Magnox Swarf Storage Silo Retrievals Project

Agreement to implement Phase 2 active commissioning trials of the MSSS compartment 10 Miscellaneous Beta Gamma Waste retrieval scheme

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EXECUTIVE SUMMARY

Title
Agreement to implement Phase 2 active commissioning trials of the MSSS compartment 10 Miscellaneous Beta Gamma Waste retrieval scheme

Permission Requested
In accordance with its arrangements made under Licence Condition 22(1), Sellafield Ltd (SL) has requested the Office for Nuclear Regulation's 'Agreement', to carry out active commissioning of the Compartment 10 Retrieval Ventilation System phase 2 as described in Plant Modification Proposal (PMP): Active Commissioning of the Compartment 10 Miscellaneous Beta Gamma Waste (MBGW) Retrievals Scheme using SEP 2 (phases 2 & 3). SL's request only seeks agreement for the implementation of phase 2 activities as defined by the plant modification proposal and recognises that prior to commencement of subsequent phase 3 and 4 activities, additional agreement will be sought from ONR.

SL's proposal for phase 2 commissioning activities represent a significant change to the MSSS hydrogen management strategy which if ill-conceived or inadequately implemented, could lead to a significant radiological dose to workers and/or members of the public as a result of hydrogen deflagration and subsequent loss of containment.

Background
The Magnox Swarf Storage Silo (MSSS) has stored intermediate level waste under water from Magnox reprocessing for approximately forty years and is currently assessed as the highest risk nuclear facility in the Nuclear Decommissioning Authority estates. In order to accelerate hazard and risk reduction, SL has commenced a programme of work to retrieve solid waste from MSSS and transport it for storage in a more modern storage facility. Waste retrievals will commence with compartment 10 (C10). This is different from the other compartments as the top half contains a homogenous layer of MBGW and retrieval of this waste represents a reduced chronic hydrogen hazard.

SL has provided an implementation strategy to introduce Silo Emptying Plant №2 (SEP2) into service on C10 for commencement of active commissioning by retrieval of MBGW from this compartment. The implementation strategy identifies 4 phases:

> Phase 1 - transfer the extract ventilation of compartments 1 to 22 onto the 2nd extension ventilation system. Phase 1 activities have been completed.
> Phase 2 - introduce reactive passive ventilation on C10 and commence commissioning activities of the retrieval ventilation system (RVS) (nitrogen inerting) with a) the silo roof plug installed and b) auxiliary seal plug (ASP) installed in the C10 chargehole. The SEP2 machine will remain sited over C4 and not form part of phase 2 commissioning activities.
> Phase 3 - move SEP2 to from its current position to C10 and connect it to the ASP to C10. This will enable further RVS commissioning that take account of the SEP machine and compartment ullage.
> Phase 4 - commence active commissioning of waste retrieval activities of MBGW from C10 and transfer the waste to an external storage facility.

This project assessment report only considers the phase 2 activities outlined above and as detailed in SL's PMP.

Two reactive passive vents (RPV) have been installed on C10 as part of preparatory work but are not currently operational. Phase 2 will permit operational implementation of the RPVs. These provide a key safety function of keeping the passive vent sealed whilst nitrogen is applied to C10 thereby maintaining the inert atmosphere, and also act to open the passive vent on loss of nitrogen to allow dissipation of hydrogen from C10 equivalent to the extant

quiescent passive vents. Introduction of the RPVs is also the main change to the SL's current hydrogen hazard management strategy in MSSS.

Nitrogen inerting of C10 will be required to support subsequent phase 4 retrieval activities where there is a potential for an increase in the rate of hydrogen generation. Phase 2 and phase 3 commissioning tests will be used to confirm the suitability of the RVS to maintain an adequate inert atmosphere for phase 4.

Adequacy of the commissioning trials and operation of the RPVs were a key focus of ONR's assessment of SL's safety case to confirm that the hydrogen hazard has been appropriately assessed and managed to reduce the risk to ALARP.

Assessment and inspection work carried out by ONR in consideration of this request
Following initial consideration of SL's proposal, I judged it proportionate to obtain specialist inspector advice in the following areas: human factors, mechanical engineering, chemical / process engineering, fault studies, internal hazards, control and instrumentation, radiological protection, conventional health and safety.

ONR specialist inspector advice was focused on the following areas:

- Appropriateness of SL's assessment of the proposed changes to the hydrogen management strategy to manage the risk of deflagration as part of phase 2 activities and adequacy of controls.
- Appropriateness of SL's assessment of C10 overfilling faults associated with filling the ASP water seal and adequacy of control measures.
- Substantiation, testing and commissioning of safety related equipment including safety mechanisms (SM).
- Substantiation of any claims on human performance, including those in response to alarms.
- Radiological protection of workers from normal operations.
- Protection of workers from asphyxiation hazards.
- Training in new plant, safety systems and those related to emergency actions from fault conditions.

This assessment consisted of review of SL's PMP and the supporting safety case, inspection of the operational area and operational procedures, and a readiness inspection to confirm that the people, plant and procedures are available to support safe operations.

Matters arising from ONR's work
SL's safety case identifies two shortfalls against its own arrangements in its design basis assessment regarding:

- Only one 'basket' safety measure (BSM) has been identified for a fault sequence relating to an over filling fault on the auxiliary seal plug service platform, when two BSMs would be expected. The safety case therefore identifies a shortfall in the number of claimed independent safety measures.
- The low temperature withstand of the auxiliary seal plug and silo roof plug park stands coincident with a seismic event does not meet modern standards. The shortfall affects sustained low temperature behaviour of the park stands steel work in coincident with a design basis earthquake. Should these items fail there is potential for them to collapse with their load onto the operations floor which could impact safety related equipment in the vicinity.

SL claims that sufficient alternative safety measures have been implemented that serve to reduce the associated risks SFAIRP. ONR considered SL's safety case in relation to this and judges that the available safety measures and the independence of operator response to be adequate given the remote nature and combination of initiating event.

ONR's specialist inspectors raised a number of recommendations related to subsequent phases, but those related to phase 2 have been adequately addressed by SL. No nuclear safety shortfalls or remaining recommendations prevent ONR agreeing to SL's request. As a result, all inspectors support ONR agreeing to SL's proposal.

ONR's readiness inspection judged SL's implementation of its safety case under its LC 22 arrangements for the proposed modification as adequate. In addition, SL has confirmed to my satisfaction that its proposal has been subject to independent internal governance by its management safety committees, consideration by its nuclear safety committee and oversight by its internal regulator. All conclude that they have no objection to SL's proposed modification, which provides additional regulatory confidence.

Conclusions

Commencement of phase 2 commissioning activities is judged to be an important enabling activity for the programme of work to start MBGW retrievals from C10. Based on the evidence sampled and the safety controls implemented by SL, I am satisfied with the adequacy of SL's proposal and supporting safety case and that risks have been reduced so far as is reasonably practicable (SFAIRP) in this instance.

Recommendation

I recommend that ONR issues License Instrument number 524 giving permission to SL to commence active commissioning of the C10 RVS phase 2.

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
ASP	Auxiliary Seal Plug
BSM	Basket Safety Measure
C10	Compartment / number e.g. C10 = Compartment 10
C&I	Control and Instrumentation
DAP	Duly Authorised Person
HARR	Hazardous Activity Readiness Review
HF	Human Factors
HSE	Health and Safety Executive
MBGW	Miscellaneous Beta Gamma Waste
MSSS	Magnox Swarf Storage Silo
NIO	Sellafield Ltd, Nuclear Independent Oversight
mSv	milli-Sievert
ONR	Office for Nuclear Regulation
PAR	Project Assessment Report
PI	Pressurised Inerting
PMP	Plant Modification Proposal
QPV	Quiescent Passive Ventilation
RGR	Rapid Gas Release
rOI	Required Operating Instruction
RPV	Reactive Passive Ventilation
RVS	Retrievals Ventilation System
SAP	Safety Assessment Principle
SCIP	Safety Case Implementation Plan
SEP2	Silo Emptying Plant N^{o}2
SGR	Sudden Gas Release
SM	Safety Mechanism
SFAIRP	So far as is reasonably practicable
SL	Sellafield Ltd
SSC	Systems, Structures, Components
STL	Shift Team Leader
STM	Shift Team Manager
TAG	Technical Assessment Guide

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1 PERMISSION REQUESTED

1. In accordance with its arrangements made under Licence Condition 22(1), SL has requested [1] the Office for Nuclear Regulation's 'Agreement', to carry out active commissioning of the compartment 10 retrieval ventilation system phase 2 as described in plant modification proposal: active commissioning of the compartment 10 MBGW retrievals scheme using SEP 2 (phases 2 & 3) [2].

2. SL's request [1] only seeks agreement for the implementation of phase 2 activities as defined by the PMP [2] and recognises that prior to commencement of phase 3 and 4 activities, additional agreement will be sought from ONR.

3. SL has categorised the radiological significance of the PMP [2] as "A" indicating that it could give rise to a consequence of more than 1mSv to a member of the public if ill-conceived or inadequately implemented. In addition, SL's radiological safety assessments indicate potential consequences in the region of 20-1000mSv to workers. The most significant radiological hazard identified in SL's proposal [2] results from changes to the hydrogen hazard management strategy where the current air based C10 configuration will be transitioned to a nitrogen inerted configuration (and visa-versa).

2 BACKGROUND

4. The MSSS facility comprises 22 vertical concrete silo compartments, partially below ground level, that were in active use between 1964 and 1999 to store fuel cladding arising from the decanning of Magnox fuel elements. These compartments contain a mixture of different types of wet intermediate level solid and sludge waste. Primarily the waste is irradiated Magnox swarf most of which has become sludge due to corrosion. Approximately 10% of the total MSSS waste by volume is a variety of irradiated and contaminated Miscellaneous Beta Gamma Waste (MBGW).

5. In order to accelerate hazard and risk reduction, SL has commenced a programme of work that aims to retrieve all solid waste from MSSS and transport it for storage in a more modern facility. This programme of work is expected to run until at least 2045. Waste retrievals will commence with compartment 10 (C10) as it is different from the other compartments as the top half contains a homogenous layer of MBGW. Commencing with retrieval of this waste represents a reduced chronic hydrogen hazard.

6. SL has provided an implementation strategy [3] to introduce SEP2 into service on C10 for commencement of active commissioning and operation by retrieval of MBGW from this compartment. The implementation strategy identified 4 phases:

> Phase 1 - modify the extract ventilation system in preparation for waste retrieval. Phase 1 activities have not attracted ONR assessment and permissioning due to the low radiological safety significance and this phase is now complete.
> Phase 2 - to introduce RPVs on C10 and carry out RVS commissioning activities (nitrogen inerting) with a) the silo roof plug installed and b) ASP installed in the C10 chargehole. The SEP2 machine will remain sited over C4 and not form part of this phase commissioning activities.
> Phase 3 - to move SEP2 to compartment 10 and connect this via the ASP to C10. This will enable further RVS commissioning that take account of the SEP machine and compartment ullage.

Phase 4 - to commence active commissioning and waste retrieval activities of MBGW from C10 and transfer the waste to an external storage facility.

7. Given the safety significance of the activities, complexity and novel nature, three hold points have been identified on SL's hold point control plan prior to implementation of phases 2, 3 & 4. In accordance with its arrangements, SL will need to seek ONR permission to proceed beyond each of these hold points before commencing the associated activities.

8. This PAR and permission concerns the first of these hold points – HP41a, to undertake nitrogen inerting trials of the compartment 10 of the MSSS facility and consists of the following "phase 2" commissioning activities as described in the SL PMP [2]:

- Transferring chronic hydrogen hazard management strategy for C10 to RPVs. Nitrogen will be fed into the compartment to lower the oxygen content in the compartment below the lower flammable limit for hydrogen.
- Confirming that an adequate inerted atmosphere can be achieved with the silo roof plug fitted in C10.
- Remove the silo roof plug and replace with the ASP fitted to the C10 chargehole.
- Confirming that an adequate inerted atmosphere can be achieved with the ASP fitted in C10.

9. Reactive Passive Vents (RPVs) are key new SMs and form part of the physical modifications required to support nitrogen inerting on C10. The RPVs open on loss of nitrogen to allow C10 to revert to an air based configuration. RPVs in the open configuration form the same safety function as quiescent passive vents (QPVs) which ONR has previously assessed [4].

10. The RVS phase 2 commissioning activities form an important enabling activity that will verify design assumptions on nitrogen inject requirements. Specifically, it will prove that the compartment ullage can be inerted to less than lower flammable limit for hydrogen . The change to an inerted atmosphere is required to support the retrieval operations at phase 4, when an increase in hydrogen generation is predicted due to waste disturbance.

11. The RVS will utilise the same nitrogen stocks as that required to maintain the MSSS PI capability for excursion management. It is important to confirm that SL's proposals do not compromise the PI capability and that sufficient safeguards are placed.

12. Adequacy of the commissioning trials, operation of the RPVs and maintenance of PI capability were a key focus of ONRs assessment of the SL safety case to confirm that hydrogen hazard has been appropriately assessed and managed.

13. Additionally SL proposal [2] introduces a new initiator to an extant fault sequence related to compartment overfilling and loss of containment. Operator error during filling operations of the auxiliary seal plate water trough seal, could result in overflows into secondary containment and to a loss of containment. The consequence of this is the potential for a significant radiological dose to workers and/or members of the public. ONR's assessment has also focused on this scenario.

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

14. In accordance with ONR's permissioning guidance [5], inspectors have engaged regularly with the SL project to understand and build confidence in SL's safety case for the proposed activity.

15. Following my consideration of SL's proposal to commence phase 2 active commissioning of the RVS, I sought ONR specialist inspector advice in the following areas:

- Appropriateness of SL's assessment of the proposed changes to the hydrogen management strategy and control measures for this as part of phase 2 activities.
- Appropriateness of SL's assessment of C10 overfilling faults associated with topping up the auxiliary seal plug water seal and associated controls
- Substantiation, testing and commissioning of safety related equipment including SMs.
- Substantiation of any claims on human performance, including in response to alarms.
- Radiological protection of workers from normal operations.
- Protection of workers from asphyxiation hazards.

16. In addition to the above and to support the permissioning decision, I judged that it was proportionate for ONR to undertake a readiness inspection [6]. The purpose of this was to give confidence that the physical installation and operating instructions were complete and reflected the requirements of the safety case, and that sufficient numbers of people are suitably qualified and experienced, including completion of all relevant training to operate the revised systems.

17. I therefore judged that it was proportionate to obtain the following specialist inspector advice:

- Fault Studies
- Chemical / Process Engineering
- Human Factors
- Internal Hazards
- Mechanical engineering
- Control and Instrumentation
- Radiological Protection
- Conventional Health and Safety.

3.1 ONR ASSESSMENT

18. This assessment considers SL's safety case for the proposed modification to implement phase 2 activities as detailed in the PMP [2] to commence nitrogen inerting of C10 of the MSSS facility at Sellafield. ONR specialist assessment of SL's proposal has been completed and their advice is summarised below.

3.1.1 CHEMICAL ENGINEERING ASSESSMENT

19. The chemical engineering specialist inspector has undertaken an assessment [7] of SL's proposal [2] against the relevant expectations of ONR's Safety Assessment Principles (SAP) [8] and Technical Assessment Guides (TAG) [9]. The purpose of the assessment was to confirm that SL's consideration of process safety of hydrogen management has met ONR expectations and is sufficient to ensure that related risks are reduced to ALARP. The assessment has sampled the following areas:

- Chronic hydrogen – suitability RPVs.
- Acute hydrogen - Oxygen concentration in the C10 ullage.
- Excursion hydrogen - Changes to the PI safety case.

20. Chronic hydrogen

21. At phase 2, introduction of the RVS could give rise to the fault condition whereby the supply of nitrogen is lost and C10 remains sealed allowing the accumulation of chronic hydrogen. RPVs form the principle safeguard, delivering a category A safety function, preventing the accumulation of hydrogen.

22. In the open position RPVs are analogous to QPVs which ONR has previously assessed and content with their deployment [4]. When open RPVs provide an opening vent into the MSSS compartments allowing dilution of the chronic hydrogen hazard by air when the forced extract ventilation is running (normal condition) and passive dispersion of the hydrogen hazard should the extract ventilation fail (fault condition). In the closed position, the RPVs seal the vent aperture allowing nitrogen to provide an inert atmosphere within C10. To enable phase 2 commissioning activities there are two RPVs fitted to C10 and one QPV is retained in a lidded (sealed) configuration. Should both the RPVs fail to open on demand (fault condition) the lid on the QPV is removed to restore passive ventilation and allow passive dispersion of the hydrogen.

23. The specialist inspector undertook a number of lines of enquiry to determine that the licensee has undertaken appropriate assessment and commission of the RPVs. These assessment activities included:

- Confirming that RPV aperture is similar to the QPV and therefore analogous to the QPV.
- Confirming that SL has provided suitable evidence to substantiate a claim that single passive vent operation per compartment with interconnecting compartments is valid.
- Witnessing RPV testing during build and factory testing and also at SLs inerting trials test facility.
- Confirming the substantiation of the 5.8 hr time frame for hydrogen concentrations to reach the lower flammable limit which sets the timeframe by which the QPV must be unlidded to allow hydrogen dispersion following loss of nitrogen.
- Confirming that the increase in the derived RPV hydrogen dispersion limit of 1.42m^3/hr from trials is adequate with safety margin.

24. The inspector is satisfied that SL has provided an adequate justification in its safety case that the operation of the RPV will provide the same benefit of the QPVs, including dispersion limits and single vent operation. The inspector has taken into account hydrogen additions as a result of cooler operations and confirmed that conservatisms in SL's analysis bound the effect of hydrogen addition by this mechanism.

25. The inspector also confirms that the RPVs were demonstrated to open on low nitrogen pressure and close when nitrogen is applied thereby fulfilling its safety function.

26. The inspector notes that SL has started collecting data on actual hydrogen generation rates and that the initial findings are in line with assessment expectations. This data collection is important for establishing baseline hydrogen generation rates against which to compare during waste retrieval activities at phase 4. However, SL has yet to formally record the results of the current data collection which has led the

specialist inspector to raise a recommendation to provide the hydrogen generation data prior to HP41b. This has been recorded as an action in Regulatory Issue RI7394.

27. Acute Hydrogen

28. The acute hydrogen hazard from cooler start-up operations is an existing hazard managed by the existing QPV safety measures. The inspector considers the effect of cooler operations within chronic assessment as described above and confirmed that conservatisms in SL's analysis bound the effect of hydrogen addition by cooler operations.

29. The remaining sources of acute hydrogen hazard occur as a result of waste disturbance after the start of phase 4 activities. Nonetheless, the acute hydrogen hazard has been assessed to ensure that the phase 2 commissioning is fit for purpose and supports future permissioning decisions.

30. The inspector undertook a number of lines of enquiry to determine that SL has undertaken appropriate assessment of the acute hydrogen hazard and has identified and suitable means to control the risk from this. These assessment activities included confirming:

- SL's assessment of the threshold of hydrogen combustion / deflagration is conservative as this will inform definition of the safe operating envelope for phase 4 retrievals.
- The design of nitrogen inject nozzle is suitable and provides adequate mixing of gases.
- Appropriateness of the phase 2 testing to determine compartment air in leakage.
- The oxygen analyser (which is an existing SM for PI) remains appropriate and has sufficient accuracy to determine the success of the phase 2 inerting trials. However, no safety claim is placed on the oxygen analyser for phase 2.

31. The inspector confirms that acute hydrogen hazard has been adequately assessed by SL with suitable safety margin where applicable. The assessment has considered the modelling and trials work undertaken by SL to determine thresholds of combustion, adequacy of gas mixing and effects of air in-leakage. The inspector is content with the adequacy of the modelling and trials undertaken by SL. The inspector notes that they were conservative in nature and took into account statistical variation to three standard deviations and considers the results suitable for deriving the threshold of combustion. It was also confirmed that testing during phase 2 is appropriate to confirm that air in-leakage testing will be disperse and not from a discrete source.

32. The inspector notes that SL has not identified an operational envelope for C10 air ingress testing during phase 2 and that this is a shortfall against ONR Safety Assessment Principles. However the specialist inspector is content that arrangements are sufficient for phase 2 as any seal deterioration would be negligible, no retrieval / waste disturbance activities are occurring and the oxygen baseline will change once the SEP machine is present (phase 3). Part of the purpose of the phase 2 commissioning activities is to establish operational baselines and to inform definition of the operational envelope for phase 4 waste retrieval activities. Regulatory issue RI7394 has been raised to ensure that a suitable operational envelope is specified by SL prior to phase 4 retrieval activities. The regulatory issue will be progressed as part of normal ONR-licensee interactions and will be confirmed closed during assessment in support of the HP41b ONR permissioning decision.

33. Excursion Hydrogen

If a runaway thermal reaction occurs within the waste bed, there is a potential fault sequence that could lead to a hydrogen deflagration on the operations floor. MSSS will be employing PI to control the oxygen levels to manage high hydrogen release rates during an excursion. PI is an existing safety measure to manage hydrogen excursion and has previously been assessed by ONR [10]. As both C10 inerting trials and PI draw upon the same nitrogen stock, phase 2 activities could compromise PI if insufficient reserve of nitrogen is held to maintain the PI capability. The assessment therefore considered the management of nitrogen stock levels, in particular assessing nitrogen usage rates and operational limits and conditions.

34. The specialist inspector is content that SL has specified adequate operating rules to manage nitrogen stock levels sufficient to maintain the PI capability based upon conservative calculation of nitrogen usage.

35. In conclusion, the specialist inspector is satisfied with the claims arguments and evidence laid down within SL's safety case and considers that the risk from hydrogen excursions is reduced to ALARP. The assessor was content that SL can proceed with phase 2 commissioning of the C10 ventilation and nitrogen system.

3.1.2 FAULT STUDIES ASSESSMENT

36. The Fault Studies specialist inspector carried out an assessment [11] of SL's proposal [2] against the relevant expectations of ONR's SAPs [8] and TAGs [9]. The purpose of the assessment was to confirm the adequacy of SL's identification and assessment of potential fault sequences, the safeguards claimed to prevent a radiological consequence and to confirm risk are deuced ALARP. The assessment focused on fault sequences associated with SL's proposed changes to the hydrogen hazard management strategy, as failure to manage the chronic hydrogen hazard could result in doses in the 10 -100mSv region to the public and 20 - 1000mSv region for workers.

37. For the sampled fault sequences, the assessment considered SL's approach to overall fault analysis and the specific topics of fault identification, radiological consequence analysis, design basis analysis and risk ALARP considerations.

38. The inspector concludes that SL's hazard and fault identification is comprehensive and provided a suitable basis for fault analysis. The inspector is satisfied that the radiological consequence analysis is appropriate and that SL has identified suitable and sufficient safety measures relevant to the fault scenarios and contingency arrangements.

39. The specialist inspector is also content that SL's assessment of risks was proportionate, adequate and demonstrates risks to be ALARP for the phase 2 activities.

40. In addition to the changes to the chronic hydrogen management strategy, the fault studies assessment identified a revision by SL to the safety case identifying a potential compartment overfill fault sequence as a result of filling the water seal on the ASP. Compartment overfilling is an extant fault sequence with a number of specified independent SMs (level detection) and operator actions to detect and alarm on high compartment liquor level. The inspector notes that there is also significant time available to identify and correct the fault. The inspector is content that SL has identified adequate safety measures for phase 2. The adequacy of the safety measures identified for phase 2 is considered further in the C&I assessment below.

41. The fault studies inspector concludes that they content that ONR provides permission to SL for the phase 2 activities under HP41a.

3.1.3 HUMAN FACTORS ASSESSMENT

42. An ONR human factors (HF) specialist inspector has undertaken an assessment [12] of SL's proposal [2] against the relevant expectations of ONR's SAPs [8] and TAGs [9]. The purpose of the assessment was to confirm that SL's consideration of the impact of human error on safety important tasks are adequate and the risk of human error has been reduced ALARP. The assessment has focused on SL's human based safety claims associated with:

- Correct availability and functioning of the RPVs on C10.
- Confirming that QPVs are opened when required and function correctly is response to loss of nitrogen.
- Suitability of human based safety claims for reserving nitrogen stocks to support PI co-incident with C10 activities.
- ASP water trough seal filling operations.
- Response to alarms.

43. The inspector is satisfied that SL has provided this project with a good level of Human Factors (HF) support and there was evidence that HF had been integrated throughout the safety assessments.

44. SL's proposal [2] introduces human based safety claims in the form of operating rules (termed rOIs by SL) to confirm that the RPVs have opened as expected following loss of nitrogen, and to uncover the extant QPV should the RPVs have failed to open. Additionally, rOIs have been specified by SL to ensure that RPVs do not get covered by "sheet" material such that the passive ventilation would be compromised. The proposal also introduces rOIs for the management of liquid nitrogen stock to preserve the PI capability. The inspector is satisfied that SL has followed its own arrangements for a systematic approach to training which aligns with relevant good practice. The inspector reviewed SL's training material and confirmed that it outlined the RPV function, response to RPV failures, obstruction awareness and nitrogen stock management. The inspector found the training material adequate and suitable and sufficient for the tasks involved including responses to alarms.

45. The specialist inspector is content with the low nitrogen flow alarm design and that the supporting alarm response procedures align with HF relevant good practice. The inspector is also content that the tasks and designs associated with the passive ventilation (RPV & QPV) function for phase 2 align with RGP and meet regulatory expectations.

46. The SL proposal introduces new operating rules (rOIs), relating to ASP water trough seal top-up operations. Operators are only trained in these additional rOIs through delivery of a discretionary DAP training brief. As this brief is discretionary, the inspector identified a concern whereby this training may not be delivered to the ASP operators prior to operations. In order to remain proportionate, the inspector has balanced the nature, infrequency of this task and the limited time available post-permission and raised an action for SL nuclear independent oversight (NIO) to confirm delivery of the DAP training brief to ASP operators prior to ASP operations. This action is recorded under regulatory issue RI7363.

47. The inspector concludes that, although minor shortfalls were identified for phase 2, they are judge to be of low safety significance and it would be disproportionate to withhold permission. Consequently the inspector confirms that they support the permissioning of the phase 2 commissioning activities.

3.1.4 INTERNAL HAZARDS ASSESSMENT

48. An internal hazards specialist inspector has undertaken an assessment [13] of SL's proposal [2] against the relevant expectations of ONR's SAPs [8] and TAGs [9]. The assessment has sampled SL's safety case with respect to the key hazards associated with phase 2 commissioning activities; hydrogen deflagration and asphyxiant (nitrogen) gas releases. The inspector notes that ONR previously assessed SL's safety case for excursion management [10] and specifically, SL's consequence assessment of hydrogen fire and/or deflagration effects on systems structures and components (SSCs) as part the SL PI case. The assessment therefore focused on the differences between the previous assessment and the proposed MSSS configuration during phase 2 activities.

49. The inspector has considered:

- The limits and conditions associated with oxygen monitoring to confirm adequate inerting of C10.
- SL's evaluation of C10 air in leakage to confirm design assumptions will be validated during phase 2 activities.
- Characterisation of hydrogen deflagration hazards to confirm that existing assessments remain bounding.

50. The inspector concludes that SL has adequately considered the risks and consequences associated with chronic hydrogen releases and management of deflagration hazards during the proposed phase 2 commissioning activities. The inspector has also concluded that, from an internal hazards perspective, SL has provided adequate evidence to justify that the risks associated with phase 2 commissioning have been reduced to ALARP.

51. The extant PI case makes assumptions on maximum air ingress into compartment 10 to underpin the assessment of hydrogen fire jets and deflagration. At the time of assessment, the phase 2 commissioning test for this had not been finalised. The inspector judged that that SL would need to confirm that the air in-leakage in the vicinity of C10 would be recorded to ensure that the new configurations and penetrations (made to enable waste retrieval) have not altered the assumed PI leak areas. Based on SL's phase 2 inerting trials commissioning test documentation, the inspector is satisfied [14] that the information provided has addressed this matter. The inspector also recommends that the results from the phase 2 commissioning are reviewed by SL to confirm that the PI case has not been undermined by air in-leakage rates. I have raised regulatory issue RI7401 to ensure that this action is considered as part of the permissioning for phase 3 activities.

52. The inspector identifies no other reservations that would prevent ONR giving permission for HP41a and concludes that ONR should issue the licence instrument to undertake Phase 2 commissioning activities.

3.1.5 MECHANICAL ENGINEERING ASSESSMENT

53. The mechanical engineering specialist inspector has undertaken an assessment [15] of SL's proposal [2] against the relevant expectations of ONR's SAPs [8] and TAGs [9]. The assessment focused on the claimed safety measures, in particular the RPVs which form a category A safety function and the ability of the ASP sealing arrangement to maintain containment. The inspector has specifically considered the following areas due to their importance to radiological safety:

- Containment requirements of C10 ASP.
- Substantiation, categorisation, classification and commissioning of RPVs.

- Examination, Inspection, Maintenance, testing (EMIT) and Asset Management.

54. The inspector is satisfied the ASP can perform its safety function to provide a containment seal between the SEP machine and C10 during waste retrievals. When the SEP machine is not located over the compartment, containment is achieved by utilising a removable shield cap which interfaces with the ASP in the same manner as the SEP machine. In reaching their judgement, the inspector considered seal compression specification, seal material, evidence from works testing, maintenance activities, application of design codes and set points for the water seal that exists between the ASP top and bottom plates.

55. In assessing the RPVs, the inspector considered failure and reliability claims and data, functional testing at works, subsequent commissioning at site, extreme weather events and the applied design standards. The inspector concludes that they are content that SL has applied appropriate qualification methods and that the RPV can deliver its safety functional design intent in normal and fault conditions from a mechanical engineering perspective.

56. The inspector confirms that SL has identified suitable EIMT requirements and frequencies for the RPVs. However, the inspector notes shortfalls in the EIMT strategy for the ASP seals including the identification of a suitable replacement strategy to mitigate effects of material aging. As performance of the seals will be monitored through continuous condition monitoring of the C10 oxygen levels and the manufacturer recommends replacement at 10 years, the inspector is content that this should be monitored through a regulatory issue. Regulatory issue RI7395 has been raised to ensure that the shortfalls in ASP seal EIMT are addressed before the phase 3 permissioning decision, when the SEP machine is mated to the ASP over C10.

57. The inspector is satisfied that SL has adequately presented claims, arguments and evidence within its safety case, that appropriate analysis and testing of the engineered systems has been undertaken, that the engineered protection systems meet the expectations of their given classification and that suitable EIMT arrangements are in place to ensure the engineered protection systems can perform their safety function.

58. The inspector supports the decision, from mechanical perspective, to release HP41a and allow SL to commence phase 2 ventilation commissioning activities on C10.

3.1.6 CONTROL & INSTRUMENTATION ASSESSMENT

59. An ONR C&I engineering specialist inspector assessed [16] SL's proposal [2] against the requirements ONR's SAPs [8] and TAGs [9] and considered the requirements of international standard IEC 61508 [17]. The assessment has considered the adequacy of the design of new C&I safety measures relating to:

- Detection of low nitrogen supply to C10 and the RPVs, to protect against the fault condition of chronic hydrogen build up in C10.
- Detection of loss of the extract ventilation, which could lead to a conventional asphyxiation hazard.
- Detection of compartment liquor levels due to failure of the ASP trough seal high level filling indication, which could lead to a MSSS first extension compartment overfilling event.

60. The key areas of the specialist assessment were:

- Adequacy of the SL safety case.

- Safety classification and standards.
- Adequacy of the design for the C&I safety system.
- Substantiation of the reliability claims for the C&I safety system.
- Adequacy of the safety commissioning schedule.
- Demonstration that risk is reduced ALARP.

61. Detection of low nitrogen supply as part of chronic hydrogen management

62. Although, from a C&I perspective, the specialist inspector judges that the SL safety case identifies the measures in place to detect low nitrogen to the C10 ullage and RPV's, the inspector did not assess the adequacy of the associated alarms and responses as this lies within the human factors assessment area.

63. The ONR Human Factors specialist inspector considered this in their assessment, confirming their satisfaction with the alarm design and supporting alarm response procedures.

64. The RPVs form the principle safeguard on loss of nitrogen by opening automatically on loss of pneumatic pressure from the nitrogen supply line, thereby enabling C10 to return to an air based configuration. The SGR nitrogen flow meter (SSC0517) alarms in the Main Control Room (MC) on low nitrogen supply alerting operators to visually confirm the RPVs have operated as expected and if not, to instigate remedial measures under BSM2.

65. The inspector judged that the SSC0517 alarm forms a significant contribution to fulfilling the delivery of the RPV safety function. ONR guidance [9] identifies that such engineered safety systems should be at least class 2. SL has classified and substantiated SSC0517 to SIL 1 which is aligned to a class 3 rating. Correct classification is important as the class relates to the consequence of system failure and to the failure frequency requirements placed on the systems. The inspector therefore judged that SL has not appropriately classified the system structure component (SSC) SSC0517, which could lead to the SSC being designed with lower reliability than that required to deliver its safety function.

66. The inspector judges that it would be disproportionate at this stage to require SL to implement further measures as the identified safety measures reduce the risk below the basic safety limit (Target 4 of reference 8), there are sufficient and diverse alternative means of identifying loss of nitrogen, the phase 2 commissioning trials are relatively short (weeks) and at phase 3, additional SMs are introduced that will address this shortfall.

67. The inspector is content with the commissioning undertaken during phase 1 testing and with the test specification for phase 2 commissioning of the SGR and chronic flow meters.

68. The inspector concludes that SL has identified the hazards and provided adequate safety measures for the management of chronic hydrogen under C10 ventilation phase 2 commissioning activities to reduce the risk to ALARP.

69. Loss of extract ventilation

70. The SL safety case identifies that, for loss of extract ventilation, there are no off site consequences and the consequence to worker is low in the region of 2 and 20mSv. ONR would not normally assess such faults but it has been identified that the C11 flow meter (SSC0117) performs an important conventional safety function. On loss of extract flow, there is potential for nitrogen to disperse onto the operations floor through QPVs located on compartments adjacent to C10 giving rise to an

asphyxiation hazard. SSC0117 is used to detect loss of ventilation extract flow from the first extension and provides the signal that would alert control room operatives to sound the building evacuation alarm.

71. The inspector reviewed the substantiation of the C11 flow meter (SSC0117) and is satisfied that it will adequately meet the safety requirement to alarm on loss of induced extract ventilation.

72. Failure of the ASP water trough seal high level filling indication

73. SL identified a fault sequence whereby the operator could fail to isolate the water supply at the end of ASP trough filling operations leading to the potential overfill of the compartments. The consequence would be a loss of containment with potential doses of between 1 and 10 mSv to the public and between 20 and 1000 mSv to workers.

74. The inspector considers that the safety case has not adequately identified the fault initiating event frequency or numerical / probabilistic targets; therefore it is unclear whether the safety measures (BSM) provide adequate risk reduction. On this basis, the inspector considered the adequacy of the identified safety measures (BSM) (primarily compartment level detection), operator actions and SL's ALARP arguments.

75. The provided BSM consists of two SMs, C7 and C12 pneumercator liquor level detection and alarm (SM01) and C9 radar liquor level detection and alarm (SM02). Both SMs require operator response to compartment high level alarms. The inspector is satisfied that the two SMs meet the expectations of the SAPs [8].

76. SL's original justification identified an operating assumption that, on completion of ASP filling operations, operators will close the water ring main local isolation valve and disconnect the water supply to the ASP service platform. The inspector noted that similar fault sequences within MSSS have identified similar operating restrictions as a rOI which attract a greater level of prominence within operating instructions and compliance recording. Subsequent to this challenge by ONR, SL revised its safety justification for this fault sequence [18] identifying an appropriate rOI.

77. The inspector notes that the claimed BSM is reliant on operator actions to respond to alarms. The inspector has considered SL's justification for this and considers it would be disproportionate for SL to include additional engineered protection for reasons including: the safety measures include redundant and diverse compartment liquor level detection and alarms; due to the relatively long time to fill the compartments there are many opportunities to observe increasing compartment liquor levels before challenging safety measures; the response to compartment level monitoring and alarms is performed by persons independent of the operator initiated event. The human factors inspector is content with the feasibility of the claims made on operators in relation to this.

78. I concur with the specialist inspector that it would be disproportionate for SL to include additional engineered protection based upon the above, and noting that the arguments presented are specific to activities up until the SEP2 machine is mated with the ASP, where additional engineered protection within SEP2 protects compartment overfill faults. Water additions to C10 feature more prominently in the phase 3 and 4 activities and will be further assessed at the respective later permissions.

79. The specialist inspector concludes that the ONR project inspector recommends release of HP41a. As the inspectors recommendations have been addressed, I

consider there to be no outstanding reservations to permissioning from a C&I perspective.

3.1.7 RADIOLOGICAL PROTECTION ASSESSMENT

80. An ONR radiological protection (RP) specialist inspector has assessed [19] of the radiological protection aspects of SL's proposal [2] against the requirements of ONR's SAPs [8] and TAGs [9]. The assessment sampled the three operations likely to result in exposure to the highest dose rates during phase 2 operations and the measures SL shall put into effect to restrict exposures to ALARP. An inspection of the work area was also undertaken by the specialist inspector to further inform the assessment. The three operations sampled were:

- Compartment 10 ledge clearance.
- Removal and transfer of the C10 silo roof plug.
- Transfer and fitting of the Auxiliary Seal Plug (ASP).

81. The inspector was broadly satisfied with the information provided by SL, but noted that a number of control measures that SL had identified as being necessary to restrict the exposure of workers had not been documented in the relevant risk assessments. SL's revised risk assessments have been subsequently reviewed by the RP inspector who judges that these are acceptable [20].

82. The inspector concludes that there are no reasons on radiological protection grounds to withhold agreement for the release of Hold Point 41a which will allow the commencement of Phase 2 commissioning activities.

3.1.8 CONVENTIONAL HEALTH AND SAFETY ASSESSMENT

83. An ONR conventional health and safety specialist inspector has undertaken an assessment [21] of the conventional asphyxiation risk of SL's proposal [2] against the requirements of conventional health and safety regulations including The Management of Health & Safety at Work Regulations 1999 and the Control of Substances at Work Regulations 2002. The assessment also draws upon industry relevant good practice, HSE guidance and Approved Codes of Practice.

84. The assessment focused on the adequacy of SL's risk assessment and key safety measures related to the control of risks from the asphyxiation hazard:

- How significant risks from nitrogen asphyxiation during phase 2 commissioning activities are being identified and controlled.
- The type of oxygen detectors used (fixed, portable or personal).
- Maintenance arrangements of oxygen detectors (including function checks/bump tests and calibration).
- The arrangements in place to alert operators of accidental nitrogen releases on the operations floor.
- Consideration of how the workplace layout /environment may impact on any release.
- Training of operators.
- The details of emergency arrangements, including escape routes and the actions to be taken following an alarm.

85. Based upon a visit to the facility, review of the SL submissions and the consideration of the above, the inspector concludes that the SL has adequately considered and reduced SFAIRP, the risks and consequences associated with the nitrogen release for phase 2 activities. No reservations have been identified and the assessment supports the permissioning decision.

3.2 MATTERS ARISING

86. Low temperature performance of park stands

87. SL has identified [22] a shortfall against modern standards expectations with respect to the low temperature (between -5°C and 0ºC) performance of the auxiliary seal plug park stand and the silo roof plug park stand systems coincident with a 1 in 10,000 year, 0.25g design basis seismic event. Should the park stand systems fail, there is potential for them to collapse, shedding their load of the silo roof plug or ASP. This in turn, could impact the operations floor or neighbouring safety systems in the vicinity of compartments 5 and12.

88. SL has subsequently provided supplementary safety case documentation [23] with revised calculations that show a dynamic withstand from a seismic event down to -3°C reducing the risk gap further.

89. An ONR structural integrity specialist inspector has considered [24] SL's assessment of the park stands and considers that SL's approach and judgement that the park stands are suitable for use to temperatures down to 0°C is reasonable. The basis for this is that SL has utilised an appropriate design code for load cases that include seismic withstand. Additional confidence is based on the stands being fabricated using approved welding procedures and welders, and all welds were non-destructively examined on completion with no defects being found. Critical welds and weld repairs/modifications have also been subjected to further non-destructive examination following renovation, again with no defects being found.

90. SL's ALARP case is based on the following arguments:

- Should the event be realised, there would be some damage to the operations floor, but no major loss of containment and there would be no loss of silo liquor.
- The only safety systems considered at risk are the QPVs in the vicinity of C5 and C6 where the park stand will be located. There are three QPVs fitted to these compartments and the geography show [25] that only one is at risk, leaving two available to maintain chronic hydrogen management (only one QPV being required to maintain the safety function).
- As the initiator is a seismic event it would be expected that there would be wider ranging considerations before resuming operations and therefore it is not a dominant delaying factor to restarting retrievals post seismic event.
- The likelihood of a coincidental 0.25g design basis seismic event (1 in 10,000 year event) and a sustained period of sub-zero temperatures is considered very unlikely. It requires a sustained period to reduce the metal temperature to the sub-zero values, as the metal temperature will 'lag' the atmospheric temperature for a number of days. SL identifies that the last sustained period of low temperatures was 2010.

91. I also note that the use of the park stands in normal operations would be a transitory operation, being removed (complete with roof plug or ASP) when not required to maximise space on the operations floor. This further reduces the time at risk.

92. I concur with SL's ALARP statement that, as there are no significant radiological consequences, and that the initiating event is sufficiently remote, it would be disproportionate to delay the phase 2 commissioning activities. I note that SL's ALARP statement is predicated on the physical layout for C10 commissioning activities and does not include the package park stand utilised from phase 3 onwards. Therefore, the safety case arguments made here will need to be revaluated for subsequent hold points. I have raised regulatory issue RI7279 to ensure that the

appropriate considerations are made in a timely fashion to support permissioning of EW68 (phase 3) activities.

3.3 ONR READINESS INSPECTION

93. ONR undertook a readiness inspection of the MSSS project to support phase 2 activities [6]. The purpose of the inspection was to gain confidence that SL was ready to implement its revised safety case for phase 2 activities and inform the permissioning decision for HP41a.

94. At the time of inspection, SL's internal regulator identified through its HARR process nine outstanding activities which required action prior to implementation of the safety case. The ONR inspector was content that the HARR process and governance was sufficient to ensure these outstanding activities are appropriately managed in a timely manner. No further regulatory actions were considered appropriate or identified from the inspection. The HARR process is discussed further in section 3.4 below.

95. The inspection sampled SLs maintenance instructions, training provision and assessed the adequacy of SLs implementation of limits and conditions derived from the SL safety case [2]. The inspection was supplemented with a plant inspection and interviews with MSSS operatives. Based on the inspection, the inspector judged that SL provided sufficient evidence to demonstrate, subject to completion of the outstanding HARR activities, that it is ready to implement the safety case modification that will allow the commencement of phase 2 activities.

3.4 SL INTERNAL ASSURANCE AND GOVERNANCE

96. SL's internal regulator function has undertaken a Hazardous Activity Readiness Review (HARR) of the phase 2 activities. The HARR identified a number of findings that needed to be addressed before the phase 2 activities can commence.

97. SL's HARR findings [26] identified two areas which I considered to impact on ONR's permissioning decision. The first related to updating of the SCIP to identify all operating instructions affected by the modification. The second area related to adequacy emergency response instruction EOI/034. SL subsequently provided an update to the SCIP [27] and EOI/034[28]. I have reviewed these and content that they have been suitably amended. In addition I have confirmed with the SL internal regulator [29] that the intent of their HARR actions has been met by the revised document.

98. I am satisfied that the remaining HARR findings do not undermine safety or ONR's assessment judgements and can be closed out under SL's own governance arrangements [30]. These arrangements prevent SL from commencing operations until the HARR report is finalised.

99. In addition to the HARR process above, I have confirmed to my satisfaction that the SL proposal has been subject to internal governance by its independent nuclear safety assessment [31], management safety committee [32] and nuclear safety committee [33]. All have concluded that they have no objection to SL's proposed modification, which provides additional regulatory confidence.

3.5 STAKEHOLDER ENGAGEMENT

100. In accordance with the ONR/Environment memorandum of understanding, I have consulted the relevant EA inspector regarding whether the EA has any objections to commencement of this licensee proposal. The inspector confirmed that the EA has no objection to ONR granting the license permission to commence this activity [34].

101. I have confirmed with ONR Civil Nuclear Security specialists [35] that SL proposals for phase 2 activities have no impact on current security considerations.

4 CONCLUSIONS

102. Based on the safety case evidence sampled during this assessment process, I am of the opinion that for the proposed modification SL has provided adequate arguments and evidence to demonstrate that:

- It has done all that is reasonably practicable within the conduct of its undertaking, such that for the proposed activity it has reduced the risks to the public and workers ALARP.
- Suitable and sufficient safety measures have been designed and implemented to provide adequate control of the hazards.
- It has adequately implemented its safety case under LC 22 such that there are no safety shortfalls that would prevent ONR agreeing to SL's request.
- It has been subject to an adequate level of independent internal challenge and governance in accordance with SL's established arrangements.

5 RECOMMENDATIONS

103. I recommend that ONR issues License Instrument number 524 [36] giving permission for SL to commence the activities described in SL's proposal [2] that will result in the implementation of phase 2 (only) active commissioning trails of the MSSS compartment miscellaneous beta gamma waste retrieval scheme.

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