



PROJECT ASSESSMENT REPORT			
Unique Document ID and Revision No:	ONR-OFP-PAR-16-025 Revision 0	TRIM Ref:	2017/10598
Project:	Periodic Safety Review		
Site:	Hinkley Point B Hunterston B		
Title:	Assessment of the Hinkley Point B & Hunterston B third Periodic Safety Review (PSR3)		
Licence Instrument No: (if applicable)	N/A		
Nuclear Site Licence No:	Hinkley Point B – 62C Hunterston B – Sc.13		
Licence Condition:	LC 15		

Document Acceptance and Approval for Issue / Publication

Role	Name	Position	Signature	Date
Author	[REDACTED]	Inspector		30 Jan 2017
Reviewer	[REDACTED]	Principal Inspector		30 Jan 2017
Accepted by	[REDACTED]	Superintending Inspector		31 Jan 2017
Approval for publication ¹	[REDACTED]	Superintending Inspector		17 Feb 2017

Revision History

Revision	Date	Author(s)	Reviewed By	Accepted By	Description of Change
A	24 Jan 2017	[REDACTED]	[REDACTED]	n/a	1 st draft for DL review
B	30 Jan 2017	[REDACTED]	[REDACTED]	n/a	2 nd draft incorporating DL comments
0	30 Jan 2017	[REDACTED]		[REDACTED]	First accepted issue

Circulation (latest issue)

Organisation	Name	Date


¹ Approval is for publication on ONR web-site, after redaction where relevant

Periodic Safety Review
Assessment of the Hinkley Point B & Hunterston B third Periodic Safety Review (PSR3)

Project Assessment Report ONR-OFP-PAR-16-025
Revision 0
31 January 2017

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EXECUTIVE SUMMARY

Title

ONR Assessment of the Hinkley Point B & Hunterston B third Periodic Safety Review.

Permission Requested

This Office for Nuclear Regulation (ONR) Project Assessment Report (PAR) sets out the regulatory justification for the issue of a Decision Letter confirming that EDF Energy Nuclear Generation Ltd (NGL), “the licensee”, has carried out an adequate periodic safety review (PSR) of the Hinkley Point B and Hunterston B nuclear power stations’ safety cases to justify continued safe operations¹ at the facility for the period 2017-27.

Background

A periodic safety review is carried out every 10 years to comply with Nuclear Site Licence Condition 15: Periodic Review. The purpose of the review is to revalidate the extant safety case, to ensure the plant and operations remain adequately safe and fully reflect the site licence requirements. This is achieved by reviewing the previous 10 years of operation together with considering changes in activities that impact on nuclear safety over the following 10 years. The review takes into consideration compliance with modern standards and potential impact of ageing and obsolescence.

This was the first of the third round of periodic safety reviews (PSR3) which will be conducted on the fleet of nuclear reactors operated by NGL. The approach taken for PSR3 differed from previous PSRs in that the review structure was closely aligned to the latest International Atomic Energy Agency (IAEA) guidance on PSRs (SSG-25) and the focus was on the adequacy and effectiveness of the normal business arrangements in place to ensure plant safety.

The validity of the PSR3 extended beyond the current scheduled station cessation of electrical generation, of 2023.

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

ONR’s main area of work was in considering the adequacy of NGL’s review of the Hinkley Point B and Hunterston B power stations’ safety cases and safety management arrangements. Due to this being the first of the PSR3 submissions, and the first to be based on the IAEA guidance, it was decided that a comprehensive assessment would be undertaken which would also take a view on the new style of the PSR submission. A total of 15 regulatory assessments were commissioned.

Matters arising from ONR's work

The new approach adopted for PSR3, focussing on demonstrating that nuclear safety is maintained through the routine NGL safety management arrangements, is considered appropriate. This approach demonstrates the ongoing safety management rather than the snapshot in time often found in previous PSRs.

The PSR submission identifies a number of claims and arguments, but in some cases the evidence appeared insufficient to show that NGL had reviewed its arrangements and confirmed, or otherwise, that it had ‘adequate and effective’ processes. However, through its sampling assessments and interactions with NGL staff, ONR has been able to establish that

¹ “Operations” include maintenance, examination, testing and operation of the plant and the treatment, processing, keeping, storing, accumulating or carriage of any radioactive material or radioactive waste and as such encompasses activities which continue after the cessation of electrical generation and through to decommissioning.

the processes deployed were generally adequate and effective, but this evidence should have been more explicitly presented and ONR is seeking improvements in future submissions.

The predominant the life limiting factor affecting the graphite core at HPB and HNB is key-way root cracking, which had been predicted by NGL to occur, and the onset of which has been confirmed in the Hunterston B reactors. This reinforces ONR's expectation that NGL should ensure that continued generation remains underpinned by a detailed knowledge of the condition of the reactor cores. ONR fully acknowledges that NGL had implemented significant plant improvements at both of its Hunterston B and Hinkley Point B sites, as was evident by the increased resilience and capacity of the nitrogen plant and the introduction of super articulated control rods, to ensure that the ability to shut the reactors down safely following a seismic event was maintained.

Safety shortfalls were identified through the PSR3 recommendation process and have been categorised based on ALARP principles given their impact on safety. None of these were considered significant safety threats and NGL has a programme for all category B recommendations to be addressed by January 2019.

In total, ONR's assessments have raised twelve findings and NGL will develop proposals for the resolution and close out these within agreed timescales. ONR considers the hazard and risk identified within each of the ONR findings are reasonable challenges which NGL has not adequately addressed.

Conclusions

I consider that NGL has carried out an adequate periodic safety review of the Hinkley Point B and Hunterston B nuclear power stations' safety cases for the period 2017-27.

NGL's arrangements for LC 15 have been followed in that an adequate review of the stations' nuclear safety case and safety management arrangements has been undertaken. The review did not identify any significant nuclear safety threats that would impact on stations' operations for the period through end of generation, currently 2023, and defuelling / decommissioning activities to 2027.

ONR's assessments of the Hinkley Point B and Hunterston B PSR3 submission were considered to be thorough and systematic. ONR's assessment findings supported NGL's conclusion that no serious nuclear safety threats existed in continued operation of Hinkley Point B and Hunterston B power stations. ONR identified 12 findings in its assessment work which NGL will close out within agreed timescales.

However, the continued safe operation of the reactors will be dependent on the outcomes of the ongoing programme of graphite core inspections and inspections of other key structural components as part of the continued maintenance, inspection, and testing which will also be required to justify continued generation. Adequacy of the ongoing safety case and the safety of operations will also be confirmed by ONR as part of its permissioning process following each statutory shutdown of the reactors and through regular inspection activities.

Recommendation

I recommend that ONR confirms the adequacy of NGL's Hinkley Point B and Hunterston B PSR submission by issuing a Decision Letter agreeing to the continued operation of the site for the period 2017-2027.

I recommend that conditions are included in the Decision Letter with timescales to address the outstanding NGL category B recommendations and ONR findings.

LIST OF ABBREVIATIONS

AGR	Advanced Gas-cooled Reactor
ALARP	As low as reasonably practicable
BDB	Beyond Design Basis
C&I	Control and Instrumentation
CBSIS	Computer Based Systems Important to Safety
DTA	Damage Tolerance Assessment
EC	Engineering Change
EIMT	Examination, Inspection, Maintenance and Testing
ER	Equipment Reliability
ESBR	Early Stand Back Review
HBSC	Human Based Safety Claim
HNB	Hunterston B
HPB	Hinkley Point B
HVAC	Heating, Ventilation and Air Conditioning
IAEA	International Atomic Energy Agency
INA	Independent Nuclear Assurance
INPO	Institute of Nuclear Power Operators
IPRA	Independent Periodic Review Assessment
JER	Japanese Earthquake Response
KWRC	Key-way Root Cracking
LC	Licence Condition
MDI	Maintain Design Integrity
NNBR	New Normal Business Recommendation
NSC	Nuclear Safety Committee
NGL	EDF Energy Nuclear Generation Ltd
ONR	Office for Nuclear Regulation
OPEX	Operational Experience
PIE	Post-Irradiation Evaluation
PSA	Probabilistic Safety Analysis
PSR	Periodic Safety Review
PSR3	Third round of PSRs undertaken on the NGL fleet of nuclear power stations
SAP	Safety Assessment Principle(s)
SCHR	Safety Case Health Review
SF	Safety Factor

SHIP	System Health Information Programme
SQEP	Suitably Qualified and Experienced Person
SSC	System, Structure and Component
SSR	Safety System Review
TAG	Technical Assessment Guide (ONR)
WANO	World Association of Nuclear Operators
ZW	Zonal Walkdown

TABLE OF CONTENTS

1	PERMISSION REQUESTED	10
2	BACKGROUND	10
2.1	GENERAL	10
2.2	THE PERIODIC SAFETY REVIEW.....	11
3	ASSESSMENT AND INSPECTION WORK CARRIED OUT BY ONR IN CONSIDERATION OF THIS REQUEST	12
4	MATTERS ARISING FROM ONR'S WORK.....	13
5	CONCLUSIONS	15
6	RECOMMENDATIONS.....	15
7	REFERENCES	17

APPENDIX 1 – PSR3 submission structure

APPENDIX 2 – ONR assessment topics

Tables

Table 1:	HPB and HNB PSR3 Category B Recommendations
Table 2:	ONR Findings

1 PERMISSION REQUESTED

1. This ONR Project Assessment Report sets out the regulatory justification for issuing an ONR Decision Letter confirming that EDF Energy Nuclear Generation Ltd (NGL), “the licensee”, has carried out an adequate Periodic Safety Review (PSR) of the Hinkley Point B (HPB) and Hunterston B (HNB) nuclear power stations’ safety cases.
2. The requirement to carry out a PSR is based on the need for compliance with Nuclear Site Licence Condition (LC) 15: Periodic Review. International standards (Ref. 1) state that the period between PSRs should be 10 years. The Hinkley Point B and Hunterston B PSR (Ref. 2) submitted to ONR covers the period January 2017 to 2027.
3. The regulatory process set (Ref. 3) requires ONR to issue a statement in writing (a “Decision Letter”) confirming its position on the adequacy of the licensee’s PSR submission. The Decision Letter is issued one year after the formal submission date of the PSR. This letter sets out any regulatory requirements from the assessment of the PSR.

2 BACKGROUND

2.1 GENERAL

4. Hinkley Point B and Hunterston B power stations operate Advanced Gas-cooled Reactors (AGR) of a similar design, two per station. They both commenced generation in 1976 and are currently scheduled to cease electrical generation in 2023.
5. The PSRs are conducted by NGL in a ten year rolling programme across its fleet of nuclear power stations. The HPB-HNB PSR was the first of the third round of PSRs to be conducted, commonly referred to as PSR3. NGL conducted a joint PSR3 for HPB and HNB and formally submitted this to ONR in January 2016 (Refs. 4 and 5). To maintain consistency across the PSR3 programme, the formal submission date was taken as 31 January 2016.
6. NGL concluded from its reviews that the current safety cases for Hinkley Point B and Hunterston B remained appropriate and adequate nuclear safety risk management arrangements were in place to ensure that the risk from operations¹ at the station will be maintained As Low As Reasonably Practicable (ALARP) over the next PSR period, 2017-2027.
7. NGL also considered that continued operation of Hinkley Point B and Hunterston B stations was acceptable for the next 10 year period. It was acknowledged that this period runs beyond the current scheduled station closure date of 2023 and the conclusions of PSR3 were judged to be robust and valid for any plant state (i.e. from operation to shutdown and decommissioning).
8. ONR’s guidance (Ref. 3) states that the purpose of the PSR is to consider all factors that may alter the safety of the plant over its life-time which are summarised under the following bullet points:
 - The degree to which the safety case conforms to modern standards and good practice;

¹ “Operations” include maintenance, examination, testing and operation of the plant and the treatment, processing, keeping, storing, accumulating or carriage of any radioactive material or radioactive waste and as such encompasses activities which continue after the cessation of electrical generation and through to decommissioning.

- The degree to which the safety documentation addresses the remnant life of the facility given changes in plant status through construction, commissioning, operations, post operations and decommissioning;
- The adequacy of the arrangements in place to maintain safety until the next PSR or end of life;
- Safety improvements to be implemented to resolve any identified safety issues.

2.2 THE PERIODIC SAFETY REVIEW

9. NGL commenced the HPB-HNB PSR3 in 2013 consistent with the approach set out in NGL's scoping document (Ref. 6). This document defined the scope of work to be undertaken and established the methodology. At the start of the PSR3 programme, a review of the PSR2 work had identified key areas for improvement which resulted in the structure of the review being aligned to the IAEA PSR guidance (Ref. 1), based around safety factors, and better use of company processes to deliver PSR evidence where practicable to enable delivery of a more continuous review. The structure of the PSR3 submission is detailed in Appendix 1.
10. To enhance the continuous review activities NGL introduced a triennial safety case health review (SCHR) process which complimented the extant safety system reviews (SSR), which focused on plant condition and reliability.
11. Early in the PSR3 programme NGL performed an early stand back review (ESBR) (Ref. 7) with the main objective of identifying key themes for PSR investigation which were not being managed effectively by normal business processes. The ESBR for consisted of a series of workshops covering all safety related plant areas and disciplines. The key issues raised for PSR investigation from the ESBR were related to material condition, ageing and obsolesce, thermocouples, cable ageing and potential safety case anomalies. None of the issues raised required immediate plant action or a justification for continued operation and have been captured under normal business processes.
12. At both stations, zonal walkdowns were conducted to provide a high-level stand back review of the design and current actual configuration of the plant against the hazard safety case requirements. The walkdowns are termed 'zonal' as they were performed on the basis of physical zones containing nuclear safety related plant with the zones assigned according to the physical segregation provided by fire barriers and/or by separation.
13. To ensure consistency across the safety factor reviews and the PSR3 programme, NGL produced a synopsis document for each safety factor early in the PSR3 process. The synopsis documents set down the claims and arguments for each Safety Factor, to meet the IAEA objectives, and specified the review methods to be used to underwrite each claim.
14. The safety factor reviews focussed on providing evidence to support the claims and arguments laid out in the synopsis documents, demonstrating that the NGL processes had adequately managed safety, and would continue to adequately manage safety, and the stations would therefore be safe to operate for the forthcoming PSR period.
15. The reviews identified PSR recommendations which were categorised by their nuclear safety significance:
 - Category A: PSR identified nuclear safety significant issue which must be resolved by the ONR decision date.

- Category B: PSR identified nuclear safety significant issue, which will be resolved by a timescale commensurate with its safety significance. The timescale will be shared with ONR.
 - New Normal Business Recommendations (NNBR): PSR identified issues of a low nuclear safety significance, e.g. potential improvement comprising good practices but with limited nuclear safety benefit. Timescales will be determined by existing normal business processes for prioritisation of work.
16. NGL identified no category A recommendations and a total of 17 category B nuclear safety significant issues, as detailed in Table 1. NGL produced a plan to address all of its category B recommendations by July 2018 (Ref. 8). This approach was consistent with ONR expectations. A further 81 issues were identified of low nuclear safety significance and were categorised as new normal business recommendations which would be addressed through the routine processes and prioritisation.
17. NGL has followed its own internal assurance process in the production, review and assessment of its PSR3 and sentencing of observations. The final submission document and all of the supporting safety factor reports produced for the Hinkley Point B and Hunterston B PSR3 have been subject to an Independent Periodic Review Assessment (IPRA) by NGL's Independent Nuclear Assurance (INA) (Ref.9). INA also participates in the working group that endorses each category B recommendation raised in the PSR3.
18. The PSR3 Final Submission had been considered by the NGL Nuclear Safety Committee (NSC) (Ref. 10) which noted that a number of important issues were discussed in the PSR submission and argued to be being managed appropriately in normal business. It further identified that consideration should be given to carrying out targeted audits on a number of these normal business activities in the future.

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

19. Throughout the Hinkley Point B and Hunterston B PSR3 process, regular meetings were held to review progress and monitor the delivery of commitments against NGL's declared PSR3 programme. NGL also provided briefings for ONR's assessment inspectors on the structure and content of the PSR3 submission.
20. ONR's main area of work was in considering the adequacy of NGL's review of the Hinkley Point B and Hunterston B power stations' safety cases and safety management arrangements. Due to this being the first of the PSR3 submissions it was decided that a comprehensive assessment would be undertaken which would also take a view on the new style of the PSR submission. A total of 15 regulatory assessments were commissioned covering the following topic areas:
- Structural Integrity (Ref. 11)
 - Mechanical Engineering (Ref. 12)
 - Civil Engineering (Ref. 13)
 - Electrical Engineering (Ref. 14)
 - Control and Instrumentation (Ref. 15)
 - Chemistry (Ref. 16)
 - Graphite (Ref. 17)
 - Fuel Safety (Ref. 18)
 - Internal Hazards (Ref. 19)

- External Hazards (Ref. 20)
 - Fault Studies (Ref. 21)
 - Human Factors (Ref. 22)
 - Leadership and Management for Safety (Ref. 23)
 - Radioactive Waste Management and Decommissioning (Ref. 24)
 - Radiological Protection (Ref. 25)
21. A summary of ONR assessment views and findings are provided in Appendix 2. Although ONR considers that NGL's review of the Hinkley Point B and Hunterston B safety cases was carried out in a systematic way, a number of shortfalls were identified and have been appropriately prioritised. Regulatory issues were raised where ONR's significant assessment findings could be not resolved within the assessment period and are detailed in Table 2. The remainder of the recommendations raised during the assessments will be addressed through routine regulatory interventions.

4 MATTERS ARISING FROM ONR'S WORK

22. Based on the findings of ONR's assessments I consider that, overall, NGL has carried out an adequate review of the Hinkley Point B and Hunterston B Nuclear Power Stations' safety cases. This view is based on the findings of ONR specialist inspectors' assessment reports for specified topic areas (Refs. 11-25). The ONR assessments confirmed NGL's view that the safety case and safety management arrangements justify ongoing operations for a further ten years.
23. The new approach adopted for PSR3, focussing on demonstrating that nuclear safety is maintained through the routine NGL safety management arrangements, is considered appropriate. This approach demonstrates the ongoing safety management rather than the snapshot in time often found in previous PSRs. However as some of the safety factor reports focussed on the areas where there had been problems over the PSR period, it was found that inspectors from a number of disciplines, notably; electrical engineering, chemistry, fuel safety and external hazards, were unable to determine the adequacy of the review from the evidence presented in the submission but were able to gain sufficient confidence in the NGL arrangements from inspection.
24. The PSR submission identifies a number of claims and arguments, but in some cases the evidence appeared to conclude at description of the existence of a process. This was not considered sufficient and nor did it meet the IAEA guidance in that the evidence should be that they have reviewed their arrangements and confirmed, or otherwise, that they have 'adequate and effective' processes. In some cases the outputs of the processes have been reported but with insufficient presentation of critical review.
25. Through its sampling assessments and interactions with NGL staff, ONR has been able to establish that the processes deployed were generally adequate and effective, but this evidence should have been more explicitly presented. Whilst it was judged to be disproportionate for the HPB and HNB PSR3 submission to be rectified, an ONR finding was raised to improve future submissions.

HPB HNB-PSR3-001

NGL should ensure that future periodic safety reviews and submission documentation demonstrate that appropriate reviews have been conducted and

provide evidence that the safety management arrangements are adequate and effective.

26. The new triennial safety case health review (SCHR) process had completed its first cycle of reviews prior to the PSR3 reports and the second cycle of reviews was progressing during the ONR assessment period. From the range of SCHR reports sampled ONR considered that it was a beneficial and effective process which should ensure the currency of the safety cases. However as the work programmes arising from their findings had not yet concluded ONR would continue to monitor how effective the process would be in the longer term.
27. The ONR discipline-based assessment of the process-focussed PSR3 submission identified that whilst the introduction of fleet wide corporate processes had generally provided consistency across the fleet, there were still differences in implementation between the traditional discipline areas. These have been highlighted in the various assessment findings and recommendations.
28. Across the AGR fleet one of the primary life limiting factors will be the ageing and degradation of the graphite core. The predominant mechanism affecting HPB and HNB is Key-Way Root Cracking (KWRC) and how this affects the core geometric integrity. The early onset of KWRC, which had been predicted by NGL to occur, and which has been confirmed in the Hunterston B reactors, reinforces ONR's expectation that NGL should ensure that continued generation remains underpinned by a detailed knowledge of the condition of the reactor cores. The graphite assessment identified a number of improvements to monitor and manage the graphite core through to end of life, where NGL should; develop the inspection of the control rod channels, determine the end of life criteria of the core and reassess the scope of their damage tolerance assessments.
29. ONR fully acknowledges that NGL had implemented significant plant improvements at both of its Hunterston B and Hinkley Point B sites, as was evident by the increased resilience and capacity of the nitrogen plant and the introduction of super articulated control rods, to ensure that the ability to shut the reactors down safely following a seismic event was maintained.
30. One of the requirements for a PSR is to review the degree to which the safety case conforms to modern standards and good practices. Within the PSR3 submission reviews had been conducted against current codes and standards and relevant good practice for many areas. However, the submission did not directly address relevant good practice in the context of the levels of safety being achieved by modern plant designs and whether it would be reasonably practicable to close or reduce any gaps. Whilst reviews against modern codes and standards go some way towards this it is not clear that they will have identified all reasonably practicable improvements. Similarly it is also acknowledged that past PSR's would have considered this aspect to some degree; however relevant good practice has continued to develop in this respect. ONR has raised the following finding to address this shortfall:

HPB HNB-PSR3-002

NGL should conduct a review of the safety performance of the plant design against the relevant good practice provided by modern plant designs to identify any further reasonably practicable improvements.

31. ONR assessment took into account NGL's identification of shortfalls and I consider the process followed by NGL was structured and subject to independent scrutiny. I judge

NGL's categorisation of all shortfalls into category B or new normal business work-streams reasonable with the appropriate ALARP considerations and the impact on nuclear safety.

32. In total, ONR's assessments have raised twelve findings (Table 2). The two relating to the overall process are summarised above; the more topic-specific findings are summarised in Appendix 2. NGL will develop proposals for the resolution of the twelve ONR findings by 31 March 2017 and close out the findings within agreed timescales. I consider the hazard and risk identified within each of the ONR findings are reasonable challenges which NGL has not adequately addressed.
33. ONR will monitor the close out of all NGL's category B recommendations and ONR findings by January 2019 through normal business activities delivered by the ONR Hinkley Point B and Hunterston B PSR3 Project Inspector. Attention will be given to ensure the adequacy of response and effectiveness of implementation.

5 CONCLUSIONS

34. I consider that NGL has carried out an adequate periodic safety review of the Hinkley Point B and Hunterston B nuclear power stations' safety cases for the period 2017-27. This view is based on the following:
 - NGL's arrangements for LC 15 have been followed in that an adequate review of the stations' nuclear safety case and safety management arrangements has been undertaken. This review was subject to independent review via NGL's internal assurance process and Nuclear Safety Committee.
 - NGL's review did not identify any significant nuclear safety threats that would impact on stations' operations for the period through end of generation, currently 2023, and defuelling / decommissioning activities to 2027. Safety shortfalls were identified through the PSR3 recommendation process and have been categorised based on ALARP principles given their impact on safety. NGL has a programme for all category B recommendations to be addressed by January 2019.
 - ONR's own assessment of the Hinkley Point B and Hunterston B PSR3 submission in support of continued safe operations until 2027 were considered to be thorough and systematic.
 - ONR's assessment findings supported NGL's conclusion that no serious nuclear safety threats existed in continued operation of Hinkley Point B and Hunterston B power stations. ONR identified 12 findings in its assessment work for which NGL will develop proposals for resolution by 31 March 2017 and close out the findings within agreed timescales.
35. However, the continued safe operation of the reactors will be dependent on the outcomes of the ongoing programme of graphite core inspections and inspections of other key structural components as part of the continued maintenance, inspection, and testing which will also be required to justify continued generation. Adequacy of the ongoing safety case and the safety of operations will also be confirmed by ONR as part of its permissioning process following each statutory shutdown of the reactors and through regular inspection activities.

6 RECOMMENDATIONS

36. I recommend that ONR confirms the adequacy of NGL's Hinkley Point B and Hunterston B PSR submission by issuing a Decision Letter agreeing to the continued

operation of the site for the period 2017-2027, subject to the caveats highlighted above.

37. I recommend that conditions are included in the Decision Letter with timescales to address the outstanding NGL category B recommendations and ONR findings.

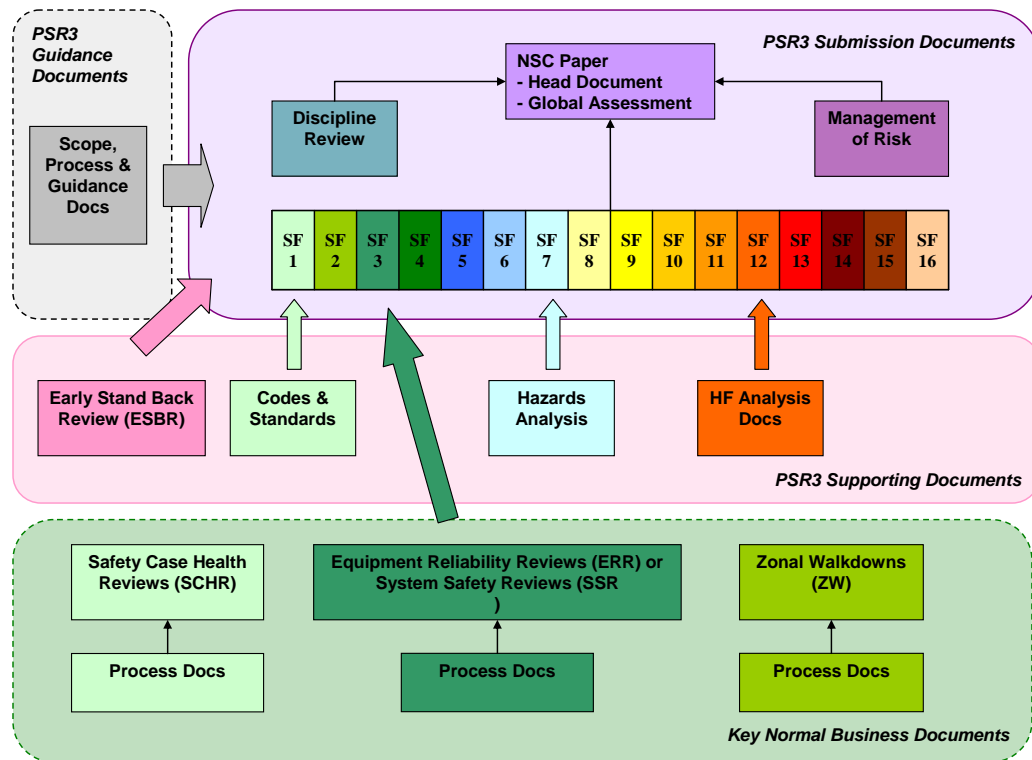
7 REFERENCES

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- 2 NPSC 7729 Hinkley Point B - Hunterston B PSR3 Final submission, October 2015, TRIM 2015/396065
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- 7 EDF – DAO/REP/JIEF/050/GEN/13 - HPB-HNB Early Stand Back Review, May 2014, TRIM 2015/396074
- 8 HPB-HNB PSR3 - Cat B Recommendations - Planned Completion Dates, 15 Dec 2016, TRIM 2017/7862
- 9 EDF - INA/PSR3/H*B/IPRA/NPSC7729 - NPSC 7729 Final submission IPRA Clearance Certificate, 23 Nov 2015, TRIM 2015/450775
- 10 EDF NGL – Nuclear Safety Committee – Minutes of the meeting held at Hartlepool on 12 November 2015, TRIM 2015/452837
- 11 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-021 - Structural Integrity assessment of the HNB and HPB PSR3 for the Period 2017 to 2027, Aug 2016, TRIM 2016/289167
- 12 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-027 - Mechanical Engineering assessment of the HPB and HNB PSR3, Jan 2017, TRIM 2017/6634
- 13 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-042 - Civil Engineering assessment of the HPB and HNB PSR3, Dec 2016, TRIM 2016/474543
- 14 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-047 - Electrical Engineering assessment of the HPB and HNB PSR3, Nov 2016, TRIM 2016/452555
- 15 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-051 - Control and instrumentation assessment of HPB and HNB PSR3, Dec 2016, TRIM 2016/431505
- 16 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-055 - Chemistry assessment of the HPB and HNB PSR3 (2017 - 2027), Dec 2016, TRIM 2016/305206
- 17 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-030 – Graphite assessment of the HPB and HNB PSR3 for the Period 2017 – 2027, Oct 2016, TRIM 2016/298194
- 18 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-056 - Fuel Safety assessment of the HPB and HNB PSR3, Dec 2016, TRIM 2016/370894
- 19 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-012 - Internal Hazards assessment of the HPB and HNB PSR3, Jan 2017, TRIM 2016/205002
- 20 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-036 - External Hazards Assessment of the HPB and HNB PSR3, Jan 2017, TRIM 2017/11875
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- 23 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-022 - LMfS assessment of the HPB and HNB PSR3, Jan 2017, TRIM 2017/1480

- 24 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-039 - Radioactive Waste Management and Decommissioning assessment of the HPB and HNB PSR3, Jan 2017, TRIM 2017/33863
- 25 NGL - Hinkley Point B and Hunterston B - Assessment Report - 16-023 - Radiological Protection Assessment of the HPB and HNB PSR3, Jan 2017, TRIM 2017/17851

APPENDIX 1 – PSR3 submission structure

38. The documentation provided by NGL follows the guidance laid out in International Atomic Energy Agency (IAEA) document number SSG-25 (Periodic Review for Nuclear Power Plants) (Ref.1). The documentation included a final submission document, zonal walkdown reports for HNB and HPB and an early stand back review. The document structure and relationships are shown in the figure below.



39. The submission included a number of specified Safety Factor (SF) documents, as identified below:

- SF 1: Plant design
- SF 2: Actual condition of plant important to safety
- SF 3: Equipment qualification
- SF 4: Ageing, obsolescence and lifetime management
- SF 5: Deterministic safety analysis
- SF 6: Probabilistic safety analysis
- SF 7: Hazards analysis
- SF 8: Safety performance
- SF 9: Use of experience from other plants and research findings
- SF 10: Organisation, the management system and safety culture
- SF 11: Procedures
- SF 12: Human factors
- SF 13: Emergency planning
- SF 14: Radiological impact on the environment
- SF 15: Radiological protection
- SF 16: Decommissioning

APPENDIX 2 – ONR Assessment topics

40. This appendix gives an overview of the various topics assessed within the Hinkley Point B and Hunterston B PSR3 submission and presents the conclusions and ONR findings (where applicable) for each of the topics.

Structural Integrity (Ref. 11)

41. Overall ONR was satisfied, from a structural integrity perspective, that NGL produced the PSR3 for HPB and HNB based on a reassessment of its processes and safety cases in line with ONR's expectations and that it has completed an assessment of current plant condition to compare it against the design intent and the predicted operating life of the stations.
42. The PSR3 identified a number of category B and normal new business recommendations relevant to structural integrity that need to be addressed in order to support safe operation during the next PSR period. ONR was content that NGL has plans in place to resolve these and that none pose an immediate risk to continued operation.
43. ONR was satisfied that NGL had conducted suitable plant walkdowns as part of the PSR3 process, focussed on areas of nuclear safety significance and following a zoned approach. The walkdowns identified a number of common themes relevant to structural integrity, such as insufficient support, segregation or protection for equipment, equipment damaged or in poor condition and previously unidentified potential hazard/plant interactions. ONR was content with the responses provided from NGL on a number of issues identified in the zonal walkdown reports.
44. ONR considered that NGL satisfied the claim that the actual condition of safety related plant and structures was understood and would meet the design basis and functional requirements for the next PSR period. The condition of the plant was documented; maintenance, surveillance and in-service inspection programmes were subject to appropriate review.
45. NGL had made effective use of their management systems to monitor and understand plant condition and ONR was encouraged to review evidence that defect backlogs were showing an improving trend at both stations. However, ONR remained concerned that the necessary additional inspection activity relating to corrosion under insulation, buried and trenched pipework would challenge the process of defect remediation at HPB and HNB.
46. NGL had been able to demonstrate that processes were in place for ageing, obsolescence and lifetime management at HPB and HNB, so that the required safety functions were maintained for the plant lifetime, including the decommissioning phase. However, ONR did not consider that NGL had fully embedded or implemented these arrangements and made recommendations for future progress monitoring.

Mechanical Engineering (Ref. 12)

47. ONR was satisfied with the adequacy of the mechanical engineering aspects of the Hinkley Point B and Hunterston B Periodic Safety Review 3 and supported the continued operation of the Hinkley Point B and Hunterston B.
48. During the period of operation leading up to station closure in 2023, utilisation of the reactor charge machines will increase. This will be due to the graphite core inspection programme, transfer of the more productive fuel from the shutdown reactor to the remaining operational reactor and final end-of-life defuelling. ONR therefore chose the fuel route as the focus for the mechanical engineering assessment sample. ONR

chose not to sample the mechanical equipment directly associated with the primary (reactor) and secondary (boiler) circuits as this equipment was routinely subject to examination, inspection, maintenance and test procedures. Also, NGL's monitoring systems indicated that, since the last periodic safety review, the overall trend for this equipment was increased reliability and availability.

49. The new safety case health reviews (SCHR) and zonal walkdowns (ZW) were claimed by NGL to have achieved significant improvements for PSR3, in that they allowed safety case issues to be promptly identified and resolved whilst considering appropriate prioritisation of these issues alongside other normal business activities. ONR judged that the application of these routine comprehensive safety assessment programmes, SCHR and ZWs were an appropriate means of monitoring overall safety performance.
50. ONR queried the design codes applied to the reactor charge machines and fuel route cranes which had recently been superseded. NGL provided examples of comparative analysis of the old and new design codes applied to their equipment and ONR was satisfied that NGL's claim that there was no evidence of any deficiency in the BS2573 (rules for the design of cranes) design code, could be supported. ONR was also satisfied that NGL's review of BS ISO 6336:2006 (calculation of load capacity of spur and helical gears) had determined that there no shortfalls that would lead to a catastrophic failure and potential for an uncontrolled lower event.
51. NGL stated that work was currently in progress on addressing the HPB/HNB charge machine skew fault case, which was the main risk in the gantry and travel safety case. ONR recommended that this work should also take account of the analysis methodology provided in recently introduced standards.
52. The zonal walkdowns at both stations identified that there was limited supporting evidence to show that the reactor side systems supporting the fuel route systems were maintained in accordance with the demands of the safety case. ONR judged that this indicated that gaps may exist in the demarcation and interfaces between safety systems, which may result in some safety related systems structures and components (SSCs) being overlooked and hence, their condition unknown. ONR recommended that there was clear demarcation of each safety system and, where interfaces exist, ensure that the responsibility for examination, inspection, maintenance and testing (EIMT) was understood and accepted by the respective system owners.
53. ONR sought clarification on how the charge machine and charge hall crane would continue to be safe to operate until the next PSR, taking into account the expected additional demands placed on it due to more graphite inspections, fuel movements between reactors and 'end of life' defuelling. NGL stated that all lifting components were within allowable fatigue limits assuming a service life of 50 years. The safety case for the charge machine pressure boundary was being updated and will include a fatigue assessment based on a best estimate of the pressure cycles up to the currently planned closure date of 2023. The assessments would also be reviewed when the defuelling strategy was clarified and the pressure cycles for the defuelling process were known. ONR was therefore satisfied that NGL was taking due account of the additional charge machine duties through to completion of reactor defuelling.
54. ONR concluded that, although NGL had yet to assess the effects of an increased demand on the use of the fuel route equipment leading up to the end of generation and through into the decommissioning period, there was significant remaining design life available. ONR was also satisfied that NGL planned to undertake further assessment when the defuelling strategy was clarified.

Civil Engineering (Ref. 13)

55. ONR was broadly satisfied with the claims, arguments and evidence laid down within the submitted documents as far as they appertain to the civil engineering discipline. Noting NGL's responses to the comments and queries raised during the assessment, ONR had no objections to NGL's continued operations at Hinkley Point B and Hunterston B for the next PSR period.
56. Three category B recommendations were raised against the actual condition of plant concerning the civil engineering discipline. These related to corrosion management and the condition of the sea defences and the proposed resolutions of which would be monitored during future ONR interventions.
57. The PSR3 recommended and NGL implemented some improvements to the management of codes and standards for the civil engineering discipline. ONR reviewed these and recommended some further minor improvements to ensure that changes to codes and standards were detected in a timely fashion.
58. ONR noted that a dedicated civil engineering suitably qualified and experienced person (SQEP) had been appointed at HPB, a civil engineering user group had been established to share experience between all EDF NGL sites, and a new Company Technical Standard (CTS/230) on the management of civil engineering structures had been issued. Collectively, these should improve the inspection and maintenance of civil engineering structures and reduce the number of defects requiring remediation. ONR judged that although the position reported in 2014 was less than satisfactory, the progress by 2016 in addressing the defects found was adequate, and these new initiatives should improve the situation still further.
59. The performance of plant and equipment on site is continually assessed under a system health information programme (SHIP). The PSR3 identified that the 'passive' civil engineering assets were not explicitly included within SHIP codes but the observation was not progressed further. ONR has recommend that suitable codes should be incorporated into the SHIP system to enable the condition and performance of buildings, structures and civil engineering works to be adequately recorded and monitored.
60. The civil engineering related defects recorded during the zonal walkdowns of both stations were of a relatively minor nature (e.g. small rainwater leaks, concrete spalling) and were being adequately remedied through a managed process under normal business. The PSR3 Project Board was also monitoring their completion.

Electrical Engineering (Ref. 14)

61. Overall, ONR judged that NGL did not specifically demonstrate in its PSR submission that its asset management arrangements for electrical equipment and systems important to safety are appropriate for maintaining its safety case for the 2017-2027 PSR period. However, from a review of the implementation of these processes at both sites and the additional supporting activities undertaken by the sites, ONR was content that both sites were managing equipment in an appropriate manner and were duly considering the change to a post-operational state in their lifetime plans for the equipment and systems.
62. NGL identified three category B recommendations relating to electrical engineering; essential supply cable replacement, HVAC capability and obsolescence. ONR supported the category B and new normal business recommendations, noting that in a number of cases work had already been completed or plans were in place for their management over the forthcoming years.

63. ONR considered that the sites were managing plant ageing and obsolescence issues in an acceptable manner. However, ONR also reached the conclusion that for electrical equipment and systems important to safety, neither the NGL normal business processes nor the PSR consider a timeframe over which it could be expected to have a full understanding of lifetime degradation. Therefore, ONR did not consider that NGL had met the expectations of Paragraph 2.9 of the IAEA Guidance on Periodic Safety Reviews (SSG-25) and did not present a comprehensive assessment of its processes in respect of ageing and obsolescence to demonstrate they are both adequate and effective.
64. Whilst ONR did not consider significant benefit would be gained from NGL addressing this shortfall for HPB and HNB, it would expect any future PSR submissions to ensure such reviews are explicitly reported and concluded. This requirement was raised in the overarching ONR finding **HPB HNB-PSR3-001**.
65. During the site visit to Hinkley Point B, ONR determined that some electrical systems important to safety were not subject to regular Safety System Reviews (SSR), a significant input to the licensee's asset management approach. ONR raised the following PSR assessment finding:
- HPB HNB-PSR3-006**
- NGL should:**
- **Review the Safety System Reviews at Hinkley Point B to establish that they consider all the electrical equipment important to safety and undertake them as necessary.**
 - **Review the Safety System Reviews across all stations to confirm that all equipment important to safety is appropriately considered.**
66. The licensee advised that it would review its arrangements and identify all the systems that were not subject to review by March 2017. To ensure appropriate recognition of the claimed contribution that these provide in assessing that the equipment continues to meet its safety case requirements and therefore to their overall asset management strategy; ONR has recommended that NGL should ensure that following its identification of any systems important to safety, not currently subject to SSRs at Hinkley Point B, then such reviews should be scheduled to be completed in line with NGL's own process and initially, no later than April 2020.

Control and Instrumentation (Ref. 15)

67. Overall, ONR considered that the Hinkley Point B and Hunterston B PSR3 submission, supporting documentation and requested information sufficiently supported the adequacy of the existing control and instrumentation (C&I) arrangements to maintain safe operation of these sites for the period until the next periodic safety review.
68. NGL identified two category B recommendations relevant to control and instrumentation, these related to reactor internal thermocouples and the boiler thermocouples. Work was underway to combine two NGL technical guidance notes in this area and establish a database of in-vessel thermocouple ageing. In addition, the potential to include further tests to understand thermocouple health was being considered and there were plans being considered to increase the availability of in-vessel thermocouples. However, further work was needed (beyond the establishment of the thermocouple database) for NGL to demonstrate that an effective ageing management process exists for in-vessel thermocouples. ONR considered this a fleet-wide issue and will continue to monitor NGL management of in-vessel thermocouple progress during scheduled fleet-wide C&I level 4 meetings and will review progress in future PSR3 assessments.

69. Whilst the scope of the PSR3 specifically excluded physical security, ONR considered that the cyber security of computer based systems important to safety (CBSIS) should have been in scope. The ability of C&I systems to deliver their functionality can be critically undermined by cyber-attack and there are specific station-wide and fleet-wide challenges maintaining adequate arrangements for cyber security. NGL had company standards and governance arrangements for cyber security including a mandatory requirement for all CBSIS to be routinely inspected at the frequency agreed with ONR (currently set at 3 years). Since many of the cyber security controls were station wide, and were essential to maintaining equipment reliability and availability, ONR considered that there would be benefit in undertaking a periodic review of the station wide cyber security arrangements and raised the following finding:

HPB HNB-PSR3-003

NGL should:

- **Conduct a station wide review of their cyber security arrangements as part of the PSR3**
- **Clarify how cyber issues are integrated / addressed in the equipment reliability process.**

70. The NGL SHIP process provides a composite indicator used to gauge the overall performance of plant systems at each of NGL's power stations and is used to allow the development of targeted system action plans for improvement. It forms a key part of the performance monitoring element of the NGL's Equipment Reliability (ER) process used to drive improvements in safe and reliable operation. The Safety Factor 2 report, and also found more recently, identified that defects had been allocated to the wrong SHIP codes resulting in a system condition erroneously being shown as amber for an extended period. ONR reviewed NGL's SHIP arrangements and found them to be adequate and should have avoided the mis-allocation of systems to the SHIP codes. To address this recurrent problem ONR raised the following finding:

HPB HNB-PSR3-004

NGL should:

- **Investigate known occurrences of SHIP incorrect data to identify reason/source of error**
- **Review the training arrangements and communication of procedures associated with SHIP to ensure reliable data is provided to the Equipment Reliability process.**

71. The Safety Factor 4 report and the Codes and Standards Review referenced a number of international standards and industry guidance relating to C&I. The standards referenced contain a brief introduction to C&I ageing and obsolescence management issues. However, there are now more recent and detailed specific C&I ageing and obsolescence standards, including:

- BS IEC 62765-1:2015 C&I Important to Safety – Management of ageing of sensors and transmitters and
- BS IEC 60780-323:2016 Nuclear Facilities – Electrical equipment important to safety – Qualification.

72. In addition, whilst not C&I specific, the recent IAEA Safety Report 62 was not referenced. It is also noted that IAEA documents NS-G-1.1 and NS-G-1.3 were referenced but since the report was prepared have been replaced by SSG-39.

73. To ensure that C&I systems are appropriately managed over the remaining life of the plant, ONR raised the following finding:

HPB HNB-PSR3-005

NGL to undertake a review of their company standards; and in subsequent PSR3 submissions, and address any gaps between existing NGL standards and modern standards, including a gap analysis against IAEA specific safety guide 39 Design of Instrumentation and Control Systems for Nuclear Power Plants.

74. The overall focus of the PSR3 was on the adequacy and effectiveness of the normal business arrangements to ensure plant safety. ONR assessed these arrangements in the context of their application to C&I safety systems to determine their adequacy to maintain safety until the next PSR or the end of life. Clarification was sought on how the reports and reviews listed in the PSR3 documentation interfaced to provide the health overview of the plant, and how this informed plant lifetime management decision making.
75. ONR considered that the overarching process of the management of ER described in the documentation reviewed was fragmented resulting in it being difficult to understand the links between the various documented processes. In addition, the structure of the documentation may result in useful information being potentially missed. ONR therefore recommended that NGL considers developing an overall description of the purpose and scope of the many processes that contribute to the arrangements for the identification, review and maintenance associated with plant health. This description should consider providing a definition of key terms and provide a route map through the ER process to aid understanding of the process and promote procedural use and adherence.
76. During the ONR PSR3 assessment period, ONR raised concerns that the intent of LC28, examination, inspection, maintenance and testing had not been properly satisfied on a number of occasions across the NGL fleet. These findings from ONR's C&I inspections impact on the PSR3 assessment in that if the intent of LC28 had not been properly satisfied it challenged the NGL's premise regarding the adequacy and effectiveness of the normal business arrangements to ensure plant safety. This was communicated to the NGL fleet-wide maintenance manager and ONR will monitor NGL's response as part of normal regulatory business.

Chemistry (Ref. 16)

77. ONR judged that the approach, process and scope applied for PSR3 of HPB and HNB was adequate. In many aspects it was an improvement over the previous PSR processes used by NGL and could be shown to be effective as it identified a number of shortfalls that ONR agreed were important to address. Although ONR was content that it represented a suitable framework for demonstrating the chemistry-related aspects of the PSR, some significant weaknesses in the submitted PSR were identified. However, ONR gathered sufficient evidence from additional sources during its assessment to be able to support acceptance of PSR3 for HPB and HNB for the period until January 2027.
78. Five of the category B recommendations identified by NGL were considered relevant to the chemistry assessment. ONR was satisfied that the recommendations made by NGL appropriately identified areas for further focus in terms of chemistry and they have developed suitable plans to deal with these in a timely manner.
79. A common shortfall of many of the documents was the provision of suitable and sufficient evidence to support the claims and arguments presented. ONR judged this to be a consequence of the change in focus for PSR3 to "...reviewing the effectiveness of

company business processes [for safety management]". In effect the focus was on the processes themselves, not the evidence which demonstrated that these were working effectively. Most of the evidence to support the assessment has therefore been derived from outside of the main PSR3 submissions. While this proved adequate for HPB and HNB, ONR consider that this would need to be addressed in future PSR submissions, particularly for those stations where chemistry may not be as well controlled. This requirement was raised in the overarching ONR finding **HPB HNB-PSR3-001**.

80. Neither the living safety case document, nor the sampled SCHR provided evidence to show that the adequacies of the chemistry elements of the safety cases were challenged as part of PSR3 (or indeed normal business). ONR also considered that the safety cases for neither HPB nor HNB provided sufficient clarity on the importance of chemistry control to safety, in line with expectations for a modern standards safety case (as defined in the SAPs and TAGs). However, ONR did not consider there to be any fundamental shortfalls in this area, rather it was related to how chemistry was considered and presented within the highest levels of the safety case. This deficiency was recognised in the extant ONR Issue 1786 (consistency and visibility of chemistry in the safety case) but ONR further recommended that the relevant living safety case documents be updated to improve the clarity, accessibility and currency of the chemistry related aspects of the safety case.
81. Based on the information initially presented within PSR3 safety factor reports and discipline review submissions, there was insufficient evidence to form a judgement in relation to adequacy of chemistry control. However, from the evidence gained during visits to both stations and that reviewed from follow-up actions, ONR was content that both HPB and HNB were controlling chemistry and managing the respective challenges to maintain operating chemistry within defined limits.
82. ONR sampled the through-life management strategies for the gas by-pass plant and boiler systems, and was largely content that NGL was maintaining the correct focus for ageing and obsolescence from a chemistry perspective and had seen evidence that this process was delivering safety benefits in terms of better chemistry control.
83. ONR assessed the impacts of chemistry in accidents and found that whilst the impact normal operational chemistry controls on accidents (i.e. as an initiating event) was considered and understood, the chemistry effects during accident progression was not adequately considered. ONR recommended that NGL should demonstrate that adequate consideration has been given to chemistry effects during accidents.

Graphite (Ref. 17)

84. ONR reviewed the graphite aspects of the HPB and HNB PSR3 submission and considered that an adequate periodic safety review had been conducted. NGL recognised that the graphite core lifetime was the dominant station life-limiting feature and that it was currently not possible to make a safety case for the graphite core to the scheduled station closure date of 2023. Continued operation of the reactors will be subject to the findings of inspections at outages and monitoring between inspections, however, there remain uncertainties that safety cases can actually be produced in time to ensure the reactors meeting the scheduled station closure date of 2023.
85. The fundamental nuclear safety requirements of the graphite core are affected by the two principal ageing and degradation mechanisms affecting the HPB/HNB graphite bricks; graphite weight loss and irradiation induced dimensional change. The stresses within the graphite bricks later in life can result in cracks originating from the key-ways on the periphery of the bricks, known as key-way root cracking (KWRC). This is of nuclear safety concern because it potentially affects the functioning of the keying

system of the core, which holds the bricks in alignment. Along with the graphite weight loss, the progression of KWRC will probably determine the lifetime of the reactors.

86. The rate of KWRC was however uncertain, due to the differences in irradiation between bricks and the variability in the material properties of the bricks. NGL had attempted to derive the rate of cracking from statistical analyses. The PSR3 submission, based on mid-2014 data, predicted KWRC in 2019. However, the first KWRC was observed at HNB in 2015. Continued operation of HPB/HNB reactors is now supported by NGL's safety case NP/SC 7716 which sets an operational limit of 20% cracking in the core. The justified period of operation of each reactor at HPB/HNB is therefore dependent upon the findings from the inspections at each outage.
87. A significant nuclear safety concern for operation beyond the onset of KWRC was the ability to safely shutdown the core during a seismic event. In addressing the concern, NGL identified and implemented a series of reasonably practicable modifications to the plant, e.g. establish diverse shutdown capability of the core, in order to support plant life extension. These included:
- Seismic qualification of the N₂ Plant (Secondary Shutdown System) and increased capacity of N₂ Plant to enable hold down capability on both reactors;
 - Super Articulated Control Rods.
88. ONR considered that inspection will play a crucial role in supporting the period of safe operation of the reactor in late life. The quality, extent and frequency of the inspection will be the focus points of the graphite safety cases going forward. ONR will closely monitor and oversee NGL's inspection plan for each outage. ONR had been disappointed that the PSR did not identify any significant improvements that could be made to the inspection and monitoring technology. ONR now considers that certain improvements are necessary, such as the development of a capability to measure the condition of control rod channels i.e. channel distortion measurements, as well as visual inspection. ONR therefore raised the following finding to address this issue:

HPB HNB-PSR3-009

NGL should develop improved inspection and monitoring technology; in particular equipment capable of performing visual inspection and dimensional measurements of control rod channels.

89. NGL's damage tolerance assessment (DTA) was focused on brick cracking but ONR noted that the DTA had not yet defined a limit on the graphite channel bore distortion, nor channel bow or tilt. Given that these parameters were measures of changes in the geometry of the graphite channel hence bear direct influence on the normal operation, ONR considered that it would ultimately be necessary for a safety limit, end-of-life criteria, on the change of the channel shape to be substantiated in NGL's safety case. ONR has raised the following finding to recommend that such criteria are developed:

HPB HNB-PSR3-010

NGL should determine end-of-life criteria for the reactors. This is likely to include measures of core distortion as well as numbers and morphology of cracks.

90. ONR considered that for the late life operation of the graphite core, NGL needed to demonstrate that the geometry of the control rod channels would be maintained to ensure free and unimpeded control rod insertion in normal operation, fault and seismic conditions. Due to the significant uncertainties in graphite ageing with irradiation and weight loss, ONR considered that NGL should review the scope of its damage

tolerance assessment, following each outage. Significantly different findings might trigger additional assessment that either enhances the current understanding of the damage mechanism, or augments the scope in addition to cracking and weight loss. An example of the latter could be the damage mechanisms that directly affect the normal operation of the reactor, such as significant changes in the channel shapes. The following finding was raised:

HPB HNB-PSR3-011

NGL should review the scope of their damage tolerance assessment following each outage. Significantly different findings might trigger additional assessment that augments the scope in addition to cracking and weight loss.

Fuel Safety (Ref. 18)

91. ONR was broadly satisfied with the claims and arguments laid down within the licensee's safety case with respect to fuel safety and judged that they are supportable by evidence. The assessment focused on a sample of the PSR documentation in relation to fuel and criticality safety and in particular looking forward to the next ten years of operation, which based on current planned lifetime, will include the end of electricity generating operations. ONR found that in some cases evidence was not effectively presented in the PSR3 submission and required a judgement based on further discussion and information from ongoing interactions with NGL under the fuels topic.
92. The PSR3 identified two normal new business recommendations relevant to fuel safety against which progress had already been demonstrated in order to support safe operation during the next PSR period. ONR therefore considered that progress against the recommendations raised was adequate.
93. Throughout the operational period of the AGR fleet the fuel design has evolved based on operational feedback and data from Post-Irradiation Evaluation (PIE). Further changes to the fuel design and safety case had been brought about through life due to supply chain changes or design improvements. Examples within the period since the last PSR were; robust fuel, improvements in the AGR criticality safety cases, the development of an AGR generic failed fuel safety case and an alternative manufacturing route for tiebars.
94. In general Hinkley Point B and Hunterston B had a relatively good performance in terms of fuel cladding integrity in so far as the number of operational (not induced by faults) fuel failures had fallen to a rate significantly lower than the fleet average. Furthermore, a programme to remove failed fuel from the reactor sites (across the AGR fleet) had enabled HNB to be the first site to be completely free from failed fuel and HPB only had two failed stringers on site
95. Although fuel performance was currently good at HPB and HNB, there was evidence from other AGRs that operation at reduced power could result in unanticipated fuel cladding degradation mechanisms. ONR therefore recommended that NGL should demonstrate that adequate consideration of the effects of prolonged part power operation on the fuel integrity was included within the ongoing research and PIE programme.
96. Based on current operating plans it was anticipated that the HPB and HNB reactors would cease generation before the next round of PSR was due and hence ONR expected to see suitable consideration of the issues regarding fuel leading to end of generation. This should include suitable arrangements to enable planning of fuel

cycles to optimise the fuel utilisation, adequate safety cases, analysis of potential risks to fuel integrity and associated PIE to support the revised fuel regimes.

97. ONR found the PSR3 documentation incomplete with respect to the safety aspects of this forward planning. However, on request NGL provided additional information which outlined a plan for how they intend to produce a safety case integrated with the commercial operation. As a result ONR was satisfied that the forward strategy was currently adequate for fuel safety to end of generation life.
98. Through review of the SCHR process ONR raised a number of observations and considered that the process could be improved and strengthened. In some cases the demonstration of ALARP decision making did not meet expectations. However, ONR did not identify a specific weakness in the safety case and therefore it would be disproportionate to conclude that the process is ineffective. In order to address the weaknesses and bring about a strengthening of the process ONR raised the following finding:

HPB HNB-PSR3-008

NGL should review and update the Safety Case Health Review process to ensure that adequate evidence of decision making is recorded. Attention should be paid to the application of ALARP and strategic decision making to ensure that fuel safety risks from identified issues and shortfalls are demonstrably reduced in so far as is reasonably practicable.

99. Although the performance of Hinkley Point B and Hunterston B nuclear fuel was considered adequate, as was apparent from the recent operational record for the fuel, this was likely to be as a result of enforced reduced power operation. The PSR did not demonstrate this through explicit evidence using trends in performance, which would show that the management processes resulted in safe performance against modern benchmark plant and standards. ONR recommended that for future PSRs, NGL presented evidence that demonstrated adequate safety for nuclear fuel based on plant and fuel performance data, and a gap analysis against modern standards and plant design. This was considered to part of ONR finding **HPB HNB-PSR3-001**.

Internal Hazards (Ref. 19)

100. ONR considered that the Hinkley Point B and Hunterston B PSR3 was an adequate review of hazards within the context of periodic safety review. The internal hazards aspects of PSR3 had shown the benefit of the licensee's change of approach towards periodic review. Both the zonal hazard walkdown process and the safety case health reviews provided input and the evidence produced from these normal business processes were well summarised within the PSR3 summary documents.
101. ONR looked across the full range of internal hazards, but carried out a "deeper-slice" assessment for three of the hazards – fire, hot gas and steam release. The assessment focussed on the SF7 report (Hazards Analysis), relevant SCHR and the zonal hazard walkdown (ZW) reports.
102. ONR noted that a significant reduction in fire hazard had been achieved by the removal of large propane tanks no longer required since the installation of a new nitrogen storage and distribution facility.
103. ONR noted the extant safety case for steam release did not meet the standard ONR would expect for new reactors, it was more based upon the justification of acceptably low frequencies for failures built on a structural integrity case for the pipe work welds and vessels and ongoing inspection. A modern safety case such as that for the latest AGRs is based upon a layout where steam releases are limited in their effects by

passive features such as layout (e.g. quadratisation for Heysham 2 and Torness reactor building) and strict segregation for post trip cooling plant.

104. ONR found SF7 had a good presentation of each of the hazards and the reviews carried out in the relevant hazard appendices; drawing upon evidence gathered in the SCHR and ZW processes, formed the basis of an adequate approach to periodic safety review.
105. Hinkley Point B and Hunterston B were the first two stations to transition to the new PSR3 model, using SCHR and ZW, and have acted as a pilot for the fleet. In the area of internal hazards the SCHR were recognised within NGL as having achieved a good standard with their safety case health reviews, such that other PSR3 projects are looking to learn from their example. Lessons were learned from the first ZWs, and these were being taken forward by the NGL hazard leads. In the area of internal hazards ONR judged they have met a good standard within the HPB/HNB PSR3 project from the SCHR and zonal walkdowns.
106. ONR noted that it was still early days for the new SCHR and ZW processes. These had only ran for a few years and it was not clear how well embedded the changes were, or how effective these processes would be in the longer term. The work programmes arising from their findings had not yet concluded and especially so close to the end of station life, there was limited opportunity for improvements. This was recognised by both NGL and ONR when the PSR3 approach was first mooted, and it was recognised that the advantages would be more apparent for later stations with more residual life.

External Hazards (Ref. 20)

107. Overall, ONR considered that from assessment of external hazards aspects of the Hinkley Point B and Hunterston B PSR3, NGL carried out an adequate periodic safety review. During the assessment, the most significant shortfalls ONR identified related to NGL's internal processes relevant to external hazards rather than the PSR itself.
108. ONR focussed on the assessment of the design basis and beyond design basis seismic, flooding and weather hazards in SF07 (Hazards Analysis) and further considered the effects of plant ageing/degradation on seismic and weather hazards withstand.
109. An example of good practice by NGL concerned the Japanese Earthquake Response (JER) programme, which covered resilience enhancements developed in the light of the earthquake and tsunami at Fukushima Daiichi nuclear power plant on 11 March 2011. ONR had recognised previously that a significant amount of work had been undertaken as part of the JER project to review flooding assessments and the provision of off-site emergency recovery equipment including power supplies, fuel, pumps and mobile emergency co-ordination centres. NGL also provided on-site resilience enhancement including mobile pumps, generators, connection points, debris clearance equipment and deployable dam boards. Building service entry points were also protected from flooding. From an external hazard perspective this is seen as an excellent response.
110. ONR noted that much of the JER work was not discussed within the PSR, and ONR recognised that the scheduling of the PSR and the JER programme activity dates had made this difficult. ONR expects beyond design basis events to be included as part of the safety case for external hazards, and therefore the JER information should be part of those safety cases. ONR recognised that NGL has been updating the living safety case documentation considered the position with the JER implementation programme to be adequate.

111. PSR3 indicated that, with the exception of aircraft crash, there had been no calculation of cliff edges/safety system failures that would occur for beyond design basis (BDB) events. Whilst there was qualitative discussion of cliff edges for external hazards in PSR3, in general there were no numerical assessments of BDB events. ONR SAPs call for cliff edges/safety system failures that could occur for DBD events to be evaluated to demonstrate an appropriate safety margin beyond the design basis. This was a fleet wide issue being addressed through ongoing regulatory interventions.
112. ONR found that for industrial hazards, the design basis was discussed in the main safety case documents, but not in the PSR3 submission. NGL recognised that continual assessment of industrial hazards was needed as nearby industrial activities develop but there was currently no plan to revisit the industrial hazards safety case for HPB or HNB. NGL also noted that there was liaison between the proposed new build site at Hinkley Point C and HPB as this was being assessed as an external industrial hazard to HPB but this was not reflected in the PSR3 submission. ONR recommended that NGL should assess changes to industrial hazards in the vicinity of HPB and HNB projected over the 10 year PSR3 period.
113. An important aspect of a PSR was to consider the effects of plant ageing. Qualification against external hazards following plant corrosion and degradation potentially affects a very wide range of SSCs and spans several disciplines, e.g. external hazards, civil engineering and structural integrity. NGL had identified a shortfall prior to the PSR and recommended:

“Consideration should be given to incorporating a check of the hazard qualification of SSCs detailed in the Equipment Qualification Schedules as part of the associated Maintenance, Inspection and Testing Schedule activities”.

114. ONR found that although new corrosion management arrangements, CTS/031, had been deployed across the fleet, there appeared to be a significant omission in that the process did not explicitly consider plant condition in relation to its effect on withstand against external hazards. The corrosion effects on the external hazards qualification of plant should be explicitly addressed within the corrosion management process in sufficient detail to ensure a systematic, rigorous, proportionate and practicable approach. Following assessment, ONR considered that plant ageing issues affecting external hazard withstand are not assessed systematically and rigorously by NGL’s processes. The process should include suitable and sufficient detail and involve external hazards SQEP. ONR therefore raised the following finding:

HPB HNB-PSR3-007

NGL should:

- **Update the corrosion management process to explicitly address the requirements of external hazards qualification of plant to ensure a systematic, rigorous, proportionate and practicable approach.**
 - **Review current corrosion assessments to establish if there are shortfalls against the external hazards requirements.**
115. ONR found that the PSR3 structure was rather cumbersome and opaque when pursuing some external hazards issues. ONR also noted that, even for issues which appeared to be adequately addressed by NGL’s processes, the PSR3 documents tended to be rather poor at effectively presenting and summarising the specific outputs from the processes. This concern was considered to part of ONR finding **HPB HNB-PSR3-001**.

Fault Studies (Ref. 21)

116. ONR judged that that from fault studies point of view the established processes for identification and resolution of discrepancies between the safety case and the actual plant status at Hinkley Point B and Hunterston B were suitable to ensure maintenance of appropriate safety margins during the PSR3 period.
117. The PSR3 identified seven elements of the HPB/HNB safety cases as “currently in production”. Five of these are now completed and two are planned for completion in 2017. ONR considered that the implementation of reasonably practicable improvements to the Hinkley Point B and Hunterston B deterministic analyses were appropriately planned, executed and documented.
118. The assessment of the SF05 report, Deterministic Safety Analysis, and the discipline review found that the stations’ plant condition, OPEX, safety cases and management arrangements were described in a clear and consistent way with sufficient level of detail. ONR judged that the HPB/HNB PSR3 structure and contents complied with the applicable ONR guidance and international good practice.
119. ONR sampled the SCHR records and observed that the actions for sentencing of identified anomalies according to their safety significance and the definition of remedial actions were based on SQEP workshops and expert panels which apply company guidance and produce appropriately documented decisions. ONR found this approach reasonable and efficient as it used the practical knowledge of the station personnel, engineering advice notes prepared by specialised company units and expert panels.
120. ONR found that PSR3 post-generation arrangements, addressed in SF 16, did not have plans for deterministic safety analyses. ONR noted however that the licensee had committed to take into consideration Magnox decommissioning activities. Based on ONR’s assessment of the deterministic safety analyses supporting the post generation and defuelling safety case of the Wylfa Magnox station, ONR found this commitment appropriate for the current state of HPB/HNB (seven years before end of generation).

Human Factors (Ref. 22)

121. Overall, ONR considered that NGL had completed an appropriate human factors review in support of the Hinkley Point B and Hunterston B PSR3 and this included a number of areas of good practice. However, based on the evidence presented, it was ONR’s view that this was insufficient to fully support the licensee’s claim that relevant good practice was complied with and that the risk from human factors aspects of operations could be demonstrated to be ALARP. ONR was however content that there was no evidence from either the PSR3 submission, or subsequent ONR assessment, that indicated there was currently a significant safety risk from human factors aspects of operating either station.
122. In relation to human factors, NGL identified four ‘areas of strength’ and 13 recommendations, all of which are considered to be of low nuclear significance and as such were being addressed through normal business processes.
123. ONR was satisfied that NGL had reviewed the living safety case documents for both stations and had confirmed that actions impacting safety were identified and that, where required, the safety cases highlight administrative controls that maintain / return the facilities to their normal operating envelopes. It was also clear that some analysis of tasks important to safety had been completed and that key demands on personnel in terms of perception, decision making and action were understood. Whilst evidence of quantitative human reliability assessments of human based safety claims (HBSC) was provided for some HBSCs, the absence of sufficiently detailed qualitative

assessments across all risk significant HBSCs indicated that ONR's human reliability expectations were not fully met.

124. On the basis its assessment ONR found that currently there was insufficient evidence to fully uphold the HPB / HNB PRS3 overall claims in relation to *SF12 – Human Factors* and *SF 11 – Procedures*. ONR considered that risk significant HBSCs were not substantiated to modern standards and there was evidence that human factors considerations were not yet sufficiently embedded within the licensee's normal business processes to manage and ultimately reduce this risk in a timely manner.
125. In relation to this whilst ONR found no immediate safety significant concerns, it was not clear that the corporate review processes identified by NGL (i.e. Engineering Change (EC) and SCHR) were sufficiently robust to effectively manage and reduce human factors-related risks in a timely manner (i.e. within the two year PSR window). This was primarily because the associated human factors arrangements were; in a relatively early stage of implementation, not fully integrated within NGL's wider Maintain Design Integrity (MDI) corporate process and therefore not fully effective in delivering modern standards substantiation.
126. ONR considered that further work was required by NGL which could most effectively be achieved by focusing on improving and accelerating the implementation of NGL's human factors arrangements within their existing processes. In particular effort was required to ensure, and demonstrate the adequacy of, human factors considerations within the wider corporate processes, such as MDI, EC and SCHR which were identified as key to managing and reducing future risk. This was in lieu of a specific programme of work to tackle the specific substantiation shortfalls highlighted in the assessment. This work should promote better integration with the existing risk-based processes, ensure appropriate timescales for remediation are identified and will build on / strengthen the existing work of the licensee. The following ONR finding was raised to address this:

HPB HNB-PSR3-012

NGL should develop a strategy, and implement an appropriate programme of improvements, to ensure the timely substantiation of Human Based Safety Claims (HBSCs) to modern standards. This should include consideration of the Fuel Route Programme and Safety Case Health Reviews as a vehicle for the update of extant HBSCs to meet modern standards.

Leadership and Management for Safety (Ref. 23)

127. ONR was content that NGL's review of its management of safety arrangements set out in the PSR met relevant good practice and that it had taken into account relevant standards and guidance. We are also content that the review has been subject to appropriate due process and that there has been appropriate independent oversight throughout. ONR was satisfied that NGL's arrangements were adequate for the management of nuclear safety at HPB and HNB and supported a decision letter confirming that NGL had carried out an adequate PSR of the HPB and HNB stations justifying continued operations for the next PSR period
128. NGL's nuclear safety policy sets out nuclear safety as the company's overriding priority. The policy was underpinned by eight principles from INPO and WANO standards and, as such, was based on appropriate international standards. ONR reviewed the safety policy and considered it to be suitable and sufficient with evidence of regular review. Line management and individual accountability for nuclear safety were explicit.

129. ONR found that NGL had a mature well-structured and well controlled integrated management system which was based on international standards. The system, which had 36 company level processes, was well maintained and had external third party oversight and review. There were established arrangements for maintaining the management system and there was a comprehensive internal and independent oversight and assurance programme to monitor compliance and effectiveness.
130. ONR considered that NGL met relevant good practice in its arrangements for leadership and safety culture and the arguments presented in SF10 provided a thorough description of existing processes and arrangements. However, ONR recommended that this description should be complemented by a more diagnostic review of how these arrangements were being implemented at the stations and their suitability going forward particularly with respect to the main challenges identified for the next PSR period.
131. NGL recognised the importance of training in supporting performance improvement. It had invested heavily in its training facilities and staff including the Central Technical Training Team and Nuclear Power Academy at Barnwood, its Leadership Academy and station facilities. NGL's training accreditation process was mature and had helped to deliver consistency and continuous improvement.
132. Whilst there were some gaps in the review: it did not consider arrangements for non-accredited training, for example, overall, ONR considered that 'Training and authorisation' (as key elements of a competence management system) was a good example of where PSR3 was generally successful in drawing on evidence from existing company processes to support the review and provide evidence to demonstrate how current arrangements were adequate for the next PSR period and the drive for continuous improvement was established and relevant good practice was being met.
133. The Procurement and Materials Management process was a mature process which was owned by the central supply chain team. The associated process documentation was reviewed and rationalised in 2015 to improve its usability. ONR had regular engagements with the central supply chain team who provided updates on supply chain developments. The arrangements described for managing contract support align with what has been experienced during the regular and on-going engagements with NGL's central and station supply chain teams.
134. NGL had an internal established regulator, INA, who had a large central team and a smaller team on each station and was heavily involved in safety-related activities. INA was independent of line management and had direct reporting routes to the licensee's senior management on safety matters. INA sat on a range of project fora and was able to interject on matters of safety concern. ONR had regular meetings with INA and had undertaken joint reviews with them. ONR judged INA to be a mature and effective internal regulator.
135. It was clear that both the management system and business processes had continued to evolve since the 2014 cut-off date for inclusion of information in the PSR. Consequently, centrally-driven initiatives (for example those designed to enhance organisational capability and organisational learning) were being successfully adopted by the stations and there was greater consolidation of the centrally based management system.

Radioactive Waste Management and Decommissioning (Ref. 24)

136. Overall, based on the evidence sampled, ONR was satisfied that with respect to radioactive waste management and decommissioning aspects, the PSR3 had been

conducted in accordance with relevant good practise and adequate arrangements are in place to support the continued operation of the Hinkley Point B and Hunterston B power stations.

137. NGL conducted zonal walk downs of the systems at both HPB and HNB stations and, from a radiological waste perspective, no major issues were found. A number of minor improvements were identified which were being addressed through normal business processes.
138. NGL had developed revised radioactive waste management arrangements which describe key accountabilities and responsibilities, oversight arrangements, and management arrangements for each disposal route. Both HPB and HNB were progressing with implementation of these new arrangements. Based on the evidence sampled, ONR considered that there were appropriate arrangements in place to support continued operations of the radioactive waste facilities. Improvements to the facilities have been identified; however these were of low safety significance and would be addressed during normal business. Adequacy of the facilities and arrangements to meet the longer term future decommissioning demands will be part of on-going routine regulatory interactions with NGL on decommissioning.
139. The decommissioning strategy for AGR power stations is for 'safe store'. This will involve an initial scope of work to defuel, manage any potentially mobile waste and complete some decommissioning work. The remainder of the defueled power station will be placed under a care and surveillance regime while any remaining radioactivity decays, prior to final decontamination and dismantling to achieve a brownfield site. This was outlined in the corporate decommissioning strategy and plans.
140. ONR considered that adequate arrangements were in place to develop and maintain the decommissioning strategy and plans. NGL had an integrated company practise which identified requirements during operational, transitional and end of generation phases. In addition, NGL had established two specific projects; the first was focussed on the site transition into defueling, and the second addressed the preparations for post-operational clean-out and decommissioning activities.
141. Based on the evidence sampled, ONR considered that adequate arrangements were in place for managing the transition from end of generation, defueling and into decommissioning. The development and implementation of the strategy and plans will be the subject of on-going routine regulatory interactions with NGL outside the PSR process.

Radiological Protection (Ref. 25)

142. ONR considered that NGL's PSR3 safety factor 15 (radiological protection) submission was adequate for the purpose of enabling it to come to robust conclusions about the fitness-for-purpose of its arrangements for managing radiation protection in relation to all plant safety cases. ONR was broadly satisfied with the claims, arguments and evidence set out within the PSR submission and with the outcome of the discussions had with NGL's radiological protection fleet management team.
143. The arguments presented in SF 15 were consistent with the seven radiation protection criteria specified in ONR's SAP and were those that ONR would expect to see addressed in a PSR. ONR considered that the arguments were adequately supported by the evidence provided within the SF 15 report. Many of the matters discussed in the report were those which ONR had noted during radiological safety inspections conducted at both Hunterston B and Hinkley Point B power stations in the last three years.

144. ONR identified a few review areas that could have been better developed and discussed these with NGL's radiological protection fleet management team. NGL regarded SF15 as a live process applicable to all stations within the fleet and one that would be updated and refined as the sequence of AGR fleet PSRs progresses through to the end of 2019. NGL agreed to make a range of enhancements to its SF15 documentation as the PSR3 programme progressed across the AGR fleet.

Table 1 - HPB and HNB PSR3 Category B Recommendations

Safety Factor	Recommendation Number	Title	Planned completion
1 - Plant Design	SF1 Rec 1	Implementation and Effective Governance of the Safety Case Health Review Procedure	Completed, awaiting formal closure
2 - Actual Condition of Plant Important to Safety	SF2 Rec 1	Enactment of a Corrosion Management Strategy	Completed, awaiting formal closure
	SF2 Rec 2	Build-up of Shingle at the Base of the Sea Wall	Completed, awaiting formal closure
	SF2 Rec 3	Condition of HPB Gabion Wall	Quarter 2/3 2017
	SF2 Rec 4	HPB 3.3kV Essential Supplies Cable Replacement	31 January 2017
	SF2 Rec 5	HVAC Equipment Reliability Improvements in HPB Electrical Switchrooms	Completed, awaiting formal closure
	SF2 Rec 6	Replacement of Vaporising Auxiliary Boilers (VABs) Fuel Tanks	31 January 2017
	SF2 Rec 7	Inspection of Buried Pipe work	Q2 2017
	SF2 Rec 8	CO ₂ Gas Circulator Endurance Purge Pipe work Replacement	31 December 2017
	SF2 Rec 9	Inspection and Defect Repair of Trenched Pipe work	Q1/2 2017
3 – Equipment Qualification	SF3 Rec 1	Implementation, Effective Governance and Oversight of the Zonal Walkdowns and Zonal Based Views	30 April 2017
4 – Ageing & Lifetime Management	SF4 Rec 1	Agree a Strategy for the Management of Reactor Thermocouples over Station Life	Completed, awaiting formal closure
	SF4 Rec 2	Agree a Strategy for the Management of Boiler Thermocouples over Station Life	Completed, awaiting formal closure
	SF4 Rec 3	Consider Prioritising Delivery of the TLMS for Decay Heat Boilers (DHBs)	31 December 2017
	SF4 Rec 4	Consider Prioritising Delivery of the TLMS for Reheaters	Completed, awaiting formal closure
	SF4 Rec 5	Obsolescence	28 June 2018
	SF4 Rec 6	Gas Bypass Plant	31 January 2017

Table 2 – ONR Findings

ONR Finding	Detail
<p>HPB HNB-PSR3-001 General Issues Database Number: 5093</p>	<p>NGL should ensure that future periodic safety reviews and submission documentation demonstrate that appropriate reviews have been conducted and provide evidence that the safety management arrangements are adequate and effective.</p>
<p>HPB HNB-PSR3-002 General Issues Database Number: 5094</p>	<p>NGL should conduct a review of the safety performance of the plant design against the relevant good practice provided by modern plant designs to identify any further reasonably practicable improvements.</p>
<p>HPB HNB-PSR3-003 C&I Issues Database Number: 5095</p>	<p>NGL should:</p> <ul style="list-style-type: none"> • Conduct a station wide review of their cyber security arrangements as part of the PSR3 • Clarify how cyber issues are integrated / addressed in the equipment reliability process.
<p>HPB HNB-PSR3-004 General Issues Database Number: 5096</p>	<p>NGL should:</p> <ul style="list-style-type: none"> • Investigate known occurrences of incorrect SHIP data to identify reason/source of error • Review the training arrangements and communication of procedures associated with SHIP to ensure reliable data is provided to the Equipment Reliability process.
<p>HPB HNB-PSR3-005 C&I Issues Database Number: 5097</p>	<p>NGL should undertake a review of their company standards; and in subsequent PSR3 submissions, and address any gaps between existing NGL standards and modern standards, including a gap analysis against IAEA specific safety guide 39 Design of Instrumentation and Control Systems for Nuclear Power Plants.</p>
<p>HPB HNB-PSR3-006 Electrical and General Issues Database Number: 5098</p>	<p>NGL should:</p> <ul style="list-style-type: none"> • Review the Safety System Reviews at Hinkley Point B to establish that they consider all the electrical equipment important to safety and undertake them as necessary. • Review the Safety System Reviews across all stations to confirm that all equipment important to safety is appropriately considered.
<p>HPB HNB-PSR3-007 External Hazards Issues Database Number: 5099</p>	<p>NGL should:</p> <ul style="list-style-type: none"> • Update the corrosion management process to explicitly address the requirements of external hazards qualification of plant to ensure a systematic, rigorous, proportionate and practicable approach. • Review current corrosion assessments to establish if there are shortfalls against the external hazards requirements.

<p>HPB HNB-PSR3-008 Fuel Safety Issues Database Number: 5100</p>	<p>NGL should review and update the Safety Case Health Review process to ensure that adequate evidence of decision making is recorded. Attention should be paid to the application of ALARP and strategic decision making to ensure that fuel safety risks from identified issues and shortfalls are demonstrably reduced in so far as is reasonably practicable.</p>
<p>HPB HNB-PSR3-009 Graphite Issues Database Number: 5101</p>	<p>NGL should develop improved inspection and monitoring technology; in particular equipment capable of performing visual inspection and dimensional measurements of control rod channels.</p>
<p>HPB HNB-PSR3-010 Graphite Issues Database Number: 5102</p>	<p>NGL should determine end-of-life criteria for the reactors. This is likely to include measures of core distortion as well as numbers and morphology of cracks.</p>
<p>HPB HNB-PSR3-011 Graphite Issues Database Number: 5103</p>	<p>NGL should review the scope of their damage tolerance assessment following each outage. Significantly different findings might trigger additional assessment that augments the scope in addition to cracking and weight loss.</p>
<p>HPB HNB-PSR3-012 Human Factors Issues Database Number: 5104</p>	<p>NGL should develop a strategy, and implement an appropriate programme of improvements, to ensure the timely substantiation of Human Based Safety Claims (HBSCs) to modern standards. This should include consideration of the Fuel Route Programme and Safety Case Health Reviews as a vehicle for the update of extant HBSCs to meet modern standards.</p>