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Hunterston B Reactor 4 Periodic Shutdown 2017

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

Project Assessment Report ONR-OFD-PAR-17-008

Revision 0

30 October 2017

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EXECUTIVE SUMMARY

Title

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

Permission Requested

NGL, the licensee of Hunterston 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 Sc.13.

Background

NGL is licensed to operate two advanced gas-cooled reactors (AGRs), known as Reactor 3 and Reactor 4 at Hunterston B Power Station.

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. In addition, the licensee also undertakes plant safety improvements to be implemented where these are deemed to be reasonably practicable. The licensee's arrangements require that periodic shutdowns, as required by Licence Condition 30(1), are carried out every three years on each reactor at Hunterston B. The previous start-up consent for Reactor 4 was granted on 29 September 2014. On completion of a periodic shutdown, the reactor concerned cannot be started up without consent from ONR under Licence Condition 30(3).

During the Reactor 4 periodic shutdown 2017 which commenced on 8 September 2017, the licensee has conducted:

- Examinations, inspections, maintenance and testing activities in accordance, with the maintenance schedule,
- Inspections to support the station safety case,
- Work to comply with statutory requirements,
- Remedial work to rectify plant adverse conditions,
- Plant safety improvements where these are deemed to be reasonably practicable.

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 reactor start-up.

Towards the end of the periodic shutdown, the Hunterston B Station Director wrote to ONR requesting consent to start-up Reactor 4. In that letter, the Station Director confirmed that all maintenance required for start-up would be completed.

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

No matters preventing the granting of consent to start-up arose from the work undertaken by ONR inspectors in relation to the Hunterston B Reactor 4 periodic shutdown 2017.

Conclusions

Following assessment and inspection of matters arising in relation to the Hunterston B Reactor 4 periodic shutdown 2017, ONR was satisfied that the licensee's justification to start-up the reactor and operate for a further period was adequate; consequently, it was recommended that consent to start-up the reactor was issued by ONR.

Recommendation

It was recommended that, in accordance with the request from the licensee, ONR should grant consent under LC 30(3) attached to Nuclear Site Licence Sc.13 for Reactor 4 at Hunterston B nuclear power station to start-up following the 2017 periodic shutdown, and Licence Instrument 558 be issued to the licensee.

LIST OF ABBREVIATIONS

ALARP	As low as reasonably practicable
APEX	Appointed Examiner
BS	British Standards
C&I	Control & Instrumentation
EBFP	Emergency Boiler Feed Pump
EC	Engineering Change
EIMT	Examination, Inspection, Maintenance and Testing
FME	Foreign Material Exclusion
GAP	Graphite Assessment Panel
GC	Gas Circulator
GSRV	Gas Safety Relief Valve
HNB	Hunterston B
IGV	Inlet Guide Vanes
INA	Independent Nuclear Assurance
INSA	Independent Nuclear Safety Assessment
IR	Intervention Record
IRR99	Ionising Radiation Regulations 1999
KRC	Keyway Root Crack
LI	Licence Instrument
LP	Low Pressure
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
PRV	Pressure Relief Valve
PSSR	Pressure Safety Systems Regulations 2000

QA	Quality Assurance
RCW	Reactor Cooling Water
RTR	Rapid Trending Review
RP	Radiological Protection
SEPA	Scottish Environment Protection Agency

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1 PERMISSION REQUESTED

1. EDF Energy Nuclear Generation Limited (NGL), the operator and Licensee of Hunterston B power station (HNB), has written [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) 558.

2 BACKGROUND

2.1 GENERAL

2. The nuclear site licence issued to NGL for HNB requires the Licensee to periodically shut down plant under LC30. This is to enable examination, inspection, maintenance and testing (EIMT) to take place in accordance with the requirements of HNB's Plant Maintenance Schedule (MS) under LC28. At HNB, 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, Hunterston B LI 543 [3] was dated 29 September 2014 and the R4 periodic shutdown 2017 commenced on 8 September 2017.

2.2 OUTAGE PLANNING AND MANAGEMENT

2.2.1 Outage intentions

4. NGL's planned outage work programme was outlined in the HNB Outage Intentions Report (OIR) [4]. This was examined by ONR specialist inspectors and the nominated site inspector in preparation for the outage intentions meeting held on 4 March 2017 [5].
5. During the R4 2017 periodic shutdown NGL would be conducting:
 - Examinations, inspections, maintenance and testing activities in accordance with the MS,
 - Inspections to support the station safety case,
 - Work to comply with statutory requirements,
 - Remedial work to rectify plant adverse conditions,
 - Plant safety improvements where these are deemed to be reasonably practicable.
6. The notable packages of work to be undertaken were:
 - 3 Gas Circulator exchanges (4A1, 4B2 and 4D2),
 - 9 Channels of core inspection using Prototype Eddy Current Inspection Tool (PECIT),
 - 31 New In-Core Inspection Equipment Mark 2 (NICIE2) inspections,
 - 6 Trepanned channels,
 - 2 Major and 2 Minor Gas Circulator overhauls,
 - Turbine Generator (TG) 8 Generator Rotor exchange,
 - 3 Low Pressure (LP) rotor exchanges,
 - Unit Aux Transformer 8 exchange.

7. In common with the rest of the NGL fleet, an island approach was to be adopted to plan and manage the outage activities. This approach co-located relevant personnel for each island (planning, engineering, operations and maintenance) in the Station Control Centre (SCC). The following island teams were deployed:
 - Boiler Island
 - Boiler area
 - Gas circulator area
 - Reactor balance area
 - Conventional Island
 - Turbine area
 - Conventional balance area
 - Fuel Route Island
 - Electrical Island
 - Operations Island.

2.2.2 Licensee's outage management

8. The outage has been managed in accordance with the requirements of NGL's integrated company practice BEG/ICP/OPS/009 'Outage Management Process'.
9. 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 [7] relating to the inconsistent use of barriers and protected plant which may lead to unauthorised access and could challenge configuration management.
10. A Start-Up Meeting was held on 11 October 2017 for NGL to demonstrate to ONR that it had adequately met the requirements of the MS, dealt with emergent issues, identified any additional actions to be completed and demonstrated the safety of R4 for the next operational period [8].
11. On 27 October 2017, the HNB 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.
12. 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.
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 [9]. A statement to support the request for consent to start up [1] was provided in advance of the formal concurrence Part B statement, in-line with NGL arrangements (SRD/PROC/009).
14. NGL will produce a Return to Service (RTS) Engineering Change (EC) that approves the results of inspections completed in the outage inspection programme. INA will also issue an Independent Nuclear Safety Assessment approval statement for the RTS EC. Both these documents will be provided to ONR.

15. The Pressure Systems Safety Regulations (PSSR) competent persons [1] and the Appointed Examiner (APEX) have confirmed that they are content for R4 to start-up [10].
16. Following ONR's issue of its Consent to allow Hunterston 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 published 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

17. The ONR activities in support of the HNB R4 outage were planned and recorded in the ONR outage plan [11].
18. The scope of the interventions and assessments was determined by conducting reviews of:
 - 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.
19. The following ONR specialisms were identified as required for the HNB R4 outage 2017 project:
 - Graphite
 - Civil engineering
 - Structural integrity
 - Mechanical engineering
 - Electrical engineering
 - Control and instrumentation systems
 - Radiological protection
 - Conventional safety
 - Site inspection oversight
20. 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 restart of the reactor.

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

21. The work undertaken by ONR can summarised as follows:
 - Engineering assessments and inspections of maintenance, modifications and other work during the outage covering the following areas:
 - Graphite core integrity
 - Civil engineering
 - Structural integrity
 - Mechanical engineering

- Electrical engineering
- Control and instrumentation
- Assessment of the safety management of the outage including:
 - Radiological protection
 - Conventional safety
- Emergent issues
- Start-up meeting

3.1 ENGINEERING ASSESSMENTS

3.1.1 Graphite core integrity

22. Reference [12] provides the findings of the ONR graphite core integrity assessment of the inspections of Hunterston B R4 during the 2017 periodic shutdown and supporting documentation provided by NGL.
23. The scope of the inspector's intervention included:
 - Discussion of inspection progress and findings,
 - Review of inspection and training records,
 - Discuss progress of Fuel Grab Load Trace analysis and results from recent Low Power Refuelling validation,
 - Attending a Monitoring Assessment Panel meeting,
 - Initial feedback/requests for information.
24. The graphite core inspection during the outage consisted of:
 - Visual inspection and channel bore assessment of 31 fuel channels,
 - Visual inspection of one control rod channel,
 - 36 trepanned samples taken from 6 fuel channels,
 - PECIT was deployed in 9 fuel channels for inspection.
25. Of the 31 channels inspected, one new singly axially cracked brick was observed in layer 6 of channel 14:80. NGL sentenced this crack as a keyway root crack (KRC) and determined from bore measurement data that this brick was part of the main population. The observation of one main population KRC in HNB R4 is consistent with HNB R3 at the same level of core irradiation.
26. Based on the observation of 1 KRC brick in a targeted channel, NGLs statistical models suggest that the safety limit of the number of cracked bricks for safe shutdown of the reactor will not be reached until July 2019 at the earliest, with a 99.9% confidence.
27. NGL re-inspected a secondary cracked brick in channel 12:80 and an induced cracked brick in channel 28:84.
28. When channel 12.80 was inspected in 2014, a layer 5 brick was observed to contain a KRC. Subsequent inspection in 2016 found that a secondary crack at 90° to the primary KRC had developed. Re-inspection in 2017 found that the KRC had continued to open and that the secondary crack had developed to the full height of the brick. Therefore, continued dimensional change under irradiation has driven crack opening and propagation during the period since initiation. However, crack opening remains of the order of a few millimetres. The inspector was content that the brick does not constitute a concern in terms of structural integrity.
29. In channel 28.84, re-inspection of the layer 5 primary KRC and induced crack in layer 4 which were first evident in 2016 revealed that both cracks had continued to open by a

further 0.5mm approximately, to a maximum width of 1.5 mm. However, it appears that the continued opening has induced a further partial height axial crack in the layer 3 brick below. This is similar development to that observed in HNB R3, at an equivalent level of core irradiation, and indicates that induced cracking may be a consistent mechanism following the initiation of a primary KRC within a channel. Overall, NGL has considered the consequences of a large number of axial cracks within the same channel within its safety case. The inspector was therefore content that NGL is appropriately accounting for the effects of induced cracking in the development of their safety case.

30. In general the core distortion measurements of channel bow, brick bow, ovality and shrinkage are consistent with expectations. However, a number of the channel tilt measurements either exceeded or were equal to the maximum observed values. NGL have committed to explaining the observed results at HNB R4 with regard to tilt and partial key disengagement in their 60 day EC. The inspector considered that the observed tilts do not constitute a change in core geometry that would in any way hinder its safety functions and was therefore content to consult the 60 day EC for a detailed explanation of what can be inferred from channel bow and tilt measurements.
31. Based on inspection and the results of the review, the inspector was satisfied that the amount of cracking found in HNB R4 in no way challenges current safety case limits and that return-to-service and continued operation is justified whilst NGL produces its 60 day EC to justify the length of operation before HNB R4 next graphite inspection.

3.1.2 Civil Engineering

32. Reference [13] 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.
33. The focus of the inspector's assessment has been based on the Statutory Examination Report of the PCPV produced by the Appointed Examiner (APEX). The Statutory Examination Report assessed is an interim version, and records NGL's progress with the statutory surveillances, inspections and tests on the pre-stressed concrete pressure vessel as prescribed in the station Maintenance Inspection and Test Schedule (MITS).
34. A full report will be presented in an updated Statutory Examination Report by the licensee within 28 days of return to service. The APEX's report has been structured under the following headings:
 - Concrete Surface Cracking and Cooling Water Leakage Search
 - Anchorages
 - Tendon Load Checking
 - Strand Withdrawal
 - Settlement & Tilt
 - Strain Gauge Monitoring
 - Vessel Temperature
 - Main Reactor Coolant Loss
 - Pressure Vessel Cooling Water
 - Top Cap Deflection.
35. The inspector sampled the revised structural survey drawings and the new cracks identified are generally noted as "Fine Cracks" (0.1-0.2mm). Two newly recorded vertical cracks were found in the upper pre-stressing gallery wall. These cracks are similar to others on this wall, which structurally is not supporting the reactor pressure boundary and so are not considered to be of concern for PCPV integrity.

36. Regular moisture monitoring surveys have been carried out on the vessel outer surface and lower stressing gallery, with the objective of detecting pressure vessel cooling water (PVCW) leakage and any resulting degradation. The APEX has confirmed that no signs of water leakage have been reported since the last periodic shutdown.
37. The APEX reports that the visual examination of tendon anchorages was completed in 2016 and that the anchorages are in a satisfactory condition, with no signs of mechanical damage or significant corrosion.
38. The tendon pre-stress anchorage load was measured on a sample of 32 tendons, (approximately 1.1% of the population of 2813). The safety case requires that the average value of tendon anchorage load remains in excess of the Minimum Design Load (MDL) for both the upper and lower anchorages when checked separately. Both these results for the 32 tendons are in excess of the required MDL. The analysis indicates that there will still be adequate margins above the MDL during the next period of operation and beyond.
39. The MITs requires that the central strand is withdrawn from a minimum of five tendons selected by the APEX. The examinations found that three of the five samples contained pitting corrosion. The ONR civil engineering inspector was content that the observed corrosion is of limited extent and supported the judgement of the APEX that it would not represent a threat to the integrity of the strand.
40. Mechanical testing was undertaken from each of the five tendons removed. The inspector considered that all the test results except one demonstrate compliance with the code of practice. The strand from one tendon showed a shortfall in breaking load of less than 0.2%, which is considered insignificant.
41. The settlement and tilt survey of the PCPV showed the ongoing movement was within the acceptable design limits.
42. A sample of the results of the most recent MITS examination for CO₂ losses at tendon anchorage blocks showed that no CO₂ was detected at any of the anchorages checked. The APEX confirmed that he has not received any reports of CO₂ being detected at the tendon anchorages in the last operating period.
43. The APEX has confirmed that no PVCW leaks were reported in the last operating period. The inspector did not find any signs of water leakage on the vessel from the areas sampled during the inspection.
44. A review of the top cap deflection survey results provided by the APEX concluded that the results are within the expected range and consistent with previous readings over the last 6 years.
45. Based on the assessment of the results of the surveillances and inspections on site the ONR Civil engineering inspector is content to support the return to service of the R4 PCPV for the next operating period of three years.

3.1.3 Structural integrity

46. Reference [14] provides the findings of the ONR structural integrity inspector's assessment of NGL's examination, inspection, maintenance, and testing (EIMT) of systems, structures and components on R4 that fulfilled a nuclear safety function.
47. The assessment primarily focussed on NGL's work covering:
 - The inspections of:
 - Welds,
 - Metallic reactor internal structures and components,

- Main cooling water system,
 - Pipe hangers,
 - Thermal movement survey,
 - Compliance with Pressure Systems Safety Regulations (PSSR).
48. During the periodic shutdown, the ONR inspector visited the site to confirm the adequacy of the work being conducted by NGL. Based on the items important to safety the following areas were sampled:
- Pressure Systems Safety Regulation (PSSR) compliance,
 - Gas By-pass Plant,
 - Flow Assisted Corrosion (FAC) inspections,
 - Corrosion Management update,
 - Steam and Feed Systems inspections, including pipe hangers,
 - In-service Inspection / Non-destructive testing,
 - Seawater & Essential Cooling Water Systems,
 - CO₂ System,
 - Reactor Internals.
49. For each of these areas, the ONR structural integrity inspector discussed the scope, progress and outcome of EIMT activities with responsible personnel and was provided with diverse evidence of LC28 compliance.
50. Discussions were held on the progress of examinations and inspections undertaken during the periodic shutdown, as required by the PSSR. It was 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.
51. The inspector sampled sentencing and remediation of two (of 11 in total) Category C defects reported:
- A fatigue crack in a boiler start-up-vessel safety relief valve pad-to-stub weld. The area will be re-inspected during future outages, as will similar features of Reactor 3 (R3).
 - A single incident of unexpected degradation by FAC was reported in main boiler feed pump turbine (MBFPT) exhaust pipework. Wall thinning had resulted in a steam leak. All of the damaged material was replaced and the new welds will be inspected in future outages and inspection of similar locations in R4 will be inspected in the present outage.
52. The ONR structural integrity inspector was satisfied there is adequate remediation of the defects sampled.
53. A review of the progress of the programme of inspection of pipe hangers was carried out. The inspector was satisfied that NGL's programme for maintenance of hangers is adequately defined and progressing at an acceptable rate.
54. The inspector discussed progress on inspection and repair activities associated with the Seawater and Essential Cooling Water Systems. The inspections were progressing according to plan with no significant issues identified. Several examples of plant improvements and effective remediation were identified, for example:
- Cameras have been fitted to reveal sea life ingress and so prompt action to clear the screens.

- Maintenance of Reactor Cooling Water (RCW) pumps has included fitting of new pump seals and new pump motors.
- Vylastic coated pipework is being renewed with glass flake lined carbon steel, as part of a fleet-wide approach.

55. Based upon the sampling undertaken, and the evidence presented, the ONR structural integrity inspector judged that NGL had undertaken sufficient inspection and assessment to support the return to service of HNB R4.

3.1.4 Mechanical engineering

56. Reference [15] provides the findings of the ONR mechanical engineering inspection conducted during the outage. The inspection focused on the EIMT of the gas circulators (GC), gas safety relief valves (GSRV) and control rod drop times.
57. During the outage there were 3 planned GC exchanges (4A1, 4B1 and 4D2). The inspector reviewed the plan for GC exchanges which he was satisfied with.
58. A sample of maintenance information and records were inspected including a number of work order cards (WOCs). The inspector highlighted one WOC that had been filled in without specification acceptance criteria. The inspector requested further clarification from site as to why this was acceptable and received a suitable response from Central Technical Organisation (CTO) Barnwood. Overall the ONR inspector was satisfied that EIMT associated with the GCs was adequately controlled.
59. The inspector undertook a walk down of the GC and GSRV maintenance facility. He inspected the EIMT arrangements for safety significant valves and held discussions with the GSRV system engineer. He sampled maintenance arrangements for GSRVs due to the importance of their safety function to prevent overpressure of the Pre-stressed Concrete Pressure Vessel (PCPV). The inspector was content that the GSRVs remain within acceptable tolerances and that EIMT associated with the Reactor Gas Safety Relief Valves was adequately controlled.
60. The inspector discussed with the NGL system engineer the control rod system and their safety functions. During the reactor outage all the control rods inserted within the R4 core within the time specified by the R4 safety case. The ONR inspector was content that these drop times still have a conservative margin to the safety case requirement.
61. Based on the sampling undertaken as part of this inspection, the ONR mechanical engineering inspector was satisfied to support the return of Hunterston B R4 to operation following its 2017 periodic shutdown.

3.1.5 Electrical engineering

62. Reference [16] presents the findings of the ONR electrical engineering inspection conducted during the outage. The inspection considered the electrical work being undertaken as part of the R4 statutory outage, including:
- Planned electrical EIMT activities,
 - Implementation of the detailed modifications,
 - Reactive electrical work emergent from the outage.
63. 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.

64. The inspection confirmed the progress made against the electrical activities identified in Hunterston B's OIR was as planned and anticipated.
65. The inspector sampled a number of shutdown-related electrical activities referred to within the OIR. Through explanations, discussions and a live demonstration using the station's asset management system, he was satisfied that clear and auditable links were apparent between the shutdown-related electrical activities and the station's maintenance schedule through to the maintenance instructions. It was also evident that the electrical activities were undertaken in the appropriate periodicity.
66. The inspector was advised of the maintenance activities on the Reactor Shutdown Sequencing Equipment (RSSE) and some emergent test issues that had occurred in the early stages of the outage. During the testing of the RSSE Diesel Generator (DG) 8A was found to be unable to provide its required support due to loading and stability issues. The station advised that it had to finely adjust the settings of the DG governor to enhance the apparent loading and stability issues and enable the DG to provide its intended support. The ONR inspector was satisfied, at this point, with the advice, discussions and explanations given.
67. There were a number of relatively significant electrical work activities being undertaken as part of this shutdown that were non-routine. Specifically, the replacement of TG 8 generator rotor including some additional diagnostic instrumentation, the replacement of 240 V DC/110 V AC Safety Invertors and the replacement of SF6 circuit breakers associated with R4 gas circulators. A number of the non-routine work activities had been implemented without issue and the majority of the remaining non-routine activities were progressing as anticipated.
68. 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

69. Reference [17] provides the findings of the ONR control and instrumentation (C&I) inspection 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 to confirm that systems important to safety remained fit for their intended purpose for HNB R4.
70. The areas reviewed during the inspection included the following plant areas:
 - Central control room,
 - Data processing room,
 - Data logging room,
 - Instrument room (R4),
 - R4 auto control room,
 - Safety room,
 - Marshalling and monitoring and rod control room (R4).
71. The inspector reviewed the following modifications being implemented during the outage:
 - T2 Reference Servo (EC335142),
 - Shut-Down Amplifier (SDA) cable fault (EC358604),
 - Turbine Water Carry Over Protection (TWCOP) Upgrade (EC361682),
 - Digital Control System (DCS) Single Board History Module (EC361332).

72. Based on the modifications sampled, the inspector considered the arrangements and their implementation to be adequate.
73. The maintenance and testing activities in the following areas were sampled by the inspector:
- Gas Circulator over frequency calibration,
 - Laddic waveform tests,
 - In-core thermocouples,
 - Neutron flux detectors,
 - GC instrumentation,
 - RSSE,
 - Computing systems.
74. Based on the inspection of the maintenance activities and documentation sampled the inspector was satisfied that the C&I safety systems at HNB R4 have undergone suitable and sufficient maintenance.
75. On the basis of the inspection of the C&I aspects of the outage, the inspector identified no issues which would prevent ONR consent to allow R4 at HNB to start-up.
76. During the C&I inspection, an unauthorised NGL laptop was found on site that had been issued to an NGL contractor. The C&I Inspector raised this matter with the station as it contravened the requirements of the approved site security plan issued under the Nuclear Industry Security Regulations. Whilst this highlights a shortfall against cyber security, the C&I inspector did not consider it to be a matter that affected the safe start-up of R4 but has separately satisfied himself that NGL have taken appropriate actions in relation to this finding.

3.2 SAFETY MANAGEMENT

3.2.1 Radiological protection

77. Reference [18] presents the findings of the ONR radiological protection specialist. The aim of this intervention was to establish whether the statutory outage work programme for HNB was being conducted in compliance with the Ionising Radiations Regulations 1999 (IRR99).
78. The IRR99 compliance inspection reviewed the following areas;
- Summary of outage programmed work and its radiological implications,
 - Progress against radiological issues and events,
 - Planning for radiologically significant outage tasks,
 - Radiological protection arrangements associated with radioactive waste and graphite channel inspection work,
 - Radiation protection personnel and monitoring equipment provision,
 - Radiological event performance, monitoring and investigation,
 - Contamination control and controlled area management,
 - Operational dose management and profiling during the outage,
 - Plant inspections of the reactor Radiation Controlled Area (RCA) including the pile-cap/ charge-hall, gas plant, cooling ponds, gas circulator 'hall' and Active Waste building,
 - Operation of the vehicle radiation monitor installed at station entrance.
79. The IRR99 inspection did not reveal any nuclear safety issues relevant to R4 outage that required action by NGL or follow-up by ONR. On the basis of the inspection of the IRR99

management aspects of the R4 outage, the Radiological Protection inspector identified no issues which would prevent ONR consent to allow R4 at HNB to start-up.

3.2.2 Conventional safety

80. Reference [19] provides the findings of the ONR conventional health and safety inspection conducted during the outage. This sought to provide regulatory confidence in the management of conventional health and safety hazards present during outages, focusing on the site's arrangements for asbestos management, working at height and the control of legionella risks.
81. The key plant locations visited during the inspection were:
- R4 and R3 Pile Cap,
 - R3 Gas Circulator Hall,
 - R4 Gas Circulator Hall,
 - Turbine Hall,
 - Cooling Water Pump House,
 - R4 Cooling Tower.
82. A number of observations were made that indicate that the licensee needs to review certain elements of the asbestos management policy, specifically ensuring certain areas are included on their asbestos survey and register and reviewing the policy of storing asbestos waste in unsecured waste bins. The station has been required to confirm actions taken or planned to address these matters.
83. Examples of good control of work locations involving work at height activities were seen, although some minor work at height risks were found during the inspection.
84. The inspectors found that control of legionella risks, and particularly the efforts made to control iron oxide (the presence of which encourages the growth of the bacteria) influx into the system had improved greatly since the previous conventional health and safety inspection.
85. Although shortfalls were identified and are being dealt with, the inspection did not raise any issues that would affect the start-up of the R4.

3.2.3 Control and supervision, LC26

86. The nominated site and outage project inspectors carried out a compliance inspection of control and supervision of outage operations under LC 26, reference [20]. This focussed on the control and supervision of contractors performing maintenance operations during the outage.
87. The arrangements for effective supervision of contractors were examined and discussions were held with several contract partners to explore how this was managed.
88. The nominated site inspector and project inspectors judged that an appropriate level of control and supervision was evident at the workplace and suitable oversight was being provided by the licensee.
89. No issues were identified that would prevent the re-start of R4.

3.3 EMERGENT ISSUES

3.3.1 Charge Machine Clamp

90. During the early stages of the outage, the site experienced some challenges with the Charge Machine. On the 5th Channel of Off-load Depressurised Handling (ODH) the charge machine experienced an issue with one of the clamp drives. This occurred when attempting to disconnect from the channel. Station utilised off site support and the Fuel Route team took control and corrective action to repair the Charge Machine Clamp drives was taken. This ensured the Charge Machine ODH / NICIE program was restarted in a safe and timely manner. As a result of this issue it was necessary for one of the channels to be handled twice. No further issues were experienced with the Charge Machine during the remainder of the outage.

3.3.2 Start-up test (SUT) 8C – Diesel Generator 8A

91. As discussed in section 3.1.5, HNB experienced issues during the start-up testing of DG 8A during the early stage of the outage. Two failures occurred that required a retest to be undertaken. The first was the failure of DG 8A to start three GC in sequence. An investigation highlighted that the engine response of the DG was not quick enough when GC loads were applied, resulting in the engine speed not recovering. The required tests were repeated successfully after necessary adjustments had been made.

92. The second issue was due to instability during the low pressure (LP) sequence. During the first LP sequence the vessel conditions were such that when three GC Inlet Guide Vanes (IGVs) were opened, it resulted in the maximum DG load being exceeded causing instability. The issue was due to the vessel pressure being high and T1 being low, which results in high gas density and a larger load on the DG. The test was subsequently repeated successfully at a lower vessel pressure.

3.4 START UP MEETING

93. The Start-Up Meeting was held on 11 October 2017. Prior to this meeting there was a comprehensive plant walk-down on 10 October 2017. ONR was represented by the Superintending Inspector, the Site Inspector and Project Inspector. The walk down encompassed many of the major work packages 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.

94. The inspection included the Charge Hall, Irradiated Fuel Disposal cell, Pond, Circulator Hall, new CO₂ plant and Cooling Water pump house. The Safety Centre was also visited to meet the safety advisors and the area safety co-ordinators.

95. 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 re-start. However no plant conditions were identified that would have an impact on the re-start of R4.

96. A number of minor house-keeping and procedural compliance issues were identified during the inspection. These were brought to the attention of the Plant Manager who confirmed they would be dealt with immediately.

97. The start-up meeting was attended by the same ONR inspectors. The meeting was chaired by the Technical and Safety Support Manager (TSSM) and attended by a cross section of the HNB management team. HNB provided the outage start up report and briefing notes, References [21] and [22] respectively, prior to the meeting and were used as the basis for the presentations and discussions held. A detailed record of the meeting is contained in Reference [8].

98. No issues were identified at the meeting that would prevent the re-start of R4.

4 MATTERS ARISING FROM ONR'S WORK

99. As the Project Inspector for the outage, I have considered the licensee's request to ONR to grant a consent under LC30(3) to start-up Hunterston B R4 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.

100. 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.

101. INA has provided a concurrence statement [1] which confirms that, based on their assessment activities so far, there are no issues of which they are aware which would prevent their provision of the concurrence part B prior to start up.

102. 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.

103. ONR specialist inspectors from the following disciplines undertook inspections and assessments to support ONR permissioning return to service:

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

104. Each discipline has produced a report that presents the inspection findings, inspectors' opinions, judgments and recommendations. No actions requiring resolution before granting of consent were raised.

105. 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.

106. I consulted with the Scottish Environment Protection Agency (SEPA) to establish if they had any specific objections that would prevent ONR from issuing LI 558, consent to start-up Hunterston B R4. The SEPA [23] confirmed they did not object to ONR granting consent.

5 CONCLUSIONS

107. The Hunterston B Reactor 4 periodic shutdown 2017 has been undertaken in accordance with the requirements of the work scope outlined within the Outage Intentions Report.

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

109. NGL'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 Reactor 4 following its periodic shutdown.
110. 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.
111. I consider that the licensee delivered a shutdown that was safely managed and completed the required safety-related work activities.
112. Following assessment and inspection of matters arising in relation to the Hunterston B R4 periodic shutdown 2017, 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.
113. I have prepared Licence Instrument 558, for LC 30(3) consent, in conjunction with this PAR.

6 RECOMMENDATIONS

114. I recommend that the Superintending Inspector:
 - Signs this Project Assessment Report to confirm support for the ONR technical and regulatory arguments that justify issuing Hunterston B Licence Instrument 558.
115. I recommend that ONR issues Licence Instrument 558, which grants consent under Licence Condition 30(3) attached to Nuclear Site Licence Sc. 13 to start-up Hunterston B R4.

7 REFERENCES

- [1] EDF, HNB R4 2017 Outage - Restart Consent request letter, PSSR Competent Person Letter and INA Memorandum. TRIM 2017/399038.
- [2] ONR, Hunterston B, copy of letter specifying consent to restart. March 1996. TRIM 2015/435748.
- [3] ONR Licence Instrument No:543 Consent under Condition 30(3) attached to Site Licence Sc.13. September 2014. TRIM 2014/340467.
- [4] NGL – Hunterston B - Outage Management Departments Report - Reactor 4 / TG8 Statutory Outage 2017 - Outage intentions report- 13 February 2017. TRIM 2017/60937.
- [5] NGL – OF – CR - 16-662- Hunterston B Annual Review of Safety (Level 3) + Handover Meetings – 14 - 16 March 2017. TRIM 2017/122494.
- [6] EDF-ONR-OFD-CR-17-410 - Hunterston B - R4 Outage 2017 - Rapid Trending Review - 18-21 September 2017. TRIM 2017/374636.
- [7] NGL - HNB R4 2017 Outage Rapid Trending Review Presentation. TRIM 2017/374076.
- [8] ONR-OFD-IR-17-133 - Hunterston B - R4 Outage 2017 - Start-up meeting and plant inspection - 10-11 October 2017. TRIM 2017/385008.
- [9] INA - SRD/REP/CON/HNB/011A revision 000, Independent Nuclear Assurance Concurrence Part A. TRIM 2017/339114.
- [10] EDF NGL - Hunterston B - E/REP/BNCB/0570/HNB/17 Rev 000- Statutory Examination of Prestressed Concrete Pressure Vessel for R4 2017. TRIM 2017/377426.
- [11] ONR - Hunterston B - R4 Outage 2017 - ONR Inspection Plan. TRIM 2017/168711.
- [12] ONR-OFD-AR-17-041 Revision 0 Hunterston B Reactor 4 Periodic Shutdown: Structural Integrity Assessment of Graphite Core Inspection Findings. TRIM 2017/390044.
- [13] NGL - Hunterston B - Assessment Report ONR-OFD-AR-17-039 - Assessment of the civil engineering aspects in support of the restart of Reactor 4. TRIM 2017/374915.
- [14] NGL - Hunterston B - ONR-OFD-AR-17-040 Assessment of Structural Integrity in Support of Restart of R4 Following 2017 Periodic Shutdown - 13 October 2017. TRIM 2017/383696.
- [15] ONR-OFD-IR-17-110 - Hunterston B - R4 Outage 2017 – Mechanical Engineering Inspection – 19-20 September 2017. TRIM 2017/371544.
- [16] ONR-OFD-IR-17-124 - Hunterston B - R4 Outage 2017 - LC 28 Inspection of Electrical Related Aspects - 3-4 October 2017. TRIM 2017/383258.
- [17] ONR-OFD-IR-17-126 - Hunterston B - R4 Outage 2017- C&I Inspection - 3-4 October 2017. TRIM 2017/385682.
- [18] ONR-OFD-IR-17-121 - Hunterston B - R4 Outage 2017 – Radiological Protection Inspection – 22 September 2017. TRIM 2017/372993.
- [19] ONR-EDF-IR-17-128 - Hunterston B - R4 Outage 2017- Conventional health and Safety Inspection - 26-27 September 2017. TRIM 2017/383194.
- [20] ONR-OFD-IR-17-113- Hunterston B - R4 Outage 2017 - Planned intervention - 18-22 September 2017. TRIM 2017/366769.
- [21] NGL - HNB R4 2017 Statutory Outage ONR Start Up Report. TRIM 2017/375160.
- [22] HNB Reactor 4 Re-start Meeting - EDF Briefing Notes - 11 Oct 2017. TRIM 2017/380325.
- [23] HNB R4 Outage 2017 - E-Mail from SEPA - 23 Oct 2017. TRIM 2017/392738.