



PROJECT ASSESSMENT REPORT			
<b>Unique Document ID and Revision No:</b>	ONR-HYA-PAR-15-012 Revision 0	<b>TRIM Ref:</b>	2015/308268
<b>Project:</b>	Boiler spine recovery project		
<b>Site:</b>	Heysham 1		
<b>Title:</b>	Specification of Heysham 1 reactor 2 boiler spine structural integrity safety case & justification for return to full power following implementation of the spine cooling modification, NP/SC 7728, EC35506.		
<b>Licence Instrument No:</b> (if applicable)	LI 592 – Specification		
<b>Nuclear Site Licence No:</b>	60		
<b>Licence Condition:</b>	22(4)		

**Document Acceptance and Approval for Issue / Publication**

Role	Name	Position	Signature	Date
Author	[Redacted]	[Redacted]		[Redacted]
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Accepted by <sup>1</sup>	[Redacted]	[Redacted]		
Approval publication <sup>2</sup> for	[Redacted]	[Redacted]		

**Revision History**

Revision	Date	Author(s)	Reviewed By	Accepted By	Description of Change
A	[Redacted]			[Redacted]	[Redacted]
[Redacted]				[Redacted]	[Redacted]
[Redacted]					[Redacted]

<sup>1</sup> Acceptance of the PAR to allow release of LI

<sup>2</sup> Approval is for publication on ONR web-site, after redaction where relevant

**Circulation (latest issue)**

Organisation	Name	Date
Office for Nuclear Regulation	[REDACTED]	
[REDACTED]	[REDACTED]	
[REDACTED]	[REDACTED]	

**Boiler spine recovery project**

**Specification of Heysham 1 reactor 2 boiler spine structural integrity safety case & justification for return to full power following implementation of the spine cooling modification, NP/SC 7728, EC355061**

Project assessment report ONR-HYA-PAR-15-012  
Revision 0  
27 August 2015

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Published 08/15

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## 1 Permission requested

1. This report presents the justification to issue a specification under Licence Condition 22(4) requiring that the licensee, EDF Energy Nuclear Generation Ltd (NGL), shall not commence nor thereafter proceed with “Heysham 1 reactor 2 boiler spine structural integrity safety case and justification for return to full power following implementation of the spine cooling modification, NP/SC 7728, EC355061.” without the Consent of the ONR.

## 2 Background

2. During the 2013 Heysham 1 reactor 1(R1) statutory outage (commencing August 2013), an unusual test result was found on quadrant D, boiler 1 spine (1D1). NGL presented a safety case (*Ref. 1*) to justify a limited period of reactor operation of Heysham 1 R1 (six months) with the D boiler quadrant shutdown with both boiler pods stored dry and in a nitrogen atmosphere. This mode of operation is known as three quadrant operation.
3. In July 2014 a crack was identified on weld 12.3 on the spine of boiler 1D1. This weld is associated with supporting the weight of the main boiler and re-heater. NGL took the decision on to shut down the operating reactors at Heysham and Hartlepool to allow further investigations on all of the boiler spines in each of the four reactors. This decision was supported by ONR.
4. NGL produced a safety case [NP/SC 7717 (*Ref.2*)] for the return to service of three of the four reactors; Heysham 1 reactor 2, and Hartlepool reactors 1 and 2 operating at reduced power. The purpose of the reduced power operations was to reduce the operating temperature of weld 12.3 below the point where crack initiation and propagation were possible. The case was assessed by ONR (*Ref. 3*) and the reactors returned to reduced power operations under LI 587.
5. NP/SC 7717 made several commitments to improve the safety case position in the longer term, including a commitment to develop an implementation plan for a cooling modification to reduce weld 12.3 temperatures. The cooling modifications were installed Heysham 1 R2 during the 2015 statutory outage under NP/SC 7733 (*Ref. 4*) and the reactor returned to power under the existing reduced power safety case (NP/SC 7717). ONR assessed this case (*Ref. 5*) on a no detriment basis as no formal claim was made on the cooling benefits associated with the modification at that time.
6. The ultimate aim of the cooling modification was to support an increase in reactor operating power. NGL have now produced a Heysham 1 R2-specific safety case, seeking to justify return to long term full power operations.

## 3 Regulatory consideration of this Safety Case

7. The return to full power operations of Heysham 1 R2 (NP/SC 7728, *Ref. 6*) constitutes a significant departure from the current operating conditions. The ONR assessment of the cooling modification and subsequent return to service of the reactor was based on a ‘no detriment’ scope. This approach was taken as the reactor was returned to “reduced power operations” with no claims made on the effectiveness of the installed cooling modifications to reduce weld 12.3 operating temperature.
8. NGL have now produced a safety case proposing to return Heysham 1 R2 to full power. This safety case is based on the following claims:

**Claim 1:** The integrity of key butt welds meets the deterministic requirements for infrequent failure tolerability;

**Claim 2:** In the event of boiler spine failure, the consequences remain tolerable; and

**Claim 3:** The radiological risk arising from boiler spine failure at Heysham 1 reactor 2 is as low as reasonably practicable such that the cost of remaining de-rated is grossly disproportionate to the safety benefit.

9. The return to full power operations represents a number of significant changes in conditions within the reactor. Increases in operating temperatures associated with the increased power represent significant changes to plant conditions local to the position of weld 12.3.
10. Claims 1 and 2 of the full power operations are based on complex and novel arguments and evidence. These have been developed by NGL and have undergone due process in line with the licensee's arrangements. However, ONR has not had an opportunity to consider these proposals in respect to full power operations.
11. The absence of physical plant monitoring such as thermocouples local to weld 12.3 prohibits accurate measurement of the true weld temperature and therefore the actual effectiveness of the cooling modifications. Assumptions made by NGL in modelling the thermal affects have been partially supported by test rig operation, providing a degree of confidence in the model. However until thermocouples are installed locally to weld 12.3 on later reactors, it is not possible to fully validate the model.
12. Work to identify problems with other weld 12.3 sites in terms of cracks and non-standard weld techniques have been developed and deployed by NGL. A question remains on the effectiveness and validation of these techniques to identify with accuracy the presence of these problems. The ability of NGL to present an adequate forewarning of failure case is yet to be assessed and signifies a significant area of interest for ONR.
13. I consider it reasonable to assume that, if ill-conceived or poorly implemented, the Heysham 1 reactor 2 return to full power safety case has potential to significantly increase the risk of a radiological hazard. Formal assessment is required to provide confidence that the risks associated with the return to full power operations are demonstrated as being as low as reasonably practicable.
14. NGL's approach to the installation of boiler spine cooling modifications on Heysham 1 R1 (*Ref. 4*) was considered by ONR (*Ref. 5*) to be unusual. NGL did not follow its normal arrangements for managing a project with such wide reaching implications. At the time, no nuclear safety requirements specification or paper of principle had been produced for the Heysham 1 R2 case, with work being proposed through a series of standalone ECs.
15. Whilst a paper of principle (*Ref. 7*) covering the remaining boiler spine recovery project has now been produced and acknowledged by ONR (*Ref. 8*), there remains a degree of uncertainty around NGLs approach to such a nuclear safety-significant tranche of work.
16. Based on the above, I judge it proportionate to use primary powers in specifying that the licensee, NGL, shall not commence nor thereafter proceed with Heysham 1 reactor 2 boiler spine structural integrity safety case and justification for return to full power following implementation of the spine cooling modification, NP/SC 7728, EC355061" without the Consent of the ONR.

## **4 Conclusions and recommendations**

### **4.1 Conclusions**

17. I judge that it is reasonable to assume that inadequate conception or execution of the Heysham 1 R2 return to full power safety case might lead to a serious increase in the risk of a radiological hazard.

18. Based on the justifications discussed above, it is the judgment of ONR that the use of primary powers is appropriate.
19. I have prepared LI 592 in conjunction with this PAR for Heysham 1 R2. Specifications under Licence Condition 22(4) are not considered standard, and the LI has therefore been considered by the Government Legal advisors.

#### **4.2 Recommendations**

20. I recommend issuing a specification under Licence Condition 22(4) requiring that the licensee, EDF Energy Nuclear Generation Ltd, shall not commence nor thereafter proceed with “Heysham 1 reactor 2 boiler spine structural integrity safety case & justification for return to full power following implementation of the spine cooling modification, NP/SC 7728, EC355061” without the Consent of the ONR.
21. In accordance with the delegated authorities identified in How 2 (*Ref. 9*), I recommend that the Superintending Inspector endorses the above recommendation and issues specification 592.

## REFERENCES

1. NGL Engineering Change Proposal EC No. 351365 000 Version1 - Justification For 3 Quadrant Start-Up and Operation of HYA R1 for a Short Period in Response to an Unexpected Inspection Finding On HYA 1D1 Boiler Spine [REDACTED]
2. NGL Safety Case NP/SC 7717 Rev 6, Safety case for return to service of Heysham 1 reactor 2, Hartlepool reactor 1 and reactor 2 at reduced temperature operation following the discovery of a defect on Heysham 1 reactor 1 boiler spine 1D1, [REDACTED]
3. ONR Project Assessment Report - ONR-CNRP-PAR-14-015 Revision 0 - Hartlepool and Heysham 1 Boiler Spines Return to Service - A safety case for return to service of Heysham 1 Reactor 2, Hartlepool Reactor 1 and Reactor 2 at reduced temperature operation following the discovery of a defect on Heysham 1 Reactor 1 boiler spine 1D1 [REDACTED]
4. Reactor 2 Return to Service at Reduced Power with Spine Cooling Modifications Installed – NP/SC 7733 - EC355558, Revision 000, Version 04 Dated 06/2015, [REDACTED]
5. ONR Project Assessment Report – ONR-HYA-PAR-15-004 Revision 0 - NP/SC 7733 Heysham 1 Power Station Reactor 2 Return to Service at Reduced Power with Spine Cooling Modifications Installed (EC355558) [REDACTED]
6. Heysham 1 Reactor 2 Boiler Spine Structural Integrity Safety Case & Justification for Return to Full Power Following Implementation of the Spine Cooling modification, NP/SC 7728, EC355061 [REDACTED]
7. Paper of Principle, Installation of insulation in boiler spine annulus and subsequent reactor operation, NP/SC 7733 (Hartlepool: EC 355834, Heysham 1: 356010), 29 July [REDACTED]
8. ONR Project Assessment Report - ONR-CNRP-PAR-15-010 Revision 0 - Hartlepool and Heysham - Paper of Principle - Installation of insulation in boiler spine annulus and subsequent reactor operation, NP/SC 7733 [REDACTED]
9. ONR How2 guidance - Administrative Arrangements for Delegated Authorities within the Office for Nuclear Regulation - NS-PER-GD-013 Revision 1