



**Heysham 2 Reactor 8 Periodic Shutdown 2020
Consent to Start-Up Reactor 8 Following Periodic Shutdown**

Project Assessment Report ONR-OFD-PAR-19-017
Revision 0
03 April 2020

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Published 05/2020

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EXECUTIVE SUMMARY

Title

Heysham 2 Reactor 8 Periodic Shutdown 2020 - Consent to Start-Up Reactor 8 Following Periodic Shutdown

Permission Requested

EDF Energy Nuclear Generation Limited (NGL) [the 'licensee'] has requested that the Office for Nuclear Regulation (ONR) grants Consent under Licence Condition (LC) 30(3) to start-up Heysham 2 Reactor 8 following completion of the 2020 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

No issues were identified by NGL to prevent the return to service of Heysham 2 Reactor 8 and safe operations until the next outage. A number of intervention findings were made by ONR specialist inspectors during the outage that have been recorded within respective inspection records and reported to NGL. None of these findings identify matters that need to be addressed before Consent to start-up Reactor 8 and will be followed up by ONR through routine business.

Conclusions

ONR's assessment and inspection of the Heysham 2 Reactor 8 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 would prevent the start-up of Heysham 2 Reactor 8 following its 2020 periodic shutdown.

Recommendation

The ONR outage project inspector recommends that Licence Instrument 628 is issued to grant ONR's Consent to start-up Heysham 2 Reactor 8, following its 2020 periodic shutdown.

LIST OF ABBREVIATIONS

ACB	Air Circuit Breakers
AGR	Advanced Gas Cooled Reactor
ALARP	As Low As Reasonably Practicable
APEX	Appointed Examiner
C&I	Control and Instrumentation
CP	Competent Person
DPCS	Data processing and control system
EC	Engineering Change
EDF	Électricité de France
EIMT	Examination, Inspection, Maintenance and Testing
EOR	Early Outage Review
GAP	Graphite Assessment Panel
GC	Gas Circulator
HYB	Heysham 2
INA	Internal Nuclear Assurance
IP	Intermediate Pressure
IRR	Ionising Radiations Regulations 2017
LC	Licence Condition
LFE	Learning From Experience
LI	Licence Instrument
LOLER	Lifting Operations and Lifting Equipment Regulations
mSv	milli Sieverts
NDT	Non-Destructive Testing
NGL	Nuclear Generation Ltd
OAP	Outage Assessment Panel
ONR	Office for Nuclear Regulation
PAR	Project Assessment Report
PCPV	Pre-stressed Concrete Pressure Vessel
PMS	Plant Maintenance Schedule
PSSR	Pressure Systems Safety Regulations
PVCS	Pressure Vessel Cooling System
PVCW	Pressure Vessel Cooling Water
QA	Quality Assurance
R8	Reactor 8
RPA	Radiation Protection Adviser
RTS	Return to Service
SAP	Safety Assessment Principles

SQEP	Suitable Qualified and Experienced Persons
SI	Structural Integrity
SSC	Structure, System and Component
TOR	Torness
UPS	Uninterruptable Power Supply

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1 PERMISSION REQUESTED

1. This Office for Nuclear Regulation (ONR) Project Assessment Report (PAR) has been produced to support ONR's decision to issue a Licence Instrument (LI) granting Consent to start-up EDF Energy Nuclear Generation Limited (NGL) Heysham 2 Reactor 8 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 8 (Ref. 1) as required under Nuclear Site Licence Condition (LC) 30(3): Periodic Shutdown. Heysham 2 Nuclear Power Station has two Advanced Gas-cooled Reactors (AGR), identified as Reactor 7 and Reactor 8. The current shutdown period for Reactor 8 is 3 years 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 shut down 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 2000), Lifting Operations and Lifting Equipment Regulations (LOLER 1998) 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 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 July 2019 through the Outage Intentions meeting. At this meeting NGL set out its intended scope of work through its Reactor 8 Outage Intentions Document (Ref. 3). 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 corporate and local arrangements (Refs 4 to 11).
7. The Heysham 2 Reactor 8 outage commenced on 31 January 2020. At the Outage Start-up meeting on 18 March 2020 (Ref. 12). NGL presented findings from the Reactor 8 Outage. NGL did not identify any issues that would prevent start-up of Reactor 8 and no significant incidents occurred during the outage period. A number of minor conventional safety events did occur during the outage which NGL recorded and investigated to identify learning and prevent further occurrences. A number of minor 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

8. 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 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.
9. ONR's mission is to provide efficient and effective regulation of the nuclear industry, holding it to account on behalf of the public. To this aim, the primary focus in carrying out assessment and inspection activities during the Heysham 2 Reactor 8 outage was to confirm that nuclear safety requirements have been suitably addressed.
10. Prior to the commencement of the periodic shutdown, ONR specialist inspectors reviewed the outage intentions document (Ref. 3) 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 8 outage:
- Civil Engineering
 - Structural Integrity
 - Graphite Reactor Core
 - Mechanical Engineering
 - Internal Hazards
 - Electrical Engineering
 - Control and Instrumentation
 - Radiological Protection
 - Quality and Supply Chain
11. Inspections and assessments were undertaken in line with ONR internal guidance set out in ONR Technical Inspection and Assessment Guidance.
12. The ONR project inspector took on an overview 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

13. The following section provides a summary of the ONR specialist inspectors' inspection and assessment findings for each of the technical discipline areas evaluated during the Heysham 2 Reactor 8 outage. These summaries provide the information and evidence to underpin ONR's considerations and judgment to Consent start-up of Heysham 2 Reactor 8.

4.1 CIVIL ENGINEERING INTERVENTION AND ASSESSMENT

14. The ONR specialist inspector's opinion and judgement from the site intervention and assessment of the appointed examiner (APEX) pre-stressed concrete reactor pressure vessel (PCPV) report are recorded in Refs 13 and 14.
15. The ONR civil engineering specialist inspector performed an LC28 inspection to judge the adequacy of the APEX inspection and to discuss the findings of the statutory outage prior to the issue of the APEX return to service report. The intervention served

to inform an Assessment Report relating to the APEX's return to service report for this outage.

16. Areas considered included:

- Review of previous APEX report, changes and emerging issues
- Concrete surfaces
- Tendon Anchorages
- Tendon load checks
- Strand withdrawal and examination
- Settlement and tilt
- Strain gauge monitoring
- Vessel temperature
- Main reactor coolant loss
- Pressure vessel cooling system
- Top cap deformation
- Pressure relief valves
- Update on outstanding issues

17. The specialist inspector reviewed the maintenance schedule, branch instructions and relevant guidance notes / specifications. It was judged that for the sample inspected the Licensee had made and implemented adequate arrangements including the provision of a plant maintenance schedule. EMIT was being carried out regularly and systematically by suitably qualified and experienced personnel at the intervals specified within the plant maintenance schedule. The specialist inspector therefore concluded that the LC28 arrangements were adequate.

18. The Statutory Examination Report has been produced by the Appointed Examiner (APEX) for Heysham 2 Reactor 8 (Ref. 15) and is presented by the licensee in support of its request for permission to return Reactor 8 to service following the 2020 periodic shutdown. The Appointed Examiner is NGL's nominated, suitably qualified and experienced person, responsible for ensuring the provision of in-service inspection and surveillance activities relating to the pre-stressed concrete pressure vessel. A final 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.

19. Based on assessment of the surveillance activities, the Appointed Examiner concluded that the Heysham 2 Reactor 8 pre-stressed concrete pressure vessel is satisfactory for return to service, subject to normal in-service surveillance, until the next scheduled statutory examination due in 2023. The Appointed Examiner's conclusion is subject to the satisfactory completion of crack monitoring, PVCW flow balancing and leak sealing activities prior to return to service.

20. From the ONR specialist assessment of:

- the results of the surveillances and inspections carried out and documented,
- LC28 Site outage Intervention Record,
- discussions held with the Appointed Examiner and station civil engineer,
- acceptance of the judgements made by the Appointed Examiner

21. They are content to support the return to service of the Reactor 8 pre-stressed concrete pressure vessel for the next operating period of three years, subject to the satisfactory completion of the identified activities during the remainder of the outage.

22. To conclude, the specialist civil engineering inspector has no objection to Consent for the return to service of Heysham 2 Reactor 8. This is however contingent on the ONR

Project Inspector receiving the confirmation of satisfactory completion of the outstanding works.

23. As of 13 March which is the cut-off date for the preparation of the interim Statutory Examination Report, the outstanding activities were:
- It is recommended that the DEMEC gauge measurements of Crack 3 are undertaken as soon as access is available.
 - Checking and resetting of PVCS flows are not yet complete. Once checking of the PVCS flows are complete these will be reviewed and reset where necessary.
 - Sealing of the current PVCS leak (CR 1134481) has been attempted without success and further attempts to seal this leak are to be undertaken during the outage.
24. The outstanding activities have been progressed to the satisfaction of the specialist civil engineering inspector (Ref. 16). The results will be produced and discussed in detail within the Rev 001 of the APEX regulatory outage report (following return to service) in support of station 28 day reporting, and to satisfy the reporting requirements of regulation 9 of the Pressure Systems Safety Regulations.

4.2 STRUCTURAL INTEGRITY INTERVENTION AND ASSESSMENT

25. The ONR specialist inspector's view and judgement from the site intervention and assessment are recorded in Refs 17 and 18.
26. The specialist inspector undertook site meetings and plant inspections with relevant staff from NGL to determine the adequacy of the work being undertaken on Reactor 8 in complying with the requirements of Licence Condition 28.
27. The inspection sampled aspects of the inspection programme undertaken during the periodic shutdown on the steam and feed systems and other safety related systems external to the reactor pressure vessel.
28. The specialist inspector visited site approximately a third of the way through the periodic shutdown, according to the licensee's programme and was content with the inspection work sampled. They judged that there was a suitable process in place to confirm the adequacy of non-destructive testing (NDT) procedures prior to a periodic shutdown (outage).
29. The specialist inspector sampled the inspection work that had been undertaken as part of the reactor external inspection programme, looking at both the inspection work itself and the categorisation of the results, and was satisfied.
30. The operation of the licensee's outage assessment panel (OAP) was sampled during the visit, by observing an OAP meeting. The OAP meets to review the inspection work undertaken during the periodic shutdown and sentences the inspection findings. The specialist inspector was satisfied that the OAP was following due process and that the inspection items raised were sentenced appropriately.
31. A plant walk down was undertaken, the licensee was able to provide satisfactory explanations of both the operation of the systems and the inspection/maintenance of the systems planned or already performed during the periodic shutdown.
32. Progress on inspection, maintenance and testing activities associated with the seawater systems was discussed. The work programme was progressing in accordance with pre-outage intentions documentation and associated inspection specifications, with no significant issues identified.

33. From the information that was sampled during the inspection, the specialist inspector concluded that, from a structural integrity perspective, the licensee has performed the examination, inspection, maintenance and testing work to an adequate standard against the requirements of LC28. At the time of the visit, and from the sample inspections, the specialist inspector found nothing that would prevent Heysham 2 Reactor 8 returning to service following completion of the 2020 periodic shutdown.
34. The structural integrity specialist inspector also produced an assessment report which assessed the structural integrity related aspects of the outage including the adequacy of the inspections of welds, pipe hangers and restraints, main cooling water system, metallic reactor internal components and flow accelerated corrosion in line with Licence Condition 28, Heysham 2 maintenance schedules and compliance with Pressure Systems Safety Regulations (PSSR) undertaken.
35. Based upon the items sampled which the specialist inspector considered important to nuclear safety, and the evidence presented, the specialist inspector judged that the licensee had undertaken sufficient inspection and assessment to support the safe return to service (RTS) of Heysham 2 Reactor 8 from a structural integrity perspective. The specialist inspector was satisfied with the inspection scope proposed by the licensee, that these inspections were undertaken in line with the Reactor 8 2020 outage intentions proposal documents and that the licensee has followed corporate procedures in the assessment and sentencing of inspection results.
36. The judgements and conclusions were based on some information that had yet to complete due process, and was therefore contingent on receiving a number of additional documents and assurances as outlined in the recommendations below.
37. To conclude, the specialist structural integrity inspector has no objection to Consent for the return to service of Heysham 2 Reactor 8. This is however contingent on receiving the following information:
 - the independent Nuclear Safety Assessment (INSA) certificate for the RTS EC365253 report should be submitted as part of the licensee's application for Consent to RTS to show satisfactory completion of the steam system inspection programme and completion of the work of the OAP;
 - a return to service statement from the PSSR Competent Person (CP) should be submitted as part of the licensee's application for Consent to RTS to show satisfactory completion of the PSSR inspections;
 - the RTS EC365253 report must include a statement from the licensee's design authority supporting the fitness for RTS to show satisfactory completion of the inspections not covered by the Appointed Examiner (APEX) and PSSR CP;
 - confirmation from the structural integrity inspector that no emergent issues, relating to structural integrity, have been identified since completion of this assessment report that would prevent Heysham 2 Reactor 8 from returning to service.
38. I can confirm that this information has been received and the specialist structural integrity inspector is satisfied (Ref. 19).
39. The specialist inspector also requested that the project inspector should ensure that the licensee provides ONR with an approved copy of the RTS EC365253 and the 28 day report. The EC has now been received and distributed (Ref. 24) and the 28 day report, which will be distributed when available.

4.3 GRAPHITE INSPECTION AND ASSESSMENT

40. The ONR specialist inspector's views and judgements from the assessment of Heysham 2, Reactor 8 graphite return to service safety case and inspections are recorded in References 20, 21 and 22.
41. The specialist inspector carried out two site interventions at Heysham 2 during the periodic shutdown. The purpose of the first intervention was to inspect the adequacy of NGL's examinations and inspections of the graphite core and determine compliance with LC 28(1), this included:
 - Inspection of the quality of the graphite core inspections;
 - Inspection of training records and quality control procedures of inspection staff.
42. At the time of the site intervention, the graphite inspections had only just commenced. NGL had completed inspection of 2 of the 16 channels planned for inspection, with no reported defects. There was no apparent issue which could prevent the scope of the graphite inspections from being completed at that time.
43. Based on the documentation sampled during the intervention, the specialist inspector judged that the licensee was compliant with their Quality Assurance requirements. The quality of the video footage observed appeared to be of sufficient quality to allow for appropriate detection and sentencing of any defects that could be observed. The training records sampled were up-to-date and relevant to the tasks carried out by the operators. The station staff spoken to during the intervention appeared to be knowledgeable and suitably experienced. The graphite core inspection that was observed during the intervention appeared to have been carried out with appropriate rigour.
44. In the view of the specialist inspector, the licensee's arrangements for the graphite core inspections appeared to be appropriate and no shortfalls were observed during the inspection.
45. The purpose of the second intervention was to inspect the adequacy of NGL's examination and inspection of the peripheral shielding bricks and determine compliance with LC 28(1). The findings from the graphite core inspections were also discussed as these had just been completed at the time of the intervention.
46. At Heysham 2 and Torness, the reactor core is surrounded by peripheral shielding bricks to help guide the gas flow around the reactor. Peripheral shielding is composed of 16 faces surrounding the core, each face being made of either 10 or 11 aligned graphite blocks, arranged in 11 layers (i.e. each face has 110 or 121 graphite blocks).
47. Cracking in a number of peripheral shielding bricks was first observed at Torness in Reactor 2 in 2015, during routine inspection of the reactor internals. Similar types of cracks have also been observed in Heysham 2 (2016), Torness Reactor 1 (2017) and Heysham 2 Reactor 7 (2018). It is therefore the second inspection of the peripheral bricks for Heysham 2 Reactor 8 since peripheral brick cracking was discovered. To justify the tolerability of the extent of cracking observed in these bricks, EDF NGL has produced and maintains a safety case which is reviewed and updated after each inspection campaign of the peripheral brick walls at Heysham 2 and Torness.
48. At the time of the intervention, 3 out of the 12 targeted peripheral brick face inspections had been completed. No significant defects had been found in the faces inspected. There was no apparent issue which might prevent the scope of these inspections from being completed.

49. In the opinion of the specialist inspector, the station staff spoken to during the intervention were knowledgeable and suitably experienced. The peripheral shielding brick inspections observed appeared to have been carried out with appropriate rigour. The training records sampled were up-to-date and relevant to the tasks carried out by the operators. The Quality Assurance records sampled during the intervention were appropriately completed and up-to-date and the video footage of the peripheral shield wall bricks was of reasonable quality. In the view of the inspector, the licensee's arrangements for the peripheral shielding brick inspections were appropriate. The inspector did note that the viewing facilities for the second line assessors could be improved. However, they did not observe any shortfall in NGL's inspection arrangements.
50. Overall, from the activities sampled during the intervention the specialist inspector found NGL to be compliant with LC 28 with respect to the peripheral shielding brick inspections.
51. The specialist inspector also assessed the Heysham 2 Reactor 8 2020 periodic shutdown inspection results relating to the graphite core. These findings have been compared against the claims and limits in the current graphite safety case and they have been assessed against the expectations laid down by the relevant Safety Assessment Principles (SAP). Overall, NGL states that the results of the graphite core inspections at Heysham 2 Reactor 8 2020 periodic shutdown are acceptable and do not challenge safe operation. However, an Independent Nuclear Safety Assessment certificate was not available at the time of the specialist assessment. The specialist inspector therefore recommended that the ONR Project Inspector should ensure that this certificate is available and in agreement with the views in the Engineering Change document. This document has been received and the specialist graphite inspector is content (Ref. 23 and 24)
52. According to NGL's core behaviour predictive models, the onset of keyway root cracking at Heysham 2/Torness could occur within the next operating period of Heysham 2 Reactor 8 (February 2022). NGL is developing a post-onset of keyway root cracking safety case to be provided for assessment by ONR by the end of 2020. The specialist inspector is content that the changes in the predicted onset of keyway root cracking do not affect ONR's ability to permission the restart of Heysham Reactor 8. NGL will also be providing an update to the inspection strategy at Heysham 2/Torness before the end of May 2020.
53. During the inspection of the fuel channels, two full height axial cracks were found in channel D77, layer 6. The other channels inspected did not reveal any defects. In the specialist inspector's view, the evidence from the channel inspection supports NGL's conclusions that the cracks have initiated from the bore of the brick earlier in the life of the reactor. It is also the specialist inspectors opinion that the graphite core inspection results do not challenge the current claims and limits specified within the safety case and do not present any impediment to return to service of Heysham 2 Reactor 8. The specialist inspector also stated that NGL should consider whether this channel should be re-inspected in future fuel channel inspections. This is addressed via the conclusion of graphite assessment panel (GAP) 5 (Ref 25) the minutes of which state that:
- "Re-inspection of D77 should take place at the next available opportunity".*
54. In respect to the peripheral brick inspections, in the view of the specialist inspector, the level of inspection carried out during the inspection completed NGL's commitment to achieve 100% inspection of the peripheral shielding wall for this reactor over two inspection campaigns. Five faces were re-inspected and the defects observed did not reveal any evidence of progression since the last inspection in 2016. Overall, the number of defects observed remains low and uniformly distributed around the

peripheral wall. The specialist inspector is therefore of the opinion that the defects observed do not challenge the integrity of the peripheral wall.

55. The specialist inspector is therefore satisfied that the findings of the peripheral brick inspections do not challenge the claims in the safety case.
56. To conclude, the specialist graphite inspector has no objection to Consent for the return to service of Heysham 2 Reactor 8 (Ref. 26)

4.4 JOINT MECHANICAL ENGINEERING / INTERNAL HAZARDS INTERVENTION

57. ONR internal hazards and mechanical engineering specialist inspectors carried out an inspection against the requirements of Licence Condition 14: Safety documentation and Licence Condition 28: Examination, inspection, maintenance and testing (Ref 27). A combined internal hazard/mechanical engineering inspection was carried out due to the common areas of interest and to limit the regulatory burden on the Licensee. The activities examined were selected due to their nuclear safety significance.
58. The following areas were targeted for inspection:
- Intermediate Pressure (IP) turbine rotor exchange
 - Gas Circulator (GC) maintenance, impellor inspection and GC exchange
 - Control rod drop times
 - Reactor Gas Relief Valve maintenance
 - Outage rapid trending and learning from experience (LFE)
 - Management of Laydown Areas
 - Management of outage activities
 - Control of Fire Protection Systems
59. The inspection involved reviewing the arrangements in place for identifying and minimising any nuclear safety impacts that may arise from internal hazards during outage activities along with the implementation of the mechanical engineering arrangements relevant to planned outage activities.
60. The intervention sampled; the examination, inspection, maintenance and testing performed during the periodic shutdown on safety systems and components, as specified in the Heysham 2 Reactor 8 2020 Outage Intentions Document (Ref. 3).
61. The internal hazards inspection sampled the arrangements in place for identifying and minimising any nuclear safety impacts that may arise during the outage. This was achieved by targeting some of the key outage tasks (gas circulator exchange and turbine rotor exchange) where internal hazards (i.e. fire, dropped loads and impacts) may arise.
62. Based on sampling, the specialist inspectors were satisfied from an internal hazards and mechanical engineering perspective that during the Heysham 2 2020 Reactor 8 periodic shutdown:
- Examination, inspection, maintenance and testing associated with gas circulators, safety significant valves, control rods and turbines are being adequately controlled, in line with the requirements of the safety case.
 - The arrangements adopted by Heysham 2 for management of internal hazards during outage activities are suitable and adequate.
 - Sufficient records are being kept and monitored to identify problems both reactively and proactively.
63. Based on sampling undertaken as part of this intervention, the specialist inspectors were satisfied that the Licence Condition 14 and Licence Condition 28 arrangements in

place are adequate and have been adequately implemented with no significant shortfalls.

64. To conclude, the specialist internal hazards and mechanical engineering inspectors have no objection to Consent for the return to service of Heysham 2 Reactor 8.

4.5 ELECTRICAL ENGINEERING INTERVENTION

65. The ONR electrical engineering specialist inspector conducted an LC 28 compliance inspection (Ref 28) targeting the planned electrical EIMT activities from the station's outage intentions document, the implementation of the detailed modifications and any reactive electrical work including:
- High voltage protection equipment replacement
 - Switchgear maintenance activities undertaken on gas circulator 11kV and 3.3kV air circuit breakers (ACB)
 - Overhaul and cleaning of essential services transformer 8DY ACB
 - Insulation resistance/polarisation index testing of transformer 8DY circuits and insulation resistance testing of the 3.3kV station auxiliary board bus-bars.
 - Engineering Change for the proposed use of alternative battery supplier
 - Gas Circulator Remote Control Quadrant Switches
 - Plant inspection of the main electrical supplies system and associated systems including:
 - Cooling water supply pump house
 - Unit 8 essential supplies building including 3.3kV switch-room, uninterruptable power supply (UPS) room, variable speed drive room and battery room
 - 400kV protection suite room
66. A plant walk-down was conducted and for the areas sampled, the specialist inspector observed acceptable standards of general housekeeping. The electrical plant and equipment inspected was in an acceptable condition and there were no visible signs of external corrosion or flaking paintwork. The station staff spoken to and those accompanying the specialist inspector on the walk-down, all presented a knowledgeable and professional approach, and provided open and honest responses to questions.
67. The inspectors were advised that the progress made against electrical activities during the shutdown was as planned. The station expected to complete all scheduled electrical work activities before return to service with no plans to defer any activities. Through explanations, discussions and a live demonstration using the station's asset management system the specialist inspectors were satisfied that there were clear, auditable links between the shutdown related electrical activities and the station's maintenance schedule and instructions. It was also evident that the electrical activities were being undertaken at the appropriate periodicity.
68. To conclude, the specialist electrical engineering inspector has no objection to Consent for the return to service of Heysham 2 Reactor 8 This was subject to the completion of the planned EIMT activities, the implementation of the detailed modifications, the completion of emergent electrical work and the assessment of any EIMT activity deferrals.
69. I can confirm that this work is now complete and the specialist inspector has no objections to the restart of Heysham 2 Reactor 8 (Ref. 29).

4.6 CONTROL AND INSTRUMENTATION INTERVENTION

70. The ONR control and instrumentation (C&I) inspector carried out an LC 28 compliance inspection (Ref. 30). The inspection covered a sample review of the Heysham 2 Reactor 8 2020 statutory outage activities carried out in relation to C&I equipment and systems important to nuclear safety, NGL's arrangements for compliance with LC 28 Examination, inspection, maintenance and testing (EMIT) and LC 22 modification or experiment on existing plant.
71. The specialist inspectors found that the commitments made in the Heysham 2 Reactor 8 outage intention scoping document have been satisfied in relation to the sampled C&I equipment and systems important to nuclear safety.
72. Inspection of the work activities covered during this intervention found that the workmanship applied was adequate and consistent with the standards expected from C&I suitably qualified and experienced persons (SQEP).
73. During the inspection the specialist inspectors noted that system engineers and maintenance technicians demonstrated a good knowledge of their respective systems and that good practices have been applied. These included, trending of thermocouple behaviour, which led to an identification of an increase in degradation of the thermocouples and an engineering change to improve the design. In addition, the engineers demonstrated an adequate appreciation of the nuclear safety implications of equipment failures. From a cyber-security perspective, the station demonstrated improved control of portable computing devices entering the station and identified an improvement in the registration of portable computer devices on site. Overall, the specialist inspectors were satisfied with the cyber security arrangements.
74. During the plant walk-down, the specialist inspectors found the plant areas and equipment cubicles inspected were clean and tidy, which provided evidence that Heysham 2 have followed good housekeeping practices. They also found examples of good ageing and obsolescence management that included a proposal to manage the ageing of the data processing and control system (DPCS) communication bus cables.
75. The specialist inspectors identified areas for improvement for the recording of test results for the reactor safety circuit end contactors. This included requesting Heysham 2 to consider adding the range of contactor coil temperature in the plant maintenance instruction, when measurements should be taken and to clarify why the drop-off voltage is always at the bottom of the tolerable range. These areas for improvement were considered by the specialist inspectors to be minor shortfalls which do not have a significant impact on nuclear safety and are not required to be addressed prior to return to service.
76. During the inspection the specialist inspectors also sampled the implementation of two plant modifications relating to the latest software release for Reactor 8 data processing and control system and modifications to the half unit valves. They were satisfied that the implementation of these ECs was adequate and the station demonstrated due processes had been appropriately followed.
77. On the basis of the inspection of the C&I aspects of the Heysham 2 Reactor 8 2020 statutory outage the specialist inspectors recommend that support be given for a Consent to allow Reactor 8 to return to service
78. To conclude, the specialist control and instrumentation inspectors have no objection to Consent for the return to service of Heysham 2 Reactor 8.

4.7 RADIOLOGICAL PROTECTION INTERVENTION

79. The ONR radiological protection specialist carried out an inspection to provide regulatory confidence that the NGL statutory outage work programme for Heysham 2 was being conducted in compliance with the Ionising Radiations Regulations 2017 (IRR17) (Ref. 31).
80. The following areas were focussed on during the inspection:
- Summary of outage programmed work and its radiological implications.
 - Radiation protection personnel and monitoring equipment provision.
 - Contractor control and supervision.
 - Radiation protection input to outage work planning.
 - Integration of ALARP management principles with personal radiation exposure restriction and contamination control.
 - Radiation survey instrument maintenance and provision.
 - Radiological event investigation and follow-up.
 - Planning for radiologically significant outage tasks.
 - Operational dose management, i.e. day-to-day dose management and profiling during the outage.
 - Radioactive source management.
 - Health Physics clearance arrangements.
81. The inspection did not reveal any significant radiological safety issues that required action by the Licensee or follow-up by ONR. The specialist inspector judged that from a radiological protection standpoint, the station is conducting its outage to a sufficient standard of risk management and dose restriction, and in accordance with its outage plan in this regard.
82. The Station appeared to be managing dose control very effectively, with a current projection that the work will come in close to the pre-outage target of 9.5 man mSv. Instances of personal contamination were low and were being well investigated and understood.
83. The survey schedule completion rate was above 99%, with non-completions due to lack of accessibility. This was confirmed by the corporate Radiation Protection Adviser (RPA) as being the best in the fleet.
84. The specialist inspector spoke to a number of contract monitoring staff (Radwise) and they appeared to be well informed and understood the work they had been assigned, their role in it and the radiological controls required.
85. To conclude, the specialist radiological protection inspector has no objection to Consent for the return to service of Heysham 2 Reactor 8 quality and supply chain intervention

4.8 SPECIALIST QUALITY AND SUPPLY CHAIN INTERVENTION

86. The specialist quality and supply chain inspector conducted a planned Licence Condition (LC) 17 - Management Systems compliance inspection in relation to Heysham 2's supply chain and Quality Assurance (QA) management arrangements for the outage (Ref 32).
87. The purpose of LC17 is to ensure the licensee has established and implemented management systems which give due priority to safety and within its management systems, make and implement adequate quality management arrangements within the reactor outage period in respect of all matters which may affect safety.

88. This LC17 inspection examined the Quality Assurance (QA), supply chain (including goods receipt) and lifetime records arrangements for the reactor outage. A number of low-level shortfalls in the arrangements were found which the station has started to address and progress and which will be tracked through normal business. Overall, from the evidence sampled, the specialist inspector judged that the licensee adequately demonstrated compliance with the requirements of LC17 in respect to this outage.
89. To conclude, the specialist quality and supply chain inspector has no objection to Consent for the return to service of Heysham 2 Reactor 8.

4.9 ONR SITE INSPECTOR OVERVIEW OF OUTAGE ACTIVITIES

90. The project inspector for the Heysham 2 Reactor 8 outage and the nominated Heysham 2 site inspector joined the NGL internal nuclear assurance (INA) team on their early outage review (EOR) inspection and in addition carried out an unannounced inspection of the effectiveness of the control and supervision arrangements out of hours (Ref. 33).
91. The early outage review looked at work area standards and working practices. The unannounced inspection tested the effectiveness of the control and supervision arrangements out of hours.
92. Overall the EOR found no significant issues, although it concluded that the station management need to be aware of the possibility of behavioural drift over the next few days / weeks. In general all the staff seen were happy to engage with the team.
93. During the unannounced out of hour's control and supervision inspection we spoke to a number of contract personnel from a variety of companies who were performing outage work. All had a reasonable understanding of the station's, 'do your 5 a day,' message consisting of time out for personal safety, procedural use and adherence, pre-job briefs, work area standards and peer to peer coaching. No unsafe practices were seen and the personnel all had a good awareness of their supervisor and knew what to do in the event of an emergency or accident.
94. The findings of this intervention were communicated verbally to Heysham 2 management on the night and the following day. There were no findings from this inspection that could significantly undermine nuclear safety.

4.10 RETURN TO SERVICE MEETING

95. A return to service meeting was held on the 18 March 2020 (Ref. 12). The purpose of the meeting was for NGL to present the findings to date of the Heysham 2 Reactor 8 2020 periodic shutdown to ONR. The shutdown of Reactor 8 has been undertaken in compliance with NGL's Nuclear Site Licence.
96. Prior to the start-up meeting, ONR inspectors were given the opportunity for a plant walk down which included the following areas:
- Pile Cap
 - 8A Quadrant Boilers
 - Gas Circulators and Bypass Gas Plant
 - 8DX Essential Supplies
 - Turbine Hall
 - Safety Centre
97. Overall we felt that the outage had been successful and station had been open and communicative. The observation and trending process appeared to have been

successful and all staff that we spoke to appeared engaged in the job they were doing / had done. When compared to previous outages, the number of health and safety accidents during this outage, so far, has reduced significantly and we were supportive of the use of drug sniffer dogs which increased visibility of the station's stance on drugs. We were also supportive of the use of drones on a number of occasions both to inspect tanks and other hard to reach areas of plant.

98. To conclude, there were no issues or areas of concern that would prevent Consent to the restart of Heysham 2 Reactor 8.

4.11 ENGAGEMENT WITH OTHER GOVERNMENTAL AGENCIES

99. ONR has engaged with the Environment Agency who has confirmed that they have no objections to the restart of Heysham 2 Reactor 8 following the 2020 statutory outage (Ref. 34).

5 CONCLUSIONS

100. NGL's request to ONR for Consent to start-up Heysham 2 Reactor 8 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 8 outage intentions document (Ref 3) have been met. This excludes testing of equipment which can only take place when the reactor becomes pressurised and steam-raising commences. Based upon ONR's intervention evidence I am of the opinion that the station has complied with their plant maintenance schedule requirements.
101. NGL has submitted the Heysham 2 Reactor 8 APEX report (Ref. 15) following completion of civil inspection and maintenance of the PCPV. This confirms that there are no safety issues in returning the vessel back to service. This report was reviewed by the ONR civil engineering inspector and found to be accurate and balanced based on site intervention findings and assessment of claims and arguments set out in the APEX report. The ONR inspector supports NGL's conclusion that the PCPV is safe to return to service and will remain in this condition until its next periodic shutdown. The ONR civil engineering inspector supports ONR issuing Consent for Reactor 8 start-up.
102. NGL's return to service safety justification for Reactor 8 is set out in EC357403 covering graphite and steel components (Ref. 24). It confirms that no safety issues have been identified from EIMT activity to challenge safety case claims that would prevent Reactor 8 start-up or its safe operation until its next periodic shutdown planned in 2023. NGL support this claim with statements from their independent third party PSSR Competent Person, Bureau Veritas (Ref. 35), who confirmed that there were no compliance issues from inspections carried out in accordance with PSSR written schemes of examination. NGL's findings from thorough examination of PCPV penetrations were found to be satisfactory. These documents have been reviewed by ONR Inspectors supporting the Reactor 8 shutdown, who agreed that claims and arguments presented are in line with their views from intervention findings and assessment. ONR structural integrity and graphite specialist inspectors therefore support ONR issuing a Consent for Reactor 2 start-up.
103. Heysham 2 Independent Nuclear Assurance (INA) has provided a statement (Ref. 36) that based on their Reactor 8 shutdown concurrence activities to date no issues have been identified that would challenge their support for start-up of Reactor 8.
104. Based on evidence gathered from ONR's intervention and assessment activities for the Heysham 2 Reactor 8 shutdown together with claims, arguments and evidence presented by NGL in its request for start-up of Reactor 8, it is my judgement that Heysham 2 power station has complied with its LC30(1) requirements for Reactor 8 in

carrying out the required EIMT work in accordance with the station's plant maintenance schedule. The work was carried out in accordance with the station's procedures by competent SQEP personnel working to identified quality arrangements and with appropriate supervision. Where EIMT findings were anomalous with safety case requirements, NGL has provided adequate safety justification that relevant safety case limits and conditions are not challenged.

105. In conclusion, ONR has identified no matters of concern that would prevent ONR granting Consent for Heysham 2 Reactor 8 to start-up following its periodic shutdown.

6 RECOMMENDATIONS

106. I recommend that, in response to the request by NGL, ONR issue Licence Instrument 628 granting Consent under LC30(3) of Nuclear Site Licence 60 to start-up Heysham 2 Reactor 8 following the 2020 Periodic Shutdown.

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