Office for Nuclear Regulation

Hartlepool – Reactor 2 – 2019 Statutory Outage

EDF Energy Nuclear Generation Limited (NGL) – Hartlepool Power Station – Assessment of the Hartlepool Reactor 2 2019 Periodic Shutdown.

Project Assessment Report ONR-HRA-PAR-19-008
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EXECUTIVE SUMMARY

Title

EDF Energy Nuclear Generation Limited (NGL) – Hartlepool Power Station – Assessment of the Hartlepool Reactor 2 2019 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 Reactor 2 at Hartlepool Power Station following completion of the 2019 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) states: "When necessary for the purpose of enabling any examination, inspection, maintenance or testing of any plant or process to take place, the licensee shall ensure that any such plant or process shall be shut down in accordance with the requirements of its plant maintenance schedule referred to in Condition 28." [LC28: Examination, Inspection, Maintenance and Testing (commonly known as EMIT)].

LC 30(3) states: "The licensee shall, if so specified by ONR, ensure that when a plant or process is shut down in pursuance of paragraph 1 of this condition it shall not be started up again thereafter without the consent of ONR."

ONR issued a specification, via Licence Instrument No 06, dated 28 March 1996, that the Licensee shall not, without the Consent of ONR, start up a Reactor at Hartlepool following a periodic shutdown for the purposes of LC 30(1).

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 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 have assessed NGL documentation produced from the outage and EMIT 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

Hartlepool was the first station in the NGL fleet to receive a 10% challenge to scope reduction for statutory outages, set by the NGL Chief Technical officer. Due to timescales and planning issues associated with justifying any potential reductions to scope, ONR were not presented

with any Engineering Changes to justify removing or deferring activities from the maintenance schedule, and all planned maintenance schedule activities were successfully completed.

An emergent issue was raised by NGL prior to requesting consent to re-start of Hartlepool Reactor 2. During NGL's planned review of the extant Hartlepool and Heysham 1 graphite safety cases NP/SC 7570, a potential issue was identified relating to control rod operations during a seismic event requiring clarification before ONR granted consent to restart. Clarification was provided to ONR and following a review, ONR were content that this issue was resolved and no longer constituted a Hartlepool Reactor 2 re-start issue.

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

Conclusions

ONR's assessment and inspection of the Hartlepool Reactor 2 periodic shutdown confirms that NGL has carried out EMIT 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 remain that would prevent the start-up of Hartlepool Reactor 2 following its 2019 periodic shutdown.

Recommendation

The ONR Statutory Outage Project Inspector recommends that Licence Instrument 569 be issued to grant ONR's Consent to start-up Hartlepool Reactor 2, following its 2019 periodic shutdown.

LIST OF ABBREVIATIONS

3PC	Three Points of Contact
ALARP	As Low As Reasonably Practicable
APEX	Appointed Examiner
C&I	Control & Instrumentation
CR	Control Rod
EC	Engineering Change
ECW	Essential Cooling Water
EMIT	Examination, Maintenance, Inspection and Testing
EOR	Early Outage Review
GAP	Graphite Assessment Panel
HRA	Hartlepool
INA	Independent Nuclear Assurance
LC	Licence Condition
LI	Licence Instrument
NGL	EDF Nuclear Generation Limited
ONR	Office for Nuclear Regulation
PCPV	Pre-stressed Concrete Pressure Vessel
PMS	Plant Maintenance Schedule
PSSR	Pressure Systems Safety Regulations
R1	Reactor 1
R2	Reactor 2
SCAP	Safety Case Assessment process
SQEP	Suitably Qualified and Experience Person(s)
WSE	Written Scheme of Examination

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1 PERMISSION REQUESTED

1. This Office for Nuclear Regulation (ONR) Project Assessment Report has been produced to support ONR's decision for issuing a Licence Instrument (LI) granting Consent to start-up EDF Energy Nuclear Generation Limited's (NGL) Hartlepool Reactor 2 (R2) following periodic shutdown as required under Nuclear Site Licence Condition 30(3): Periodic Shutdown.

2 BACKGROUND

2. NGL has requested ONR's Consent to start-up Hartlepool R2 (Reference 1) as required under Nuclear Site Licence Condition (LC) 30(3): Periodic Shutdown.

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 Plant Maintenance Schedule (PMS) as referred to in LC 28: Examination, Inspection, Maintenance and Testing (commonly known as EMIT).

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 2000 (PSSR), Lifting Operations and Lifting Equipment Regulations 1998 and equipment manufactures 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 LC 30 (1) it should not be started up again thereafter without the consent of ONR. ONR specified under LC 30(3) through LI No 6, dated 28 March 1996, Unique Document No HRA 70609 (Reference 2) for Nuclear Site Licence 59, that NGL shall seek ONR's Consent to start up a reactor at the Hartlepool Power Station following a shutdown of the reactor for the purposes of Licence Condition 30(1).

6. Hartlepool Nuclear Power Station comprises two Advanced Gas-cooled Reactors, identified as Reactor 1 (R1) and Reactor 2 (R2). The current shutdown period for R1 and R2 is 3 years based upon safety justification set out in the Station's Safety Case and PMS requirements.

7. NGL's preparation for Hartlepool R2 outage started in 2018, with formal engagement with ONR in February 2019 through the Outage Intentions meeting (Reference 3). At this meeting NGL set out its intended scope of work through its R2 Outage Intentions Document (Reference 4). This set out PMS requirements as well as identifying other work to be carried out in support of safety. The document also identified Hartlepool's approach for managing safety and quality during the outage, which was to be delivered by processes set out in corporate and station arrangements (References 5, 6, 7 and 8).

8. During the Outage Intentions meeting (Reference 3), ONR were made aware of a 10% challenge on the scope of the Hartlepool Statutory Outage, which had been set by NGL's Chief Technical Officer. The intention was to streamline activities and conduct work more efficiently to reduce outage timescales. ONR advised that any changes to the current outage intentions would need to be justified via an appropriate Engineering Change (EC). ONR advised that any justifications to remove or defer key maintenance schedule activities from the scope of the outage may be subject to formal assessment from ONR.

9. The Hartlepool R2 outage commenced on 10 August 2019. At the Outage Start-up meeting on 01 October 2019 (Reference 9) NGL presented findings from the R2 Outage (Reference 10). At that time, NGL had not identified any issues that would prevent start-up of R2 and no significant incidents had occurred during the outage period. A number of 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

10. The purpose for ONR inspection and assessment activities during a nuclear 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 Systems, Structures and Components 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 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 Hartlepool R2 outage was to confirm nuclear safety requirements have been suitably addressed. Prior to the commencement of the periodic shutdown ONR reviewed the outage intentions document (Reference 4) together with operational experience gained from other ONR outage assessments and NGL's own event recording system. This informed the production of Outage Inspection Programmes (Reference 11) for the various specialist discipline inspections and assessments carried out during the Hartlepool R2 outage:

- Civil Engineering
- Structural Integrity
- Graphite Reactor Core
- Mechanical Engineering/ Quality Management
- Electrical Engineering
- Control and Instrumentation
- Radiological Protection
- Regulatory Reform (Fire Safety) Order 2005/ Internal Hazards
- Conventional Health and Safety
- Security

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

13. ONR compliance inspections against Conventional Safety (Reference 26), Regulatory Reform (Fire Safety) Order 2005 (Reference 25) and security requirements were also undertaken during the outage to support R2 Start-up.

14. The ONR Site Inspector took on an overview role during the outage including maintaining oversight of the work undertaken by ONR specialist inspectors etc. monitoring events; and providing regulatory input as necessary.

4 MATTERS ARISING FROM ONR'S WORK

15. 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 Hartlepool R2 outage. These provide the information and evidence to build ONR's considerations and judgment to consent start-up of Hartlepool R2.

4.1 CIVIL ENGINEERING INTERVENTION AND ASSESSMENT

16. The ONR civil engineering inspector's opinion and judgement from the site intervention and assessment, including the appointed examiner (APEX) pre-stressed concrete reactor pressure vessel (PCPV) report are recorded in References 12 and 13. The following areas were sampled during the inspectors interventions;

- Visual inspection of concrete surface condition
- Visual inspection of pre-stressing anchorages
- Vertical tendon residual load tests
- Review of monitoring data for circumferential pre-stressing system
- Assessment of pre-stressing strand and wire condition
- Vertical tendon tensile testing
- Vertical tendon grease testing
- Settlement and tilt survey
- Review of embedded strain gauge readings
- Review of vessel concrete temperatures
- Review of reactor coolant leakage
- Review of pressure vessel cooling water leaks
- Top cap deflection survey
- Boiler Closure Unit review of instrumentation data and remote access inspections
- PCPV Bearings

17. The ONR inspector followed up on progress made in the APEX Statutory Examination Report during (and following) the 2016 R2 periodic shutdown. The interim report on which this assessment is based includes details of the surveillances, inspections and tests completed up to 20th September 2019 and describes the further activities required to be completed before return to service. Further results of inspections and tests will be provided in an updated statutory examination report, which will be issued to ONR within 28 days of return to service.

18. The APEX concluded that "based upon an assessment of the [P]MS PCPV inspection activities discussed, and subject to the satisfactory completion of the identified activities during the remainder of the outage, that the Hartlepool Reactor 2 PCPV is satisfactory for return to service subject to normal in-service surveillance until the next scheduled statutory examination due in 2022".

19. The APEX highlighted that not all of the information required to complete the statutory examination report was available. ONR civil engineering inspectors consider that the outstanding information is not critical to make a judgement regarding the re-start of the reactor; subject to the satisfactory completion of the outstanding PMS works.

20. In line with the requirements of PSSR a full and detailed report of the examinations will be presented in an updated statutory examination report which is due to be issued within 28 days of the ONR regulatory consent to start-up of Reactor 2.

21. The recommendation for ONR to grant the consent to restart Reactor 2 was raised contingent on the ONR's project inspector to ensure that the outstanding work is satisfactorily completed prior to return to service which includes the following;

- PMS item 16.02.065 – Complete the minor repairs required following the Peripheral Pile Cap Shield Wall inspection in 2D quadrant.
- PMS item 03.01.030 – complete the remaining nominated vertical tendon lift-off tests (Soffit multi on CDB5, Pile-cap multi on ABA4, C1G9, CCA4)
- PMS item 03.01.041 - Complete the strand withdrawal and re-stress of nominated tendons.

22. The ONR project inspector has confirmed the above has been satisfactorily completed with the ONR civil engineering inspector, the close out statement to support this recommendation can be found in Reference 36.

23. In conclusion, following ONR's civil engineering inspectors' assessment of the results surveillances and inspections, site inspection, discussions held with the APEX, and acceptance of the judgements made by the APEX, the civil engineering inspector is content to support the return to service of the Hartlepool Reactor 2 PCPV for the next operating period of three years.

4.2 STRUCTURAL INTEGRITY INTERVENTION AND ASSESSMENT

24. The ONR structural integrity specialist's view and judgement from the site intervention and assessment are recorded in References 15 and 16. The following areas were sampled during the Inspector's interventions;

- Main cooling water system inspections
- Steam and feed system inspections
- Reactor internal remote visual inspections (steel components)
- Pipe hanger and restraint inspections
- Flow accelerated corrosion inspection

25. ONR's structural integrity inspector reviewed a broad selection of inspection activities completed by the licensee during the Hartlepool R2 2019 periodic shutdown. The information gathered was used to judge the adequacy of the licensee's inspection of items that are considered important for nuclear safety, including metallic component welds, pipework, vessels and support structures located internally and externally of the reactor pressure vessel.

26. The ONR inspector reported that the licensee intends to modify the PSSR examination report and revise the Written Scheme of Examination (WSE) for the PCPV components. This is to improve clarity of component level inspections because of weaknesses in the licensee's ability to meet PSSR requirements with respect to the periodicity of examination. The inspector will amend an existing fleet-wide Level 4 Regulatory Issue (2333) to monitor the modifications to PSSR examination reports, and revisions to the WSE to determine their adequacy to demonstrate future PSSR compliance.

27. During 2019 operations, the Essential Cooling Water (ECW) system which is constructed from glass-flaked carbon steel pipework, suffered localised failure as a result of internal degradation. ECW pipework was not available during the outage period for routine inspections. However, NGL gained an understanding of the extent of condition during valve replacement activities on similar pipework, which the inspector considered an appropriate response. Future monitoring has been limited to external pipework inspections which the inspector deemed appropriate to mitigate for the potential flooding and consequential loss of post trip cooling noting that failure would present itself as a pin hole leak rather than a catastrophic failure.

28. There was no clear mitigation of risks of buried or encased pipework of a similar construction and further information was requested from the licensee via a level 4

regulatory issue (7527). Subsequently EDF have provided additional information confirming the maintenance schedule activity for internal inspection of buried section of ECW pipework. EDF have also confirmed that adequate inspections of buried and trenched pipework of the ECW (glass-flaked lined sections) are currently being undertaken to mitigate the risk. The inspector is content with this response and has now closed regulatory issue 7527.

29. Following the Hartlepool outage intention meeting (Reference 3), the licensee proposed the conditional removal of the 2B1 gas circulator liner penetration 'Incredibility of Failure' weld inspections from the Outage Intention Document. However, following challenge from ONR, this proposal was subsequently withdrawn. The inspections were re-instated since, within the remaining time available to NGL, adequate justifications in accordance with the written scheme of examination could not be made, nor could it be demonstrated that the risks were "as low as reasonably practicable" (ALARP).

30. One recommendation was raised that the ONR project inspector ensures that the outstanding work is satisfactorily completed prior to return to service which includes the following;

- The project inspector should ensure that the PSSR return to service statement is reviewed to ensure that adequate compliance to PSSR requirements have been met.
- The project inspector should ensure that the licensee provides the ONR with an approved copy of the return to service Engineering Change.

31. The ONR project inspector has confirmed the above has been satisfactorily completed, the documentation to support close out of this recommendation can be found in References 31 and 32.

32. In conclusion, from a structural integrity perspective, the ONR structural integrity inspector recommended that ONR should issue the Licence Instrument to grant Consent for start-up of Hartlepool Reactor 2, following the 2019 periodic shutdown.

4.3 GRAPHITE INTEGRITY ASSESSMENT

33. The ONR inspector's views and judgement from the site intervention and assessment of NGL's Hartlepool, Reactor 2 graphite return to service safety case, are recorded in Reference 24 and 37 which covers the following areas:

- The adequacy of the graphite core inspections performed by NGL during the periodic shutdown of Hartlepool R2 in compliance with LC 28 and LC 30 expectations;
- The assessment of the inspection results as reported in the Graphite Assessment Panel (GAP) inspection sheets and minutes;
- The consideration of the inspection findings with regards to the Heysham 1 and Hartlepool graphite safety case.

34. The ONR inspector assessed the EC document (Reference 29) and compared the findings with the current graphite safety case. At the time of the inspection, the EC had yet to be completed as 10-fuel channel inspections were still outstanding, out of the 20 fuel channels scheduled. The delay to these inspections was due to the reduced cooling rate of the reactor caused by the high seawater temperatures at the time of the shutdown. The inspector therefore based his assessment on the inspection findings

available from the 10 fuel channels and one control rod channel that had completed inspection.

35. The ONR inspector based his assessment on the information available from the GAP inspection sheets and the GAP meeting minutes. Graphite specialists from NGL and from NGL's independent nuclear assurance (INA) endorsed these documents. The inspector therefore considers that this information is suitable and sufficient to inform his judgements.

36. Bore measurements were taken from 10 of the fuel channels inspected. Thirty-six graphite specimens were trepanned from the core, which is in line with NGL's target before the periodic shutdown. Provided the remaining 10 fuel channels are complete before the return to service, the inspector considers that the level of graphite inspections carried out for this periodic shutdown is consistent with the maintenance schedule requirements.

37. All the defects observed in the fuel channels were sentenced as bore cracks by the GAP. Two of the channels inspected during previous campaigns were known to have defects. In addition, NGL reported the following newly observed cracks during the 2019 periodic shutdown:

- 1 doubly cracked brick (channel W25, layer 11);
- 3 fully axial cracks in a singly cracked brick (channel L29, layer 10; channel M35, layer 11; channel W25, layer 8);
- 1 fully circumferential crack (channel L19, layer 10).

38. NGL reported that a fully circumferential defect was found during the inspection of control rod (CR) channel Q22. Based on the ONR inspector's review of the inspection and original commissioning video for this channel, and examples of machining defects observed in other CR channels, the inspector is content that this defect is likely to be a machining defect. In addition, the inspector is content that this defect is unlikely to develop into a crack in service due to the low irradiation of CR channels.

39. The ONR inspector reported that the level of cracking observed in the fuel channels is consistent with the findings from previous inspections. The core distortion measurements were consistent with historical observations. Keyway root cracking is not expected at Hartlepool until approximately 2022 according to NGL's models. In the graphite inspector's opinion, the results from the graphite core inspections are within expectations and do not challenge the assumptions of the safety case.

40. ONR's graphite inspector carried out an inspection (Reference 37) during the outage. This was to evaluate NGL's arrangements for the graphite core inspections with respect to the ONR safety assessment principles. The inspector was content that NGL's arrangements were satisfactory.

41. Overall, the EC document makes the single claim that the results of the graphite core inspections at Hartlepool reactor 2 2019 periodic shutdown are acceptable and do not challenge safe operation. The inspector judged that this is a claim that has been adequately demonstrated. The inspector also noted that NGL's independent nuclear safety assessment is also in agreement (Reference 30).

42. A recommendation was raised that the ONR project inspector ensures that the outstanding work is satisfactorily completed prior to return to service which includes the following;

- The project inspector should ensure that EC363869 summarising the findings of the graphite inspections is presented to ONR as part of the return to

service, and has been through the Independent Nuclear Safety Assessment process.

- The project inspector will need to confirm [with the graphite specialist inspector] that the graphite inspections are complete and that the findings from these inspections do not challenge the safety case.

43. The ONR project inspector has confirmed the above has been satisfactorily completed, the documentation to support close out of this recommendation can be found in references 22 and 29.

44. In conclusion, the graphite integrity inspector has no objection to the subsequent project assessment report recommending that consent is given to return Hartlepool Reactor 2 back to service.

EMERGENT GRAPHITE SAFETY CASE ISSUE

45. Prior to restart of Hartlepool Reactor 2, EDF NGL was in the process of reviewing its extant graphite core safety case NP/SC 7570. During the review, NGL identified that low margins (slightly less than unity) were predicted against control-rod impedance for a few control rods during a 1 in 10,000 year seismic event. NGL informed ONR of the low margins and ONR declared this to be a restart issue that needed due consideration prior to the Hartlepool Reactor 2 restart.

46. NGL presented its justification for the restart of Reactor 2 in Reference 38 which has been assessed by ONR's graphite integrity inspector (Reference 39) and fault studies inspector (Reference 40). NGL's justification explains that because of the choice of graphite grades during core construction, the seismic performance of the intact core provides low margins to the unimpeded insertion of control rods positioned around the periphery of the core. However, the ONR fault studies inspector has reviewed and accepted NGL's argument that even if all 12 of the peripheral control rods failed to insert, an adequate shutdown margin has been demonstrated on a conservative deterministic basis for the upcoming fuel batch at Hartlepool Reactor 2.

47. The graphite integrity inspector considers this provides adequate additional mitigation of the low margins for control rod entry at the periphery of the core, and found NGL had demonstrated that control rod entry margins within the central region of the core are acceptable.

48. The graphite integrity inspector highlighted that it is important to recognise that Hartlepool Reactor 2 is pre-keyway root cracking, with the earliest onset predicted for 2022. The inspector noted that further work will be required to demonstrate that ageing of the Hartlepool and Heysham 1 cores, in terms of weight loss, dimensional change and the onset of keyway route cracking, do not further degrade the available margin to an unacceptable position. This will be closely monitored by ONR.

49. The graphite integrity inspector also noted that NGL needs to reconsider the current position of reactors at Hartlepool and Heysham 1 with respect to the ALARP principle. This should consider the implementation and timing of plant modifications which are needed to provide further mitigations of the potential consequences of a 1 in 10,000 year seismic event on the safety functions of the core. ONR will be writing to NGL on these matters in due course.

50. In conclusion, the graphite integrity inspector found NGL has adequately demonstrated that at the current time-in-life and pre-keyway root cracking, successful shutdown and hold-down of the Hartlepool Reactor 2 would be achieved following a 1 in 10,000 year seismic event, and from a graphite structural integrity perspective concludes that they have no objection to the restart of Hartlepool Reactor 2.

4.4 MECHANICAL ENGINEERING/QUALITY MANAGEMENT INTERVENTION

51. The ONR mechanical engineering and quality management inspectors carried out an LC 28 compliance inspection on 21st and 22nd of August 2019 (Reference 18). EMIT and the general standards of key nuclear significant maintenance facilities were sampled during the inspection, this included:

- Gas circulators
- Reactor gas safety relief valves
- Control rod drop times
- Standard of Nuclear Significant Maintenance Facilities during walk downs of maintenance facilities/areas
- Emerging Mechanical issues

52. EMIT arrangements and a number of written instructions used by NGL's operators were sampled and a plant walk down was conducted where the inspector observed a number of items, which had been, or were planned to be maintained. The inspector took the opportunity to discuss a number of activities with key staff and question their understanding of relevant arrangements and how these maintenance activities related to the safety case. The inspector judged that there are adequate arrangements in place for EMIT, and these arrangements are being implemented appropriately to meet relevant good practice.

53. The ONR inspector reviewed two ECs (365569 (Gas Circulator 2B1 Exchange Deferral) and EC 365574 (Change to PMS Routines for R1 and R2 Aux Gas Vortex Valves) to understand NGL's categorisation process.

54. The ONR inspector discussed the proposed deferral of one of the gas circulators with the Nuclear Safety Group Engineer. The EC was categorised as a category 3 proposal, however, it was the inspector's initial view that the EC should have been a category 2 proposal based on the nuclear safety significance.

55. The Nuclear Safety Group Engineer provided the inspector with a copy of the EC categorisation notes and stated that the categorisation process took into account the history of the gas circulator, the equipment reliability reviews and the safety case requirements associated with having two gas circulators available for post trip cooling. Following these discussions, the ONR inspector was content that the categorisation process had been applied correctly.

56. Following the ONR specialist inspector's interventions, the 2B1 maintenance and inspections were re-instated within the current outage scope, this was due to the inability to provide a timely justification to support the deferral.

57. In conclusion, the ONR mechanical and quality engineering inspectors was satisfied that LC28 arrangements were adequate for the areas sampled, and therefore support a request under License Condition 30 to return Hartlepool Reactor 2 to operation following its 2019 periodic shutdown.

4.5 ELECTRICAL ENGINEERING INTERVENTION

58. The ONR electrical engineering inspector carried out a pre-outage compliance inspection (Reference 19) on 18th June 2019, to take the opportunity to enhance ONR's understanding of the electrical engineering activities that would be undertaken during the periodic shutdown.

59. The ONR electrical engineering inspector conducted an LC 28 compliance inspection on 20th August 2019 (Reference 20) 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;

- Proposal to defer the replacement of Gas Circulator 2B1
- Unit 1 Generator Micro-governor and Unit Trip
- Plant inspection of the main electrical supplies system

60. The ONR inspector also conducted a plant walk-down of a sample of the station's electrical system and concluded that no matters of significant safety concerns were observed. The electrical systems walked down included;

- National Grid Switch Yard
- Unit 2 Generator Transformer
- Unit 2 415V Boiler Valves Switchboard Switch Room
- Generator 2 Protection Relay Cabinets
- Gas Turbine Buildings

61. Based on the inspection findings the ONR inspector considered that the targeted inspection confirmed that the planned EMIT and modification activities during this outage were appropriate, and that electrical plant and equipment was being maintained in accordance with the established arrangements.

62. The ONR electrical engineering inspector requested a follow up telecom (Reference 17) as the LC28 compliance inspection was carried out early in the outage programme, and further reassurance was required to ensure no emergent issues had been raised and the electrical work was progressing as per the PMS. The focus of this telecom was to;

- Understand progress with outage related activities
- Understand any findings of significance
- Understand any resultant solutions

63. The ONR electrical inspector was satisfied with, and assured by, the telephone discussion held in respect of the electrical aspects of the planned outage activities completed. There was no identified need for any further regulatory action.

64. In conclusion, the ONR electrical engineering inspector reported that there were no current issues identified from the electrical work activities which would prevent ONR granting consent for Hartlepool, Reactor 2 to return to service.

4.6 CONTROL AND INSTRUMENTATION INTERVENTION

65. The ONR control and instrumentation inspector carried out an LC 28 compliance inspection (Reference 23) on the 27th and 28th of August 2019, focussing on maintenance of the following systems;

- Reactor safety circuits, including:
  - Main guard lines
  - Diverse guard lines
  - Neutron flux detectors
  - Control rod control equipment
  - Reactor post trip logic system
  - Gas circulator instrumentation
  - Data processing computer system
  - Hot box dome instrumentation
- Boiler feed and water treatment systems, including:
  - Make-up water treatment plant

  - Condensate polishing plan
  - Chloride ingress protection
  - Pressure vessel cooling water system
- Control & Instrumentation (C&I) Related Plant modifications
- Recent ONR incident notification forms
- Electromagnetic interference and radio frequency interference safety case progress
- Cyber security arrangements

66. The inspector sampled a number of commitments made in the Outage Intentions Document (Reference 4) in relation to the C&I equipment important to nuclear safety, and was content that they had been adequately implemented.

67. During the inspection the ONR C&I inspector observed the maintenance and testing of a number of relays, noting that they appeared to have a clear understanding of the task and the importance of the work they were undertaking. The engineering staff had a good level of knowledge of the systems and equipment they were responsible for and the level of maintenance record keeping was adequate.

68. The ONR inspector raised a level 4 regulatory issue (7505) to track general plant improvements. The improvements related to lighting conditions, replacement of failed lighting and ensuring cubicle doors are secured closed etc., these improvements will be monitored through normal regulatory business, and do not pose a risk to nuclear safety, and do not require to be addressed prior to R2 returning to normal operating service.

69. In conclusion, on the basis of the C&I aspects of the Hartlepool R2 outage, and successful completion of the remaining EMIT activities, the ONR inspector recommends that support be given for a consent to allow Reactor 2 at Hartlepool to return to normal operating service.

4.7 INTERNAL HAZARDS INTERVENTION

70. The ONR internal hazards inspector carried out a compliance inspection on 29th August 2019 (Reference 27). The key areas sampled included;

- Reviewing the arrangements in place for identifying and minimising any nuclear safety impacts that may arise from internal hazards during outage activities.
- Sampled some of the key internal hazards that may arise during outage activities.
- Sampled the training provided to contractors to ensure internal hazards are effectively managed.
- Inspected modifications made to the cable fire segregation arrangements in the reactor basement.

71. Based on the discussions, explanations and the sample inspected, the ONR inspector was satisfied that there had been improvements in hazard management in recent outages, and no significant shortfalls were identified with the internal hazards management arrangements in relation to the planned outage activities.

72. The ONR inspector noted the improvements for additional cable fire segregation appeared to be adequately carried out, and a sufficient length of cable had been protected. From the manufacturer's information, it is likely that the particular application of coating will have a service life in excess of that for the station.

73. The ONR internal hazards inspectors sampled the improved hazard awareness training and associated hazard awareness booklet, and judge that this will further benefit and enhance both EDF and contract staffs awareness of the risks from internal hazards. This improved training will be monitored through ONR's continuing interaction with NGL central technical organisation and its continued role out across the EDF fleet.

74. The ONR internal hazards inspector identified no significant issues with the internal hazards arrangements, therefore no shortfalls were raised against relevant Licence Conditions.

4.8 CONVENTIONAL SAFETY INTERVENTION

75. The ONR conventional health and safety inspector conducted a two part compliance inspection (Reference 26) against the Health & Safety at Work etc. Act 1974 on the 22 to 24 May and 14 to 16 August 2019 focusing on;

- Gaining regulatory confidence in the management of conventional health and safety hazards at Hartlepool, with a focus on work at height issues.
- Interviewing a range of staff and contractors conducting, arranging, managing and overseeing work at height.
- Inspecting the management of work at height activities during the statutory outage and testing the perception of risk management gained from the staff interviews.

76. A plant walk-down was undertaken to sample outage activities. These areas included;

- Reactor Containment Area
- Turbine Hall
- Cooling Water Pump House
- The Auxiliary Boiler Stack
- Generator Transformer 2
- Contractor Areas
- Roadways around site

77. During the first inspection on 22-24 May 2019, ONR inspectors reported that they had found a number of themes relating to workplace transport and guarding that would be followed up on during the subsequent inspection planned for the 14 to 16 August 2019. Following a number of interviews, NGL had provided ONR with the impression of a positive safety culture on site, particularly regarding the management of work at height risks and gave inspectors some useful areas to test at the next visit to site.

78. During the second inspection which took place on 14-16 August 2019 – Some examples of good standards were observed during the visit, however there are a number of areas where significant issues were found and improvements are required. These were summarised during feedback at the conclusion of the inspection to the station director and the industrial safety team.

79. During the inspection, ONR inspectors observed several examples of potential breaches relating to working at height, workplace (health, safety and welfare) and work equipment regulations. NGL industrial safety engineers addressed all of the issues at source. ONR did however request that NGL take action to improve the monitoring of these issues, review any similar areas which may need enhancing and implement any further improvements.

80. The inspector raised one level 3 regulatory issue (7499, related to machinery guarding) and two further level 4 regulatory issues (related to work at height and workplace transport) will be raised in order to monitor the required improvements. This has been

communicated to the industrial safety engineers and technical and safety support manager at Hartlepool, confirming the actions required and establishing timescales.

81. In conclusion, although some areas for improvement were identified, the ONR conventional health and safety inspector identified no issues that would prevent ONR granting consent for Hartlepool, Reactor 2 to return to service.

4.9 FIRE SAFETY INTERVENTION

82. The ONR fire safety and internal hazards inspectors jointly carried out a compliance inspection against regulatory reform (Fire Safety) Order 2005 on 29 August 2019 (Reference 25).

83. Based on the sample inspected, the ONR inspector reported that the fire safety arrangements were found to comply with legal requirements and the inspector was of the opinion that the required standard was met, with no shortfalls in regulatory compliance during the inspection and the response of the site management team was positive throughout.

4.10 ONR SITE INSPECTOR'S OVERVIEW OF OUTAGE ACTIVITIES

84. The ONR site and project inspectors carried out a number of routine outage meetings during the months of February and August 2019 (Reference 3 and 33). An LC 26 compliance inspection was also conducted in September 2019 (Reference 34).

85. During the outage intentions meeting, NGL informed ONR that the key outage focus themes were being considered, and included industrial safety, quality and foreign material exclusion. These themes were sampled during ONR's inspections through observations of meetings and discussions with station personnel. ONR were content that the key focus areas had been adequately embedded.

86. During the outage intentions meeting, ONR were informed that a 10% challenge to reduce the scope of the Hartlepool outage had been requested by NGL's Chief Technical Officer. ONR were informed that this review had the potential to include deferral of some PMS activities. ONR advised that any such changes to the outage intentions would require an adequate justification, and ONR may call the justifications in for assessment.

87. Subsequently, the licensee proposed the conditional removal of the 2B1 gas circulator inspections and maintenance from the Outage Intentions Document. However, following challenge from ONR, these proposals were subsequently withdrawn and the inspections and maintenance re-instated due to the inability to provide a timely 'ALARP' justification.

88. The ONR Outage project inspectors observed the Hartlepool R2 early outage review (EOR). The EOR was led by station INA and the focus was to identify any performance shortfalls in the early stages of the outage. This enabled the station's management to reduce or eliminate undesirable behaviours and conditions that could have an adverse impact on the outage performance.

89. Five "Findings" were identified relating to working at height, workplace standards, implementation of NGL standards and expectations, access to plant emergency equipment and some issues relating to work execution.

90. The outage management team accepted the findings following the EOR and committed to making further improvements during the remainder of the outage. The findings were also communicated during feed back to the Hartlepool lead team. The significant issues were followed up immediately including an event where a contractor

was found working on the outside of scaffolding without any fall protection. This event is now the subject of a full NGL investigation and the ONR site inspector will follow up as part of routine site activities.

91. The ONR site and project inspectors undertook an LC 26 – control and supervision compliance inspection where a selection of outage activities were sampled, observing a number of planning meetings and tasks being undertaken. The safety focus themes were discussed (Safety, Human Performance, Foreign Material Exclusion and Quality) at the meetings ONR attended to varying levels. Discussion points were relevant to the level of meetings attended. The meetings were well attended and nuclear safety was considered.

92. ONR were informed that the "Dynamic Learning Activity" training was conducted prior to the commencement of the Hartlepool statutory outage. The training included control of work, foreign material exclusion and hazard/risk perception. ONR asked a sample of staff and contractors to clarify what this training entailed and what the key messages were. Following the discussions ONR were content that the training for both NGL staff and contractors had been effective.

93. The ONR inspectors sampled a number of planned outage activities including;

- Drum screen (chamber 4) ladder and platform replacement
- 415v no break 2A and 2C board electrical maintenance/refurbishment
- 2B Safety Valve bellows replacement
- Overhaul and replacement of WF53 and 53Y valves
- TG2 2A liquid ring pump electrical disconnection

94. ONR were content that supervisors and workers were clear on who their immediate line managers and supervisors were, and the reporting lines should any issues occur during the activities being undertaken. ONR were informed that for technical issues, the outage teams could also consult with Senior Authorised Persons, responsible engineers or island leads for resolutions. ONR were content that roles and reporting lines were clearly embedded.

95. ONR reviewed a number of work packs relating to the activities and were content that the documentation was appropriate for the tasks being undertaken, the supervisors and workers were able to talk through the relevant phases of the work activities.

96. A number of observations were made during the inspection relating to the quality and incompleteness of contractor risk assessments, method statements, quality plans and inspection test plans, all of which had been subject to NGL review process.

97. ONR raised these issues during the inspection close out meeting with senior management, highlighting that the observations support previous, non-outage related inspection findings. ONR informed NGL that this issue had been identified by NGL's industrial safety team at a corporate level, and a subsequent improvement plan was being drafted to deal with this issue.

98. The observations made by ONR's site and outage project inspector are recorded in references 33 and 34. Neither inspector identified any issues which would prevent the re-start of Hartlepool Reactor 2 following the 2019 statutory outage.

4.11 ENGAGEMENT WITH OTHER GOVERNMENTAL AGENCIES

99. ONR have engaged with the Environment Agency who has confirmed (Reference 28) that they are not aware of any environmental issues that should prevent the start-up of Hartlepool Reactor 2 following the 2019 statutory outage.

5 CONCLUSIONS

100. NGL's request to ONR for consent to start-up Hartlepool Reactor 2 following periodic shutdown in compliance with LC 30(1) has been supported by their letter (Reference 1) stating that all plant maintenance schedule requirements and modifications identified in the Reactor 2 outage intentions document (Reference 4) have been met. This excludes testing of the equipment that 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 Hartlepool Reactor 2 APEX report (Reference 14) following completion of civil inspection and maintenance of 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 inspector supports ONR issuing consent for Reactor 2 start-up.

102. NGL's return to service safety justification for Reactor 2, set out in EC366205 and EC364139 covering graphite and steel components respectively (Reference 29 and 31) confirmed no safety issues have been identified from EMIT activity to challenge safety case claims preventing Reactor 2 start-up or its safe operation until its next periodic shutdown planned in 2022. NGL support this claim with statements from their independent third party PSSR Competent Person 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 2 shutdown, who agreed that the claims and arguments presented are in line with their views from intervention findings and assessment. The ONR inspectors support ONR issuing consent for Reactor 2 start-up.

103. Prior to restart of Hartlepool Reactor 2, NGL reviewed the extant graphite core safety case NP/SC 7570. During the review, NGL identified that low margins were predicted for control-rod impedance for a few control rods in the core periphery in a 1 in 10,000 year seismic event. NGL informed ONR of the low margins and ONR declared this to be a restart issue that needed due consideration prior to the Hartlepool Reactor 2 restart.

104. ONR received further information to support the graphite safety case (Reference 38) from NGL and following the assessment of this information (Reference 39), ONR were content that the graphite safety case issues had been resolved and would not prevent re-start of the Hartlepool Reactor 2 following its statutory outage.

105. Hartlepool INA has provided a statement (Reference 35) that based on their Reactor 2 shutdown concurrence activities to date, no issues have been identified that would challenge their support for start-up of Reactor 2.

106. Based on evidence gathered from ONR's intervention and assessment activities for the Hartlepool R2 shutdown, together with claims, arguments and evidence presented by NGL in its request for start-up of Reactor 2, it is my judgement that Hartlepool power station has complied with its LC30(1) requirements for Reactor 2. This is based on NGL carrying out required EMIT 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 appropriately supervised. Where EMIT findings were anomalous with safety case

requirements, NGL has provided adequate safety justification that relevant safety case limits and conditions are not challenged.

107. In conclusion, ONR have not identified any matters of concern that would prevent ONR granting consent for Hartlepool Reactor 2 to start-up following its periodic shutdown.

6 RECOMMENDATIONS

108. I recommend, that in response to the request by NGL, ONR issue Licence Instrument 569 granting consent under LC30(3) of Nuclear Site Licence 59 to start-up Hartlepool Reactor 2 following the 2019 Periodic Shutdown.

7 REFERENCES

1. NGL Letter NSL/HRA/51190 (R) – Request for Consent to Start up Reactor 2 Following its Periodic Shutdown under Site Licence Condition 30 (2019/297933).

2. Licence Instrument No. 6 for Nuclear Site Licence No. 59 Hartlepool issued 28 March 1996, Unique Document No HRA 70609, (2016/313986).

3. ONR Intervention Record ONR-OFD-IR-18-214, Outage Intentions meeting Issued 15 March (2019/76498).

4. Outage Intentions Document for Unit 2 R212 Statutory Outage, NGL document Ref HAR/MO/R/020/233 Issue 0 (2019/5545).

5. HRA/T/NS/144 – Independent Shutdown Safety Review of the outage R2 2019 station outage

6. BEG/SPEC/OPS/007 REV 7 Outage Safety Arrangements.

7. BEG/SPEC/OPS/008 REV 9 Model Quality Assurance Arrangements.

8. BEG/ICP/OPS/009 REV 10 Outage Management Process.

9. ONR Contact Record Hartlepool R2 start-up meeting ONR-OFD-CR-19-480 (2019/284430).

10. NGL Hartlepool Start up Meeting presentation (2019/284490).

11. ONR Hartlepool R2 2019 outage Periodic Shutdown Plan (2019/102313)

12. ONR Civil Engineering Intervention Record ONR-OFD-IR-19-061 (2019/246130).

13. ONR Civil Engineering Assessment Report ONR-OFD-AR-19-045 (2019/279350).

14. Statutory Examination of the Pre-stressed Concrete Pressure Vessel of Reactor 2 – 2019. (APEX report) E/REP/BNCB/0599/HAR/19, dated 25 September 2019 CM 2019/292043

15. ONR Structural Integrity Intervention Record ONR-OFD-IR-19-055 (2019/273315).

16. ONR Structural Integrity Assessment Report ONR-OFD-AR-19-058 (2019/279491).

17. ONR Electrical Engineering follow up Contact Record ONR- OFD-CR-19-467 (2019/275656).

18. ONR Mechanical Engineering Intervention Record ONR- OFD-IR-19-070 (2019/257293).

19. ONR Electrical Engineering Pre-outage Inspection ONR-OFD-CR-19-210 (2019/193219).

20. ONR Electrical Engineering Intervention Record ONR-OFD-IR-19-064 (2019/248830).

21. Reference 21 unused

22. ONR Graphite Inspectors recommendation close out email (2019/296211)

23. ONR Control and Instrumentation Intervention Record ONR-OFD-IR-19-077 (2019/267307).

24. ONR Graphite Assessment Report ONR- OFD-HRA-AR-19-055 (2019/273315).

25. ONR Fire Safety Inspection Intervention Record ONR-OFD-IR-19-069 (2019/253689).

26. ONR Conventional Health and Safety ONR-OFD-IR-19-058 (2019/257311).

27. ONR Internal Hazards ONR-OFD-IR-19-066 (2019/270263).

28. Email from Environment Agency - Statement to Support the Return to Service of Reactor 2 at Hartlepool following its Statutory Outage. (2019/286678).

29. NGL Hartlepool 2019 Return to Service Safety Justification for R2 from review of graphite core inspections EC 366205 (2019/295908)

30. NGL Independent Nuclear Safety Assessment approval statement Graphite integrity (CM9 2019/297936)

31. NGL HARTLEPOOL 2019 Return to Service Safety Justification for R2 from review of reactor core steel components EC 364139 (2019/297936)

32. Hartlepool INA statement Structural Integrity Steel (2019/297936)

33. ONR-OFD-CR-19-419, Hartlepool Early Outage Review meeting (2019/255080)

34. ONR-OFD-IR-19-419, Hartlepool (R2) LC26 Compliance Inspection (2019/272900)

35. NGL independent Nuclear Safety Assessment in support of start up of reactor 2 following 2019 periodic shut down (2019/297936)

36. ONR Civil Engineering recommendation close out email 2019/0291530

37. ONR-OFD-IR-19-063, Hartlepool Reactor 2 Graphite Core Inspection (2019/253499)

38. NGL Letter GEN32703R Hartlepool / Heysham 1 Graphite Core Safety Cases - Return to Service of Hartlepool R2 and Continued Operation of Hartlepool R1 and Heysham 1 R1 & R2 (2019/315988)

39. HRA R2 2019 Return-to-Service: Graphite Structural Integrity Assessment of EDF energy NGL Letter GEN32703R (2019/317464)

40. Fault Studies Assessment Note Rev1 - HRA R2 RTS Graphite Case Reactor Physics Mitigation - R Le Grove (2019/316104)