



PROJECT ASSESSMENT REPORT			
Unique Document ID and Revision No:	ONR-HYA-PAR-15-006 Revision A	TRIM Ref:	2015/249218
Project:	Heysham 1 Reactor 2 periodic shutdown 2015		
Site:	Heysham 1		
Title:	Consent to re-start Reactor 2 following periodic shutdown		
Licence Instrument No: (if applicable)	590		
Nuclear Site Licence No:	60		
Licence Condition:	30(3)		

Document Acceptance and Approval for Issue / Publication

Role	Name	Position	Signature	Date
Author	[Redacted]	Principal Inspector		07 Aug 2015
Reviewer	[Redacted]	Principal Inspector		07 Aug 2015
Accepted by ¹	[Redacted]	Superintending Inspector		10 Aug 2015
Approval for publication ²	[Redacted]	Superintending Inspector		10 Aug 2015

Revision History

Revision	Date	Author(s)	Reviewed By	Accepted By	Description of Change
A	06 Aug 2015	[Redacted]	[Redacted]	n/a	Revision A submitted for review and comments
B	07 Aug 2015			n/a	Incorporates comments of reviewers
0	10 Aug 2015				First accepted issue

¹ Acceptance of the PAR to allow release of LI

² Approval is for publication on ONR web-site, after redaction where relevant

Circulation (latest issue)

Organisation	Name	Date
Office for Nuclear Regulation	<p>[Redacted] CNRP Deputy Chief Inspector [Redacted] CNRP Operating Reactors Delivery Manager [Redacted] Heysham 1 Site Inspector [Redacted] [Redacted] Civil Engineering Inspector [Redacted] Structural Integrity Inspector [Redacted] Mechanical Engineering Inspector [Redacted] Electrical Engineering Inspector [Redacted] Control and Instrumentation Inspector [Redacted] Graphite Inspector [Redacted] Radiation Protection Inspector [Redacted] Fire Safety Inspector</p> <p>TRIM Folders Project Assessment Report Folder 4.4.1.2605. Case File Folder 4.4.2.14956.</p>	
Environment Agency	[Redacted] Site Inspector	
Licensee	[Redacted] Heysham 1 Station Director	

Heysham 1 – Reactor 2 – 2015 statutory outage

Assessment of the Heysham 1 Reactor 2 2015 periodic shutdown

Project Assessment Report ONR-HYA-PAR-15-006
Revision 0
10 August 2015

© Office for Nuclear Regulation, 2015

If you wish to reuse this information visit www.onr.org.uk/copyright for details.

For published documents, the electronic copy on the ONR website remains the most current publicly available version and copying or printing renders this document uncontrolled.

EXECUTIVE SUMMARY

Title

EDF Energy Nuclear Generation Limited (NGL) – Heysham 1 Power Station – Assessment of the Heysham 1 Reactor 2 2015 periodic shutdown.

Permission Requested

)The licensee NGL has requested that the Office for Nuclear Regulation (ONR) grants consent under Licence Condition (LC) 30(3) to start-up Reactor 2 following completion of the 2015 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 and operate, until the next periodic shutdown.

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, Maintenance Inspection and Testing (EMIT).

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) Licence Instrument No 10, dated 25 March 1996. As such, NGL is required to seek ONR's consent before restarting Heysham 1 Reactor 2.

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

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

- requirements set out in the station's maintenance schedule have been complied with;
- work has been carried out in accordance with arrangements for identified structures, systems and components 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 enable ONR to make a regulatory judgement that re-start of power generation is safe and will remain in this state until the next outage.
- Although NGL has introduced cooling modifications to the boiler spines of Reactor 2 during this outage, this is outside the scope of this assessment report which has focused upon the adequacy of the work carried out during the statutory outage. The cooling modifications have been subject to a separate assessment by ONR and are reported elsewhere. This forms a key enabler to underpin the recommendations given to support the return to service of Reactor 2.

ONR has assessed NGL documentation produced from the outage of EMIT of those structures, systems and components important to nuclear safety. Site inspections were conducted to confirm that 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 1 Reactor 2 and safe operations until the next outage. A number of observations were made by ONR

Inspectors during the outage that have been recorded within inspection records and reported to NGL. These will be followed up through routine business.

Conclusions

It has been concluded from ONR assessment and inspection activities during the Heysham 1 Reactor 2 outage that NGL has carried out EMIT in accordance with requirements set out in its maintenance schedule. Work was conducted to the required quality standards and by competent personnel. No issues were identified by NGL or ONR that would prevent re-start of Heysham 1 Reactor 2 and its safe operation until its next outage.

ONR's assessment of the boiler spine cooling modifications has been completed and Licence Instrument No.589 was issued on 7 August 2015 agreeing to the operation of Reactor 2 with the cooling modifications fitted within defined power limits.

Recommendation

It is recommended that ONR issue a Licence Instrument giving consent to NGL's request to re-start Heysham 1 Reactor 2.

LIST OF ABBREVIATIONS

APEX	Appointed Examiner
ACR	Adverse Condition Report
AR	Assessment Report
DPS	Data Processing System
EMIT	Examination, Maintenance Inspection and Testing
MS	Maintenance Schedule
ONR	Office for Nuclear Regulation
PCPV	Pre-stressed Concrete Pressure Vessels
SEQP	Suitably Qualified and Experience Persons
SSD	Solid State Disks
SUS	Start-Up Statement

TABLE OF CONTENTS

1	PERMISSION REQUESTED.....	8
2	BACKGROUND	8
3	ASSESSMENT AND INSPECTION WORK CARRIED OUT BY ONR IN CONSIDERATION OF THIS REQUEST	9
4	MATTERS ARISING FROM ONR'S ASSESSMENT AND INSPECTION WORK	10
4.1	Civil Engineering	10
4.2	Structural Integrity	11
4.3	Mechanical Engineering	12
4.4	Electrical Engineering.....	13
4.5	Control and Instrumentation	14
4.6	Graphite	15
4.7	Ionising Radiation Regulations (IRR 1999) Inspection.....	15
4.8	Fire Safety Inspection.....	15
4.9	Conventional Safety	16
4.10	Security	16
4.11	ONR Site Inspector's Overview of Outage Activities.....	16
4.12	Engagement with other Governmental Agencies.....	19
5	CONCLUSIONS.....	19
6	RECOMMENDATIONS	19
7	REFERENCES.....	20

1 PERMISSION REQUESTED

1. This Office for Nuclear Regulation (ONR) Project Assessment Report (PAR) has been produced to record ONR's justification for issuing a Licence Instrument (LI) giving Consent to EdF Energy Nuclear Generation Limited (NGL) to allow Heysham 1 Reactor 2 (R2) to re-start power generation after its periodic outage as required under Nuclear Site Licence Condition (LC) 30(3): Periodic Shutdown.

2 BACKGROUND

2. NGL has requested ONR's Consent to re-start Heysham 1 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 (MS) as referred to in LC 28: Examination, Inspection Maintenance and Testing (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 plant Maintenance Schedule (MS). The MS draws together requirements from a range of sources, including the facility's Nuclear Safety Cases, regulatory requirements through Pressure Systems Safety Regulations (PSSR 2000), Lifting Operations and Lifting Equipment Regulations (LOLER 1998) and equipment manufacturers guidance. This approach demonstrates how Structures, Systems and Components (SSCs) important to nuclear safety are actively managed and how safety claims placed on SSCs are satisfied given their range of potential demands faced through damage and degradation mechanisms (including creep, corrosion, erosion, radiation damage and fatigue).
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 10, dated 25 March 1996, Unique Document No HYA 70566N (Reference 2) for Nuclear Site Licence 60, that NGL shall seek ONR's Consent to start up a reactor at the Heysham 1 Power Station following a shutdown of the reactor for the purposes of Condition 30(1).
6. Heysham 1 Nuclear Power Station is an Advanced Gas-cooled Reactor (AGR) comprising of 2 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 Nuclear Safety Case and MS requirements. Outages are staggered between the two reactors by an 18 month interval given operational and resource requirements.
7. NGL's preparation for Heysham 1 R2 outage started in late 2013 with formal engagement with ONR in November 2014 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 MS requirements as well as identifying other work to be carried out in support of safety. The document also identified Heysham 1'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).
 - As part of the Outage Intentions meeting NGL also outlined its intention to carry out cooling modifications to all 8 Boiler Spines in R2, which would involve installing thermal heat shields around weld 12.3 of each Boiler Spine. The installation of cooling modifications to the boiler spines of Reactor 2 during this outage is outside the scope of this assessment report which focuses upon the adequacy of the work carried out during the statutory outage. The cooling

modifications has been subject to a separate assessment by ONR and is reported elsewhere (Reference 9) and forms a key enabler to underpin the recommendations given to support the return to service of Reactor 2.

8. It was anticipated at the OIM that the work to install the cooling modifications would result in the outage being extended beyond its normal 65 day period by a further 31 days. ONR stated that return to service of the R2 Boilers would require NGL to seek ONR's Agreement under LC 22(1): Modification or Experiments on Existing Plant.
9. The safety justification for return to service at reduced power with Boiler Spine cooling modifications installed for Heysham 1 R2 is presented in NGL Category 1 safety justification NP/SC 7733, Engineering Change EC 355558 (Reference 10). ONR stated that Consent to re-start power generation for Heysham 1 R2 would not be granted until Agreement under LC 22(1) for return to service of the R2 Boilers had been issued. This was addressed through ONR PAR, ONR-HYA-PAR-15-004 titled Heysham 1 Power Station Reactor 2 Return to Service at Reduced Power with Spine Cooling Modifications Installed (NP/SC 7733) (Reference 9) which supported the issuing of ONR LI589 giving ONR's Agreement (Reference 11).
10. The Heysham 1 R2 outage commenced on 13 April 2015. At the Outage Start-up meeting 12 June 2015 (Reference 12) NGL presented findings from the R2 Outage Reference 13). NGL had not identified any issues preventing re-start of R2 and no serious injuries or events had occurred during the outage period. A number of minor issues in relation to nuclear safety were identified and these are discussed in the ONR Matters Arising section of this report. A few conventional safety events did occur during the outage which NGL recorded and responded to with event investigation to identify learning from the incidents and prevent further occurrences.

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

11. The purpose for ONR inspection and assessment activities during a power reactor outage is to establish that:
 - requirements set out in the Station's MS have been complied with;
 - work has been carried out in accordance with arrangements for identified SSC and conducted to required quality;
 - 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 re-start of power generation is safe and will remain in this state until the next outage.
12. Given ONR's aim to provide efficient and effective regulation of the nuclear industry, holding it to account on behalf of the public, the primary focus in carrying out assessment and inspection activities during the Heysham 1 R2 outage was to generate a body of evidence to confirm nuclear safety requirements have been suitably addressed. Prior to the commencement of the outage the ONR outage assessment team reviewed (Reference 4) together with considering operational experience gained from ONR AGR outages and reports from NGL's event recording system. This informed the different technical disciplines to produce Outage Inspection Programmes (Reference 14) with the following inspections carried out during the Heysham 1 R2 outage:
 - Civil Engineering
 - Structural Integrity
 - Mechanical Engineering
 - Electrical Engineering
 - Control and Instrumentation
 - Graphite

13. These inspections were undertaken in line with ONR internal guidance drawing on information set out in ONR Technical Inspection Guide for LC 28.
14. ONR compliance inspections against Ionising Radiation Regulations (IRR 1999), Regulatory Reform (Fire Safety) Order 2005 and security requirements during the outage and for R2 Start-up were also undertaken.
15. The ONR Site Inspector took on an overview role during the outage including maintaining oversight of the work undertaken by ONR specialist assessors etc. monitoring events; and providing regulatory input as necessary.

4 MATTERS ARISING FROM ONR'S ASSESSMENT AND INSPECTION WORK

16. The following provides summaries of the ONR Specialist Inspectors' inspection and assessment findings for each of the technical discipline areas evaluated during the Heysham 1 R2 outage. These provide the information and evidence to build ONR's considerations and views in evaluating the case to allow Heysham 1 R2 to be re-started and safely operate for a further 3 years, until its next statutory outage in 2018.

4.1 Civil Engineering

17. The ONR Civil Engineering Inspector attended the Outage Intentions meeting (Reference 3) and raised the following issues:
 - Slow implementation of document changes to Heysham 1's MS from amendments resulting from Category 1 safety justification NP/SC 7676 Pre-stressed Concrete Pressure Vessels (PCPV) Extended Operational Life. The impact of this administrative issue is that the licensee has carried out the requirements of NP/SC 7676; however, it was judged that these did not align with current MS requirements. As such, Heysham 1 was unable to state that it has complied with MS requirements.
 - NGL's had omitted to include its 2012 commitment to carry out inspection of the R2 PCPV inner wall bearing pad from its Outage requirements.
18. The Inspector met with the NGL Heysham 1 outage Appointed Examiner (APEX) on 25 March 2015 (Reference 15) to review surveillances, examinations and inspection activities and findings for the PCPV.
19. The ONR Civil Engineering Inspector's assessment of NGL's outage findings for the PCPV is presented in (Reference 16) which draws on information provided in APEX's Start-Up Statement (SUS).
20. ONR's Civil assessment targeted the following PCPV features and components:
 - PCPV Stressing Tendon Examinations
 - Concrete Vessel Surface Examinations
 - Concrete Vessel Bearing Pads Examinations
 - Concrete Vessel Foundation Tilt and Settlement Surveys
 - Concrete Vessel Vibrating Wire Strain Gauges (VWSG) Monitoring
 - Concrete Vessel and Liner Temperature Monitoring
 - PCPV Top Cap Deflection Surveys
 - Reactor Vessel Coolant Leakage Summaries
 - Pressure Vessel Cooling Water System
 - Boiler Closure Unit
21. The Inspector's view was that NGL had complied with the civil engineering requirements set out in the Heysham 1 MS for R2 PCPV. In reviewing the SUS the Inspector considered that the conclusions NGL had drawn from its inspection findings were acceptable. Stressing tendons for both vertical and circumferential orientations were identified as providing the correct compressive loads. Visual inspection of tendons removed from the PCPV and the anchors did not show any significant signs of corrosion. The metallurgical inspections and the tensile tests results were not available

at the time the ONR assessment report was completed. The Inspector noted that minor defects had been reported and, in the case of shroud anchorage points, these had been repaired.

22. In evaluating NGL's findings from inspection of concrete PCPV structure, stability and foundation settlement / tilt, the Inspector was satisfied with NGL's findings and that they met the acceptable limits allowed by its safety case. The Inspector raised concerns over the maintenance of Vibration Wire Strain Gauges (VWSG) used to monitor vessel behaviour during pressurisation and operation. The issue was the declining level of coverage provided by these instruments due to gauge failure. NGL reported that they intend to address this issue by increasing maintenance focus.
23. The Inspector raised concerns over NGL's approach to resolving PCPV Cooling Water leaks, which is a major cause of tendon corrosion. At the start of the R2 outage, NGL had reported three leaks in cooling circuit A and one in cooling circuit B. A safety case limit of no more than four leaks per cooling circuit has been set by NGL. Therefore it was the Inspector's view that this safety margin had been met and should therefore work should be undertaken to rectify this position. NGL subsequently reported that sealing of all leaks on circuits A and B had been completed
24. NGL had not completed inspection of the R2 Boiler Closure Units (BCUs) when the SUS was issued. However, the Inspector considered the findings presented at the time were reasonable; in that the BCUs were in good condition although there were anomalies in thermocouple trending. The Inspector has requested that the APEX reviews and provides clarification on identified thermocouple trending anomalies. This is being followed up as part of normal business and is not considered to be of sufficient concern to prevent ONR granting consent to start up R2.
25. At the Heysham 1 R2 Start-up Meeting the NGL APEX was asked to confirm resolution of the 2012 commitment to inspect inner wall bearing pads. The APEX stated that this was not a MS requirement and was related to the station's plant life extension. Inspection of the outer wall bearing pad has been conducted and no significant issues were found. The APEX reported that NGL were reviewing their position on this requirement, given the safety risks involved in carrying out this work and the benefits it would provide given inspection findings from the outer wall bearing pads. The ONR Outage Project Inspector is monitoring the outcome of this review and has stated that if NGL did not carry out identified inspection work then an As Low As Reasonably Practicable (ALARP) argument would be needed to justify not undertaking this work. Completion of this review is not required to support the ONR decision on granting consent to restart R2.
26. The Inspector has been informed by NGL (Reference 17) that it has updated the Heysham 1 Station MS to reflect the requirements of safety justification NP/SC 7676 and the Written Scheme of Examination.
27. In conclusion, although a number of issues have been raised, the ONR Civil Engineering Inspector judged that the PCPV and its components comply with relevant design code and that it is safe to allow the Heysham 1 R2 reactor to be returned back to power generation for a further 3 years operation. Identified issues will be addressed through routine ONR business.

4.2 Structural Integrity

28. An ONR Structural Integrity team inspection for the Heysham 1 R2 outage was carried out 20-21 May 2015 (Reference 18). The Lead Inspector also visited Site on 8 June 2015 (Reference 19) to close out issues identified from the inspection. Findings from ONR Structural Integrity Assessment Report (AR) are presented in (Reference 20).

29. The ONR Lead Structural Integrity Inspector is of the opinion that there are no structural integrity issues to prevent Heysham 1 R2 re-starting and operating safely for the next 3 years.
30. ONR's structural integrity inspection focused on:
 - Reactor Pressure Components
 - Reactor Internal Inspections
 - Flow Assisted Corrosion
 - Seawater Cooling System
 - Pipe Hanger Integrity
31. The ONR Lead Structural Integrity Inspector reviewed the NGL Outage Assessment Panel (OAP) minutes which recorded specialist views and opinions together with sentencing decisions. It was the Inspector's view that NGL had demonstrated balanced decision making based on inspection findings, reference to company standards and appropriate technical codes requirements. The Inspector also sampled video footage of reactor internal inspections and reviewed inspection procedures. Based on this evidence the Inspector judged that NGL had followed their due process.
32. The ONR Inspector considered that NGL's approach to the sentencing of wall thickness measurements for the west dished end of the R2 De-Aerator Vessel was acceptable. Although one of the measurements fell below the minimum acceptable wall thickness value, The NGL company expert and Pressure Systems Safety Regulations (PSSR) Competent Person reviewed all the measurements and judged that the vessel could remain in service. This was supported by a safety argument which was reviewed by the OAP panel and considered reasonable.
33. In the case of NGL's sentencing of defects detected using automated Ultrasonic Testing (UT) in Superheater Tube Plate Upper Radii for R2, the ONR Inspector was satisfied that the defects had been appropriately sentenced. NGL demonstrated that the increased defect size (including the maximum probe detection uncertainty) was still within allowable safety margins. This view is provided by NGL's Structural Analysis Group in their review of results and peer review by OAP. NGL has given a commitment to carry out additional inspections after approximately 18 months operation (dependant on boiler/reactor trip frequency) to confirm the sentencing decision.
34. In the case of reactor metal internals, the ONR Inspector reviewed inspection documentation to confirm findings and sentenced decisions based on guide-sheets requirements was appropriate. No issues were identified, although one non-conformity was raised following the identification of a bolt on the floor of R2 cover plate. The ONR Inspector was satisfied with NGL's sentencing of this finding and its decision to leave the bolt in position, given that it was considered to pose no threat to safety.
35. A sample of inspection documentation examining the impact of Flow Assisted Corrosion (FAC) on the steam and feed system components was reviewed by the ONR Inspector. The Inspector concluded that NGL had adopted an appropriate strategy in the management of FAC. Inspection findings showed FAC was present and, in some cases, was being addressed through replacement or local repair by the application of new material through weld buttering.
36. No issues were identified from Seawater Cooling System or Pipe Hanger Integrity inspections. The ONR Inspector confirmed that inspection and maintenance requirements identified in the MS had been undertaken and raised no issues that would prevent R2 from re-starting or operating safely for the next 3 years.

4.3 Mechanical Engineering

37. The ONR Mechanical Engineering Inspector carried out a pre-outage compliance inspection against LC28 12 March 2015 (Reference 21) in support of the Heysham 1

R2 outage. This inspection assessed NGL's preparation for undertaking outage work focussing on the following nuclear safety systems:

- Gas Circulators (GC)
 - Safety Significant Valves (SSVs)
 - Control Rod Assemblies (CRA)
38. The Inspector's findings and views are recorded in ONR assessment report (Reference 22). In summary, the Inspector reviewed the operational and maintenance history of GC to be installed during the R2 outage and judged that the maintenance procedures and standards were appropriate. An issue over cleanliness and Foreign Material Exclusion (FME) within GC workshop was raised and the Inspector has requested that Station carry out a self-assessment of the GC workshop against NGL corporate standard BEG/SPEC/MNT/003 and report their findings to him. This is being pursued as part of normal business and is not considered to impact on the decision to grant consent to restart R2 after its statutory outage.
39. In the case of SSVs the Inspector looked at EMIT arrangements for Gas Safety Relief Valves (GSRV) fitted to the reactor PCPV and Hot Gas Release Valves (HGRV) for auxiliary gas plant. The Inspector judged the maintenance and inspection arrangements to be adequate, although he considered improvements could be made in record keeping and monitoring of external and internal operational experience on SSVs.
40. The Inspector reported that CRA maintenance and testing arrangements were adequate with CRA appropriately managed and controlled during refurbishment. It was considered that improvements in quality plan assurance could be made by incorporating additional quality checks for tasks containing a large number of sub-activities. The example given was a task which contained 50 sub-tasks where the quality plan did not identify quality hold points in the sub-task activities. The issue of FME was again identified as an issue within the CRA maintenance facility. These issues are being addressed by Station.
41. In conclusion, the ONR Mechanical Engineering Inspector reported that there were no safety issues to prevent the Heysham 1 R2 reactor being returned back to power generation for a further 3 years of operation. Identified issues will be addressed through ONR's routine business.

4.4 Electrical Engineering

42. The ONR Electrical Engineering Inspector carried out his LC 28 compliance inspection on 15 May 2015 (Reference 23) targeting the following electrical systems:
- 11kV and 3.3kV switchboards and breakers
 - Station batteries
 - GT2 23kV and 400kV equipment
43. The Inspector's assessment findings are recorded in an assessment report (Reference 24). The Inspector reported that electrical work inspected was carried out in accordance with outage intention expectations and that there were no significant emergent issues. Switchboard maintenance intervals have been extended to a 12 yearly interval. The Inspector's review of NGL's safety justification for this change in maintenance interval, which was based on operational experience and condition monitoring, considered the arguments presented adequate and justifiable.
44. The Inspector visited maintenance work on 11kV 3B Unit Auxiliary Circuit Breakers and 400kV insulator maintenance and coating being carried out on the outdoor equipment in the GT2 400kV compound. In both cases the Inspector considered work was being carried out in accordance with required quality standards and adequately controlled.

45. There was a series of plant walk-downs of electrical systems including the following areas:
- GT2 400 kV compound
 - Unit transformer 2B
 - 3.3 kV Unit Aux Switchroom
 - 11 kV Unit Switchroom
 - 110V Station Battery B
 - GT2 23 kV generator circuit breaker
46. The Inspector reported that equipment was well-maintained, with appropriate access control arrangements in place and the work observed was judged to be consistent with appropriate permits issued and on display.
47. In conclusion, the ONR Electrical Engineering Inspector reported there were no safety issues identified to prevent the Heysham 1 R2 reactor being returned back to power generation for a further 3 years operation.

4.5 Control and Instrumentation

48. The Control and Instrumentation (C&I) Specialist Inspector carried out his LC28 compliance inspection on 20 May 2015 (Reference 25) focusing on the following areas:
- Reactor Safety Circuits
 - Gas Circulator Instrumentation
 - Plant Computer System
 - Plant Modifications
49. Inspection findings confirmed that NGL's staff and contractor personnel carrying out C&I outage work were Suitably Qualified and Experienced Persons (SQEP). This view was based on responses to questions posed by the Inspector during his inspection which showed individuals were both knowledgeable of the activities they were carrying out and competent in their field of expertise. He reported that work was being appropriately managed, with the creation of Work Order Cards (WOCs) setting out tasks to be undertaken and method of work. Documentation was provided to record test results and appropriate quality assurance and oversight arrangements were in place and being followed.
50. In evaluating work undertaken in support of Plant Computer Systems the Inspector followed up on Adverse Condition Report (ACR) dealing with a power transient resulting in the loss of the R2 Data Processing System (DPS). This required the R2 desk operator to manually control reactor conditions whilst the automatic control system, DPS, was brought back into service. The main safety issue in this event was the loss of visibility of reactor operating parameters and alarms. NGL reported that Reactor Desk Operators are trained to deal with these situations and the additional lines of protection in this event were not challenged. This event caused problems with the DPS Solid State Disks (SSD) in that data became fragmented and was inserted into incorrect memory locations. The event has been attributed to neoprene insulating connector degradation on DPS which is a known problem. NGL have replaced the SSD during this outage with original equipment manufacturer's spares and, at the time of this inspection, had replacing 70% of the neoprene connectors. NGL reported that further improvements to the DPS system are to be carried out through the DPS phased reinforcement project. The Inspector concluded that, in the case of DPS improvements, work was progressing according to plan and in a controlled manner.
51. A number of Category 1 plant modifications installed during this outage were inspected (including Feed Flow Y Trip Group Equipment and Gas Circulator Under-Voltage) together with Category 2 plant modifications (dealing with In-Reactor Bulk Moisture Analysis, CO₂ Dryer Instrumentation and Control Equipment, Gas Circulator Stator

Winding Temperature Trip Function Veto). Sampling these work packages provided evidence that procedures were being followed, testing of systems was being recorded and, where issues were identified, appropriate measures taken to resolve them.

52. The C&I Specialist Inspector Assessment Report (Reference 26) based on inspection findings and evidence gathered, concludes that the Inspector supports the issuing of ONR's Consent to re-start Heysham 1 R2; no issues were identified based on available information to prevent safe operation for the next 3 years.

4.6 Graphite

53. Evaluation of NGL inspection of Heysham 1 R2 graphite core was carried out on 23 April 2015 (Reference 27) and assessment findings are presented in (Reference 28).
54. In summary, the safety case justifying the Heysham 1 graphite core is set out in NP/SC 7570 Heysham 1 / Hartlepool graphite core safety case. NGL were seeking to confirm the following from their inspections of Heysham 1 R2 graphite core:
- No keyway root cracked bricks have been observed.
 - The level of bore cracking is within that expected and does not challenge the number assumed in the current safety case.
 - The axial bore cracked bricks have not started to open.
 - The measured core, channel and brick distortion are within expected limits.
55. NGL carried out visual inspection of 20 fuel channels and one control rod channel. They dimensionally surveyed 10 of the visually inspected fuel channels and took a total of 30 trepanned samples from 4 fuel channels. This was against an original plan target of 36 trepanned samples from 6 channels. The change in trepanning requirements was due to issues with trepanning equipment. However, the ONR inspector accepted this position and the number of samples obtained was judged to be sufficient.
56. The ONR Inspector attended the NGL Graphite Assessment Panel. A safety case limit for no more than 10% of axial cracked brick in the graphite core has been set within the Heysham 1 safety case. Based on visual inspection findings an estimated value of 2.5% axial cracked bricks is considered to exist in R2. Other types of brick cracking were observed from inspection of video footage but no significant issues were identified. The ONR Graphite Inspector considered inspection findings were adequate and appropriately sentenced.
57. No issues were identified from fuel or control rod channel dimensional surveys and the Station was confirmed to be operating within its safety case weight loss limits.
58. The Inspector concluded that, based on graphite inspection findings, there was no issue identified to prevent Heysham 1 R2 being re-started and operated safely for the next 3 years.

4.7 Ionising Radiation Regulations (IRR 1999) Inspection

59. The ONR Health Physics Inspector carried out an IRR 1999 compliance inspection during the outage 28 April 2015 (Reference 29) focussing on:
- Management Systems
 - Monitoring Arrangements
 - Worker Control and Risk Assessments
60. From this the Inspector concurred that Heysham 1 has adequate radiation protection arrangements in place in the setting to work and monitoring of individual exposure doses. This view is based on inspection of Pile Cap and Charge Hall operations, Gas Circulator replacement and Carbon Dioxide Gas By-Pass Plant desiccant replacement.

4.8 Fire Safety Inspection

61. The ONR Fire Safety Inspector carried out a compliance inspection against Regulatory Reform (Fire Safety) Order 2005 on 5 March 2015 (Reference 30). The Inspector

concluded from his Site visit that NGL Heysham 1 Power Station demonstrated an adequate level of Fire safety provision and management. A number of areas for improvement were identified which have been communicated to station and will be addressed through normal business.

4.9 Conventional Safety

62. The ONR Conventional Safety team has confirmed that there are no conventional safety issues which would prevent ONR granting its Consent for the return to service of Reactor 2 following its statutory outage (Reference 31).

4.10 Security

63. Security requirements during and for return re-start were reviewed by the ONR Security Inspector and he has confirmed that there are no Security issues which would prevent ONR granted Consent for R2 to return to service following its statutory outage (Reference 32).

4.11 ONR Site Inspector's Overview of Outage Activities

64. The ONR Site Inspector has taken an overview of activities carried out during this outage (Reference 33). In consideration of NGL's request for return to power for Heysham 1 R2 the Inspector has taken into account:

- Implementation of a Cooling Cowl;
- The revised justification for continued operation in light of challenges to the seismic claims on the Reserve Feed Tanks (RFTs) and Direct Contact (DC) Heaters;
- Continued unavailability of Gas Turbine 5;
- Out of specification delay times for Control Rod Assembly 2L14;
- The East Carbon Dioxide (CO₂) plant pipe failure.

Implementation of a Cooling Cowl on Control Rod Guide Tube 2L22

65. During this outage a cooling cowl has been successfully fitted on R2 central control rod guide tube 2L22, (Reference 34) in accordance with EC 348833 (Reference 35). The purpose of this cooling cowl is to assist in reducing the temperature of the Hot Box Dome. The EC has been subject to INSA and approval granted at Reference 36.
66. Although the EC has not been formally assessed, ONR has accepted the INSA approval of EC 348833 and noted the improvements made to the cowl deployment method following the experience gained at Hartlepool. On this basis ONR raised no objections to the implementation proposed modification on Heysham R2 (Reference 37).

Direct Contact (DC) Heaters

67. The DC heaters improve the efficiency of the secondary circuit heat transfer by bleeding some of the steam from the low pressure (LP) turbine to heat the condensate which will then become boiler feedwater.
68. On the 19th March 2015 a crack was discovered on a cross member supporting the DC Heater stage 2 on reactor 1. The DC Heater train was taken out of service and emptied to reduce the loading on the support structure. The station has undertaken inspections of the associated heaters supporting R2 at Heysham 1 and the two reactors at Hartlepool. The inspections have also showed cracks in one of the DC heaters stage 2 support members at Heysham 1 R2 and both reactors at Hartlepool.
69. The cause of these cracks is believed to be as a result of fatigue due to a poor design feature and poor installation. To address this, the cracks on the R2 DC heater stage 2 have been stress relieved and repaired by welding and the inclusion of plates on either side of the cracked web.

70. A subsequent review of the seismic withstand of the R2 DC heater stage 2 showed that further modifications were required to meet the design intent for a frequent seismic event. These modifications have now been implemented to ensure that post-trip cooling will be available via the deaerator make-up route.

Post Trip Cooling

71. The bottom line seismic case for an operating reactor at Heysham 1 claims that adequate post-trip cooling will be provided by:
- Electrical supplies via the Gas Turbines
 - Forced gas circulation by gas circulator pony motors and main motors in two quadrants
 - Boiler feed provided by the Emergency Boiler Feed (EBF) system, with deaerator make-up supplies sourced from the RFTs
 - Vessel cooling provided by seismically qualified pressure vessel cooling water and essential cooling water.
72. This is a relatively recent change to the seismic safety case (NP/SC 7125 Add 3) where originally the boiler feed claim was based upon High Pressure Back-Up Cooling System (HPBUCS).
73. Since this change two recent challenges to the bottom line claim on emergency boiler feed have been identified :
- The 5 RFTs at Heysham 1 have suffered corrosion under insulation and are undergoing a programme of remedial work. Recent assessments have indicated that the degradation is such that they will not withstand an infrequent or frequent seismic event.
 - Cracking in some of the Direct Contact (DC) heater supports may result in structural collapse following a seismic event. This collapse may impact on the deaerator make-up route and compromise the water supply to the EBF pumps.
74. The RFTs supply make-up feedwater to the deaerators (and hence EBF pumps) post trip if no feedwater recovery systems are available. Currently only RFT No. 2 has completed the required remedial work. The seismic safety case demonstrates that there are sufficient water stocks available to support a 24 hour mission time and hence no dependency on stocks from the RFTs. Use of the RFT 2 and/or RFT 3 as High Pressure BackUp Cooling System (HPBUCS) water stock is currently permitted by the safety case. However, an embargo is currently in force in doing this, due to the discovery that RFTs, even in perfect condition, are not qualified against the infrequent seismic event, for which HPBUCS is claimed.
75. A safety justification has been produced (Reference 38) to justify continued operation of the Heysham 1 reactors in light of these challenges to the seismic safety case and reverts back to the boiler feed claim being based upon HPBUCS rather than the EBF system. In addition the feed water source is claimed as the HPBUCS tanks. This has been subject to INSA approval at Reference 39. This safety justification places a number of additional requirements on the operators post seismic event and therefore a number of changes have been made to operational documentation. These changes have been confirmed complete in Reference 1.
76. In light of these additional requirements on the operators ONR recommended that the station provide a formal training session to the operations staff to explain the changes and new safety case requirements (Reference 40). The station has stated (Reference 41) that the operators will receive formal awareness training with sufficient staff receiving the training before the start-up of R2.

Gas Turbine (GT5)

77. The Gas Turbines (GT) at Heysham 1 provide sufficient electricity for post trip cooling systems to operate in the event of a loss of grid supplies to the site and as such provide a fundamental barrier to secure nuclear safety. On 22 August 2013, the GT5 fire protection system at Heysham 1 initiated resulting in flooding of the GT house. This tripped the electrical protection on GT5 and in addition challenged the availability of the remaining GTs (GTs 3, 4 and 6). As a result of this the station entered a four hour Technical Specification shutdown condition and both operating reactors were duly shutdown. In the period following the shutdown, action was taken to restore the availability of GTs 3, 4 and 6 and temporary measures were put in place to mitigate the risk of flooding in the GT house.
78. The GT5 alternator was damaged by the water ingress and a number of actions have been taken to try and return it to service as soon as possible. Unfortunately a number of issues have prevented GT5 returning to service. GT5 unavailability does not cause any specific concerns with respect to returning R2 to service after its statutory outage and is permitted by the Tech Specs and GTs 3, 4 & 6 provide an acceptable level of redundancy from a safety case perspective. However, long-term unavailability of GT5 erodes the defence in depth arguments for post trip cooling and risk mitigation measures have been put in place. Given the significant period of GT5 unavailability the station has produced a safety justification (Reference 42) which concludes that it is acceptable for GT5 to remain out of service until 15 January 2016.
79. Whilst ONR is disappointed that GT5 remains out of service, ONR acknowledges that the Licensee is doing everything reasonably practicable to return it back to service. Although there is a small increase risk of having to shut both reactors down, the unavailability of GT 5 is still justified within Reference 42. Consequently this issue is not considered to prevent the granting of consent to start up R2.

Control Rod Assembly 2L14

80. During a pre-maintenance drop test in the Control Rod Mechanism Maintenance Room (CRMMR) Control Rod Assembly (CRA) 5804A failed to drop as normal, hanging up for a prolonged period before commencing its descent. Subsequent investigations and a review under the Safety Case Anomalies Process (SCAP) concluded that this event does not at present pose any significant challenge to the ongoing in-reactor test regime that underpins the safety case assumptions on primary shutdown system reliability. Notwithstanding this, a number of further investigations were identified to confirm this.
81. During this outage whilst R2 was shutdown in air, a test of CRA 2L14 also gave an out of specification delay time. The original SCAP sentencing has been reviewed and a justification produced to capture the new information and support the continued underpinning of the original SCAP judgements in regard to reliability claims on the shutdown capability of running reactors.
82. This problem is not considered systematic and further batches of CRAs maintained in the CRMMR have not shown delay time issues. Successful cold rod drop tests have been carried out on the remaining Reactor 2 safety rods (11 out 12, excluded 2L14). In addition the latest rod taken from the Control Rod Store, which had been in same conditions as CRA 2L14 (Reactor 2 then in cold store), demonstrated a satisfactory drop test.
83. Further work is ongoing to investigate these anomalies. In the meantime CRA 2L14 has been removed from R2 for forensic evidence and replaced with a correctly functioning CRA before the return to service (Reference 43). In light of this the site inspector judged that since the CRA has been replaced and there is no evidence of a

systematic issue, there are no remaining issues which would prevent ONR granting Consent for R2 start-up.

East Carbon Dioxide (CO₂) Plant

84. Leading up to the outage an uncontrolled release of Carbon Dioxide (CO₂) gas occurred from the East CO₂ plant. ONR served an Improvement Notice on NGL for failing to make and implement adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of this facility. The Inspector is satisfied that NGL has undertaken a comprehensive review of the East CO₂ plant to ensure that the components of this plant are in satisfactory condition to deliver its safety functions in accordance with the plant safety justification and that similar failures cannot happen. Although further work has to be undertaken to satisfy the Improvement Notice the Inspector has judged that satisfactory progress has been made to allow the East CO₂ plant to return to service (Reference 44).
85. The Site Inspector has confirmed that no issues are outstanding which would prevent the issuing of ONR Consent to allow re-start of Heysham 1 R2.

4.12 Engagement with other Governmental Agencies

86. ONR has engaged with the Environment Agency who has confirmed (Reference 45) that they are not aware of any environmental issues that should prevent the re-start of Heysham 1 R2 following the statutory outage.

5 CONCLUSIONS

87. The pre-requirements to the issuing of this ONR Consent is that ONR have issued an Agreement under LC 22(1) for return to service of the Reactor 2 at low power following the installation of the spine cooling modifications. This has been completed with agreement issued under LI589. (Reference 9 and 11).
88. ONR has reviewed NGL's supporting documentation justifying re-start of Heysham 1 Reactor 2 including the additional statements provided under cover of Reference 1. NGL have indicated that they have not identified any issues which would prevent start up of Reactor 2 and its safe operation until its next periodic shutdown. This view is supported by NGL's own internal Regulatory Department Independent Nuclear Assurance (INA) (issued under Reference 1).
89. Based on the sampling of NGL's maintenance activities during the Heysham 1 Reactor 2 outage, ONR considers that the maintenance schedule requirements established under LC 28 have been met.
90. Work undertaken during the outage has been carried out in accordance with identified arrangements for safety systems and components and these activities have been conducted to the required quality standards.
91. 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 to confirm Heysham 1 Reactor 2 can be re-started for the purpose of electrical power generation and will remain in a safe state until its next statutory outage.
92. In conclusion, no nuclear safety issues have been identified in this outage to prevent the re-start of Heysham 1 Reactor 2. It is considered that Reactor 2 is able to operate safely for the next 3 years until its next periodic outage.

6 RECOMMENDATIONS

93. It is recommended that ONR issue LI590 giving Consent to NGL Nuclear Generation Limited to re-start Heysham 1 Reactor 2 following its 2015 statutory outage.

7 REFERENCES

1. NGL Letter NSL/HYA/50773 (Y) – Request for Consent to Start up Reactor 2 Following its Periodic Shutdown under Site Licence Condition 30 (2015/292842).
2. Licence Instrument 10 for Nuclear Site Licence 60 Heysham issued 25 March 1996, Unique Document No HYA 70566N, (2015/292878).
3. ONR Contact Report ONR-CNRP-HYA-CR-14-276, Issued 4 December (2014/447209).
4. Outage Intensions Document R2 Outage Statutory Outage 22, NGL document Ref HYA/M/Methods/136/Rev 001 (2015/134175).
5. NGL Procedure HYA/T/NS/119 Independent Shutdown Safety Review of the Outage R2 2015 Station Outage.
6. NGL Procedure BEG/SPEC/OPS/007 Rev 6 Outage Safety Arrangements.
7. NGL Procedure BEG/SPEC/OPS/008 Rev 6 Model Quality Assurance Arrangements.
8. NGL Procedure BEG/ICP/OPS/009 rev 7 Outage Management Process.
9. ONR Project Assessment Report (ONR-HYA-PAR-15-004) titled Heysham 1 Power Station Reactor 2 Return to Service at Reduced Power with Spine Cooling modifications Installed (NP/SC 7733) (2015/177118)
10. NGL Category 1 safety justification NP/SC 7733, Titled Reactor 2 Return to Service at Reduced Power with Spine Cooling Modifications Installed, Engineering Change EC 355558 (2015/221673)
11. ONR Agreement LI589 for Heysham 1 Power Station Reactor 2 Return to Service at Reduced Power with Spine Cooling modifications Installed (2015/296005)
12. ONR Intervention Record Heysham 1 R2 re-start meeting CNRP-HYA-IR-15-030 (2015/213607).
13. NGL ONR Start up Meeting HYA/M/METHODS/138 Rev 0 (2015/262005).
14. ONR Heysham 1 R2 2015 outage technical discipline inspection plans Structural Integrity (2015/66861), Mechanical Engineering (2015/60358), Electrical Engineering TRIM (2015/88184), Control and Instrumentation (2015/88899).
15. ONR Civil Engineering Contact Record ONR-HYA-IR-14-386 (2015/114837).
16. ONR Civil Engineering Assessment Report ONR-HYA-AR-15-011 (2015/177472).
17. NGL email confirming Maintenance Schedule requirements from safety justification from had NP/SC 7733 had been implemented (2015/228976).
18. ONR Structural Integrity Intervention Record ONR-CNRP-IR-15-022 (2015/199289).
19. ONR Structural Integrity Contact Record ONR-CR-15-072 (2015/211537).
20. ONR Structural Integrity Assessment Report ONR-CNRP-AR-15- 012 (2015/200078).
21. ONR Mechanical Engineering Intervention Record ONR- CNRP-IR-14-231 (2015/102195).
22. ONR Mechanical Engineering Assessment Report ONR-HYA-AR-14-112 (2015/102750).
23. ONR Electrical Engineering Intervention Record ONR-CNRP-IR-15-016 (2015/183305).
24. ONR Electrical Engineering Assessment Report ONR-CNRP-AR-15-016 (2015/214195).

25. ONR Control and Instrumentation Intervention Record ONR-HYA-IR-15-020 (2015/193148).
26. ONR Control and Instrumentation Assessment Report ONR-HYA-AR-15-013 (2015/193611).
27. ONR Graphite Intervention Record ONR- CNRP-HYA-IR-15-008 (2015/155847).
28. ONR Graphite Assessment Report ONR- CNRP-HYA-AR-15- 015 (2015/203692).
29. ONR Radiation Protection Assessment Intervention Record ONR-CNRP-IR-15-009 (2015/159782).
30. ONR Fire Safety Inspection Intervention Record ONR-COP-IR-15-005 (2015/167706).
31. Email from ONR Conventional Safety Team (2015/236914).
32. Email from ONR Security Inspector (2015/293377).
33. ONR Heysham 1 Site Inspector's Position Statement for Return to Service of Heysham 1 Reactor 2 Outage (2015/258392).
34. Email from [REDACTED] (EDF Heysham 1) to [REDACTED] (ONR)- ONR Start up Meeting Action (2015/238226).
35. EDF NGL Engineering Change (EC) 348833 Version 00 - Hot Box Dome Recovery – Introduction of Cooling Cowl at the L22 Control Rod Guide Tubes.
36. EDF NGL INSA of EC No 348833 - Version 00 - Hot Box Dome Recovery – Introduction of Cooling Cowl at the L22 Control Rod Guide Tubes - 8 May 2015 (2015/173806).
37. Email from [REDACTED] (ONR) to [REDACTED] (EDF) - No objection to fitting Cowl on Reactor 2 (2015/238334).
38. EDF NGL Engineering Change Proposal – EC 355646 – Justification for Continued Operation of HYA Reactors in Light of Challenge to Seismic Safety Case Claims on RFTs and DC Heaters. (2015/293877).
39. EDF NGL INSA Approval Statement for EC 355646 - Justification for Continued Operation of HYA Reactors in Light of Challenge to Seismic Safety Case Claims on RFTs and DC Heaters. (2015/282686).
40. Email from [REDACTED] (ONR) to [REDACTED] (EDF) - Operator Training to Support the JCO for Continued Operation of HYA Reactors in light of challenges to Seismic Safety Case Claims on RFTs and DC Heaters (2015/294510).
41. EDF NGL Email from [REDACTED] to [REDACTED] - JCO for Seismic Qualification Issues on RFT's & DC-Heaters (EC355646) - CCR Team Awareness Training (2015/295434).
42. EDF NGL Engineering Change EC350935 Rev 003 - Extended Unavailability Review (EUR) for GT5 Following Damage to Alternator by FJFS Deluge on 22.08.13 - Extension to 15 January 2016 (2015/244765).
43. EDF NGL - Email from [REDACTED] to [REDACTED] - Start Up Meeting Action 2015-4 - Confirmation of removal of 2L22 from Reactor 2 (2015/294905).
44. ONR Letter to EDF HYA 71069N – Return to Service of East CO2 Plant (2015/260196).
45. Email from Environment Agency - Statement to Support the Return to Service of Reactor 2 at Heysham 1 following its Statutory Outage. (2015/236890).