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Heysham 2 Reactor 7 Periodic Shutdown 2021
Consent to Start-Up Reactor 7 Following Periodic Shutdown

Project Assessment Report ONR-OFD-PAR-21-007
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EXECUTIVE SUMMARY

Title

Heysham 2 Reactor 7 Periodic Shutdown 2021 - Consent to Start-Up Reactor 7 Following Periodic Shutdown

Permission Requested

EDF Energy Nuclear Generation Limited (NGL) has requested that the Office for Nuclear Regulation (ONR) grants Consent under Licence Condition (LC) 30(3) to start-up Heysham 2 Reactor 7 following completion of the 2021 Periodic Shutdown carried out in accordance with the requirements of the Plant Maintenance Schedule made under LC 28(4). The licensee has confirmed that the required outage work has been completed and the reactor is safe to restart.

Background

LC 30(1): Periodic Shutdown states that for the purpose of enabling any examination, inspection, maintenance or testing of any plant or process to take place, the licensee shall, when necessary, ensure that any such plant or process is shut down in accordance with the requirements of the Plant Maintenance Schedule as referred to in LC 28: Examination, Inspection, Maintenance and Testing (EIMT).

LC 30(3) states that the licensee shall, if so specified by ONR, ensure that when a plant or process is shut down in pursuance of LC 30(1) it should not be started up again thereafter without the Consent of ONR. ONR specified, under LC 30(3) of Heysham Nuclear Site Licence 60, that the licensee shall seek ONR's Consent to start-up a reactor at Heysham 2 Power Station following shutdown under LC 30.

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

ONR inspection and assessment activities during a power reactor outage are to establish that:

- requirements set out in the Station's Plant Maintenance Schedule (PMS) have been complied with;
- work has been carried out in accordance with arrangements for identified Structures, Systems and Components (SSC) to the required quality by competent persons;
- safety issues identified during the reactor outage have been adequately addressed with suitable and sufficient justification provided to allow a regulatory judgement to be made that start-up of the reactor is safe.

ONR has assessed NGL documentation produced from the outage and EIMT of SSC important to nuclear safety. Site inspections were conducted to confirm work was carried out by competent individuals and to required quality standards.

Matters arising from ONR's work

During the graphite inspections a single keyway root crack was observed which resulted in the Heysham 2 and Torness reactors (including Heysham 2 Reactor 7) requiring a safety case for continued operation of the reactors. This was assessed by ONR specialist inspectors who

concluded that NGL had made an adequate case, which supports re-start of Heysham 2 Reactor 7.

A number of findings were made by ONR specialist inspectors during the outage. No issues were identified that would prevent the consent for return to service of Heysham 2 Reactor 7. Any other matters will be followed up by ONR through routine business.

Conclusions

ONR's assessment and inspection of the Heysham 2 Reactor 7 periodic shutdown confirms that NGL has carried out EIMT in accordance with the requirements of its Plant Maintenance Schedule. Work has been conducted to the required quality standards and by competent personnel. No issues of such significance have been identified by NGL or ONR that prevent the start-up of Heysham 2 Reactor 7 following its 2021 periodic shutdown.

Recommendation

The ONR outage project inspector recommends that Licence Instrument 635 is issued to grant ONR's consent to start-up Heysham 2 Reactor 7, following its 2021 periodic shutdown.

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LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
APEX	Appointed Examiner
COVID	Corona Virus Disease
C&I	Control and Instrumentation
EC	Engineering Change
EDF	Électricité de France
EIMT	Examination, Inspection, Maintenance and Testing
EOSR	Early Outage Safety Review
FAC	Flow Accelerated Corrosion
HYB	Heysham 2
INA	Independent Nuclear Assurance
ISI	In Service Inspection
KWRC	Keyway Root Crack
LC	Licence Condition
LI	Licence Instrument
LOLER	Lifting Operations and Lifting Equipment Regulations
NGL	Nuclear Generation Ltd
ONR	Office for Nuclear Regulation
PAR	Project Assessment Report
PCPV	Pre-stressed Concrete Pressure Vessel
PMS	Plant Maintenance Schedule
PSSR	Pressure Systems Safety Regulations
SQEP	Suitable Qualified and Experienced Persons
SRGW	Seal Ring Groove Wall
SSC	Structure, System and Component

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1 PERMISSION REQUESTED

1. This ONR Project Assessment Report (PAR) has been produced to support its decision to issue a Licence Instrument (LI) granting Consent to start-up EDF Energy Nuclear Generation Limited (NGL) Heysham 2 Reactor 7 following periodic shutdown, as required under Nuclear Site Licence Condition (LC) 30(3): Periodic Shutdown.

2 BACKGROUND

2. NGL has requested ONR's consent to start-up Heysham 2 Reactor 7 (Ref. 1) as required under Nuclear Site Licence Condition 30(3): Periodic Shutdown. Heysham 2 Nuclear Power Station has two Advanced Gas-cooled Reactors, identified as Reactor 7 and Reactor 8. Periodic shutdowns are normally required every 3 years for Reactor 7 based upon the safety justification set out in the Station's Safety Case and Plant Maintenance Schedule (PMS) requirements.

3. LC 30(1): Periodic Shutdown states that for the purpose of enabling any examination, inspection, maintenance or testing of any plant or process to take place, the licensee shall when necessary ensure that any such plant or process be shutdown in accordance with the requirements of the PMS as referred to in LC 28: Examination, Inspection Maintenance and Testing (EIMT).

4. LC 28(1) requires the licensee to make adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant that may affect safety. LC 28(4) states that these arrangements shall provide for the preparation of a PMS. The PMS draws together requirements from a range of sources, including the facility's Safety Case, regulatory requirements such as Pressure Systems Safety Regulations (PSSR), Lifting Operations and Lifting Equipment Regulations (LOLER) and equipment manufacturer's guidance etc.

5. LC30(3) states that the licensee shall, if so specified by ONR, ensure that when a plant or process is shut down in pursuance of LC 30(1) it should not be started up again thereafter without the consent of ONR. This is the case for the Heysham 2 Power Station reactors as ONR specified under LC 30(3) by issuing Licence Instrument (LI) No 11, dated 25 March 1996, Unique Document Ref HYB 70470N under Heysham Nuclear Site Licence 60 (Ref. 2).

6. NGL formally engaged with ONR in March 2021 through the Outage Intentions meeting (Ref. 3). At this meeting NGL set out its intended scope of work through its Reactor 7 Outage Intentions Document (Ref. 4). This set out PMS requirements as well as identifying other work to be carried out in support of safety. The document also identified the Heysham 2 approach for managing safety and quality during the outage which was to be delivered by processes set out in NGL corporate and local arrangements.

7. The Heysham 2 Reactor 7 outage started on 14 May 2021. At the start-up meeting on 22 July 2021 (Ref. 5), NGL presented findings from the outage. NGL did not identify any issues that would prevent start-up of Reactor 7 and no significant incidents occurred during the outage period.

8. During the graphite inspections on Reactor 7 a keyway root crack (KWRC) was observed. This required NGL to produce a new safety case for continued operation of

the reactors at Heysham 2 and Torness. This is discussed in more detail in sections 4.3 and 4.4.

9. A number of conventional safety events did occur during the outage which NGL recorded and investigated to identify learning and prevent further events. Regulatory matters identified during ONR's outage assessment and inspection activities are discussed in the ONR Matters Arising section of this report.

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

10. The purpose of ONR inspection and assessment activities during a power reactor outage is to establish that:

- requirements set out in the station's PMS have been complied with;
- work has been carried out in accordance with arrangements for identified Structures, Systems and Components (SSC) and conducted to required quality by competent persons; and:
- any safety issues identified during the reactor outage have been adequately addressed with suitable and sufficient justification provided to allow a regulatory judgement to be made that start-up of the reactor is safe.

11. ONR's mission is "to protect society by securing safe nuclear operations". To this aim, the primary focus in carrying out assessment and inspection activities during the Heysham 2 Reactor 7 outage was to confirm that nuclear safety requirements have been suitably addressed.

12. Prior to the start of the periodic shutdown, ONR specialist inspectors reviewed the outage intentions document (Ref. 4) together with operational experience gained from other ONR outage assessments and NGL's own event recording system. This informed the production of inspection scopes for the various specialist discipline inspections and assessments carried out during the Heysham 2 Reactor 7 outage:

- Civil Engineering
- Structural Integrity
- Graphite
- Fault Studies
- Mechanical Engineering
- Electrical Engineering
- Control and Instrumentation
- Internal Hazards
- Conventional Safety

13. Inspections and assessments were undertaken in line with ONR internal guidance set out in ONR Technical Inspection and Assessment Guidance.

14. The ONR project inspector had an oversight role during the outage including maintaining oversight of the work undertaken by ONR specialist inspectors, monitoring events and providing regulatory input as necessary.

4 MATTERS ARISING FROM ONR'S WORK

15. The following sections provide summaries of the ONR specialist inspectors' inspection and assessment findings for each of the technical discipline areas evaluated during the Heysham 2 Reactor 7 outage. These summaries provide the information and evidence to underpin ONR's considerations and judgment to consent to start-up of Heysham 2 Reactor 7.

4.1 CIVIL ENGINEERING ASSESSMENT

16. An ONR civil engineering specialist inspector carried out an assessment of the activities related to the pre-stressed concrete pressure vessel (PCPV) (Ref 6). The focus of the assessment centred on the report titled "2021 Statutory Examination of the Pre-stressed Concrete Pressure Vessel of Reactor 7 (hereinafter referred to as the Statutory Examination Report) (Ref 7). The report records NGL's progress with the statutory surveillances, inspections and tests on the PCPV as prescribed in the Plant Maintenance Schedule up to 19th June 2021.

17. The Statutory Examination Report was produced by the appointed examiner (APEX) for Heysham 2 Reactor 7 and is presented by the Licensee in support of its request for permission to return Reactor 7 to service following the 2021 periodic shutdown. The APEX is NGL's nominated, suitably qualified and experienced person, responsible for ensuring the provision of in-service inspection and surveillance activities relating to the PCPV. A full report of the statutory surveillances, inspections and tests will be presented by the licensee in an updated Statutory Examination Report within 28 days of the agreed return to service.

18. Based upon their assessment of the surveillance activities, the APEX concluded that the Heysham 2 Reactor 7 PCPV is satisfactory for return to service, subject to normal in-service surveillance. The APEX conclusion was subject to the satisfactory completion of some outstanding activities prior to return to service.

19. The specialist inspector was therefore content to support the return to service of the Reactor 7 PCPV for the next operating period, subject to the satisfactory completion of the identified activities highlighted within the APEX report during the remainder of the outage.

20. The specialist inspector has subsequently confirmed that they are satisfied that the work necessary for the purposes of the Pressure Systems Safety Regulations (PSSR), Statutory Examination of Reactor R7 PCPV have been satisfactorily completed. (Ref 8). From a civil engineering perspective, the specialist inspector supports the return to service of Heysham 2 Reactor 7 to operation following its periodic shutdown.

4.2 STRUCTURAL INTEGRITY INTERVENTION AND ASSESSMENT

21. An ONR structural integrity specialist inspector's views and judgements from a compliance intervention and assessment are recorded in References 9 and 10.

22. During the intervention, the specialist structural integrity inspector sampled the following areas:

- Reactor Sea Water systems
- Compliance with PSSR
- In-service inspection

- Corrosion management, including flow assisted corrosion (FAC)
- Pipe hangers and supports
- Reactor internal inspections, including boiler components

23. The specialist inspector found satisfactory progress of planned EIMT at the time of their visit, which was approximately half-way through the periodic shutdown programme. Of 289 components in the In-Service Inspection (ISI) programme, 49 were not started, 112 components were being prepared for inspection (in grinding), 11 in progress, 2 in referral, 0 repaired and 115 complete.

24. At Heysham 2, the recommendations from the initial corrosion management review have now all been addressed. NGL has therefore implemented the corrosion programme as part of their 'normal business'. The specialist inspector sampled some of the inspections which have been undertaken and completed as part of the reactor external inspection programme. The specialist inspector was content that the work was progressing effectively, with inspection results sentenced appropriately. Weld and flow accelerated corrosion (FAC) inspections were progressing to programme with no significant issues identified.

25. The specialist inspector discussed progress on examinations and inspections undertaken during the periodic shutdown, as required by PSSR. The PSSR Competent Person and the PSSR Advisor confirmed that the examinations were proceeding as planned and that station personnel had been providing effective support to their activities. The specialist inspector noted the positive contribution of Heysham 2's PSSR coordinator who ensures that the PSSR inspection requirements are up-to-date on the plant. The specialist inspector was therefore content that the PSSR's arrangements in place at Heysham 2 are appropriate.

26. During the site intervention, the specialist inspector obtained an update on NGL's progress with proposed improvements and the inspection strategy for the Active Effluent Treatment Plant discharge pipework. Whilst the specialist inspector observed a number of improvements had recently been made, in their opinion, NGL could consider further as low as reasonably practicable (ALARP) improvements, in particular regarding active chamber No. 5. There were however no significant shortfalls which could prevent further operation.

27. The specialist inspector also undertook a plant walk down, accompanied by NGL's Engineering Programmes & Design Group Head. Overall, a good standard of housekeeping was observed. An apparent slippage in some aspects of the personal safety standards was observed and the specialist inspector advised NGL to reinforce the company's expectations with regards to personal safety. The specialist inspector judged that the licensee's inspection arrangements appeared to have been correctly implemented at the time of their visit.

28. Based on evidence sampled, the specialist inspector concluded that NGL is conducting adequate EIMT, in line with ONR's expectations. EIMT work planned by the licensee during the periodic shutdown was not complete by the end of the inspection and the specialist inspector monitored further progress and provided their judgement regarding return to service in an assessment report summarised below.

29. The assessment report assessed the adequacy of the inspections of welds, metallic reactor internal structures and components, main cooling water system, pipe hangers and thermal movement survey in line with LC 28; and compliance with the PSSR.

30. The specialist inspector was satisfied with the proposed inspection programme, that these inspections have been undertaken in line with the Heysham 2 Reactor 7 2021 outage intentions documents and that Heysham 2 has followed corporate procedures in the assessment and sentencing of inspection results. Where changes to the inspection scope have been made, the specialist inspector was satisfied that they had been sentenced appropriately and in accordance with the licensee's arrangements.

31. Based on the activities sampled and the evidence presented, the specialist inspector judged that the licensee has undertaken sufficient inspection and assessment, from a structural integrity perspective.

32. Judgements and conclusions were based on an amount of information that has yet to complete due process and were therefore contingent on receiving a number of additional documents and assurances as outlined in the recommendations to ONR's Project Inspector below.

33. The specialist inspector also raised a Level 4 Regulatory Issue (No. 8866) for ONR to monitor NGL's progress with the fleetwide review of thermal ageing consideration in the main steam and in the hot reheat pipework. Resolution of this Regulatory Issue was not considered necessary to allow return to service of the reactor.

34. The specialist structural integrity inspector recommended that ONR should issue the Licence Instrument to grant Consent for start-up of Heysham 2 Reactor 7, following the 2021 periodic shutdown. However, this recommendation was contingent on the project inspector receiving the following information:

- A demonstration that the periodic shutdown inspection programme and sentencing of actions through the outage assessment panel has been completed satisfactorily. The licensee should submit the Independent Nuclear Safety Assessment certificate for the return to service Engineering Change report as part of the licensee's application for consent to return to service.
- A demonstration that the Pressure Systems Safety Regulations inspections have been completed satisfactorily and no concerns have been raised. The licensee should submit a return to service statement from the third-party Competent Person as part of the licensee's application for consent to return to service.
- A demonstration that the inspections not covered by the Appointed Examiner and third-party Pressure Systems Safety Regulations Competent Person have been completed satisfactorily. The return to service Engineering Change report must include a statement from the licensee's second party Pressure Systems Safety Regulations Competent Person supporting the fitness for return to service.

35. I can confirm that this information has now been received and reviewed by the specialist inspector (Ref. 11) and that they support the return to service of Heysham 2 Reactor 7 to operation following its periodic shutdown.

4.3 GRAPHITE INSPECTION AND ASSESSMENT

36. An ONR graphite specialist inspector's views and judgements from a compliance intervention and assessment are recorded in References 12 and 13.

37. The specialist inspector carried out an LC 28 compliance inspection focussing on arrangements for graphite core examination, inspection and testing. The objectives of this intervention were:

- To examine the adequacy of the licensee's arrangements with regards to graphite core inspection during this outage;
- To establish confidence that the various safety case commitments for core inspection and trepanning would be met;
- To consider the quality of the examinations performed, both in terms of data quality and the adequacy of the training and understanding of those involved in the work being carried out.

38. A site visit was conducted with the following objectives:

- To provide regulatory confidence in the implementation of the Heysham 2 Reactor 7 Outage Intentions Document in relation to Graphite;
- To provide evidence to inform the ONR decision relating to the issue of a Licence Instrument for a consent for return to service of Heysham 2 Reactor 7 on completion of the work undertaken during the outage.

39. The target requirement for this periodic shutdown was to carry out 30 fuel channel inspections and one control rod channel inspection. At the time of the intervention, NGL had completed 11 channel inspections which included visual and bore measurements.

40. As part of the intervention the specialist inspector:

- Examined some of the visual records to form an ONR view as to the quality and adequacy of the data being recorded;
- Reviewed the training records and their administrative arrangements to ensure the adequacy of the graphite core inspections;
- Observed a graphite activity and checked the documentation being used by the operators.

41. The specialist inspector also held discussions with a number of personnel who were involved in the graphite core inspections during the periodic shutdown. The personnel involved were knowledgeable and the inspector was content that NGL had a process in place to ensure only suitable qualified and experienced persons (SQEP) personnel perform the graphite inspections.

42. Following the intervention, the specialist inspector considered that the licensee's arrangements with regards to graphite core inspection during the outage were suitable and adequate. In their opinion, the visual records and the data sampled were of adequate quality for NGL to form an accurate judgement and enable sentencing of the cracks.

43. A specialist graphite inspector also assessed the Heysham 2 Reactor 7 2021 periodic shutdown inspection results relating to the graphite core.

44. During the planned graphite inspections a KWRC was observed. The licensee has since inspected an additional 15 channels, with no further KWRCs discovered, and written a dedicated safety case (Ref. 23). This case justifies the return to service of Heysham 2 Reactor 7 and continued operation of Heysham 2 Reactor 8, Torness Reactor 1 and Reactor 2 for a limited period of operation (~ 6 months operation from RTS of Heysham 2 Reactor 7). A safety case will then be required for operation beyond this period of operation.

45. The licensee states that all reactors at Heysham 2 and Torness will remain within the 'essentially intact' limit during the operating periods proposed. This implies that there will not be any impediment to the safe shut down and hold down of these reactors within the operating periods proposed. The specialist inspector is content that a conservative prediction of core state has been made by the licensee.

46. The licensee states that Seal Ring Groove Wall (SRGW) debris will not be widespread (<25 channels) within the operating periods proposed. The specialist inspector is content that the predictions are appropriate and demonstrate a margin to this implied limit.

47. The licensee argues that a safety significant blockage of the element 1 grid due to SRGW debris would be an infrequent event ($<10^{-3}$ per year). The specialist inspector is content that the licensee's arguments support this position. The consequences of a safety significant blockage have been assessed by an ONR specialist fault studies inspector (see Section 4.4).

48. The licensee states that a snag event due to SRGW debris is a credible event, this position is supported by the specialist inspector. The consequences of a snag event have been assessed by an ONR specialist fault studies inspector (see Section 4.4).

49. From a graphite perspective, the specialist inspector supports the return to service of Heysham 2 Reactor 7 to operation following its periodic shutdown.

50. Through their review the specialist inspector has identified certain areas where they view the uncertainties would challenge operation beyond the proposed period of operation. These areas are captured as a set of recommendations which are being monitored via regulatory issue 8970.

- **Recommendation 1:** To support a further period of operation beyond EC 369321 / 369716, the licensee should provide further evidence to characterise the evolution of cracking within a keyway cracked brick and the influence on the timing of cracking of vertically adjacent bricks.
- **Recommendation 2:** To support the reinstatement of off-load pressurised refuelling (OPR) or low power refuelling (LPR), the licensee should consider the risks from seal ring groove wall debris.
- **Recommendation 3:** To support a further period operation beyond EC 369321 / 369716, the licensee should clarify the impact of misalignment of vertically adjacent bricks on the risk of prompt SRGW failure.

- **Recommendation 4:** To support a further period of operation beyond EC 369321 / 369716, the licensee should review the supporting analyses to ensure CrackSim inputs are representative for the period of operation being proposed.

4.4 FAULT STUDIES ASSESSMENT

51. An ONR specialist fault studies inspector has assessed (Ref. 14) NGL's safety case for continued operation of the Heysham 2 and Torness reactors for a prescribed period following the discovery of a KWRC (Ref. 23).

52. The fault studies assessment focusses on determining whether EDF NGL have adequately demonstrated that the nuclear safety risks associated with graphite brick cracking over the operating period have been reduced as low as reasonably practicable (ALARP). The specialist inspector has considered the risks associated with:

- Control rod entry
- Fuel handling
- Fuel cooling impairment due to flow blockage
- Sleeve gapping

53. If the freedom of movement of control rods is significantly impeded, this could affect the reliability of primary shutdown. The specialist inspector concluded that NGL has provided sufficient evidence to demonstrate that the free movement of control rods for all plant faults is not unduly affected by the level of cracking predicted over the proposed operating period and that risks have been reduced as low as reasonably practicable.

54. Debris caused by graphite brick cracking has the potential to cause an obstruction and lead to fuel becoming stuck during fuel handling. This could result in fuel being dropped which would likely lead to fuel damage, and a release of radioactive isotopes into the primary circuit. The specialist inspector examined the revised assessment of the risk of graphite debris causing stuck fuel stringers and concluded that the risks have been reduced so far as is reasonably practicable.

55. Core distortion and graphite debris have the potential to cause gaps to open between fuel elements; this could affect cooling flows to the fuel and tie bar. The specialist inspector assessed the effects of the revised predictions of fuel sleeve gapping up to levels of core degradation in excess of that predicted over the operating period in this report and have concluded that the potential consequences of fuel sleeve gapping are acceptable over the operating period.

56. If debris is produced and becomes loose, it is possible that it could make its way into the bottom of a fuel stringer and create an obstruction to the cooling gas flow at element 1; this has the potential to cause localised clad melt. The specialist inspector reviewed the safety case position for flow blockage by graphite debris at the element 1 grid as set out by EDF NGL in its submission. Considering supporting arguments relating to thermal analysis, potential consequences and likelihood the specialist inspector is satisfied that the licensee has demonstrated that risks have been reduced as low as reasonably practicable over the operating period.

57. The specialist fault studies inspector raised the following recommendations:

- **Recommendation 1**: Prior to ONR agreeing to the modifications to the safety case described in EC 369321 / 369716, the project inspector should confirm that the graphite specialist inspector is satisfied that NGL have adequately demonstrated that all control rods will insert in normal operation and following a design basis seismic event.
- **Recommendation 2:** I recommend that, for operation beyond the operating limits defined in EC 369321 / 369716, justification of adequate reliability of control rod entry in plant faults should be included in the future safety case.
- **Recommendation 3**: Prior to ONR agreeing to the modifications to the safety case described in EC 369321 / 369716, the project inspector should confirm that the graphite specialist inspector is satisfied that NGL has presented an adequate justification that there will be no more than 25 channels containing SRGW debris in a single reactor by the end of the proposed operating period.
- **Recommendation 4:** Prior to ONR agreeing to the modifications to the safety case described in EC 369321 / 369716, the project inspector should confirm that the graphite inspector is satisfied that the methodology employed by NGL to predict sleeve gap sizes over the operating period is acceptable.
- **Recommendation 5**: Prior to ONR agreeing to the modifications to the safety case described in EC 369321 / 369716, the project inspector should confirm that the graphite inspector is satisfied that NGL has adequately demonstrated that the likelihood of a flow blockage of ~16% is infrequent ($<10^{-3}$ pry) over the proposed operating period.

58. The specialist graphite inspector has provided positive confirmation in response to recommendations 1, 3, 4 and 5 (Ref. 25). Recommendation 2 is being tracked via regulatory issue 8970

59. The specialist inspector therefore supports the return to service of Heysham 2 Reactor 7 to operation following its periodic shutdown from a fault studies perspective.

4.5 MECHANICAL ENGINEERING INTERVENTION

60. An ONR specialist mechanical engineering inspector carried out an inspection against the requirements of Licence Condition 28: examination, inspection, maintenance and testing (Ref 15). The purpose of this inspection was to gain regulatory confidence in the implementation of the mechanical engineering aspects of the overhaul and exchange of gas circulators, CO2 pressure relief valves and control rod function. This would inform the ONR decision relating to the issue of a Licence Instrument for consent to start-up, post outage activities at Heysham 2.

61. The following activities were sampled during the inspection:

- 7AX1 & 7DX2 Gas Circulators - Exchange
- 7BX2 & 7CX1 Gas Circulators - Inspection
- Overhaul and testing of the vessel CO_2 pressure relief valves
- Control Rods insertion characteristics

62. The specialist inspector observed two gas circulators in the process of being exchanged. It was noted that penetrations on the gas circulators and other plant

equipment undergoing maintenance and in a state of partial assembly were fitted with appropriate foreign material exclusion covers.

63. As part of the walkdown the specialist inspector witnessed good technician interaction with challenging attitudes. Work areas were managed in a disciplined manner with good housekeeping observed.

64. The specialist inspector sampled and examined several gas circulators, CO_2 pressure relief valves and control rod task sheets and activity control document arrangements which met with their expectations and were of good quality.

65. Based on the evidence presented by the licensee, the specialist inspector was satisfied that the LC28 arrangements in place for EIMT were adequate and that they were being adequately implemented. From the sample inspected, it was judged that for the mechanical engineering work activities undertaken at Heysham 2, 2021 outage, compliance against LC28 met the required standard.

66. From a mechanical engineering perspective, the specialist inspector concluded that they had no objections to ONR granting consent for the return to service of Heysham 2 Reactor 7 following its periodic shutdown.

4.6 ELECTRICAL ENGINEERING INTERVENTION

67. An ONR specialist electrical engineering inspector undertook a planned inspection of the implementation of the arrangements for LC 28 Examination, Inspection, Maintenance and Testing (EIMT) at Heysham 2 Power Station. (Ref. 16).

68. The inspection sample targeted the planned electrical work being undertaken as part of the Reactor 7 2021 Statutory Outage including the planned electrical EIMT activities from the station's Outage Intentions Document and any reactive electrical work emergent from the shutdown.

69. Based on the discussions, explanations and the sample inspected, the specialist inspector was satisfied that there were no significant shortfalls identified with the implementation of the established arrangements for LC 28 EIMT in relation to the planned electrical work undertaken as part of the Reactor 7 2021 Statutory Outage. The targeted inspection undertaken confirmed that the planned EIMT and modification activities during this shutdown were appropriate and that electrical plant and equipment was being maintained in accordance with the established arrangements.

70. During the inspection the specialist inspector sampled a number of statutory outage related electrical activities. The specialist inspector was advised that progress made against electrical activities during the statutory outage was as planned and anticipated. The station had completed all scheduled electrical work activities to date and anticipate completing them all before the planned return to service. Through explanations and discussions, the specialist inspector did not identify any significant shortfalls in compliance with the established arrangements and was satisfied that the protection and electrical group representatives had acted in a timely manner to address any areas of specific interest.

71. Following the site inspection, there was an issue which resulted in the displacement of core laminations found in the red phase main tank of generator transformer 7. Based

on the explanations provided by NGL and the mitigations that EDF have put in place, the specialist inspector has no objection, to Heysham 2 returning generator transformer 7 to service at the end of the outage period (Ref. 24).

72. From an electrical engineering perspective, the specialist inspector concluded that they had no objections to ONR granting consent for the return to service of Heysham 2 Reactor 7 following its periodic shutdown.

4.7 CONTROL AND INSTRUMENTATION INTERVENTION

73. An ONR specialist control and instrumentation (C&I) inspector carried out an LC 28 compliance inspection (Ref. 17). The main purpose of this inspection was to inspect a sample of outage work activities carried out in relation to C&I equipment and systems important to nuclear safety, to confirm that they remain fit for their intended purpose at Heysham 2.

74. The inspection included a sample review of the Heysham 2 Reactor 7 2021 statutory outage activities carried out in relation to C&I equipment and systems important to nuclear safety and considered compliance of the associated arrangements in relation to Licence Condition (LC) 28 –EIMT.

75. During the inspection the specialist inspector found that the C&I equipment and systems important to nuclear safety EIMT related activities referenced, and plant modifications identified, appeared to have been satisfactorily completed or were on schedule to be completed. It should be noted that in relation to the latter the specialist inspector was confident, based on the information provided, that the outstanding EIMT activities and plant modifications would be completed satisfactorily.

76. The specialist inspector held discussions with several C&I equipment and system stakeholders and found that they had a good understanding of the systems and equipment they were responsible for and appreciated the importance of the statutory outage work being undertaken. The specialist inspector also observed two maintenance technicians (MTs) undertaking reactor protection system related functional testing and found that they had a clear understanding of the associated work instruction.

77. The specialist inspector did identify a small number of maintenance record keeping shortfalls and raised them with the relevant system engineers, who agreed to address them. However, the specialist inspector considered them to be minor in nature and that they did not pose an immediate or significant risk to nuclear safety.

78. During the plant walkdown, the specialist inspector found the operating conditions and lighting levels generally afforded a comfortable working environment for maintainers and the specialist inspector did not identify any significant signs of age-related degradation with respect to the items of C&I equipment inspected. The specialist inspector also found the general standard of housekeeping to be adequate. It was also noted that new post-office type protection relays had been installed within a number of systems, which were considered to be a good example of proactive ageing equipment management.

79. The specialist inspector did raise five regulatory issues (RIs) and will monitor their progress through to resolution as part of normal regulatory business. None of these

issues were considered to pose an immediate or significant risk to nuclear safety and none of them need to be addressed before Reactor 7 can return to service.

80. From a C&I perspective, the specialist inspector concluded that they had no objections to ONR granting consent for the return to service of Heysham 2 Reactor 7 following its periodic shutdown.

4.8 CONVENTIONAL SAFETY AND INTERNAL HAZARDS INTERVENTION

81. ONR specialist conventional safety and internal hazards inspectors carried out an inspection which focussed on work at height and lifting operations at the Heysham 2 site during the outage (Ref 18).

82. The key regulatory activities undertaken during the inspection were:

- Discussions with NGL Heysham 2 staff, contractors, and a Trade Union safety representative;
- Site walk-down accompanied by NGL Heysham 2 staff;
- Sampling of documents and records;
- Further email correspondence after the site visit with NGL Heysham 2 seeking clarification on documents and records.

83. Whilst on site, ONR inspectors observed and followed the COVID-19 workplace control measures that NGL had put in place including testing arrangements before attending site, use of facemasks, hand-sanitising and cleaning regimes in buildings, social distancing. The arrangements put in place at Heysham 2 were considered to be adequate.

84. The inspectors identified the following areas of good practice including:

- Rope access work observed was well planned, especially the application of the work at height hierarchy of control before commencing work. The workers demonstrated a sufficient level of competence in managing the hazards and risks associated with the work;
- Routine lift work observed was adequately planned, managed, and monitored. The workers demonstrated sufficient level of competence in managing the hazards and risks associated with the work;
- Use of ‘Load Angels’ as a safe working platform for loading and offloading from heavy goods vehicles demonstrated adequate controls have been put in place to mitigate work at height risks.

85. One area of improvement was identified in respect to the work at height arrangements for the crane driver access to the 65-tonne overhead crane in the Turbine Hall. NGL acted promptly to put in sufficient temporary measures to mitigate the risk and started to develop an engineering solution as the permanent measure.

86. Based on the areas observed and examined, ONR inspectors were satisfied that NGL demonstrated adequate management of hazards and risks associated with lifting operations against relevant good practice.

87. From a conventional safety and internal hazards perspective, the specialist inspectors support the return to service of Heysham 2 Reactor 7 to operation following its periodic shutdown (Refs 19 and 20).

4.9 ONR PROJECT INSPECTOR OVERVIEW OF OUTAGE ACTIVITIES

88. The ONR project inspector attended three days of the early outage safety review (EOSR) (Ref 21). The EOSR is a week-long inspection led by a team of internal nuclear assurance individuals from NGL.

89. The purposes of the EOSR are:

- Identification of safety performance shortfalls in the early stages of an outage;
- Assist station management in reducing or eliminating undesirable behaviours and conditions which could have an adverse impact on outage success. This includes station response and reinforcement following significant findings;
- Assist fleet to identify potential issues at various levels of outage oversight and implement long term, sustainable solutions with the relevant process owners.

90. There was a lifting event during the nightshift of the 23 May where a sling was dropped and subsequently hit an individual on the shoulder. The individual subsequently missed work due to the injury. There had also been a recent event where a pallet slipped and injured an individual's leg.

91. Based on these events, the EOSR team focussed some time observing lifting operations in the turbine hall. During a lift of the low-pressure turbine casing, the lift had to be called off due to the failure of the suspension on the flatbed trailer. During this lift one of the other EOSR teams reported poor lifting practices as the trailer driver placed his head in the wheel arch of the flatbed trailer to inspect the suspension failure.

92. During a second lift there were repeated occurrences of poor lifting practice by the trailer driver who placed his hand/arm under the load to retrieve some dunnage. A condition report was raised for both events and lifts were embargoed for a period of time to re-enforce expectations. Feedback to station from the EOSR lead was that Peer-to-Peer coaching needed reinforcement by station as for each of the poor safety behaviours that were witnessed by the EOSR team, there were numerous other witnesses from the individuals work team, other contractors and from NGL, who all had the opportunity to intervene.

93. There was an issue with some of the "banshee" alarms on nuclear fire safety significant doors. Some of them were not functional and when checked by station one of them had been covered in tape. The following day another non-functional banshee alarm was found and further evidence of tape being used. This was fed back to the lead team who committed to investigate and remedy the issue.

94. Positive and negative observations were fed back daily to the Heysham 2 lead team. The significant issues were followed up immediately. NGL have developed an action plan to address the remaining findings and INA will test the effectiveness as part of ongoing inspection activities, and will reflect on this as part of the concurrence.

4.10 START-UP MEETING

95. A plant walkdown and start-up meeting was held on 22 July 2021 (Ref. 5). The purpose of the meeting was for NGL to present the findings of the Heysham 2 Reactor 7 periodic shutdown to ONR.

96. During the walkdown, ONR inspectors spoke to personnel who had been involved in the maintenance of the gas circulators, moisture sampling issues were discussed, and the temporary sampler was observed in operation.

97. ONR inspectors also spoke to the project team responsible for the re-lining of the Y-piece in the pump house. They explained how the previous rubber-based liner was removed and how this operation had partly covered the area in dust (much of which had been removed), The area was tented, and air was being circulated. The team were waiting for the correct environmental conditions in which to apply the lining as temperature and humidity were critical. They explained how the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) and personal safety were being managed.

98. ONR inspectors had a discussion with the system engineer who explained issues found with the transformer. This included issues with the red phase and a decision to inspect the other phases, the operation to remove and process the oil and the ODM recommendations. Heysham 2 was exploring the possibility of replacing an additional phase(s) at a later date from Hunterston once it had ceased generating.

99. During the start-up meeting, the licensee provided updates for each of the safety management areas including:

- Nuclear Safety
- Industrial Safety
- Fire Safety
- Radiological Protection, Environmental Safety and Radwaste
- Quality

100. Slides were also presented for each of the focus areas:

- Reactors – Gas Circulators
- Reactors – Aux Gas
- Condensate and Feed
- Turbine and Auxiliary Systems
- ISI and Refuelling
- Protection and Electrical
- Cooling Water
- Boiler Tops
- Boilers

101. Overall ONR felt that the outage had been successful, and station had been open and communicative. The observation and trending process appears to have been successful and all staff spoken to appeared engaged in the job they were doing / had done.

4.11 ENGAGEMENT WITH OTHER GOVERNMENTAL AGENCIES

102. ONR has engaged with the Environment Agency who has confirmed that they have no objections to the restart of Heysham 2 Reactor 7 following the 2021 statutory outage (Ref. 22).

5 CONCLUSIONS

103. NGL's request to ONR for Consent to start-up Heysham 2 Reactor 7 following periodic shutdown in compliance with LC 30(3) has been supported by their letter (Ref. 1) stating that all plant maintenance schedule requirements and modifications identified in the Reactor 7 outage intentions document (Ref. 4) have been met. This excludes testing of equipment which can only take place when the reactor becomes pressurised, and steam-raising commences. Based on ONR's intervention evidence the project inspector is content that the station has complied with their plant maintenance schedule requirements.

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

105. The PSSR competent person has confirmed that they are content for the reactor to start up.

106. ONR inspectors have sampled the safety management and engineering activities throughout the shutdown and judged them to be adequate, and all either support, or have no objection to, issuing consent to start-up the reactor. All actions raised during their inspections and assessments have been satisfactorily addressed or have acceptable plans for resolution.

107. In conclusion, ONR has identified no matters of concern that would prevent ONR granting consent for Heysham 2 Reactor 7 to start-up following its periodic shutdown.

6 RECOMMENDATIONS

108. The project inspector recommends that, in response to the request by NGL, ONR issue Licence Instrument 635 granting Consent under LC30(3) of Nuclear Site Licence 60 to start-up Heysham 2 Reactor 7 following the 2021 Periodic Shutdown.

7 REFERENCES

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2. Heysham 2 - Licence Instrument 11 - HYB70470N - Specification LC30(3) - Requirement for a consent to start up a reactor after LC30(1) shutdown, 25 Mar 1996, CM9 2016/182843.

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4. HB/REPS/OM112, Statutory Outage Scope Document, Heysham 2 Reactor 2 2021 Outage Intentions Document, CM9 2021/18068

5. ONR-OFD-CR-21-473, NGL / ONR Heysham 2 S12R7 Start-up meeting, CM9 2021/65295

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15. ONR-OFD-IR-21-054, Heysham 2 (EDF Energy), Outage Inspection (Mechanical Engineering), CM9 2021/56898

16. ONR-OFD-IR-21-036 Heysham 2 R7 Statutory Outage 12 2021 – LC 28 Inspection of Electrical Engineering Related Aspects; CM9 2021/51078

17. ONR-OFD-IR-21-059, Heysham 2 R7 Statutory Outage (S12R7) Control and Instrumentation (C&I) Inspection; CM9 2021/60397

18. ONR-OFD-IR-21-029, R7 Outage Conventional and Health and Safety and Internal Hazards Compliance Intervention for work at height and lifting operations CM9 2021/48969

19. E-mail from the conventional safety specialist inspector to the project inspector titled HYB R7 RTS PAR, 0209/2021, 2021/65089

20. E-mail from the internal hazards specialist inspector to the project inspector titled HYB R7 RTS PAR, 02/09/2021, 2021/65088

21. ONR-OFD-CR-21-194 Revision 0, Heysham 2 Reactor 7 Early Outage Safety Review, CM9 2021/44322

22. E-mail from the environment agency to the project inspector titled Heysham 2 Reactor 7 Return to Service, 02/09/2021, 2021/65502

23. Justification for Continued Operation of the Heysham 2 and Torness Reactors following the First Observations of Keyway Root Cracked Bricks in the Graphite Core at Heysham R7 in 2021, EC No.: 369321 000 / 369716 000, July 2021, CM9 2021/59425

24. Email from [redacted] – Re: HYB R7 RTS, 03/09/2021, CM9 2021/65951

25. Email from [redacted] - HPE CM: FW: Recommendations, CM9 2021/66900