Office for Nuclear Regulation

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Sizewell B – Periodic Shutdown 2016 (Refuelling Outage 14)

EDF Energy Nuclear Generation Limited (NGL) – Sizewell B - Consent under Licence Condition 30(3) to start-up the reactor following periodic shutdown.

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EXECUTIVE SUMMARY

Title

EDF Energy Nuclear Generation Limited (NGL) – Sizewell B - Consent under Licence Condition 30(3) to start-up the reactor following periodic shutdown.

Permission Requested

NGL, the licensee of Sizewell B power station, has requested that the Office for Nuclear Regulation (ONR), grants consent to start-up the reactor following its periodic shutdown as required under Licence Condition (LC) 30(3) of nuclear site licence number 63.

Background

Sizewell B is a single pressurised water reactor (PWR) incorporating a nuclear steam supply system (NSSS) based on a Westinghouse standard four loop design. The NSSS comprises of enriched uranium fuel assemblies contained within a steel reactor pressure vessel (RPV) with four associated coolant loops each connected in parallel to the RPV. Each cooling water loop has its own reactor coolant pump (RCP), steam generator and interconnecting pipe work. The primary cooling circuit is closed and pressurised by a single pressuriser vessel which is maintained part filled with water and part with steam in equilibrium. The secondary coolant side is isolated from the primary by the steam generator tubes that produce steam which is passed to two 600MW turbine generators producing a nominal 1200MW of electricity.

The reactor cycle is approximately every 18 months when it is required to shut down so that it can be refuelled. When refuelling is undertaken some of the fuel assemblies (around one-third) are replaced with new ones. The existing fuel assemblies are returned to the core in a rearranged array to ensure optimum fuel utilisation.

To continue to operate safely and reliably the reactor plant requires regular examination, inspection, maintenance and testing. Continuous improvement also requires plant upgrades to be implemented where deemed to be reasonably practicable. Whilst some of these activities can safely take place when the reactor is operating at power, many of them require the reactor to be shut down. The refuelling outages at Sizewell B provide the opportunity for undertaking such activities. As required under an ONR specification the reactor may not be started-up following a refuelling outage without the consent of ONR.

The current shutdown for the Sizewell B reactor commenced on 15 April 2016 and represents the end of cycle 14 and commencement of refuelling outage 14. The shutdown was preceded by three days of the reactor running at reduced power, facilitating work to replace one of the two 600MW station generator transformers. It is the intention of NGL, upon receipt of the consent to restart to operate the reactor at reduced load to allow completion of the work on the generator transformer.

In addition to the routine inspection and maintenance activities, the following significant work was completed during the outage:

- Reactor Pressure Vessel (RPV) 10 year ASME XI In Service Inspection (ISI)
- Reactor Coolant Pump (RCP) ‘B’ Motor and Internals exchange
- RCCA and guide card inspections
- Completion of the Japanese Earthquake Response (JER) Mechanical Tie-Ins
- Polar Crane load monitoring improvements
- Turbine 1 – Generator major overhaul
- Turbine 2 – Low pressure rotor exchange
- Generator Transformer 2 – 3 phase replacement

Assessment and inspection work carried out by ONR in consideration of this request

ONR inspectors have sampled the licensee's arrangements for controlling and completing the examination, inspection, maintenance and testing requirements of the maintenance schedule, and other plant modifications of nuclear safety significance, as identified within the licensee's outage intentions document. This has included attending the significant outage planning and progress meetings and visiting site to inspect samples of the licensee's implementation of arrangements. ONR specialist inspectors have undertaken inspections and assessments and produced reports for each specialism. I have made use of these reports in the production of this Project Assessment Report (PAR).

The main focus for this periodic shutdown was the 10 year in service inspections of the reactor pressure vessel which were the subject of a significant structural integrity intervention.

The regulatory interventions carried out by ONR have not identified any issues of safety significance, which remain unresolved in relation to the licensee's safety case for the start-up of the reactor, and its operation for a further period, allowing ONR consent to start-up the reactor under LC 30(3) to be recommended as described within this report.

Matters arising from ONR's work

The licensee has confirmed to ONR that the requisite periodic shutdown related work has been successfully completed and that all actions identified by ONR for resolution prior to consent have been addressed. The actions agreed for the longer term, have been included in the relevant station processes, and will be tracked to completion within its arrangements to ensure risks continue to be reduced as low as reasonably practicable.

No matters preventing the granting of consent to start-up arose from the work undertaken by ONR inspectors in relation to the Sizewell B reactor periodic shutdown 2016, refuelling outage 14.

During the outage, ONR was informed by Areva and the French nuclear safety regulator ASN that a quality audit had revealed historical production anomalies at their Le Creusot plant. ASN initiated a review and a total of 22 components were identified as being supplied by Cruesot Forge for the Sizewell B project. Areva subsequently confirmed that none of the anomalies relate to forgings supplied to Sizewell B. ONR reviewed the Sizewell B lifetime records held by NGL in order to provide additional confidence in the quality documentation for the reactor componence in advance of the return to service.

Conclusions

Following assessment and inspection of matters arising in relation to the Sizewell B reactor periodic shutdown 2016, I am satisfied that the licensee's justification to start-up the reactor and operate for a further period is adequate; consequently, consent to start-up the reactor can be granted.

Recommendation

I recommend that in accordance with the request from the licensee, ONR should grant consent under LC 30(3) attached to Nuclear Site Licence No:63 for the reactor at Sizewell B nuclear power station to start-up following the 2016 periodic shutdown, and Licence Instrument 550 be issued and released to the licensee to permit this outcome.

LIST OF ABBREVIATIONS

ALARP	As low as reasonably practicable
APEX	Appointed Examiner
ASME	American Society of Mechanical Engineers
ASN	French nuclear safety regulator
C&I	Control and Instrumentation
CBSIS	Computer Based Systems Important to Safety
CNS	Civil Nuclear Security (ONR)
EA	Environment Agency
EBS	Emergency Boration System
EC	Engineering Change
HICS	High Integrity Control System
INA	Independent Nuclear Assurance
INSA	Independent Nuclear Safety Assessment
ISI	In-Service Inspections
JER	Japanese Earthquake Response project
LC	Licence Condition
LI	Licence Instrument
MITS	Maintenance, Inspection and Test Schedule
NGL	EDF Energy Nuclear Generation Limited
NSSS	Nuclear Steam Supply System
OCC	Outage Control Centre
OID	Outage Intentions Document
ONR	Office for Nuclear Regulation
OPEX	Operational Experience
PAR	Project Assessment Report
PCC	Pre-stressed Concrete Containment
PSSR	Pressure Systems Safety Regulations
PWR	Pressurised Water Reactor
RCP	Reactor Coolant Pump
RO14	Refuelling Outage 14 (this outage)
RTR	Rapid Trending Review
RTS	Return To Service
SAP	Safety Assessment Principle(s)
SIP	Structural Integrity Panel
SZB	Sizewell B power station
UPS	Uninterruptible Power Systems
WISCO	Westinghouse Integrated System for Centralised Operation

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1 PERMISSION REQUESTED

1. EDF Energy Nuclear Generation Limited (NGL), the operator and licensee of Sizewell B power station, has written (Reference 1) to the Office for Nuclear Regulation (ONR) requesting consent under Licence Condition (LC) 30(3) to start-up the reactor on completion of its periodic shutdown (also known as its refuelling outage (RO14)). This Project Assessment Report (PAR) presents my consideration of this request and recommends that ONR grants consent to start-up the reactor through issuing Licence Instrument (LI) 550.

2 BACKGROUND

2.1 GENERAL

2. Sizewell B is a single pressurised water reactor incorporating a nuclear steam supply system (NSSS) based on a Westinghouse standard four loop design. The NSSS comprises of enriched uranium fuel assemblies contained within a steel reactor pressure vessel (RPV) with four associated coolant loops each connected in parallel to the RPV. Each cooling water loop has its own reactor coolant pump (RCP), steam generator and interconnecting pipe work. The primary cooling circuit is closed and pressurised by a single pressuriser vessel which is maintained part filled with water and part with steam in equilibrium. The secondary coolant side is isolated from the primary by the steam generator tubes that produce steam which is passed to two 600MW turbine generators producing a nominal 1200MW of electricity.

3. The reactor cycle is approximately every 18 months when it is required to shut down so that it can be refuelled. When refuelling is undertaken some of the fuel assemblies (around one-third) are replaced with new ones. The existing fuel assemblies are returned to the core in a rearranged array to ensure optimum fuel utilisation.

4. To continue to operate safely and reliably the reactor plant requires periodic examination, inspection, maintenance and testing. Ongoing plant modifications and upgrades are implemented where deemed to be reasonably practicable. Whilst some of these activities can safely take place when the reactor is operating at power, many of them require the reactor to be shut down. The refuelling outages at Sizewell B provide the opportunity for undertaking such activities.

5. ONR has specified (Reference 2) that the licensee requires consent, from ONR under LC30(3), to start-up the reactor following a periodic shutdown. The previous consent to start-up the reactor, Sizewell B LI 543 (Reference 3), was dated 21 November 2014.

6. The current shutdown for the Sizewell B reactor commenced on 15 April 2016 and represents the end of cycle 14 and commencement of refuelling outage 14. The shutdown was preceded by 3 days of the reactor running at reduced power, facilitating work to replace the second of the two 600MW station generator transformers, the first was replaced in RO13. It is the intention of NGL, upon receipt of the consent to restart to operate the reactor at reduced load to allow completion of the work on the generator transformer.

2.2 OUTAGE PLANNING AND MANAGEMENT

2.2.1 Reactor outage intentions

7. NGL's planned outage work programme was outlined in the Sizewell B outage intentions document (OID) (Reference 4). This was examined by ONR specialist inspectors and the nominated site inspector in preparation for the outage intentions meeting held on 30 September 2015 (References 5 and 6).

8. It was noted that island lead principle which was deployed during RO13 would be enhanced further in RO14 with the presence of both engineering and operations leads based in the outage control centre (OCC). The work programme would be managed within the following islands:

- Refuelling
- Nuclear steam supply system
- Balance of Plant
- Electrical

9. This outage would see the first use of RPV nozzle plugs at Sizewell B to achieve isolation of the RPV, although there was considerable OPEX of installation elsewhere. The preparation and planning was underway for installation including a mock up training rig in the outage store.

10. ONR commended the approach taken by NGL in relation to the preparations for the surveillance programme 6 periodic in-service inspections (ISI) of the RPV. Close engagement with ONR provided confidence that the ISI would provide the evidence needed to support the extant safety case.

2.2.2 Licensee's outage management

11. The arrangements for the management of the refuelling outage were described in the Station Management Control Procedure SZB/MCP/034V 'Outage Management' which implemented the requirements of NGL's integrated company practice BEG/ICP/OPS/009 'Outage Management Process'.

12. NGL's own internal regulator, Independent Nuclear Assurance (INA), independently supports the request to start up the reactor following the outage when it was satisfied that the reactor was in a fit state to be restarted and that the associated risks were both tolerable and ALARP.

13. INA sought assurance that the material state of the plant was acceptable to support safe operation and that activities undertaken during the outage were conducted with due regard for nuclear safety through a series of assessment activities detailed in their Concurrence Part A (Reference 7). A statement to support the request for consent to start up (Reference 8), was provided in advance of the formal concurrence part B statement, in-line with NGL arrangements (SRD/PROC/009).

14. In line with NGL's arrangements, a team of INA inspectors, and outage staff from other stations, conducted a rapid trending review (RTR) during the first week of the outage, observed by ONR outage project inspector (Reference 9). The RTR report (Reference 10) presented points of positive feedback as well as highlighting areas for improvement during the outage. There were a number of areas of good practice which were identified that were taken to be replicated at other stations.

15. The licensee produced a Return To Service (RTS) Engineering Change (EC) (Reference 11) that approves the results of inspections completed in the RO14 inspection programme. INA has issued an Independent Nuclear Safety Assessment (INSA) approval statement (Reference 12) for the RTS EC.

16. Following ONR's issue of its consent to allow Sizewell B to return to service, during the reactor start-up and raising to full power there will be further tests and inspections which can only be conducted at this time. The results of these, and other inspections conducted during the shutdown which required further analysis, will be published in a document known as the '28 day report'.

2.2.3 ONR's intervention management process

17. ONR business management process within the Operating Facilities Programme requires that a task sheet is produced for activities exceeding five man days' work. The task sheet provided the background to the proposed intervention, the anticipated outcomes, duration, and prioritisation and listed the ONR specialisms assigned to the project and the intervention strategy.

18. The ONR activities in support of the NGL outages for 2016/17 are articulated in task sheet TS058 (Reference 13). The task sheet was endorsed by the Operating Reactors sub programme board.

19. The scope of the interventions and assessments was determined by conducting reviews of:

- scope of work for the outage as indicated by the OID
- previous outage reports and actions
- OPEX and outstanding issues recorded in the regulatory issues database
- specialism specific areas of interest
- other areas of interest which could only be assessed during an outage period

20. The following ONR specialisms were identified as required for the RO14 project:

- Structural integrity
- Fuels
- Mechanical engineering
- Electrical engineering
- Control and Instrumentation systems
- Civil engineering
- Fire safety
- Site inspection oversight

21. During the planning it was agreed that the quality management systems intervention should be targeted at the supply chain which supports the outages. As most of the equipment to support this outage was already delivered, this intervention would therefore take place outside the outage period and focus on equipment for the next outage, RO15.

22. ONR's process for delivering a permissioning project requires preparation of a Project Assessment Report (PAR) to support the permissioning decision by the Delegated Authority. The PAR is informed by the intervention findings of the inspectors assigned to the project to allow the Delegated Authority to consider issuing Consent for the restart of the reactor.

23. The RO14 project inspector has maintained a spread sheet Sizewell B RO14 Outage ONR Action Tracker (Reference 14) to monitor progress and status of all restart and non-restart related actions.

3 ASSESSMENT AND INSPECTION WORK CARRIED OUT BY ONR IN CONSIDERATION OF THIS REQUEST

24. The work undertaken by ONR can summarised as follows:

- Engineering assessments of maintenance, modifications and other work during the outage covering the following areas:
  - Structural integrity
  - Fuel performance

- Mechanical engineering
- Electrical engineering
- Control and instrumentation
- Civil engineering

- Assessment of the safety management of the outage including:
  - Fire safety
  - Outage management
- Japanese earthquake response project
- Emergent issues
- Start-up meeting

3.1 ENGINEERING ASSESSMENTS

3.1.1 Structural integrity

25. Reference 15 presents ONR's assessment of the adequacy of the inspections of all components required by ASME Boiler and Pressure Vessels Code, Section XI, any additional NGL identified components and compliance with Pressure Systems Safety Regulations (PSSR) undertaken during Sizewell B periodic shutdown.

26. This outage was the end of the 2nd 10 year operating interval and as such, a large programme of inspection work was required on the reactor pressure vessel (RPV) to meet the ASME XI code inspection requirements. This required the use of complex equipment; including a large robotic arm capable of positioning inspection probes on the inside surface of the RPV. These inspections provided additional information to support the safety case for the RPV. Separately, the inspections were able to support NGL's view that the core shell was not affected by hydrogen flake defects which had been identified in other PWR RPVs at Doel 3 and Tihange 2 in Belgium.

27. The assessment was essentially conducted in four stages;

- Routine level 4 meetings on Surveillance Programme (SP) 6, in-service-inspection of Sizewell B, and SP9, the irradiation embrittlement programme, work streams and a review of the outage intentions proposals (including attendance at the outage intents meeting),
- observing the Inspection Validation Centre activities at Rugby and Risley (Warrington),
- a visit to site during the outage to assess the adequacy of the inspections in progress and how the licensee was complying with the commitments provided in the outage intents document, and
- monitoring of the Structural Integrity Panel (SIP) minutes throughout the outage to identify how the inspections were progressing and how any issues identified are managed and resolved.

28. In January 2013, NGL assessed the implications of the Doel 3 findings for Sizewell B. ONR then encouraged NGL to examine fully the benefits and dis-benefits of performing the extended core shell inspections. NGL subsequently confirmed that it would extend their normal inspection of the RPV core shell welds to inspect the core shell forging that had been found defective at Doel 3 and Tihange 2 in Belgium. ONR considered this to be a positive measure taken by NGL. Continued engagement ensured that these inspections would meet the required standard to achieve adequate detection and sentencing of the Doel 3 and Tihange 2 type defects.

29. The completed inspections resulted in 14 recordable and no reportable indications. The 14 recordable indications were point like, which were as expected when compared with the previous inspection data. NGL also reported that there were no relevant suspect volumes, areas/regions identified during the preliminary analysis of the data requiring further analysis, within the core shell region. The inspector was satisfied that the inspections gave confidence that the reactor pressure vessel core shell region does not contain flake defects as found in Doel 3 and Tihange 2.

30. The inspector had, where possible, compared the sampled inspections against the requirements of the ASME XI code and was satisfied that the programme of work aligned with the requirements of this code. He was also satisfied that the scope of the inspections performed during this outage, was reasonable, based on a sample audit of the items in the intentions document and the number of items listed within the first interval summary report.

31. The inspector observed the working of the SIP which met to review the inspection work undertaken during the periodic shutdown and sentenced the inspection findings. He was satisfied that the SIP was following due process and found evidence of the panel taking a conservative approach on the findings. An open approach to the discussion was adopted throughout the meeting, with a suitable level of challenge from the INA representative. The inspector monitored progress on the inspections through reviewing the ongoing SIP minutes, and considered that all defects and anomalies appeared to have been appropriately sentenced by the panel. There were no emerging matters of concern.

32. Following the discovery of undesirable levels of carbon segregation in the Flamanville 3 RPV domes, ONR had requested NGL to consider the manufacturing, inspection and testing of the Sizewell B RPV domes in order to be satisfied that Sizewell B was not affected by the same issue. The inspector reviewed the NGL reports produced by the structural assessment and the materials groups, and was satisfied that they provided an adequate level of assurance that Sizewell B RPV domes are not affected by carbon segregation levels witnessed on the Flamanville 3 RPV domes. A design authority summary report was considered to be a concise summary of the findings of both reports and supported the claim that there was no significant threat to the integrity of the Sizewell RPV.

33. Based upon the sampling conducted, and the evidence presented, the inspector judged that the licensee had undertaken sufficient inspection and assessment to support the safe return to service of Sizewell B from a structural integrity perspective, and no issues were found that would prevent Sizewell B from returning to service for the next operational period.

3.1.2 Fuel performance

34. The Sizewell B Cycle 15 reload safety case has been assessed by an ONR specialist fuels inspector (Reference 16). The scope of the assessment covered primarily the fuel performance aspects of the cycle 15 reload safety case. However, where necessary the inspector considered other aspects of reactor fuel and core safety as appropriate in assuring adequacy of NGL's safety case.

35. During RO14 the reactor would be refuelled to provide sufficient reactivity for the next operating cycle; cycle 15. Each time a refuelling outage takes place, the previous core is completely unloaded and replaced with a mixture of both fresh fuel assemblies and fuel assemblies that have been used in previous cycles. The overall arrangement of fuel assemblies in the core is also altered. These changes constitute a revision to the core design and require formal justification, the reload safety case.

36. The assessment covered three main areas:

- Review of the cycle 15 reload safety case
- Changes to the reload safety case for cycle 15 relative to cycle 14
- Fuel assembly operability

37. It was identified early in cycle 14 that the Z-bank rod stepping rate, which provides fine control of reactivity during operation, was much larger than in previous cycles and potentially challenged the safety margins on the fuel clad fatigue limits. A correction to the control system was developed and there was a commitment to deploy the modification at power during cycle 14, to confirm if it was successful before cycle 15. The inspector identified that changes in the scope of pre-outage work had removed this commitment and he challenged this decision. As a result, the commitment was met as originally intended, although later in cycle 14 and the modification resulted in a 90% reduction in Z-bank movement and restored the safety margin to the clad fatigue limits.

38. The report on activity analysis of the primary coolant prior to offload of the cycle 14 fuel confirmed the absence of fuel failures, none in the last four operating cycles. The inspector judged that this was adequately supported by the evidence from coolant activity.

39. Discovery of a small piece of foreign material on a fuel assembly, during inspection while being transferred to the fuel storage pond, resulted in a detailed review of all camera footage for all fuel assemblies discharged from the reactor at the end of cycle 14. This inspection resulted in two assemblies requiring further inspection, not to be used for cycle 15, and minor debris found on three 'fully burnt' assemblies which were due to be transferred to storage.

40. As a result of the discovery of debris on the fuel assemblies it was decided by NGL that a minor core redesign was necessary, utilising the two contingency quartets of assemblies available (planned for such an occurrence). The revision to the reload safety case was assessed by the inspector who confirmed that the revised safety case remained adequately robust.

41. Based on the assessment of the cycle 15 reload safety case submission, the inspector identified no safety concerns with the proposed core design or to the Sizewell B reactor returning to power following its refuelling outage.

3.1.3 Mechanical engineering

42. Reference 17 presents the findings of the ONR inspection of the adequacy of the Mechanical Engineering related activities conducted by the licensee to comply with the requirements of LC 28 – Examination, Inspection, Maintenance and Testing against a sample of nuclear safety significant reactor components.

43. The following areas considered as part of the intervention were based on their nuclear safety significance and associated with recently reported events:

- Emergency boration system (EBS); and
- Reactor coolant pumps (RCP).

44. The EBS is unique to Sizewell B and offers a tertiary line of protection to the operation of the reactor. Its purpose is to initiate on failure of two or more of the control rods to fully insert into the core. Due to the corrosive nature of the high concentration boric acid, the internal components of the isolation valves degrade over time. Work is carried out on a rolling basis to inspect and maintain these components with seals and plugs

replaced and valve seats lapped in-situ. The valves are operated via gas operated fail-closed actuators and there is routine monitoring of the gas pressure in the accumulators.

45. The inspector was satisfied that the EBS surveillances adequately demonstrate compliance with the relevant technical specification and provided a reasonable test of the integrity of the associated isolation valves. The approach taken in managing issues associated with the EBS actuator gas leaks was appropriate, demonstrating a reasonable response to the problem.

46. The four RCPs were undergoing a range of maintenance activities. The inspector primarily reviewed the maintenance of RCP 'B' which was undergoing a major package of work; internals and motor refurbishment. Based on the information sampled he was satisfied that the work carried out on maintaining and testing the RCPs was adequate.

47. From a mechanical engineering perspective, the inspector judged that maintenance activities carried out during the Sizewell B 2016 outage were being adequately controlled and supported the requirements of the safety case. He therefore supported the request under LC 30 to return the reactor at Sizewell B to operation.

3.1.4 Electrical engineering

48. Reference 18 presents the findings of the ONR inspection of the adequacy of the Electrical Engineering related activities conducted by the licensee. The inspection considered electrical work activities being undertaken as part of the RO14 periodic shutdown together with any electrical issues that had occurred at the station since the RO13 outage in 2014.

49. The inspection of RO14 work activities covered electrical works specified in the outage intentions document (Reference 4) and covered the following areas:

- Maintenance of an 11kV station board and 3.3kV unit auxiliary board, both deferred from RO13.
- Modifications to the electrical systems to enable the replacement of station uninterruptible power systems (UPS).
- Insulation tests on a new 3.3kV cable for the cooling water pump house supplies.
- Maintenance of the control rod drive mechanism motor-generator sets.
- Replacement of generator transformer 2, following the replacement of generator transformer 1 during RO13.

50. Updates were provided on the following electrical issues and developments since RO13:

- Replacement of battery cells following failed discharge tests.
- Emergency diesel generator 3 rotor replacement.
- Mechanical interlocks fitted to motor control centres and load control centres.
- Management of UPS ageing and obsolescence.
- Replacement of incorrect fuses fitted to a number of 415V fuse switches.

51. The inspector undertook an inspection of the site to observe plant condition and progress of selected outage works. The work areas and test areas in switchrooms were found to be appropriately demarcated with chains. There was also evidence of

markings affixed to switchboards at the boundaries between live and isolated sections. Equipment removed for maintenance appeared to be safely stored and segregated from access routes, while work places appeared to be reasonably tidy.

52. From the information gathered and evidence obtained during the intervention, the inspector was content with the progress the licensee was making with their electrical engineering activities as part of the outage. A small number of issues were identified in the way maintenance work was instructed and recorded but these were considered minor.

53. In respect of the safety related electrical engineering work, the inspector did not identify any issues of significance that should prevent ONR from granting consent for Sizewell B Reactor to restart and operate for a further period.

3.1.5 Control and instrumentation

54. Reference 19 presents the findings of the ONR inspection of the control and instrumentation (C&I) systems maintenance and modification activities being conducted during the outage. The main focus of the inspection was to verify that relevant work activities had been carried out in relation to C&I equipment and systems important to safety in order to confirm that it remains fit for its intended purpose at Sizewell B.

55. The inspection covered the following systems and relevant maintenance, inspection and test schedule (MITS) work activities during the RO14 outage:

- Reactor safety circuits, including; the primary protection system, the high integrity control system (HICS), calibration and testing of reactor protection equipment (Guardline 3 transmitters) and Cameron transmitter replacement.
- Plant Computing Systems; process control system, data processing system, Westinghouse integrated system for centralised operation (WISCO), upgrade of WISCO HICS Eagle highway transceiver and CR 982188 Data Highway Gateway failure.
- Instrumentation important to safety; external to core (ex-core) neutron flux and nitrogen (N16) monitoring system, internal to core (in-core) neutron flux mapping system, mid-loop instrumentation.
- Other issues important to safety; polar crane (load monitoring modifications both previous and current), polar crane seismic event monitor and pond fuel handling machine modification.
- Computer Based Systems Important to Safety (CBSIS) security related to the outage: supply chain and portable electronic devices

56. The inspector reviewed two aspects of the polar crane work; the load monitoring system and the planned site survey work, the latter associated with the midterm through life refurbishment. NGL informed ONR that during the initial RPV head lift the load readout would periodically ‘drop out’ and in addition there was a non-linear offset to the load readings, see section 3.3.1.

57. A site survey of the polar crane was due to take place later in the outage. This survey was primarily to determine the current condition and status of the C&I equipment on the crane, particularly in respect of ageing and obsolescence. This would support the development of a plan for the crane refurbishment scheduled for RO16.

58. The scope of the outage included the replacement of Cameron transmitters that were coming towards the end of their qualified life; this work was scheduled to be completed over four outages. However it emerged just prior to the outage that the replacement transmitters had ‘drift’ problems and NGL had decided not to fit these transmitters.

ONR expressed concern with the replacement programme for the Cameron transmitters and raised an action that the scope of work in RO15 is explicitly defined in the OID and any changes notified to ONR.

59. From the evidence gathered during this C&I-based intervention, the inspector considered that there were no significant matters that may impact on nuclear safety and he did not identify any significant issues in relation to the C&I equipment and systems that should prevent ONR from issuing consent to allow the Sizewell B reactor to restart.

60. On the basis of the inspections of C&I aspects of the Sizewell B RO14 statutory outage it was recommended that support be given for a consent to allow Sizewell B to return to normal operating service.

3.1.6 Civil engineering

61. Reference 20 presents the findings of the ONR assessment of the report submitted by the NGL Appointed Examiner (APEX) and the surveillances undertaken on the Sizewell B pre-stressed concrete containment (PCC). The assessment included communications with the station to resolve queries; however the inspector judged that a site visit was not required for the purpose of the assessment.

62. The APEX's in-service inspection summary report provides the results of statutory surveillances, inspections and tests required on the PCC and other nuclear safety-related civil engineering structures during the current outage. As the outage and certain inspections and tests had not been completed at the time of the issue of the report, it represented a progress statement on the maintenance schedule activities pending the issue of the APEX 'Mode 4 Up' statement and the overview report.

63. The report provided a progress statement on such activities as the visual examination of the steel liner, sumps, access airlocks, penetrations, moisture barriers, concrete surfaces, crane corbels, and on penetration leak rate tests.

64. The overall conclusion reached by the APEX, on the basis of the results obtained up to the time of writing the report, was that the PCC and its internal nuclear safety-related civil structures examined were in a satisfactory condition for continued service, subject to the successful completion and acceptable outcome of the remaining planned outage work.

65. The inspector considered that; the codes and standards used during the surveillance work, the examination and test procedures and the inspection intervals were appropriate and met the requirements of the relevant Safety Assessment Principles (SAPs) (Reference 21).

66. The inspector compared the work reported in the APEX summary report with the surveillance requirements in the relevant sections of ASME XI and found adequate agreement.

67. The tendon load values were last checked in 2012 and assessed prior to giving consent to return the reactor to power after RO12 in July 2013. The next tendon load checks are planned for 2017. The tendon loads were not therefore considered as part of this assessment.

68. The inspector reviewed the APEX overview report from the previous outage, RO13, and confirmed that there are no outstanding recommendations made in that report that should prevent ONR granting permission to return the reactor to service.

69. The inspector reviewed the 'Mode 4 Statement' (Reference 22) when it became available near the end of the outage. This reported the completion of the inspections and assessments on the containment liner plate, equipment access hatch, fuel transfer tube, penetrations, recirculation and floor drain sumps, lift well liner, 'sunken' floor area wall liner, containment concrete outer surface, supporting structures for cranes and lifting structures, and the sea defences.

70. Inspection of the instrument tunnel liner and the polar crane corbels had yet to be completed but were scheduled to be done prior to the end of the current outage, and will be reported in the updated ISI Summary Report and the overview report which will be produced after the outage.

71. From the results of the surveillances, inspections and tests reported in the documentation provided and the acceptance of the judgements made by the Appointed Examiner, the inspector was content to support the return to service of the containment vessel and the associated internal civil structures for the next operating period.

3.2 SAFETY MANAGEMENT

3.2.1 Fire safety

72. Reference 23 provides the findings of the ONR fire safety inspection conducted during the outage to ensure that the Licensee was achieving compliance with the requirements of the Regulatory Reform (Fire Safety) Order 2005. The inspection primarily concentrated on the practical application of the general fire precautions during an outage period including:

- Oil leak management
- Scaffolding – escape routes, signage and alarms
- Discharge testing of batteries of emergency lights
- Hot work and confined spaces

73. The overall impression was one of a well-managed fire safety strategy which adequately demonstrated an ability to ensure that fire safety was taken seriously and was given the due consideration it deserved during an outage.

74. The inspector was of the opinion that the Sizewell B Power Station management team displayed an appreciation of the importance of effective fire safety measures within the facilities and that overall they showed a desire to achieve compliance with the relevant legislation.

75. Overall, in the areas inspected, the inspector considered that Sizewell B demonstrated an adequate level of fire safety provision and management.

3.2.2 Control and supervision of operations

76. In addition to periodic surveillance activities during the outage, an unannounced inspection of the licensee's arrangements for the control and supervision of operations was conducted (Reference 24).

77. The site inspector observed the test run of high head safety injection pump C and accumulator B discharge which was being conducted during the evening. These operations required the coordination of personnel at various locations around the plant.

78. During the observation the inspector noted expected practices and behaviours inherent to sound control and supervision including:

- Procedural use and adherence to test procedures
- Peer checking of actions and decision making
- 3 way communications and use of phonetics
- Positive challenge and discussion between operatives
- Considerations of dose minimisation during procedure waiting time
- Consideration of risks and hazards from operations to plant, personnel & environment
- Clear communications including external notification of potential test effects
- Coaching techniques including reactor operator to training operatives

79. The inspector found the control and supervision of operations, performed to written test procedures, controlled through the main control room to be in line with expected good practice and ONR guidance for LC 26.

3.2.3 Outage management

80. Over the duration of the outage the nominated site inspector and the outage project inspector observed the operation of the outage control centre (OCC) and a variety of the outage management meetings (References 9 and 25) including:

- Mode change meeting
- Bulk work meeting
- Forward focus meeting
- Operational decision making meeting
- Condition report screening meeting
- Mid-shift brief
- Nuclear safety operations review committee

81. Within the OCC it was observed that the use of the RiskWatcher and ORAM systems ensured the appropriate defence in depth during high risk periods; varying plant modes and equipment availability. The outage managers were observed to have a good focus on risk management during a period of elevated risk; mode 5 and 6, and ensured that all work was controlled and ensured timely completion to enable safe progress to a lower risk state.

82. Overall the nominated site inspector and the project inspector concluded that the licensee's outage management and focus on nuclear safety was robust.

3.3 JAPANESE EARTHQUAKE RESPONSE PROJECT

83. During this outage the last of the mechanical pipework tie-ins, planned as part of the Japanese earthquake response programme of enhancements, were completed. These provided a connection point for coolant injection during mode 6 operations (reactor head de-tensioned) and an alternative supply point for the clean air trains system.

84. The remaining enhancements are electrical and equipment monitoring, which are due to be complete before the next outage, RO15.

3.4 EMERGENT ISSUES

3.4.1 Polar crane load monitoring

85. During the previous outage, RO13, work was conducted on the polar crane to install a wireless load monitoring system to replace a faulty hard wired system. The reliability

of the new system was found to be intermittent and it was removed at the end outage resolve these issues. The rectified load monitor was reinstalled at the start of the RO14 outage and confirmed working. Due to the location of the polar crane there were no test weights to confirm the as installed calibration.

86. While conducting a lift of the multi-stud tensioner, it was noticed that the load indication was over 3Te low. An operational decision meeting was called to discuss the issue and provide a way forward. It was identified that an offset appeared to have been changed, but it was decided not make any further adjustments.

87. The offset was consistent and able to be determined for each of the critical lifts, so use was made of a look-up table and management controls to conduct the polar crane lifting for the rest of the outage. The load indication results of the subsequent lifts corresponded to those calculated assuming a static offset to the load monitor.

88. While the C&I inspector was content with the explanation and arguments to continue with operations, ONR requested that NGL inform them, before return to service, of their plans regarding the removal of any of the load monitoring equipment from the polar crane, to enable diagnostics and resolution of the emergent issues, prior to completion of the outage. At the start-up meeting ONR was informed that the whole load monitoring system was to be removed at the end of the outage for examination and calibration and will be reinstalled at the start of the next outage, RO15

89. ONR also requested to be kept informed of the plan and actions for the resolution of the issues that arose with the load monitoring system during the outage (off-set and signal drop out).

3.4.2 Crane lift management in containment

90. During the outage there were a number of incidents relating to the management of lifting operations within the containment. These ranged from minor load impacts during crane movements to a snagged load during the removal of an RCP stud. The collection of minor incidents was grouped together for investigation to prevent recurrence.

91. During a routine inspection of equipment areas below the +21m level deck in containment, a number of broken bolts were found. Further investigation identified an area of damage to the structural steelwork supporting the +21m level deck. From the damage pattern it appeared that the multi-stud tensioner lifting jig had been lifted from its storage position without its securing pins being removed. The fact that this incident had been unreported at the time was of significant concern to NGL and ONR and is being investigated. The ONR site inspector will follow this up when NGL's investigation has been completed.

92. The damage to the steelwork was assessed by the NGL civil engineering specialists and original construction contractors. They identified a number of immediate repairs, replacing damaged bolts etc., to make the structure sufficiently safe to not compromise the safety case or present a hazard to plant operations. A full civil design review of the affected steelwork will be conducted during the next operating cycle to identify if there are any further repairs to be undertaken.

93. The ONR civil engineering specialist reviewed the damage assessment report and the recovery plan (Reference 26) and was satisfied with the actions taken to restore the integrity of the structure before the reactor was restarted (Reference 27).

3.4.3 Production records for Areva supplied NSSS components

94. On 29 April 2016 Areva released a press statement announcing that a quality audit had revealed historical production monitoring anomalies at their Le Creusot plant (Creusot Forge) and that they were in discussion with ASN, the French nuclear safety regulator, on the matter. On 4 May 2016 ASN issued a press statement stating that the audit at Creusot Forge had been requested by ASN and that it had revealed irregularities in the manufacturing checks on about 400 parts produced since 1965, of which about 50 were in-service on French nuclear power plants.

95. Following these press releases ONR contacted ASN for further information, who confirmed that ASN had initiated the review following recent quality issues at the plant. The nature of the inconsistencies were thought to be related to aspects such as material composition, heat treatment, mechanical tests etc, and most appeared to be of a relatively minor nature. The ASN understanding was that at that point in time Areva had not found any irregularities in the forgings produced for Sizewell B or Hinkley Point C and that Areva planned to contact non-French licensee's by 31 May 2016 if any anomalies affected their plant.

96. A total of 22 components were identified as being supplied by Creusot forge for the Sizewell B project according to NGL records. NGL therefore approached Areva for information on the components supplied to Sizewell B and conducted an internal review of their position based on their own lifetime records and evidence from in-service inspections. Areva confirmed to NGL by e-mail on 20 May 2016, who formally notified ONR on 25 May 2016 (Reference 28), that their initial screening to identify which files had potential anomalies had been completed, and that of those with anomalies, none relate to forgings supplied for Sizewell B. Areva also claimed that where anomalies did exist, none would preclude the return to service of a plant.

97. ONR has also reviewed the Sizewell B lifetime records held by NGL in order to provide additional confidence in quality documentation for the reactor components in advance of the return to service of Sizewell B (Reference 29). The inspector was satisfied that the records were comprehensive and complete.

98. From the inspector's understanding of the work that was undertaken at the time of manufacture to ensure the quality of the forgings supplied by Creusot Forge for the Sizewell B project; the review of the lifetime records held by NGL; the in-service inspection results that have been obtained for Sizewell B at the current and previous outages; and the work that has been recently undertaken by NGL to review their lifetime records; The inspector is confident that the components supplied by Creusot Forge for Sizewell B are of proven quality and is therefore satisfied that the Sizewell B safety case has not been affected by the recent announcements in relation to these components.

3.5 START-UP MEETING

99. The Sizewell B start-up meeting was held on 18 May 2016 chaired by the station Technical and Safety Support Manager with presentations from the outage programme leads (References 30 and 31). ONR's attendance at the start-up meeting consisted of the operating reactor sub-programme superintending inspector, nominated site inspector and the RO14 project inspector.

100. The agenda covered:

- Minutes previous meeting and status of actions
- Outage manager's report
- Feedback from ONR site tour
- Safety management review

- Maintenance review and projects
- Safety case review by exception
- Independent nuclear assurance report
- Review of consent and start-up issues

101. No new outage actions were raised during the meeting and it was considered that all of the start-up consent issues identified throughout the outage would be addressed prior to the start-up request letter being sent. All outstanding actions would be tracked to completion via the action tracker sheet (Reference 14) and ONR issues database as appropriate.

4 MATTERS ARISING FROM ONR'S WORK

102. I have considered the licensee's request to ONR to grant a consent under LC30(3) to start-up the Sizewell B reactor on completion of its periodic shutdown. To inform my work I have taken note of the statements associated with safety contained in the request letter, the findings of the periodic shutdown associated work undertaken by NGL's internal regulator, INA, the statements of the PSSR competent persons and the findings and opinions of ONR specialist inspectors and the ONR site inspector.

103. In Reference 1, the Sizewell B Plant Manager stated that an Operational Safety Review Committee would be convened prior to start-up to review the fitness for service of the plant and endorse return to service.

104. INA has provided a concurrence statement (Reference 8) which confirmed that based on their assessment activities so far, there were no issues which they were aware of which would prevent their provision of the concurrence part B prior to start up.

105. The PSSR competent persons (for the nuclear island and the conventional island) have confirmed that their examinations have been satisfactorily completed and the plant was considered to be acceptable to return to service.

106. ONR specialist assessors from the following disciplines undertook inspections to support my permissioning work:

- Fuel
- Structural integrity
- Civil engineering systems
- Control and instrumentation systems
- Electrical systems
- Mechanical engineering
- Fire safety
- Site inspection

107. Each discipline has produced a report that presents the inspection findings, inspector's opinions, judgments and recommendations. A number of recommendations and actions arose from the inspectors' work, see Reference 14. None of the outstanding actions have been deemed sufficiently significant for ONR to withhold consent to start-up the reactor. All the reports contain either a statement supporting issuing consent to start-up the reactor, or note that there is no reason to withhold consent.

108. I consulted with other relevant regulators, Environment Agency (EA) and Civil Nuclear Security (CNS), to establish if either had any specific objections that would prevent ONR from issuing LI 550, consent to start-up the Sizewell B reactor. Both the EA (Reference 32) and CNS (Reference 33) confirmed they do not object to ONR granting consent.

5 CONCLUSIONS

109. The Sizewell B reactor periodic shutdown, refuelling outage 14, has been undertaken in accordance with the requirements of the work scope outlined within the OID.

110. The licensee has followed its arrangements in undertaking the periodic shutdown, culminating in the Sizewell B Plant Manager (as agent of the Licence) writing to ONR requesting consent to start-up the reactor. His letter stated that subject to the completion of the remaining outage activities, he was satisfied that the reactor was fit for return to service and sufficient procedures were in place to assure safe operation through to the next periodic shutdown.

111. The licensee's internal regulator, INA, has provided a concurrence statement that confirmed that they have no issues that would prevent the provision of the concurrence part B report in due course to support the return to service of the reactor post its periodic shutdown.

112. The PSSR competent persons have each confirmed that they are content for the reactor to start up.

113. ONR inspectors have sampled the safety management and engineering activities throughout the shutdown and judged them to be adequate, and all support issuing consent to start-up the reactor. All actions raised during their inspections and assessments have been satisfactorily addressed or have acceptable plans for resolution.

114. I consider that the licensee delivered a shutdown that was safely managed and completed the required safety related work activities.

115. Following assessment and inspection of matters arising in relation to the Sizewell B reactor periodic shutdown, RO14, I am satisfied that the licensee's justification to start-up the reactor and operate for a further period is adequate; consequently, consent to start-up the reactor can be granted.

116. I have prepared Sizewell B Licence Instrument 550, for LC 30(3) consent, in conjunction with this PAR. The licence instrument is one of the standard formats given within ONR procedures and does not require review by the Solicitors Office.

6 RECOMMENDATIONS

117. I recommend that the Superintending Inspector:

- Signs this Project Assessment Report to confirm support for the ONR technical and regulatory arguments that justify issuing Sizewell B Licence Instrument 550.

118. I recommend that the Deputy Chief Inspector signs Sizewell B Licence Instrument 550, which grants consent under Licence Condition 30(3) attached to Nuclear Site Licence No.63 to start-up the Sizewell B reactor.

7 REFERENCES

1 EDF - Sizewell B - NSLSZB50831R - LC 30(3) - Request for Consent to Start-up the Reactor under Licence Condition 30(3), 25 May 2016, TRIM 2016/216124

2 Sizewell B - SZB 75704N - Specification LC 30(3) - Requirement for a consent to start up a reactor, 27 March 1996, TRIM 2016/173892

3 EDF NGL - Sizewell B - LI 543 Consent to Start Up Reactor, 21 November 2014, TRIM 2014/431698

4 EDF NGL Sizewell B RO14 2016 – SZB/OZR/235 Outage Intentions Document - Rev 001,11 Sept 2015, TRIM 2015/358469

5 EDF - CNRP - Contact Record - 15-192 - Level 4 Meeting Sizewell B Outage Intentions and ONR Issue Review, 30 September 2015, TRIM 2015/373723

6 EDF NGL Sizewell B RO 14 Outage Intentions Meeting Slides, 30 September 2015, TRIM 2015/367536

7 EDF NGL Sizewell B RO14 - INA Concurrence Part A - Rev 000 , Aug 2015, TRIM 2015/453605

8 SZB 50831R - Attachment 8 - Memorandum Stating INA's Position on SZB Return to Service from RO14, 25 May 2016, TRIM 2016/214268

9 NGL - OPF - Contact Record - 16-070 - Sizewell B RO14 Rapid Trending Review and Outage Management, 18-22 April 2016, TRIM 2016/187513

10 SZB RO14 - Sizewell B 2016 Rapid Trending Review (RTR) final report, 5 May 2016, TRIM 2016/186422

11 SZB 50831R - Attachment 5 - Return to Service EC354871, 25 May 2016, TRIM 2016/214234

12 SZB 50831R - Attachment 5 INSA for RTS EC354871, 25 May 2016, TRIM 2016/215769

13 ONR - CNRP OPERATING REACTORS - 2016 17 - INTERVENTION TASK SHEET TS058 - Operating Reactors Outage Resource Plan April 2016 – March 2017, TRIM 2016/29055

14 SZB RO14 ONR Action Tracker, TRIM 2016/137876

15 EDF NGL Sizewell B Nuclear Power Station - Assessment Report - 15-079 - Assessment of Structural Integrity in Support of the Restart following the 2016 periodic shutdown, 23 May 2016, TRIM 2016/145347

16 NGL Sizewell B Assessment Report 16-008 - SZB Fuel Performance Assessment of Cycle 15 RO14 Core Reload Safety Case EC 354713, May 2016, TRIM 2016/120782

17 NGL - OPF - Intervention Record - 16-019 - Sizewell B - Mechanical Inspection Outage, 5 May 2016, TRIM 2016/192423

18 EDF Energy - OPF - Intervention Record - 16-018 - Sizewell B Refuelling Outage 14 Electrical Inspection, 27 April 2016, TRIM 2016/185812

19 NGL-OPF- Intervention Record - 16-027 - SZB RO14 Control and Instrumentation outage Inspection, 10-12 May 2016, TRIM 2016/211718

20 NGL - Sizewell B – Assessment Report – 16-013 - In-service inspection of the Pre-stressed Concrete Containment: Assessment of the Appointed Examiner's RO14 In-service Inspection Summary Report, 23 May 2016, TRIM 2016/207333

21 Safety Assessment Principles for Nuclear Facilities. 2014 Edition Revision 0. January 2014. http://www.onr.org.uk/saps/saps2014.pdf.

22 EDF NGL - Sizewell B - RO14 outage - ONR civil specialist memo on APEX Mode 4 statement, 24 May 2016, TRIM 2016/213569

23 ONR-COP-IR-16-003 - Sizewell B Outage FS Inspection, 28th April, TRIM 2016/181232

24 NGL - OPF - Intervention Record - 16-015 - Sizewell B Power Station - LC 8 LC 9 and LC26, 18-22 April 2016, 2016/175313

25 NGL - OPF - Contact Record - 16-092 - Sizewell B RO14 Outage Activities and Management Arrangements, 3-5 May 2016, 2016/200223

26 Sizewell B RO14 - Structural Steelwork on 21m Level in the Reactor Building - update, 24 May 2016, TRIM 2016/213074

27 Sizewell B RO14 - Structural steelwork on 21m level - review of proposed remedial works, 25 May 2016, TRIM 2016/215709

28 SZB 50831R - Attachment 6 - Areva email summarising the findings of the Creusot Record Review, 20 May 2016, TRIM 2016/214256

29 ONR-OPF-CR-16-109 - SZB CR - Review of Lifetime Records, 24 May 2016, TRIM 2016/214958

30 SZB RO14 Start Up Meeting Presentation, 18 May 2016, TRIM 2016/205822

31 SZB RO14 Start Up Report – Final, 18 May 2016, TRIM 2016/205821

32 Email - Sizewell B RO14 - EA statement for return to service post outage, 12 May 2016, TRIM 2016/195986

33 Email - Sizewell B RO14 - Start-up security statement from CNS, 4 May 2016, TRIM 2016/187515