



| PROJECT ASSESSMENT REPORT | | | |
|--|---|------------------|-------------|
| Unique Document ID and Revision No: | ONR-OFD-PAR-17-006 Revision 0 | TRIM Ref: | 2017/271134 |
| Project: | Dungeness B Reactor 21 Periodic Shutdown 2017 | | |
| Site: | Dungeness B | | |
| Title: | EDF Energy Nuclear Generation Limited (NGL) – Dungeness B – consent under Licence Condition 30(3) to start-up Dungeness B Reactor 21 following the 2017 Periodic Shutdown | | |
| Licence Instrument No: (if applicable) | 554 (Consent) | | |
| Nuclear Site Licence No: | 61 | | |
| Licence Condition: | 30(3) | | |

Document Acceptance and Approval for Issue / Publication

| Role | Name | Position | Signature | Date |
|---------------------------------------|------------|------------|-----------|------------|
| Author | [Redacted] | [Redacted] | | [Redacted] |
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| Accepted by ¹ | [Redacted] | [Redacted] | | [Redacted] |
| Approval for publication ² | | [Redacted] | | [Redacted] |

Revision History

| Revision | Date | Author(s) | Reviewed By | Accepted By | Description of Change |
|----------|------------|------------|-------------|-------------|---|
| A | [Redacted] | [Redacted] | [Redacted] | [Redacted] | 1 st draft for DL review |
| B | [Redacted] | [Redacted] | [Redacted] | [Redacted] | 2 nd draft incorporating DL comments |
| 0 | [Redacted] | [Redacted] | [Redacted] | [Redacted] | 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 | [Redacted Name] | |
| Environment Agency | [Redacted Name] | |
| Licensee | [Redacted Name] | |

Dungeness B Reactor 21 Periodic Shutdown 2017

**EDF Energy Nuclear Generation Limited (NGL) – Dungeness B – Consent under Licence
Condition 30(3) to start-up Dungeness B Reactor 21 following periodic shutdown**

Project Assessment Report ONR-OFD-PAR-17-006
Revision 0
1 September 2017

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Published October 2017

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EXECUTIVE SUMMARY

Title

EDF Energy Nuclear Generation Limited (NGL) – Dungeness B – Consent under Licence Condition 30(3) to start-up Dungeness B Reactor 21 following periodic shutdown.

Permission Requested

NGL, the licensee of Dungeness B power station, has requested that the Office for Nuclear Regulation (ONR), grants consent to start-up Reactor 21 following its periodic shutdown as required under Licence Condition (LC) 30(3) of nuclear site licence number 61.

Background

Dungeness B is comprised of two operating Advanced Gas-cooled Reactors, known as Reactor 21 and Reactor 22. To continue to operate safely and reliably; systems, structures and components important to safety require regular and systematic examination, inspection, maintenance and testing. Whilst some of these activities can take place when the reactor is at power, many of them require it to be shut down. In addition, the licensee also undertakes plant safety improvements to be implemented where these are deemed to be reasonably practicable. The licensee's arrangements require that periodic shutdowns, as required by LC 30(1), are carried out triennially at each reactor at Dungeness B. On completion of a periodic shutdown the reactor concerned cannot be started up without consent from ONR under LC 30(3).

During the Reactor 21 periodic shutdown 2017 which commenced on 16 June 2017, the licensee has conducted:

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

Where inspection work revealed the potential for an adverse plant condition, the licensee has assessed the inspection results in accordance with its arrangements and taken appropriate remedial action as necessary prior to reactor start-up.

Towards the end of the periodic shutdown, the Dungeness B Station Director wrote to ONR requesting consent to start-up Reactor 21. In that letter, the Station Director confirmed that all maintenance required for start-up would be completed.

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

ONR inspectors have inspected a sample of 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 examine aspects of the implementation of the licensee's arrangements.

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 21, and its operation until the next periodic shutdown.

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.

No matters preventing the granting of consent to start-up arose from the work undertaken by ONR inspectors in relation to the Dungeness B Reactor 21 periodic shutdown 2017.

Conclusions

Following assessment and inspection of matters arising in relation to the Dungeness B Reactor 21 periodic shutdown 2017, I am satisfied that the licensee's justification to start-up the reactor and operate for a further period is adequate; consequently, consent to start-up the reactor should be issued by ONR.

Recommendation

I recommend that in accordance with the request from the licensee, ONR should grant consent under LC 30(3) attached to Nuclear Site Licence No: 61 for Reactor 21 at Dungeness B nuclear power station to start-up following the 2017 periodic shutdown, and Licence Instrument 554 be issued to the licensee.

LIST OF ABBREVIATIONS

| | |
|-------|--|
| ALARP | As low as reasonably practicable |
| APEX | Appointed Examiner |
| C&I | Control and Instrumentation |
| DNB | Dungeness B Power Station |
| DWTS | Diverse Winch Trip System |
| DRO | Double Reactor Outage |
| EA | Environment Agency |
| EIM&T | Examination, Inspection, Maintenance and Testing |
| EC | Engineering Change |
| GC | Gas Circulator |
| GSRV | Gas Safety Relief Valve |
| INA | Independent Nuclear Assurance |
| IRR99 | Ionising Radiations Regulations 1999 |
| LI | Licence Instrument |
| LC | Licence Condition |
| LPG | Liquid Petroleum Gas |
| MDL | Minimum Design Load |
| MS | Maintenance Schedule |
| NGL | EDF Energy Nuclear Generation Limited |
| OID | Outage Intentions Document |
| ONR | Office for Nuclear Regulation |
| PAR | Project Assessment Report |
| PCPV | Pre-stressed Concrete Pressure Vessel |
| PSSR | Pressure Systems Safety Regulations 2000 |
| RCA | Radiation Controlled Area |
| RTR | Rapid Trending Review |
| RTS | Return To Service |
| SCTS | Single Channel Trip System |
| SCC | Station Control Centre |
| WSFS | Water Spray Fire System |

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1 PERMISSION REQUESTED

1. EDF Energy Nuclear Generation Limited (NGL), the operator and Licensee of Dungeness B power station (DNB), has written (Reference 1) to the Office for Nuclear Regulation (ONR) requesting consent under Licence Condition (LC) 30(3) to start-up Reactor 21 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 Reactor 21 through issuing Licence Instrument (LI) 554.

2 BACKGROUND

2.1 GENERAL

2. The nuclear site licence issued to NGL for DNB requires the Licensee to periodically shut down plant under LC30. This is to enable examination, inspection, maintenance and testing to take place in accordance with the requirements of DNB's Plant Maintenance Schedule (MS) under LC28. At DNB, reactor periodic shutdowns are undertaken triennially as specified in the MS Preface, which is an Approved document under LC28(4). NGL also undertook work during the shutdown associated with the requirements of Pressure Systems Safety Regulations 2000 (PSSR), previous commitments, and plant safety improvements/ modifications.
3. ONR had specified (Reference 2) that the Licensee required consent from ONR under LC30(3) to start-up Reactor 21 following a periodic shutdown. The previous consent to start-up Reactor 21, Dungeness B LI 543 (Reference 3), was dated 18 June 2014 and the Reactor 21 periodic shutdown 2017 commenced on 16 June 2017.

2.2 OUTAGE PLANNING AND MANAGEMENT

2.2.1 Outage intentions

4. NGL's planned outage work programme was outlined in the Dungeness B Outage Intentions Document (OID) (Reference 4). This was examined by ONR specialist inspectors and the nominated site inspector in preparation for the outage intentions meeting held on 13 December 2016 (Reference 5).
5. During the Reactor 21 periodic shutdown 2017 NGL would be conducting:
 - Examinations, inspections, maintenance and testing activities in accordance with the MS;
 - Inspections to support the station safety case;
 - Work to comply with statutory requirements;
 - Remedial work to rectify plant adverse conditions; and
 - Plant safety improvements where these are deemed to be reasonably practicable.
6. The notable packages of work to be undertaken were:
 - Unit transformers replacement;
 - Water spray fire system (WSFS) – overhaul of R21/R22 common plant; and
 - Boiler inlet and outlet header inspections.
7. In common with the rest of the NGL fleet, an island approach was to be adopted to plan and manage the outage activities. This approach co-located relevant personnel

for each island (planning, engineering, operations and maintenance) in the Station Control Centre (SCC). The following island teams were deployed:

- Reactor Island;
 - Boiler area
 - Gas circulator area
 - Reactor balance area
 - Conventional Island;
 - Turbine area
 - Conventional balance area
 - Fuel Route Island;
 - Electrical Island; and
 - Operations Island.
8. During statutory outages at DNB there is a requirement to shut down both reactors, a double reactor outage (DRO), to enable the isolation of parts of the cooling water systems to allow inspection and maintenance. This is usually conducted at the start and the end outage, to isolate then relink water culverts. Prior to the outage commencing, NGL decided to conduct a single DRO with a longer shutdown period. This would be the first time this had been tried and would allow more extensive maintenance of systems common to both reactors.
9. Early in the outage the scope of the work in the OID was increased to conduct additional boiler header inspections and to recover some foreign material found in one of the boiler tubes during initial inspections.

2.2.2 Licensee's outage management

10. The outage has been managed in accordance with the requirements of NGL's integrated company practice BEG/ICP/OPS/009 'Outage Management Process'.
11. In line with NGL's arrangements, a team of Independent Nuclear Assurance (INA) inspectors, NGL's own internal regulator, and outage staff from other stations, conducted a rapid trending review (RTR) during the second week of the outage; this was observed by the ONR nominated site inspector (Reference 6). The RTR identified points of positive feedback as well as highlighting areas for improvement during the outage.
12. A Mid-Outage Meeting was held on 18 July 2017, the purpose of which was to allow NGL and ONR to review the progress and developments with the periodic shutdown (Reference 7). A Start-Up Meeting was held on 16 August 2017 for NGL to demonstrate it had adequately met the requirements of the MS, dealt with emergent issues, identified any additional actions to be completed and demonstrated the safety of Reactor 21 for the next operational period (Reference 8).
13. On 23 August 2017, the DNB Station Director wrote to ONR requesting consent to start-up Reactor 21 on completion of the periodic shutdown (Reference 1). NGL will convene an Operational Safety Review Committee prior to start-up to review the fitness for service of the plant and endorse return to service.
14. INA independently supported the request to start up the reactor following the outage when it was satisfied that the reactor was in a fit state to be restarted and that the associated risks were both tolerable and ALARP.
15. INA sought assurance that the material state of the plant was acceptable to support safe operation and that activities undertaken during the outage were conducted with

due regard for nuclear safety through a series of assessment activities detailed in their Concurrence Part A (Reference 9). A statement to support the request for consent to start up (Reference 10), was provided in advance of the formal concurrence part B statement, in-line with NGL arrangements (SRD/PROC/009).

16. NGL produced a Return To Service (RTS) Engineering Change (EC) (Reference 11) that approves the results of inspections completed in the outage inspection programme. INA has issued an Independent Nuclear Safety Assessment approval statement (Reference 12) for the RTS EC.
17. The PSSR competent persons (for the Pre-stressed Concrete Pressure Vessel (PCPV), the reactor penetrations and the balance of plant) have each confirmed that they are content for Reactor 21 to start up (References 13, 14 and 15).
18. Following ONR's issue of its consent to allow Dungeness B Reactor 21 to return to service, during the reactor start-up and raising to full power there will be further tests and inspections which can only be conducted at this time. The results of these, and other inspections conducted during the shutdown which required further analysis, will be published after return to normal operation in a document known as the '28 day report'.

2.2.3 ONR's intervention management process

19. The ONR activities in support of the outage were planned and recorded in the ONR outage plan for the Dungeness B Reactor 21 Outage 2017 (Reference 16).
20. The scope of the interventions and assessments was determined by conducting reviews of:
 - Scope of work for the outage as indicated by the OID;
 - Previous outage reports and actions;
 - Recent regulatory attention;
 - Operational experience and outstanding issues recorded in the regulatory issues database;
 - Specialism specific areas of interest; and
 - Other areas of interest which could only be assessed during an outage period.
21. The following ONR specialisms were identified as required for the DNB R21 outage 2017 project:
 - Graphite
 - Civil engineering
 - Structural integrity
 - Mechanical engineering
 - Electrical engineering
 - Control and instrumentation systems
 - Radiological protection
 - Nuclear liabilities
 - Fire safety
 - Quality management systems
 - Conventional safety
 - Site inspection oversight
22. ONR's process for delivering a permissioning project requires preparation of a PAR to support the permissioning decision by the Delegated Authority. The PAR is informed

by the intervention findings of the inspectors assigned to the project to allow the Delegated Authority to consider issuing Consent for the restart of the reactor.

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

23. The work undertaken by ONR can summarised as follows:

- Engineering assessments and inspections of maintenance, modifications and other work during the outage covering the following areas:
 - Graphite core integrity
 - Civil engineering
 - Structural integrity
 - Mechanical engineering
 - Electrical engineering
 - Control and instrumentation
- Assessment of the safety management of the outage including:
 - Radiological protection
 - Nuclear liabilities
 - Fire safety
 - Management systems
 - Conventional safety
 - Management of modifications
 - Fatigue management
- Emergent issues
- Start-up meeting

3.1 ENGINEERING ASSESSMENTS

3.1.1 Graphite core integrity

24. Reference 17 provides the findings of the ONR graphite core integrity assessment of the inspections of Dungeness B Reactor 21 during the 2017 periodic shutdown and supporting documentation provided by NGL.
25. NGL conducted inspections of five fuel channels and two control rod channels. The inspector reviewed the results of the inspections and found that the dimensional measurements made did not challenge the safety case and the results of the inspections were in-line with his expectations for the shutdown.
26. The inspector observed one of the trepanning activities and was satisfied that the quality process was being adequately followed. During the outage a total of forty-four graphite samples were trepanned from various channels in Reactor 21. This was slightly less than planned, due to a tool failure, but more than the minimum required by safety case commitments. The inspector considered that the number of trepanned samples retrieved from the core during the shutdown was sufficient and the additional risks associated with decontamination and tool repair did not justify attempting a repair at the time of the shutdown.
27. The inspector noted an improving trend in reactor gas chemistry for DNB, with recent performance approaching that for the rest of the fleet. While some fluctuations were still apparent for recent data associated with DNB R21, NGL expressed an expectation that similar improvements would be achieved from modifications made during the current shutdown.

28. NGL provided a graphite weight loss update document, incorporating the results from the 2015 R22 outage graphite samples, and an EC justifying a 10% graphite weight loss limit. These documents have been reviewed but ONR will formally assess these documents before the next R22 outage in 2018.
29. The weight loss update indicated that the graphite weight loss was estimated to be around 7% at the time of the periodic shutdown of R21. Based on the estimated rate of annual weight loss, the inspector was confident that the current graphite weight loss limit of 8% will not be reached before the start of the DNB R22 periodic shutdown.
30. The risk of boiler tube failures (BTF) is predicted to increase as the plant ages as a result of progressive degradation mechanisms. The consequence of a BTF could lead to significant water ingress in the reactor core, which could potentially challenge the shutdown and/or the hold-down capability of the reactor.
31. To address these risks, NGL has proposed boiler modifications which would allow the early termination of BTF fault sequences and minimise the risks associated with steam-water ingress in the reactor. The inspector considered these changes as being essential to ensure the long-term nuclear safety of the plant. ONR is currently actively involved in the boiler improvement programme and is pursuing this issue in a specific project.
32. NGL have conducted their third periodic safety review of DNB which is being assessed by ONR. During this assessment work, which was coincident with the R21 outage, a potential deficiency in the seismic analysis supporting the graphite safety case was identified. NGL were able to establish that improvements in modelling and reduced station operating periods had meant that the safety case was still valid. The inspector reviewed documents supplied by NGL and judged that they provided an acceptable margin against control rod obstruction during a seismic event. The inspector therefore considered that the seismic justification provided was sufficient for the return-to-service of R21 after the periodic shutdown until an update can be provided by the end of 2017. ONR has raised a regulatory issue to address the recommendation that an update to the seismic case for the graphite core is provided.
33. Based on inspection and the results of the review, the inspector was satisfied that the outage requirements had been met. The inspector considered that consent could be granted to return Dungeness B Reactor 21 back to service at the end of the periodic shutdown.

3.1.2 Civil Engineering

34. Reference 18 provides the findings of the ONR civil engineering assessment of the statutory examination of the pre-stressed concrete pressure vessel (PCPV) of Reactor 21 and other supporting documentation provided by NGL.
35. The Appointed Examiner (APEX) for the PCPV produced a start-up statement on the scheduled inspections and tests that had been carried out on the R21 vessel since the previous statutory outage in 2014.
36. The start-up statement reported the progress of the statutory surveillance inspections prescribed in the station Maintenance Schedule. It provided a statement on each of the maintenance schedule surveillance items namely;
 - Concrete surface examination;
 - Tendon load checks;
 - Tendon anchorage examination;
 - Tendon corrosion examination;

- PCPV settlement and tilt;
 - Vibrating wire strain gauges;
 - Vessel temperature;
 - Main reactor coolant loss;
 - Pressure vessel cooling system; and
 - Top cap deflection.
37. Some of the surveillance items had statements based on initial findings which would be fully presented in the Statutory Examination Report which is due to be issued within 28 days of the ONR consent to start-up. The inspector concurred with the judgements of the APEX for these items, pending the issue of the 28 day report.
38. A total of 31 tendons had their residual loads checked. The deployment of the new lighter weight stressing jacks had enabled the checking of tendons previously considered inaccessible. All of the residual loads were measured in excess of the minimum design loads (MDL). The inspector compared the load values with those from previous checks and agreed with the APEX that the rate of relaxation in the tendons was insufficient to cause the average tendon load to fall below the MDL before the end of the next operating period.
39. The settlement and tilt survey of the PCPV showed the ongoing movement was within the acceptable design limits. Following a recommendation raised by the inspector during the last R22 outage in 2015 the levelling points used for the survey had been re-established back to a suitable off-site datum.
40. No leaks had been observed from the vessel cooling systems in the last operating period and no significant irregularities had been identified in the cooling water chemistry.
41. Following de-stressing of tendon 25/3 in 2014, a number of failed wires (approximately 40); emulsified grease, and a significant amount of corrosion was found on the wires and the anchorage components. The whole tendon was removed for further investigation. The intention was to replace the tendon this outage but it was subsequently decided to justify continued operation of Reactor 21 with tendon 25/3 permanently removed (EC357518). This justification was reviewed by the inspector and he agreed with the acceptability of the safety case to operate Reactor 21 for an indefinite period with tendon 25/3 omitted.
42. From assessment of the results of the surveillance inspections (as reported in the documentation provided) and EC357518, acceptance of the judgements made by the APEX, and the observations made during the site visit, the inspector was content to support the return to service of the Reactor 21 pre-stressed concrete pressure vessel for the next operating period of three years.

3.1.3 Structural integrity

43. Reference 19 provides findings of the ONR structural integrity assessment of NGL's examination, maintenance, inspection and testing of systems, structures and components on Reactor 21 that fulfilled a nuclear safety function.
44. The assessment primarily focussed on NGL's work covering:
- The inspections of:
 - Welds;
 - Metallic reactor internal structures and components;
 - Main cooling water system;
 - Pipe hangers.

- Thermal movement survey
 - Compliance with Pressure Systems Safety Regulations (PSSR)
45. During the periodic shutdown the inspector visited the site to confirm the adequacy of the work being conducted by NGL. Based on the items important to safety the following areas were sampled:
- Main cooling water system inspections
 - Materials and weld inspections
 - Reactor internal remote visual inspections (steel components)
 - Pipe hanger and restraint inspections
 - Flow assisted corrosion inspections
 - PSSR compliance
 - Gas by-pass plant (North wall plant rooms)
 - Corrosion management update
46. The inspector reviewed the recommendations from the hot and cold pipe hanger surveys. A recommendation to renew hangers that had reached the lower extent of their travel was sampled. The modelling of the steam pipework movement required reviewing and new hangers had to be designed and manufactured. The inspector reviewed an engineering assessment which concluded that bottomed hangers did not significantly challenge the integrity of the welds on the steam system. The inspector was content with the evidence and justification provided for the replacement of the hangers being deferred until the R22 2018 double reactor outage.
47. Licensee inspections during the outage identified cracking on the pressure seal plugs of several steam stop valves, their primary safety function is to close following a trip and isolate each boiler to assist in preventing water ingress to the reactor. An assessment of the defects concluded they were dormant or very slow growing thermal fatigue cracks. A number of the plugs were renewed, with spares ordered in preparation for the R22 outage in 2018. Following the visit and subsequent review of information provided, the inspector was satisfied that NGL had responded appropriately to this issue.
48. NGL had made commitments to provide a long term strategy to manage water ingress and prevent further deterioration of filter vessels and associated pipework of the gas bypass plant. The inspector reviewed the inspections of the condition of the filter vessels and modifications to remove water build up in the plant rooms. NGL acknowledged that there were inspection restrictions associated with the filter vessel, in particular the lower section of the vessel that formed a debris pot. This is discussed further in the emergent issues section below.
49. The inspector was satisfied that the inspections had been undertaken in line with the DNB Reactor 21 2017 outage intentions documents and that NGL had followed corporate procedures in the assessment and sentencing of inspection results. Where changes to the outage intentions document had been made, the inspector was satisfied that they had been sentenced appropriately and in accordance with NGL's arrangements.
50. Based upon the sampling undertaken, and the evidence presented, the inspector judged that NGL had undertaken sufficient inspection and assessment to support the safe return to service of DNB Reactor 21 from a structural integrity perspective.

3.1.4 Mechanical engineering

51. Reference 20 provides the findings of the ONR mechanical engineering inspection conducted during the outage. The inspection focused on the examination, inspection maintenance and testing (EIMT) of the gas circulators (GC) and gas safety relief valves (GSRV).
52. During this outage, there were no planned major overhauls of the GCs and motors, only routine maintenance. The work being conducted in the onsite GC maintenance workshops, operated by one of the contract partners, was inspected. The inspector was satisfied that the supervisor was able to provide a good description of the components, demonstrating a good working knowledge of the equipment he was maintaining.
53. The work order cards for the GC and fluid drive maintenance were sampled and the inspector was satisfied that the GC maintenance activities had been demonstrated to have been completed adequately.
54. The inspector sampled the maintenance arrangements for reactor GSRVs due to the importance of their safety function to prevent overpressure of the PCPV. The records for the undisturbed lift pressure tests were reviewed for this outage and the previous 2014 outage. The inspector queried one of the records sampled which indicated an out of tolerance lift, over by 1 psi. NGL subsequently provided the justification of acceptability of the high lift which was attributed to a calibration error and subsequent tests were within tolerance. The inspector was satisfied that EIMT associated with the reactor GSRVs was adequately controlled.
55. Based on the sampling undertaken as part of this inspection, the inspector was satisfied that the LC 28 arrangements in place were adequate and had been adequately implemented. The inspector therefore supported the return of Dungeness B Reactor 21 to operation following its 2017 periodic shutdown.

3.1.5 Electrical engineering

56. Reference 21 presents the findings of the ONR electrical engineering inspection conducted during the outage. The inspection considered the electrical work being undertaken as part of the Reactor 21 statutory outage, including:
 - Planned electrical EIMT activities;
 - Implementation of the detailed modifications;
 - Reactive electrical work emergent from the outage.
57. The inspector reviewed the station's progress against electrical activities, both electrical maintenance and electrical modification, identified in the OID, focussing on electrical switchgear, unit transformer replacements and 400kV cable inspections.
58. The inspector sampled maintenance work ongoing across 11kV, 3.3kV and 415V switch rooms. The station reported that work was progressing to plan and that no issues of significance had been identified from the activities undertaken to date. During the plant walk-down, the inspector noted that there were no visible signs of external corrosion or flaking paintwork on any plant, equipment or supporting structures within the electrical switch rooms and observed that the temperature and humidity within these areas was as expected.
59. The replacement of the unit transformers 21A & 21B was ongoing. Both of the original transformers had been removed and the first of the new ones was being installed.

This was a repeat of the replacements conducted during the last R22 outage from which lessons had been learnt to allow a more efficient replacement process.

60. Whilst the 400kV cables were de-energised, the earthing equipment was replaced and the inspection of the cable's containment equipment was underway at the time of the ONR intervention. The inspection sample included 1 out of every 3 cable cleats with no issues having been found. During the start-up meeting it was reported that the inspections were complete and only one minor fault was found which was appropriately repaired.
61. The inspection confirmed that the planned EIMT and modification activities undertaken during the outage period were appropriate and that electrical plant and equipment was being maintained in accordance with the established arrangements.
62. The inspector considered that based on the targeted interventions, there were no issues identified from the electrical work activities which would prevent ONR granting consent for Reactor 21 to return to service. This is subject to the completion of the planned EIMT activities, the implementation of the detailed modifications and the completion of emergent electrical work.

3.1.6 Control and instrumentation

63. Reference 22 provides the findings of the ONR control and instrumentation (C&I) inspection conducted during the outage. The main focus of the inspection was to verify that relevant work activities had been carried out in relation to C&I equipment and systems important to safety in order to confirm that they remained fit for their intended purpose at DNB.
64. The areas reviewed during the inspection included the following plant areas:
 - Central control room;
 - Turbine hall;
 - R21 safety circuit room;
 - R22 safety circuit room;
 - Instrumentation cabinets;
 - Radiation controlled area (RCA); and
 - Reactor pile cap.
65. The inspector reviewed modifications being implemented during the outage; neutron flux detector replacement strategy and single channel trip system (SCTS) improvement project. These modifications should address changes in the manufacturing supply chain and obsolescence problems. Based on the modifications sampled, the inspector considered the arrangements and their implementation to be adequate.
66. The maintenance and testing activities in the following areas were sampled by the inspector:
 - Channel gas outlet temperature and boiler gas outlet temperature thermocouples
 - Neutron flux detectors
 - SCTS power supply units
 - Laddic waveform tests
 - GC instrumentation
 - Enhanced shut down system
 - Post trip interlock
 - Computing systems

67. The inspector found that relevant good practice was generally met, with only minor shortfalls identified. These shortfalls would be monitored by the C&I inspector through routine regulatory business. On the basis of the inspection of the C&I aspects of the outage, the inspector identified no issues which would prevent ONR consent to allow Reactor 21 at DNB to start up.

3.2 SAFETY MANAGEMENT

3.2.1 Radiological protection and nuclear liabilities

68. Reference 23 presents the findings of a joint intervention by ONR radiological protection and nuclear liabilities specialists and the Environment Agency (EA). The aim of the joint intervention was to inspect compliance with the Ionising Radiations Regulations 1999 (IRR), LC5 (Consignment of nuclear matter) and LC32 (Accumulation of radioactive waste).

69. The IRR compliance inspection reviewed the following areas;

- Radiation protection input to outage work planning.
- Operational dose management, i.e. day-to-day dose management and profiling during the outage.
- Radiation protection personnel and monitoring equipment provision.
- Contractor control and supervision in relation to radiological protection.
- Integration of ALARP management principles with personal radiation exposure restriction and contamination control.
- Radiological event investigation and follow-up.
- Control and supervision of site-radiography contractors.
- Radiation protection arrangements associated with radiological waste

70. The IRR inspection did not reveal any significant nuclear safety issues relevant to the reactor Unit 21 outage that required action by NGL or follow-up by ONR.

71. The LC 5 inspection reviewed the Waste Management Outage Plan, and its implementation, and the monitoring arrangements for the waste transfer to the decontamination facility. Documentation related to the consignment of waste despatched off-site on the day of the inspection was also sampled. The records had been completed and appeared clear, legible and consistent with the Site's arrangements. Based on the evidence sampled, the inspectors considered the arrangements and their implementation to be adequate.

72. The LC 32 inspection focussed on the management of solid waste during the outage. This had been subject to an improvement plan to improve waste forecasting, waste stream management and waste stream processing. Overall, based on the evidence sampled, it was clear that the site had made some improvements on how it forecasts and manages the waste generated during outages. However, due to resource constraints, not all improvements planned had been fully implemented prior to the outage but a significant number were due for completion shortly after the outage. The inspector would progress the delivery of the improvement plan through routine regulatory business.

73. On the basis of the inspection of the IRR99 and nuclear liabilities (radioactive waste) management aspects of the Unit 21 outage, the inspectors supported the issuing of a consent under licence condition 30 to allow Unit 21 at DNB to start-up.

3.2.2 Fire safety

74. Reference 24 provides the findings of the ONR fire safety inspection conducted prior to the outage to confirm that the General Fire Safety provisions on site were adequate and to confirm compliance with the requirements of the Regulatory Reform (Fire Safety) Order 2005 was being achieved.
75. The fire safety measures pertinent to the forthcoming outage were reviewed, this included:
- 'Life safety' arrangements;
 - Water spray fire system (WSFS);
 - Turbine Hall;
 - Back-up diesel generator buildings;
 - Auxiliary low pressure boiler rooms;
76. During the double reactor outage, a major overhaul of the WSFS would be completed on plant which was common to both unit 21 and 22. For a period of days the WSFS would be out of service and additional fire safety measures would be put in place. The inspector reviewed these arrangements; additional fire tender, temporary water storage tanks and site wide briefings, and found that good preparations had been made for the period of reduced automatic fire protection.
77. The inspector found that the site had a good appreciation of fire safety risks and control measures, as evidenced by a suitable and sufficient fire risk assessment process and an exemplary level of housekeeping across the site.
78. Overall, the inspector judged that standard of compliance with the Regulatory Reform (Fire Safety) Order 2005 to be adequate.

3.2.3 Management systems, LC17

79. Reference 25 provides the findings of the ONR compliance inspection carried out against LC 17 'Management Systems'. This focussed on the adequacy of the outage quality management oversight arrangements and the in-outage concurrence review by the internal Nuclear Assurance (INA) QA Team. This inspection was conducted as a joint review with the NGL corporate INA QA team.
80. The inspection covered a broad range of outage activities, including:
- Outage quality management arrangements;
 - Review of INA pre-outage concurrence review
 - Surveillance programme
 - Quality forum
 - Quality control;
 - Stores management;
 - Unit transformer replacement project;
 - Contract partner surveillance activities; and
 - INA QA concurrence approach.
81. The inspector concurred with the small number of INA QA findings which were accepted by the station and were being addressed. None of the findings affected the return to service of unit R21.
82. From the activities sampled, the inspector was satisfied that the quality management oversight arrangements for the outage were adequate. The INA QA's mid-outage concurrence was well structured and carried out effectively.

83. Based on the areas and activities sampled during this inspection, the inspector considered that the LC17 management systems arrangements for the outage were adequate to support the return to service of R21.

3.2.4 Conventional safety

84. Reference 26 provides the findings of the ONR conventional health and safety inspection conducted during the outage. This sought to provide regulatory confidence in the management of conventional health and safety hazards present during outages, focussing on asbestos management and a review of the site's arrangements for managing a liquid petroleum gas (LPG) installation, including associated pipework.

85. The key plant locations visited during the inspection were:

- Turbine hall, various parts of the operating level and the TH/21 D/C Heater area.
- LPG installation.
- Main Stores roof.
- Service Building - deaerator level.
- Cooling water pumphouse.
- Drumscreens.

86. The inspector identified shortfalls in the site's arrangements for asbestos management which related to the provision of asbestos-related information to site workers, management of asbestos-related information and oversight/prioritisation of work with asbestos. The inspector has written to NGL seeking improvements and the resolution of these issues will be progressed through routine regulatory business.

87. During the review of the arrangements for managing the LPG installation, the inspector identified shortfalls in the justification of inspection for the below ground LPG pipework and in the assessment of risks presented by leaks of LPG into nearby trenches and drains. These issues will be progressed by the conventional safety inspector through routine regulatory business.

88. Although shortfalls were identified, the inspector did not consider that they affected the start-up of the reactor and therefore supported the issue of the consent to start-up reactor 21.

3.2.5 Modifications management, LC 22

89. Reference 8 provides the findings of a compliance inspection conducted during the outage relating to LC 22 Modification or experiment on existing plant. This inspection focussed on implementation of a modification, in particular the impact on drawings, instructions and training.

90. The inspectors sampled two engineering changes which were being implemented during the outage period. This included reviewing the engineering change document, the affected document list and the training considerations:

- EC359796 - Replacement of the waterspray pressure sustaining tank 6" discharge line including valves 20/FS/8, 9 & 10.
- EC354888 - Main water treatment plant acid dilution system and bulk storage tank.

91. The inspectors found that the asset management system used by the licensee provides the capability to record, control and track engineering changes, through to

implementation and close-out. The evidence sampled demonstrated that the system is being appropriately used and the implementation of the modifications is being considered and tracked.

92. In both cases the affected document list was being used to identify all documents which may be impacted by the change and was being used to register new instructions if required. The inspectors confirmed with the responsible engineers that training had been considered. One minor shortfall was identified relating to the issue of revised plant operating instructions during the intervention but this was quickly rectified.

3.2.6 Control and supervision, LC26

93. Reference 8 provides the findings of a compliance inspection conducted during the outage relating to LC 26 control and supervision of operations. The inspection focussed on the licensee's oversight of gas circulator return to service commissioning activity. This is governed by Gas Circulator return to service flow-sheet and controlled by a number of plant operating instructions and plant schedule instructions.
94. The inspector judged that an appropriate level of control and supervision was evident at the workplace and suitable oversight was being provided by the licensee.
95. No significant shortfalls were identified although an observation was made relating to the return to service flow-sheet. The licensee has raised a condition report and an existing ONR regulatory issue has been updated to track resolution of the observation.

3.2.7 Fatigue management, LC36

96. Reference 27 provides the findings of the fatigue management intervention, under LC 36, conducted during the outage. The main focus of the inspection was to confirm compliance with the working time regulations 1998 (as amended) and verify that worker fatigue was being appropriately managed.
97. The inspectors confirmed NGL had been monitoring working time non-compliance and had mapped actual against planned hours from January 2015 to date, indicating key work activities such as refuelling and outages. The station had recently completed a working time deep dive audit. The inspectors were of the opinion that this demonstrated management of working time by the station and leadership commitment in this area.
98. The inspectors discussed fatigue management with a number of team leaders and found a good understanding of signs of fatigue and what controls were available to manage worker fatigue. A sample of a number of completed working time risk assessments for both NGL and its contract partners found that working time risk assessments were being raised in a timely manner. However, the quality of the risk assessments that had been completed by NGL was poor and not in line with NGL's corporate arrangements.
99. The basis of decisions to extend working hours was discussed with the relevant team leaders and in the majority of cases an ALARP decision was presented verbally, but this had not been recorded adequately on the requisite forms.
100. An ONR regulatory issue was raised requesting the station to improve the awareness of decision making prior to extending working hours and improve the recording of the risk assessment.

101. During July the inspector conducted a follow-up inspection to monitor progress against the regulatory issue. The inspectors revisited the teams and sampled recent completed fatigue risk assessments. They found a small number raised and noted that the quality had improved. The team leaders were aware of their responsibilities and recognised the importance of the decision making for exceptional cases.
102. The inspectors also confirmed that the risk assessment process, including the decision making, had been discussed at leadership meetings and there was recognition that further improvement is needed by the leadership team. Based upon the evidence presented the inspector closed the regulatory issue and no further action was considered to be warranted.

3.3 EMERGENT ISSUES

3.3.1 Gas bypass filter vessel integrity

103. During the review of the work on the gas bypass plant, NGL acknowledged that there were inspection restrictions associated with the filter vessel, in particular the lower section of the vessel that formed a debris pot. The inspector was informed that thickness measurements were not feasible in this region and that remote visual inspection was taking place on a best endeavours basis. The lack of suitable inspection data was seen as a concern and NGL was unable to adequately justify to the inspector that operations were safe. The inspector raised a start-up consent action to provide an adequate justification for continued operations.
104. Subsequent to the visit NGL was able to provide;
 - Original manufacturing test certificates for all the welds which showed all tests were completed successfully and concluded that the filter vessels were free from visible defects at construction.
 - Assessment of the vessel previously carried out by NGL that identified minimum acceptable thickness for various regions of the vessel and a judgement that corrosion was the only degradation mechanism of concern.
 - Results of the sample thickness measurements taken at accessible locations of the vessel completed at this outage which did not indicate any significant loss of wall thickness that may challenge vessel integrity and there was adequate margin to the minimum acceptable thickness.
105. The inspector also requested further information regarding the consequences following any failure of the filter vessels and mitigation taken by DNB to minimise their effects. NGL identified that the gas by-pass circuit in the north wall plant rooms have 3 slam shut and one non-return valve fitted, which are part of the seismic pressure boundary of the vessel. Two further non-return valves had been installed during station commissioning to prevent back flow of CO₂ from the filter vessels into the plant rooms.
106. The inspector considered that DNB was taking appropriate measures to install equipment that should minimise moisture ingress to the plant rooms in future and available inspection results did not show any significant corrosion of the filter vessels for R21; however some uncertainty remained due to the inspection access restrictions.
107. The inspector was content that the start-up consent action was closed but considered further work should be done to improve the inspections and therefore recommended that NGL consider alternative options that could be implemented to gain access to all relevant regions of the gas by-pass plant filter vessels, for example the debris pots, in

order to carry out future inspections. The structural integrity inspector raised a regulatory issue to monitor progress related to future inspection of the filter vessels.

3.3.2 Loss of electrical supplies

108. On Saturday 8 July, when both reactors were shut down, during testing of Gas Circulator (GC) 27, the GC27 main motor tripped. When an attempt was made to restart the motor, it resulted in a station transformer tripping and loss of supply to a station switchboard. Following the station switchboard trip, an attempt to interconnect between the affected station switchboard and another station transformer, in order to restore electrical supply to it, was made. This resulted in the interconnected station switch board tripping and a subsequent partial loss of electrical power to the Station. Only one other station switch board remained energised.
109. As a consequence of the loss of station supplies, Operational Alert was entered to assist Operations, thereby focusing station resource on ensuring the 3Cs (Criticality, Cooling and Containment) remained effective and intact. The station also entered an immediate Technical Specification action condition due to the loss of all GC main motors as a consequence of losing the station board and unavailability of the 11kV unit boards. The immediate action taken by the station restored the majority of supplies to site through the interconnection of a station transformer to the affected station switch boards. This was achieved within the safety case action conditions. The procedures for restarting GCs and loading of switchboards were reviewed to prevent recurrence.
110. This event was reviewed by the electrical inspector and he was satisfied that the supplies to the transformers had been appropriately reinstated in a timely manner and in accordance with the established arrangements. Also, from the discussions and explanations given he was satisfied, from an electrical engineering perspective, that there was no significant impact on nuclear safety.

3.3.3 Fuelling machine spurious trips

111. Early in the outage, the station encountered problems with the diverse winch trip system (DWTS) on the fuelling machine. Spurious tripping of one channel of the DWTS resulted in NGL entering their technical fault finding process. The fault was intermittent and could not be replicated; further functional tests were performed to confirm the system would trip when required. Over the course of the outage further spurious tripping of the DWTS occurred and was investigated.
112. The design and safety case requirements allowed for the DWTS to operate with a single channel not functioning for a period of time to finish an activity. The main impact of the tripping and time spent on fault finding was on the programme of work in the charge hall, most of which required the use of the fuelling machine. The various work packages were rescheduled to ensure the immovable milestones were met; i.e. double reactor outage.
113. The C&I inspector reviewed how NGL had managed the tripping issues and the proposed recovery actions. NGL confirmed that all the faults seen to date had failed in a safe manner and the fuelling machine was entering a planned 3 / 6 monthly maintenance outage which would enable in depth fault finding and component testing / replacement. During the maintenance a faulty cable was identified and replaced, NGL considered that this should resolve the intermittent fault. The C&I inspector will continue to monitor this issue to confirm satisfactory resolution.

3.4 START UP MEETING

114. The Start-Up Meeting was held on 16 August 2017. Prior to this meeting there was a comprehensive plant walk-down on 15 August 2017. ONR was represented by the Superintending Inspector, the Site Inspector and Project Inspector. The walk down encompassed many of the major work packages conducted during the periodic shutdown. A number of the work packages were for long term replacement of items; e.g. new nitrogen injection system tie-in point and Unit transformer replacements, to enhance nuclear safety and/or improve reliability through to the plant end of life.
115. Across the station there was evidence of significant planned corrosion management activities to ensure the long term availability of plant. The station had also undertaken replacement and protection activities throughout the outage where the opportunity arose which would not impact on the overall programme.
116. It was noted that a considerable amount of planning had gone into this outage to ensure the outage activities were optimised but remained flexible to ensure the overall programme was maintained.
117. The Start-Up Meeting was chaired by the station Technical and Safety Support Manager and was again attended by the same ONR representatives. The purpose of the meeting was for NGL to demonstrate it had adequately met the requirements of the Maintenance Schedule, dealt with emergent issues and demonstrated the safety of Reactor 21 for the next operational period. The Dungeness B Reactor 21 2017 Outage Start-Up Meeting Report, Reference 28, was provided prior to the meeting and was used as the basis for the presentations and discussions held during the meeting. A detailed record of the meeting is contained in Reference 8.
118. ONR noted the success of the outage in delivering all the scheduled work, addressing emergent issues and completing additional work where opportunities arose.
119. No further actions were identified during the meeting.

4 MATTERS ARISING FROM ONR'S WORK

120. I have considered the licensee's request to ONR to grant a consent under LC30(3) to start-up Dungeness B Reactor 21 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 work undertaken by NGL's internal regulator (INA), the statements of the PSSR competent persons and the findings and advice of ONR specialist inspectors and the ONR site inspector.
121. NGL will convene an Operational Safety Review Committee prior to start-up to review the fitness for service of the plant and endorse return to service.
122. INA has provided a concurrence statement (Reference 10) which confirms that, based on their assessment activities so far, there are no issues of which they are aware which would prevent their provision of the concurrence part B prior to start up.
123. The PSSR competent persons have confirmed that their examinations have been satisfactorily completed and the plant was considered to be acceptable to return to service.
124. ONR specialist assessors from the following disciplines undertook inspections and assessments to support ONR permissioning return to service:

- Graphite
- Civil engineering
- Structural integrity
- Mechanical engineering
- Electrical engineering
- Control and instrumentation systems
- Radiological protection
- Nuclear liabilities
- Fire safety
- Management systems
- Conventional safety

125. Each discipline has produced a report that presents the inspection findings, inspectors' opinions, judgments and recommendations. A single action requiring resolution before granting of consent was raised, relating to the welds on the gas bypass filter vessel debris pot and this has been satisfactorily resolved, with evidence being submitted by NGL to support the condition of the welds and a commitment for NGL to consider alternative options that could be implemented to gain improved access for inspections.
126. A number of recommendations arose from the inspectors' work which will be addressed through routine regulatory business. All the reports contain either a statement supporting issuing consent to start-up the reactor, or note that there is no reason to withhold consent.
127. I consulted with ONR Civil Nuclear Security and confirmed (Reference 29) that they had no objections to ONR granting consent to start-up Reactor 21.
128. I consulted with the Environment Agency (EA) to establish if they had any specific objections that would prevent ONR from issuing LI 554, consent to start-up Dungeness B Reactor 21. The EA (Reference 30) confirmed they did not object to ONR granting consent.

5 CONCLUSIONS

129. The Dungeness B Reactor 21 periodic shutdown 2017 has been undertaken in accordance with the requirements of the work scope outlined within the OID.
130. NGL has followed its arrangements in undertaking the periodic shutdown, culminating in the Dungeness B Station Director writing to ONR requesting Consent to start-up Reactor 21. His letter stated that he was satisfied that there were no safety issues associated with return to service of Reactor 21. Any emergent issues which required safety justifications would be dealt with as part of the Engineering Change process.
131. NGL's internal regulator, INA, has provided a concurrence statement that confirmed that they have no issues that would prevent the provision of the concurrence part B report in due course to support the return to service of Reactor 21 following its periodic shutdown.
132. The PSSR competent persons have each confirmed that they are content for Reactor 21 to start up.
133. 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 the reactor. The single action raised during the inspections which required closure before consent has been satisfactorily addressed.

134. I consider that the licensee delivered a shutdown that was safely managed and completed the required safety-related work activities.
135. Following assessment and inspection of matters arising in relation to the Dungeness B Reactor 21 periodic shutdown 2017, I am satisfied that the licensee's justification to start-up the reactor and operate for a further period is adequate; consequently, consent to start-up the reactor can be granted.
136. I have prepared Licence Instrument 554, for LC 30(3) consent, in conjunction with this PAR.

6 RECOMMENDATIONS

137. I recommend that the Superintending Inspector:
 - Signs this Project Assessment Report to confirm support for the ONR technical and regulatory arguments that justify issuing Dungeness B Licence Instrument 554.
138. I recommend that ONR issues Licence Instrument 554, which grants consent under Licence Condition 30(3) attached to Nuclear Site Licence No.61 to start-up Dungeness B Reactor 21.

7 REFERENCES

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- 2 Dungeness B, LI 6 - DNB70597N - LC30(3) Specification to require consent to start up a reactor after LC30(1) shutdown, 28 Mar 1996, TRIM 2015/288185
- 3 Dungeness B - Licence Instrument number 543 - Granted under condition 30(3) of schedule 2 attached to Nuclear Site Licence No 61, 18 Jun 2014, TRIM 2014/233750
- 4 Dungeness B - DNB/SPEC/OUT/R21017/008 - R21 Statutory Outage 017 (2017) - Outage Intentions Document (OID)
 - Rev 000 - 29 Nov 2016, TRIM 2016/465601
 - Rev 001 - 16 Jul 2017, TRIM 2017/280747
- 5 NGL - OFP - Intervention Record - 16-191- Dungeness B (EDF Energy), Outage Intentions Meeting and Emergency Generation System Based Inspection (SBI 06), 12–15 Dec 2016, TRIM 2016/499502
- 6 NGL - OFD - Intervention Record - 17-054 - Dungeness B - Planned Inspection - Rapid Trending Review and LC9 compliance inspection, 26-28 Jun 2017, TRIM 2017/268242
- 7 NGL - Dungeness B - ONR - OFD - CR - 17-288 - Dungeness B R21 Mid-Outage Meeting and Outage Management, 18-19 Jul 2017, TRIM 2017/295537
- 8 NGL - OFD - Intervention Record - 17-086 - Dungeness B - Licence Condition Compliance Inspections and Statutory Outage Start Up Meeting, 14-16 Aug 2017, TRIM 2017/328182
- 9 Dungeness B - SRD/REP/CON/DNB/011A - R21 Outage 2017 - INA Concurrence Part A - Dec 2016, TRIM 2017/321028
- 10 NSLDNB50951R - Appendix 11 - INA Concurrence Statement, 21 Aug 2017, TRIM 2017/325478
- 11 NSLDNB50951R - Appendix 3 - EC357862 - Return to service EC, 1 Sep 2017, TRIM 2017/325446
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- 13 NSLDNB50951R - Appendix 5 - Appointed Examiner's Start-up Statement - E/EAN/BNCB/0894/DNB/17, Aug 2017, TRIM 2017/325455
- 14 NSLDNB50951R - CPV Penetrations - PSSR Out of Service Examinations
 - Appendix 6 - Materials Group, 18 Aug 2017, TRIM 2017/325458
 - Appendix 7 - Design Authority, 18 Aug 2017, TRIM 2017/325465
- 15 NSLDNB50951R - Appendix 8 - PSSR competent person certificate, Sep 2017, TRIM 2017/325467
- 16 Operating Reactors Sub-Division - Dungeness B R21 Outage 017 (2017) - Outage Plan, May 2017, TRIM 2017/140443
- 17 ONR - OFD - AR - 17-017 Dungeness B R21 2017 periodic shutdown - graphite core structural integrity assessment, 25 Aug 2017, TRIM 2017/325897
- 18 NGL - Dungeness B - Assessment Report - 17-026 - R21 Statutory Outage 2017 - ISI of the PCPV - Assessment of the Appointed Examiner's Start-up Statement, 29 Aug 2017, TRIM 2017/326646

- 19 ONR - OFD - AR - 17-020 - Dungeness B - Assessment of Structural Integrity in Support of the Restart of R21 Following the 2017 Periodic Shutdown, 23 Aug 2017, TRIM 2017/300146
- 20 NGL - OFD - Intervention Record - 17-074 - Dungeness B - R21 Outage – Mechanical Engineering Inspection, 4 Jul 2017, TRIM 2017/287334
- 21 NGL - OFD - Intervention Record - 17-066 - Dungeness B - R21 Outage - Inspection of Electrical Aspects, 11 Jul 2017, TRIM 2017/272337
- 22 NGL - OFD - Intervention Record - 17-088 - Dungeness B R21 Statutory Outage 2017 Control and Instrumentation (C&I) Inspection, 8 & 9 Aug 2017, TRIM 2017/315191
- 23 NGL - OFD - Intervention Record - 17-078 - Dungeness B - Outage inspection - IRR, LC32 and LC5 compliance inspection, 18 Jul 2017, TRIM 2017/298878
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- 26 NGL - OFD - Intervention Record - 17-082 - Dungeness B - Conventional health and safety inspection during R21 outage 2017, 8-9 Aug 2017, TRIM 2017/334626
- 27 NGL - OFD - Intervention Record - 17-067 - Dungeness B - LC 36 Compliance Inspection Focused on Fatigue Management and Working Time Directive, 17-19 Jul 2017, TRIM 2017/291582
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- 29 Dungeness B R21 017 Outage 2017 - Start-up consent - Security, 2 Aug 2017, TRIM 2017/297428
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