review and further developments during the recent meeting held [37]. However, this work is not yet complete. The ONR civil engineering inspector attended the first confidence building review and notes [38] that from a civil engineering perspective, SZC Ltd has undertaken studies on possible barriers to mitigate against the effect of turbine disintegration as part of the turbine hall structure. These studies have considered steel plate up to 180 mm thick on the southern wall and SZC Ltd stated that such an additional mass would likely be able to be accommodated without incurring re-design costs in gross disproportion to the mitigated risk.
11. The ONR civil engineering inspector notes that SZC Ltd is still developing its safety case for turbine disintegration. To this end, detailed design of the barrier has, therefore, not yet been undertaken, but SZC Ltd has shared some high-level optioneering concepts with ONR. SZC Ltd presentations to date provide ONR with confidence in a barrier being feasible. However, SZC Ltd has not yet submitted a safety case providing ALARP judgements, including any residual risk. The ONR civil engineering inspector notes that from the limited information presented to date, there is evidence that a barrier could be designed and incorporated, noting that the missile characterisation work and potential interaction with the barrier is ongoing.
12. SZC Ltd is still in the process of developing and writing its safety case for turbine disintegration. There are a number of unresolved issues which are yet to be communicated to ONR:

* design of the passive protection;
* underpinning of the initiating event frequencies for runaway overspeed (ROS); and
* demonstration that risk from all missiles is ALARP.

1. SZC Ltd will address these areas in the safety case for turbine disintegration which will take the form of a Licence Summary Statement. ONR will assess this safety case to ensure that risks from turbine disintegration are reduced ALARP.
2. SZC Ltd claimed that since it is not considering the turbine to be of highest reliability, it is considering credible missiles and developing options to minimise impact on SZB in the vicinity [23] [39]. The current option SZC Ltd is developing is to strengthen the turbine building wall facing SZB against impacts from the rotor shaft end missile. I consider that for SZC Ltd to demonstrate that it has reduced the risks to SZB ALARP, it must consider the risks arising from all missiles, not just the rotor shaft end missile. This is consistent with SAP SC.4 “A safety case should be accurate, objective and demonstrably complete for its intended purpose.” ONR made it clear that it expected SZC Ltd to consider all credible missiles to inform the final design [39] including SZC Ltd’s optimisation on barrier design (e.g., webbed plate providing enhanced strength to mass ratio). SZC Ltd confirmed that its approach would address the risks from all credible missiles ( [39] and [37]). As a result, I am content with the proposed multi-legged safety case approach as outlined above but note that should SZC Ltd employ a gross disproportion argument with regard to the provision of passive protection against specific types of missiles, it needs to provide robust evidence to justify that position.
3. The ONR Operating Reactors team has attended the confidence building reviews and regular meetings are held between the ONR New Reactors and Operating Reactors teams (both collectively and within specialisms) to ensure a common understanding of the case being made by SZC Ltd and to feed into the assessment process any concerns held by the Operating Reactors team. In addition, EDF Nuclear Generation Limited (NGL) at SZB has also been heavily engaged with the development of the turbine disintegration safety case, attending key meetings with SZC Ltd, reviewing key safety case documentation and producing a strategy for addressing the turbine disintegration issue within the SZB safety case, which will be submitted to the ONR Operating Reactors team for review/assessment.
4. At this point no issues have been identified by myself or other inspectors involved in the engagements with SZC Ltd which would significantly undermine the safety case being developed by SZC Ltd for turbine disintegration. I have confidence that the issues identified above can be resolved as the safety case is developed by SZC Ltd (which is currently due to be issued to ONR by the end of September 2025). Key to the safety case is that SZC Ltd must demonstrate that the risks to SZB from all missiles need to be reduced to ALARP including progression of the optioneering, design and implementation of all reasonably practicable measures, as agreed by ONR and SZC Ltd [39] [40].

### Hazards which may propagate to or impact nearby facilities – Regulatory Issue 10936

1. In my assessment report for licensing SZC I identified that there are a number of hazards on the SZC site which have the potential to propagate to or impact nearby buildings or facilities. As a result of this I raised a regulatory issue which comprised several specific actions:

Action 1 – SZC Ltd to review the potential for [REDACTED] to determine the need for additional safety measures.

Action 2 – SZC Ltd to 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]

Action 3 – SZC Ltd to assess the potential impact of the interim spent fuel store (HHK) collapsing on to the auxiliary administration building (HUC) in a seismic event.

Action 4 – SZC Ltd to 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.

Action 5 – SZC Ltd to 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.

Action 6 – SZC Ltd to 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.

Action 7 – SZC Ltd to 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] 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;
* 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).

Action 8 – SZC Ltd to assess the potential impact of the contaminated tool storage (HHD) collapsing on to the back-up emergency equipment store (HHE) in a seismic event

1. SZC Ltd provided me with a progress statement on these actions [41]. Actions 2, 5 and 7 relate to the risk of hydrogen explosions on the SZC site and the hazard this might pose to other facilities on either the SZB or SZC sites. SZC Ltd has confirmed that a SZC specific explosion study has been delivered for review and that wider demonstration that the risks due to the positioning of the [REDACTED] have been reduced ALARP will be presented in a subsequent [REDACTED] report (expected quarter 2 2024).
2. The documentation related to these two aspects of the hydrogen explosion issues will be assessed when they become available. Whilst I have not yet been able to assess the content of the evidence, I am satisfied that SZC Ltd has been addressing the issues in line with the actions in the regulatory issue. I have identified no new issues beyond those already identified in the previous assessment report [3] (and discussed in this section) and, as for this previous assessment report, 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). Therefore, where matters are still outstanding, I have confidence that these can be resolved after the granting of a nuclear site licence.
3. For actions 1, 3, 4, 6 and 8 I asked SZC Ltd for further information [41].

Action 1

1. SZC Ltd has advised that the Centre National d'Équipement de Production d'Électricité (CNEPE) has produced several de-risking analyses based on its methodology on Hinkley Point C (HPC) fire domino effects analysis. SZC Ltd advises that this has not yet been formally delivered for review but SZC Ltd is confident that this will be done by the due-date and that SZC Ltd has seen the key sections.
2. SZC Ltd advises that the report concludes that no classified buildings in or adjacent to the [REDACTED] are at risk due to a fire in any adjacent building as the proposed separation distances are shown to be adequate.
3. I have asked SZC Ltd to confirm that the effects of other hazards has also been considered. SZC Ltd has confirmed [41] that other relevant hazards have also been addressed for the SZB site. I note that the other key hazard identified by [3] which may result in domino effects on the SZC site is explosion which is addressed by actions 2, 5 and 7. I am, therefore, content that SZC Ltd is adequately progressing the issue of [REDACTED] and 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 fire for all the hazardous buildings co-located in this location.

Action 3

1. SZC Ltd has advised that it considers this to be low risk due to separation as demonstrated in de-risking studies [42].
2. SZC Ltd noted that a comprehensive scope of work is planned this year for ancillary buildings scope (Hazards Gap Assessment, Hazard Protection Schedule, Safety Functional Requirements Note, Civil Safety Functional Requirements (SFR)) which will ratify the position.
3. SZC Ltd states [41] that there would be options to mitigate the risk if the planned work does not validate the scoping work conclusions, such as:

* reducing the size of the HHK such that its northern extent is reduced;
* include seismic qualification in the design requirements of the structure such that it is robust to earthquake; and
* install protection between HUC and HHK such that the HUC would be protected from the collapse of HHK.

1. I am, therefore, content that SZC Ltd is adequately progressing the potential impact of the interim spent fuel store (HHK) collapsing on to the auxiliary administration building (HUC) in a seismic event and that alternative options are available to mitigate the risk which if required can be progressed at engineering design to reduce the risks ALARP.

Action 4

1. SZC Ltd considers this issue to be low risk on the basis of the de-risking work it has carried out [41] and that there are options to mitigate hazards. SZC Ltd noted that this could even involve returning to the previous Reference Configuration 1.2 HUC arrangement at HPC whereby the security administration centre (HUD), the emergency response centre (HUM) and the emergency response energy centre (HDU) were in separate buildings. However, SZC Ltd judges this to be unlikely given the options available to mitigate hazards. The HUC was separated on HPC in order to meet the operational needs. A single HUC building was not feasible to be constructed due to the geotechnical concerns for the proposed location at HPC and the lack of availability of the plot for development due to construction sequencing issues associated with the heavy haul crane.
2. SZC Ltd added that a comprehensive scope of work is planned this year for ancillary buildings scope (Hazards Gap Assessment, Hazard Protection Schedule, Safety Functional Requirements Note (SFRN), Civil SFR).
3. I am, therefore, content that SZC Ltd is adequately progressing the issue of 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 facilities and that alternative options are available to mitigate the risk which if required can be progressed at engineering design to reduce the risks ALARP.

Action 6

1. SZC Ltd noted [41] that a scope of work is planned this year for the SZC ancillary buildings scope (Hazards Gap Assessment, Hazard Protection Schedule, SFRN, Civil SFR).
2. SZC Ltd noted that HHK design is still in preliminary stages at HPC so the work for the SZC case will likely be a holding statement based on latest developments. SZC Ltd noted also that it will aim to replicate the HPC approach (i.e. no classification other than the foundation slab). SZC Ltd considers this to be a low risk given the impact cases demonstrated within the design basis of the Hi-Storm cask (e.g. aircraft impact and turbine missiles).
3. I emphasized to SZC Ltd that I would expect defence in depth to be considered within the HHK design. SZC Ltd noted [41] that the design of HHK will be carried out in line with its engineering design process which includes safety case requirements for design inputs developed through the process Manage Safety Reports including consideration of define in depth through the Nuclear Safety Design Assessment Principles. As such, SZC Ltd claims that defence in depth is considered within the design development of HHK.
4. I am, therefore, content that SZC Ltd is adequately considering the 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 that additional engineering measures which if required can be progressed at engineering design to reduce the risks ALARP.

Action 8

1. SZC Ltd noted that de-risking had shown that the collapse radius of the HHD building was not sufficient to present a risk to the HHE [42].
2. SZC Ltd added that the de-risking is considered to have been undertaken using a bounding building envelope, which may be reduced in detailed design. If a superstructure is required to meet the requirements of the long term installation (which is yet to be confirmed), and its collapse radius could reach HHE, SZC Ltd confirmed that design options to manage could include:

* reducing the size of the HHD such that its collapse radius does not reach HHE (likely feasible as the original design appears to be conservative considering input from SZB operational requirements);
* a potential increase in the gap between the buildings to eliminate the risk (if required);
* inclusion of seismic qualification in the design requirements of the HHD structure, such that it is robust to earthquake; and
* installation of protection between HHD and HHE such that the HHE would be protected from the collapse of HHD.

1. I am, therefore, content that SZC Ltd is adequately progressing the potential impact of the contaminated tool storage (HHD) collapsing on to the back-up emergency equipment store (HHE) in a seismic event and that alternative options are available to mitigate the risk which if required can be progressed at engineering design to reduce the risks ALARP.
2. I have reviewed the progress made by SZC Ltd on the eight actions raised under Regulatory Issue 10936 and am content that work is ongoing to address the issues addressed therein. SZC Ltd’s updates to the actions provide me with assurance that work is progressing. My review of SZC Ltd’s progress is that it is in line with the assessment scopes and that the timelines for resolution are adequate. Where issues have not yet been resolved, I am content that alternative options are available to mitigate the risk which, if required, can be progressed at engineering design to reduce the risks ALARP. As a result, I am content that the issues identified within Regulatory Issue 10936 may be resolved satisfactorily and that the risks arising from the associated hazards can be shown to be ALARP.

# Conclusions and Recommendations

## Conclusions

1. This report presents the proportionate reassessment of the internal hazards area of SZC Ltd’s application for a NSL.
2. SZC Ltd has not yet submitted its safety case to ONR for turbine disintegration as work is ongoing. My conclusions regarding turbine disintegration are drawn from early engagement ahead of the safety case submission.
3. I have concluded that for both the regulatory issues derived from the internal hazards assessment for licensing, SZC Ltd has made adequate progress. For both issues SZC Ltd still has considerable work to carry out but the engagements held with ONR and evidence submitted have provided confidence that the issues are surmountable. ONR will continue to engage with SZC Ltd and will assess the turbine disintegration safety case in line with the safety case, design development and hold point control plans to satisfy itself that the risks arising from SZC Ltd operations (to both the SZC and SZB sites) are reduced ALARP.
4. SZC Ltd has demonstrated progress against the regulatory issues in line with the expected safety case and design development timelines, and no new issues have arisen from this assessment. My overall conclusion, as per the previous assessment report is, therefore, that SZC Ltd is ready to be granted a NSL for the proposed development at Sizewell C, noting that future permissioning hold points will provide ONR with the opportunity to assess the adequacy of the internal hazards case, once it has been further developed by SZC Ltd.

## Recommendations

1. Based on my proportionate assessment of the internal hazards area, I recommend that a licence is granted to SZC Ltd noting that ONR will assess the adequacy of the internal hazards safety case at appropriate future permissioning hold points for the proposed development at SZC.

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# Appendices

Appendix1: ONR licensing assessment 2020/22

ONR assessment reports available at [www.onr.org.uk/publications/regulatory-reports/site-specific-reports/assessment-reports-for-nuclear-site-licence-application-for-sizewell-c/](http://www.onr.org.uk/publications/regulatory-reports/site-specific-reports/assessment-reports-for-nuclear-site-licence-application-for-sizewell-c/) :

1. [Electrical engineering assessment - ONR-NR-AR-21-001](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c/ONR-NR-AR-21-001.docx)
2. [Mechanical engineering assessment - ONR-NR-AR-21-003](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c/ONR-NR-AR-21-003.docx)
3. [External hazards assessment - ONR-NR-AR-21-005](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c/ONR-NR-AR-21-005.docx)
4. [Civil engineering assessment - ONR-NR-AR-21-006](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c/ONR-NR-AR-21-006.docx)
5. Nuclear site [health and safety/life fire safety assessment - ONR-NR-AR-21-007](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c/ONR-NR-AR-21-007.docx)
6. [Assessment of the safety case delivery strategy - ONR-NR-AR-21-008](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c/ONR-NR-AR-21-008.docx)
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8. [Organisational capability assessment - ONR-NR-AR-21-010](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c/ONR-NR-AR-21-010.docx)
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12. [Security arrangements assessment - ONR-CNSS-AN-22-002](https://www.onr.org.uk/civil-nuclear-reactors/sizewell-c/onr-cnss-an-22-002.docx)