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**Atomic Weapons Establishment (AWE) – Implementation of the Provision of
Performance Monitoring of the [REDACTED] Over-Temperature Trip Safety
Thermocouples**

**Assessment of AWE’s Request for the Installation of Monitoring Panels on the Over-
Temperature Trip System of the [REDACTED]
[REDACTED]**

Project Assessment Report ONR-OFD-PAR-18-014
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EXECUTIVE SUMMARY

Assessment of AWE's Request for the Installation of Monitoring Panels on the Over-Temperature Trip System of the [REDACTED]

This report provides a summary of the assessments conducted by the Office for Nuclear Regulation (ONR) to justify its permissioning decision in respect of the licensee's (AWE plc.) request to install monitoring panels on the over-temperature trip system of the [REDACTED]

Permission Requested

In accordance with its arrangements, made under Licence Condition 22(1) ('Modification or Experiment on Existing Plant') of Nuclear Site Licence No. 77, AWE has requested an 'Agreement' Licence Instrument (LI) to implement the modification described in the relevant Pre-Operational Safety Report (POSR), namely to install monitoring panels on the over-temperature trip system of the [REDACTED]

Background

AWE has developed an improvement to the [REDACTED] over-temperature trip safety system, to add on-line performance monitoring of the four safety trip thermocouples in order to meet established Relevant Good Practice (RGP) for a safety system which lacks sensor diversity.

According to its own Licence Condition LC 22 arrangements, AWE has produced a POSR to justify the installation work from a nuclear safety perspective. The POSR has received advice from AWE's Nuclear Safety Committee (NSC), which has been addressed and the POSR has then successfully passed through AWE's Site Governance Meeting (SGM). AWE's own due process has hence been followed and successfully completed.

Since the change has been classified as a 'Red Route' modification, AWE's processes under its LC 22 arrangements require that permission for implementation of the modification be sought from ONR. Accordingly, AWE has requested an 'Agreement' Licence Instrument under its arrangements made under LC 22(1). The 'Agreement' Licence Instrument will permit AWE to install the monitoring panels on the over-temperature trip system of the [REDACTED].

Assessment and Inspection Work Carried out by ONR in Consideration of this Request

In assessing AWE's request to implement the modification, ONR has:-

- Considered the previous Fault Studies (FS) assessment work, conducted by ONR specialist Fault Studies inspectors on the [REDACTED] over-temperature trip system.
- Performed a specialist assessment of the Control and Instrumentation (C&I) aspects of the proposed modification (i.e. to install the monitoring panels on the over-temperature trip system) to ensure that (a) the proposed modification conforms to Relevant Good Practice - RGP; (b) the existing over-temperature trip system conforms to RGP; (c) the modification has no detrimental effect on the existing over-temperature trip system and (d) to ensure it is appropriate for ONR to permission the proposed modification from a C&I perspective.
- Performed a specialist Human Factors (HF) inspection to gain assurance that AWE has developed the Key Safety Actions (KSAs) and associated arrangements

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(Operating Instructions - OIs) for their implementation to enable ONR to permission implementation of the proposed modification from a HF perspective.

Based upon the totality of the work conducted by ONR's inspectors, ONR is satisfied that AWE has produced an adequate safety justification to install the monitoring panels on the over-temperature trip system of the [REDACTED]

Matters Arising from ONR's Work

All matters that ONR has raised with AWE, during the conduct of its assessment work and during its inspections, have been resolved to ONR's satisfaction and there are no outstanding matters arising.

Conclusions

In accordance with its LC 22 arrangements, AWE has submitted a detailed POSR and associated documentation, justifying the nuclear safety aspects of its proposed installation of monitoring panels on the over-temperature trip system of the [REDACTED]. AWE's POSR has successfully completed its own due process. The POSR and associated documentation have been subjected to assessment and/or inspection by ONR specialists in FS, C&I and HF, which are the key disciplines relevant to this proposed modification.

Based upon the totality of the work conducted by ONR's inspectors, ONR is satisfied that AWE has produced an adequate safety justification to implement the modification (as described in the POSR and supporting documentation). There are no technical or regulatory reasons to prevent ONR agreement being given to AWE's proposal to implement the proposed modification.

Recommendation

Permission should be granted to AWE plc, via the issue of 'Agreement' Licence Instrument Number 538, to allow AWE to install monitoring panels on the over-temperature trip system of the [REDACTED] at AWE Aldermaston.

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LIST OF ABBREVIATIONS

ACR	Asset Change Request
ALARP	As Low As Reasonably Practicable
AWE	Atomic Weapons Establishment
C&I	Control and Instrumentation
DNSR	Defence Nuclear Safety Regulator
DVR	Design Verification Report
EA	Environment Agency
FS	Fault Studies
HBSC	Human Based Safety Claims
HF	Human Factors
HMI	Human Machine Interface
HPCP	Hold Point Control Plan
KSA	Key Safety Action
LC	Licence Condition
LI	Licence Instrument
NSC	Nuclear Safety Committee
OI	Operating Instruction
ONR	Office for Nuclear Regulation
PAR	Project Assessment Report
POSR	Pre-Operational Safety Report
PSF	Performance Shaping Factor
RGP	Relevant Good Practice
RI	Regulatory Issue
SAP	Safety Assessment Principle(s)
SGM	Site Governance Meeting
TAG	Technical Assessment Guide (ONR)

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1 PERMISSION REQUESTED

1. In accordance with its arrangements, made under Licence Condition LC 22(1), the licensee (i.e. AWE plc) has requested (Ref. 1) an 'Agreement' Licence Instrument from the ONR to conduct a modification to the [REDACTED] i.e. to install monitoring panels on the over-temperature trip system (this is also referred to as the performance monitoring system within this report). Since the change has been classified as a 'Red Route' modification, AWE's processes under its LC 22 arrangements require that permission for the modification be sought from ONR.
2. AWE has produced a POSR (Ref. 14) and supporting documentation to support/justify the work from a nuclear safety perspective. The POSR has successfully passed through both AWE's NSC (Ref. 2) and its SGM (Ref. 18). AWE's own due process has hence been followed and successfully completed. AWE has also produced an Asset Change Request, ACR, No. 000747 (Ref. 3) as per its arrangements made under LC 22 ('Modification or Experiment on Existing Plant').

2 BACKGROUND

3. [REDACTED] AWE has installed an over-temperature trip system to prevent this fault. In the event of excessive temperatures the [REDACTED] to the [REDACTED] is automatically cut.
4. Associated with this trip system AWE proposes to install monitoring panels (the installation being the subject of this PAR), which will be a trip safety thermocouple performance monitoring system, giving a visual indication of the health status of the over-temperature trip thermocouples. The monitoring system will derive its data from the over-temperature trip system thermocouples.
5. The [REDACTED] over-temperature trip project has a considerable history stretching back to 2010. Appendix 1 of this Project Assessment Report (PAR) gives the detailed chronology of this project and corresponding references. This PAR sets out to summarise the ONR assessment of the trip safety thermocouple performance monitoring system installation proposal, but also sets out to confirm that all previous ONR concerns, with respect to both the over-temperature trip system and the trip safety thermocouple performance monitoring system have been adequately closed out. The chronology of this project is briefly summarised below.
6. In 2010, AWE identified a shortfall against deterministic requirements with respect to over-temperature faults in the [REDACTED]. In January 2011 AWE undertook optioneering and implemented engineered measures and operator actions to rectify the shortfall. The engineered safety measure of relevance here is a hardwired temperature trip.
7. At that time, ONR had concerns with AWE's proposed safety improvements and also that AWE intended to return the [REDACTED] to service with identified shortfalls. ONR also considered that the engineered safety systems fell short of modern standards requirements, based upon the fault frequency and consequence, and that an adequate ALARP (As Low As Reasonably Practicable) justification had not been made.
8. ONR's expectation is that a safety system based upon temperature measurements should be engineered to Class 1 reliability standards. In order to achieve Class 1 reliability, ONR's advice was that standard BS EN 61508 (*Functional Safety of Electrical/ Electronic/ Programmable Electronic Safety-related Systems*) (Ref. 4) should be met for the engineered safety systems.

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9. ONR also considered that AWE should provide a read-out of the temperature trip parameter using monitoring, display and recording of the trip system thermocouple outputs. This is the key focus of this PAR.
10. In early 2014 ONR undertook a safety review of [REDACTED] to assess its ALARP adequacy for operations until [REDACTED] could be made available. ONR's assessment included consideration of the substantiation of the over-temperature trip, as well as the means of monitoring the condition of the over-temperature trip system thermocouples.
11. ONR's review conclusions in early 2014 were that aspects of AWE's C&I substantiation of the over-temperature protection system potentially fell short of ONR's expectations and that a high level of compliance with RGP such as BS EN 61508 was expected for the over-temperature trip system.
12. By July 2014, AWE was commencing a review of the over-temperature trip engineering substantiation and a Category B modification to the trip system to replace existing trip amplifiers and to install trial thermocouple monitoring equipment.
13. ONR Regulatory Issue 2737 (still extant) was subsequently raised to track AWE's progress against this next phase of work. Issue 2737 records that ONR's position is that the [REDACTED] (as implemented at that time) was not adequately supported by engineering substantiation assessment and did not incorporate all reasonably practicable risk controls when considered against RGP. (Section 3.5 of this PAR discusses this in more detail).
14. However, the view of the ONR fault studies inspector in September 2014 was that the fault studies queries for Issue 2737 had been adequately addressed (Reference 9). This fault studies view did not consider whether the installation of the new temperature monitoring system could adversely affect the reliability of the over-temperature trip system. This has now been addressed in the recent C&I assessment of the proposed installation of the monitoring panels on the over-temperature trip system (Reference 6).
15. In October 2014, AWE provided ONR with the Design Verification Report (DVR) Issue 1a (Ref. 5) for the over-temperature trip system. In February 2015, AWE stated that there would be two additional actions during the proposed thermocouple monitoring trials on the [REDACTED]
 - To undertake initial [REDACTED] system testing to provide a level of data relating to normal thermocouple behaviour during a run.
 - To undertake real-time monitoring of the output from the installed temperature monitoring equipment and to compare these values with the process control thermocouple outputs.
16. During 2015, ONR continued to monitor AWE's progress with its trials. AWE informed ONR that diverse trip amplifiers would not be installed for these trials. No subsequent ONR engagement with AWE regarding the [REDACTED] temperature trip system has taken place until recently (early 2017 and onwards).

2.1 PURPOSE AND SCOPE OF THE REPORT

17. The scope/purpose of this PAR is twofold:
 - i. To summarise the conclusions and judgements, arising from ONR's historical and recent assessments and inspections of AWE's proposal for installation of monitoring panels on the over-temperature trip system of the [REDACTED] for the following specialisms:

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- Control and Instrumentation (C&I)
 - Human Factors (HF)
 - Fault Studies (FS)
- ii. To collate and summarise the previous ONR assessments and interactions (going back several years) to allow a definitive ONR view to be formed as to whether the initial ONR concerns (see sections 3.1 and 3.5 of this PAR), arising from the over-temperature trip project, have been adequately addressed, such that successful closure of Issue 2737 will only be contingent on delivery of a final ALARP paper from AWE.
18. The outputs arising from this PAR will be as follows:
- a) A clear ONR position on the adequacy of the proposed installation of the performance monitoring system on the over-temperature trip system of the [REDACTED] and its conformity with RGP.
 - b) Production of a Licence Instrument to permission lifting Hold Point No. PP495 on AWE's Hold Point Control Plan (HPCP), based on the historical ONR work and judgements that precede this PAR and the conclusions and judgements arising from the C&I, HF and FS assessments/inspections described in this PAR.
19. The installation and subsequent commissioning of the performance monitoring system will enable AWE to generate a paper justifying that the proposed temperature trip and monitoring solution reduces risks ALARP. Receipt of an adequate ALARP paper by ONR (programmed for delivery to ONR circa October 2018 – Hold Point PP350 on the [REDACTED] Hold Point Control Plan, HPCP) and confirmation that the historical ONR concerns, relating to the [REDACTED] over-temperature trip system have been adequately addressed by AWE (paragraph 46 later in this report) will enable closure of Issue 2737.

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

3.1 INITIAL WORK

20. There is a considerable body of historic assessments and interactions relating to this project, which is detailed in Appendix 1 of this PAR. The salient historical concerns arising from these previous engagements are:
- i. Aspects of AWE's C&I substantiation of the over-temperature protection system fell short of ONR's expectations, and a high level of compliance with RGP such as BS EN 61508 was expected for the over-temperature trip system.
 - ii. Issue 2737 - ONR's position is that the [REDACTED] over-temperature protection system as implemented was not adequately supported by engineering substantiation assessment and did not incorporate all reasonably practicable risk controls when considered against RGP.
21. ONR specialists in C&I and HF have recently engaged with the [REDACTED] project with a view to:
- a) Ensuring that the proposed implementation of the over-temperature trip performance monitoring system has been adequately conceived, will be adequately executed and conforms to extant C&I and HF RGP for safety systems such as this one. This is the primary focus of this PAR. The C&I

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assessment has also considered whether the proposed modification could adversely affect the functionality of the already existing over-temperature trip system.

- b) Resolving the historical ONR concerns (i) and (ii) above, with a view to facilitating closure of Issue 2737. This is the secondary focus of this PAR, and is detailed in Section 3.5 of this PAR.

3.2 C&I ASSESSMENT

- 22. The findings of an ONR C&I assessment of AWE's POSR and associated documentation for the proposed modification are presented in Ref. 6. All documents sampled as part of this assessment are detailed in Ref. 6. The C&I inspector supports the issue of the LI for the installation of the monitoring panels on the over-temperature trip system of the [REDACTED]. The ONR assessment was conducted against the appropriate ONR Safety Assessment Principles (SAPs) – Ref. (7) and ONR advice as presented in its Technical Assessment Guides (TAGs) – (Ref. 8). Further information on the SAPs and TAGs utilised within the C&I assessment can be obtained from Ref. 6.
- 23. The C&I assessment considered the extent to which C&I aspects of the modification support AWE's request to install the monitoring panels on the over-temperature trip system and return the [REDACTED] to normal operational use. A sampling approach was employed, based on a proportionate review of three key aspects of the modification proposal:
 - i. Assessment of the capability of the proposed modification to fulfil its intended function of on-line performance monitoring of the over-temperature trip safety thermocouples.
 - ii. Consideration of whether the proposed modification could have a detrimental impact on the extant Class 1 over-temperature trip safety system.
 - iii. A high-level review (not a repeat assessment) of the [REDACTED] over-temperature trip safety system (including the proposed performance monitoring modification), in order to judge whether the C&I aspects of the over-temperature trip safety system support the closure of regulatory issue 2737.
- 24. The key conclusions arising from the ONR C&I specialist assessment (Ref. 6) are:
 - a) The system performance monitoring system will be functionally capable of fulfilling the stated requirements; to diagnose faulty safety thermocouples and instigate an appropriate operator response.
 - b) The modification has been adequately conceived to avoid detriment to the already existing [REDACTED] over-temperature trip safety system. (Also see the historical fault studies conclusions discussed overleaf).
 - c) The proposed [REDACTED] commissioning tests, when updated to accommodate the modification, will adequately verify that the existing over-temperature trip safety system will continue to perform its safety function following installation of the performance monitoring panels.
 - d) The long-standing historical shortfall of a lack of on-line safety sensor monitoring capability will be adequately addressed by this modification. The judgement of the ONR C&I assessor is hence that AWE's submission supports the closure of the C&I aspects of ONR regulatory Issue 2737.

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- e) The supplied safety case (POSR) and its supporting documentation provide an adequate demonstration that the C&I aspects of the modification support AWE's request for permission to install the monitoring panels and return the [REDACTED] to normal operational use.

3.3 FAULT STUDIES ASSESSMENT

25. The historical engagements on the over-temperature trip project also involved Fault Studies analysis (Ref. 9) of the adequacy and efficacy of the automatic over-temperature trip system. The key conclusions of this prior fault studies analysis are summarised below:

- a) The over-temperature trip will be effective at maintaining the [REDACTED] temperature below the temperature safety limit for design basis faults, [REDACTED].
- b) The effectiveness of the over-temperature trip [REDACTED] demonstrates that there is little safety benefit from fitting a [REDACTED]. This supports AWE's view that a [REDACTED] is not needed to demonstrate that risks are ALARP. Hence the over-temperature trip alone is sufficient to meet RGP for the design basis of the [REDACTED].
- c) There is adequate time for multiple operator interventions for faults in which the over-temperature trip function fails to operate on demand.
- d) The availability of at least one thermocouple in each [REDACTED] zone should be reflected in the operating philosophy once monitoring is fitted to the over-temperature trip system.
- e) The [REDACTED] performance trials in Ref. 10 and AWE's response to ONR comments in Ref. 11 provides adequate evidence that the [REDACTED] performance characteristics of the [REDACTED] have been explored and are understood by AWE. The trials do not show any unusual [REDACTED] performance behaviours or cliff-edge effects.

26. The conclusions of this historical fault studies analysis were that the technical queries for action (Item 5 of Issue 2737) have been adequately addressed, and that the over-temperature trip system alone will provide adequate protection against over-temperature faults.

27. The conclusion of the ONR C&I assessment (Ref. 6) is that the proposed modification to install the performance monitoring for the over-temperature trip system will not detrimentally affect the reliability of the installed trip system for the reasons detailed in Section 4.2.2 of Ref. 6. Hence the conclusions of the original fault studies assessment (Ref. 9) outlined above are still valid, and no additional fault studies assessment is proposed for the purposes of this PAR.

3.4 HUMAN FACTORS INSPECTION

28. An ONR HF inspection (Ref. 12) was undertaken at AWE Aldermaston to inform the permissioning of the modification to install the performance monitoring panels on the over-temperature trip system of the [REDACTED]. All documentation sampled in this inspection is given in Ref. 12.

29. AWE claims that the modification to install the performance monitoring system does not affect the reliability of the operators to complete the Human Based Safety Claims

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- (HBSC) claimed in the safety case. The operators are required to terminate an [REDACTED] [REDACTED] faults during certain phases of the process. To do this, the safety case identifies Key Safety Actions (KSAs) in line with AWE's arrangements.
30. A previous intervention in April 2018 (Ref. 13) raised a number of concerns regarding the definition of these KSAs and the activities operators would be required to conduct to fulfil the associated safety functions. AWE agreed to undertake further work to develop these KSAs and the arrangements via which they would be implemented.
 31. The ONR inspection (Ref. 12) was undertaken to gain assurance that AWE had developed the KSAs and associated arrangements for their implementation, to enable ONR to permission the modification from a HF perspective. What was required to successfully address the historical HF concerns relating to the [REDACTED] are the following:
 - A clear definition of the [REDACTED] Human Based Safety Claims (HBSCs).
 - Arrangements to ensure operators remain situationally aware throughout the process and understand their role in maintaining safety
 - Operating Instructions (OIs) that support the role of the operator and provide clear guidance as to what action is required under what circumstances and when it should be initiated
 - Human Machine Interfaces (HMIs) that support the role of the operator, providing information and/or action prompts in an appropriate format to support HBSC delivery
 - Absence of significant Performance Shaping Factors (PSFs) that could have a negative impact on human performance
 32. AWE has developed a suite of new KSAs identified from the Pre-Operational Safety Report (Ref. 14) associated with the [REDACTED] to support Operating Rule (OR) 28, which limits the temperature of components within the [REDACTED] machine.
 33. Draft Operating Instructions (OIs) have been developed for operators to use to ensure compliance with the new and existing KSAs. A draft [REDACTED] Run Chart (Ref. 15) has been developed for operators to use to demonstrate compliance with the KSAs. A draft Objective Based Training document has also been developed incorporating the performance monitoring panels that will support the implementation of the modification. These documents were all examined and discussed during the course of the inspection.
 34. Based upon the evidence obtained during the recent inspection the ONR HF inspector was satisfied that AWE is developing the KSAs and their associated arrangements to complete the claimed HBSC in the [REDACTED] safety case. AWE was able to demonstrate the following:
 - The new arrangements clearly identify limits and conditions necessary for safety, in the form of KSAs associated with the performance monitoring system.
 - Procedures are being developed to support operator performance.
 - Training is being developed to ensure operators are competent to conduct the extant [REDACTED] process with the performance monitoring system in place.
 35. A number of good practices were observed during the inspection.

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- The KSAs have been formulated by a multidisciplinary team, and identify limits and conditions associated with the performance monitoring system necessary for safety.
 - The OIs clearly identify the KSAs, and in the view of the ONR HF Specialist Inspector are sufficiently detailed to enable operators to conduct operations safely.
36. The overall conclusions of the ONR HF Specialist inspector are:
- On the basis of evidence sampled during this inspection, AWE has demonstrated it is developing suitable arrangements to support the KSAs claimed in the safety case.
 - RGP is generally met, with minor shortfalls identified, when compared with appropriate benchmarks.
 - No significant shortfalls were identified in the delivery of safety or security functions.
 - Based on the evidence obtained during this inspection, the ONR HF inspector raised no objections from a HF perspective to commissioning the installation of the performance monitoring panels on the over-temperature trip system of the [REDACTED]
37. A number of specific areas of improvement were identified during the inspection, notably in the development of the OIs and the [REDACTED] Run Chart (Ref. 15). It should be noted that the OIs and [REDACTED] Run Chart documents are currently in draft form. AWE has taken cognisance of the ONR concerns raised during the inspection, and has an ongoing programme of work in place to resolve these concerns.
38. A Regulatory Issue (RI) (Issue 6529) has been raised to monitor progress with this programme of work as part of routine engagements with the facility. The raising of this RI is simply to facilitate tracking of AWE's progress with addressing the minor areas of concern identified during the inspection, and does not impede the issuing of the LI to permission the proposed modification.

3.5 CLOSURE OF HISTORICAL ONR CONCERNS

39. From Section 3.1 of this PAR, the historical concerns arising from previous ONR engagements on the [REDACTED] over-temperature trip project are:
- i. Aspects of AWE's C&I substantiation of the over-temperature protection system fell short of ONR's expectations, and a high level of compliance with RGP such as BS EN 61508 was expected for the over-temperature trip system.
 - ii. Issue 2737 - ONR's position is that the [REDACTED] over-temperature protection system as implemented was not adequately supported by engineering substantiation assessment and did not incorporate all reasonably practicable risk controls when considered against RGP.
40. Concern (i) is now closed out, on the basis that the conclusions of the C&I inspector's assessment (Ref. 6) were that sampling of Issue 2 of the DVR (Ref. 17) was found to demonstrate that the extant AWE substantiation was aligned with BS EN 61508 (Ref. 4). This included tabulated responses to record the techniques and measures used to control systematic failure or influence, as listed in part 2 of BS EN 61508.

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41. Following the implementation of the performance monitoring system, the over-temperature trip safety system will employ redundancy, limited diversity and on-line monitoring to deliver the safety function with an integrity which the ONR C&I inspector judges to be commensurate with the requirements for a Class 1 safety system, in line with NS-TAST-GD-003 (Ref. 8), NS-TAST-GD-094 (Ref. 8) and BS EN 61508.
42. The ONR C&I inspector also states in (Ref. 6) that AWE has improved the coverage of their substantiation (since ONR's original assessment) by producing the DVR for the trip system (Ref. 17). AWE state that the purpose of the DVR is to provide evidence that demonstrates the safety system meets the expectations of RGP; primarily BS EN 61508, ONR SAPs and AWE's own hazard control and design safety principles. In the view of the C&I inspector, the results of sampling the DVR discussed above also satisfy the closure of concern (ii) above.
43. The historical Fault Studies assessment (Ref. 9) raised the concern that the availability of at least one trip thermocouple in each [REDACTED] zone should be reflected in the operating philosophy once the performance monitoring system is fitted to the over-temperature trip system. This concern is addressed by the fact that on detection of a single unhealthy safety trip thermocouple, the performance monitoring system will raise an audible and visual alarm.
44. On the trip system itself, two unhealthy safety thermocouples will lead to a [REDACTED] trip. An audible and visual alarm will be raised by the performance monitoring system, with the 'trip' condition being latched until the fault is corrected and a manual reset is performed.
45. Hence the historical Fault Studies concern relating to operator visibility of the trip thermocouple availability is addressed by the installation of the performance monitoring system. Concerns (i) and (ii) have also been closed out as discussed above.
46. From the work conducted by the ONR HF, FS and C&I inspectors, it has been confirmed that all historical ONR concerns, relating to the over-temperature trip system on the [REDACTED] have been adequately addressed by AWE.

4 MATTERS ARISING FROM ONR'S WORK

47. All matters that ONR has raised with AWE, during the conduct of its assessment and inspection work and during previous interactions, have been resolved to ONR's satisfaction and there are no outstanding matters arising other than the following, which will be monitored as part of routine regulatory interactions with the facility:
 - AWE to produce a final ALARP report justifying that the modifications to the [REDACTED] are sufficient to reduce risks ALARP. Closure of Issue 2737 is now dependent only on provision of this final report.
 - AWE to continue the extant programme of work to finalise development of the draft OIs and the draft [REDACTED] run chart, noted in ONR Issue 6529.
 - AWE to continue development of the operator training programme to support implementation of the performance monitoring system modification within the broader [REDACTED] over-temperature trip system.

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4.1 OTHER GOVERNMENT AGENCIES

48. Both the Defence Nuclear Safety Regulator (DNSR) and the Environment Agency (EA) have been consulted regarding ONR's intention to permission the modification described in Ref. 14. The [REDACTED] is out with the considerations of DNSR, and hence DNSR do not consider this modification to fall under their legal remit. EA has confirmed (Ref. 16) that it has no objections to ONR issuing a Licence Instrument, permitting AWE to implement the modification.

5 CONCLUSIONS

49. This report presents the findings of assessment and inspection work, conducted by ONR, of AWE's safety justification to install monitoring panels on the over-temperature trip system of the [REDACTED] at AWE Aldermaston [REDACTED]
50. **Conclusion 1:** The ONR C&I inspector is satisfied that the proposed performance monitoring system modification is adequately conceived, and when implemented, will have no detrimental effect on the reliability and functionality of the existing over-temperature trip system. There are no C&I objections to ONR issuing a Licence Instrument to allow AWE to install the monitoring panels.
51. **Conclusion 2:** The ONR C&I inspector is satisfied that the historical concerns (i) and (ii), as documented in sections 3.1 and 3.5 of this report, have now been adequately addressed by AWE, and hence the C&I actions of Issue 2737 can now be closed out.
52. **Conclusion 3:** The ONR HF inspector is satisfied that the implementation of the Operating Instructions and Operator training program for the performance monitoring system is adequate, subject to finalisation of the OIs and training program etc. (see ONR Issue 6529) as part of AWE's extant program for the installation of the monitoring panels on the over-temperature trip system of the [REDACTED]
53. **Conclusion 4:** The historical HF concerns were related to the absence of detailed OIs. Hence the HF aspects of Issue 2737 can be closed on the basis of the evidence presented by AWE at the recent inspection. There are no HF objections to ONR issuing a Licence Instrument to allow AWE to install the monitoring panels on the over-temperature trip system.
54. **Conclusion 5:** The technical queries for action (Item 5 of Issue 2737) have been adequately addressed from a Fault Studies perspective, and the over-temperature trip system alone will provide adequate protection against over-temperature faults.
55. It should be noted that closure of Issue 2737 is now contingent only on the delivery of a final ALARP paper by AWE. The intention of this paper is to capture the ALARP arguments relating to the modification performed on the [REDACTED] (i.e. the installation of the monitoring panels on the over-temperature trip system of the [REDACTED]), and is not a prerequisite for issue of the LI to permission implementation of the modification.
56. Based upon the totality of the recent and historical assessments and inspections, ONR is satisfied that AWE has produced an adequate safety justification and has an adequate plan in place to perform the modification (i.e. to install monitoring panels on the over-temperature trip system of the [REDACTED]) and to finalise the OIs etc. (ONR Issue 6529 refers). Hence there are no technical or regulatory reasons to prevent ONR agreement being given to AWE's proposal to implement the proposed modification to install the monitoring panels on the over-temperature trip system on the [REDACTED] at AWE Aldermaston.

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6 RECOMMENDATIONS

57. This Project Assessment Report recommends, based upon the totality of the work conducted by ONR inspectors, that permission should be granted to AWE plc via the issue of 'Agreement' Licence Instrument No. 538, to allow AWE to install monitoring panels on the over-temperature trip system of the [REDACTED] at AWE Aldermaston.

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7 REFERENCES

1. AWE Letter, "Condition 22(1) of Schedule 2 of Nuclear Site Licence No. 77 – AWE Aldermaston: [REDACTED] Installation of Monitoring Panels on Over-Temperature Trip System [Red Route Modification (MR20523)]", ONR 202-295 (Dated 19/3/18), TRIM 2018/250629
2. NSC/3594 – "Minutes of Meeting 02/18 of the AWE plc Nuclear Safety Committee, held on 23rd Jan 2018", 2/2/18 (TRIM 2018/46195)
3. "AWE, Asset Change Request form, [REDACTED] Over-Temperature Protection - Provision of Safety Thermocouple Performance Monitoring", ACR-000747, Rev.03, April 2015 (Electronic Copy on REDNET)
4. BS EN 61508:2010, "Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems"
5. Letter from AWE - RESTRICTED - ONR 202-244 - [REDACTED] Additional Information, Design Substantiation of the Over-Temperature Trip" - 13 October 2014 (Draft 1A of A**/AS/SF/549), TRIM 2014/382006.
6. ONR-OFD-AR-18-015 – "Control and Instrumentation Assessment of the Provision of Performance Monitoring for the [REDACTED] Over-Temperature Trip Safety Thermocouples" (TRIM 2018/200378)
7. "Safety Assessment Principles for Nuclear Facilities". 2014 Edition Revision 0. November 2014. <http://www.onr.org.uk/saps/saps2014.pdf>.
8. ONR Technical Assessment Guides:
http://www.onr.org.uk/operational/tech_asst_guides/index.htm
 - NS-TAST-GD-003
 - NS-TAST-GD-094
9. "AWE [REDACTED] - Technical Note Supporting ONR Issue 2737 - AWE Responses to ONR Comments on [REDACTED]" - September 2014 [REDACTED], TRIM 2014/347624
10. "ONR Technical Note. [REDACTED]", May 2014. TRIM 2014/187311 (Folder 4.4.1.1854.).
11. AWE Letter to ONR. ONR202-231 dated 28 July 2014, [REDACTED] [REDACTED] – Responses to TRIM 2014/260290."
12. AWE - ONR-OFD-IR-18-086 – "[REDACTED] Over Temperature Monitoring - Human Factors Inspection" - 10th July 2018, TRIM 2018/229389
13. AWE - OFD - CR-18-068 – "[REDACTED] - Human Factors - Human Factors Discussion" - 30 April 2018, TRIM 2018/148735

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14. "AWE, Pre-Operational Safety Report for the Provision of Performance Monitoring of the [REDACTED] Over-Temperature Trip Safety Thermocouples", A**/AS/SF/662, Issue 3, 28/02/2018, TRIM 2018/115618
15. "AWE [REDACTED] Over Temperature Monitoring" - Human Factors Inspection - 10th July - Draft [REDACTED] Run Chart, TRIM 2018/229879
16. "AWE [REDACTED] Over-Temperature Trip Performance Monitoring" - EA Comments on PAR - Addendum - 30 July 2018, TRIM 2018/247500
17. AWE, Safety Instrumented System A** Facility – "[REDACTED] Over-Temperature Trip Design Verification Report", A**/AS/SF/549, Issue 2, Jan 2018, TRIM Ref. 2018/115615
18. EDMS3/802ABB6B/SL002/037, NSC/3628, SGM095 – "Site Governance Meeting – Record of Meeting (Held 14th Feb 2018)," (TRIM 2018/267045)

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APPENDIX 1 – Chronology of the [REDACTED] Temperature Monitoring System Project

Early 2010 - AWE identified a shortfall against deterministic requirements with respect to over-temperature faults in the [REDACTED]

AWE undertook optioneering and implemented both engineered measures and operator actions to rectify the shortfall. ONR¹ took an interest in AWE's modification (see TRIM 2010/270326) and reviewed relevant documentation. A fuller description of AWE's optioneering and ONR's views can be found at TRIM 2010/335320.

In response to the shortfalls, AWE implemented:

- A engineered redundant hardwired temperature trip (providing protection across the operating range of the [REDACTED] but allowing only a limited claim to be made in the safety case, due to the lack of diversity)
- An engineered redundant hardwired [REDACTED] trip (having some diversity with respect to the temperature trip [REDACTED])
- An operator trip [REDACTED].
- [REDACTED]
- An operator trip [REDACTED]

July 2010 - ONR indicated concerns with AWE's proposed safety improvements and discussed its concerns with AWE at a meeting (TRIM 2010/297458, 2010/298910) i.e. that AWE intended to return the [REDACTED] to service with the identified shortfalls. ONR considered that the engineered safety systems fell short of the requirements, based upon the fault frequency and consequence and that an adequate As Low as Reasonably Practicable (ALARP) justification had not been made.

There was significant engagement with AWE throughout 2010 (TRIM 2010/297262, 2010/355476, 2010/333753). Letters were also sent to AWE explaining ONR's position and its expectations for an adequate safety justification for an engineered solution to the identified [REDACTED] shortfalls (TRIM 2010/295214 and 2010/448619).

January 2011 - (TRIM 2011/37727), AWE's optioneering process (i.e. to consider options allowing two engineered systems to be claimed, in all regions of the [REDACTED] operations where there could be [REDACTED] under fault conditions) was complete. AWE intended to provide [REDACTED] monitoring and enhanced thermocouple monitoring (although assurances were provided that a long-term modern standards engineered solution was still being sought).

March 2011 - AWE presented its final design (TRIM 2011/0139622). The [REDACTED] was operating with engineered trips on high temperature [REDACTED], with an operator initiated trip [REDACTED]. However, in order to return to [REDACTED], AWE proposed to provide (in order to make up the presently identified shortfall):-

- The use of two or more thermocouples in a safety role (these would use diverse trip amplifiers, relay and contactor allowing an increased claim to be made on the temperature protection, providing protection across the full operating range).

¹ NB – 'ONR' used throughout to signify both the current ONR and the historical Nuclear Installations Inspectorate - 'NII'

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[REDACTED]

Additionally, AWE intended to retain an operator trip [REDACTED] and to reinstate an earlier operator trip [REDACTED].

ONR Fault Studies engagements with AWE in early 2011 (TRIM 2011/193720 and 2011/212198) accepted that AWE's March 2011 Hazard and Operability (HAZOP II) studies for the [REDACTED] gave a comprehensive and detailed analysis of the faults and hazards but advised that the potential for further improvements and ALARP justification needed to be robust.

April 2011 - A letter to AWE (TRIM 2011/211956) summarised ONR's position i.e. ONR supported the engineering enhancements programmed but did not consider them to provide an adequate standard of engineered safeguards for unlimited operation of the [REDACTED]. Before the [REDACTED] was returned to service ONR wished to be content that this was supported by a robust substantiation that the risks from its operation would be ALARP until long-term improvements could be attained.

Technical engagements with AWE continued in 2011 (TRIM 2011/336190, 2011/411504, 2011/488692, 2011/653580, 2011/522138 and 2011/504352) with ONR focus being on exploring AWE's ALARP justification for the re-start of [REDACTED] operations. ONR's view was that a safety system based upon temperature should be engineered to Class 1. In order to achieve Class 1, ONR's advice was that standard BS EN 61508:2010 should be met (in respect of the hardware fault tolerance for the temperature trip contactors). ONR also considered that AWE should provide a read out of the trip parameter.

September 2011 - A revised AWE ALARP justification report was issued in September 2011 and ONR concluded (TRIM 2011/504535 and 2011/502057) that improvements to the [REDACTED] had been made; ensuring the risks to [REDACTED] operators and building workers were tolerable. However, a robust ALARP argument was still required, as additional available engineered options had not been fully examined by AWE.

November 2011, ONR permitted the [REDACTED] to return to service (TRIM 2011/566764); this was predicated on AWE demonstrating adequate progress with developing potential future enhancements. ONR did not consider that a fully robust ALARP substantiation had been provided. Monthly progress meetings were held with AWE to update ONR on progress with additional optioneering, the ALARP case and other potential improvements (TRIM 2011/655754 and 2012/16594).

August 2013 onwards - At a presentation to ONR (TRIM 2013/313641), AWE concluded that, *'installation of a monitoring system, for the status of the over-temperature trip, was practicable and meets Relevant Good Practice (RGP), but offers no quantifiable risk reduction and its cost was grossly disproportionate to the benefit.'* ONR's view (TRIM 2013/358706) was that the main emphasis within the ALARP should be to improve the Class 1 safety measure using monitoring, display and recording of the protection system thermocouple outputs and that the HF aspects of monitoring the thermocouple outputs would also need to be addressed. Discussion continued (TRIM 2013/345368 and 2013/363653) during which it was stressed that AWE's lack of commitment to thermocouple monitoring was an area of sensitivity to ONR.

Early 2014 - ONR undertook a safety review of the [REDACTED] (TRIM 2014/31405 and 2014/47731) to assess its ALARP adequacy for operations until a [REDACTED] could be made available. ONR's assessment included technical consideration of the substantiation of the

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installed over-temperature trip, as well as the means of monitoring the condition of the over-temperature system. ONR's assessment comments are summarised at TRIM 2014/96575.

March 2014 - Feedback was provided to AWE (TRIM 2014/135180 and 2014/119794) that the extent of the substantiation relating to C&I aspects of the over-temperature protection system potentially fell short of ONR's expectations, and that a high level of compliance with RGP was expected for the over-temperature trip system. Engagements with AWE continued during 2014 (TRIM 2014/177557, 2014/187311, 2014/208398 and 2014/0270169) to monitor AWE's progress with further modifications to the protection system.

July 2014, AWE was commencing:-

- A review of the over-temperature trip engineering substantiation,
- A Category B modification to the trip system, to replace existing trip amplifiers and to install trial thermocouple monitoring equipment.

An ONR Regulatory Issue 2737 (which is still extant) was placed, to track AWE's progress against this next phase of work. Issue 2737 recorded that ONR's position is that the [REDACTED] as currently implemented was not adequately supported by engineering substantiation assessment and did not incorporate all reasonably practicable risk controls when considered against RGP.

September 2014 - Ongoing dialogue with AWE continued with the ONR Fault Studies inspector being able to record in September 2014 (TRIM 2014/347235) that the technical queries for Issue 2737 had been adequately addressed (FS Technical Note at TRIM 2014/347624).

October 2014 - AWE provided ONR with the Design Verification Report for the over-temperature trip system (TRIM 2014/382006)

February 2015, - AWE wrote to ONR (TRIM 2015/52313) committing AWE to two additional actions during the planned thermocouple monitoring trials on the [REDACTED] i.e.

- To undertake [REDACTED] system testing to provide a level of data relating to normal thermocouple behaviour during a run.
- As the trials progress, to undertake real time monitoring of the output from the monitoring equipment installed to monitor the safety thermocouples and to provide comparison with the process control thermocouple outputs.

2015 onwards - ONR continued to monitor AWE's progress with its trials work e.g. TRIM 2015/62465 and 2015/159677. AWE informed ONR that diverse trip amplifiers would not be installed for these trials.

Late 2016 / early 2017 - Subsequent ONR engagement with AWE regarding the progress of the [REDACTED] temperature trip system has taken place recently.

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