Office for Nuclear Regulation

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Hinkley Point B Reactor 4 - Periodic Shutdown 2018

EDF Energy Nuclear Generation Limited (NGL) – Hinkley Point B – Consent under Licence Condition 30(3) to start-up Hinkley Point B Reactor 4 following periodic shutdown.

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EXECUTIVE SUMMARY

Title

EDF Energy Nuclear Generation Limited (NGL) – Hinkley Point B – Consent under Licence Condition 30(3) to start-up Hinkley Point B Reactor 4 following periodic shutdown.

Permission Requested

NGL, the licensee of Hinkley Point B power station, has requested that the Office for Nuclear Regulation (ONR), grants Consent to start up Reactor 4 following its periodic shutdown as required under Licence Condition (LC) 30(3) of nuclear site licence number 62C.

Background

Hinkley Point B power station is a nuclear licensed site operating two Advanced Gas-cooled reactors, known as Reactors 3 and 4. To continue to operate safely and reliably, systems, structures and components important to safety require regular and systematic examination, inspection, maintenance and testing. Whilst some of these activities can take place when the reactor is at power, many of them require it to be shut down. The licensee's arrangements require that periodic shutdowns (also referred to as statutory outages) are carried out every three years at each reactor at Hinkley Point B, providing the opportunity to undertake such activities. On completion of a periodic shutdown the reactor cannot be started up without Consent from ONR under LC 30(3). The previous Consent to start-up Reactor 4 was dated 1 April 2015.

During the 2018 Reactor 4 periodic shutdown, which commenced on 26 March 2018, the licensee has conducted:

- Examinations, inspections, maintenance and testing activities in accordance with the plant Maintenance Schedule,
- Inspections to support the station safety case,
- Work to comply with statutory requirements (such as Pressure Systems Safety Regulations),
- Remedial work to rectify plant adverse conditions and emergent work,
- Work to modify and/or enhance the plant where deemed appropriate.

Where inspection work revealed the potential for an adverse plant condition, the licensee has assessed the inspection results in accordance with its arrangements and taken appropriate remedial action as necessary prior to ONR granting Consent to reactor start-up.

The Hinkley Point B Station Director has written to ONR requesting Consent to start-up Reactor 4. In the letter, the Station Director confirmed that following completion of the outstanding work, as controlled by the Operational Safety Review Committee, Reactor 4 will be safe to return to service. The licensee's internal regulator, Independent Nuclear Assurance (INA), has indicated there are no issues that prevent the start-up or continued operation of Reactor 4. INA's confirmation that its assessment programme has been concluded is a necessary component that informs the Operational Safety Review Committee's decision to authorise return to service.

The third party Pressure Systems Safety Regulations competent person has issued an inspection report that is included in the licensee's request for Consent. The final inspection report will be included in the licensee's final outage report issued within 28 days of reactor restart. The appointed examiner for the Reactor Pre-stressed Concrete Pressure Vessel has issued a start-up report that concludes that the pressure vessel is in a satisfactory condition

and fit for return to service for a further period of three years subject to normal in-service surveillance.

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

ONR inspectors have inspected a sample of 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 report. This has included attending the significant outage planning and progress meetings and visiting site to examine aspects of the implementation of the licensee's arrangements.

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 Reactor 4, and its operation until the next periodic shutdown.

Matters arising from ONR's work

There are no outstanding matters preventing the granting of Consent to start-up from the work undertaken by ONR inspectors in relation to the Hinkley Point B Reactor 4 periodic shutdown 2018.

Conclusions

Following assessment and inspection of matters arising in relation to the Hinkley Point B Reactor 4 periodic shutdown 2018, ONR is 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

It is recommend that, in accordance with the request from the licensee, ONR should grant Consent under LC 30(3) attached to Nuclear Site Licence 62C for Reactor 4 at Hinkley Point B nuclear power station to start-up following the 2018 periodic shutdown, and Licence Instrument 557 be issued to the licensee.

LIST OF ABBREVIATIONS

ALARP	As low as reasonably practicable
APEX	Appointed Examiner
C&I	Control & Instrumentation
CP	Competent Person
EA	Environment Agency
EIM&T	Examination, Inspection, Maintenance and Testing
FME	Foreign Material Exclusion
GAP	Graphite Assessment Panel
GC	Gas Circulator
GSRV	Gas Safety Relief Valve
HNB	Hunterston B
HPB	Hinkley Point B
IGV	Inlet Guide Vanes
INA	Independent Nuclear Assurance
INSA	Independent Nuclear Safety Assessment
IoGF	Incredibility of Guillotine Failure
IR	Intervention Record
IRR17	Ionising Radiation Regulations 2017
KWRC	Keyway Root Crack
LI	Licence Instrument
MS	Maintenance Schedule
MITs	Maintenance Inspection and Testing Schedule [EDF]
NGL	EDF Energy Nuclear Generation Limited
NICIE2	New In-Core Inspection Equipment Mark 2
OAP	Outage Assessment Panel
ODH	Off-load Depressurised Handling
OIR/D	Outage Intentions Report/ Document
ONR	Office for Nuclear Regulation
OSRC	Operational Safety Review Committee
PAR	Project Assessment Report
PCPV	Pre-stressed Concrete Pressure Vessel
PECIT	Prototype Eddy Current Inspection Tool
PSSR	Pressure Safety Systems Regulations 2000
QA	Quality Assurance
RCW	Reactor Cooling Water

RTR	Rapid Trending Review
RP	Radiological Protection
WoC	Work Order Card

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1 PERMISSION REQUESTED

1. EDF Energy Nuclear Generation Limited (NGL), the operator and Licensee of Hinkley Point B power station (HPB), has written (reference [1]) to the Office for Nuclear Regulation (ONR) requesting Consent under Licence Condition (LC) 30(3) to start-up Reactor 4 (R4) on completion of its periodic shutdown (also known as its statutory outage). This Project Assessment Report (PAR) presents ONR's consideration of this request and recommends that Consent is granted to start-up R4 through issuing Licence Instrument (LI) 557.

2 BACKGROUND

2.1 General

2. The nuclear site licence issued to NGL for HPB requires the Licensee to periodically shut down its operational reactors under LC30. This is to enable examination, inspection, maintenance and testing (EIM&T) to take place in accordance with the requirements of HPB's Plant Maintenance Schedule (MS) under LC28. At HPB, reactor periodic shutdowns are undertaken triennially as specified in the MS Preface, which is an Approved document under LC28(4). NGL also undertook work during the shutdown associated with the requirements of the Pressure Systems Safety Regulations 2000 (PSSR), previous commitments, and plant safety improvements/modifications.

3. ONR had specified [2] that the Licensee required Consent from ONR under LC30(3) to start-up R4 following a periodic shutdown. The previous Consent to start-up R4, LI 548 [3] was dated 1 April 2015 and the R4 periodic shutdown 2018 commenced on 26 March 2018.

2.2 Outage Planning and Management

2.2.1 Outage Intentions

4. NGL's planned outage work programme was outlined in the HPB Outage Intentions Report (OIR) [4]. This was examined by ONR specialist inspectors and the nominated project inspector in preparation for the outage intentions meeting held on 16 November 2017 [5].

5. During the 2018 outage the notable packages of work to be undertaken included:

- Gas Circulator 17B exchange,
- Graphite core inspections,
- Station transformer 4 maintenance,
- Generator transformer 8A and B phase tank replacement.

2.2.2 Licensee's Outage Management

6. The outage has been managed in accordance with the requirements of NGL's integrated company practice BEG/ICP/OPS/009 'Outage Management Process'.

7. In line with NGL's arrangements, a team of Independent Nuclear Assurance (INA) inspectors (NGL's own internal regulator) and outage staff from other stations conducted a Rapid Trending Review (RTR) during the second week of the outage; the ONR project inspector for the outage also participated in parts of the RTR [6]. The RTR identified

points of positive feedback as well as highlighting one Area For Improvement (AFI) [7] relating to Control of Confined Space and Hot Work Tasks.

8. A Start-Up Meeting was held on 2 May 2018 for NGL to demonstrate to ONR [8] that it had adequately met the requirements of the MS, dealt with emergent issues (to the extent that they do not impact on returning R4 to power safely), identified any additional actions to be completed and demonstrated the safety of R4 for the next operational period [9].

9. On 23 May 2018, the HPB Station Director wrote to ONR requesting Consent to start-up R4 on completion of the periodic shutdown [1]. NGL will convene an Operational Safety Review Committee (OSRC) prior to start-up to review the fitness for service of the plant and endorse return to service.

10. INA independently supported 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.

11. 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. INA stated their support to start up Reactor 4 in their Concurrence Part B [10], in-line with NGL arrangements.

12. The Pressure Systems Safety Regulations (PSSR) competent persons (CP) [11] and the Appointed Examiner (APEX) have confirmed [12] that they are content for R4 to start-up.

13. Following ONR's issue of its Consent to allow Hinkley Point B R4 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 collated after return to normal operation in a document known as the '28 day report' which will be provided to ONR.

2.2.3 ONR's Intervention Management Process

14. The ONR activities in support of the HPB R4 outage were planned and recorded in the ONR outage plan [13].

15. The scope of the assessment work was developed in accordance with the ONR Enforcement Policy Statement (EPS) and was based on the following criteria:

- Scope of work for the outage as indicated by the OIR,
- Previous outage reports and actions,
- Recent regulatory attention,
- Operational experience 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.

16. Based on the safety significance of the intended outage work the following ONR specialisms were assigned to the project:

- Graphite
- Civil engineering

- Structural integrity
- Mechanical engineering
- Electrical engineering
- Control and instrumentation systems
- Radiological protection
- Conventional safety

17. ONR's process for delivering a permissioning project requires preparation of a 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 start-up of the reactor.

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

18. The following sections summarise findings and views of ONR's specialist Inspectors in their intervention and assessment of safety claims made by NGL in requesting start-up of R4 following its periodic shutdown.

3.1 Engineering Assessments

3.1.1 Graphite Core Integrity

19. References [14] and [15] provide the findings of the ONR graphite core integrity assessment of the inspections of Hinkley Point B R4 during the 2018 periodic shutdown and supporting documentation provided by NGL.

20. The purpose of the graphite inspection work by the licensee is to demonstrate that the condition of the graphite core is in accordance with the relevant safety cases and fit for purpose. Prior to the outage 51 full height single axial bore initiated cracks were known to have been observed in the four Hinkley Point B/Hunterston B (HNB) reactors. During the visual inspections carried out during this periodic shutdown, the licensee observed one new fully axial bore crack and one keyway root crack (KWRC) in the graphite moderator bricks. The licensee demonstrated that bore cracking is a consequence of early life ageing behaviour and do not expect this type of damage to progress significantly with core age. This has been consistent with inspections.

21. KWRCs are more significant as, once initiated, the damage mechanism is predicted to increase as the core ages. The licensee considers that this may be potentially life limiting for the reactor. NGL observed the first KWRC in the HPB reactors during this periodic shutdown, but similar cracks have already been observed in the HNB reactor cores. Since the HPB reactor cores are of similar design and core age as those at HNB, the licensee expected this type of crack to be observed. The findings of the graphite inspection therefore do not challenge the safety case of the graphite core.

22. The ONR regulatory intervention for the graphite element of the outage consisted of both an onsite inspection and offsite review of the licensee's submissions. The purpose of the onsite inspection was to examine the adequacy of the licensee's arrangements and to establish that the safety case commitments would be met. Additionally the inspection focused on the quality of the examinations being performed and the adequacy of the training and understanding of these involved in the work being carried out.

23. During the offsite review the inspector observed the regular Graphite Assessment Panels (GAP). The licensee considers and sentences the findings of the visual and dimensional inspections via the GAP. This is the licensee's internal governance body

with a requirement for a quorum of suitably qualified and experienced persons (SQEP), who are able to sentence the inspection findings in terms of whether they present challenges to the extant safety case. It also considers matters such as whether the inspections, dimensional measurements and trepanning have been performed adequately.

24. Graphite inspection takes place at each periodic shutdown of the reactor. The extent of the inspection is specified in the station Maintenance, Inspection, Testing Schedule (MITS), subject to LC28. MITS specifies the minimum graphite inspection commitment regarding the number of channels for inspection and number of graphite samples to be trepanned. Inspection of the fuel channels involves visual inspection of the channel bore and measurements of the bore diameter, ovality, and channel bow and tilt. The trepanned samples are sent to the National Nuclear Laboratory (NNL) for post irradiation examination, where graphite density, strength and other material properties are measured.

25. The graphite core inspection during the R4 2018 outage consisted of:

- Visual inspection and channel bore measurement of 31 fuel channels,
- Trepanning of 36 samples from fuel channel bricks within the core,
- Visual inspection of one control rod channel.

26. At the time of the onsite inspection, the licensee had completed 14 visual inspections and bore measurements, out of a target requirement of 31. The inspector was satisfied with the quality of the inspections and that the staff performing the inspections had been adequately trained.

27. The licensee completed all the MITS requirements at this periodic shutdown.

28. The inspector has reviewed the data provided by NGL to estimate the graphite weight loss during the next operating period. Based on his assessment he is content that no safety case limits will be exceed based on the expected core burn up during the next operating period.

29. During this outage one Super Articulated Control Rod (SACR) and its associated channel was inspected (RS28). This SACR was selected due to a previously identified defect with the control rod actuator mechanism that was addressed during the outage. All SACR operated correctly during the shutdown for the outage. During the review of the inspection damage to the graphite was observed via the video footage of the channel. This is discussed further in section 3.3.5.

30. The inspector was satisfied that the inspections undertaken during the periodic shutdown have been undertaken in line with the safety case and none of the results would preclude Consent being given to return HPB R4 back to service.

3.1.2 Civil Engineering

31. Reference [16] provides the findings of the ONR civil engineering assessment of the statutory examination of the pre-stressed concrete pressure vessel (PCPV) of R4 and other supporting documentation provided by NGL.

32. The focus of the inspector's assessment has been based on the Statutory Examination Report of the PCPV produced by the Appointed Examiner (APEX). This report gives the progress of the statutory surveillance inspections prescribed in the Station Maintenance Schedule. This is focussed primarily on those aspects that affect the structural integrity of the PCPV, namely concrete surface examination, tendon load checks, tendon

anchorage examination, tendon corrosion examination, PCPV settlement and tilt, vibrating wire strain gauges, vessel temperature, main reactor coolant loss, pressure vessel cooling system and top cap deflection.

33. A full report will be presented in an updated Statutory Examination Report by the licensee within 28 days of return to service.

34. The APEX reports that there is little change in the structural condition from the previous examination in 2015 and there is no obvious evidence of any new significant degradation.

35. The APEX reports that two sets of tendon load checks have been carried out during the previous operating period consisting of a 1% sample of 'top anchorages only' in August 2015, and the Maintenance Schedule requirement of a 1% sample of both top and bottom anchorages in September and October 2016.

36. The tendon load check data has been assessed by the APEX who concludes that the residual pre-stress level is adequate to satisfy the minimum design load (MDL) of 160tonf requirement for the next 3 year period of planned operation based on the current safety case.

37. The APEX reports that the tendon anchorage components and supporting concrete elements showed no signs of mechanical damage, significant corrosion or strand slippage and were found to be in a satisfactory condition.

38. The APEX reports that uPVC shrouds were fitted over the lower anchorages and tendon 'tails' in 2002 to prevent oil and grease from the tendons falling onto the floor of the stressing gallery and becoming a personnel slip hazard. During previous statutory outages small quantities of water were observed in some of these shrouds. This water had also been observed during the 3-monthly inspections of the lower stressing galleries of both reactors by the station Chemistry Section since 2002.

39. The amounts of water are very small compared to typical pressure vessel cooling water (PVCW) leaks, or rain water incursions, and the disposition of the affected shrouds (across a single quadrant of the gallery) also rules out PVCW water leaks or rain water entering the helical tendon ducts via the top anchorages.

40. To confirm that the small amounts of water evident in the lower anchorage shrouds have not adversely affected the actual tendons, tendons have been withdrawn from this sector of the PCPV and no significant corrosion was found.

41. The Licensee's site Chemistry Section carries out 3-monthly inspections of the underside of the PCPV within the lower stressing gallery and the APEX has reviewed the data from these visual examinations. Based upon the inspections and assessments undertaken for the anchorage components and the tendon tail ends during the 2017/8 surveillance activities, the APEX concludes that the presence of water in the shrouds does not compromise the integrity of the PCPV.

42. The APEX confirmed that the Reactor 4 PCPV tendon strands remain in a satisfactory condition and are compliant with the original performance specification.

43. The APEX has assessed the results of the tilt survey and concludes that the results are satisfactory, showing no significant change from the previous survey data and the differential settlement measurements remain well within tolerable limits.

44. The strain behaviour of the PCPV is routinely monitored using embedded vibrating wire strain gauges (VWSGs) which were cast into the vessel concrete during the original construction to provide strain indications at the following locations:

- Bottom Cap (including bottom cap corner),
- Side 'Barrel' Wall,
- Top Cap (including top cap corner and top corner bar).

45. The APEX reports that a preliminary assessment of the data indicates that the PCPV remains in a generally compressive state and there are no significant changes to strain and temperature trends during the period of this assessment.

46. No instances of significant main reactor coolant CO_2 leakage are reported by the APEX and there are no adverse trends of bulk CO_2 losses. The overall CO_2 losses are reported to have remained within the Technical Specification Limiting Condition of Operation 7.3.1 Action Limit of 4 tonnes/day.

47. The APEX reports that there are currently no known or reported instances of PVCW leakage affecting the PCPV.

48. Based on the assessment of the results of the surveillance inspections, and acceptance of the judgements made by the Appointed Examiner, the ONR inspector is content to support the return to service of the Reactor 4 pre-stressed concrete pressure vessel for the next operating period of three years.

3.1.3 Structural Integrity

49. Reference [17] and [18] provides the findings of the ONR structural integrity assessment of the inspections of Hinkley Point B R4 during the 2018 periodic shutdown and supporting documentation provided by NGL.

50. During the periodic shutdown, the ONR inspector visited HPB to confirm the adequacy of the work being conducted by NGL. Based on the items important to safety the following areas were sampled:

- Cooling water system inspections,
- Pressure system safety regulations (PSSR),
- ISI weld inspections,
- Corrosion management,
- Materials and weld inspections,
- Reactor internal remote visual inspections (steel components),
- Pipe hanger and restraint inspections,
- Flow assisted corrosion (FAC) inspections.

51. For each of these areas, the ONR structural integrity inspector discussed the scope, progress and outcome of EIM&T activities and was provided with satisfactory evidence of LC28 compliance.

52. Discussions were held with the PSSR Competent Person (CP) on the progress of examinations and inspections undertaken during the periodic shutdown, as required by the PSSR. The CP confirmed that PSSR examinations were proceeding as planned and no significant issues had been identified as a result of PSSR examinations at the time of inspection.

53. During the inspection the site Outage Assessment Panel (OAP) was observed by the inspector. The OAP meets to review the inspection work undertaken during the periodic shutdown and sentences the inspection findings. He was satisfied that the OAP was following due process and that the panel demonstrated a conservative approach to the findings. The meeting was well attended by the necessary technical and operational personnel, which he considered was managed efficiently and effectively.

54. During the outage HPB embargoed the use of the Decay Heat Loops on both R3 and R4 after the discovery of an Incredibility of guillotine failure (IoGF) weld issue at Hunterston B (HNB). This is discussed further in section 3.3.3 below.

55. A separate issue was also identified later in the outage with another IoGF weld on the cold reheat system. This is discussed further in section 3.3.6 below.

56. Based upon the sampling undertaken, and the evidence presented, the ONR structural integrity inspector judged that NGL had undertaken sufficient inspection and assessment, as well as suitably managing all emergent defects, to support the return to service of HPB R4.

3.1.4 Mechanical Engineering

57. Reference [19] provides the findings of the ONR inspection of the adequacy of the mechanical engineering related activities to comply with the EIM&T requirements of LC28. The ONR intervention included sampling the planned EIM&T activities during this outage, including:

- Gas Circulators (GC),
- Gas safety relief valves (GSRV),
- Control rod drop times.

58. During the outage there was one GC exchange (17B) as per the MS.

59. A sample of maintenance information and records were inspected including a number of work order cards (WOCs) and SQEP training records. The inspector raised a small number of queries regarding completion of some WOC that were adequately addressed during the inspection.

60. A repeat finding from a previous Systems Based Inspection (SBI) conducted during 2017 [20] related to SQEP records identified by the inspector. As a regulatory issue (5562) had already been raised during that inspection a duplicate issue has not been raised and the shortfall will be progressed through normal Regulatory Issue management.

61. The inspector undertook a walk down of the GC and GSRV maintenance facility. He sampled maintenance arrangements for GSRVs and was content that they remain within acceptable tolerances and that EIM&T activities were adequately controlled.

62. The inspector reviewed data confirming that the Control Rod Drop times remain within the safety case limits.

63. Based on the samples taken and observations during the inspection, the mechanical engineering specialist was satisfied that the LC28 arrangements in place for EIM&T were adequate and therefore supports a request to start up R4 at following its 2018 periodic shutdown.

3.1.5 Electrical Engineering

64. Reference [21] presents the findings of the ONR inspection of the adequacy of the electrical engineering related activities to comply with the requirements of LC28.

65. The inspection included a brief overview, explanation and demonstration of the electrical engineering aspects of the shutdown. This included discussions, explanations and demonstrations of; progress with the outage work activities, findings of significance, resolution of findings, deferred activities, a sample of documentation related to the outage work activities and a plant walk-down to observe the work.

66. Based on their nuclear safety significance the inspector reviewed outage work packages including the 11kV air-circuit breakers (ACB), switchboards, protection relays, and reactor shutdown sequencing equipment (RSSE). The inspector was satisfied with the areas sampled. The inspector also reviewed a number of Work Order Cards (WOC), maintenance instructions and completed check sheets for the shutdown related electrical activities referred to within the OIR and the MS that had been completed. A small number of anomalies were identified on a number of different check sheets. The anomalies included: missing pass/fail criterion; the inconsistent use of engineering terms, the recording of results that were out with the requirements of the stated pass/fail criterion; the recording of results in a timescale that was different to that required by the activity.

67. The inspector judged that that the anomalies identified were minor and was satisfied with the response from site and that he would follow this up at a future intervention under normal regulatory business.

68. During this outage there was a significant non-routine work package being carried out to replace the generator transformer phase tanks (A and B). The tanks are being replaced with a modern type of phase tank. This replacement is due to the station identifying life limiting features during a forensic strip down of a failed generator transformer phase tank on the station's other generator transformer.

69. The ONR electrical engineering inspector considered that, based on the targeted interventions, there were no issues identified from the electrical work activities which would prevent ONR granting Consent for R4 to return to service.

3.1.6 Control and Instrumentation

70. Reference [22] presents the findings of the ONR Control and Instrumentation (C&I) specialist inspector. The main focus of this inspection was to inspect a sample of outage work activities carried out in relation to control and instrumentation (C&I) equipment and systems important to nuclear safety in order to confirm that they remain fit for their intended purpose at HPB.

71. The following areas were covered during the outage C&I inspection, based on their nuclear safety significance:

- Reactor safety circuits, including:
  - Neutron flux detectors (NFDs) testing,
  - Main guardlines (MGL) maintenance and testing,
  - Diverse guardlines (DGL) maintenance and testing,
  - Channel gas outlet temperature (CGOT), boiler outlet gas (BOG), circulator outlet gas (COG) and quadrant protection equipment (QPE) thermocouples testing.

- Reactor shutdown sequencing equipment (RSSE) maintenance and testing,
- Gas circulator (GC) instrumentation maintenance and testing,
- Nitrogen injection system testing,
- Plant modifications,
- Cyber security arrangements.

72. Based on the inspection of the maintenance activities and documentation sampled the inspector was satisfied that the C&I safety systems at HPB R4 have undergone suitable and sufficient maintenance.

73. During the inspection the inspector raised an ONR issue (6334) to cover various requests for further information from the station post the inspection that will be progressed through normal regulatory issue management. None of these requests were considered to have any impact on the RTS of R4.

74. On the basis of the inspection the inspector identified no issues which would prevent ONR issuing Consent to allow R4 to start-up.

3.2 Safety Management

3.2.1 Radiological Protection

75. Reference [23] presents the findings of the ONR radiological protection specialist.

76. The inspection sought to establish the licensee's readiness to undertake maintenance and inspection activities in compliance with their policies under the IRR17. The intervention reviewed the following areas:

- Planning for radiologically significant outage tasks,
- Radiation protection input to outage work planning and pre-outage ALARP report,
- Radiological protection arrangements associated with trepanning and NICIE reactor core inspection work,
- Radiation protection personnel and monitoring equipment provision,
- Radiation Work Permits (RWPs) and ALARP briefings,
- Radiological event performance, monitoring and investigation,
- Record-keeping,
- Operational dose management.

77. The inspection did not reveal any nuclear safety issues relevant to the R4 outage that required action by NGL or follow-up by ONR. On this basis the radiological protection inspector identified no issues which would prevent ONR issuing Consent to allow R4 to start-up.

3.2.2 Conventional Safety

78. Reference [24] provides the findings of the ONR conventional health and safety inspection conducted during the outage. The purpose of this intervention was to provide regulatory confidence in the management of conventional health and safety (CHS) hazards present during the outage for setting to work.

79. The key regulatory activities undertaken during the inspection were based around:

- Work planning, risk assessment, setting to work and work specifier competence,

- Planning arrangements for work in confined spaces,
- Plant walkdowns of a number of locations to sample maintenance work and confined space work to evaluate the effectiveness of planning and setting to work arrangements.

80. During the inspection the issue around confined space working that had been identified during the RTR by INA (see para 7) was discussed with site staff. Although the arrangements are comprehensive, areas on site have unnecessarily been classed as confined spaces irrespective of the work to be completed. It was advised that in treating areas that did not need to be classed as confined spaces, as defined in the Confined Spaces Regulations 1997 and associated ACoP, could potentially undermine the permit system which should be used for high hazards and unusual jobs. There could also be a potential for moving away from sustainable compliance due to the number of permits issued. Following the RTR, HPB immediately stopped all confined space work and reviewed their systems.

81. An ONR issue (6347) was raised to manage oversight of EDF's review of their arrangements for confined space working which will be progressed through normal regulatory issue management.

82. There are no findings from this inspection that would prevent ONR issuing Consent for the start-up of R4.

3.2.3 Control and Supervision, LC26

83. The outage project inspector carried out a compliance inspection of control and supervision of outage operations under LC 26 [6]. This focussed on the control and supervision of contractors performing maintenance operations during the outage. During an outage the number of contractors on site increases significantly from routine operation, as such it is important that suitable control and supervision is in place to absorb this additional workforce safely.

84. The arrangements for effective supervision of contractors were examined and discussions were held with station management and contract partners to explore how this was managed.

85. The outage project inspector judged that an appropriate level of control and supervision was evident at the workplace and suitable oversight was being provided by the licensee.

86. No issues were identified that would prevent the re-start of R4.

3.3 Emergent Issues

3.3.1 NICIE2 Equipment and Tilt Measurement Procedure

87. Tilt measurements give an indication of the change in tilt angle up the height of a channel relative to the layer 1 brick. The measurements are used to determine channel bow and provide information as to whether the core is distorting relative to historical measurements. The concern with the core tilt is that brick cracking may give rise to widespread core distortion which might impair control rod entry thus impacting on safe shutdown. It is therefore important to determine the tilt with sufficient accuracy and in particular any change in tilt over time.

88. Visual inspections and bore measurements are made using an inspection tool referred to as 'NICIE2' (New In-Core Inspection Equipment). The angle of the channel is determined by its 'tilt' and gives a measure of the overall distortion of the core. This measurement is

determined from two transducers which measure and record the angle of the tool as it passes through the channel. The brick bow, channel bow and channel tilt are derived from these readings.

89. During the inspections, NGL notified ONR that a fault on one of the transducers had been identified. NGL identified that a faulty transducer was at the origin of these erroneous readings and changed the faulty transducer. The licensee subsequently reviewed the recent inspection data. This identified that the fault occurred in the 5th channel in the inspection sequence (channel U35) and suggested that these measurements could be corrected using the reading from a single transducer.

90. Originally, the calculation method from which the measurements are derived for the channel and for the brick, uses a simple equation which takes the measurements from both transducers. The licensee therefore developed a new method to calculate the tilt from a single transducer by modifying this equation accordingly.

91. The licensee also carried out a review of the tilt data during the current inspections, but also considered historical data from HNB. This review was used to validate the new calculation method and did not highlight any adverse values in the tilt measurements. The ONR inspector considered this change to be minor and adequate

92. During the inspections, NGL also carried out two channel re-inspections to further validate the new calculation method. The two measurements were in good agreement and provided some confidence that the calculation using a single transducer and that using a set of two transducers produced similar measurements.

93. On this basis, the ONR graphite specialist inspector was satisfied that the licensee adequately addressed this issue and provided evidence that the channel tilt measurements were not significant and did not show any adverse evolution with reactor age. He considered that the measured core, channel and brick distortions were acceptable.

3.3.2 Gas Circulator Inlet Guide Vane Position Monitoring

94. The Inlet Guide Vanes (IGV) are used to alter gas flow. There is a single drive train for operating the IGVs but there are two induction motors to drive the IGV. Also driven off this drive train are 2 Selsyn transmitters which transmit the IGV position, one unit to the local and CCR position indications and the other to the local auto control positioners. The auto control positioning system uses the position feedback to drive the IGV's to the demanded position.

95. During testing of the R4 GC IGV motors and associated Selsyn IGV position transmitters it was revealed that the 19B and 20B Selsyns had insulation resistance values below the acceptance criteria. The System Engineer (SE) informed the inspector that should one of the position transmitters fail the other one can be aligned to fulfil both indication and auto control roles. The NGL SE stated that both Selsyns will still function adequately.

96. The issue was referred to the Engineering Decision Making (EDM) and Operational Decision Making (ODM) committees. The EDM committee recommended that both Selsyns be repaired during this outage; however the ODM committee decided that their repair should be deferred until the next R4 statutory outage. The SE stated that the ODM committee considered this decision to be As Low As Reasonably Practicable (ALARP) after taking wider organisational and operational issues into account, and that he supported the decision.

97. Following a detailed post-inspection review of the EDM and ODM Activity Logs ONR reviewed the Safety Assessment that the ODM committee requested be produced to

justify return to service. Having reviewed this information, the ONR inspector considered the approach taken by HPB to be reasonable and does not object to the decision taken by the ODM committee.

3.3.3 Decay Heat System IoGF welds

98. Before the ONR structural integrity specialist visited HPB he was made aware of a failure of an IoGF weld in the decay heat outlet line of HNB reactor 3 (R3). Due to the similarities between the systems HPB took the decision to embargo their Decay Heat Loops (DHL) on both R3 and R4. Following this HPB has produced an IJCO (EC 363313) to support continued operation of R3 and R4 RTS.

99. The inspector was informed that comprehensive inspection of all IoGF welds of the decay heat system had been added to the outage inspection programme. The system has now been inspected on both R3 and R4. ONR have subsequently received copies of the following documents:

- EC363313, Interim Justification for Continued Operation of R3 and R4 Decay Heat System in light of discovery of through-wall defect in HNB Decay Heat System IoGF Weld R3/DO/18,
- EC363389, Rev000, R3 Decay Heat Welds: Justification of Pipework Modifications to Satisfy IoGF Integrity,
- INSA certificate, R3/R4 Decay heat welds: Justification of pipework modifications to satisfy IoGF integrity requirements.

100. Following the inspector's review of information provided by NGL and taking cognisance of ONR's assessment of the justification for return to service of HNB R3 following leak and repair of decay heat outlet weld, he was content that the mitigating measures completed by NGL for the decay heat systems on R3 & 4 at HPB are appropriate.

101. A Regulatory Issue will be raised for ONR to monitor development of the long term safety case for the four reactors of HNB and HPB and NGL's proposals to address the fleet-wide implications of the failure of HNB weld.

3.3.4 R3/R4 Gas Circulator Endurance Controller Set Point Anomalies

102. During the outage HPB issued Incident Notification Form (INF) (2018/219) to ONR regarding the identification of an anomaly on the Gas circulator endurance (GCE) controller set points. Whilst carrying out testing of R4 Gas Circulator Endurance system during the statutory outage HPB identified the process controller for the CO2 purge valve on all quadrants had the incorrect set point. It should be 20mbar but was found set at 0 mbar. An extent of condition was immediately conducted on R3 (the running unit) and similarly the set point on all quadrant GCE process controllers was also found to be 0 mbar.

103. The function of the GCE purge valve is to inject clean CO2 into the gas circulator motor compartment and maintain a positive pressure (20mbar) above reactor pressure in the event of a boiler tube failure to keep wet gas out of the circulator. At no point was this plant called into operation (i.e. no initiating event) and the operator has the ability to manually control the purge valve if required so the plant could have been operated if necessary.

104. The set point on the process controllers fitted to R4 was immediately corrected and tested satisfactorily. Likewise all the set points on the R3 (the running unit) process controllers were re-set correctly back to 20mbar.

105. The HPB SE informed the ONR inspector that NGL will produce an associated Adverse Condition Investigation (ACIN) report and Operational Experience (OPEX) Brief. The ACIN will be provided to ONR when complete.

3.3.5 Graphite Inspection Anomaly of Super Articulated Control Rod Channel

106. One of the EMI&T requirements is to perform the visual inspection of a control rod channel during every periodic shutdown and the licensee chose to inspect channel RS 28. This channel houses a 'contract' super-articulated bulk control rod manufactured by IMI. During inspection of channel RS28, unusual markings were found on the channel wall, including damage in the form of chipping at the top and bottom of the Layer 7 brick and contact marks on the Layer 2 brick. The cause for the damage was not clear from the inspection.

107. After observing the damage in the control rod channel, the licensee decided to change the scope of the inspections to inspect a fuel channel R27 adjacent to control rod channel RS28 where the damage had been observed. The licensee performed bore measurements in fuel channels R27 and confirmed that there was negligible channel distortion and that measurements were similar to the previous inspection in 2015. The licensee reported that no defect and no damage to the bricks had been observed in fuel channel R27. There is no adverse indication in this fuel channel that could explain the damage in control rod channel RS28. In addition, the inspections in fuel channel R27 provide confidence that the damage in channel RS28 is localised and is not the result of excessive core distortion. NGL has also committed to inspect a channel housing a super-articulated control rod of the same manufacturer as the control rod in HPB R4 channel RS28 in the HPB R3 reactor core in 2019.

108. Control rod drop times did not suggest any inhibition of movement of the control rod in the channel.

109. After a request from ONR, NGL provided possible explanations for the damage observed. NGL considers that the markings observed may have been caused by; contact of the control rod during drops, original defects, inspection equipment or the removal of the control rod shock absorbers to allow sub-diagrid viewing. The licensee also mentions that this type of damage had not been observed before, but that similar scuff marks have been observed in fuel channels where the stabilising brushes interact with the channel walls. NGL will consider the observed damage in more detail within the 60 day EC which will be provided to ONR.

110. The inspector considered based on the further inspection work during this outage and the control rod drop times being within specification that the licensee took sufficient and adequate action to provide evidence that control rod entry would not be impaired in this channel and therefore would not impact on RTS of R4.

3.3.6 Cold Reheat IoGF Weld Anomaly

111. During weld inspections completed as part of the routine outage work an issue was identified with weld inspection of 4/LT/29 in the cold reheat supply to 17/15/RI. This is an IoGF weld that was previously inspected in 1996 and 2005.

112. In order to understand the issue the weld was excavated for further investigation and metallurgical examination. The results from the forensic testing showed that the observation was non-crack like and originated from a number of lack of fusions at original construction that have been deemed innocuous for the weld integrity.

113. The discussion of this and the repair to the weld will be reported in the ISI RTS EC which will be provided to ONR. The ONR structural inspector was content with the approach taken by NGL to address the matter and did not consider it a restart issue.

3.4 Start-up Meeting

114. The Start-Up Meeting was held on 2 May 2018 [9]. Prior to this meeting there was a comprehensive plant walk-down. ONR was represented by the superintending inspector, the HPB site inspector and the outage project inspector. The walk down encompassed many of the major work package areas conducted during the periodic shutdown. The purpose of the inspection was to determine whether any areas of the station were unsuitable for return to service. The meeting was chaired by the Plant Manager and attended by a cross section of the HPB management team. HPB provided the outage Start up report [8] prior to the meeting which was used as the basis for the presentations and discussions held.

115. It was recognised that outage programmed work was still progressing in a number of areas and that in these areas the plant was not yet in a condition to start-up. However no other plant conditions were identified that would have an impact on the start-up of R4.

116. A number of minor house-keeping issues were identified during the inspection. These were brought to the attention of the Plant Manager who dealt with these issues immediately.

117. No new actions were raised during the Start-up meeting.

4 MATTERS ARISING FROM ONR'S WORK

118. I have considered the licensee's request to ONR to grant a Consent under LC30(3) to start-up Hinkley Point B Reactor 4 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 work undertaken by NGL's internal regulator (INA), the statements of the PSSR competent persons and the findings and advice of ONR specialist inspectors and the ONR nominated site inspector.

119. NGL will convene an Operational Safety Review Committee (OSRC) prior to start-up to review the fitness for service of the plant and endorse return to service.

120. INA has provided a concurrence statement [10] which confirms that, based on their assessment activities there are no issues of which they are aware which would prevent start up.

121. The PSSR Competent Person has raised no issues as part of their inspections so far and satisfactory completion of their inspections will be confirmed at the OSRC prior to start up.

122. ONR specialist inspectors have each produced a report that presents the inspection findings, inspectors' opinions, judgements and recommendations. No actions requiring resolution before granting of Consent were raised.

123. A number of recommendations arose from the inspectors' work which will be addressed through routine regulatory business. 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.

124. As per the guidance document [25] to support the Memorandum of Understanding (MoU) between the ONR and Environment Agency (EA) I consulted with the HPB EA Inspector to establish if he had any specific objections that would prevent ONR from issuing LI 557, Consent to start-up Hinkley Point B R4. The EA [26] confirmed they did not object to ONR granting Consent to allow start-up of HPB R4 post its triennial statutory maintenance outage.

5 CONCLUSIONS

125. The Hinkley Point B Reactor 4 periodic shutdown 2018 has been undertaken in accordance with the requirements of the work scope outlined within the Outage Intentions Report.

126. NGL has followed its arrangements in undertaking the periodic shutdown, culminating in the Hinkley Point B Station Director writing to ONR requesting Consent to start-up Reactor 4. His letter stated that he was satisfied that were no safety issues associated with return to service of Reactor 4.

127. I consider that the licensee delivered a shutdown that was safely managed and completed the required safety-related work activities in accordance with its safety case.

128. Following assessment and inspection of matters arising in relation to the Hinkley Point B R4 periodic shutdown 2018, I am satisfied that the licensee's request to start-up the reactor and operate for a further period is supportable; consequently, Consent to start-up the reactor can be granted.

129. I have prepared Licence Instrument 557, for LC 30(3) Consent, in conjunction with this PAR.

6 RECOMMENDATIONS

130. I recommend that the Superintending Inspector:

- Accepts this Project Assessment Report to confirm support for the issuing Hinkley Point B Licence Instrument 557.

131. I recommend that ONR issues Licence Instrument 557, which grants Consent under Licence Condition 30(3) attached to Nuclear Site Licence 62C to start-up Hinkley Point B R4.

REFERENCES

[1] EDF, HPB R4 Outage 2018 - Request for Consent to start up Reactor 4 under LC30(3). TRIM 2018/173739.

[2] ONR, Hinkley Point B, Letter specifying consent to restart. January 1998. TRIM 2018/107486.

[3] ONR Licence Instrument No:548 Consent under Condition 30(3) attached to Site Licence 62C. TRIM 2015/126367.

[4] NGL – Hinkley Point B - Outage Intentions Report - Reactor 4 Statutory Outage 2018 TRIM 2017/362270.

[5] Outage Intentions Meeting NGL – Hinkley Point B – 11 November 2017. TRIM 2017/427722.

[6] Hinkley Point B - ONR-OFD-IR-18-005 - HPB R4 2018 Outage Planned LC26 Compliance Inspection - 3-5 April 2018. TRIM 2018/127294.

[7] Hinkley Point B - ONR - HPB R4 2018 Outage RTR close out presentation. TRIM 2018/118469.

[8] Hinkley Point B - ONR - HPB R4 2018 Outage Start up meeting Report. TRIM 2018/141148.

[9] EDF NGL - Hinkley Point B - ONR-OFD-CR-18-096 - R4 2018 Outage Start-Up Meeting - 2 May 2018. TRIM 2018/157776.

[10] INA - HPB R4 Outage 2018 - INA Concurrence Part B. TRIM 2018/173467.

[11] HPB R4 Outage 2018 - Outage 033 Completion Letter BV(2). TRIM 2018/173952.

[12] HPB R4 2018 Statutory Outage APEX Report Rev 000 - TRIM 2018/153678.

[13] Hinkley Point B - ONR R4 2018 Outage- ONR Inspection Plan. TRIM 2018/87043.

[14] Hinkley Point B - ONR-OFD-IR-18-009 - HPB R4 2018 Outage Graphite Core Inspection - 16 April 2018. TRIM 2018/132550.

[15] ONR-OFD-AR-18-003 - HPB R4 2018 Outage - Assessment of the Graphite Structural Integrity Aspects. TRIM 2018/144215.

[16] ONR-OFD-AR-18-010 - HPB R4 2018 Outage - Assessment of the Appointed Examiner’s start-up statement for the pre-stressed concrete pressure vessel. TRIM 2018/154224.

[17] Hinkley Point B - ONR-OFD-IR-18-027 - HPB R4 2018 Outage Structural integrity inspection - 17-18 April 2018. TRIM 2018/148600.

[18] ONR-OFD-AR-18-006 - HPB R4 2018 Outage - Assessment of Structural Integrity in Support of the Restart of Reactor 4. TRIM 2018/143911.

[19] Hinkley Point B - ONR-OFD-IR-18-011 - HPB R4 2018 Outage Mechanical Engineering Inspection - 10-11 April 2018. TRIM 2018/143742.

[20] NGL - OFD - Intervention Record - 17-097 - Hinkley Point B - System Based Inspection – SBI 17 – Gas Circulators - 8-11 August 2017. TRIM 2017/331726.

[21] ONR-OFD-IR-18-020 - Hinkley Point B - R4 Outage 2018 - LC 28 Inspection of Electrical Related Aspects - 17 April 2018. TRIM 2018/143427.

[22] Hinkley Point B - ONR-OFD-IR-18-016 - HPB R4 2018 Outage C&I Inspection - 17 & 18 April 2018. TRIM 2018/154435.

[23] Hinkley Point B - ONR-OFD-IR-18-024 - HPB R4 2018 Outage Radiological Protection Inspection - 19 April 2018. TRIM 2018/149456.

[24] Hinkley Point B - ONR-OFD-IR-18-028 - HPB R4 2018 Outage CH&S

inspection - 25-26 April 2018. TRIM 2018/154855.

[25] Guidance to Support the Joint Regulatory Memorandum of Understanding between the ONR and the EA on Matters of Mutual Interest in England. March 2018. TRIM 2018/114211.

[26] ONR-HPB R4 Outage 2018 - Environment Agency Support to Restart. TRIM 2018/153447.