



Torness Reactor 1 Periodic Shutdown 2021
Consent to Start-up Reactor 1 Following Periodic Shutdown

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EXECUTIVE SUMMARY

Title

Torness Reactor 1 Periodic Shutdown 2021 - Consent to Start-Up Reactor 1 Following Periodic Shutdown.

Permission Requested

EDF Energy Nuclear Generation Limited (NGL) the licensee has requested that the Office for Nuclear Regulation (ONR) grants Consent under Licence Condition (LC) 30(3) to start-up Torness Reactor 1 following completion of the 2021 Periodic Shutdown carried out in accordance with the requirements of the Plant Maintenance Schedule made under LC 28(4). The licensee has confirmed that the required work has been completed and the reactor is safe to restart.

Background

LC 30(1): Periodic Shutdown states that for the purpose of enabling any examination, inspection, maintenance or testing of any plant or process to take place, the licensee shall, when necessary, ensure that any such plant or process is shut down in accordance with the requirements of the Plant Maintenance Schedule as referred to in LC 28: Examination, Inspection, Maintenance and Testing (EIMT).

LC 30(3) states that the licensee shall, if so specified by ONR, ensure that when a plant or process is shut down in pursuance of LC 30(1) it should not be started up again thereafter without the Consent of ONR. ONR specified, under LC 30(3) of Torness Nuclear Site Licence Sc.14, that the licensee shall seek ONR's Consent to start-up a reactor at Torness Power Station following shutdown under LC 30.

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

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

- Requirements set out in the Station's Plant Maintenance Schedule (PMS) have been complied with.
- Work has been carried out in accordance with arrangements for identified Structures, Systems and Components (SSC) to the required quality by competent persons.
- Safety issues identified during the reactor outage have been adequately addressed with suitable and sufficient justification provided to allow a regulatory judgement to be made that start-up of the reactor is safe.

ONR has assessed NGL documentation produced from the periodic shutdown and EIMT of SSC important to nuclear safety. Site inspections were conducted to confirm work was carried out by competent individuals and to the required quality standards.

Matters arising from ONR's work

No issues were identified by NGL to prevent the return to service of Torness Reactor 1. A number of intervention findings were made by ONR specialist inspectors during the outage that have been recorded within respective inspection records and reported to NGL. All matters have now been addressed to allow Consent to start-up Reactor 1 with some minor non-start up issues to be followed upon through routine business.

Conclusions

ONR's assessment and inspection of the Torness Reactor 1 periodic shutdown confirms that NGL has carried out EIMT in accordance with the requirements of its Plant Maintenance Schedule. Work has been conducted to the required quality standards and by competent personnel. No issues of such significance have been identified by NGL or ONR that prevent the start-up of Torness Reactor 1 following its 2021 periodic shutdown.

Recommendation

The ONR outage project inspector recommends that Licence Instrument 562 is issued to grant ONR's Consent to start-up Torness Reactor 1, following its 2021 periodic shutdown.

LIST OF ABBREVIATIONS

AGR	Advanced Gas-cooled Reactor
ALARP	As low as reasonably practicable
APEX	Appointed Examiner
BV	Bureau Veritas
C&I	Control and Instrumentation
CP	Competent Person
CR	Condition Report
CTO	Central Technical Organisation
EIMT	Examination, Inspection, Maintenance or Testing
EOR	Early Outage Review
FMA	Flux Measuring Assemblies
GC	Gas Circulator
HoRP	Head of Radiological Protection
INA	Independent Nuclear Assurance
INSA	Independent Nuclear Safety Assessment
IRR17	Ionising Radiations Regulations 2017
ISI	In-Service Inspection
KWRC	KeyWay Root Cracking
LC	Licence Condition
LI	Licence Instrument
LOLER	Lifting Operations and Lifting Equipment Regulations
NDE	Non-Drive End
NGL	EDF Energy Nuclear Generation Limited
OAP	Outage Assessment Panel
ODM	Operational Decision-Making
OpEx	Operating Experience
ONR	Office for Nuclear Regulation
PCPV	Pre-stressed Concrete Pressure Vessel
PMS	Plant Maintenance Schedule
PSSR	Pressure Systems Safety Regulations
R1	Reactor 1
RP	Radiological Protection
RSC	Reactor Safety Circuit
SQEP	Suitably Qualified and Experienced Person
SRGW	Seal Ring Groove Wall
SSC	Structures, Systems and Components
TOR	Torness

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1 PERMISSION REQUESTED

1. EDF Energy Nuclear Generation Limited (NGL), the licensee, has written (Ref. 1) to the Office for Nuclear Regulation (ONR) requesting Consent to start-up Torness (TOR) Reactor 1 (R1) following its periodic shutdown, as required under Nuclear Site Licence Condition (LC) 30(3) Periodic Shutdown.
2. This ONR Project Assessment Report (PAR) has been produced to record its regulatory views and judgements in consideration of the licensee's request for Consent to start-up TOR R1.

2 BACKGROUND

3. TOR Nuclear Power Station has two Advanced Gas-cooled Reactors (AGR) identified as R1 and R2. The normal shutdown period for R1 is every three years, as specified in the Plant Maintenance Schedule (PMS) preface, which is an approved document under LC 28(4).
4. LC 30(1) Periodic Shutdown, states that for the purpose of enabling any examination, inspection, maintenance or testing (EIMT) of any plant or process to take place, the licensee shall when necessary ensure that any such plant or process be shutdown in accordance with the requirements of the PMS as referenced in LC 28 Examination, Inspection, Maintenance and Testing.
5. LC 28(1) requires the Licensee to make adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant that may affect safety. LC 28(4) states that these arrangements shall provide for the preparation of a PMS. The PMS draws together requirements from a range of sources, including the facilities Safety Case, regulatory requirements such as Pressure Systems Safety Regulations (PSSR 2000), Lifting Operations and Lifting Equipment Regulations (LOLER 1998) and equipment manufacture's guidance etc.
6. ONR formally engaged with NGL through the outage intentions meeting, where the licensee set out its intended scope of work through its R1 Outage Intentions Document (Ref. 2). This set out the PMS requirements, as well as identifying other work to be carried out in support of safety. The document also identified the processes set out in the licensee's corporate and local arrangements for managing safety and quality during the TOR R1 periodic shutdown.
7. Consent to start-up TOR R1 Licence Instrument (LI) 553 (Ref. 3), following the previous periodic shutdown was issued on 6 June 2017. Therefore, the operating period should have expired on 6 June 2020. However, there have been two deferrals prior to the start of this periodic shutdown. The first deferral (Ref. 4) extended the operating period to no later than 26 July 2020. This was to prevent a significant overlap with the planned periodic shutdown at Heysham A power station. The licensee subsequently requested (Ref. 5) a further extension to the operating period to no later than 7 March 2021. This second deferral was because of the impact of the Covid-19 pandemic and indications that supply chain and contractor availability would be affected, posing a challenge to the safe execution of the periodic shutdown. Both deferrals were examined by specialist inspectors to ensure that there were no safety concerns preventing ONR's Agreement.
8. The TOR R1 outage began on 22 January 2021. At the start-up meeting on 24 March 2021 (Ref. 6), the licensee presented its findings from the outage. The licensee did not identify any issues that would prevent the start-up of R1 and no significant incidents have occurred during the outage period. Regulatory matters identified during ONR's outage assessment and inspection activities are discussed in section 4 of this report.

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

9. The purpose of ONR inspection and assessment activities during a power reactor periodic shutdown is to establish that:
- Requirements set out in the station's PMS have been complied with.
 - Work has been carried out in accordance with arrangements for identified Structures, Systems and Components (SSC) and conducted to the required quality by competent persons.
 - Any safety issues identified during the reactor periodic shutdown have been adequately addressed with suitable and sufficient justification provided to allow a regulatory judgement to be made that start-up of the reactor is safe.
10. ONR's mission is "To protect society by securing safe nuclear operations". To this aim, the primary focus in carrying out inspection and assessment activities during the TOR R1 periodic shutdown was to confirm that nuclear safety requirements have been suitably addressed.
11. Prior to the start of the periodic shutdown, ONR specialist inspectors reviewed the outage intentions document together with operational experience gained from other ONR periodic shutdown assessments and the licensee's own event recording system. This informed the production of inspection scopes for the various specialist discipline inspections and assessments performed during the TOR R1 2021 periodic shutdown:
- Civil Engineering
 - Structural Integrity
 - Graphite
 - Mechanical Engineering
 - Electrical Engineering
 - Control and Instrumentation
 - Radiological Protection
 - Conventional Safety
12. Inspections and assessments were undertaken in accordance with ONR Technical Inspection and Assessment Guidance. The ONR project inspector had an oversight role including maintaining an overview of the work undertaken by its specialist inspectors, monitoring periodic shutdown activities and providing regulatory input as necessary.

4 MATTERS ARISING FROM ONR'S WORK

13. The following sections provide summaries of the ONR specialist inspectors' inspection and assessment findings for each of the technical discipline areas evaluated during the TOR R1 periodic shutdown. These summaries provide the information and evidence to underpin ONR's considerations and judgement to grant Consent to start-up TOR R1.

4.1 CIVIL ENGINEERING INTERVENTION AND ASSESSMENT

14. References 7 and 8 report the findings of ONR's civil engineering engagement and assessment of the TOR R1 2021 periodic shutdown activities.
15. The civil engineering specialist inspector held an early engagement meeting with the Appointed Examiner (APEX) ahead of the TOR R1 periodic shutdown. The purpose of the engagement was to discuss progress of pre-stressed concrete pressure vessel (PCPV) related examination, inspection, maintenance and testing required under the PCPV Written Scheme of Examination. The APEX reported that examinations were

largely complete, with some remaining examinations to be completed during the outage itself. Based on the discussion, the inspector did not consider it necessary to conduct any further planned interventions.

16. The specialist inspector also assessed the Statutory Examination Report of the Pre-stressed Concrete Pressure Vessel, and supporting documentation provided by the licensee.
17. The scope of the civil engineering assessment included the findings of the surveillances, inspections and tests of certain key safety related components of TOR R1 PCPV, including:
 - Visual inspection of concrete surface condition
 - Visual inspection of pre-stressing anchorages
 - Tendon residual load tests
 - Assessment of pre-stressing strand condition
 - Strand tensile testing
 - Settlement and tilt survey
 - Review of embedded strain gauge readings
 - Review of vessel concrete temperatures
 - Review of reactor coolant loss
 - Review of pressure vessel cooling system leaks
 - Top cap deflection survey
 - Bearings
18. The surveillances, inspections and tests assessed were not limited to those carried out during the 2021 periodic shutdown, but also included activities undertaken since the previous R1 periodic shutdown in 2017.
19. The specialist inspector highlighted one area where further work will be required during the next operating period. The inspector noted that the mean pre-stressing tendon loads have a low margin above the minimum value specified in the safety case. Whilst the current tendon loads are adequate, the inspector considered that given the trend of reducing tendon load, further work will be required to develop a long-term safety case strategy to account for the measured tendon load trend falling below the current minimum design load.
20. The inspector did not consider that the licensee currently has evidence that the tendon effective anchorage loads will have adequate margins to their safety case limits (the MDL) for the proposed period of operation. Given the projections that the current safety case MDL limits will be breached during the next operating period, the specialist inspector made the following recommendation *"I recommend that NGL demonstrate that the tendon loads will remain within safety margins for the operational period 2021-2024. This work should include development of a long-term safety case strategy to address the measured tendon load trend falling below the current minimum design load (MDL) of 1600 kN. These activities should be completed within the next 9 months, prior to completion of the tendon stressing campaign scheduled for November 2021."* This will be tracked by Regulatory Issue 8424.
21. Although the average tendon load may drop below the MDL, the specialist inspector does not consider that this poses an immediate threat to the PCPV integrity. The inspector acknowledges that the licensee has produced an EC, which justifies the measured tendon load to temporarily fall below the MDL. Within the EC, the licensee notes that 'it is not intended to invoke such claims in order to permit long-term operation of the plant with a mean residual tendon load below the current MDL.' Furthermore, the inspector notes that the tendon load regression curve shows an

average load above the MDL when considering historic data and a marginally decreasing rate of reduction.

22. The inspector derived further confidence on the basis that the licensee has previously noted that “The current safety case is considered to be valid until 2028 but acknowledged that if before this time the tendon surveillance results show a trend line with a mean residual load at either anchorage less than the MDL then the safety case anomalies process would have to be entered.”
23. The Statutory Examination Report (Ref. 9) has been produced by the Appointed Examiner for TOR R1 and is presented by the licensee in support of its request for permission to return R1 to service following the 2021 periodic shutdown. The Appointed Examiner is the licensee’s nominated, suitably qualified and experienced person, responsible for ensuring the provision of in-service inspection and surveillance activities relating to the PCPV. A full report of the statutory surveillances, inspections and tests will be presented by the licensee in an updated Statutory Examination Report within 28 days of the agreed return to service date.
24. The specialist inspector considered that the quality and detail in the Statutory Examination Report was adequate. The inspector noted that not all of the information required to fully complete the Statutory Examination Report was available at the time of the assessment. The inspector accepted a commitment by the Appointed Examiner, that outstanding works will be satisfactorily completed prior to the return to service and the relevant information will be included in the “28 day” Statutory Examination Report. The inspector considered that the outstanding information was not critical to their judgement regarding the re-start of TOR R1.
25. The specialist inspector is therefore content to support the return to service of the TOR R1 PCPV for the next operating period of three years.

4.2 STRUCTURAL INTEGRITY INTERVENTION AND ASSESSMENT

26. References 10 and 11 report the findings of ONR’s structural integrity inspection and assessment of the TOR R1 2021 periodic shutdown activities.
27. The structural integrity specialist inspector conducted an on-site inspection on days 24 and 25 of the periodic shutdown, approximately half-way through the inspection programme. During the intervention, the specialist inspector discussed the inspection arrangements, general management process and the inspection findings with the licensee’s system engineers and coordinators. The inspector also conducted a plant walkdown accompanied by the system engineer. The inspector sampled the structural integrity aspects of the following systems and inspections:
 - Steam and feed system inspections (e.g. PSSR)
 - Main cooling water system inspections
 - Reactor internal remote visual inspections (steel components)
 - Pipe hanger and restraint inspections
 - Flow assisted and general corrosion inspections
28. The inspector was satisfied with the progress of the planned EIMT at the time of the inspection. Out of 282 components in the programme, 107 were complete and nine had been deleted (or replaced). The inspector noted that the scope of the inspections had not been reduced owing to Covid-19 restrictions.
29. The inspector sampled work that had been undertaken as part of the reactor external inspection programme, reviewing the completed inspections and associated results. The inspector was content that the work was progressing effectively, and that

inspection results were being sentenced appropriately. Weld and FAC inspections were progressing to programme with no significant issues identified.

30. The inspector sampled the operation of the licensee's outage assessment panel (OAP) by observing the OAP meeting on 10 March 201. The OAP meets to review the inspection work undertaken during the periodic shutdown and sentences the inspection findings. In the inspector's opinion, the OAP was efficiently run, covering all aspects of the meeting in a reasonable time and allowing sufficient challenge when necessary. In addition, the inspector monitored the OAP minutes relating to the periodic shutdown and based on the sample, was satisfied that the meeting is appropriately managing and sentencing defects from the periodic shutdown inspections. From the information sampled, the inspector was satisfied that the inspection programme is being adequately monitored and controlled by the OAP and was content that the OAP is providing adequate oversight of the outage activities.
31. The inspector discussed the scope and progress of the inspections performed in accordance with PSSR with the Competent Person (CP) from Bureau Veritas (BV) and with licensee's PSSR advisor. The PSSR advisor had completed an extensive review of the recommendations made by the CP in the TOR R1 examination reports. The PSSR advisor confirmed that there was no shortfall in compliance with the PSSR for TOR R1.
32. NGL is engaged in a review of practice against PSSR across the fleet with ONR performing its own interventions of PSSR activities across NGL. In a separate engagement with the licensee (Ref. 12) the inspector examined TOR's response to, and implementation of the recommendations from the CP following recent PSSR inspections. The inspector was satisfied that no safety significant shortfalls had been found at TOR. In addition, the PSSR inspections carried out during the periodic shutdown had not revealed any significant issues.
33. The inspector judged that the work to satisfy the requirements of PSSR during the TOR R1 periodic shutdown were appropriate.
34. The specialist inspector judged that, from a structural integrity perspective, the licensee was conducting examination, inspection, maintenance and testing to an adequate standard against the requirements of LC 28. Based on the information sampled during the inspection, the specialist inspector did not identify any nuclear safety significant issues of concern. The inspector was satisfied that the licensee was adequately managing defects or anomalies identified.
35. The structural integrity specialist inspector also assessed the adequacy of the inspections of welds, metallic reactor internal structures and components, main cooling water system, pipe hangers and thermal movement survey in line with LC28 and compliance with the Pressure Systems Safety Regulations (PSSR) 2000 undertaken during the TOR R1 2021 periodic shutdown.
36. The inspector reviewed a broad selection of inspection activities completed by the licensee during the shutdown. The information was used to judge the adequacy of the licensee's inspection in terms of items that are considered important to nuclear safety, including metallic component welds, pipework, vessels and support structures located internally and externally of the reactor pressure vessel.
37. The inspector was satisfied with the inspection programme and that the inspections have been undertaken in accordance with the TOR R1 2021 outage intentions document, and the reactor internals proposals document. The inspector was satisfied that the licensee had followed corporate procedures in the selection, assessment and sentencing of component inspections and subsequent results.

38. Based on the items sampled, and the evidence presented, the specialist inspector judged that the licensee had satisfactorily completed the in-service inspection activities during the shutdown.
39. The inspector was satisfied that the findings of the structural integrity inspections do not challenge the claims, arguments and evidence of the safety case. In the inspector's opinion, from a structural integrity viewpoint, TOR R1 has appropriately fulfilled the requirements of LC28 and can be returned to service following the 2021 periodic shutdown.
40. The inspectors judgements and conclusions were based on an amount of information that has yet to complete due process and are therefore dependent on receiving a number of additional documents and assurances as outlined in the recommendations to ONR's Project Inspector below.
41. From a structural integrity perspective, the inspector recommended that ONR should issue the Licence Instrument to grant Consent for start-up of TOR R1, following the 2021 periodic shutdown. However, this recommendation is dependent on the Project Inspector receiving the following information:
- A demonstration that the periodic shutdown inspection programme and sentencing of actions through the OAP has been completed satisfactorily. The Independent Nuclear Safety Assessment certificate for the return to service Engineering Change report, submitted as part of the licensee's application for consent to return to service.
 - A demonstration that the PSSR inspections have been completed satisfactorily and no concerns have been raised. The licensee should submit a return to service statement from the third-party Competent Person as part of the licensee's application for consent to return to service.
 - A demonstration that the inspections not covered by the Appointed Examiner and third-party PSSR Competent Person (namely the gas side penetrations of the reactor pressure boundary) have been completed satisfactorily. The return to service Engineering Change report must include a statement from the licensee's second party PSSR Competent Person supporting the fitness for return to service.
42. The project inspector has received and is content with the above information (Ref. 13, 14, 15,).

4.3 GRAPHITE INTERVENTION AND ASSESSMENT

43. Reference 16 and 17 report the findings of ONR's graphite inspection and assessment of the TOR R1 2021 periodic shutdown activities.
44. The graphite specialist inspector conducted an LC 28 compliance inspection focusing on the graphite core inspection arrangements and arrangements for the peripheral shielding brick inspections. The objectives of the intervention were:
- To examine the adequacy of the licensee's arrangements with regards to graphite core inspection during the periodic shutdown.
 - To establish confidence that the various safety case commitments for core inspection and trepanning would be met.
 - To consider the quality of the examinations performed, both in terms of data quality and the adequacy of the training and understanding of those involved in the work being carried out.

45. Owing to the Covid-19 arrangements at the time of the inspection, a site visit was not conducted. Instead the specialist inspector conducted a remote inspection, in two parts:
 - A discussion with site to understand the activities ongoing and collect evidence of procedural compliance and quality of results.
 - A session to obtain clarity and provide feedback on the intervention activities.
46. The licensee's target requirement for the periodic shutdown was to inspect 30 fuel channels and one control rod channel. At the time of the intervention the licensee had completed 14 channel inspections which included visual and bore measurements.
47. The inspector interviewed personnel who were involved in the graphite core inspections during the periodic shutdown. In the inspector's opinion, they appeared knowledgeable, and the training records sampled were up to date. From the training records sampled, the specialist inspector considered that the personnel involved in undertaking the graphite core inspections had adequate training and experience to perform their various tasks.
48. The specialist inspector questioned if there was a role profile for the 1st line assessor or the ISI lead role. The ISI Lead stated that work was ongoing which might address the intent of the inspectors' challenge, but at the time was not able to provide a sufficient answer during the inspection. Shortly after the inspection, the licensee's Graphite Manager stated that they understood the challenge and had raised a condition report (CR) to record and track this observation (Ref. 18). The CR committed to consider the benefits of a role profile definition for the key roles in the graphite inspections. The specialist inspector was content that licensee understood the issue and that their process will consider and take the appropriate action.
49. Following the intervention, the specialist inspector concluded that the licensee's arrangements with regards to graphite core inspection during the outage were suitable and adequate. In the specialist inspector's opinion, the visual records and the data sampled were of adequate quality for the licensee to form an accurate judgement and sentence any cracks observed in the graphite bricks.
50. The specialist inspector also assessed the TOR R1 2021 periodic shutdown results relating to the graphite core. The specialist compared the findings against the claims and limits in the current graphite safety case and assessed them against the expectations laid down by the relevant Safety Assessment Principles. The inspector considered the implications of the inspection results and whether they challenge the relevant graphite safety case limits.
51. The fuel channel inspections observed three new defects, two of which were fully circumferential and one partially circumferential. In addition, three existing defects were re-examined. Based on the crack morphology, brick deformation and the level of irradiation at the layers where the new cracks were observed, the licensee concluded that all the cracks were bore initiated and therefore consistent with the expectations of the safety case.
52. The inspector noted the presence of two defects at brick interfaces which may be an indication of seal ring groove wall (SRGW) damage. As these defects have been observed previously, have shown no sign of progression and are not linked to the presence of an axial crack, the GAP did not view the defects as a cause for concern. In the inspectors' view, because the defects have not shown signs of progression, there is no reason to suggest that they present an immediate concern over the next operating period. Therefore, the inspector was content that the safety case is not challenged.

53. During the peripheral brick inspection, the top right corner of one of the bricks was found missing. The brick had been inspected in 2017 where it was observed to be intact. The inspector questioned whether the debris affected any claims in the safety case. The licensee justified that the postulated debris will not impact the safe operation of TOR R1 upon return to service. Based on a previous assessment, the inspector was content that the licensee had presented adequate arguments to justify the acceptability of the generated debris.
54. The licensee stated that the results of the graphite core inspections at the TOR R1 2021 periodic shutdown are acceptable and do not challenge safe operation. The specialist inspector is content that the evidence presented during the periodic shutdown supports the licensee's conclusions that the findings of the graphite core inspections do not challenge the TOR R1 graphite safety case and do not present any impediment to the return to service of TOR R1.
55. At the time the assessment was performed an Independent Nuclear Safety Assessment Certificate was not available. The specialist inspector therefore raised a recommendation that "the project inspector confirms the Independent Nuclear Safety Assessment (INSA) statement has been made available by the licensee and is in agreement with the views in the Engineering Change document.
56. The project inspector has now seen this certificate (ref. 19) and is content that these changes are only minor and do not change the conclusions and the views expressed in their assessment.
57. The inspector notes that according to the licensee's core behaviour predictive models, the onset of keyway root cracking (KWRC) is likely to occur within the next operating period of TOR R1. In addition, the licensee has also identified a new risk posed by debris from the SRGW as a result of KWRC. As a result, the licensee has implemented an enhanced inspection scope with reduced intervals between inspections. The number of fuel channels inspected during the periodic shutdown has increased from 16 to 30 channels (approximately 10% of the core). In addition, a further 20 fuel channels will be inspected during an "interim" outage 12-24 months after the periodic shutdown.
58. The licensee is also developing a safety case to justify the risk of SRGW debris up to first KWRC and a post-onset of keyway root cracking safety case. These will be provided to ONR for assessment by mid-2021.
59. The inspector is content that there is sufficient confidence that the proximity to the onset of keyway root cracking and potential generation of SRGW debris does not affect ONR's ability to permission the restart of TOR R1. From a graphite perspective, the specialist inspector has no objection to recommending that Consent is given to return TOR R1 back to service.

4.4 MECHANICAL ENGINEERING INTERVENTION

60. Reference 20 reports the findings of ONR's mechanical engineering inspection of the TOR R1 2021 periodic shutdown activities.
61. The mechanical engineering specialist inspector conducted a remote inspection against LC 30 to gather evidence to support ONR's permissioning decision regarding granting Consent to start-up TOR R1 following its 2021 periodic shutdown. The scope and regulatory objectives of the intervention were:
 - To confirm EIMT requirements for mechanical systems specified in the Stations PMS for periodic shutdown periodicities, were carried out in accordance with Station's arrangements.

- That EIMT work was carried out by Suitably Qualified and Experienced Persons (SQEP), with appropriate supervision and quality standards.
 - That any safety issues identified during the periodic shutdown work were suitably addressed.
62. Based on the scope undertaken during a reactor periodic shutdown, the inspector targeted the intervention on systems considered important to safety and focused on:
- Gas circulator refurbishment
 - Reactor vessel CO2 safety relief valves
 - Control rods
63. From the evidence gathered the inspector identified some minor compliance issues with the procedures and paperwork for the Gas Circulator (GC) refurbishment. These matters were brought to the attention of the TOR Reactor Systems Group Head. The licensee confirmed updates to the Rotor Balance procedure and coaching of maintenance personnel would be undertaken. The inspector was content that no formal regulatory action was necessary.
64. During the intervention, Station reported that GC machine 23, located in R1 position 1CX1, had experienced a high temperature excursion event on the Non-Drive End (NDE) bearing during a test run. The licensee applied its operational decision-making (ODM) process and discussed the event with the licensee's Central Technical Organisation (CTO) who advised them to replace the GC, given potential significant damage to the bearing. Subsequently, the licensee replaced GC machine 23 with refurbished machine 16, which was originally planned for R1 location 1AX1.
65. The licensee's investigation concluded that the most credible cause of the event was the introduction of foreign material into the GC oil system for machine 23 which resulted in a NDE high temperature excursion event.
66. The inspector considered that the licensee's investigation into the event was adequate. Although no foreign material has been detected, with it either disintegrating or becoming trapped within the GC oil drain tank. The replacement of lubrication oil and test run of machine 16 provide confidence in the licensee's assessment of the cause of this event. The inspector considers that the licensee took a cautious approach in their decision making with replacement of GC machine 23 with machine 16 given the potential damage to the white metal bearing.
67. Based on discussions (Ref. 21) with the licensee covering their investigation and supporting documentation covering the failure assessment and operational decision making, the inspector is content with the information provided and the licensee's confirmation that the GC test run was within operating limits, and considers the matter closed.
68. Based on the intervention findings the inspector considered that TOR had complied with their periodic shutdown PMS requirements for R1 and that the work had been undertaken by SQEP, with the appropriate level of supervision and compliance with quality requirements. The inspector did not identify any matters that would challenge the start-up of R1 or impact on its safe performance until its next periodic shutdown in January 2024.
69. From a mechanical engineering perspective, the inspector recommends ONR give its consent to allow TOR R1 to start-up following its 2021 periodic shutdown.

4.5 ELECTRICAL ENGINEERING INTERVENTION

70. Reference 22 reports the findings of ONRs electrical engineering inspection of the TOR R1 2021 periodic shutdown activities.
71. The electrical engineering specialist inspector conducted an LC 28 compliance inspection targeting the planned electrical work being undertaken as part of the TOR R1 2021 periodic shutdown. This includes the planned electrical EIMT activities from the station's Outage Intentions Document and any reactive electrical work emergent from the shutdown. The inspection covered a sample of the electrical engineering plant and equipment relevant to TOR R1, including:
- Main electrical system
 - Transformers
 - Grid systems
 - Emergency generation systems
 - Short break systems
 - No break systems
 - NGLs 20% efficiency target and any impact on outage activities
72. The inspection was conducted remotely and comprised of a pre-outage meeting and three mid-outage interventions. The scope included a brief overview, explanation and demonstration of the electrical engineering aspects of the outage. The inspection focused on the progress of the outage work activities; findings of significance; resolution of findings, where appropriate; deferred activities and a sample of documentation related to the outage work. The licensee's Independent Nuclear Assurance (INA) site evaluator conducted a plant walkdown and observed plant and equipment being maintained in support of the inspection.
73. The inspection sampled a number of shutdown related electrical activities. The licensee advised the inspector that progress made against electrical activities during the shutdown was as planned and anticipated. The licensee expected to complete all scheduled electrical work activities before the return to service and provided reasoning for the activities that had been deferred. Through explanations, discussions and a live demonstration of the station's asset management system the inspector was satisfied that there were clear, auditable links between the shutdown related electrical activities and the licensee's maintenance schedule and instructions. It was also evident that the electrical activities were undertaken at the appropriate periodicity.
74. INA reported that, overall, it found the activities sampled to be acceptable, with the electrical plant and equipment inspected in an acceptable condition. The licensee's staff spoken to as part of the inspection, all presented a knowledgeable and professional approach, and provided open and honest responses to questions.
75. The inspector was satisfied with and assured by the advice provided by the licensee during the intervention related to the electrical aspects of the ongoing outage activities. As a result, the inspector judged that there was no need for any regulatory action.
76. From the evidence sampled during the inspections the specialist inspector considers that the TOR R1, electrical systems and their associated arrangements are in line with regulatory expectations and that the aspects of the electrical systems sampled met the requirements of the safety case.
77. Based on this targeted intervention there were no issues identified from the electrical work activities which would prevent ONR granting Consent under LC30 for TOR R1 to return to service at this point.

4.6 CONTROL AND INSTRUMENTATION INTERVENTION

78. Reference 23 reports the findings of ONRs Control and Instrumentation inspection during the TOR R1 2021 periodic shutdown.
79. The focus of the inspection was to verify that relevant work activities have been carried out in relation to control and instrumentation (C&I) equipment and systems important to safety in order to confirm that they remain fit for their intended purpose.
80. The inspection sampled outage related maintenance activities, including relevant documentation, that have been applied to Reactor Safety Circuits (RSCs) and other C&I equipment and systems that are important to safety at TOR. The inspection covered the following systems and activities being undertaken during the outage:
81. Reactor safety circuits:
- Neutron flux detectors; insulation resistance and performance, pulse counter plateaux tests. Current position with replacement programme.
 - Main guardline systems testing, including final break contactor.
 - Functional tests of control rod interlocks and end contactor tests.
 - Diverse guardline functional test.
 - Calibration and testing of reactor protection equipment.
 - Channel gas outlet temperature thermocouple
 - Boiler outlet gas, channel outlet gas and quadrant protection equipment thermocouple maintenance and test.
82. Post trip sequencing equipment including:
- Functional checks of X and Y train.
83. Gas circulator instrumentation including:
- Sample of calibration and testing instrumentation on gas circulators to include gas inlet and differential pressure and vibration instrumentation. Testing over/under speed signals, recent OpEx regarding HYA, HRA, HPB on speed signal failures.
 - Lubrication oil maintenance and testing on 1CX1 and 1AX1.
84. During the outage testing of flux measuring assemblies (FMA), the channel 2, type P8A, used in Pulse Campbell mode was declared unavailable for use. In addition, the channel 3, type DC12, used in Log/Lin mode was powered down owing to frequent alarms and trips. The unit had been taken out of service and an already installed DC12 'patched' into the safety circuit.
85. The licensee held an ODM, which identified replacing both flux detectors prior to retuning to service, as the preferred option. Furthermore, the licensee initiated their event recovery process to obtain clarity on plans and ensure that both FMAs could be delivered and assembled in required time scales.
86. On review of this outcome the inspector agreed and supported the licensee's position for the exchange of flux detectors and the testing that is scheduled before the return to service. However, the inspector stressed the importance of continuing with further exchanges to the licensee, particularly FM7 1V05, as soon as reasonably practicable following the return to service. The inspector intends to follow this up through the site inspector and normal regulatory business.
87. During the inspection, the inspector found examples of good ageing and obsolescence forward planning and management. The inspector also found the plant areas and equipment cubicles inspected to be clean, tidy and free from foreign materials, which

demonstrated that good housekeeping practices were being followed. The staff the inspector spoke with appeared to have a good level of knowledge of the systems and equipment they were responsible for. One particularly noteworthy point was some proactive testing and learning from operational experience, on some main guardline trip units that had identified a failed unit. This could have resulted in a spurious trip if not identified. This led to the identification of other potential 'at risk' trip units that had been sent to the original equipment manufacturer for refurbishment.

88. The inspector found that the commitments made in the TOR R1 outage intentions document for C&I equipment and systems important to nuclear safety had been satisfied for those elements of work complete at the time of the inspection. The inspection of the work activities covered during the intervention generally found that the workmanship applied was adequate and consistent with the standards expected from C&I SQEP.
89. The inspector reviewed the implementation of some Engineering Changes that had been identified in the outage intentions document. These were, in the main, associated with the Quadrant hardening project. However, there were some additional modifications being undertaken to the TOR on-line computer system over and above the quadrant hardening related modifications. The inspector considered that the modifications and testing had been satisfactorily completed with the documentation and processes appropriately managed and signed off.
90. The inspectors assessment of the outage intentions document found that it provides a description of the C&I-related maintenance activities and plant modification proposals. Samples of these activities were covered by the inspection and generally found to have been adequately implemented
91. From the evidence gathered during the intervention, the inspector considers that the licensee is managing the exchange of two flux measuring assemblies, which can be monitored by ONR as part of normal regulatory business. The inspector did not identify any other significant issues in relation to the C&I equipment and systems that should prevent ONR from issuing a Consent under LC30 to allow TOR R1 to restart following the periodic shutdown.
92. The project inspector has confirmed that the licensee has exchanged both of the flux measuring assemblies (Ref. 24)
93. On the basis of the inspection of C&I aspects of the TOR R1 2021 periodic shutdown, the inspector supported giving Consent to allow TOR to return to normal operating service following successful completion of the planned maintenance activities in accordance with LC30.

4.7 RADIOLOGICAL PROTECTION INTERVENTION

94. Reference 25 reports the findings of the ONRs Radiological Protection inspection during the TOR R1 2021 periodic shutdown.
95. The intervention sought to establish if the outage work programme was being conducted in compliance with the Ionising Radiations Regulations 2017 (IRR17) and assessed the licensee's radiological risk management arrangements during the periodic shutdown. The inspection involved discussing issues with the licensee, conducting a plant walkdown accompanied by the TOR Head of Radiological Protection (HoRP), the INA outage lead and a representative of the licensee's corporate RPA.
96. The aim of the Radiological Protection intervention was:

- To meet the requirements of the TOR periodic shutdown as defined in the ONR Outage Inspection Plan.
 - To provide regulatory confidence in relation to RP and compliance with Ionising Radiations Regulations 2017 (IRR'17).
 - To inform ONR's decision relating to the issue of a Licence Instrument for Consent for return to service of R1 at TOR.
97. The intervention focussed on the following during the opening meeting and plant inspection:
- Summary of outage programmed work and its radiological implications, as provided in an As Low As Reasonably Practicable (ALARP) document prepared for the outage.
 - Review of outage RP performance, dose, PCEs, significant events, observations.
 - NGL Radiation Protection personnel organisation including level of support available and role of RPS.
 - Outage contractor selection, training, control, supervision and competence.
 - Radiation protection input to outage work planning including risk assessment.
 - Operational dose management, i.e. day-to-day dose management and profiling during the outage.
 - Radiological event investigation and follow-up including response to leakages and spillages of radioactive material.
 - Radiation survey instrument maintenance and support arrangements including adequate monitoring equipment resources for the outage.
 - Radioactive source management.
 - Health Physics clearance arrangements.
 - Radiological protection arrangements for the maintenance and operation of gloveboxes and ventilated enclosures.
98. The specialist inspector found that the licensee's radiological protection resourcing arrangements were adequate and that the licensee demonstrated an adequate level of control over dose accrual for the periodic shutdown. The inspector identified a number of areas of good practice and some opportunities for improvement, which were fed back to the licensee.
99. The inspection did not reveal any significant nuclear safety concerns relevant to the TOR R1 periodic shutdown that require action by the licensee or further follow-up by ONR.
100. Discussions with the HoRP for TOR gave the RP specialist inspector suitable assurance that there is effective RP practice in place; an adequate level of compliance with the requirements of IRR'17 was noted by the RP staff from the licensee's corporate centre.
101. To conclude, the inspector did not identify any matters to prevent ONR granting Consent to allow TOR R1 to return to power.

4.8 CONVENTIONAL SAFETY INTERVENTION

102. Reference 26 reports the findings of ONR's conventional safety inspection during the TOR R1 2021 periodic shutdown.
103. The key regulatory activities undertaken during the inspection were:
- To provide regulatory confidence in the management of work at height risks present during the TOR outage and compliance with the Work at Height

Regulations 2005. The focus was on three areas – planning and supervision of work at height activities, competence of staff carrying out the work and suitability of the equipment used.

- To provide regulatory confidence in the management of workplace transport risks present during the TOR outage and compliance with the relevant parts of the Workplace (Health, Safety and Welfare) Regulations 1992. The focus was on the three areas of safe site, safe vehicle and safe driver as set out in HSE publication HSG136 A guide to workplace transport safety.
 - To seek an update on the stations progress with their review of fixed plant guarding.
104. The specialist inspector sampled work at height activities being carried out during the periodic shutdown and generally observed good practice taking place in relation to the three focus areas, planning, supervision and competence of staff and suitability of equipment. The inspector identified one area for improvement; the wooden boards used for centreline work should be captured within formal station inspection and maintenance arrangements. This was discussed with the station and suitable actions were agreed to remedy the situation.
105. The inspector sampled workplace transport activity, observing examples of good practice in relation to the three focus areas of safe site, safe vehicle and safe driver.
106. The inspector noted that some aspects of safety documentation sampled from one contractor required more detail. This was discussed and action agreed to remedy the situation.
107. During the inspection the inspector made general observations regarding Covid-19 control measures. The inspector found compliance with use of face coverings and hand washing.
108. To conclude, the specialist conventional safety inspector has no objection to Consent for the return to service of TOR R1.

4.9 ONR PROJECT INSPECTOR OVERVIEW OF OUTAGE ACTIVITIES

109. Throughout the periodic shutdown the project inspector received a daily progress brief from the licensee and attended a weekly oversight meeting with the licensee's outage lead team. The weekly meeting covered:
- Overview of the shutdown performance
 - Review of events
 - Progress and critical path
 - Feedback on ONR intervention findings
 - Review of issues affecting start-up
 - Key outage dates and activities
110. The project inspector attended a sample of specialist inspectors interventions, and meetings between the specialist inspectors and the licensee concerning significant events and inspection findings.
111. ONR's project inspector supported the licensee's INA team remotely, on their early outage review (EOR) (Ref. 27).
112. The purpose of the EOR is to:

- Assist the station management in reducing or eliminating undesirable behaviours and conditions which could have an adverse impact on the success of the outage.
 - Identify any performance shortfalls in the early stages of an outage.
 - Identify any Fleet issues for resolution in the longer term.
113. Owing to Covid-19 restrictions ONR participated in the EOR remotely and the number of INA staff on-site was reduced. As a consequence, ONR were not able to take part in any of the on-site inspections, and involvement was limited to attendance of:
- Pre-job brief with the INA team
 - Opening Brief
 - Daily Findings Review – with INA team
 - Daily update brief – with station lead team
 - Closing brief – with station lead team
114. A hot debrief was given to the station lead team at the end of each day and significant issues were followed up immediately, e.g. where a contractor was observed working under a suspended load.
115. At the end of the EOR positive observations, areas to watch, areas for improvement and Fleet level considerations were fed back to the TOR lead team.
116. INA's observations were generally accepted. However, there was some robust discussion and good evidence of challenge from both INA and the station lead team.

4.10 RETURN TO SERVICE MEETING

117. A return to service meeting was held on 24 March 2021 (Ref. 6). The purpose of the meeting was for NGL to present the findings to date of the TOR R1 periodic shutdown to ONR.
118. The licensee provided updates for each of the safety management areas, including:
- Nuclear Safety
 - Industrial Safety
 - Fire Safety
 - Quality Assurance and Human Performance
 - Safety Rules
 - Working Time Directive
 - Environment Safety
 - Radiological Protection
 - Corrective Action Programme and OpEx
 - COVID Response
119. During the outage there had been three accident book entries at the time of the meeting, the most significant being an individual who tripped on a reinforced hose in the charge hall injuring his leg. In addition, there three level 1 safety rules events.
120. Slides were also presented for each of the focus areas:
- Reactor Core Components
 - Reactivity Control and Fuel Handling Systems
 - Main, Reheat and Decay Heat Boilers and Steam and Feed Pipework
 - Gas Circulators
 - Reactor Coolant Gas Aux Systems
 - Main Turbine

- Condensate and Feed System
- Main and Auxiliary Cooling Water Systems
- Control and Instrumentation Equipment
- Electrical System
- Post Trip Sequencing Equipment
- PCPV Inspections
- Engineering Change
- PSSR Inspections
- Maintenance Schedule
- Return to Service Testing

121. Following presentations, ONR informed the licensee that they are content that the main issues relating to re-starting TOR R1 had been raised and discussed during the meeting. ONR fed back that we considered that the licensee had reacted to Covid-19 during the outage and the issue with the FMAs in an appropriate manner. ONR advised the licensee to apply the OpEx gained during the outage and to share it with other NGL sites.

4.11 ENGAGEMENT WITH OTHER GOVERNMENTAL AGENCIES

122. ONR has engaged with the Scottish Environment Protection Agency, who confirmed (Ref. 28) that they have no objections to the restart of TOR R1 following the 2021 periodic shutdown.

5 CONCLUSIONS

123. The licensee's request for ONR's Consent to start-up TOR R1 following periodic shutdown in compliance with LC 30(3) has been supported by their letter (Ref. 1). The letter states that all plant maintenance schedule requirements and modifications identified in the TOR R1 outage intentions document have been met. This excludes the testing of equipment that can only take place when the reactor is pressurised, and steam-raising commences. Based on the evidence from ONR's interventions and assessments, the project inspector is content that the licensee has complied with their plant maintenance schedule requirements.

124. The licensee has submitted the TOR R1 APEX report (Ref. 9) following completion of the civil inspection and maintenance of the PCPV. This confirms that there are no safety issues associated with returning the vessel back to service. This report was reviewed by the ONR civil engineering inspector who is content. ONR supports the licensee's conclusion that the PCPV is safe to return to service and will remain in this condition until its next periodic shutdown. The ONR civil engineering inspector supports ONR issuing Consent for TOR R1 start-up.

125. The licensee's return to safety justification for TOR R1 is set out in EC366338 (Ref. 29) covering steel components and EC 369097 (Ref. 30) covering graphite core inspections. It confirms that no safety issues have been identified from EIMT activity to challenge safety case claims that would prevent TOR R1 start-up or its safe operation until its next periodic shutdown planned in 2024. The licensee supports this claim with statements from their independent third party PSSR Competent Person, Bureau Veritas (Ref. 14), who confirmed that there were no compliance issues from inspections carried out in accordance with the PSSR written schemes of examination. The licensee's findings from thorough examination of PCPV penetrations were found to be satisfactory. These documents have been reviewed by ONR inspectors supporting the TOR R1 periodic shutdown, who agreed that the claims and arguments presented are in line with their views from intervention findings and assessments. ONR structural integrity and graphite specialist inspectors therefore support issuing Consent for TOR R1 start-up.

126. TOR INA has provided their concurrence (Ref. 32) that based on their R1 shutdown concurrence activities, no issues have been identified that would challenge their support for the start-up of TOR R1.
127. Based on the evidence gathered from ONR's intervention and assessment activities for the TOR R1 2021 periodic shutdown, together with the claims, arguments and evidence presented by the licensee in its request for Consent to start-up TOR R1, it is the project inspectors judgement that TOR has complied with its LC 30(1) requirements for R1 in performing the required EIMT work in accordance with the stations plant maintenance schedule. The work was performed in accordance with the stations procedures by competent SQEP's working to identified quality arrangements and with appropriate supervision. Where EIMT findings were anomalous with safety case requirements, the licensee has provided adequate safety justification that relevant safety case limits and conditions are not challenged.
128. In conclusion, ONR has not identified any matters of concern that would prevent it granting Consent for TOR R1 to start-up following its 2021 periodic shutdown.

6 RECOMMENDATIONS

129. The project inspector recommends that, in response to the request by the licensee, ONR issue Licence Instrument 562 granting Consent under Licence Condition 30(3) of Nuclear Site Licence Sc.14 to start-up Torness Reactor 1 following the 2021 Periodic Shutdown.

7 REFERENCES

1. Application for Consent to Start up Reactor 1 Under Licence Condition 30(3) CM9 2021/29795
2. TOR/OM/037/PW/19 Outage Intentions Document Unit 1 Statutory Outage 2021 CM9 2020/320451
3. TOR – Licence Instrument (Consent) No 553 under LC30 (3). Consent to the start-up of Torness Reactor 1, 6 June 2017. CM9 2017/221421
4. Torness Reactor 1 2020 Outage - LI560 - Agreement. CM9 2020/157884.
5. Torness Outage Deferral 2020 - LI 561 Agreement. CM9 2020/209650
6. Torness Power Station - 2021 R1 Start-Up Meeting - 24 March 2021 – Minutes CM9 2021/29598
7. TOR-OFD-CR-20-737-Civil Engineering Meeting with the Torness PCPV Appointed Examiner – Early Engagement for R1 Outage 2021 - 04 November 2020 - C Ryan CM9 2020/310269
8. Torness - ONR-OFD-AR-20-107 - Civil Engineering AR for Torness R1 2021 Periodic Shutdown - P Garesse CM9 2021/13764
9. Torness, Statutory Examination of the Prestressed Concrete Pressure Vessel of Reactor 1. CM9 2021/22213
10. EDF - ONR-OFD-IR-20-115 - Torness Power Station Reactor 1 Periodic Shutdown 16-17 February 2021 CM9 2021/15499
11. EDF - ONR-AR-OFD-20-109 - Torness Reactor 1 2021 - Assessment of the licensee's structural integrity inspections carried out during periodic shutdown - Assessment Report CM9 2021/20511
12. ONR-OFD-DR-20-064 Permissioning Decision Record - PSSR Torness CM9 2021/18176
13. INSA Certificate for Return to Service EC366338. CM9 2021/29797
14. Appointed Examiner Statement PSSR. CM9 2021/29798
15. E/TSK/TOR/15686/19.07 Torness Reactor 1 – PCPV Penetration PSSR – Thorough Examination. CM9 2021/29799
16. EDF - ONR-OFD-IR-20-119 Graphite Inspection at Torness R1 2021 - 10 & 16 February 2021 CM9 2021/14263
17. ONR-OFD-AR-20-106- Torness Reactor 1 2021 Periodic Shutdown: Structural Integrity Assessment of the Graphite Core Inspection Findings CM9 2021/20595
18. E-mail subject: Confirmation of Tor ISI Actions S12R1 date 18-2-21 CM9 2021/15698
19. INSA Certificate for Graphite Core Inspections EC 369097. CM9 2021/29801
20. EDF - ONR-OFD-IR-20-127 - Mechanical Engineering Compliance Intervention Record - Torness Reactor 1 - 2021 Periodic Shutdown - 9-17 March 2021 CM9 2021/17828
21. E-mail - Torness Gas Circulator Test Run 1CX1 CM9 2021/28272

22. ONR-OFD-IR 20-112 - Torness R1 Statutory Outage 2021 - Electrical Engineering Inspection - March 2021 - CM9 2021/24989
23. ONR-OFD-IR 20-134 - Torness R1 Statutory Outage 2021 - Control and Instrumentation inspection - 1-2 March 2021 - CM9 2021/23902
24. Torness R1 - Periodic Shutdown 2021 - Flux Measuring Assembly Event Recovery - Progress Update. CM9 2021/29794
25. Torness - ONR-OFD-IR-20-143 - EDF - Reactor 1 Statutory Outage 2021 Radiological Protection Inspection - 9 March 2021 - CM9 2021/27713
26. EDF - ONR-OFD-IR-20-123 - Inspection of Work at Height and Workplace Transport arrangements during R1 statutory outage - 17 February 2021 2021/19414
27. EDF - Torness - ONR-OFD-CR-20-1016 - Torness Reactor 1 - Early Outage Review, 8 -12 February 2021 - CM9 2021/15314
28. Torness Reactor 1 - 2021 Periodic Shutdown - Notice of No Objection CM9 2021/28279
29. Torness R1 Periodic Shutdown 2021 - Return to Service EC 366338. CM9 2021/29796
30. Torness R1 Periodic Shutdown 2021 - Graphite Core Inspections EC 369097. CM9 2021/29800 EC
31. Station INA Statement. CM9 2021/29802