Magnox Swarf Storage Silo – Risk and Hazard Reduction Programme

Agreement to the implementation of pressurised inerting to manage excursion hydrogen within the Magnox Swarf Storage Silo

Project Assessment Report ONR-SDFW-PAR-17-005
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EXECUTIVE SUMMARY

Agreement to the implementation of pressurised inerting to manage excursion hydrogen within the Magnox Swarf Storage Silo

Permission Requested
Sellafield Limited (SL) has requested the Office for Nuclear Regulation's (ONR) agreement to commence the implementation of pressurised inerting (PI) in the Magnox Swarf Storage Silo (MSSS), in accordance with its arrangements made under licence condition 22.

Background
MSSS is a legacy facility on the Sellafield site that was built in the 1960s for the underwater storage of fuel cladding arising from decanning of Magnox fuel elements. The facility comprises 22 vertical concrete silos, partially below ground level, that were in active use between 1964 and 1991. The ageing silo compartments contain a large inventory of radioactive waste (a mixture of intermediate level solid and liquid waste and miscellaneous beta gamma waste). The MSSS facility represents one of the highest nuclear hazards in the United Kingdom.

Recent assessment carried out by ONR concluded that the risk posed by MSSS is intolerable and continues to increase with time as the building structure ages. Safe and timely retrieval of radioactive waste from MSSS is a national priority and must be dealt with promptly. ONR's regulatory strategy is focussed on ensuring that SL progresses its radioactive waste retrievals and subsequent decommissioning as quickly as is safely practicable, whilst maintaining continued safe storage of the radioactive waste inventory within MSSS.

The underwater storage of radioactive waste within MSSS gives rise to the continuous chronic generation of hydrogen. This is primarily due to Magnox metal corrosion and requires continuous management and control to avoid hydrogen build-ups that could lead to formation of flammable atmospheres. The MSSS ventilation systems are essential to support hydrogen management prior to and during retrieval operations.

SL has recently improved the fault tolerance of the ventilation systems by installing quiescent passive vents (QPV) on each compartment and implementing them into the safety case. ONR permissioned this activity, issuing a Licence Instrument (LI 909) in 2016.

SL has identified a number of challenges with the current inerting system resulting in part from degraded plant conditions in this ageing facility. Following an optioneering study, the licensee decided that implementation of a pressurised inerting scheme would provide the safest reasonably practicable option to improve control over hydrogen excursions. SL claims that implementing the scheme promptly in 2017, utilising existing equipment (Phase 1) followed by further improvements aligned with the retrievals ventilation project (Phase 2), provides the biggest overall risk reduction. ONR will undertake a targeted assessment of Phase 2 when suitable detail is available.

The implementation of PI as the principal hazard management strategy represents a significant change and improvement for the management of hydrogen excursions. The licensee has categorised this change in accordance with its procedures as Category A (the most safety significant). This is based on potentially significant radiological consequences to workers and off-site associated with a hydrogen deflagration in any compartment following loss of hydrogen management during an excursion in the facility. This permission is associated with the implementation of the proposed system of PI (Phase 1) to replace the existing inerting system.

Assessment and inspection work carried out by ONR in consideration of this request
Given the safety significance of this proposal and the potential for significant worker and off-site radiological doses from a failure to manage hydrogen safely, ONR carried out a programme of work to consider the activities proposed by SL, and to judge whether SL's proposal minimises risks so far as is reasonably practicable (SFAIRP). Focussing on management of the risks from the key hazards, I sought advice from specialist ONR inspectors in the following areas; chemical engineering, internal hazards, fault studies, human factors, radiological protection and mechanical engineering.

ONR also undertook a readiness inspection to inform the permissioning decision. The purpose of the inspection was to gain regulatory confidence that SL was in a state of readiness to safely implement PI.

Matters arising from ONR's work
The specialist assessments raised a number of recommendations; however, all the specialist inspectors have advised that they have no objections to SL's proposal and recommend that ONR issues the Licence Instrument. The recommendations are not judged to be significant to safety and considered reasonably practicable for SL to address during or after implementation of PI (Phase 1) as appropriate. They have been included in ONR's regulatory issues database to ensure appropriate regulatory oversight and timely follow up.

Conclusions
Based on the evidence sampled, the outcome of several specialist inspector assessments, a readiness inspection and a number of engagements with the licensee, I consider that SL has provided an adequate safety justification that the change to PI (Phase 1) reduces risks so far as is reasonably practicable in the facility and that this can be implemented safely.

Phase 1 of PI allows an immediate risk reduction from a hydrogen excursion hazard. I note that SL has undertaken an optioneering study to identify additional engineered improvements to the PI system. These will be implemented in Phase 2. The additional risk reduction that will be possible in Phase 2 relies on the changes to the retrievals ventilation project that is part of the overall hazard and risk reduction. This will require significant plant modifications that are integrated to the overall hazard and risk reduction programme. ONR will assess and as appropriate, permission Phase 2 when suitable detail is available.

Recommendation
I recommend that agreement (Licence Instrument 504) is issued to commence the implementation of Pressurised Inerting in the Magnox Swarf Storage Silo.

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
DAP	Duly Authorised Persons
EA	Environment Agency
HF	Human Factors
IGVEP	Inert Gas Ventilation and Extract Plant
INSA	Independent Nuclear Safety Assessment
LI	Licence Instrument
MSSS	Magnox Swarf Storage Silo
NSC	Nuclear Safety Committee
ONR	Office for Nuclear Regulation
PI	Pressurised Inerting
PMP	Plant Modification Proposal
QPV	Quiescent Passive Vent
SFAIRP	So Far As Is Reasonably Practicable
SL	Sellafield Limited

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1 PERMISSION REQUESTED

1. The Licensee requested (REF 1) Office for Nuclear Regulation's (ONR) agreement via its arrangements made under Licence Condition 22 to commence steps B1 to B4 (relating to pressurised inerting) as described under section 2 of the plant modification proposal for "The introduction of Quiescent Passive Ventilation and Pressurised Inerting to manage Chronic and Excursion hydrogen challenges within MSSS". (REF 2).

2. Steps B1 to B4 of the plant modification include:

   - Modify and inactively commission the changes required to the inerting control electrical & instrumentation systems to align with the Instrument Process Data Sheets for Pressurised Inerting.
   - Carry out a Pressurised inerting proof / functional test on Block B[1] equipment.
   - Carry out a Pressurised inerting proof / functional test on Block A equipment.
   - Implement the Pressurised Inerting Safety Case - Controlled via the Safety Case Implementation Plan and electrically disconnect the existing fans for depressurised inerting.

2 BACKGROUND

3. The Magnox Swarf Storage Silo (MSSS) is a legacy facility on the Sellafield site that was built in the 1960s for the underwater storage of fuel cladding arising from decanning of Magnox fuel elements. The original building was built with six compartments, but has been extended three times (named 1st, 2nd and 3rd extensions), adding additional capacity and facilities. The facility now comprises twenty-two vertical concrete silos, partially below ground level, that were in active use between 1964 and 1991. The ageing silo compartments contain a large inventory of radioactive waste (a mixture of intermediate level solid and liquid waste and miscellaneous beta gamma waste). MSSS represents one of the highest nuclear hazards in the United Kingdom.

4. Recent assessment (REF 3) carried out by ONR concluded that the risk posed by MSSS is intolerable and continues to increase with time as the building structure ages. The risk continues to increase with time as the building structure ages. Safe and timely retrieval of radioactive waste from MSSS is a national priority and that must be dealt with promptly. ONR's regulatory strategy is focussed on ensuring that Sellafield Limited (SL) progresses retrievals and subsequent decommissioning as quickly as is safely practicable, whilst maintaining continued safe storage of the radioactive waste inventory within MSSS. SL is proposing a series of modifications to support retrievals and decommissioning (REF 4) and these are subject to targeted ONR permissioning.

5. The underwater storage of radioactive waste within MSSS gives rise to the continuous chronic hydrogen generation. This is primarily due to Magnox metal corrosion and to a much lesser extent radiolysis of water. The hydrogen generated requires continuous management and control to avoid build-ups that could lead to flammable atmospheres being formed that may then be ignited.

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[1] The Magnox swarf waste in the original building has mostly corroded to sludge and the existing safety case justifies that inerting is not required. The eight compartments in the 1st and 2nd extensions are connected as Block A for inerting purposes and the eight compartments of the 3rd extension comprise Block B. This allows inerting to be applied to the affected compartment and adjacent compartments without the need to inert all 22 compartments.

6. The MSSS ventilation systems are essential to support hydrogen management prior to and during retrieval operations. SL has recently improved the fault tolerance of the ventilation systems by installing quiescent passive vents (QPV) on each compartment and implementing them into the safety case as described in Section A of the Plant Modification Proposal (PMP) (REF 2). ONR permissioned this activity, issuing a Licence Instrument (LI 909) in 2016 as recommended in ONR's project assessment report (REF 5). This significantly reduces risks from chronic hydrogen during normal quiescent storage.

7. Whilst quiescent chronic hydrogen generation in MSSS arises primarily due to Magnox corrosion, there are also transient contributions from operation of compartment coolers. Total generation rates from all sources are typically at levels that can be easily diluted in the air-based ventilation system, as installed, or the passive vents (REF 6). However, elevated excursion hydrogen generation has previously occurred in the original building and first extension. These historic excursions have given rise to peak compartment hydrogen generation rates of up to two orders of magnitude greater than the quiescent chronic generation rate; the last such excursion was in 1980 (REF 6).

8. The excursion risk in the 2nd and 3rd Extensions, whilst higher than the 1st Extension due to the greater quantities of uncorroded Magnox present, is still low. These Extensions have never had an excursion, and though the compartments are fitted with coolers to reduce the temperature should this be required, the temperatures are such that they have not needed to be operated for a number of years. This indicates to SL that evaporative cooling alone is sufficient to maintain waste bed temperatures below relevant thresholds. (REF 6).

9. Whilst SL maintains that the risk of an excursion is low, it cannot be discounted, hence, it has an excursion management strategy that currently consists of (REF 7):

- Cool the waste (by operation of the plants active cooling systems) should the average waste bed temperatures exceed a pre-defined limit as indicated by the temperature monitoring system.

- Reconfigure the ventilation system (using the Inert Gas Ventilation and Extract Plant (IGVEP)) and invoke the transition to inerting of the affected compartments should a pre-defined hydrogen concentration be detected by the hydrogen monitoring system in the ventilation extract.

10. SL has identified a number of challenges with the current system resulting in part from degraded plant conditions in this ageing facility (REF 7);

- The IGVEP Control Room requires refurbishment.

- The cryogenic nitrogen generation plant cannot be economically refurbished and has been unavailable for many years[2]. The current substitution arrangement relies on liquid nitrogen stored in tanks with tanker deliveries needed (during an excursion) at a frequency that would be challenging over a few months.

- The current nitrogen delivery systems are in need of refurbishment

- The IGVEP fans and control system require refurbishment.

[2] ONR has previously undertaken enforcement against SL to remove the risk from MSSS and has a published regulatory strategy "to help drive improvements at Sellafield, aiming to facilitate and encourage hazard and risk remediation whilst maintaining adequate safety standards". Details can be found at http://www.onr.org.uk/sellafield-strategy.htm

11. In addition, SL considers (REF 7) that operationally it is a complex and challenging process to safely manage the transition from air based extract ventilation to a fully inerted environment via a balanced depressional system. Once transitioned, maintaining the inert environment requires balancing of the nitrogen supply rate and the IGVEP extract rate. The balancing of these two systems is known to be difficult, usually requiring manual intervention. As a result, maintaining an inerted environment for up to three months (as would be required to manage an excursion) is demanding and has not been robustly demonstrated as part of the plant's inerting proof tests to date.

12. This poses a risk that whilst trying to maintain a balanced depressional inerted atmosphere, there is the potential to adversely affect air in-leakage rates. In turn, this could undermine the safety function of the inerting response i.e. maintaining the oxygen concentration in the system at the low level required.(REF 7)

13. In recognition of the importance of maintaining the inert environment in the system during excursion management, the oxygen monitoring system on detection of oxygen concentrations at 4% will initiate a trip of the extract system fans (IGVEP). The system will then pressurise at this point as the incoming nitrogen feed remains on. This feature provides a back-up default position in order to protect the primary hazard management concern of preventing a hydrogen deflagration, whilst accepting the secondary impacts of hydrogen, nitrogen and activity migration via inherent leak paths in the concrete containment.

14. Following an optioneering study (REF 21), SL decided that implementation of a pressurised inerting (PI) scheme would provide the safest reasonably practicable option. SL identified that implementing the scheme promptly in 2017, utilising existing equipment (Phase 1), followed by further improvements aligned with the retrievals ventilation project (Phase 2), provides the largest risk reduction for the facility when balancing the benefits of the PI project with progressing the overall hazard and risk reduction programme.

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

15. The implementation of PI as the principal hazard management strategy represents a significant change and improvement for the management of excursions. The licensee has categorised this change in accordance with their procedures as Category A (the most safety significant). This is based on the potentially significant radiological consequences to workers and off-site associated with a hydrogen deflagration in any compartment following loss of hydrogen management during an excursion in the facility.

16. Given the safety significance of this proposal and the potential for significant worker and off-site radiological doses from a failure to manage hydrogen safely, ONR carried out a programme of work to consider the activities proposed by SL and to judge whether the licensee's proposal minimises risks so far as is reasonably practicable (SFAIRP). I targeted the assessment on gaining regulatory confidence in the licensee's safety justification for the control of the most significant hazards and associated risks.

17. From my knowledge, discussions with ONR specialist inspectors (particularly chemical engineering) and intelligence from SL's proposal, I have identified that the key success criteria for preventing the consequences from a hydrogen deflagration in a compartment during an excursion are:

- To minimise the risk of an excursion by temperature management in the compartments;

- To identify the onset of an excursion event;

- To successfully reduce the oxygen levels within the compartment block affected to less than the limiting oxygen concentration (i.e. a concentration at which hydrogen cannot combust regardless of its concentration);

- To maintain the oxygen levels within the compartment block affected to less than the limiting oxygen concentration for as long as necessary for the excursion to stop. The ability to control and manage the nitrogen inerting is a key focus as this is a significant shortfall in the current inerting system.

18. There are also secondary hazards associated with a PI response identified by SL, with which I concur, that must be safely managed, namely:

    - Hydrogen management in the cavities around the primary and secondary containment;

    - Hydrogen management on the operations floor - there is a risk of the flammable gas igniting resulting in a hydrogen flame;

    - Asphyxiant hazard management on the operating floor;

    - Operating floor contamination and recovery. –Following successful management of an excursion, with personnel excluded from the operations floor and the building's weatherproof cladding offering adequate protection to the local environment, there would be no significant radiological hazards to the workforce or public. However, the need to decontaminate the operating floor following successful management of an excursion and a return to normal ventilation configuration, could impact on the hazard and risk reduction programme on this legacy facility and thus subject the public to extended risk if not managed.

19. In addition to the hazards identified above, the tasks during implementation of PI are intensive regarding demands placed upon operators and the control and supervision by duly authorised persons (DAP). From advice provided by human factors (HF) specialist inspectors, I judged this area needed to be targeted.

20. Targeting the assessment on management of the risks from the key nuclear safety hazards, I sought advice from specialist ONR inspectors in the following areas; chemical engineering, internal hazards, fault studies, human factors, radiological protection and mechanical engineering. .

21. ONR also undertook a review of SL's readiness to commence the implementation phase for PI. The readiness inspection was supported by chemical engineering and human factor specialist inspectors. The primary focus was to inspect people, plant and process to gain regulatory confidence that SL was in a state of readiness to safely implement PI, given the intended implementation timescales.

22. Conventional hazards are not included in ONR nuclear safety permissions, as they are subject to other legislation. However, as this is a key risk to plant personnel, SL's management of this hazard was considered as part of both the readiness inspection and the human factors assessment.

4 MATTERS ARISING FROM ONR'S WORK

23. I sought specialist inspector advice on SL's proposal and they have made the following conclusions and recommendations:

24. The chemical engineering specialist inspector assessed (REF 8) SL's submission, specifically focusing on

- Waste bed temperature management
- Oxygen and hydrogen analyser performance
- Pressure instrumentation
- Nitrogen flowrate Control
- Hydrogen release
- Key benefits.

25. The inspector determined that the licensee has adequate safety systems available to implement a waste cooling strategy in MSSS, providing mitigation against a temperature rise and hence a hydrogen excursion. The inspector is satisfied that the oxygen, hydrogen, pressure and nitrogen instrumentation and equipment are adequate to deliver their safety functions. The excursion hydrogen design basis and calculation for determining hydrogen evolution on the operations floor are also concluded as adequate.

26. The inspector raised the following recommendations:

- **Recommendation 1:** The chemical engineering Inspector is to perform a readiness review in support of the commissioning of the PI system. The focus of the review is to include as a minimum:-
  - Operational status of the coolers
  - QPV and other penetration sealing arrangements
  - Pressure, oxygen and hydrogen instrumentation
  - Nitrogen flowrate control
  - Exclusion of personnel.
- **Recommendation 2:** The licensee is to consider whether the liquid nitrogen re-order stock level is to be modified during the continuous phase, based on actual usage rates, to ensure three days' supply is available.
- **Recommendation 3:** The licensee is to consider performing further cavity leak measurements, on a regular basis, for the 1st, 2nd and 3rd Extensions, in order to confirm that there is no further degradation in the seals and building fabric between the ullage and the cavities. This is to be provided before final implementation of PI (Phase 1).
- **Recommendation 4:** The licensee is to determine the consequences of a hydrogen deflagration in the cavity and the consequences of failure to provide ventilation to the cavities and identify suitable mitigation measures. Firstly if the fans are not operational during the initial transition period (as stated within the safety case, passive vent could be in operation) and secondly if the fans fail at any point during the 90 days (noting they are on a two hour guaranteed

interruptible supply). This is to be provided before final implementation of PI (Phase 1).

- **Recommendation 5:** The licensee is to review the Hazardous Area Zoning Assessment against the requirements of the Dangerous Substances and Explosive Atmospheres Regulations, Regulation 7. This review is to be provided before final implementation of Pressurised Inerting.

27. Recommendations 2, 3, 4 and 5 have been placed on the ONR's regulatory issues database as a single level 4 issue (Issue 5440). Recommendation 3 was closed out (REF 28). Recommendation 1 was addressed during the readiness inspection and subsequently closed out by the chemical engineering specialist inspector (REF 22). SL is expected to close out the remaining recommendations prior to final implementation on PI (Phase 1). ONR will monitor this via our Regulatory Issues process. The inspector judged that the safety significance of the recommendations does not prevent issue of the licence instrument.

28. Overall the inspector is satisfied with the claims, arguments and evidence presented within the Licensee's safety case and recommends that ONR issues the Licence Instrument. The inspector concludes that the licensee has provided adequate evidence to justify the safety case for PI Phase 1, and that the benefits from modifying the excursion response from depressional inerting to pressurised inerting, outweigh the small residual risks identified with the assessment shortfalls.

29. The fault studies specialist inspector has assessed (REF 9) the hydrogen excursion hazards and faults associated with operation of SL's PI system against ONR's standards and expectations.

30. The inspector raised a number of areas where some shortfall was judged against regulatory expectations.

31. The inspector is of the opinion that SL had not adequately demonstrated proactive cooling operations in all of the MSSS extensions in advance of its request to implement the PI (Phase 1) system (the Mark III and Mark IV coolers are not yet substantiated). However, the assessment notes that although the provision of cooling gives increased confidence that an excursion event is unlikely to occur, failure of the coolers cannot directly initiate an excursion event.

32. ONR is already regulating a fault studies issue from the long term periodic review at MSSS entitled "*SL should implement the silo cooling systems re-commissioning project as soon as possible to reduce the chronic hydrogen evolution rates*" (REF 29). In addition, I have received assurance from SL that, as the coolers are only required if the temperatures exceed a threshold and the onset of this is very slow, cooling could be reinstated at 30-day notice as required by the existing safety case (REF 23). Therefore, although the inspector considers this a shortfall against expectations, it is mitigated by the availability of the coolers as a key leg of SL's current safety case.

33. The inspector raised a concern that various components, which contribute to the PI (Phase 1) safety function, are connected to the 'guaranteed interruptible power supply'. These components include the forced extract fans and motorised valves in some of the nitrogen supply lines. SL claims this power supply can always be restored within two hours following a fault and has updated its relevant emergency arrangements (REF 24) to include a mobile diesel alternator to be delivered to MSSS with the purpose of backing up the guaranteed interruptible power supply with minimal delay. This has addressed the concern for PI. However, the inspector recommends that ONR considers the electrical supply in MSSS further and a wider-scoped recommendation:

- **Recommendation 1:** ONR to undertake a fault studies initiative to consider the adequacy of SL's electrical supplies to meet the overall safety case requirements for the MSSS facility.

34. ONR has an ongoing site-wide initiative (REF 25) to examine SL's electrical supply and its safety functional requirements. MSSS has been included in the scope of this work (REF 28), which will ensure suitably targeted prioritisation of regulatory attention.

35. The internal hazards specialist inspector focussed assessment on the potential consequences of a hydrogen fire and/or deflagration on structures, systems and components (SSC) situated on the Operations Floor, which are required for maintaining nuclear safety, including safe control of the excursion hydrogen design basis. The inspector is satisfied that licensee has adequately considered and identified suitable measures to control the risks and consequences associated with the accumulation of hydrogen onto the Operations Floor during PI operations.

36. The inspector judged that the licensee has provided adequate evidence to justify the implementation of Phase 1 of PI, and considers that the benefits from modifying the excursion response from depressional inerting to PI (i.e. utilises less nitrogen, controlling oxygen in the compartments to ensure a flammable mixture cannot form) outweigh the risks (i.e. hydrogen management in the cavities and Operations Floor, asphyxiant hazard management of nitrogen on the Operations Floor and Operations Floor contamination and recovery), and recommends that ONR issues the Licence Instrument.

37. The inspector also made a recommendation the SL reviews the Hazardous Area Zoning assessment against the requirements of the Dangerous Substances and Explosive Atmospheres Regulations, Regulation 7, prior to PI Phase 1 implementation. This is a duplicate of the recommendation raised by the chemical engineering specialist inspector (above) and is covered in regulatory issue 5440.

38. The mechanical engineering specialist inspector has assessed (REF 10) SL's submission. The inspector is satisfied for this modification to proceed on the basis that SL has given a commitment to perform "inspection of areas of potential weakness [of the ventilation ductwork]". The inspector has raised a regulatory issue (Issue 5375) to track SL's close out of the inspections that are identified as a compliance issue. The inspections affect the current provision for inerting and, whilst required, do not alter the benefits of implementation of PI (Phase 1).

39. The human factors specialist inspector has assessed (REF 11) SL's submission focusing on how:

    - Safety significant claims have been substantiated as achievable and feasible through suitable and sufficient assessment.

    - Management of asphyxiation hazard associated with the use of nitrogen for PI.

40. To gain regulatory confidence in SL's claims, the inspector has considered its arrangements for ensuring that:

    - Operators and supervisors are suitably trained in the new PI response;

    - Written instructions are suitable to support their tasks;

    - Activities to transition to PI can be achieved within the required timescales;

    - Asphyxiation hazard is suitably managed;

- Legacy MSSS control rooms and equipment are suitable to support PI.

41. The inspector is satisfied that the licensee has focussed its HF resource on the assessment of safety significant tasks and has taken a structured and systematic approach to the substantiation of claims on the operator, as well as considering credible errors and how they are guarded against. This is in line with ONR's expectations.

42. The inspector also found that there has been appropriate HF input to the development of written instructions. These are considered to be broadly suitable to support the tasks undertaken, both as part of the transition to / from PI and when controlling personnel access during inerting operations.

43. However, the inspector required SL to provide further evidence to demonstrate the ability of operators to transition to PI within the claimed 12 hour timescale; a key claim to manage the hazard. SL subsequently undertook further HF analysis and has provided a technically underpinned timeline which demonstrates the transition can be completed within 10 hours.

44. ONR is satisfied that SL has applied the Systematic Approach to Training (SAT) and provided PI specific training to DAPs. However, at the time of the assessment and inspection, SL was unable to provide evidence of suitable training material for all operators, competency assessment criteria or the extent of training implementation required to support PI implementation. Following issue of a Licence Instrument for PI, there will be approximately one month before full PI implementation on MSSS. This will allow SL to reconfigure the existing plant, make the required equipment modifications and improve the maturity of the training roll-out. SL has committed to completing its PI training and competence assurance activities during this window. Based on this and the evidence assessed to date, the inspector is content that competency assurance is suitable and meets ONR expectations. An action was raised on SL to provide evidence via the internal regulator (see below).

45. Overall, the HF specialist inspector considers that SL has undertaken a suitably structured and targeted assessment of the HF aspects of the PI safety case, and has adequately substantiated the safety claims made on the operator. On the basis that the recommendations (below) are adequately addressed during implementation, the inspector is content that SL's human factors analyses supports the requirements to implement PI (Phase 1) and recommends issue of the Licence Instrument.

46. The inspector raised one recommendation that has been incorporated in ONR's regulatory issues database (Issue 5477) to track completion during the implementation of PI (phase1):

47. **Recommendation 1:** SL's internal regulator to confirm successful completion and close out of the following prior to final implementation of PI (Phase 1):

- HF recommendations and outstanding actions identified in SL's Human Factors Assessment Report.

- Intermediary planned modification of the alarm panels and instrumentation in the IGVEP control room to ensure it is fit-for-purpose for implementation of PI (phase 1).

- Completion of competency assurance arrangements for all key staff associated with MSSS PI (including operators).

48. The specialist radiation protection inspector has assessed (REF 12) SL's submission. This focussed on the direct radiological consequences (to workers and members of the public) associated with the implementation of PI (Phase 1), and the potential for such implementation to result in contamination levels within the building. The latter could have an adverse impact on planned hazard and risk reduction activities within MSSS.

49. The inspector is satisfied that the radiological risks to both workers and members of the public have been reduced to ALARP. The RP inspector also judges that the risks arising from the potential delay to future hazard and risk reduction activities due to contamination of the operations floor should PI be needed, are unlikely to be significant, compared to the risk posed by delays from any requirement to consider, design and implement any alternative strategy to manage hydrogen excursions. The inspector has no objection for SL to implement PI from radiological protection considerations and supports issue of the Licence Instrument

50. I have reviewed the recommendations and discussed the proposed impact of these on the issuing of a Licence Instrument with the specialist inspectors. All the inspectors conclude that the LI should be issued and consider that their recommendations can be completed either during or after implementation of PI (Phase 1), without detriment to the safety case. The recommendations have all been added to ONR's regulatory issues database (issues 5440, 5477, and 5375) to ensure regulatory oversight of satisfactory and timely close out by SL. None of the inspectors recommended that further specific regulatory hold points should be added to prevent the licensee continuing. This does not prevent ONR from taking enforcement to halt implementation should a future need arise.

51. On 18 May 2017, ONR undertook a readiness inspection (REF 13). This inspection was supported by chemical engineering and human factors specialist inspectors and focussed on a number of key areas such as; the adequacy of training and competence, command and control, adequacy of instructions, substantiation of the ability to implement in the required time, plant control room, identification of hazardous areas and associated risk assessments.

52. We noted that training was developed but only two DAPs (out of the thirteen planned prior to PI implementation) had been through the process at the time of the inspection. SL acknowledged that it needs to complete its specified programme of work, including supervisor and operator training. Additionally, the inspection identified a number of lessor safety significant actions for SL to provide additional information/evidence to support its safety case. These have been considered in closeout of the assessments and incorporated into the recommendations where full close out was not possible.

53. With regard to the intended implementation timeline, SL has identified (REF 14) that approximately one month is required for implementation work to modify let-down stations, compartment pressure switches and oxygen analysers, followed by proof and functional testing of equipment. SL will then carry out an internal readiness review prior to full PI implementation. This provides SL with time to complete training and outstanding actions. ONR will retain oversight of this via our regulatory issues process.

54. Based on the inspection and the timeline for implementation, I judged that the people, process and plant for the proposed modification are adequate, or that suitable arrangements will be implemented to assure this. No significant shortfalls were identified that would prevent permission being granted for SL to commence the modification

55. I have also gained confidence from SL's own internal governance process. SL has confirmed that the project is subject to independent internal review by the SL Internal

Regulator (REF 15). This also includes internal readiness inspections programmed before the modification work commences and prior to implementation of the safety case.

56. SL's proposal and supporting documents have been subject to its due process including Independent Nuclear Safety Assessment (INSA) (REF 17) and consideration by the Nuclear Safety Committee (NSC) (REF 16). This included considerable challenge on the proposed approach prior to acceptance. I therefore judge that SL's proposal has been subjected to an adequate level of internal challenge and governance.

57. In accordance with the ONR/Environment Agency (EA) Memorandum of Understanding, I have consulted with the EA inspector whether he had any objections on environmental grounds to ONR agreeing to implementation of the activities requested. The EA inspector has confirmed that EA has no objection (REF 18). Similarly the Civil Nuclear Security inspector has indicated that he has no objection (REF 19).

5 CONCLUSIONS

58. ONR has carried out a programme work to confirm that the modifications proposed by SL minimise the risks SFAIRP. This included:

- Undertaking targeted specialist assessment of SL's proposal.
- Identifying regulatory issues (Issue ID 5440, 5477, and 5375) to ensure the outstanding recommendations are adequately progressed in a timely manner.
- Undertaking a review of SL's readiness to implement PI
- Gaining confirmation that SL's proposal and supporting documents have been subject to SL's due process (Internal Regulator, NSC & INSA)
- Discussing SL's proposal with the EA and Civil Nuclear Security. Both have stated they have no objection to the issue of an LI.

59. Based on the evidence sampled, I am satisfied with the claims, arguments and evidence laid down within the PMP and supporting safety case documentation. I consider the change to PI (Phase 1) reduces risks SFAIRP in the facility. I note that SL has undertaken an optioneering study and identified additional engineered improvements to the PI system which will further reduce risk. Phase 1of PI allows an immediate risk reduction from a hydrogen excursion hazard. The additional risk reduction that will be possible in Phase 2 relies on changes to the retrievals ventilation project that is part of the overall hazard and risk reduction programme for MSSS. This will require significant plant modifications that are integrated to the overall hazard and risk reduction programme. ONR will assess Phase 2 when suitable detail is available.

6 RECOMMENDATIONS

60. I recommend that agreement (Licence Instrument 504) (REF 20) is issued to SL for the introduction of Pressurised Inerting in the Magnox Swarf Storage Silo.

7 REFERENCES

1. Condition 22, Schedule 2 of the Nuclear Site Licence No:1031 Sellafield (Windscale Works and Calder Works) Application for Agreement to Commence Modification to an Existing Plant. 10 May 2017, TRIM Ref 2017/188694

2. Plant Modification Proposal, "The introduction of Quiescent Passive Ventilation and Pressurised Inerting to manage Chronic and Excursion hydrogen challenges within MSSS", [redacted] Issue 2, TRIM Ref 2017/188692

3. ONR Assessment Note, Risks Presented by Legacy Facilities at Sellafield Site – June 2014, TRIM Ref 2014/257959

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