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Periodic Review of Safety

**Assessment of RRMPOLE Periodic Review of Safety 2017 for the Neptune Nuclear
Licensed Site (NNLS)**

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10 April 2018

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EXECUTIVE SUMMARY

Assessment of Rolls Royce Marine Power Operations Ltd (RRMPOL Periodic Review of Safety 2017 for the Neptune Nuclear Licensed Site (NNLS)

This Report presents the findings of ONR's assessment of the submission made by Rolls Royce Marine Power Operations Limited (RRMPOL) of its decennial Periodic Review of Safety of the Neptune Nuclear Licensed Site (NNLS) in Raynesway, Derby.

Permission Requested

This assessment has been carried out to inform ONR's decision as to whether an adequate periodic review has been undertaken to support continued operations at RRMPOL's NNLS at Raynesway Derby for a further period of ten years.

Background

Licence Condition 15 (Periodic Review) requires licensees to make and implement adequate arrangements for the periodic and systematic review and re-assessment of safety cases.

The submission made by RRMPOL is the output from its Periodic Review. The review was undertaken in accordance with the International Atomic Energy Agency (IAEA) Specific Safety Guide (SSG) SSG-25 for Periodic Safety Review for Nuclear Power Plants, which aligns with ONR Technical Assessment Guide (TAG) NS-TAST-GD-050. The purpose of a Periodic Review, in line with guidance, is to determine by means of assessment the extent to which the facilities and safety cases conform to modern standards, and the identification and implementation of safety improvements identified from the various reviews.

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

The NNLS is comprised of three facilities: the Neptune Reactor Facility (NRF), the Radioactive Components Facility (RCF) and the Neptune Radiological Calibration Facility (NRCF). The NRF houses the Neptune Reactor and is the dominant nuclear risk on the site. At the time of the PRS submission NRF was shut down and de-fuelled. This therefore removed the nuclear risk from the site. The NRF will remain in this state for the foreseeable future as the facility is undergoing an upgrade and modification for the next phases of operation on the NNLS.

This upgrade/modification work is being progressed through RRMPOL's arrangements for Licence Condition 22, and will be subject to further ONR assessment and permissioning ahead of the NRF commissioning and re-start. The RCF and NRCF will remain in operation during the NRF modification; these facilities are considered low risk in comparison to the NRF.

ONR's assessment of the PRS submission has taken account of the status of the facilities and the current site risk. The PRS submission also included the Pre-Construction Safety Report (PCSR) underpinning the modification and upgrade work to the NRF, and this formed part of ONR's assessment. However the PCSR requires further development, and at the time of submission the NRF design had not progressed sufficiently for the PCSR phase. Therefore ONR took the decision to conduct a proportionate review of the PCSR, recognising that this will be further developed and subject to additional regulatory assessment and permission.

Matters arising from ONR's work

Assessment of the PRS submission for the NNLS concluded that for the NRCF and RCF the periodic review was adequate. The implementation of the findings and recommendations from those assessments will ensure that the respective safety cases will meet modern standards.

The majority of ONR's assessment of the PRS focussed on the NRF as, when operating, it presents the greatest risk on the NNLS. Recognising that the NRF is currently shut down, pending significant modification and a new safety case, ONR assessment concluded that the PRS and PCSR for the NRF do not meet our regulatory expectations. Moreover, the PCSR was not sufficiently mature to demonstrate that the risks from the future Neptune facility will be ALARP. A robust, holistic and complete safety case is required to justify the new facility design and operation ahead of the restart of the Neptune reactor, which will be subject to regulatory approval.

To ensure that RRMPOOL continues to implement the findings of the PRS for the NNLS, and address the concerns raised by ONR's assessment work, the following recommendations have been made; progress against these recommendations will be managed via a (level 3) regulatory issue:

- **PAR recommendation 1:** RRMPOOL shall provide an implementation plan and schedule to ensure timely completion of the improvements (Submission Date (SD) +3 years) identified from their PRS review, and those actions to be agreed with ONR to address the recommendations identified from the ONR assessment (Table 1). This plan should be submitted no later than 1 month after the decision date.
- **PAR recommendation 2:** RRMPOOL to develop a plan to submit a revised, mature PCSR for the NRF to ONR, which proposes regulatory hold-points to be agreed with ONR. This plan should be submitted no later than 1 month after the decision date.

Conclusions

Therefore on balance, and considering their relatively low risk contribution, it is concluded that adequate submissions for the RCF and the NRCF have been presented. It is therefore recommended that ONR supports further operations in these facilities up to the next scheduled PRS, to be submitted to ONR no later than 19th April 2027, for ONR decision by 19th April 2028.

RRMPOOL has identified a range of improvements together with an implementation plan and schedule. These improvements should be completed, together with the recommendations identified in the ONR assessment reports, for all facilities on the NNLS and before the Neptune reactor is restarted. The improvements and recommendations should be addressed within the two year, post PRS period.

Recommendation

The Superintending Inspector for the ONR Propulsion Sub-Division should provide a decision letter to Rolls Royce Marine Operations Power Limited indicating that ONR supports the continued operation of the RCF and NRCF, and requires RRMPOOL to provide a robust, holistic and complete safety case to justify the new NRF design and operation ahead of the restart, which will be subject to regulatory approval. It should also be indicated that to retain the next PRS date of April 2028, the improvements and recommendations should be addressed within the two year, post PRS period.

LIST OF ABBREVIATIONS

ALARP	As low as reasonably practicable
BSL	Basic Safety level (in SAPs)
BSO	Basic Safety Objective (in SAPs)
CASD	Continuous At Sea Deterrent
CDM	Core Design and Manufacture
CNS	Civil Nuclear Security (ONR)
COTS	Commercial off The Shelf
CPC	Core Production Capability
DBA	Design Base Analysis
DSR	Design Substantiation Report
ECE	Engineering principles: Civil Engineering
EC&I	Electrical, Control and Instrumentation
EMIT	Examination, Maintenance, Inspection and Testing
FAP	Forward Action Plan
HBCS	Human Based Safety Claims
HOW2	(Office for Nuclear Regulation) Business Management System
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
IEF	Initiating Event Frequency
IH	Internal Hazards
L&C	Limits and Conditions
LC	License Condition
NDA	Nuclear Decommissioning Authority
NFPP	Nuclear Fuel Production Plant
NNLS	Neptune Nuclear Licensed Site
NR	Neptune Reactor
NRCF	Neptune Radiological Calibration Facility
NRF	Neptune Reactor Facility
NRH	Neptune Reactor Hall
ONR	Office for Nuclear Regulation
OFI	Opportunities for Improvement
PAR	Project Assessment Report
PCER	Pre-construction Environment Report
PCSR	Pre-construction Safety Report
PRA	Probabilistic Risk Assessment
PRS	Periodic Review of Safety

PSA	Probabilistic Safety Analysis
PSR	Periodic Safety Review
RCF	Radioactive Components Facility
RGP	Relevant Good Practice
RIF	Regulatory Interface Forum
RRMPOL	Rolls Royce Marine Power Limited
SA	Safety Action
SAP	Safety Assessment Principle(s)
SD	Submission Date
SFAIRP	So far as is reasonably practicable
SFR	Safety Functional Requirements
SFRR	Safety Factor Review Report
SMS	Safety Management System
SQEP	Suitably Qualified and Experienced Person
SSC	Structure, System and Component
TAG	Technical Assessment Guide (ONR)

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1 PERMISSION REQUESTED

1. This report presents the ONR assessment of the Periodic Safety Review (PSR) for the Neptune Nuclear Licensed Site (NNLS) at Raynesway, Derby. The report sets out the regulatory justification for recommending the issue of an ONR decision letter to confirm that the Licensee, Rolls Royce Marine Power Limited (RRMPOL) has undertaken an adequate periodic review of their radiological facilities and further improvements are required to justify the restart of their nuclear reactor facility.
2. Licence Condition (LC) 15 requires the licensee to make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases. Licensees are responsible for determining when a PSR should be undertaken, subject to the internationally endorsed recommendation that the period between PSRs should be no more than ten years. RRMPOL uses the term Periodic Review of Safety (PRS) and this term is used in the remainder of this report.

2 BACKGROUND

2.1 GENERAL

3. Nuclear Site Licence No.13C is held by Rolls Royce Marine Power Limited (RRMPOL); the licensee for the NNLS. The purpose of the NNLS is to test the fuel modules for the submarine nuclear power plants that are manufactured at a separate licensed site in Raynesway, Derby.
4. The NNLS is comprised of three main facilities; Neptune Reactor Facility (NRF), Radioactive Components Facility (RCF) and the Neptune Radiological Calibration Facility (NRCF). The NRF houses the Neptune Reactor (NR), and the RCF and NRCF contain various radiological sources. The nuclear safety related activities at this site are:
 - [REDACTED]
 - Assembly of various core geometries within the NR to prototype, test and experimentally confirm the design methods used in the development of cores for the [REDACTED] pressurised water reactors.
 - Fuel handling activities.
 - Check/calibrate radiological instruments and detectors along with undertaking shielding experiments, within the NRCF.
 - Decontamination, repair and refurbishment of radioactive components together with the preparation of active metallurgical specimens for examination by electron microscope or other examination techniques, within the RCF.

2.2 REGULATORY INTERACTIONS

5. The NRF is undergoing a significant modification program, which is being managed through RRMPOL's arrangements for Licence Condition 22; modification or experiment on existing plant. To justify the safety of these modifications, the Neptune Pre-Construction Safety Report (PCSR) [Ref.6] was developed and submitted, to supplement the PRS for the NRF.
6. This approach is not novel and is in line with ONR guidance (Ref.9), which states that the submission of a new safety case is an acceptable alternative approach, provided that the totality of the process adopted for writing the new case addresses all the facets of a PSR including incorporating any findings from the review of the prior safety case.

7. In line with ONR guidance the scope and plan of the PRS was agreed with RRMPOLE [Ref. 1, 2] ahead of the submission and this included agreeing the inclusion of the PCSR for the NRF. ONR also agreed with RRMPOLE to re-baseline the submission date (SD) for the PRS from the 30th June 2016 to 19th April 2017.
8. RRMPOLE submitted its PRS on 7th April 2017 [Ref.3] comprising of its Periodic Review Safety Report head document [Ref.4] along with a suite of supporting documentation. RRMPOLE also submitted its PCSR [Ref.6] on 19th April 2017 [Ref.5] and supporting documents in support of its PRS submission.

3 RRMPOLE PRS ARRANGEMENTS

9. The regulatory basis for carrying out a PRS derives from LC15, principally 15(1):
 - The licensee shall make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases.
10. RRMPOLE's arrangements against LC15 [Ref.10] have a tiered system of review and re-assessment of safety cases, with a corresponding level of detail for each tier. The main tiers are:
 - Interim Review of Safety.
 - Periodic Reviews of safety.
11. For periodic reviews, RRMPOLE's arrangements [Ref.10, 11] require that the reviews are undertaken by Suitably Qualified and Experienced Personnel (SQEP). The RRMPOLE arrangements are in line with ONR guidance and are adequate.
12. The RRMPOLE PRS scoping document [Ref. 12] defines the following phased approach to assessment:
 - Review of the Plant Design Basis and confirm Systems, Structures and Components (SSC's), through review of facility design documents and drawings.
 - Conduct preliminary investigations/reviews to understand the strengths and shortfalls of the current site safety cases and associated arrangements against modern standards.
 - Undertaking safety factor reviews (in line with IAEA guidance (Ref.13)) to draw together the preliminary investigations.
 - Preparation of a global assessment that builds on all the safety factor reviews, to identify whether there are any underlying weaknesses behind the common themes in the individual safety factor reviews.
 - Production of a PRS Review Report head document which presents the overall conclusions of the global assessment, and provides a summary of the whole PRS process.
 - Resolution of findings through optioneering and then implementing improvements.
13. The PRS was managed and structured in accordance to the guidance of the International Atomic Energy Agency (IAEA) Specific Safety Guide (SSG) SSG-25 for Periodic Safety Review for Nuclear Power Plants [Ref.13], and ONR Technical Assessment Guide (TAG) NS-TAST-GD-050 [Ref.9]. This is considered relevant good practice and is in line with ONR expectations.
14. The PRS summary head document [Ref.4] is underpinned by a number of Safety Factor Review Reports (SFRR). Supporting these SFRRs are the lower tiers of

documentation collated from the various plant reviews and preliminary investigations assessing plant, equipment, structures and operations against relevant modern standards, which fed into the plant reviews and SFRR's.

15. RRMPO's arrangements [Ref.12] sets out a process for identifying and implementing improvements to address shortfalls identified from the SFRR reviews. RRMPO's review includes categorising and recording shortfalls, and undertaking ALARP reviews of potential improvements. This process is in line with ONR expectations for the management of identified PRS shortfalls (Ref. 9).
16. The PRS summary (as captured in the head document) [Ref.4] states that approximately 1100 observations were made within the various SFRRs across all three facilities (NRF, NRCF and RCF). These were reviewed and grouped into 85 consolidated issues.
17. For timely closure of these issues, RRMPO's arrangements [Ref.10, 12] identify timescales (listed below) for implementation of improvements. In order to address each of the issues, RRMPO identified a series of work streams and a responsible person to manage their resolution.
 - Submission Date (SD) + 1 year. As far as reasonably practicable, all improvements shall be completed by the Decision Date.
 - SD + 3 years. Highlight any improvements that may not be completed until after the Decision Date, and provide appropriate justification that the facilities can be safely operated in the intervening period.
18. To implement their PRS findings, RRMPO adopted a risk informed approach and prioritised the work relating to the NRF safety case, over the two lower risk facilities (RCF & NRCF). The PRS head document [Ref.4] presents a series of Forward Action Plans (FAPs) aligned to the NRF modification project, of which the findings of the relevant PRS work streams would be implemented and addressed.
19. The PRS issues relating to RCF and NRCF are being addressed by a separate project programme [Ref.14]. This will provide a new RCF and NRCF facility safety case as part of planned improvement works.

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

20. ONR has assessed RRMPO's periodic review of safety as detailed in their submission, its supporting documents and on-going work to determine whether operations at RRMPO's NNLS at Raynesway, Derby have been justified to continue for the next 10 years.
21. ONR's assessment of RRMPO's Periodic Review of Safety was undertaken in accordance with ONR procedures [Ref. 7], ONR Safety Assessment Principles (SAP) [Ref. 8], and relevant supporting Technical Assessment Guides (TAGs) [Ref. 9].
22. The scope of ONR's assessment included the following specialisms:
 - Civil and structural engineering
 - Electrical, control and instrumentation (EC&I) engineering
 - Criticality
 - Fault studies
 - Human factors
 - Internal hazards

- Mechanical engineering
 - Nuclear liabilities.
23. External hazards and leadership and management for safety were omitted from this ONR assessment because both specialisms had recently undertaken assessments on this site. The outputs of these assessments were applicable to the site as a whole, which includes the NNLS. Therefore it was deemed disproportionate to reassess these specialist areas.
24. Our assessment included inspection of the existing facilities, requests for additional information and meetings with relevant RRMPOLE specialists. An LC15 inspection, [Ref.16], was also undertaken to review the arrangements in place to implement PRS shortfalls identified for the NRCF and RCF.

5 MATTERS ARISING FROM ONR'S WORK

5.1 NRCF & RCF ASSESSMENT- LC15 INSPECTION

25. An LC15 inspection was undertaken [Ref.16] to gain assurance that RRMPOLE had implemented adequate arrangements for the management of shortfalls from their periodic review of safety (PRS) for the Neptune Radiological Calibration Facility (NRCF) and the Radioactive Components Facility (RCF). The intervention included review of various documents and visual inspection of the facilities to observe the physical improvements implemented. The key findings were:
- RRMPOLE is managing the identified PRS shortfalls and has programmes in place to close these out.
 - The facilities are well managed and kept in a good state of repair.
 - RRMPOLE is planning significant redevelopment in the facilities to replace old equipment; no concerns were identified relating to the current condition of plant and the planned timescales for them to be replaced.
 - No PRS shortfalls had been formally closed out at the time of the inspection, however, RRMPOLE was able to demonstrate good progress in addressing all PRS shortfalls sampled; and a number of improvements to address PRS shortfalls were already implemented on plant.
 - RRMPOLE was developing their methodologies for the identification of safety measures for radiological hazards, which when reviewed were not clear. Therefore to ensure adequate regulatory oversight of this work a regulatory issue was raised to track progress.
 - RRMPOLE is managing the PRS shortfalls for the NRCF and RCF facilities, and is implementing the recommendations from the assessments. However, to ensure that the recommendations are completed in a timely manner, we requested a delivery programme.
 - **PAR recommendation 1:** RRMPOLE shall provide an implementation plan and schedule to ensure timely completion of the improvements (SD+3 years) identified from their PRS review and those actions to be agreed with ONR to address the recommendations identified from the ONR assessment (Table 1). This plan should be submitted no later than 1 month after the decision date.

5.2 NRF ASSESSMENT FINDINGS

26. Summaries of all the assessment reports [Ref.15] can be found in Appendix 1.

5.2.1 Periodic Review

27. The NRF review was submitted on time; it identified numerous safety case shortfalls through the various SFRR's, which were categorised, prioritised and incorporated in to Neptune modification plan for sentencing in line with ONR and IAEA guidance [Ref 9, 13].
28. The implementation plans submitted by RRMPOLE provided a high-level overview of its NRF schedule of work, addressing the FAP items identified in their PRS head document [Ref.4]. However, RRMPOLE has not provided an updated status of their progress against any of the FAP Items. To ensure that RRMPOLE completes their PRS implementation program in an adequate time scale, PAR recommendation 1 has been raised.

5.2.2 Adequacy of PCSR to address PRS shortfalls

29. ONR's assessment of the Pre-Construction Safety Report (PCSR) took account of the maturity of the PCSR as it was understood that further work was progressing under RRMPOLE's LC22 arrangements, and would be subject to further ONR assessment and permissioning.
30. A review of all the specialist assessment reports identified the following themes:

5.2.2.1 Theme 1: Modern standards safety case

31. In line with ONR guidance, the PCSR should meet modern standards and demonstrate that all reasonably practicable improvements will be implemented to ensure that the risks to the public and work force are ALARP.
32. In a wide range of technical areas the PCSR does not meet modern standards. Overall it was judged to be insufficiently mature to demonstrate that all of the shortfalls identified from the PRS were adequately addressed and that the risks associated with the NRF are ALARP. Therefore further work is required by RRMPOLE to develop its PCSR to modern standards across all technical areas, and to demonstrate that all PRS shortfalls have been appropriately addressed.

5.2.2.2 Theme 2: Continued use of the legacy NRF

33. The NRF was constructed in 1962 to provide the principal shielding and confinement safety functions. Due the age of the facility it is likely to have exceeded its original design life.
34. The structural integrity of the NRF was not adequately assessed against the original design codes and standards or against modern codes and standards in order to understand any compliance gaps and their significance for normal operations and extreme environmental conditions.
35. It is recognised that at the time of the original design and construction, there was no requirement for nuclear facilities to be seismically qualified. The seismic analysis undertaken does not adequately substantiate the building's seismic withstand.
36. Therefore it was not possible to determine the adequacy (or otherwise) of the NRF against relevant modern codes and standards (both nuclear and non-nuclear) to determine whether the risks associated with the continued use (accounting for aging management) of the extant civil structure are ALARP.
37. The proposed modification program for the NRF only considers the strip-out and replacement of reactor plant and control systems within the extant building, with no significant modification planned to the building structure. Therefore based on the

shortfalls identified above, further work is required to demonstrate that the NRF will deliver its safety functions and that the continued use of the extant structure (without modification) is ALARP.

5.2.2.3 Theme 3: Categorisation and classification of safety functions and systems

38. There is a lack of clarity over the methodology used in determining the categorisation of safety functions and the classification of safety systems, structures and components within the Neptune facility. ONR expectations for a modern standards safety case categorisation and classification methodology should:
- Have in place a systematic process for the identification and categorisation of safety functions.
 - Have in place a systematic process for the identification and classification of those SSCs delivering the safety function.
 - Apply the principle of defence-in-depth with a clear focus on prevention, protection and mitigation in that order.
 - Have a clear demonstration of ALARP.
39. The PCSR has not adequately demonstrated these key principles. The safety functions to be delivered within the facility, both during normal operation and in the event of a fault or accident, are not categorised based on their safety significance and the associated potential consequences. This has resulted in a lower classification of safety systems than would typically be expected for a similar facility with similar fault consequences.
40. Therefore as part of their PCSR development, RRMPOLE needs to demonstrate that the basis of their categorisation of safety functions and classification of safety systems is line with ONR expectations.

5.2.2.4 Summary

41. The PCSR submitted as part of the PRS submission is not sufficiently mature to support the closure of findings from the PRS, or to demonstrate that the risks from the proposed future Neptune facility design are ALARP. This is primarily due to the number of shortfalls identified against a modern standard safety case and from a lack of clarity in the methodology used to define the classification of structures systems and components that deliver safety functions. RRMPOLE must ensure as part of its ongoing design work that it captures both the recommendations from the ONR assessment and their PRS and adequately address them, prior to the NRF return to service. ONR will continue to engage with RRMPOLE to monitor this work and to exert regulatory control via suitable hold point permissioning ([Ref. 21]) as the project progresses. This is captured in the following recommendation:
- **PAR recommendation 2:** RRMPOLE to develop a plan to submit a revised, mature PCSR to ONR, which proposes regulatory hold-points to be agreed with ONR. This plan should be submitted no later than 1 month after the decision date.

5.3 COMMUNICATION OF ONR'S FINDINGS TO RRMPOLE

42. In accordance with ONR's TAG on Periodic Safety Review, NS-TAST-GD-050 [Ref.9], ONR has made available to RRMPOLE its provisional findings on the PRS submission and associated recommendations [Ref.17].

43. Following this, a level 3 meeting was held with RRMPOLE to discuss the findings from this assessment [Ref. 18]. During this RRMPOLE made a commitment to:
- Undertake a review of all the Safety Factor Review findings/observations/shortfalls, and ensure that each one has been captured and progressed through their consolidation process. Independent review will be undertaken by their Quality Assurance team.
 - Review all shortfalls that have been closed out to ensure that they have not been closed out prematurely, through review of activities and evidence.
 - Establish a SQEP team to review the PCSR related findings and engage with ONR to address them within the PCSR.
44. In response to the above commitments, RRMPOLE subsequently provided an update [Ref. 20], outlining their findings. RRMPOLE stated that:
- They have acknowledged that there was a lack of formal oversight relating to the closure of PRS issues. RRMPOLE has identified two actions to address the shortfalls identified, which will be incorporated into their PRS implementation plan;
 - Action 1: RRMPOLE to revise the issue database to provide clear line of sight from the original observations through to recommendation and action closeout.
 - Action 2: All closed actions/observations to be re-opened, and the Neptune Engineering Manager to confirm their categorisation and formally endorse all action/observation closeouts.
 - They have engaged with ONR to discuss the findings from the PRS and issues related to PCSR.

6 CONCLUSIONS

45. This report presents the findings of ONR's assessment of the RRMPOLE submission for its periodic review of safety of the NNLS at Raynesway, Derby.
46. ONR assessment of RRMPOLE's PRS submission [Ref.4] and supporting documentation together with the PCSR, identified the following:
- RRMPOLE has implemented adequate arrangements for their periodic review of their safety cases.
 - The PRS was submitted on time and is considered to be broadly adequate; it identified numerous safety case shortfalls that are due to be sentenced as part of the Neptune modification plan.
 - The findings from the LC15 inspection support continued operation of the NRCF and RCF; these are low risk facilities and the inspection found sufficient evidence to demonstrate that the implementation of the PRS shortfalls was adequate.
 - The PCSR for the Neptune Reactor Facility is not adequate. There are wide ranging shortfalls including the safety case methodology, substantiation of the continued use of the unmodified legacy NRF and a lack of maturity in the control system design. These shortfalls, and those highlighted in the individual assessment reports need to be addressed to demonstrate a clear ALARP position for the risks associated with operations in the NRF, ahead of any procurement or construction activities.
47. The significance of the shortfalls identified for the NRCF and RCF does not preclude further operation of these two facilities. The claims, arguments and evidence in the

PRS submission and its supporting documents are adequate, and RRMPOl has carried out an adequate periodic review.

48. Therefore to ensure that RRMPOl continues to implement the findings of the PRS for the NNLS, and address the concerns raised by ONR's assessment work (Table 1), the following recommendations have been made (progress against these recommendations will be managed via a (level 3) regulatory issue):
- **PAR recommendation 1:** RRMPOl shall provide an implementation plan and schedule to ensure timely completion of the improvements (SD+3 years) identified from their PRS review, and those actions to be agreed with ONR to address the recommendations identified from the ONR assessment (Table 1). This plan should be submitted no later than 1 month after the decision date.
 - **PAR recommendation 2:** RRMPOl to develop a plan to submit a revised, mature PSCR to ONR, which proposes regulatory hold-points to be agreed with ONR. This plan should be submitted no later than 1 month after the decision date.
49. A regulatory issue will also be raised, in line with ONR due process, to ensure continued regulatory oversight against the shortfalls identified in this PAR.
50. In conclusion, ONR should support continued operations at RRMPOl's NNLS for a further ten year period, subject to the implementation by RRMPOl of improvements to address the recommendations listed in this report, on timescales to be agreed with ONR.

7 RECOMMENDATIONS

51. The Superintending Inspector for the ONR Propulsion Sub-Division should provide a decision letter to Rolls Royce Marine Operations Power Limited, indicating that ONR supports the continued operation of the RCF and NRCF, and requires RRMPOl to provide a robust, holistic and complete safety case to justify the new NRF design and operation ahead of the restart, which will be subject to regulatory approval. It should also be indicated that to retain the next PRS date of April 2028, the improvements and recommendations should be addressed within the two year, post PRS period.

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Table 1 - Recommendations for the licensee from the ONR supporting assessments

ID	Discipline	Recommendation
1	Civil Engineering	A complete submission comprising all civil engineering aspects of the Neptune Nuclear Licensed Site should be presented by this Periodic Review of Safety (PRS).
2	Civil Engineering	RRMPOL should adequately demonstrate that the risks associated with carrying out the planned operations in the Neptune Reactor Hall (NRH) are as low as reasonably practicable.
3	EC&I	C&I modifications which are intended to address PRS findings regarding C&I shortfalls were not sufficiently developed at the time of the PRS/PCSR submission to ONR. RRMPOL should therefore ensure that adequate information to substantiate the intended C&I modifications and to demonstrate that the improvements will reduce risk to ALARP is provided in a revised PCSR, prior to commencement of the Neptune reactor facility modifications. (See also related C&I recommendation 7).
4	EC&I	RRMPOL should demonstrate that the approach taken in the PCSR to reactor faults which have a prompt criticality consequence aligns with relevant good practice with respect to hierarchy of controls and defence in depth concepts, so far as is reasonably practicable. RRMPOL should demonstrate that the approach taken results in the identification of an adequate range of safety functional requirements for C&I based SSCs, prior to commencement of the Neptune reactor facility modifications.
5	EC&I	RRMPOL should ensure that the potential for control system initiated faults is adequately accounted for in a revised PCSR, prior to commencement of the Neptune reactor facility modifications. The licensee should demonstrate that an adequate assessment of the frequency and consequence of control system failures is identified in the fault schedule for the facility, and that adequate safety functional requirements are specified to protect and mitigate against the effects of control system failures.
6	EC&I	RRMPOL should review the PCSR fault schedule to ensure that where initiating faults have been grouped, the claimed engineered safety measure (in particular the reactor protection system, Scram) is functionally capable of protecting against all grouped initiating faults, including control system initiated faults (see Recommendation 3).
7	EC&I	RRMPOL should develop a plan to meet the C&I engineering aspects of regulatory expectations associated with the return to service of the Neptune reactor facility. This should include the identification of a suitable range of regulatory hold-points to ensure adequate engagement with ONR in the future, throughout the project.

8	Criticality	RRMPOL should further develop their criticality safety case specifically in the areas of design base and Probabilistic safety assessment such that it meets modern standards.
9	Fault Studies	Based on sampling of the information provided in the PCSR submissions ONR believes that RRMPOL's decision to close PRS Consolidated Issues #1, #2, #46, #49, #101 and #102 is premature. However, given that the Neptune Reactor is no longer operational, and that further development of the safety case is planned prior to its return to service, it is recommend that the PRS be closed and further engagement be sought via regulatory hold-points associated with the return to service of the Neptune Reactor Facility.
10	Fault Studies	RRMPOL should further develop the fault studies aspects of the PCSR; ensuring that the relevant findings from the assessment, and those recommendations resulting from the assessment of the core performance transient analysis, are adequately addressed prior to any operations being undertaken in the upgraded Neptune Reactor Facility.
11	Human Factors	RRMPOL should further develop their Human Factors safety case such that it meets modern standards expectations and demonstrates the risks arising from operations are ALARP.
12	Internal Hazards	RRMPOL to review the gas main hazard and determine the withstand claims for the shield wall and present an ALARP justification supporting the gas main remaining in its current position.
13	Internal Hazards	RRMPOL should produce a modern standards safety case for all internal hazards as part of the PCSR work. Ensuring that all the identified PRS shortfalls related to internal hazards are implemented, including PRS shortfalls relating to hazard identification and analysis, combination of hazards, design basis assessment and fire safety case.
14	Mechanical Engineering	Should RRMPOL wish to restart Neptune reactor operations with extant NRF equipment it is required to submit an ALARP justification for all mechanical SSC's.
15	Mechanical Engineering	Before any physical Neptune modifications are undertaken RRMPOL should resubmit its revised PCSR. The revised PCSR should address the following mechanical concerns: <ul style="list-style-type: none"> • Weaknesses in its arrangements for tracking the closure of mechanical related PSR shortfalls. • Immaturity in its mechanical SSC design substantiations. • Impact of shield wall integrity on safety classification of mechanical SSC's and the resulting mechanical design substantiation. • Impact of any C&I shortfalls on mechanical SSC's. • Shortfalls in its current approach to lifting equipment design, which should align with modern standards.
16	Nuclear Liabilities	Ensure that the knowledge and details of the 'design for decommissioning' features supporting the modifications within PCSR, as required for ECE.26 (Provision for

		decommissioning), are adequately retained, and guided by the good practices of SAPs DC.4 (Planning for decommissioning) and DC.6 (Records for decommissioning).
17	Nuclear Liabilities	Review the programme of work for the Neptune Reactor Facility modifications within the PCSR and ensure adequate arrangements are in place to maintain compliance with LC35 (Decommissioning), including the requirement to review the Raynesway site decommissioning plan.

APPENDIX 1 – ONR Assessment Summaries

Civil Engineering

The Civil Engineering assessment recognised that RRMPOLE had strategically aligned their PRS with the Neptune Modification and Revalidation project and commissioned a series of site survey and walk down reviews, which were well defined and based on experience and organisational and industry good practice. The assessment also found evidence to suggest that guidance documents and templates were shared with subject matter experts undertaking the site surveys and walkdowns, to assist in providing commonality of understanding and consistency. The resulting PRS observations were found to be thorough and well informed.

The assessment found that the PRS/PCSR submission was incomplete on the basis that not all civil engineering aspects of the NNLS have been reviewed and there are a series of outstanding issues that relate to the substantiation of certain civil engineering structures that are considered key to maintaining nuclear safety.

The assessment of the PRS/PCSR documents identified a number of significant shortfalls against relevant good practice and established standards. The assessor judged that there are significant systematic failures with respect to the robustness, completeness, validity and integration of the PRS process and in relation to safety aspects sought by key engineering principles. It also became apparent through this assessment, that RRMPOLE do not currently have a Civil Engineering Design Authority.

The civil assessment was unable to gain sufficient confidence in the design code justification of the Neptune Reactor Hall from the evidence presented in the PCSR/PRS and as a result was unable to judge the adequacy of the structure against modern codes and standards and to determine whether the risks associated are ALARP.

The initial linear analysis work reviewed was considered to follow relevant good practice and presented a good representation of the likely seismic behaviour and capacity of the NRH. However, it was found that the model used did not include internal steelwork in any more detail than non-structural mass. The civil assessment judged that diaphragm action from the Top Platform steelwork could alter the building's response and result in localised effects which could challenge the building structure and the support to the platform.

The seismic justification of the NRH was found to be based on a non-linear 'pushover' analysis. The adopted analysis approach is not wholly considered appropriate due to modelling assumptions, omissions, limitations and the suitability of the applied standard.

The normal operating loads proposed design approach for the Top Platform is considered adequate. However, due to the potential consequences associated with the failure of the Top Platform and the associated claims relating to Top Platform and support beams remaining operational post any foreseeable fault scenario, the new structures (and all connections) should be fully substantiated in accordance with modern seismic codes and standards to justify that the risks associated are ALARP.

The civil assessment recognised that the Neptune Reactor Hall was constructed in 1962 and therefore considered likely that there will be some shortfalls where current relevant good practice may not be fully achieved. However, the assessment found that the Licensee had attempted to justify shortfalls using methods not recognised as relevant good practice. A more suitable approach would be to clearly present the shortfalls against relevant good practice and justify that the risks associated with the shortfalls are ALARP.

The Civil Engineering assessment concluded that there were significant shortfalls in the claims, arguments and evidence presented by the PRS/PCSR submission and there are a number of omissions that need to be addressed in order to support continued operations at RRMPOLE NNLS at Raynesway.

The assessment identified the following Findings:

- The PRS submission is incomplete on the basis that not all civil engineering aspects of the Neptune Nuclear Licensed Site have been reviewed and that there are a series of Outstanding Issues that relate to the substantiation of certain civil engineering structures that are considered key to maintaining nuclear safety.
- RRMPOLE do not have a complete design authority capability with adequate detailed and up-to-date understanding of the design, operations and safety cases.
- The PRS process undertaken by RRMPOLE (following the initial raising of observations) lacks transparency and could result in the detail contained within the observations being diluted or lost and potentially result in the incorrect categorisation/closeout of the observations (shortfalls), which form the basis of this PRS approach.
- RRMPOLE have not appropriately Categorised Safety Functions and Classified Safety Measures. This is likely to have a bearing on the level of design substantiation that is required for the affected civil engineering structures.
- The NRH should be assessed for code compliance against modern (nuclear and non-nuclear) design codes and standards. Any areas of non-code compliance should be identified and quantified.
- The level of seismic withstand of the NRH should be clearly demonstrated. The chosen analysis methods and any demand / capacity evaluation should take account of the structural form and construction of the NRH and adequately reflect the proposed construction. The initial NRH linear analysis work undertaken as part of the desktop review is considered to represent relevant good practice for the seismic analysis of nuclear safety related structures.
- The design of the new Top Platform structures should consider modern seismic codes for nuclear safety-related structures and be based on relevant good practice.

The assessment raised the following two recommendations as a result of these findings:

- **Recommendation 1:** A complete submission comprising all civil engineering aspects of the Neptune Nuclear Licensed Site should be presented by this Periodic Review of Safety (PRS).
- **Recommendation 2:** RRMPOLE should adequately demonstrate that the risks associated with carrying out the planned operations in the Neptune Reactor Hall (NRH) are as low as reasonably practicable.

Electrical, Control and Instrumentation (EC&I)

The EC&I assessment considered the extent to which RRMPOLE's PRS Submission meets ONR's expectations for a periodic safety review, from a C&I engineering perspective using a sampling approach.

The assessment found that the PRS submission demonstrates that a thorough and systematic review was undertaken of the existing safety case and facility, with over 1100 findings being

raised. These findings have been grouped into 85 'consolidated issues' to provide manageable work packages.

The assessment highlights that RRMPOLE chose to combine the PRS review with a substantial facility modification, the 'Neptune Modification and Revalidation Project'. RRMPOLE claims that the majority of the SSCs claimed within the old NRF safety case will be replaced or modified, and that this work will include the whole-scale replacement of C&I systems within the Neptune reactor facility. The new C&I design is based on the development of a new safety case, with a new set of Safety Functional Requirements (SFRs).

The EC&I assessment sampled C&I systems which have a significant role in nuclear safety, in order to form an opinion on the adequacy with which the PCSR addresses shortfalls arising from the old C&I installation, which were raised by the licensee's PRS review.

Sampling of the Design Substantiation Report (DSR) for 'Neptune Reactor Facility Electrical Control and Protection Systems' revealed that the document contained no evidence to substantiate EC&I designs against safety functional requirements and relevant good practice. It was judged by the assessment that the PRS shortfalls encompassing a lack of design documentation and a lack of appropriate substantiation have been prematurely closed, and a recommendation is provided.

Having established that the new C&I development is still in its early stages, with no substantiation available for review, the assessment focused on to the licensee's derivation of the new C&I design basis for reactor control and protection systems.

The aim of this assessment was to judge whether the new SFRs (as reported in the PCSR and its references) would provide an adequate basis of design for reactor control and protection systems. This assessment is linked to the close-out of PRS shortfalls primarily covering inadequate SFR and Structures, Systems and Components (SSC) listings.

The assessment found that the licensee's submission did not meet ONR's expectations in each of the assessed areas. It was found that the claimed close-out of PRS shortfalls which covered inadequate SFR listings and their categorisation, incomplete SSC listings, and a lack of SSC performance requirements, is not adequately supported by the submission.

The assessment concludes that the Neptune reactor has been shut down and all fissile material has been removed from the NRF to allow the programme of intrusive modifications to proceed. Therefore, at this time the assessor has no immediate safety concerns requiring intervention; the recommendations from the assessment relate to improvements required prior to returning the Neptune reactor facility to service.

The assessment raised the following recommendations as a result of these findings:

- **Recommendation 1:** Where improvements to address PRS findings in respect of significant C&I engineering shortfalls have yet to be realised, RRMPOLE should ensure that adequate supplementary information is made available to demonstrate that the intended improvements will be delivered in a timely manner, and that those improvements will reduce risk to ALARP.
- **Recommendation 2:** RRMPOLE should demonstrate that the approach taken in the PCSR to reactor faults which have a prompt criticality consequence aligns with relevant good practice with respect to hierarchy of controls and defence in depth concepts, so far as is reasonably practicable. RRMPOLE should demonstrate that the approach taken results in the identification of an adequate range of safety functional requirements for C&I based SSCs, prior to commencement of the Neptune reactor facility modifications.

- **Recommendation 3:** RRMPOLE should ensure that the potential for control system initiated faults is adequately accounted for in a revised PCSR, prior to commencement of the Neptune reactor facility modifications. The licensee should demonstrate that an adequate assessment of the frequency and consequence of control system failures is identified in the fault schedule for the facility, and that adequate safety functional requirements are specified to protect and mitigate against the effects of control system failures.
- **Recommendation 4:** RRMPOLE should review the PCSR fault schedule to ensure that where initiating faults have been grouped, the claimed engineered safety measure (in particular the reactor protection system, Scram) is functionally capable of protecting against all grouped initiating faults, including control system initiated faults (see Recommendation 3).
- **Recommendation 5:** RRMPOLE should develop a plan to meet the C&I engineering aspects of regulatory expectations associated with the return to service of the Neptune reactor facility. This should include the identification of a suitable range of regulatory hold-points to ensure adequate engagement with ONR in the future, throughout the project.

Criticality

The criticality assessment found no significant concerns about the way the criticality calculations have been carried out to determine the safe numbers of elements & modules under normal and accident conditions. The assessment confirmed the results of previous inspections on similar topics, namely that RRMPOLE has a robust system in place to ensure the adequacy of these processes.

The assessment found confidence that there are significant safety margins for the criticality faults that have been assessed by RRMPOLE. All appear to satisfy the “Double Contingency Principle” (see SAP ECR.2); that is no single mishap on its own (eg double batching the fuel in transport, simple flooding, dropped fuel) could result in a criticality. Commendably, RRMPOLE has specifically calculated the safety margins for simple faults.

The assessment concludes that, except for the specific hazard of a criticality arising from a loss of reactor control (addressed under “Transient Analysis in the fault analysis assessment”); there are no areas of significant concern for criticality safety.

The Criticality assessment made the following findings:

- **Safety Criteria:** The use of the critical condition to partly justify arrangements (e.g. ... along the lines of “it exceeds the safety criterion but is not critical”). The critical condition cannot be predicted with complete accuracy. RRMPOLE’s approach is not consistent with general industry practices.
- **Criticality Consequence:** RRMPOLE claim gamma absorption through the moderator in the tank during a criticality event. The assumption does not appear to be fully justified. RRMPOLE need to demonstrate that this assumption is valid as the resulting low consequence from this claim drives DBA classes.
- **Limits and Conditions:** RRMPOLE’s approach to defining L&Cs is not consistent with ONR guidance on this subject (TAG 35).
- **Moderators:** Moderators and potential moderators are not really discussed in the safety case. Most safety cases define exactly what is meant and what is exempt.
- **Safety categorisation:** It is not clear from reading the report why some items were awarded a “2” and others a “3”.
- **DBA:** RRMPOLE’s methodology in the use of conditional probabilities to reduce the IEFs is not clearly defined.

- PRA: RRMPOLE assign values to conditional probabilities with little underpinning justification.
- ALARP: RRMPOLE do not provide a justification on the optioneering undertaken to result in their current arrangements.

The assessment raised the following recommendation as a result of these findings:

- **Recommendation 1:** RRMPOLE should further develop their criticality safety case specifically in the areas of design base and Probabilistic safety assessment such that it meets modern standards.

Fault Studies

The fault studies assessment found that the close out of findings resulting from the licensee's PRS comprises a number of shortfalls against ONR expectations. The assessment judged that there are extant issues with respect to the traceability of the process adopted for the closeout of PRS Consolidated Issues and has identified potential major issues in relation to fault studies aspects of the PCSR, that are claimed to close Consolidated Issues identified in the PRS.

However, the assessment recognises that the Neptune Reactor is no longer operational and all nuclear fuel has been removed to allow upgrade work. Therefore, assessment found that there is no significant immediate safety concerns provided the recommendations that have arisen from the assessment are addressed prior to implementation of the upgrade programme.

To conclude, the assessment has determined that further work is required to develop and substantiate the design in order to provide confidence in the operation of the facility for the next ten years and to adequately closeout the observations raised as part of RRMPOLE's own PRS review.

The main findings arising from the assessment are as follows.

- The RRMPOLE process for consolidation of its own PRS issues lacks transparency which may result in the detail contained within the observations being diluted or lost and potentially result in incorrect categorisation of the observations. RRMPOLE should therefore review the grouping of PRS Consolidated Issues and provide greater visibility of the closeout process.
- RRMPOLE should justify why the potential for mechanical damage and relocation of fuel following a prompt criticality event is not a nuclear safety concern.
- RRMPOLE should ensure that they demonstrate a comprehensive and systematic approach has been employed for the identification of faults.
- RRMPOLE should develop greater traceability of the linking between the identification of faults, categorisation of safety functions and classification of SSCs, clearly identifying the substantiation of claims made on those SSCs.
- RRMPOLE should clearly define their methodology for the use of conditional probabilities in reducing initiating event frequencies for design basis fuel handling faults.
- RRMPOLE should demonstrate the resilience of the Neptune reactor building, particularly that the shield wall will provide its safety function under all identified accident conditions, including prompt criticality.
- RRMPOLE should re-consider their approach to categorisation and classification within the Neptune reactor facility in line with the hierarchy of defence in depth,

recognising the principal role in ensuring nuclear safety provided by preventative safety functions and categorising these appropriately.

- RRMPOLE should progress the work associated with containment overpressure protection.

Based on these findings the following recommendations were raised:

- **Recommendation 1:** Based on sampling of the information provided in the PCSR submissions ONR judges that RRMPOLE's decision to close PRS Consolidated Issues #1, #2, #46, #49, #101 and #102 is premature. However, given that the Neptune Reactor is no longer operational, and that further development of the safety case is planned prior to its return to service, we recommend that the PRS be closed and further engagement be sought via regulatory hold-points associated with the return to service of the Neptune Reactor Facility.
- **Recommendation 2:** RRMPOLE should further develop the fault studies aspects of the PCSR; ensuring that the relevant findings from the assessment, and those recommendations resulting from the assessment of the core performance transient analysis, are adequately addressed prior to any operations being undertaken in the upgraded Neptune Reactor Facility.

Human Factors

The Human Factors assessment conducted a limited assessment of the PRS due to the immaturity of the PCSR. The assessment recognised that the RCF and NRCF activities are low risk and do not represent a significant hazard; therefore a high level assessment was undertaken of the PRS.

The assessment focused on the key human factor elements of the PCSR. The assessment highlighted a number of potential findings based on the evidence presented in the submission. The assessment judged that the submission did not support the licensee claims regarding current and future operations of the NRF.

The assessment acknowledged that the Neptune facility has now been shut down and dismantled, such that it does not currently constitute a hazard to the public. Proposals for extensive modification of the facility which are likely to have a significant impact on the HBSCs required to maintain safety.

The assessment concludes that in their judgement it would not be proportionate to require the licensee to undertake further assessment and re-submit a PRS which more broadly meets ONR's expectations. The assessment recommends that effort instead should be focused on ensuring that the proposed modifications to the facility and associated safety case close gaps to modern standards SFAIRP. The assessor stated that they were confident that the licensee's formal Human Factors arrangements, if appropriately implemented and integrated into safety assessment and engineer design activities, should ensure regulatory expectations are broadly met.

The assessment noted the following findings:

- The licensee should investigate why Human Factors-related findings from the previous PRS were not closed out and ensure its current arrangements are adequate to deliver the required improvements necessary to maintain safety.
- The licensee should provide adequate justification for not raising formal shortfalls where no documented Human Factors substantiation is available to

- support operator actions where a demand of $<10^{-3}$ is made. ONR expects all claims to be supported by proportionate substantiation.
- The Licensee should review observations raised where there was "... a lack of information or access to equipment limits the scope of the review" to ensure that risk associated with any unrevealed shortfalls are properly understood / managed.
 - The licensee should review and highlight which safety actions will "form principal means of assuring nuclear safety" within the safety case and ensure these are proportionately substantiated in line with modern standard expectations.
 - The licensee should justify how it can claim that an SA is "unachievable" only if more than one "level two goal" cannot be met. The feasibility of some SAs may be brought into questions due to the failure of one "level two goal" (e.g. significant shortfall in the 'SQEPness' of personnel).
 - The licensee should complete a suitably critical assessment, against modern standards, of the modified facility's Safety Management System (SMS) that will support claims that risks arising from future operations are ALARP.
 - The Licensee should review and justify the timing of future Human Factors-related activities as current timings appear to be non-compliant with relevant good practice. Specific areas of concern include the development of training materials (not proposed till commissioning phase of project) and the delivery of a simulator (currently too late to support the design process).

The following recommendations were raised from this assessment:

- **Recommendation 1:** RRMPOLE should further develop their Human Factors safety case such that it meets modern standards expectations and demonstrates the risks arising from operations are ALARP.

Internal Hazards

The Internal Hazards assessment found that RRMPOLE had not yet fully implemented its PRS findings into their pre-construction safety case report (PCSR) in support of the new reactor design. Where work had been completed the assessment found that shortfalls against modern standards remained. Furthermore, the assessment identified that the NNLS has a gas main running through it, which the assessment found had not been adequately assessed and presents a potentially significant safety shortfall with the potential to challenge a principal safety measure.

The assessment concluded that for IH a number of shortfalls were identified from the sample selected and appropriate recommendations were raised to address them. Because the Neptune reactor is not currently operational and all nuclear fuel has been removed from the NRF the assessment found no significant nuclear safety concerns in light of the issues identified.

The assessment raised no objection to ONR agreeing to continue operations for the RCF and NRCF on the condition that the recommendations identified in this assessment are adequately addressed for the NRF safety case (PCSR) before nuclear fuel is placed within the Neptune facility.

The assessment noted the following findings:

- RRMPOLE should ensure that their internal hazards assessment addresses combination of hazards as identified in shortfall 5 from the safety factor 7 review.

- RRMPOLE needs to complete their assessment to demonstrate that in the event of a prompt criticality the shield wall will maintain its safety function for any potential steam explosion.
- RRMPOLE should ensure that the shortfalls identified and incorporated into consolidated issue No 101 for internal hazards are reviewed as part of the internal hazards safety case supporting the PCSR.
- RRMPOLE should review the Argon Tank hazard and associated hazards from refuelling and substantiate the claims made as part of their internal hazards safety case for the PCSR.
- RRMPOLE should ensure that the shortfalls identified and incorporated into consolidated issue No 102 for internal hazards are reviewed as part of the internal hazards safety case supporting the PCSR. Ensuring that the claims made are adequately substantiated for both frequency of event and consequence.
- RRMPOLE should reopen consolidated issue 10 and review the combustible inventory for the upgraded Neptune reactor hall and control room. This should include review of localised fires to ensure that local fires which could affect an SSC are individually identified and the SSC should be substantiated to demonstrate that the risks from the local fires are ALARP.

The following recommendations were raised from this assessment:

- **Recommendation 1:** RRMPOLE to review the gas main hazard and determine the withstand claims for the shield wall and present an ALARP justification supporting the gas main remaining in its current position.
- **Recommendation 2:** RRMPOLE should produce a modern standards safety case for all internal hazards as part of the PCSR work. Ensuring that all the identified PRS shortfalls related to internal hazards are implemented, including PRS shortfalls relating to hazard identification and analysis, combination of hazards, design basis assessment and fire safety case.

Mechanical Engineering

The Mechanical Engineering assessment report found that RRMPOLE had undertaken a proportionate PRS review, a number of shortfalls were identified within RRMPOLE's implementation arrangements through its PCSR. The assessment concludes that there is a further need to engage with RRMPOLE on mechanical engineering aspects of their PCSR to ensure that the mechanical design of the new Neptune facility is adequate.

The main findings from the assessment were:

- Given the significant modification proposed for the extant NRF RRMPOLE has not conducted thorough asset condition reviews for mechanical SSC's. The current PSR submission does not provide assurances that all circumstances which could compromise the future safety of the extant facility have been considered.
- There is a lack of detail in RRMPOLE's PSR submission closeout statements. I consider that RRMPOLE has prematurely closed a number of PSR shortfalls for which work is still on-going. Premature closeout introduces a weakness in RRMPOLE's arrangements for tracking the closure PSR shortfalls.
- Immature design substantiations provided for mechanical SSC's, do not reflect the level of design maturity claimed.
- Integrity of the shield wall (passive safety feature) will impact the categorisation of safety functions and classification of SSC's. Any impacts on safety classification are likely to have a bearing on the level of design substantiation

that is required for the affected mechanical SSC's, particularly in the areas of equipment qualification and fault tolerance testing.

- Shortfalls in C&I SSC substantiation have the potential to impact on related mechanical SSC design and thus mechanical design substantiation.
- Undefined EMIT activities have the potential to impact on related mechanical SSC design and thus mechanical design substantiation.
- The COTS crane and hoist undergoing procurement by RRMPOLE from a specialist supplier are being designed to withdrawn standards BS 2573 and BS 466 respectively.

The following assessment recommendations were raised:

- **Recommendation 1:** Should RRMPOLE wish to restart Neptune reactor operations with extant NRF equipment it is required to submit an ALARP justification for all mechanical SSC's.
- **Recommendation 2:** Before any physical Neptune modifications are undertaken RRMPOLE should resubmit its revised PCSR. The revised PCSR should address the following mechanical concerns:
 - Weaknesses in its arrangements for tracking the closure of mechanical related PSR shortfalls.
 - Immaturity in its mechanical SSC design substantiations.
 - Impact of shield wall integrity on safety classification of mechanical SSC's and the resulting mechanical design substantiation.
 - Impact of any C&I shortfalls on mechanical SSC's.
 - Shortfalls in its current approach to lifting equipment design, which should align with modern standards.

Nuclear Liabilities

The Nuclear Liabilities assessment based on the areas sampled found that the documentation describes adequate justification and optioneering for the radioactive waste system modifications, and adequate consideration of the solid waste management strategy for the de-planting waste arising. Although not explicitly taken into consideration, evidence fundamentally satisfies the requirements of ONR's safety assessment principles (SAPs), Licence Conditions (LCs) and other sources of regulatory expectations, including the requirement to ensure the risks during operation are reduced So Far As Is Reasonably Practicable (SFAIRP).

The assessment raised two recommendations due to shortfalls identified within the decommissioning arrangements of the modifications outlined within PCSR. However, the assessment identified that the shortfalls identified have no immediate impact on nuclear safety within the PRS, and therefore should not prevent the continued activities at the Neptune Nuclear Licensed Site.

The following assessment recommendations were raised:

- **Recommendation 1:** Ensure that the knowledge and details of the 'design for decommissioning' features supporting the modifications within PCSR, as required for ECE.26 (*Provision for decommissioning*), are adequately retained, and guided by the good practices of SAPs DC.4 (*Planning for decommissioning*) and DC.6 (*Records for decommissioning*).
- **Recommendation 2:** Review the programme of work for the Neptune Reactor Facility modifications within the PCSR and ensure adequate arrangements are in place to maintain compliance with LC35 (*Decommissioning*), including the requirement to review the Raynesway site decommissioning plan.