Office for Nuclear Regulation

Torness Reactor 2 Periodic Shutdown 2015

EDF Energy Nuclear Generation Limited (NGL) – Torness – Consent under Licence Condition 30(3) to start up Torness Reactor 2 following the 2015 periodic shutdown

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EXECUTIVE SUMMARY

Title

EDF Energy Nuclear Generation Limited (NGL) – Torness – Consent under Licence Condition 30(3) to start up Torness Reactor 2 following the 2015 periodic shutdown

Permission Requested

NGL, the licensee of Torness power station, has requested that the Office for Nuclear Regulation (ONR), grants consent to start up Reactor 2 following completion of the 2015 periodic shutdown.

Background

Torness Power Station is licensed to operate two Advanced Gas-cooled Reactors (AGRs), known as Reactors 1 and 2. To continue to operate safely and reliably, the reactor plant requires examination, inspection, maintenance and testing. Continuous improvement also requires plant safety improvements to be implemented where these are deemed to be reasonably practicable. Whilst some of these activities can take place when the reactor is operational, many of them require it to be shut down. The licensee's arrangements require that periodic shutdowns, as required by Licence Condition 30(1), are carried out every three years at each reactor at Torness. The previous start up consent for Reactor 2 was granted on 6 August 2012. On completion of a periodic shutdown, the reactor concerned cannot be started up without consent from ONR under Licence Condition 30(3).

The outage for Torness Reactor 2 commenced on 10 July 2015. During this periodic shutdown, the licensee has conducted:

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

Where inspection work revealed the potential for an adverse plant condition, the licensee has assessed the inspection results in accordance with their arrangements, and taken appropriate remedial action as necessary, or provided an appropriate safety justification for continued operation, prior to ONR granting consent to reactor start up.

Towards the end of the periodic shutdown, the Torness Station Director wrote to ONR requesting consent to start up Reactor 2. In that letter, the Station Director confirmed that all maintenance required and actions requiring closure before start up would be completed and evidence provided within 28 days of start up.

The competent persons (under Pressure Systems Safety Regulations 2000) for the Pre-stressed Concrete Pressure Vessel, the reactor penetrations, and the remaining relevant plant have each confirmed that they are content for Reactor 2 to start-up.

The licensee's internal regulator, Independent Nuclear Assurance, has provided a Concurrence Statement that supports start-up.

This ONR project assessment report presents the basis for ONR's consent for the licensee to start up Reactor 2 at Torness and operate to the next periodic shutdown.

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

ONR inspectors have sampled the licensee's arrangements for controlling and completing the examination, inspection, maintenance and testing requirements of the maintenance schedule, and other plant modifications of nuclear safety significance, as identified within the licensee's outage intentions document. This has included attending the significant outage planning and progress meetings and visiting site to inspect samples of the licensee's implementation of their arrangements. ONR specialist inspectors have undertaken compliance inspections and assessments and produced reports for each specialism. These reports have been used in the production of this project assessment report.

The main issues during the periodic shutdown activities which required unplanned additional safety justification related to:

- Failure to complete the 16 intended fuel channel inspections due to graphite inspection equipment failures;
- Identification of cracking in peripheral graphite bricks.

These have been assessed and were considered adequately addressed but with a number of ongoing commitments agreed to by the licensee.

The regulatory interventions carried out by ONR have not identified any issues of safety significance which remain unresolved in relation to the licensee's safety case for the start up of Reactor 2, thereby allowing ONR to consent to start up Reactor 2 under Licence Condition 30(3), as recommended by this report.

Matters arising from ONR's work

The licensee has confirmed to ONR that the requisite periodic shutdown related work has been successfully completed and that all actions identified by ONR for resolution prior to consent have been addressed. The actions agreed for the longer term have been included in the relevant station processes, and will be tracked to completion within its arrangements to ensure risks continue to be reduced as low as reasonably practicable.

A significant issue requiring longer term actions which was identified during outage inspections has been the observance of cracks in a small percentage of peripheral graphite shielding bricks, for which the fundamental mechanism of cracking is the subject of ongoing investigation. A safety case modification (an Engineering Change submission) for return to service of Reactor 2 has provided a justification that the potential consequences are minimal. NGL have also made a number of commitments to this further work and to future inspections. ONR is satisfied that, with these in place, it is safe to restart Torness Reactor 2.

No matters preventing the granting of consent to start up arose from the work undertaken by ONR inspectors in relation to the Torness Reactor 2 2015 periodic shutdown.

Conclusions

Following assessment and inspection of matters arising in relation to this Torness Reactor 2 periodic shutdown, ONR is satisfied that the licensee's justification to start-up the reactor and operate to the next shutdown is adequate. ONR granted consent to start up the reactor on 8 September 2015.

Recommendations

It was recommended that, in accordance with the request from the licensee, ONR should grant consent under Licence Condition 30(3) attached to Nuclear Site Licence No: Sc14 for Reactor 2 at Torness nuclear power station to start up following the 2015 periodic shutdown, and Licence Instrument 537 be issued and released to the licensee to permit this outcome. The Licence Instrument was issued on 8 September 2015.

LIST OF ABBREVIATIONS

ACW	Auxiliary Cooling Water
ALARP	As low as reasonably practicable
AMS	Asset Management System
APEX	Appointed Examiner
BCD	Burst Can Detection
BCIV	By-pass Circuit Isolation Valves
BST	Buffer Storage Tubes
C&I	Control and Instrumentation
CNRP	Civil Nuclear Reactor Programme
CNS	Civil Nuclear Security (ONR)
CRA	Control Rod Assembly
CW	Cooling Water
EC	Engineering Change
EIM&T	Examination, Inspection, Maintenance and Testing
EPPE	Essential Plant Protection Equipment
ESB	Essential Services Building
FMA	Flux Measuring Assembly
GAM	Gaseous Activity Monitor
GSRV	Gas Safety Relief Valve
HoRP	Head of Radiological Protection
FFSM	Fleet Fire Safety Manager
HDPE	High Density Polyethylene
HP	High Pressure
HSAW	Health and Safety At Work Act 1974
HYB	Heysham 2
IIS	Integrated Intervention Strategy (ONR intervention rating system)
IJCO	Interim Justification for Continued Operation
INA	Independent Nuclear Assurance
INSA	Independent Nuclear Safety Assessment
IR	Intervention Record
IRR99	Ionising Radiations Regulations 1999
ISI	In Service Inspection
JCO	Justification for Continued Operation
LI	Licence Instrument
LC	Licence Condition
LEV	Local Exhaust Ventilation
MEWP	Mobile elevating work platform

MOM	Mid-Outage Meeting
MS	Maintenance Schedule
NDT	Non-Destructive Testing
NGL	EDF Energy Nuclear Generation Limited
NICIE	New In-Core Inspection Equipment
OAP	Outage Assessment Panel
OCC	Outage Control Centre
ODR	Offload Depressurised Refuelling
OEP	Orifice Extension Piece
OID	Outage Intentions Document
OIM	Outage Intentions Meeting
ONR	Office for Nuclear Regulation
OpEx	Operational Experience
PAR	Project Assessment Report
PCPV	Pre-stressed Concrete Pressure Vessel
POMP	Pre-outage milestone plan
PSSR	Pressure Systems Safety Regulations 2000
RaDep	Radiolytic Deposition
RCA	Radiation Controlled Area
RP	Radiological Protection
RSW	Reactor Sea Water
RTR	Rapid Trending Review
RTS	Return To Service
SCC	Stress Corrosion Cracking
SEPA	Scottish Environment Protection Agency
SQE	Safety Quality Engineer
SQEP	Suitably Qualified and Experienced Person
SRV	Safety Relief Valve
SUM	Start up Meeting
TOLCS	Torness On-Line Computer System
TOR	Torness nuclear power station
TS	Task Sheet
UPS	Uninterruptible Power Supply
VFC	Variable Frequency Converter
VSD	Variable Speed Drive
VWSG	Vibrating Wire Strain Gauge

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1 PERMISSION REQUESTED

1. EDF Energy Nuclear Generation Limited (NGL), the operator and licensee of Torness power station, has written (reference 1) to the Office for Nuclear Regulation (ONR) requesting consent under Licence Condition (LC) 30(3) to start up Reactor 2 (R2) on completion of its periodic shutdown (also known as its statutory outage). This Project Assessment Report (PAR) presents ONR's consideration of this request and recommends that consent is granted to start up R2 through the issuing of Licence Instrument (LI) 537 (reference 2).

2 BACKGROUND

2.1 GENERAL

2. The nuclear site licence issued to NGL for Torness power station requires the licensee to periodically shut down the reactor plant under LC30. This is to enable examination, inspection, maintenance and testing to take place in accordance with the requirements of the station's plant Maintenance Schedule (MS) under LC28. At Torness power station, reactor periodic shutdowns are undertaken triennially as specified in the MS Preface, which is an Approved document under LC28(4) (reference 3). The licensee also undertook work during the shutdown associated with the requirements of Pressure Systems Safety Regulations 2000 (PSSR), previous commitments, and plant safety improvements/ modifications under LC22.

3. The licensee requires consent from ONR under LC30 (3) to start up R2 on completion of its periodic shutdown (reference 4). The previous consent to start up R2, Torness LI 528 (reference 5), is dated 3rd August 2012. The R2 periodic shutdown 2015 commenced on 10th July 2015.

4. During the R2 periodic shutdown 2015 the licensee conducted:

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

5. Torness Reactor 2 outage commenced on 10th July 2015.

2.2 OUTAGE PLANNING AND MANAGEMENT

2.2.1 Licensee's Management

6. NGL began planning the R2 periodic shutdown two years prior to its start. Progress was monitored by NGL with the aid of their Pre-Outage Milestone Plan (POMP).

7. NGL produced the Outage Intentions Document (OID) (reference 6) for R2 periodic shutdown 2015. This outlines the outage organisation, infrastructure and management arrangements to deliver the planned safety related activities. The OID, together with the referenced scope-related supporting documents comprised the outage intentions for R2. A summary of the outage intentions, including incorporations from NGL's 2012 R2 (reference 7) and 2014 R1 outage lessons-learnt reports, is included in Appendix 1.

8. The outage activities were managed using an Outage Control Centre (OCC), which provided overall control and monitoring of shutdown work based on use of an area and plant island approach:

- In Service Inspection Island and Reactor Services;
- Gas Circulators and Boiler Island;
- CW (Cooling Water) , RSW (Reactor Sea Water) Feed and Condensate;
- Turbine;
- Electrical and Control and Instrumentation;
- Services, Inspection and NDT (Non-Destructive Testing).

9. Each island was led by an engineering group head and had allocated staff to control shutdown work planning, execution and completion, including any response required to emergent issues.

10. The licensee's outage process has planned into it a series of meetings with ONR, these being the Outage Intentions Meeting (OIM), the Mid-Outage Meeting (MOM) and the Start up Meeting (SUM).

11. NGL provided ONR with a copy of the OID prior to holding the OIM on 11th February 2015 which was distributed to ONR specialist inspectors assigned to Torness power station R2 outage 2015. The organisational arrangements and programme of work for the shutdown were discussed at the meeting.

12. NGL held the MOM and SUM on 29th July and 19th August respectively. ONR inspectors attended both meetings. The purpose of the MOM was to allow the Station and ONR to review the progress and developments of the periodic shutdown against the MS. The purpose of the SUM was for the licensee to demonstrate it had adequately met the requirements of the MS, dealt with emergent issues and demonstrated the safety of R2 for the next operational period.

13. On 4th September 2015, the Torness Station Director wrote to ONR requesting consent to start up R2 on completion of the periodic shutdown (reference 1). The request letter was sent prior to completion of the shutdown. The letter states that, subject to the satisfaction of the Station Return to Service (RTS) Panel, independent substantiation by the Station Operational Safety Review Committee, and his personal review of the Committee's recommendation, of the completion of the remaining activities identified in attachments 2, 3 and 4 of his letter, he is satisfied that R2 is fit for return to service and sufficient procedures are in place to assure safe operation through to the next periodic shutdown. Satisfactory completion of the remaining work identified in the attachments will be reported in the '28-day report' following consent .

14. The licensee's internal regulatory process requires that the internal regulator, Independent Nuclear Assurance (INA), independently support the application for reactor start up. INA seeks assurance by undertaking a series of activities both before and during the outage. The scope of these activities for the current outage is defined in the INA Concurrence Part A (reference 8). On completion of these activities, INA issues a report, Concurrence Part B (reference 9), which presents the findings of their work and includes a statement supporting the start up.

15. On 7th September 2015, INA issued Concurrence Part B for the Torness power station R2 periodic shutdown 2015 RTS. The report states that INA considers that there were no issues remaining with respect to the requirements of Concurrence Part A and they are content for start up and subsequent operation of R2 within the constraints of the current safety case.

16. The licensee produced a return to service Engineering Change (EC) (reference 10) that approves the results of inspections completed in the R2 outage inspection

programme. INA has issued an Independent Nuclear Safety Assessment (INSA) approval statement (reference 11) for the RTS EC with no caveats.

17. During the reactor start up and raising to full power, there are further tests and inspections which can only be conducted at this time. The results of these, and of other inspections conducted during the shutdown which required further analysis, will be published in a document known as the '28-day report'. The 28 days start when ONR consent is given.

2.2.2 ONR's Intervention Management Process

18. The Torness Site Inspector produced a task sheet (TS) (reference 12) which justified the resource for ONR activities during the R2 2015 periodic shutdown and was endorsed by the Operating Reactors Sub-Programme management team.

19. The anticipated outcomes of the project included:

- The licensee delivering a shutdown that is safely managed;
- Closeout of significant issues raised by ONR interventions to the satisfaction of the inspector raising the issue, prior to the conclusion of the shutdown (or an acceptable plan to address the issue beyond the shutdown);
- The licensee delivering the required safety-related work activities, enabling ONR to produce a PAR that considers NGL's request to start up R2 on completion of the shutdown.

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

20. The work undertaken by ONR can be summarised as follows:

- Assessment of the safety management of the outage including:
  - Quality management systems;
  - Radiological protection;
  - Fire safety;
  - Control and supervision of operations;
  - Fuel and criticality;
  - Management of modifications;
  - Conventional Health and Safety.
- Engineering assessments of maintenance, modifications and other work during the outage covering the following specialisms:
  - Civil Engineering;
  - Control and instrumentation systems;
  - Electrical engineering;
  - Graphite core integrity;
  - Mechanical engineering;
  - Structural integrity.
- Formal meetings (the OIM, the MOM and the SUM) looking at the preparations, progress and readiness to restart;
- Emergent issue;

- Consultation with ONR Civil Nuclear Security (CNS) and the Scottish Environment Protection Agency (SEPA).

3.1 SAFETY MANAGEMENT

3.1.1 Quality Management Systems [LC 17 IIS Rating 3 – Adequate]

21. The Management Systems inspector conducted an intervention on 28-30th July 2015 to assess the licensee's compliance against its outage management systems which support LC 17 management systems and quality assurance arrangements. The findings of the intervention are presented in the Intervention Record (IR) (reference 13).

22. The inspection focussed on the adequacy of the outage quality management oversight arrangements including: audit & surveillance; supply chain & contract management and management of outage work quality.

23. The inspector observed:

- A risk-based, intelligence-driven approach to targeting of surveillances for the outage and was satisfied that the programme was being well managed and supported, and based upon the examples reviewed, that the surveillances were of a good standard;
- The weekly Safety and Quality Forum which was attended by the contract partners and a number of EDF representatives. All parties were fully engaged in the meeting and surveillance reports were delivered consistently with no discernible trends;
- A robust and effective joint surveillance being undertaken by the Station Quality Engineer (SQE) and a Contract Partner Quality Representative on a maintenance task;
- Outage work management quality arrangements and procurement/ contract management arrangements to be adequate and outage supply chain management arrangements to be in accordance with relevant procedures.

24. The inspector was satisfied that from the activities examined, the management systems for the R2 outage, the quality management oversight arrangements and their implementation during the shutdown were adequate and consistent with the relevant integrated company practices, specifications and procedures. A number of observations were offered for consideration. No actions were raised. He has assigned an LC 17 IIS rating of 3 – Adequate.

25. Based on the areas and activities sampled during the intervention, the inspector considered that the LC17 management systems and their implementation for the outage were adequate to support the granting of consent to the start up of Torness R2.

3.1.2 Radiological Protection [IIS Rating 2 – Good]

26. The radiological protection inspector conducted an intervention on 12 August 2015 to establish that the licensee's outage work programme was being conducted in compliance with the Ionising Radiations Regulations 1999 (IRR99). The findings of the intervention are presented in the IR (reference 14).

27. The following matters were inspected:

- The licensee's outage work programme and its radiological implications;
- Radiation protection personnel cadres and monitoring equipment provision;

- Control and supervision of approximately 600 contractors;
- Radiation protection input to shutdown work planning;
- Integration of as low as reasonably practicable (ALARP) management principles with personal radiation exposure restriction and contamination control;
- Training;
- Radiation survey instrument maintenance and provision;
- Radiological event investigation and follow-up;
- Record-keeping;
- Planning for radiologically significant shutdown tasks;
- Operational dose management.

28. The outage activities had not planned to encompass any work where projected collective doses would exceed the NGL corporate threshold for its formal ALARP management processes to apply; these become effective at projected personal doses in excess of 3 mSv and collective doses in excess of 10 mSv. Accordingly, the shutdown activities were being conducted in accordance with local ALARP arrangements, for example by using radiation work permits to specify dose restriction detail. The inspector was content with the arrangements in place to manage this.

29. A visual inspection was conducted of the pile cap/charge hall, gas circulator quadrant, gas by-pass desiccator plant, and other areas to assess house-keeping and IRR99 compliance. Particular attention was paid to radiological area designations, tidiness and their segregation and demarcation, particularly at C0/C2/C3 boundaries, and to radiation monitoring point functionality and calibration. No issues were identified in any of the areas assessed.

30. The licensee had set a collective dose target for the outage of 10.1 man-mSv. The Head of Radiological Protection (HoRP) reported that the Station was on target to achieve this outcome by the end of the outage.

31. An area of good practice identified was that, notwithstanding corporate oversight arrangements, a formal ALARP assessment was completed for the proposed graphite trepanning work because the HoRP felt that this work could, in certain extenuating circumstances, lead to personal doses in excess of the 3 and 10 mSv criteria. The radiation protection inspector reviewed the document and found it to be an example of good practice in health and safety management.

32. At the time of the inspection, the HoRP reported that the graphite sampling work had now been completed without any radiological problems occurring. He also reported that gas circulator exchange work had progressed well and that the desiccant exchange in the gas blow-down system had now been completed, again without any significant radiological problems having occurred.

33. Radiological supervision of staff and contractors is undertaken by the usual station complement of 18 Radiological Protection (RP) staff and a further 14 RP staff from Radwise Radiation Protection Services Limited (Radwise).

34. The inspector considered the training records for station staff, Radwise employees, and other contractors to be entirely satisfactory and was impressed by the rigour of the pre-recruitment competence vetting exercised by the licensee.

35. Contamination control and monitoring records for the outage were good. The inspector had some concerns regarding local exhaust ventilation (LEV) performance at the low-level waste sorting cabinet for which there does not appear be an established LEV flow-rate standard or test regime. The HoRP reported that he would review this with other EDF stations and report the outcome in due course.

36. The inspection did not reveal any significant nuclear safety issues relevant to R2 start up that required action by the licensee or follow-up by ONR. Discussions with the Head of Radiological Protection at the station and his team indicated their strong commitment to effective radiological protection practice and a good level of compliance with the IRR99 was evident during plant inspections. An IIS rating of 2 (Good) was assigned.

3.1.3 Fire Safety

37. A specific inspection focused on the practical fire safety provision during the outage of R2 and associated equipment was deemed not to be required during this outage due to two other recent inspections; the outcome of these is described below.

38. A general fire safety inspection was conducted by ONR on 2nd December 2014 (reference 15). This confirmed that the licensee was compliant with the requirements of the Fire (Scotland) Act 2005. The inspection focused on both the management of fire safety and the practical fire safety provision within the Contractors Compound and a random selection of areas within the Reactor Building. The inspector concluded that the Torness management team adequately demonstrated that fire safety is taken seriously and is given the due consideration it deserves. Seven issues were identified and these have been followed up as part of ONR's post inspection process. Fire safety was rated as adequate.

39. ONR attended a Level 4 meeting with EDF NGL Fleet Fire Safety Manager on 4th August 2015 (reference 16) where NGL provided an overview of fire safety performance across the fleet concentrating on achievements and focus areas. The basis of NGL's presentation was a series of inspection visits to each NGL station. In relation to their Torness inspection they made the following statements:

- Refreshing the fire safety plan and ensuring that it includes a sufficient level of detail to drive it, will ensure that the good fire safety performance can be maintained.
- Good performing site that with some self-identified improvements to process and embedding fire safety coaching will continue to improve.

Even though these are the FFSM's own conclusions, it should be recognised that he has followed a structured process to reach these judgements.

40. During the various ONR specialist inspections housekeeping was regularly referred to as very good. However, as described in section 3.2.5 of this report, the mechanical engineering specialist did observe a fire hazard within the Gas Circulator Maintenance Facility and this was immediately addressed by the licensee.

3.1.4 Control and Supervision of Operations [LC26 IIS Rating 3 – Adequate]

41. The site inspector conducted this intervention on 27-31st July 2015 to review the adequacy and implementation of the arrangements for LC26, control and supervision of operations, during the outage. The findings of the intervention are presented in the IR (reference 17).

42. The inspection included a review of relevant primary arrangements and procedures with the Deputy Operations Manager and also followed up on Torness' response to previous events reported to ONR on INF1 forms. He inspected a series of tasks being undertaken at the time of the inspection, both within and outside the Radiation Controlled Area (RCA), for shutdown and non-shutdown related work which was being conducted by both NGL and supporting contractor staff.

43. Reference 17 also includes a review of discussions held with the INA evaluation team, which included the outcome of the 'INA Rapid Trending Review (RTR)' for the R2 outage 2015. The aim of the Outage RTR process is to identify performance shortfalls in the early stages of an outage to enable station management to reduce or eliminate undesirable behaviours and conditions which could have an adverse impact on outage success. The scope of the RTR is wide, and included a number of 'deep dives' targeting high risk areas such as the high pressure (HP) turbine, generator seal oil system, 11kV cable replacement, and feed and condensate cooling water system. Condition Reports are raised for each Opportunity for Improvement and the INA returns 6 weeks after to review progress.

44. During the outage the site inspector and project inspector have held a number of meetings (including the formal MOM and SUM) with outage management, contractors and Safety Representatives. We found that the level of supervision to be both consistent and adequate throughout. We concluded that control of both outage and non-outage related work was adequate.

3.1.5 **Fuel and Criticality** [IIS Rating 3 – Adequate]

45. The IR (reference 18) presents the findings of the ONR Fuel Performance Assessor. The scope of the assessment included the following related matters pertinent to the outage:

- Criticality safety awareness training for contract staff involved in the outage and the role of the station "Criticality Specialist" during outages;
- Any work planned during the outage to remediate reactor fuel channels, where the gas flow to the Burst Can Detection (BCD) equipment has been found to be inadequate to assure failed fuel detection by the BCD equipment and/or any general remedial or enhancement work to be conducted in the outage on the BCD system or the Gaseous Activity Monitoring (GAM) system for Reactor R2;
- The procedures, roles and responsibilities, compliance route etc. to invoke the station's permanent 'failed fuel in air' safety case, should failed fuel have been present in the core prior to going into outage, or if fuel failures had occurred during reactor blow-down;
- The station's arrangements for interrogating coolant activity data during reactor blow-down to air (to look for the possible presence of fuel failures);
- Progress with pressurised inspections of the station's fuel Buffer Storage Tubes (BST) – not strictly an activity planned for the outage, but a project ONR wishes to influence the licensee to make progress on (as the station has to certify at least 2x BSTs as being free from radiolytic deposition (RaDep) i.e. to accommodate potential failed fuel, going into an outage);
- Station progress with export of reject unirradiated fuel and fuel components from a previous inspection in May 2014.

46. The inspector was content with the licensee's performance in these areas and found a number of arrangements to be adequately robust. Examples such as pre-job outage criticality briefs were of a good quality and provide good pointers to other Company wide occurrences (operational experience – OpEx), which have had a potential to impinge upon criticality safety. Similarly, the six monthly "plant walk-down to ensure that criticality safety requirements are being met" by the station Criticality Specialists and the recording of this are considered to be examples of good practice. It was also noted that the licensee is exhibiting diligent management of its fuel failures.

47. It is the inspector's opinion that the inspection indicated no nuclear safety issues requiring further ONR intervention and that no reactor re-start issues were identified. He has assigned an LC28 IIS rating of 3 – Adequate.

3.1.6 **Modifications** [LC22 IIS Rating 3 – Adequate]

48. Prior to the outage, the site inspector and previous site inspector inspected compliance against LC22 for modifications being implemented during the R2 outage. The findings of the intervention are presented in the IR (reference 19).

49. The inspection focussed on the implementation of arrangements for modifications that are scheduled to be implemented as part of the forthcoming outage. This enabled a review to be carried out on a series of modifications in terms of their safety significance, the implications this may have on the provision of documentation to justify the safety of a proposed modification and its implementation during the outage and their current status.

50. Their inspection found that, with one exception, all outage-related modifications had reached an approved stage status and that work was focussed on ensuring that other aspects of the modifications such as development of work instructions, completed drawings, operating and maintenance instructions are completed in advance of their implementation. They also sampled the scope change process that enables additional work to be added to the outage programme only when the design is complete and funding is available for the modification to be implemented.

51. This inspection considered the process of developing ECs in response to incidents on site by reviewing the response to a recent event. Here they found that there was a clear auditable trail from initial identification of a safety case anomaly through to the nuclear safety requirements specification and production of a suitably categorised EC that demonstrates how station implements its arrangements under LC22.

52. They were satisfied that the arrangements and their implementation at Torness for LC22 are adequate and judge that the outcome of the sample inspections undertaken met expectations detailed within relevant ONR guidance. They assigned an LC22 IIS rating of 3 - Adequate.

53. The Control and Instrumentation inspector also reviewed LC22 (reference 20) in relation to the instrumentation modification to improve the earthing of the Essential Plant Protection Equipment (EPPE) speed sensor inputs and concluded that this had been performed with the appropriate process and to an adequate standard. The inspector's LC22 findings in relation to the Torness On-Line Computer System (TOLCS) and the Asset Management System (AMS) are summarised in section 3.3.2 of this report.

3.1.7 **Conventional Health and Safety** [HSAW IIS Rating 4 – Below standard]

54. The IR (reference 20) presents the findings of the ONR Non-Nuclear Health and Safety Inspector. The inspection focussed on NGL's arrangements for managing conventional health and safety (including contractor management), inspection of selected outage activities, and a review of work undertaken since ONR's intervention in December 2013 concerning ONR receipt of lifting equipment and auxiliary boiler statutory examination defect reports.

55. The inspection reviewed how information on specific hazards is communicated to contractors/EDF employees both during outage planning, and immediately prior to work commencing. It also examined NGL and contractor systems of work to see how they take account of and manage conventional health and safety hazards, including work at height, lifting operations, hot work, confined space work, and workplace transport movements, including loading/unloading vehicles. Also considered was NGL's monitoring and supervision of these arrangements.

56. The inspector visited a number of locations within and outside the RCA in order to sample the outage activities underway at the time of the visit and inspect the management arrangements in place.

57. The inspector concluded that Torness appears to have a good attitude towards managing conventional health and safety and have clearly put a significant amount of effort into managing the associated hazards during the outage. A number of priority non-start up related actions were identified during the inspection, such as control is not always being achieved, and in a number of cases compliance with legislative requirements is not currently being met. In such cases, the site committed to take prompt action to rectify the deficiencies identified. These actions will be addressed through routine interaction with the station.

58. Areas of good or best practice seen during the visit included oversight of high hazard work areas at the Outage Control Centre, e.g. confined space work, housekeeping, control of lifting operations by Alstom in the Turbine Hall, equipment in place to prevent falls during loading/unloading of vehicles, and machinery guarding in the engineering workshop.

59. Areas requiring improvement included: The use of a large forklift truck seen on the site, reviewing the EIM&T and operation of auxiliary boilers in light of statutory examination defects, assessment/management of the health risks posed by using metalworking fluids on the site, provision of asbestos information prior to work commencing, use of a mobile elevating work platform (MEWP) in the drum screen building and oversight of lifting equipment defects identified in statutory examinations.

60. Taking into account the generally good standards and prompt action by the site in relation to these matters, the inspector intends to write to the site and has assigned an Health and Safety at Work Act 1974 (HSAW) IIS rating of 4 – Below standard.

61. The inspector has confirmed that her inspection did not identify any conventional health and safety issues that prevent the return to service of R2.

3.2 ENGINEERING ASSESSMENTS

3.2.1 **Civil Engineering** [IIS Rating 3 – Adequate]

62. The Contact Report (CR) and Assessment Report (AR) (references 21 and 22) present the findings from the inspector's pre-outage visit and of the ONR assessment of the Pre-Stressed Concrete Pressure Vessel (PCPV) Appointed Examiner's (APEX) Start up Statement (referred to as "the statement"). The statement reports NGL's progress with the statutory surveillances, inspections and tests on the PCPV as described in the MS.

63. In accordance with the Pressure Systems Safety Regulations 2000 (PSSR), competent persons for the PCPV (NGL APEX Appointed Examiner) (reference 23), and the reactor penetrations (NGL competent person) and the balance of plant (Bureau Veritas) (reference 24) have each confirmed that they are content for R2 to start up. This is subject to completion of outstanding activities, including the final Vibrating Wire Strain Gauge (VWSG) report and the off-load top cap deflection survey. Commitments have been made that the outstanding activities will be completed prior to return to service and the results will be produced and discussed in detail within the '28-day report'.

64. The scope of the assessment covered inspections and tests of certain key safety-related components of the reactor pressure vessel including, tendon loads,

tendon anchorages, tendon corrosion, concrete surfaces, foundation tilt and settlements, vibrating wire strain gauges, vessel concrete liner temperatures, reactor coolant leakage, top cap deflections, tendon tensile strength and pressure vessel cooling water leakage. The recommendations within the previous '28-day report' were also discussed.

65. The inspector was satisfied with the data presented and the judgements of the APEX in the statement. Some of the inspection data was not available for ONR assessment and the inspector noted that it will be presented in the '28 day report'. The inspector therefore accepted the judgement of the APEX pending the issue of the '28-day report'.

66. The following ten recommendations, which do not prevent the start up of the reactor, were made and have been captured in the ONR issues database**:**

- Station to include the results of each tendon anchorage examination in the anchorage surveillance report. This recommendation should be completed before the next statutory outage for Torness.
- Station to include tendon grease sampling in the next statutory outage for Torness.
- APEX to consider tendons with low lift-off test results for strand withdrawal nomination. This recommendation should be completed within three years.
- EDF-NGL to provide guidance in interpreting the concrete crack inspection results and specifying action levels. This recommendation should be completed within three years.
- Station to implement the NGL Technical Guidance Note on management of thermocouples. This recommendation should be completed within three years.
- EDF-NGL to develop a procedure for managing the ageing and degradation of the VWSGs. This recommendation should be completed within three years.
- APEX to update EDF-NGL APEX inspection guidance to include the PCPV tilt using top cap deflection results. This recommendation should be completed before the end of 2016.
- Station to establish the action limits for the PCPV tilt which should consider the maximum relative movement that the pipework and other structural components connected to the PCPV can tolerate. This recommendation should be completed within three years.
- APEX to provide a benchmark value for comparing the top cap deflection survey results taking into account concrete creep and temperature effects. This recommendation should be completed before the next statutory outage at Torness.
- APEX to investigate the low top cap deflection results reported at survey point 6 and the high top cap deflection results on the peripheral survey points. This recommendation should be completed before the next statutory outage at Torness R2.

67. From the results of the surveillances, inspections and tests as reported in the documentation provided, the inspector judges that the PCPV is in adequate condition for return to service for the next three years of operation, subject to normal in-service surveillance. She has assigned an LC28 IIS rating of 3 – Adequate.

3.2.2 Control and Instrumentation Systems [LC28 IIS Rating 4 – Below Standard, LC22 ISS Rating 3 - Adequate]

68. The IR and AR (references 25 and 26) present the findings of the ONR assessment of a sample of control and instrumentation (C&I) systems and equipment important to nuclear safety as presented in the OID and its supporting documentation provided by NGL. These documents provided a description of the routine maintenance activities and engineering changes that were implemented during the outage.

69. The main focus of the inspection was to verify that relevant work activities have been carried out in relation to C&I equipment and systems important to safety in order to confirm that they remain fit for their intended purpose at Torness. This included a review of NGL's arrangements under LC22, modification or experiment on existing plant, and LC28, examination, inspection, maintenance and testing.

70. The scope of the assessment included the following plant, systems, equipment and activities:

- Testing of laddic circuits;
- Maintenance and testing of auxiliary guardline end contactors;
- Testing of neutron flux detectors;
- Investigation of errors in the Asset Management System;
- Review of the fuel standpipe temperature logger condition report;
- Review of a rod drive system fault condition report;
- Review of a boiler feed valve control computer condition report;
- Review of a quadrant protection system condition report;
- Security of safety systems;
- Modification of the Essential Plant Protection Equipment (EPPE) system;
- Torness on-line computer system (TOLCS) software updates; and
- Review of recent events:
  - Fuel standpipe temperature logger readings not updating;
  - R1 rod control system fault;
  - Boiler feed valve control computer failure;
  - R1 quad protection system trip.

71. The inspector visited a number of plant areas including the R2 safety circuit room, Instruments room 2, TOLCS computer room 2, and the Essential Supplies Building (ESB).

72. This inspection has found that the commitments made in the OID for C&I equipment and systems important to nuclear safety have been satisfied for those elements of work complete at the time of the inspection. Work activities covered during the inspection found that the workmanship applied was adequate and consistent with the standards expected from C&I suitably qualified and experienced persons (SQEP).

73. Actions were raised during the inspection. None of these actions require resolution prior to return to service of R2.

74. The inspection identified some deficiencies in the maintenance activities and documentation that had been completed in that some test pass criteria had not been met, and noted that this had not been identified by station staff. It also found evidence that the central maintenance Asset Management System (AMS) has had a number of entries corrupted and this has the potential to lead to safety system scheduled tests not being undertaken according to the maintenance schedule. Actions were raised against these deficiencies and an IIS rating of 4 (Below Standard) is assigned for compliance against LC28 (Examination, inspection, maintenance and testing). The inspector required the Station to put in place a plan of action to undertake a comprehensive check of all entries into the AMS to ensure that no further occurrences of mislabelling remain in the system. Recognising the magnitude of this task, this plan of action should aim to prioritise the more safety significant systems, and should be in place within 28 days of the consent to restart being granted by ONR.

75. The inspector assigned an IIS rating of 3 (Adequate) to LC 22 (Modification or experiment on existing plant) as a consequence of his review of the essential plant protection equipment and the TOLCS software updates.

76. Although some issues remained outstanding at the time of writing the AR, the inspector has received assurance from the Station that the remaining work will be completed in full, or the proposed way forward will be recorded under the Station's outage management and lessons learned arrangements, before return to service of R2.

77. Some of the C&I tests can only be carried out during return to service; therefore the results of these tests were not available at the time of the inspection. ONR will assess the test results, which will be part of the '28-day report', and respond accordingly through normal regulatory business.

78. Overall, the inspector found that, for the areas sampled, C&I activities undertaken had been conducted in accordance with the station work management system by SQEP. The inspector also found that, on completion of the planned and emergent work, no issues had been identified and supports consent to allow R2 at Torness to return to normal operating service.

3.2.3 **Electrical Engineering** [IIS Rating 3 – Adequate]

79. The IR and AR (references 27 and 28) present the findings of the ONR assessment of the electrical engineering work conducted during the outage period. The inspection considered the electrical work being undertaken as part of the R2 outage, including the planned work from the outage intentions document (OID), relevant documentation, and any emergent work in this area.

80. The majority of NGL's outage-related electrical work was directed towards maintenance of 11 kV and 3.3 kV electrical switchboards and switchgear, transformers (including Generator Transformer 2) and the generator load switch. Replacement was also undertaken of selected 415 V circuit breakers, 11 kV cables and essential UPS battery cells. The inspector's inspection focussed on these outage related electrical activities.

81. During the outage several interactions with Torness electrical engineering staff identified that the activities undertaken have been conducted in accordance with the station work control system, recorded appropriately in station documents and confirmed as complete by suitably qualified and experienced persons.

82. The inspector noted that the station's glanding, bonding and earthing drawings associated with the gas circulator arrangements were not complete as details for the variable frequency converters (VFCs) and variable speed drives (VSDs) were not included. The station has undertaken to rectify the shortcoming and also to highlight differences between the earthing arrangements for the VFCs and the VSDs. An issue has been raised and the inspector will track completion.

83. There were no significant emergent activities nor any associated issues which could affect nuclear safety at the time of the inspection and no deferrals are expected. With the majority of electrical outage work completed at the time of his AR he considered unlikely that significant electrical issues are likely to arise during the remainder of the outage. However, the inspector will continue to monitor progress and minor emergent activities against the OID.

84. Some maintenance activities remained to be completed at the time of the assessment but the inspector was content with the assurances received from NGL, and their processes, that these would be completed before the return to service and would be reported in the '28-day report'.

85. In relation to the electrical aspects of the outage, the inspector did not identify any issues of significance that should prevent ONR from granting consent to allow R2 to

restart. Therefore, the inspector recommended that consent was granted for R2 to start up following its 2015 outage. He has assigned an LC28 IIS rating of 3 – Adequate.

3.2.4 **Graphite Core Integrity** [IIS Rating 4 – Below Standard]

86. The IR and AR (references 29 and 30) present the findings of the assessment of the graphite core inspections. The scope of the assessment included confirmation of MS requirements and progress against them together with inspections of the core inspection equipment, calibration records of the core inspection equipment, quality of the graphite core inspection video footage, and training records of inspection staff.

87. Core inspections using New In-Core Inspection Equipment 2 (NICIE2): Due to a number of NICIE2 equipment failures, only 13 of the targeted 16 fuel channels were visually/ dimensionally inspected. The station considered that the risks presented by not attempting to achieve the targeted 16 channels of inspection were ALARP because no type III (>80% of brick height) axial cracking was observed in the 13 inspected channels which gives a greater than 99% confidence that the core has fewer than 5% cracked bricks. The INA supported this decision and also noted that there was no current formal MS requirement to inspect 16 channels. The inspector, although disappointed by the shortfall, considers that in considering the inspections from previous outages, the claim could be justified. He however noted that 13 was compliant with the MS requirements but only by virtue of the fact that a new graphite safety case has been delayed and was not in place prior to the outage as expected. [Note that subsequent to the inspection and the 13 NICIE2 channel inspections, an additional two NICIE2 channel inspections were undertaken in relation to the peripheral graphite brick cracking discussed below.]

88. Trepanning: At the time of the inspection 7 of a minimum of 30, and a target of 36 trepanned graphite core samples had been retrieved. Because the relatively small trepanning existing data set suggests that there are different rates of weight loss in R1 compared to R2 he expected final analysis of a minimum of 30 samples. Results on graphite weight loss will be in the ’28-day report’. [Subsequent to the ONR inspection, a total of 35 samples were retrieved for analysis.]

89. Calibration records and operating instructions: The inspector was satisfied that appropriate processes were in place and had been followed to ensure that the equipment was set-up and calibrated properly.

90. Training records: The inspector was satisfied that the staff performing the graphite inspections had been adequately trained and understood the purpose of the work.

91. Peripheral graphite brick cracking: During the inspection the inspector was notified that whilst conducting visual inspections of the steel core restraint system in quadrant C of the reactor core, a cracked graphite brick had been observed. The cracked brick was 1 of approximately 1600 that make up the outer graphite shield of the core and further inspections were being conducted to determine the extent of the problem. This issue is addressed further in the Emergent Issues section (3.4) of this report.

92. In conclusion, the inspector found the graphite inspection activities to be adequate. The inspector was not pleased with the reliability of the essential NICIE2 channel inspection equipment and has assigned an LC28 IIS rating of 4 – Below standard. A statement regarding consent to start up could not be made until full NGL and ONR assessment of the peripheral graphite brick cracking was complete (see section 3.4.1).

3.2.5 **Mechanical Engineering** [IIS Rating 3 – Adequate]

93. IR and AR (references 31 and 32) present the findings of the ONR assessment of the adequacy of the Mechanical Engineering-related activities conducted by the licensee

to comply with the requirements of LC28 – Examination, Inspection, Maintenance and Testing (EIM&T) against a sample of nuclear safety-significant reactor components.

94. The activities examined were selected due to their nuclear safety significance and included:

- EIM&T of gas circulators;
- EIM&T of safety significant valves;
- EIM&T of control rod assemblies;
- Standard of Nuclear Safety Significant Maintenance Facilities.

The inspection was supported by inspections of the Gas Circulator Maintenance Facility and the exterior areas of R2.

95. Two gas circulators were exchanged for overhauled units and two were removed for impeller inspection and re-installed during this outage. Based on the quality records sampled, the inspector was satisfied that EIM&T associated with the gas circulators is adequately controlled.

96. EIM&T arrangements for safety-significant valves were inspected and discussions held with the appropriate pressure system engineers. Activities associated with the main Gas Safety Relief Valves (GSRV) and by-pass Circuit Isolation Valves (BCIV), due to the importance of their respective safety functions to prevent overpressure of the PCPV, were examined.

97. During this outage, in accordance with NGL's Reactor Relief Discharge System Work instruction details, the Station carried out a full flow test of one of the four Reactor Relief Valves that protect against overpressure of the PCPV and performed a re-check of bursting disc integrity.

98. The inspector was satisfied that EIM&T associated with the safety significant valves has been adequately demonstrated, providing confidence that the work is carried out in a controlled manner.

99. NGL graph of the control rod drop times (from 1988 to present) indicated that there had been a gradual increase in the drop times over the years, but this had levelled out circa 2007. A similar trend had been recorded at Heysham 2 (HYB). Since that time, about 20 springs in the Control Rod Assembly (CRA) clutches are replaced during each overhaul. This has coincided with an improvement in control rod drop time performance. Overall the inspector was satisfied that EIM&T associated with the Control Rod Assemblies has been adequately implemented and controlled. He was satisfied that the maintenance undertaken by NGL, including the control rod drop tests were carried out in line with the requirements of the safety case, through the relevant technical specification and suitable and sufficient records have been kept and monitored to identify problems both reactively and proactively.

100. A fire hazard and a tripping hazard were identified and subsequently addressed within the Gas Circulator Maintenance Facility. Generally, record keeping was of a good standard but some minor lapses were identified during this inspection. These will be followed up as part of normal regulatory business. No regulatory issues or actions have been raised.

101. The mechanical engineering inspector was satisfied that the LC 28 arrangements in place are adequate and have been adequately implemented. He had no objection to the proposed activities associated with the release of hold point for Torness Power Station R2 to return to power for the next operating cycle. He assigned an LC28 IIS rating of 3 (Adequate).

3.2.6 **Structural Integrity** [IIS Rating 3 – Adequate]

102. IR and AR (references 33 and 34) present the findings of the ONR assessment of the structural integrity aspects of the licensee's examination, maintenance, inspection and testing of steel components with a nuclear safety function during the 2015 outage (including welds, pipework, vessels, components and metallic reactor internal structures but excluding those associated with inspection of the graphite core).

103. The inspector identified the following areas for sampling during the site inspection:

- Reactor Sea Water (RSW) cooling system inspections (including replacement programme);
- Steam and feed system in-service inspections;
- Reactor internal inspections (steel components);
- Pipe hanger and restraint inspections (including steam and CO_2 systems);
- Flow assisted corrosion inspections;
- Boiler inspection and monitoring.

104. The inspector reviewed the external and internal reactor and cooling water systems inspection programmes and noted that satisfactory progress was reported with no major issues relating to steel components.

105. He sampled video footage showing GH96 stand pipe insulation retaining clamp, carbon deposition on cover plates and a non-conformance record relating to a piece of debris. No significant issues that could affect the planned work were reported. Sentencing of non-conformances followed due process and was presented to the Outage Assessment Panel (OAP) as required. He was satisfied that the OAP also followed due process.

106. The Pressure Systems Safety Regulations (PSSR) Competent Person reported that work was progressing to plan and no significant issues had been found to date. In relation to the steam pipework hanger survey, the pre-outage hot hanger survey was complete and reported prior to his visit and the cold survey results were being audited by the contractor EAS Ltd. Following RTS, a post-outage hot survey will be performed.

107. The inspector undertook a sampling review of NGL's decision not to renew the flexible hoses based upon re-prioritising of resources. As such, instead of renewing the hoses as originally planned in the OID, detailed inspections were conducted and the licensee's metallurgist did not have any significant concerns relating to the integrity of those hoses inspected. The original intent for renewing the flexible hoses was to reduce the risk posed by failure of the hose from Stress Corrosion Cracking (SCC) and from asbestos contained within the hose structure and not in relation to any nuclear safety issues. Therefore, from the information provided and discussions on site, the inspector judged that the integrity of the Safety Relief Valve (SRV) flexible hoses was adequately managed during this outage.

108. Overall, the inspector concluded that, during his inspections, personnel were conducting their inspections in line with the pre-outage intentions documentation and associated inspection specifications. The inspections had not raised any nuclear safety-significant issues of concern and the licensee appears to be adequately managing any defects or anomalies identified whilst performing work to an adequate standard.

109. The inspector was satisfied that the licensee has undertaken sufficient inspection and assessment to support the safe return to service of Torness R2 from a structural integrity perspective, and no issues have been found that would prevent Torness R2 from returning to service for the next operational period. He has assigned an LC28 IIS rating of 3 - Adequate.

110. This conclusion was based on an amount of advance information that had yet to complete due process, and was therefore contingent on receiving a number of additional documents and assurances. These have been received and are satisfactory. The inspector has also used the minutes from the weekly OAP meetings to monitor for any emerging issues from the licensee inspections completed after his inspection and also found these to be satisfactory.

3.3 MEETINGS

3.3.1 Outage Intentions Meeting (OIM)

111. On 11th February 2015 the site inspector attended the Outage Intentions Meeting (OIM) (reference 35) for statutory outage of R2 at Torness. The purpose of the meeting was for the station to present the scope of work intended to be carried out in the R2 2015 statutory outage to ONR. In addition NGL presented an overview of the outage organisation, infrastructure and management arrangements to deliver the safety related activities being undertaken in order to meet the requirements of the relevant sections of LC28 and LC30.

112. The main issue discussed during this meeting was an existing draft Station request for deferral on an ONR commitment for GH/96 ISI inspection by manned vessel entry. No emergent nuclear safety issues that required a change to the proposed intervention task sheet for the upcoming outage were identified.

3.3.2 Mid-Outage Meeting (MOM)

113. The Mid-Outage Meeting (MOM) was held on 29th July 2015, day 19 of the outage programme (reference 36). This meeting was held relatively early in the planned outage schedule mainly due to staff availability and co-ordination of the outage and inspection schedule. ONR was represented by the Site Inspector and the Outage Project Inspectors. The INA was also present. The meeting was preceded by a walk down encompassing many of the work packages conducted during the outage.

114. The aim of the meeting was for NGL to provide ONR with an update of the outage progress up to 29th July and highlight any issues which might impact on the outage programme. The Strategic Outage Manager, with support from the appropriate NGL technical leads, provided details of general outage progress and issues.

115. Very good progress was being made against the outage schedule. A low number of minor injuries and one RIDDOR event (failure of a drawbridge support chain which had not led to injury) had occurred. There had been a few personal radiological contamination events recorded, although Graphite trepanning operations which traditionally lead to a greater incidence of personal contamination, had not yet begun.

116. Discussion on progress against the Outage Intentions Document (OID) included:

- Deferral of the physical inspection of GH96 Peripheral ISI plug repair clamp to the 2018 outage;
- An Engineering Change (EC) would be raised in addition to the Return to Service (RTS) EC for the pipe snubbers – this is due to a pre-existing condition noticed at HYB where a deviation from design has been noted. The snubbers on R2 pipework will be inspected during the outage (See EC355441 in section 3.4.2 below);
- Only 5 of 8 fuel channels were inspected with the reactor in the Offload Depressurised Refuelling (ODR) conditions due to problems with the NICIE2 inspection equipment and the reactor make-up shield. The Graphite

Assessment Panel (GAP) had endorsed the decision to proceed without completing all 8 channels. The justification for this decision was requested, and it was asked whether the 8 channels planned for inspection with the reactor "in air" could be increased to 11 to compensate. EDF agreed to provide the minutes for the GAP meeting. The number of fuel channels "in air" cannot be increased due to current safety case constraints. It was noted that a separate meeting has been arranged between ONR and EDF to discuss this issue. It was also noted that EDF are working on contingency plans if there are further problems with the NICIE2 equipment;

- A category 2 EC has been raised to justify the reason why eddy current inspection[1] of selected boiler orifice extension pieces (OEP) is no longer required. This is because a wider programme of inspections has been completed;
- The sealed flexile hoses currently fitted to the main and reheat steam safety relief valve will now no longer be replaced – inspections indicate this is not required;
- The HP turbine is now undergoing repair as damage was observed to the rotor shaft and hydrogen seals. The main rotor is being replaced with a spare. Additional work was also identified to repair end winding support brackets;
- The replacement of selected Auxiliary Cooling Water (ACW) system pipework with a High Density Polyethylene (HDPE) equivalent will be delayed to the next outage.

117. The remaining key risks to the outage were identified as the gas circulator impeller inspections (any damage observed may require time consuming repair) and the main vessel SRV full flow test (this has not been done before).

118. The INA agreed that a draft of the Concurrence Report would be provided to ONR approximately one week prior to request to re-start.

119. The majority of ONR inspections were still to take place and three administrative non-return to service ONR outage actions were agreed.

3.3.3 Start Up Meeting (SUM)

120. The Start up Meeting (SUM) (reference 37) was preceded by a comprehensive plant walk-down on 18th August 2015. ONR was represented by the Superintending Inspector, the Site Inspector, and the Outage Project Inspectors. The walk down encompassed many of the work packages conducted during the outage.

121. Although most of the OID milestones had been achieved by the time of this meeting, a significant amount of intrusive work, re-commissioning, final cleaning, and scaffolding removal had still to take place.

122. The SUM was held on 19th August 2015, chaired by the station Outage Strategic Manager, and was attended by the ONR Superintending Inspector, Site Inspector and the Outage Project Inspectors. The purpose of the SUM was for the licensee to demonstrate that it had adequately met the requirements of the MS, dealt with emergent issues and demonstrated the safety of R2 for the next operational period. The Torness R2 2015 Outage Start up Report (reference 38) was provided prior to the meeting and was used as the basis for the presentations and discussions held during the meeting.

[1] Eddy current inspection: a non-destructive inspection technique that uses electromagnetic induction to detect flaws in conductive materials.

123. ONR discussed the actions raised during their inspections and assessments, of which two required closure prior to granting consent to start up. The most significant related to the cracking identified in a number of peripheral graphite bricks which is described further in the graphite assessment section 3.2.4 above and as an emergent issue in section 3.4 below. The second related to the discrepancy of inspections dates in the written scheme of examination for the PCPV tendon lift-off test and anchorage strand inspections. These actions were subsequently confirmed as closed with responses and acceptance recorded in the ONR action tracking log (reference 39).

3.4 EMERGENT ISSUES

124. During the outage inspection and maintenance activities, defects in plant condition were identified which required unplanned additional work and safety justification. The emergent issue of significance to return to service is the identification of cracks in the core peripheral graphite bricks.

3.4.1 **Peripheral Graphite Brick Cracking** [IIS Rating 3 – Adequate]

125. As referenced in section 3.2.4 above and described in IR and AR (references 29 and 30) for the graphite core inspections, during NGL's visual inspections of the steel core restraint system in quadrant C of the reactor core, a cracked graphite brick was observed. The cracked brick is one of approximately 1600 that make up the outer graphite shield. Further inspections revealed 16 unexpected cracks in the graphite peripheral shielding bricks of quadrants A, C and D. These peripheral shielding bricks are a feature that is unique to the Heysham 2 (HYB) and Torness reactors. The design intention of the peripheral shielding wall is to partially direct re-entrant gas flow to cool the core, and to cool the core restraint rods and inserts; partially to support the weight of the horizontal restraint beams; and partially to contribute to the shielding of the components outside of the graphite core. The steel members of the core restraint structure pass through them to anchor points in graphite bricks further into the core. Subsequent NGL reviews of previous outage inspection data from 2012 revealed what appears to have been a crack present at that time. At ONR's request, NGL performed a repeat inspection of this known crack in quadrant B and confirmed that the crack had not shown any sign of development and remained the same size as in 2012. There are therefore 17 cracks known to exist in about 1200 inspected bricks, representing about 1.5% of those inspected.

126. The ONR safety assessment principles (SAP), particularly EGR.1 state: *The safety case should demonstrate that either: (a) the graphite reactor core is free of defects that could impair its safety functions; or (b) the safety functions of the graphite reactor core are tolerant of those defects that might be present.*

127. With the SAPs in mind ONR's graphite assessor is of the view that NGL's argument that the core is tolerant to the damage that has been found in the peripheral shielding bricks is not yet fully supported by detailed analysis but considers that the core's safety functional requirements would not be challenged in the short term.

128. NGL have described the three significant potential challenges to core safety as; the potential consequences of debris, flow diversion, and structural movement. In addition, the bricks have a shielding function. The key evidence provided to support the position that these will not affect core safety, and accepted by the ONR assessor, is as follows:

- Consequence of Debris
  - Due to the location of the peripheral shielding bricks, it is highly unlikely that debris of any size could cause problems for fuel cooling.

- It is noted that there are existing cases that address the consequences of debris and these are considered to be sufficient at present.

- Flow Diversion
  - The current crack size will not challenge the function of the peripheral shielding bricks in directing the re-entrant gas flow.
  - NGL judge that for larger areas of damage with all or part of a shield brick missing, there would not be a significant flow perturbation. This is considered reasonable in the context of a single or small number of damaged bricks.
  - It is judged that any flow diversion is unlikely to have any short term effect. Longer term effects on graphite oxidation are possible and will need eventually to be addressed by NGL.

- Structural Movement
  - 13 fuel channels were inspected as part of the planned outage inspections and further 2 channels near the periphery of the core were inspected following the discovery of the cracked peripheral bricks. No unusual brick shapes were found and there was no evidence of unexpected or unusual core distortion.
  - Only 17 cracked peripheral shielding bricks have been observed out of 1200 inspected (1600 total) – approximately 1.5%. This will have little impact on the core restraint system, which has significant structural redundancy.
  - NGL review of inspection results of the core restraint system at Torness R2 in 2015 and historical inspection evidence from all four reactors at Torness and Heysham 2 suggests that the restraint systems are in good condition with no indication of any unexpected movements.

- Shielding of external components
  - A physical crack in a brick will not have significant effect on its shielding properties.
  - Since the neutron dose at the outer graphite brick layer is low and the through-thickness gradient in dose is low, possible gaps in the peripheral shielding layer due to a relatively low number of cracked bricks will not have a significant effect on the shielding of external components.

129. In addition, cracking caused by indirect damage mechanisms (damage caused by forces external to the peripheral brick system) would cause abnormal behaviour of the active core, therefore, the routine monitoring and inspection during reactor operation should provide early indications of any challenge to the nuclear safety requirements of the graphite core.

130. ONR's graphite assessor is content that sufficient evidence has been provided to indicate that no effect is apparent to challenge the core's safety functional requirements. NGL is also able to monitor various reactor parameters, such as control rod movements, fuel handling and any channel power discrepancies to demonstrate that the core is operating normally and that its safety functions would not be challenged. They are therefore likely to have a forewarning of any significant change in the condition of the core. Therefore, the assessor does not have any objection to Torness R2 returning to service with such a small proportion (1.5%) of cracked peripheral shielding bricks. This judgement has been supported through peer review and by ONR's Professional Lead in approving the AR.

131. The assessor considers it necessary that the present Interim Justification for Continued Operation (IJCO), covering the other three Torness and Heysham 2 reactors (of similar design to R2), should be replaced by a Justification for Continued Operation (JCO) by the end of October 2015. NGL have committed to doing this.

132. The assessor also considers it necessary for NGL to perform a more detailed study of the possible consequences and to establish the extent of the tolerable damage of the peripheral shielding bricks. This needs to be presented in a safety case for all four reactors before April 2016, noting the forthcoming Heysham 2 R8 outage in September 2016. This may need to justify safe operation of the core with a certain extent (proportion and morphology) of cracking in the peripheral shielding bricks. This is likely to require that more detailed whole core modelling be performed to understand the tolerable limits of cracking in the peripheral shielding bricks and the consequence of cracking in the peripheral shielding bricks caused by failure or distortion of the core restraint system. The safety case may also need to contain the results of thermal hydraulic modelling to demonstrate that cracking in the peripheral shielding bricks does not have any long term consequences on core parameters. NGL have committed to producing such a safety case by the end of March 2016.

133. In EC356528: Justification for return to service of Reactor 2 with cracks observed in graphite peripheral shield bricks and INSA concurrence (references 42 and 43). NGL have made a commitment to undertake mid-cycle inspections of R2 peripheral graphite bricks, unless an adequate safety case can be made for this not to be necessary.

134. With respect to general graphite ageing issues, the assessor has also recommended that NGL should provide an updated Heysham 2 / Torness post stress reversal safety case (NP/SC 7663) before the end of 2017 and include visual inspection of all four quadrants of the shielding bricks for the next Heysham 2 and Torness outages.

135. The assessor noted the licensee has made suitable commitments to address all these concerns (detailed in reference 42) and therefore considers that the safety case for returning R2 back into operation is adequate. ONR will monitor progress against these commitments via the ONR Issues Database and through the ONR Site Inspectors for Torness and Heysham 2.

136. Based on the adequate quality of the Licensee's safety cases, that suitable commitments to further work and a mid-cycle inspection have been made, the assessor has assigned an IIS rating of 3 (Adequate).

3.4.2 Engineering Change Submissions

137. The following five ECs have been submitted to ONR prior to start up:

- EC350524: Return to service EC to collate the results of inspections: Torness Reactor 2 statutory outage 2015. (References 10 and 11)
- EC355441: JCO for operation of Reactor 1 and 2 following discovery of loose fasteners on HYB R7 hot reheat seismic snubber clamps. (References 40 and 41)
- EC356528: Justification for return to service of Reactor 2 with cracks observed in graphite peripheral shield bricks. (References 42 and 43)
- EC356558: Justification for operation of pressure tapped PISI standpipes and all FMA standpipes on Reactor 2 following inspections during the 2015 statutory outage. (References 44 and 45)
- EC356682: Fitting Of Secondary Seal Clamp To Lower ISI Closure Housing 2B2 and 2B3 On Reactor 2. (References 46 and 47)

138. Receipt of the INSA certificates confirms that these ECs have passed through due process.

4 MATTERS ARISING FROM ONR'S WORK

139. I have considered the licensee's request to ONR to grant a consent under LC30(3) to start up Torness R2 on completion of its periodic shutdown. To inform my work I have taken note of the statements associated with safety contained in the request letter, the findings of the periodic shutdown associated work undertaken by NGL's internal regulator, INA, the statements of the PSSR competent persons and the findings and opinions of ONR specialist inspectors and the ONR site inspector.

140. In reference 1, the Torness Station Director stated that, subject to the satisfaction of the Station Return to Service Panel, independent substantiation by the Station Operational Safety Review Committee, and his personal review of the Committee's recommendation, of the completion of the remaining activities identified in attachments 2, 3 and 4 of his letter, he is satisfied that R2 is fit for return to service and sufficient procedures are in place to assure safe operation through to the next shutdown. Satisfactory completion of the additional work identified in the attachments will be reported in '28-day report'.

141. INA has provided its Concurrence Part B (Reference 9), which confirmed that they have completed the periodic shutdown assurance activities specified in their pre-outage Part A Concurrence statement (reference 8). INA considers that there are no issues remaining with respect to the requirements of Part A and that the Torness Management System Arrangements are sufficiently robust to safely complete any remaining work. They therefore support the start up and subsequent operation of R2 within the constraints of the current safety case. Where INA assessment identified shortfalls in station practice they state that adequate remedial actions have been taken to correct any findings of immediate significance. INA concerns relate to process deployment shortfalls which had the potential to affect nuclear safety, namely the timely delivery of ECs, the status of project documentation, in-field use of quality plans and documentation and on the opportunity to improve performance in these areas for future outages. Key details are presented in Appendix A of Part B and a separate report will be provided using the INA standard surveillance reporting format to cover the more detailed findings.

142. The PSSR competent persons for the PCPV, the reactor penetrations and the balance of plant have each confirmed that they are content for R2 to start up.

143. ONR specialist assessors from the various disciplines and the site inspector undertook inspections to support my permissioning work.

144. Each discipline has produced a report that presents the inspection findings, inspector's opinions, judgements and recommendations. A number of recommendations and actions arose from the inspectors' work which are recorded in the ONR Torness 2015 R2 Outage Action Tracker (reference 39). None of the outstanding actions have been deemed sufficiently significant for ONR to withhold consent to start up R2. In particular, NGL has completed sufficient inspections for me to recommend that ONR grant consent to restart with the cracking in peripheral graphite bricks and has made appropriate commitments to further work and an interim shutdown for further inspections around the mid-point of the three year operating cycle. All the inspection and assessment reports contain either a statement supporting issuing consent to start up R2, or note that there is no reason to withhold consent and these have all completed peer review and Professional Lead sign-off where necessary. I consulted with other relevant regulators, SEPA and CNS, to establish if either had any specific objections that would prevent ONR from issuing LI 537, consent to start up Torness R2. Both the SEPA (reference 48) and CNS (reference 49) confirmed they do not object to ONR granting Consent.

5 CONCLUSIONS

145. The Torness Reactor 2 (R2) periodic shutdown has been undertaken in accordance with the requirements of the work scope outlined within the NGL Outage Intentions Document.

146. The licensee has followed its arrangements in undertaking the periodic shutdown, culminating in the Torness Station Director writing to ONR requesting consent to start up Reactor 2 (R2). He states that on completion of the remaining activities identified in attachments 2, 3 and 4 of his letter, he is satisfied that R2 is fit for return to service and sufficient procedures are in place to assure safe operation through to the next shutdown. Satisfactory completion of the additional work identified in the attachments will be reported in the '28-day report'.

147. The licensee's internal regulator, Independent Nuclear Assurance (INA), has provided the Concurrence Part B report that supported the return to service of Torness R2 post its periodic shutdown.

148. The Pressure Systems Safety Regulations 2000 (PSSR) competent persons have each confirmed that they are content for R2 to start up.

149. ONR inspectors have sampled the safety management and engineering activities throughout the shutdown and judged them to be adequate, and all support issuing consent to start up R2. All actions raised during their inspections and assessments have been satisfactorily addressed or have acceptable plans for resolution.

150. The most significant issue arising from discipline Specialist Inspector inspections and assessment relates to the peripheral graphite brick cracking. NGL have made a number of commitments to address this issue for both R2 and the similar reactor designs of R1 and Heysham 2 R7 and R8. ONR Site Inspectors will monitor progress against these commitments via the ONR Issues Database.

151. I consider that the licensee delivered a shutdown that was safely managed and completed the required safety related work activities.

152. I am satisfied that, noting NGL's commitment to an interim outage inspection of peripheral shielding bricks, the licensee's justification to start up R2 and operate to the next shutdown is adequate; consequently, consent to start up the reactor can be granted.

153. I have prepared Torness Licence Instrument 537, for Licence Condition 30(3) Consent, in conjunction with this Project Assessment Report. The licence instrument is one of the standard formats given within ONR procedures and does not require review by the Solicitors Office.

6 RECOMMENDATIONS

154. I recommend that the Superintending Inspector:

- Signs this Project Assessment Report to confirm support for the ONR technical and regulatory arguments that justify issuing Torness Licence Instrument 537.

155. I recommend that the Deputy Chief Inspector signs Torness Licence Instrument 537, which grants consent under Licence Condition 30(3) attached to Nuclear Site Licence No.Sc14 to start up Torness Reactor 2.

REFERENCES

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12. ONR Task Sheet for Torness Reactor 2 outage inspections TS 343, February 2015. (Trim ref 2015/69060)
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16. ONR Contact Report for Level 4 Meeting With EDF NGL Fleet Fire Safety Manager on 4th August 2015. ONR CNRP Internal Hazards inspector, 17th August 2015. (Trim ref 2015/305935)
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19. ONR Torness R2 2015 Outage Technical Discipline Intervention Record: Management of Modifications, ONR-CNRP-TOR-IR-15-044 Rev 0, 3rd July 2015. (Trim ref 2015/243738)
20. ONR Torness R2 2015 Outage Technical Discipline Intervention Record: Conventional Health and Safety, ONR-CNRP-IR-15-33 Rev 0, 1st September 2015. (Trim ref 2015/325320)
21. ONR Contact Report for Civil Engineering Meeting to Discuss Apex Work On Reactor 2 Outage 2015, ONR-TOR-CR-15-100, 3rd July 2015. (Trim ref 2015/247105)
22. ONR Torness R2 2015 Outage Technical Discipline Assessment Report: Assessment of the Pre-Stress Concrete Pressure Vessel Appointed Examiner Start up Statement, ONR-TOR-AR-15-039 Rev 0, 7th August 2015. (Trim ref 2015/279981)

23. E/EAN/BNCB/0867/TOR/15 Rev 000 – Torness Power Station. Reactor 2 Pre-stressed Concrete Pressure Vessel. Statutory Outage 2015. Appointed Examiner Start up Statement. (Trim ref 2015/291944)
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41. EC355441: INSA certificate for Engineering Change EC355441 version 02, 2nd September 2015. (Trim ref 2015/328635)
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43. EC356528: INSA certificate for Engineering Change EC356528, 4th September 2015. (Trim ref 2015/331905)
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APPENDIX 1 - SUMMARY OF 2015 TORNESS REACTOR 2 OUTAGE INTENTIONS

Key items of outage scope include:

- Inspection of 16 Fuel Channels & 1 Control Rod Channel;
- Graphite Trepanning of 35 samples (7 samples from each of 5 channels);
- 2 Gas Circulator exchanges and 2 Gas Circulator impellor inspections;
- HP Turbine inspection, rotor replacement and repair of stellite ingestion damage (from previous governor valve failure);
- HP Governor Valve seat and module replacements (to remove valve failure risk);
- Condenser Level Control Valve (TG2-WC-0258) replacement;
- Operational Focus defect repairs: 7 Operator Distractions (OB, CRA, CRD), 22 oil leaks, 42 water leaks and 13 steam leaks;

The planned outage critical path runs through Reactor De-fuelling, Cool down and Depressurisation, Off-Load Depressurised Refuelling (ODR/Fuel Channel Inspections), Purge to Air, Gas Circulator Inspections/Exchanges, Purge to CO_2, Refuelling, Re-pressurisation and Start up. Bypass Gas Plant work (including drier desiccant exchange) and the Turbine programme are both marginally sub-critical.

Key outage risks included: Potential for ODR delay due to failed fuel (failures have been detected during depressurisation in the last two Torness outages), Hot Reheat Air Release Branch inspections/repairs, Gas Circulator Impellor Inspections, HP Turbine Inspection/Repairs and Generator Stator End Winding Support Bracket Inspections. Contingency plans were in place for each of these. Remote visual inspection of the GH96 standpipe/clamp arrangement was also a key activity in support of vessel entry deferral to 2018. A full set of Discovery Milestones, encompassing these and several other identified risks of emergent/extended scope, were tracked within the outage programme.

There is a significant plant investment delivery associated with the outage. Strong Projects integration and engagement in outage preparation has enabled optimisation of this workscope to minimise outage content and programme risk. This close working with Projects should continue through the execution phase to complete the following workscope:

- Grid Disturbance Protection replacement for Unit 2 supplies (Station 1 & 2 supplies have been replaced pre-outage) - this removes risks associated with multiple reactor trips;
- Gas Circulator Variable Speed Drive (VSD) commissioning on 2A quadrant - on-load installation was completed in June 2015. Final commissioning took place post-trip and during reactor de-pressurisation. Additional mitigation work on earthing arrangements has also been completed in response to OPEX from the Heysham 2 R715 outage earlier in 2015. This work is part of a programme, commenced on R1 in 2014, to replace 50% of the existing Variable Frequency Convertors (VFCs) at Torness and Heysham 2;
- Bypass Installation on four Essential & four Non-Essential UPS Systems (enabling future on-load UPS replacement);
- 415V Air Circuit Breaker Replacement (six ACBs on four boards);
- Replacement of eight battery systems;
- Continuation of 11kV cable replacement programme (including three Gas Circulators);
- CW Pump 2A shaft & mechanical seal replacement;

Continuous Improvement

The preparation activities for the outage took account of the lessons learnt from previous statutory outages, along with key learning points identified from other NGL sites. In addition the recommendations from INA Rapid Trending Reports were reviewed. Some of the improvements NGL tried to incorporate into this outage included greater focus on:

- Cooling Water (CW) plant commissioning;
- Essential electrical board isolations;
- Maintenance resource;
- Adherence to Pre-outage milestone plan (POMP);
- Emergent work process.