



PROJECT ASSESSMENT REPORT			
Unique Document ID and Revision No:	ONR-OFD-PAR-17-020 Revision 0	TRIM Ref:	2018/185175
Project:	Assessment of Hartlepool and Heysham 1 - Updated Steam Release Safety Case		
Site:	Hartlepool and Heysham		
Title:	Hartlepool and Heysham 1 Power Stations - Updated Steam Release Safety Case - NP/SC 7657, July 2017		
Licence Instrument No: (if applicable)	Agreement 566 for Hartlepool Agreement 618 for Heysham		
Nuclear Site Licence No:	59 and 60		
Licence Condition:	22(1)		

Document Acceptance and Approval for Issue / Publication

Role	Name	Position	Signature	Date	TRIM Ref
Author	[REDACTED]	Principal Inspector		15 June 2018	NA
Reviewer	[REDACTED]	Principal Inspector		22 June 2018	2018/207287
Accepted by ¹	[REDACTED]	Superintending Inspector		2 July 2018	2018/216951
Approval for publication ²		Superintending Inspector			(as above)

Revision History

Revision	Date	Author(s)	Reviewed By	Accepted By	Description of Change
A (TRIM version 1)	05 June 2018	[REDACTED]	[REDACTED]	n/a	1 st draft for DL review
B (TRIM version 4)	12 June 2018	[REDACTED]	[REDACTED]	n/a	2 nd draft incorporating DL comments
0 (TRIM version 9)	2 July 2018	[REDACTED]	[REDACTED]	[REDACTED]	First accepted issue

¹ Acceptance of the PAR to allow release of LI

² Approval is for publication on ONR web-site, after redaction where relevant

Circulation (latest issue)

Organisation	Name	Date
Office for Nuclear Regulation	<p>[REDACTED] Cover page and summary only)</p> <p>[REDACTED]</p> <p>[REDACTED]</p> <p>[REDACTED]</p> <p>[REDACTED]</p> <p>[REDACTED]</p> <p>TRIM Files: PAR File: 4.4.1.2979. Project File: 4.4.1.3423.</p>	3 July 2018
Environment Agency		
Licensee	<p>[REDACTED] HRA Station Director [REDACTED]@edf-energy.com</p> <p>[REDACTED] HRA Technical and Safety Support Manager [REDACTED]@edf-energy.com</p> <p>[REDACTED] - HYA Station Director [REDACTED]@edfenergy.com</p> <p>[REDACTED] HYA Technical and Safety Support Manager [REDACTED]@edf-energy.com</p> <p>[REDACTED] - Safety Case Officer (Barnwood) [REDACTED]@edf-energy.com</p> <p>[REDACTED] - INA (Barnwood) [REDACTED]@edf-energy.com</p>	3 July 2018

**Assessment of the Safety Case NP/SC 7657 – Hartlepool and Heysham 1
Updated Steam Release Safety Case, July 2017**

Project Assessment Report ONR-OFD.-PAR-17-020
Revision 0
July 2018

© Office for Nuclear Regulation, 2018

If you wish to reuse this information visit www.onr.org.uk/copyright for details.

Published 08/18

For published documents, the electronic copy on the ONR website remains the most current publicly available version and copying or printing renders this document uncontrolled.

EXECUTIVE SUMMARY

Assessment of the Safety Case NP/SC 7657 - Hartlepool and Heysham 1 Power Stations – Updated Steam Release Safety Case, July 2017

This report presents the conclusions from ONR's assessment of the Safety Case NP/SC 7657 - Hartlepool and Heysham 1 Power Stations – Updated Steam Release Safety Case, further referred to as "the Safety Case".

The licensee for Hartlepool and Heysham 1 power stations, Edf Energy Nuclear Generation Limited (NGL), has produced the Safety Case to consolidate existing safety cases that address the steam release hazard, draw together the various modifications, clarify the fault and qualification schedules and address identified shortfalls.

Permission Requested

The licensee has requested ONR's Acknowledgement or Agreement of the Safety Case under Licence Condition 22(1), in order to enable finalising of the administrative arrangements for the implementation of the Safety Case. ONR confirmed its intention to assess the Safety Case and, subject to a satisfactory outcome, issue an Agreement under Licence Condition 22(1).

Background

A steam release involves failure of a steam system, which may itself provide a nuclear safety related function such as boiler feed. In addition, the steam release could threaten essential functions in a number of ways:

- Loss of plant required for reactor trip, shutdown or post-trip cooling;
- Damage to the reactor pressure boundary or supporting systems;
- Unacceptable damage to the reactor building structure leading to partial collapse and loss of essential plant;
- Initiation of consequential hazards; and
- Impairment of the ability of the operator to carry out post-fault actions due to access constraints from the steam release environmental conditions.

The Safety Case sets out the overall principles for protection against a steam release and integrity of the steam plant. It also justifies operation for extended plant life to 2024.

The Safety Case justifies the sufficiency of these protections by statement of six claims, each supported by a set of arguments based on different types of evidence. The Safety Case identifies a number of items of further work that are captured in six commitments and nine actions.

The Safety Case was required to address a number of shortfalls identified in the second Periodic Safety Review (PSR 2), in particular that the existing case was fragmented. The lack of clarity and visibility of the existing safety case was considered by the licensee to be detrimental to maintaining a high standard of nuclear safety with respect to operator response to a steam release incident and qualification and maintenance of safety systems to protect against steam release.

The Safety Case does not in itself implement any physical plant changes, but focuses on providing improvements in four main areas:

- Resolution of the shortfalls identified by PSR 2;
- Consideration of all reactor operating states, including shutdown states;
- Justification for extended operation up to 2024; and
- Confirmation that the risks from steam release are as low as reasonably practicable.

The licensee also identified three main shortfalls. The shortfalls and resolution methods were:

- The consequences of failure of the circumferential High Integrity Start-Up Vessel (SUV) welds did not recognise the resulting jet load on the remnant SUV and its supports, which could become a substantial missile with the potential to threaten all feed lines. The resolution is to upgrade the claim on the SUV circumferential welds to Incredibility of Guillotine Failure.
- Pipe whip is recognised as threatening building columns. Column failure could in some cases lead to localised building collapse and a significant threat to the lines of protection. The resolution is to identify the steam and feed pipework welds whose failure could threaten reactor building columns and to upgrade the claim on these welds to High Integrity.
- The existing safety case considers pipe whip from the turbine hall through the flood barrier into the reactor basement, however the potential threat of very high basement temperatures from the resulting steam ingress had not been adequately taken into account. The resolution is to complete safe life calculations for the welds to complete the High Integrity substantiation.

The Safety Case concludes that the risk from a steam release to reactor safety at Hartlepool and Heysham 1 power stations is considered to be tolerable and is being managed in accordance with the principle of As Low As Reasonably Practicable (ALARP).

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

The Safety Case was subject to assessment by a team of ONR inspectors in the following specialisms:

- Internal hazards
- Civil engineering
- Structural integrity

ONR held meetings with the licensee as part of early engagement prior to submission of the Safety Case, including attending a plant walk-down at Heysham 1 Power Station, so that the licensee could explain its pipework weld screening process. A further meeting was held during the assessment period to discuss ONR's comments and initial findings. The licensee provided responses to ONR's queries that have been considered as part of the detailed assessments.

The Safety Case comprises six claims supported by arguments and underpinning evidence. One or more ONR specialist inspectors have assessed each of the claims. The conclusions of these assessments are summarised in this Project Assessment Report.

Matters arising from ONR's work

In addition to assessing whether the licensee had adequately consolidated and reviewed the existing safety case, assessment effort has been concentrated on those shortfalls in the existing safety case which ONR's specialist inspectors considered the most significant with respect to nuclear safety. These areas included, in particular, the potential threat to the reactor building columns due to a pipe whip.

All of the specialist assessment reports have conclusions that support the issue of Licence Instruments under Licence Condition 22(1) to enable ONR to give Agreement to the Safety Case.

Although the specialist inspectors were broadly satisfied with the claims, arguments and evidence laid down within the Safety Case, the specialist inspectors have identified weaknesses in the Safety Case and have made recommendations, either for the licensee to carry out further work or for the timely completion of work already identified by the licensee. Regulatory Issues 6355, 6366 and 6393 have been raised so that ONR can monitor the

licensee's progress with the most significant Safety Case actions and commitments and the items of further work recommended by ONR.

Conclusions

Based on my review of the assessments undertaken, I am broadly satisfied with the claims, arguments and evidence laid down within the Safety Case. In my judgement, in relation to this submission, the licensee has provided an adequate justification that the risks from a steam release at Hartlepool and Heysham 1 Power Stations are reduced as low as is reasonably practicable (ALARP).

I am satisfied that outstanding work has been captured, either by the licensee or as Regulatory Issues, and can be monitored by ONR as part of normal regulatory business and that these activities do not prevent ONR from giving Agreement to the Safety Case.

Recommendations

I recommend that ONR should issue Licence Instruments 566 for Hartlepool Power Station and 618 for Heysham Power Station to give Agreement under Licence Condition 22(1) to Safety Case NP/SC7657 - Hartlepool and Heysham 1 Power Stations – Updated Steam Release Safety Case, Revision 000, Proposal Version No: 07, July 2017.

I further recommend that ONR write to NGL requesting that an updated work programme be provided to ONR and responses to a number of specific actions raised as part of this assessment. These actions will be tracked through the following Regulatory Issues:

- Level 3 Regulatory Issue 6355 monitoring the internal hazards concerns
- Level 4 Regulatory Issue 6393 monitoring the civil engineering concerns
- Level 3 Regulatory Issue 6366 monitoring the structural integrity concerns.

LIST OF ABBREVIATIONS

ALARP	As low as reasonably practicable
DHL	Decay Heat Loop
HI	High Integrity
HOW2	(Office for Nuclear Regulation) Business Management System
HRA	Hartlepool Power Station
HYA	Heysham 1 Power Station
IoGF	Incredibility of Guillotine Failure
NGL	EdF Energy Nuclear Generation Limited
ONR	Office for Nuclear Regulation
PAR	Project Assessment Report
PSR	Periodic Safety Review
SAP	Safety Assessment Principle(s)
SUV	Start-Up Vessel
TAG	Technical Assessment Guide (ONR)

TABLE OF CONTENTS

1	PERMISSION REQUESTED.....	10
2	BACKGROUND.....	10
3	ASSESSMENT AND INSPECTION WORK CARRIED OUT BY ONR IN CONSIDERATION OF THIS REQUEST	11
4	MATTERS ARISING FROM ONR'S WORK.....	12
5	CONCLUSIONS	18
6	RECOMMENDATIONS	19
7	REFERENCES	20

1 PERMISSION REQUESTED

1. The licensee requested (Refs. 2 and 3) the Office for Nuclear Regulation's (ONR's) 'Acknowledgement' or 'Agreement' in accordance with its arrangements made under Licence Condition 22(1) for the Updated Steam Release Safety case NP/SC 7657 at Hartlepool and Heysham 1 Power Stations (Ref. 1). ONR confirmed (Ref. 4) its intention to assess the Safety Case.
2. This Project Assessment Report (PAR) presents a summary of the results from the safety case assessments undertaken by ONR's specialist inspectors.

2 BACKGROUND

3. As required under its arrangements made under Licence Condition 22(1), EdF Energy Nuclear Generation Limited (NGL) has developed the Category 1 Safety Case NP/SC 7657 Hartlepool and Heysham 1 – Updated Steam Release Safety Case, Revision 000, Proposal Version No: 7, July 2017 (Ref. 1), which is further referred to as “the Safety Case”.
4. A steam release involves failure of a steam system, which may itself provide a nuclear safety related function such as boiler feed. In addition, the steam release could threaten essential functions in a number of ways:
 - Loss of plant required for reactor trip, shutdown or post-trip cooling;
 - Damage to the reactor pressure boundary or supporting systems;
 - Unacceptable damage to the reactor building structure leading to partial collapse and loss of essential plant;
 - Initiation of consequential hazards; and
 - Impairment of the ability of the operator to carry out post-fault actions due to access constraints from the steam release environmental conditions.
5. The Safety Case sets out the overall principles for protection against a steam release and integrity of the steam plant. It also justifies operation for extended plant life to 2024.
6. The Safety Case justifies the sufficiency of these protections by statement of six claims, each supported by a set of arguments based on different types of evidence (structural integrity analyses, fault studies and civil engineering analyses, etc.).
7. The Safety Case was required to address a number of shortfalls identified in the second Periodic Safety Review (PSR 2), in particular that the existing case (NP/SC 3485) was fragmented. The lack of clarity and visibility of the existing safety case was considered by NGL to be detrimental to maintaining a high standard of nuclear safety with respect to operator response to a steam release incident and qualification and maintenance of safety systems to protect against steam release.
8. The intent of the Safety Case is to provide a comprehensive statement, drawing together the various modifications and clarifying the fault and qualification schedules. The Safety Case does not in itself implement any physical plant changes, but focuses on providing improvements in four main areas:
 - Resolution of the shortfalls identified by PSR 2;
 - Consideration of all reactor operating states, including shutdown states;
 - Justification for extended operation up to 2024; and
 - Confirmation that the risks from steam release are as low as reasonably practicable.

9. NGL considers that the Safety Case addresses and closes the above improvement areas. In the process of drawing together the various elements of the case, NGL identified three main shortfalls, with resolution provided by the Safety Case. The shortfalls and resolution methods were:
 - The consequences of failure of the circumferential High Integrity Start-Up Vessel (SUV) welds did not recognise the resulting jet load on the remnant SUV and its supports, which could become a substantial missile with the potential to threaten all feed lines. The resolution is to upgrade the claim on the SUV circumferential welds to Incredibility of Guillotine Failure (IoGF).
 - Pipe whip is recognised as threatening building columns. Column failure could in some cases lead to localised building collapse and a significant threat to the lines of protection. The resolution is to identify the steam and feed pipework welds whose failure could threaten reactor building columns and to upgrade the claim on these welds to High Integrity (HI).
 - The existing safety case considers pipe whip from the turbine hall through the flood barrier into the reactor basement, however the potential threat of very high basement temperatures from the resulting steam ingress had not been adequately taken into account. The resolution is to complete safe life calculations for the welds to complete the High Integrity substantiation. This threat is relevant only to the Reactor 1 basement.
10. Regarding extended operation, NGL has reviewed the safety case claims to identify which relate to time dependent issues. The safety case now includes arguments specific to the arrangements for ongoing management of equipment qualification and pipework integrity. These arguments do not identify any inherent time limits beyond which the safety case will not be valid, subject to ongoing monitoring and appraisal.
11. The protection of the reactor building columns from pipe whip is currently addressed by a Justification for Continued Operation (JCO), (Ref. 6) which will be superseded by the Safety Case. At a Level 4 meeting in January 2018 (Ref. 13), ONR requested clarification of the safety case position following the expiry of the JCO in June 2016. NGL clarified (Ref. 5) that the expiry date for the JCO was unnecessary, the matter had been addressed by NGL's safety case anomalies process and the JCO remained correct and valid.
12. The Safety Case identifies six commitments and nine actions together with target completion dates.
13. NGL has categorised the modification at Category 1, which is its highest nuclear safety category. The proposal has completed NGL's due process, including consideration by its Nuclear Safety Committee (Ref. 7) and Internal Regulator (Ref. 8).

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

14. ONR has carried out a programme of work. ONR's approach when regulating the nuclear industry is to use a sampling regime that targets areas of potential high risk and consequences. On this basis, the Safety Case (Ref. 1) was subject to detailed assessment by a team of ONR inspectors, specialising in the following areas:
 - Internal hazards
 - Civil engineering
 - Structural integrity
15. In addition to the assessments described above, consultations were held with Fault Studies specialists and it was agreed that the Internal Hazards report had adequately

covered any areas of concern and that no separate Fault Studies assessment report was required.

16. The Safety Case was originally presented to the licensee's Nuclear Safety Committee (NSC) in May 2016 and issued to ONR for information prior to a formal submission. A number of specialist inspectors held a Level 4 meeting with NGL (Ref. 11) as part of early engagement so that NGL could explain the principal claims and arguments. This meeting was followed up with a site walk-down at Heysham 1 Power Station (Ref. 12), during which ONR specialist inspectors sampled steam and feed pipework welds whose failure had been assessed as a potential threat and as no threat to reactor building columns. During the walk-down, NGL explained how it had reviewed the pipework welds using a walk-down process in order to screen out those welds that it did not consider a threat to the columns.
17. The Safety Case was revised, presented to the NSC again in July 2017, and formally issued to ONR in August 2017 (Refs. 2 and 3). The relevant specialist inspectors held a further Level 4 meeting with NGL during the course of the assessment (Ref. 13), in order to gain clarity on some of the questions raised and to receive an update on the progress of the Safety Case commitments and actions. At the meeting, ONR either obtained resolution for its challenges or NGL made commitments to address them, including resolving questions and comments made during ONR's assessment.
18. The Safety Case presents a set of arguments and underpinning evidence to support the following claims:
 - **Claim 1:** Steam release faults have been identified and their environmental and local consequences assessed.
 - **Claim 2:** Fault frequency is substantiated based on demonstration of steam system plant integrity.
 - **Claim 3:** Adequate protection is provided against steam release faults.
 - **Claim 4:** Claimed protection will remain functional under steam release conditions.
 - **Claim 5:** The reactor building civil structures will not experience unacceptable damage from a steam release.
 - **Claim 6:** The risk levels associated with a steam release are as low as reasonably practicable.
19. One or more specialist inspectors have assessed the credibility of each of these claims. The conclusions are presented in detail within the respective assessment reports (Refs 14 to 16) and are summarised in Section 4 below.
20. The assessment method has followed the ONR Assessment Process set out within HOW2 (Ref. 9). The relevant ONR Safety Assessment Principles (SAPs – Ref. 10) have been applied by each of the inspectors and are listed in their reports (Refs. 14 to 16). The inspectors have also used the relevant ONR Technical Assessment Guides (TAGs – Ref. 17). The outcomes of these assessments have been summarised in this PAR to inform ONR's decision regarding Agreement of the Safety Case.

4 MATTERS ARISING FROM ONR'S WORK

21. In addition to assessing whether the licensee had adequately consolidated and reviewed the existing safety case, assessment effort has been concentrated on those shortfalls in the existing safety case which ONR's specialist inspectors considered the most significant with respect to nuclear safety. These areas included, in particular, the potential threat to the reactor building columns due to a pipe whip and the effect of missiles resulting from the guillotine failure of circumferential SUV welds. Not all the

claims have been assessed by each specialist inspector, and assessment has focused on the claims of most relevance to each discipline as follows:

- Claims 1, 3, 4 and 6 – Internal Hazards
- Claim 5 and 6 – Civil Engineering
- Claims 2, 5 and 6 – Structural Integrity

22. The following sections summarise the findings and views of the specialist inspectors who assessed the safety case.

4.1 INTERNAL HAZARDS ASSESSMENT

23. The inspector has reviewed and sampled the claims, arguments and evidence for Claims 1, 3, 4 and 6, which the inspector considered most relevant to internal hazards. The inspector also carried out a 'deep-slice' assessment of the following faults:

- Failure of the circumferential High Integrity SUV welds resulting in missile generation of the remnant SUV and its supports.
- Pipe whip threats to building columns
- Steam Ingress into the reactor basement
- Pipe whip from the turbine hall through the fire/flood barrier into the reactor basement, resulting in very high basement temperatures from steam ingress

24. The inspector took part in a site walk-down at Heysham 1 Power Station together with civil engineering and structural integrity inspectors, the purpose of which was for the licensee to explain its methodology for reviewing the pipe whip threats to the Reactor Building. The inspector considered the licensee's methodology to be reasonable.

25. The inspector found that overall the safety case was intelligible, valid, integrated and forward-looking. However, the inspector considered that there were certain areas within the claims that lacked the completeness, evidential basis and robustness identified in ONR's TAG for the assessment of safety cases (Ref. 17). In order to address these concerns, the inspector raised a number of queries with the licensee, the majority of which have been addressed. In those areas where the inspector's concerns had not been fully closed out, these were captured by the recommendations included in the inspector's assessment report.

26. The inspector was content that the licensee had given adequate consideration to defining the potential impact of adverse environmental effects and consequential effects of steam release events including the cooling plant lost, lines of protection made unavailable and consequential damage effects.

27. Whilst the inspector was satisfied that the most significant risks with respect to pipe whip and SUV damage were identified and controlled, the inspector was concerned that other dropped loads and impacts which could damage the HI or loGF welds did not appear to have been adequately considered and documented. The inspector has therefore raised a recommendation in their report, requesting that the licensee demonstrate that any credible lifting or impact scenarios in the vicinity of welds designated as HI or loGF are sufficiently controlled such that the integrity of the welds is not challenged.

28. The inspector considered how the licensee had addressed the risk of pipe whip from the turbine hall through the fire/flood barrier into the reactor basement, resulting in very high basement temperatures. The inspector accepted that the licensee had undertaken adequate optioneering and that, from an internal hazards perspective, designation of the affected welds as HI was appropriate.

29. The licensee identified that some equipment in the reactor basement had not been designed to withstand the moisture and heat related to a steam release. Whilst the licensee has already installed additional measures to terminate the release before temperatures reach 80°C, the inspector was concerned that a number of important Safety Case commitments and actions in relation to this issue were incomplete. Of particular concern to the inspector was outstanding work to replace pump motors to enhanced environmental qualification as described in Commitment 6, as the inspector's understanding was that the Safety Case was based on the assumption that these improvements, first identified in 2010, were already in place. The inspector has raised a recommendation in their report for the licensee to ensure that the remaining pump motors are replaced within the timescales identified within the Safety Case.
30. The inspector sampled a number of other shortfalls in equipment qualification highlighted by the Safety Case, including the moisture qualification of the Decay Heat Loop (DHL) short break board at Hartlepool (covered by Commitment 2) and valve actuators described in Action 1. The licensee has confirmed in updated information, that the DHL short break board cannot be qualified and that the valve actuators at Hartlepool have not yet been qualified. The licensee has created Action 9 within the Safety Case to address these concerns by determining the reasonable practicability of achieving qualification. The target completion date for this action was January 2018 but the licensee has advised that it is not expected to be complete until November 2018. As the Safety Case assumes in Claim 6 that the equipment has been qualified to function in steam/moisture environments, the inspector has raised a recommendation in their report that the licensee ensures that Action 9 is completed within the current proposed timescales, i.e. no later than November 2018.
31. In terms of pipe whip threats to building columns, the inspector noted that the licensee identified weld inspections and assessments to High Integrity as the ALARP position. The inspector noted that since the licensee carried out optioneering, the number of welds for which HI claims were proposed had reduced from 87 to around 14 per reactor. The inspector noted that no further optioneering was carried out to determine for each weld whether any further measures could be adopted to reduce risks in accordance with the ALARP principle. The licensee provided further information regarding the difficulties involved in implementing engineered controls for the remaining welds and the inspector concluded that an overall balance of safety had been achieved and that further optioneering at this stage was not necessary.
32. The inspector expressed concern at a number of textual errors and omissions in the Safety Case, which whilst not necessarily impacting on nuclear safety, called into question the level of scrutiny and the effectiveness of the licensee's verification process. The inspector's concerns were discussed with the licensee and the inspector has captured any remaining concerns in the recommendations contained in their report.
33. Overall, the internal hazards inspector was satisfied with the claims, arguments and evidence laid down within the licensee's safety case, whilst noting areas within the Safety Case that needed further work. These areas have been captured in the inspector's recommendations. The inspector has raised ONR Issue 6355 to enable ONR to monitor the licensee's progress in addressing the recommendations.

4.2 CIVIL ENGINEERING ASSESSMENT

34. The focus of the inspector's assessment was on the civil engineering aspects of Claims 5 and 6, in particular the adequacy of the licensee's assessment of the threat to reactor building integrity due to pipe whip or jet thrust effects resulting from a steam release.

35. The inspector found that overall the Safety Case was intelligible, valid, integrated, forward-looking and balanced but considered that there were certain areas within the claims that lacked the completeness, evidential basis and robustness identified in ONR's guidance for assessment of safety cases (Ref. 17). In order to address these concerns, the inspector raised a number of queries with the licensee. The inspector judged that in general the licensee's responses were adequate. In those areas where the inspector's concerns had not been fully closed out, these were captured by the recommendation included in the inspector's assessment report.
36. The inspector sampled the evidence of the licensee's optioneering process and judged that on balance, the optioneering was fit for purpose and that further optioneering would have limited safety benefit.
37. Due to the robustness of the reactor building, the inspector accepted the judgement of the licensee that the rise in global over-pressure due to steam release was insufficient to cause significant structural damage to the building.
38. The licensee judged that the failure of one reactor building column due to the local effects of steam release would lead to unacceptable damage to the building structure. The inspector challenged the absence of calculations in support of this conclusion. The licensee confirmed that calculations were prepared but were kept as a file note. Based on the material presented by the licensee at Level 4 meetings, the inspector supported the licensee's judgement.
39. The licensee judged that the failure of a concrete beam due to steam release would not lead to the failure of a building column. The key supporting evidence cited in the safety case was a draft report. The licensee confirmed that this reference was incorrect and that the judgement regarding beam failure was made by suitably qualified and experienced persons rather than proven and evidenced by calculation. The inspector was satisfied, based on the details provided in Level 4 meetings that the failure of a single beam was unlikely to lead to a progressive collapse of the reactor building.
40. The safety case provided evidence that a steam or feed jet arising from pipe whip failure was not a significant contributor to the risk of column failure. The inspector considered that the licensee's analysis had utilised relevant good practice with appropriate conservatism and agreed with the judgements made by the licensee that the columns were adequate against the load from a jet thrust.
41. With respect to horizontal pipe whip effects on reactor building columns, the licensee had carried out a series of analyses using successively more refined methods, to determine those pipe welds considered to pose a significant risk to the building columns due to pipe whip. For those welds considered a high risk, detailed walk-downs were carried out to assess whether the risk had been correctly assessed. In order to assess the qualitative judgements made, the inspector attended a walk-down at Heysham 1 Power Station (Ref. 12). The inspector was satisfied, based on the welds sampled, that appropriate judgements were made regarding the overall threat to the building columns.
42. The inspector found that no consistent approach had been used to allow for uncertainty in the pipe whip analysis and that greater consideration should have been given to following relevant good practice in this area. The inspector judged that the methods used were acceptable for initial screening purposes, but for final justification of marginal cases, a more rigorous approach would be required to meet the intent of ONR's SAPs (Ref. 10). This concern has been captured in the single recommendation in the inspector's report, which recommends that the licensee widen its column screening criteria to include lower risk pipe whip threats.

43. With respect to robustness, the inspector was satisfied that, in general, appropriate methods had been used to assess the capacity of the concrete columns. The inspector noted that the empirical approach taken by the licensee to determine allowable shear displacement was not based on applicable codes and standards. The inspector discussed this approach with the licensee, who considered that codes and standards were overly conservative for this complex problem. The inspector judged that given the significant scope for uncertainty in the assessment, that appropriate and justified factors of safety should have been applied when determining the column capacity, to ensure sufficient design margins. This concern has been captured in the single recommendation in the inspector's report, which recommends that the licensee widen its column screening criteria to include lower risk pipe whip threats.
44. The inspector noted that the authors of the column analysis report recommended the application of an overall factor of safety to column capacity in order to account for uncertainties and variables not considered. When the licensee selected its final list of weld threats to consider during walk-downs this safety factor was not applied to the column capacities. The inspector considered that the effect of this omission was that a number of lower-risk welds should have been subject to further review using the walk-down process to assess whether they posed a credible threat to the columns. To address this concern, the inspector has raised a recommendation in their report for the licensee to ensure that a sub-set of lower risk pipe whip threats are re-assessed to demonstrate to ONR that risks have been reduced ALARP.
45. The inspector agreed with the licensee that the dominant risk to column integrity was high-energy pipe whip. The inspector was satisfied that the Safety Case had identified the most significant risks with respect to pipe whip for Heysham 1 Reactor 1.
46. The inspector noted with regard to safety case completeness that a significant amount of inspection and assessment was still to be completed, as captured by the licensee in Commitment 5. This commitment related to completing pipe whip assessments for reactors other than Heysham 1 Reactor 1 and reviewing certain lower risk pipe whip threats. These lower risk threats comprised a number of remaining horizontal cases and all the vertical pipe whip threats. During further engagement, the licensee presented evidence that this commitment was closed. The inspector considered that the evidence demonstrated that the three reactors other than Heysham 1 Reactor 1 had now been subject to detailed walk-downs and weld threat evaluation and that this aspect of the work was adequate. Regarding the lower risk pipe whip threats included in Commitment 5, the inspector was satisfied that, although some of the closure evidence could have been improved, Commitment 5 had been adequately addressed.
47. Overall, the inspector was satisfied with the claims, arguments and evidence laid down within the licensee's safety case. The inspector has highlighted one area within the safety case that needs further work and has raised a recommendation for the licensee to carry out the required work. The inspector has raised Regulatory Issue 6393 to enable ONR to monitor the licensee's progress in addressing the recommendation, so that key claims in the Safety Case are underwritten in a timely manner.
48. The inspector has recommended that, from a civil engineering perspective, ONR should issue Licence Instruments under Licence Condition 22(1) to give Agreement to safety case NP/SC 7657.

4.3 STRUCTURAL INTEGRITY ASSESSMENT

49. The inspector considered that he had sampled all claims appropriate to structural integrity, and the supporting arguments and evidence within the Safety Case associated with items the inspector considered important for nuclear safety, predominantly related to claims of highest reliability. The inspector considered that

Claims 2, 5 and 6 were most relevant to his assessment. From this sampling approach, the inspector was satisfied that the licensee had presented a case that considered all of the important factors for demonstrating prevention of failure through a claim of highest reliability components, as described in the ONR SAPs (Ref. 10) and TAGs (Ref. 17), such that the risk of failure of these welds was expected to be low.

50. The inspector considered that the arguments supporting Claim 2 aligned with the licensee's guidance on the production of safety cases, adopting a multi-leg approach to provide evidence supporting quality of build, design code compliance, an understanding of ageing and degradation mechanisms and forewarning of failure.
51. The inspector sampled the following HI components being revised as a result of this safety case:
 - Start-Up Vessel (SUV) – welds to be re-designated from HI to loGF.
 - Superheater header tailpipe welds – welds to be re-designated from HI to infrequent failure
 - Turbine Hall basement welds – existing designated HI welds (Claim 2)
 - Reactor Hall basement welds – newly designated HI welds (Claim 5)
52. The inspector had no objection to the licensee's decision to reclassify the safety claim associated with gross failure of the superheater header tailpipe welds. The inspector's opinion was based on the evidence gathered to demonstrate that the components were fit for purpose and tolerable of failure through a refined level of engineering protection, conservative defect tolerance assessments and material condition inspections.
53. The inspector considered that the licensee's decision to re-designate specific SUV HI welds to loGF would have no significant negative effect on nuclear safety. In the inspector's opinion, the extant level of inspection and defect tolerance demonstrated for these welds was already sufficient to support the revised claim and met the expectations of ONR SAPs and TAGs for the demonstration of a highest reliability component.
54. For Claims 2 and 5, the inspector did not consider that the licensee had presented sufficient evidence within the case for all of the existing or newly designated HI welds when reviewed against the expectations presented within the ONR SAPs for a component of the highest reliability. The inspector's judgement takes account of a number of specific HI welds across all four reactors, where work is still ongoing to provide supporting defect tolerance assessments and confirmatory inspections. The licensee has recognised this shortfall within the case and has raised commitments to complete the work in a prioritised manner. Whilst it was the inspector's expectation that this fundamental evidence should have been in place for a Category 1 safety case, the inspector has considered the additional factors presented in the case, including planned timescales for outstanding work, when making a judgement as to whether the licensee's approach demonstrates that the level of risk remains ALARP.
55. For the extant HI welds discussed in Claim 2, the inspector judged that the licensee had completed a limited scope of defect tolerance arguments and supporting inspections during the Hartlepool Reactor 1 periodic shutdown in 2018. These assessments and inspections confirmed that an adequate defect tolerance argument could be made for a representative sample of this weld population, supported by confirmatory inspections to demonstrate absence of significant defects. The inspector recognised that from the wider, historic scope of inspections completed to date, the licensee had found no evidence of any unexpected ageing and degradation mechanisms to suggest that there was an immediate risk of failure to challenge the schedule for completing the remaining assessments. From this evidence, the inspector

was satisfied that the licensee had demonstrated there were adequate arrangements in place to complete a robust defect tolerance assessment for these remaining components within the proposed schedule. The inspector accepted the licensee's position to continue operation of these reactors while the underlying defect tolerance assessment work was completed, scheduled for completion before the end of 2018, which the inspector judged to be reasonably practicable.

56. For the newly designated HI welds in the reactor hall basement, as presented in Claim 5, the inspector was content that on the balance of the evidence presented, the licensee's approach to conduct these inspections in line with the planned reactor periodic shutdowns was reasonable. The inspector has noted that the licensee has not identified any issues with the completed weld inspections to date and the licensee has demonstrated that there are no known ageing and degradation mechanisms likely to challenge plant integrity. The inspector was satisfied that this approach minimises the need to introduce an unexpected fatigue cycle to the other highest reliability components within the reactor.
57. Overall, the structural integrity inspector was satisfied with the claims, arguments and evidence laid down within the licensee's safety case. The inspector considered that there were areas within the safety case that needed further work to underpin claims through the completion of inspections and structural assessments to demonstrate key defect tolerance arguments. The inspector was satisfied that the licensee had identified the outstanding assessments and inspections and had made commitments to address them. The inspector has captured this further work in his recommendations, which relate to the timely completion of safety case Commitments 1 and 4. The inspector has raised Regulatory Issue 6366 to enable ONR to monitor the licensee's progress in addressing the recommendations raised so that the key claims in the case are underwritten in a timely manner.
58. The inspector has recommended that, from a structural integrity perspective, ONR should issue Licence Instruments under Licence Condition 22(1) to give Agreement to safety case NP/SC 7657.

4.4 REVIEW OF NGL'S INTERNAL APPROVAL PROCESS

59. I have reviewed the report from NGL's Independent Nuclear Safety Assessment (Ref. 8) and the minutes of the relevant Nuclear Safety Committees meeting (Ref. 7). I have concluded that the Safety Case has completed NGL's own due processes, that no issues have been identified that would prevent implementation of the Safety Case and I am therefore satisfied that the Safety Case has been subject to an appropriate internal review process.

5 CONCLUSIONS

60. This report presents the findings of ONR's assessment of the Updated Steam Release Safety Case for Hartlepool and Heysham 1 Power Stations, NP/SC 7657 (Ref. 1).
61. Three specialist assessment reports were prepared. All of the specialist assessment reports have conclusions that support the issue of Licence Instruments under Licence Condition 22(1) to enable ONR to give Agreement to the Safety Case.
62. All the specialist assessment reports have identified weaknesses in the evidential basis, completeness and robustness of the safety case and have made recommendations, which have been entered into the ONR Issues database, either for the licensee to carry out further work or for the timely completion of work already identified by the licensee. It is expected that all outstanding work will be completed by 31 December 2019 for both stations.

63. Based on my review of the assessments undertaken by the specialist inspectors as summarised above, I am broadly satisfied with the claims, arguments and evidence laid down within the Safety Case. In my judgement, in relation to this submission, the licensee has provided an adequate justification that the risks from a steam release at Hartlepool and Heysham 1 Power Stations are reduced as low as reasonably practicable (ALARP).
64. I am satisfied that outstanding work has been captured, either by the licensee or as Regulatory Issues, can be monitored by ONR as part of normal regulatory business and that these activities do not prevent ONR from giving Agreement to the Safety Case. I have therefore recommended that ONR give Agreement to the Safety Case under Licence Condition 22(1).

6 RECOMMENDATIONS

65. I recommend that ONR should issue Licence Instruments 566 for Hartlepool Power Station and 618 for Heysham Power Station to give Agreement under Licence Condition 22(1) to Safety Case NP/SC7657 - Hartlepool and Heysham 1 Power Stations – Updated Steam Release Safety Case, Revision 000, Proposal Version No: 07, July 2017.
66. I further recommend that ONR write to NGL requesting that an updated work programme be provided to ONR and responses to a number of specific actions. These actions will be tracked through the following Regulatory Issues:
- Level 3 Regulatory Issue 6355 monitoring the internal hazards concerns
 - Level 4 Regulatory Issue 6393 monitoring the civil engineering concerns
 - Level 3 Regulatory Issue 6366 monitoring the structural integrity concerns.

7 REFERENCES

1. Hartlepool and Heysham 1 Power Stations, Updated Steam Release Safety Case, Rev 000 Version 7, EDF Energy, July 2017, TRIM 2017/309222.
2. EDF Energy letter to ONR – Hartlepool Power Station - Request for Agreement or Acknowledgement under arrangements made under Licence Condition 22 (1), NP/SC 7657 Updated Steam Release Safety Case (EC 346662), 3 August 2017, TRIM 2017/307144.
3. EDF Energy letter to ONR – Heysham 1 Power Station - Request for Agreement or Acknowledgement under arrangements made under Licence Condition 22 (1), NP/SC 7657 Updated Steam Release Safety Case (EC 356419), 3 August 2017, TRIM 2017/325266.
4. Intention to Assess NP/SC 7657 – Updated Steam Release Safety Case (EC 346662), Letter ONR to EDF Energy, 22 November 2017, TRIM 2017/432717
5. E-mail NGL to ONR - NGL Steam Release response, attaching document “ONR concerns: HRA/HYA Steam Release NP/SC 7657”, 15 February 2018, TRIM 2018/67991.
6. JCO - Justification for the continued operation of the reactors with respect to potential steam pipe whip threat to the reactor civil structure, EC 354383 000 and EC 355836 000 Version 1, EDF Energy, TRIM 2017/30490.
7. EDF Energy Ltd, Nuclear Safety Committees, Minutes of the meeting held at Barnwood, 18 May 2016; Minutes of the meeting held at Barnwood, 19 July 2017, TRIM 2017/307144.
8. Milestone INSA Approval Statement, NP/SC/7657, EC 346662 000 Version 07 (Hartlepool), and EC 356419 000 Version 07 (Heysham 1) Updated Steam Release Safety Case, EDF Energy, TRIM 2017/469817.
9. ONR HOW2 Guide - Purpose and Scope of Permissioning - NS-PER-GD-014 Revision 4. July 2014. <http://www.onr.org.uk/operational/assessment/index.htm>
10. Safety Assessment Principles for Nuclear Facilities. 2014 Edition Revision 0. November 2014. <http://www.onr.org.uk/saps/saps2014.pdf>.
11. Contact Record: Level 4 meeting: Steam Release and Pipe whip at Heysham 1 and Hartlepool power stations, ONR OFP CR 16-463 Rev 0, ONR, 25 November 2016, TRIM 2016/468934.
12. Contact Record: Heysham 1 inspection to review EDF pipe weld inspection criteria in support of HYA/HRA Updated Steam Release and Pipe whip Safety Case, ONR-OFD-CR-17-072 Rev 0, ONR, 24 April 2017, TRIM 2017/179781.
13. Contact Record: Level 4 meeting: Hartlepool and Heysham 1 power stations, Assessment of Updated Steam Release safety case NP/SC/7657, ONR-OFD-CR-17-602 Rev 0, ONR, 16 January 2018, TRIM 2018/27854.
14. Hartlepool and Heysham 1, Internal Hazards Assessment of the Hartlepool and Heysham 1 Updated Steam Release Safety Case, ONR-OFD-AR-17-058 Revision 0, ONR, April 2018, TRIM 2017/470919.
15. Hartlepool and Heysham 1, Assessment of the civil engineering aspects of the Updated Steam Release Safety Case NP/SC 7657, ONR-OFD-AR-17-054 Revision 0, ONR, April 2018, TRIM 2017/451941.
16. Hartlepool and Heysham 1, Structural Integrity Assessment of the Hartlepool and Heysham Updated Steam Release Safety Case, ONR-OFD-AR-17-046 Revision 0, ONR, May 2018, TRIM 2017/420131.

17. ONR Technical Assessment Guides:
 - Guidance on the demonstration of ALARP, NS-TAST-GD-005, Revision 8
 - Internal Hazards, NS-TAST-GD-014, Revision 4
 - Integrity of Metal Structures and Components, NS-TAST-GD-016, Revision 5
 - Civil Engineering, NS-TAST-GD-017, Revision 3
 - The purpose, scope and content of safety cases, NS-TAST-GD-051, Revision 4
- http://www.onr.org.uk/operational/tech_asst_guides/index.htm