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Sellafield Pile Fuel Cladding Silo

**Agreement to installation and setting to work of the
waste retrievals and containerisation area**

Project Assessment Report ONR-SDFW-PAR-18-023
Revision 2
26 October 2018

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Published 11/18

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EXECUTIVE SUMMARY

Title

Agreement to installation and setting to work of the waste retrievals and containerisation area.

Permission Requested

The licensee, Sellafield Limited (SL) has requested (Ref. 1) the Office for Nuclear Regulation's (ONR) agreement under its licence condition (LC) 22(1) arrangements to the installation and setting to work of the waste retrievals and containerisation area (WRCA). This activity will take place at the Pile Fuel Cladding Silo (PFCS) on the Sellafield nuclear licensed site.

Background

PFCS is a legacy radioactive waste storage facility and the waste inventory presents one of the largest hazards at Sellafield. It is considered to present an intolerable risk due to the outdated design and age of the building and because of the large volume of intermediate level waste that it contains, much of which is flammable and some of which is pyrophoric. Argon gas is used to maintain a low oxygen environment within the silo to prevent fire.

SL's overall strategy is to eliminate the hazard from PFCS by removing the waste and placing it into modern safe storage. This will be done in two stages. The first of these – 'Early Retrievals' – involves accessing only compartment 5 of the silo and removing waste through a high level penetration in the compartment wall above level of the waste. The second stage – 'Full Retrievals' will take place once SL has gained sufficient knowledge, experience and confidence from the approach taken in compartment 5.

The Early Retrievals plant consists of the waste container handling area (WCHA), which is currently being installed at Sellafield after ONR granted permission in 2017, and the WRCA, the installation of which is the subject of this report. The WRCA consists of a number of specially constructed modules and will be used to access the silo whilst maintaining the inert argon atmosphere and to retrieve the waste using a crane. The waste will be loaded into stainless steel waste containers before being transported inside shielded Sellafield packages to an on-site interim storage vault.

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

There are no significant nuclear safety risks associated with the proposed installation and setting to work activities. However, given the importance of the hazard and risk reduction programme, and the nuclear safety significance that will be involved in the eventual operation of the waste retrievals route, ONR carried out an assessment of the design and proposed future operation as described in SL's pre-commencement safety report (PCSR).

Matters arising from ONR's work

ONR undertook a preliminary review of the safety case supporting the design of the WRCA as part of its assessment supporting its decision to grant permission for WCHA installation in 2017. This included specialist nuclear safety assessment in all relevant disciplines. At that time, ONR's assessment identified a number areas of concern associated with WRCA-related aspects of the case that, although did not prevent our agreement to WCHA installation, needed to be resolved for the WRCA. The concerns related to control of the waste retrievals crane; safety analysis regarding potential contact or impacts between the crane and silo interior; positioning of radiological monitoring instrumentation; and some human factors

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aspects associated with recovery procedures that might be needed to deal with a contaminated waste box exterior, or to replace / repair an item of failed equipment.

These areas for improvement were progressed by SL to secure necessary improvement ahead of WRCA installation. The focus of ONR's assessment has been to confirm the adequacy of these.

Following engagement with SL and consideration of additional evidence furnished to ONR, our specialist inspectors have confirmed that they have no remaining concerns that would prevent ONR agreeing to SL's proposal. Our inspectors identified no shortfalls in the safety case that would preclude issue of permission, but have made recommendations for areas of interest for ONR prior to granting permission for active commissioning and operation of the PFCS waste retrievals route.

Conclusions

PFCS is hazardous facility and an intolerable risk to the public. WRCA installation is a major step towards providing a capability to retrieve the waste from silo and to eliminate most of this hazard. There are no significant nuclear safety risks associated with the installation and setting to work activities. However, given the importance of the hazard and risk reduction programme, and the nuclear safety significance that will be involved in the eventual operation of the waste retrievals route, ONR's assessment has focussed on ensuring a compliant and fit-for-purpose design that will be able to undertake timely and effective compartment 5 waste retrievals whilst keeping risks as low as reasonably practicable (ALARP).

I consider that the PCSR for the start of waste retrieval is suitable and sufficient to justify the installation of the plant as designed. ONR is confident in the adequacy of the risk assessment and the identification of key safety functions and controls. Whilst a number of minor shortfalls had been identified during ONR's initial review of the PCSR in 2017, these have been adequately addressed by SL during the course of 2018, and the associated regulatory issues closed on the basis of additional evidence presented by SL. This view is underpinned by assessments undertaken by ONR nuclear safety specialist inspectors. I have had no objections to SL's proposal raised by the ONR Conventional Health & Safety or Civil Nuclear Security inspectors, or by the Environment Agency.

I am satisfied with the claims, arguments and evidence laid down within the safety case supporting the design of the WRCA, noting that further development of the case is expected as experience from trials is gained to support commissioning and then ongoing operations. ONR will retain oversight as the case continues to develop during this period and will be undertaking further permissioning before nuclear safety significant active commissioning is undertaken.

Recommendation

I recommend that ONR issues Licence Instrument 517 giving agreement to SL for installation and setting to work of the WRCA, in response to its request to ONR under its LC 22(1) arrangements.

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LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
AR	Assessment Report
BEPPS	Box Encapsulation Plant Product Store
C&I	Control & Instrumentation
CHS	Conventional Health & Safety
CNS	Civil Nuclear Security
DIF	Direct Import Facility
DAP	Duly Authorised Person
DR	Decision Record
EA	Environment Agency
HF	Human Factors
HBSC	Human-Based Safety Claim
LI	Licence Instrument
LC	Licence Condition
MCR	Main Containment Room
NLR	Nuclear Liabilities Regulation
NFR	Note for the Record (SL document)
ONR	Office for Nuclear Regulation
PAR	Project Assessment Report
PAU	Pre-Assembled Unit
PCSR	Pre-Commencement Safety Report
PICSR	Pre-Inactive Commissioning Safety Report
PFCS	Pile Fuel Cladding Silo
PMP	Plant Modification Proposal
RI	Regulatory Issue
RP	Radiological Protection
SAPs	Safety Assessment Principles
SL	Sellafield Limited
SQEP	Suitably Qualified & Experienced
TAG	Technical Assessment Guide
WC	Waste container ('box')
WCHA	Waste Container Handling Area
WCTA	Waste Container Transfer Area ('tunnel')
WLP	Waste Loading Port
WRC	Waste Retrievals Crane
WRCA	Waste Retrievals Containerisation Area

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1 PERMISSION REQUESTED

1. The Licensee, Sellafield Limited (SL) has requested (Ref. 1) the Office for Nuclear Regulation's (ONR) agreement under its licence condition (LC) 22(1) arrangements to the installation and setting to work of the waste retrievals and containerisation area (WRCA). This activity will take place at the Pile Fuel Cladding Silo (PFCS) on the Sellafield nuclear licensed site.
2. This project assessment report (PAR) records my judgement on the proposed activity as described in the SL plant modification proposal (PMP; Ref 2) and gives my recommendation to the ONR Sellafield Project Delivery Sub-Division Delivery Lead. It has been produced in accordance with ONR corporate-level guidance (Ref. 3) and Division-specific permissioning guidance (Ref. 4). The decision record (DR; Ref. 5) sets-out the permissioning strategy for this regulatory hold point (PFCS hold point HP13).
3. The installation of the WRCA follows-on from the installation of the waste container handling area (WCHA) which was permissioned by ONR in late 2017 (Ref. 6) and is close to completion. The completion of construction of the Early Retrievals infrastructure is a key activity ahead of commissioning of the plant in 2019 and the start of waste retrieval from PFCS compartment 5 in 2019/20.

2 BACKGROUND

2.1 History and hazard

4. PFCS is a legacy radioactive waste storage facility and the waste inventory presents one of the largest hazards at Sellafield. The exact composition of the waste is uncertain but includes significant inventories of flammable material, some of which could be pyrophoric. The silo is internally sub-divided into six individual compartments.
5. PFCS was commissioned in 1952 and routine waste disposals in to it continued until 1964. The silo has been in a state of care and maintenance since that time. The waste remained undisturbed in the air atmosphere within the silo until the late 1990s. Since then it has been continuously inerted with argon gas as a fire prevention measure. Oxygen levels, pressure and temperature are continuously monitored within the silo.
6. Although some structural enhancement has been undertaken, the facility falls short of modern nuclear design standards for a building with such a hazardous inventory. ONR has concluded (Ref. 7) that the overall risk arising from the building is intolerable with respect to the ONR Safety Assessment Principles (SAPs; Ref. 8). This is dominated by the risk of a silo fire, which could result in a large release of radioactivity on and off the site. Hazard and risk reduction through the safe retrieval of waste from PFCS and placement into modern standards interim storage, prior to a final safe disposal option, is the accepted solution.

2.2 Waste retrievals strategy and work undertaken to date

7. SL's overall PFCS strategy is to remove the waste in two key stages. The first of these – 'Early Retrievals' – involves accessing only compartment 5 of the silo and removing waste through a high level penetration in the compartment wall above the level of the waste. As well as achieving the first meaningful hazard reduction, SL intends that this 'lead and learn' approach will allow it to build knowledge and experience prior to commencing 'Full Retrievals' from PFCS – the second stage and the point at which

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waste retrieval will be undertaken from all compartments of the building. ONR has had oversight of the development of SL's strategy which we judge will achieve progressive hazard and risk reduction. We are supportive of the approach being taken, including the rationale for the selection of compartment 5, which has been chosen by SL to maximise the potential for learning.

8. SL has already completed various enabling and preparatory works, a number of which have been subjected to ONR assessment and permissioning, including:
 - removal of the roof-top transfer tunnel and strengthening of the building;
 - construction of a superstructure next to the silo – the key feature of which is a large open platform on which the retrievals plant and equipment can be located;
 - provision of a metal firefighting capability for additional defence-in-depth against a waste fire (Refs. 9 and 10);
 - clearance and removal of the internal deflector plates (Ref. 11);
 - Cutting of the six retrievals access penetrations, each of which is sealed by a gas-tight silo containment door (Ref. 12).
9. The Early Retrievals plant is specifically designed for compartment 5 retrievals (it will subsequently need to be modified for Full Retrievals). It consists of the 'downstairs' WCHA (located in the west garage below the retrievals platform) and the 'upstairs' WRCA (which will be located on top of the platform and will seal against the side of the PFCS building itself).
10. The WRCA will be used to access the silo using a crane, retrieve scoops of waste, load these into 3 m³ stainless steel waste containers (WC; also known as 'boxes'), apply the lid and lower these via a hoist-well into the WCHA. The WCHA receives the lidded WCs, bolts the lids, weighs the boxes, swabs for contamination and loads the box into a shielded Sellafield package (also known as an SL flask) for transport to the box encapsulation plant product store (BEPSS) via the direct import facility (DIF).

2.3 WRCA operations

11. The WRCA comprises nine separate pre-assembled units (PAUs; also known as 'modules'). The most significant module is the main containment room (MCR), which is a hermetically sealed room containing the waste retrievals crane (WRC). The MCR attaches to the silo wall via a flexible skirt around the silo containment door. It will be inerted using argon gas prior to opening the silo door, at which point it will effectively become part of the PFCS containment boundary. The WRC will enter the silo through the door and remove waste using a grab. This will be lifted back into the MCR where it will then be deposited into a 3 m³ box. The box is docked to a waste loading port (WLP) situated in the base of the MCR immediately in front of the silo door.
12. Once full, an airtight cover is closed over the WLP and the box is detached from the MCR. The box is transported via the bogie and rail system within the waste container transfer area (WCTA; 'tunnel') that runs beneath the MCR. At the end of the tunnel, the box lid is applied and the box lowered into the WCHA for swabbing and loading to a flask in readiness for export.

2.4 Future planned work

13. Two complete WRCA's are being built off-site. The first of these, 'Unit A', will be (subject to the agreement being considered within this PAR) transported to and

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installed at the Sellafield site. This will also include ‘setting to work’ activities (construction, installation checks and ‘travel well’ checks to confirm that the equipment has not been damaged during transit to site). The second WRCA, ‘Unit B,’ will remain off-site and will be used for operator training and to undertake trials involving a mock-up of a PFCS compartment filled with simulated waste material. We have a planned programme of ONR regulation and oversight for these activities.

14. Inactive commissioning activities (single item checks through to fully integrated systems checks to verify operation as per the design and safety intent) will take place in 2019 under a separate PMP. Active commissioning (i.e. the start of silo waste retrievals) will be the subject of a further PMP. ONR will retain regulatory oversight of all inactive and active commissioning activities, with the latter being subject to ONR agreement (via LI – see Ref. 13) before the activity may commence. In addition, ONR intends to conduct a LC 21 (Commissioning) Compliance Inspection in December 2018 to ensure SL has made and implemented adequate arrangements at PFCS for commissioning.

2.5 Relationship of this work to potential oxygen limit changes

15. Whilst the MCR has been designed to achieve an operational oxygen concentration of around 3% or less, there remains a possibility that some relaxation of the current oxygen limits and conditions (consisting of a number of different controls below an overall safety limit of 5% oxygen concentration) may be required depending on the as-installed performance of the MCR when subjected to testing with the silo containment door open. SL is developing a separate PMP (subject to a regulatory hold point and on which ONR has already undertaken early engagement with SL) that will seek to provide a safety case to justify this relaxation should it be required.
16. Initial leak testing on the MCR has provided confidence that the 3% target should be achievable (Ref. 14). ONR specialist inspectors’ view that the MCR design is suitable also provides confidence that the remaining uncertainty should not preclude ONR agreement to WRCA installation.

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

3.1 ONR permissioning

17. As with the PMP for WCHA installation (permissioned by ONR in 2017 – see Ref. 6), the PMP for WRCA installation has been designated by SL as Category C on the basis of only minor radiological safety significance¹. This is because the installation and inactive setting to work activities do not involve the silo itself and there are no significant risks to the building as a result of undertaking them.
18. Whilst the work will result in a change in the configuration of the PFCS facility, ONR’s routine inspection programme has identified no concerns with the emergency arrangements or evacuation plans, and I have not considered it necessary to re-evaluate these as part of this permissioning decision, although ONR will include this ahead of the active commissioning permissioning in 2018.

¹ The current definition of Category C includes: no significant changes to SL Operating Rules; no realistic fault scenarios that could lead to building evacuation; and no realistic fault scenarios that could lead to operator doses exceeding the 20 mSv annual limit or to off-site doses exceeding 1 mSv.

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19. However, given the significance of the hazard and risk reduction programme at PFCS and the importance of achieving safe design, construction and installation of retrievals plant, ONR decided to permission both WCHA and WRCA installation.
20. ONR's primary interest has therefore been to ensure that the Early Retrievals plant design is compliant and fit-for-purpose to enable timely and effective compartment 5 waste retrieval whilst keeping risks as low as reasonably practicable (ALARP). I have not focussed any significant ONR attention on practical WRCA installation activities because they are only of very minor nuclear safety significance (relating to working in low-level radiation and contamination controlled areas and judged by ONR to be well within the regime of routine access and operations at the Sellafield site)
21. It is recognised that waste retrieval will lead to an increase in risk due to the need to repeatedly access the containment boundary, disturb the waste mass and to handle and pack the waste into the WCs. However, doing nothing (i.e. continuing to store the waste within PFCS) is judged by both SL and ONR not to be tolerable given the limited remaining facility lifetime and current level of risk posed by the building. The proposed waste retrieval approach is a balance between managing the heightened short-term risk and removing the waste, to secure long-term risk reduction and the eventual elimination of the hazard.
22. The pre-commencement safety report (PCSR) supporting the design of the Early Retrievals plant was originally received by ONR in 2017 and assessed prior to permissioning WCHA installation (Ref. 15). This safety case covers both the WCHA and WRCA and both aspects were examined by ONR in 2017. Subsequently, SL took the decision to separate the installation of the WCHA from the WRCA for practical reasons and to avoid hazard and risk reduction programme delays. SL was in a position to proceed with WCHA installation in late 2017 but the WRCA would not be installed on site until late 2018. ONR therefore focussed on resolving only WCHA-related aspects prior to agreeing to WCHA installation (with one exception – see RI 5988 discussed in Section 3.2 below). ONR's assessment identified a number of low-risk WRCA-related concerns that did not prevent our agreement to the WCHA installation but were instead taken forward as Level 4 regulatory issues (RIs) to seek improvements in the PCSR and plant design prior to the WRCA installation permission; the subject of this PAR.

3.2 Overall approach – regulatory issues resolution

23. In line with the DR (Ref. 5) for this permission, on the basis that the design and safety case for the WRCA has been previously assessed as noted above, I have concentrated ONR's attention on evaluating the sufficiency of SL's evidence for the closure of the WRCA-related RIs (details are available on the ONR Issues Database or through the tracking spreadsheet at Ref. 16):
 - RI 6050. This was owned by the ONR Civil Engineering Inspector and was related to aspects associated with potential silo structural damage during silo waste retrieval;
 - RI 5898. This was owned by the ONR Control & Instrumentation (C&I) Inspector and was related to the identification of protective measures to mitigate silo wall impacts. This RI was predominantly directed at C&I measures but also covered the need for development of the safety case's fault schedule. It has some overlap with RI 6050 which was managed through regular communication between the lead inspectors;

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- RI 5993. This was owned by the Human Factors (HF) Inspector and was related to the HF substantiation associated with a number of aspects of the operability and maintainability of the WRCA;
- RI 6049. This was owned by the Radiological Protection (RP) Inspector and was associated with a need for SL to consider and justify the dose rate monitoring provision in the WRCA and WCHA.

The above WRCA-related issues are discussed in greater detail in Section 4 of this PAR. All four issues have been successfully resolved and closed-out to ONR's satisfaction on the basis of further discussion and provision of evidence from SL, as summarised in an overarching note for the record (NFR) (Ref. 17) that supplements the 2017 PCSR (Ref. 15) with an SL commitment to fully embed the additional information into the pre-inactive commissioning safety report (PICSR).

24. Two further RIs (both of which are now closed) were also raised following ONR's assessment of the WCHA installation PMP (details are available on the ONR Issues Database or through the tracking spreadsheet at Ref. 16). These RIs were not related to the WRCA, but ONR has used the current WRCA installation permission as leverage to secure progress and closure.
- RI 5988. This was owned by the HF Inspector and was related to the HF substantiation of the contingency arrangements in place to deal with an unexpectedly contaminated WC in the WCHA. This RI has been closed on the basis of further evidence from SL;
 - RI 5189. This was owned by the Fault Studies Inspector and related to the clarity of limits and conditions associated with in-silo oxygen levels. This RI has since been closed on the basis that it subject to separate regulatory hold point and will be addressed during ONR's ongoing assessment of SL's proposal to amend the said limits and conditions (see Section 2.5).

3.3 Nuclear safety assessment

25. ONR assessment reports (AR) were completed in late 2017 following assessment of the PCSR (covering both the WCHA and WRCA) in support of permissioning the installation of the WCHA and remain applicable to this assessment. These assessments covered all of the relevant nuclear safety disciplines: fault studies, mechanical engineering, civil engineering, chemical (process) engineering, control & instrumentation, radiological protection and human factors (Refs. 18-24 respectively).
26. However, as discussed in Section 3.1, there has been additional ONR engagement and assessment in some areas as a result of the interventions to resolve the regulatory issues that were raised during the permissioning of WCHA installation. I have judged it proportionate to obtain further ONR specialist advice and sought assessment in civil engineering, C&I and HF. This was due to the RIs associated with each of these topics. ONR assessment reports (AR) have therefore been produced in these areas and are summarised below.
27. I did not seek further formal assessment or ARs from mechanical engineering, fault studies or chemical (process) engineering inspectors (Refs. 25-27 respectively). This is because no RIs were raised in these specific areas, although the relevant specialist inspectors have been consulted in the resolution of the RIs that were raised. In agreement with the RP Inspector we also judged that it was not necessary to seek an AR in this area (Ref. 28). This ALARP justification for the dose rate monitoring equipment was straightforward and enabled closure of the RI 6049 with no further assessment needed.

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28. None of the aforementioned specialist inspectors have any objection to the issue of the LI agreeing to WRCA installation on the basis of their previous PCSR assessments and closure of the related RIs.
29. I have not sought formal assessment from the Nuclear Liabilities Regulation (NLR) Inspector as there will be minimal radioactive waste arisings which can be easily managed through SL's normal waste management practices and routes. It has been agreed (Ref. 5) that the NLR input to PFCS retrievals permissioning (which has been ongoing through a separate regulatory intervention to date) will be captured in an AR informing the start of waste retrievals in 2019/20.

3.4 Consultation with respect to nuclear security, Conventional Health & Safety, environment and safeguards

30. To inform this permissioning decision I have consulted with the ONR Civil Nuclear Security (CNS) Inspector, the ONR Conventional Health & Safety (CHS) Inspector and the Environment Agency (EA). SL's PMP does not directly relate to the safeguarding of nuclear material although there are potential safeguarding considerations during waste retrieval. I intend to undertake further consultation with the appropriate Safeguards Inspector in support of PFCS permissioning work in 2019/20.

4 MATTERS ARISING FROM ONR'S WORK

4.1 Further ONR nuclear safety assessment findings

4.1.1 Civil engineering

31. The Civil Engineering Inspector identified in their original assessment (Ref. 19) that the proposed retrievals activities create the risk of localised damage to the concrete walls of the silo that could threaten containment. The inspector recognised that this additional shorter-term risk needed to be balanced against the overall need for hazard and risk reduction and was able to conclude that the PCSR provided an adequate substantiation for the WRCA from a civil engineering perspective judged against the ONR SAPs and the ONR civil engineering and external hazards technical assessment guides (TAGs).
32. However, the inspector considered that SL had not fully demonstrated that risks will be controlled to ALARP with respect to of the potential for structural damage to the silo and raised RI 6050 to seek further evidence with respect to the following items, which were raised in the original AR as four recommendations:
- Detailed operating instructions for the inspection of the internal faces of the concrete as the waste level is reduced, including the requirement for suitably qualified and experienced persons, should be developed;
 - Off-site demonstration of the waste recovery equipment in a mock-up of the compartment would provide increased confidence in the ability of the proposed equipment and operator controls to mitigate against impacts that could lead to through-wall cracking so far as is reasonably practicable;
 - Reasonably practicable engineering measures should be implemented to mitigate against the possibility of the telescopic boom springing upward and impacting the silo roof in the event of the release of a trapped grab;
 - The brickwork panel toward the bottom wall of the compartment should be substantiated against potentially repetitive impact loads from the grab. If substantiation cannot be achieved, strengthening or other further mitigating actions should be considered.

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33. Following engagement with SL and the submission of further documentation, the Civil Engineering Inspector is now of the opinion that the additional information provided by SL was sufficient to allow RI 5060 to be closed (Ref. 29) although some further evidence needs to be collected to address uncertainties and further underpin SL's evidential claims, which can only be collated during the off-site retrievals training using the WRCA mock-up or during the phased start to active retrievals. Whilst these do not represent any safety significant concerns, the inspector has four new recommendations identifying areas for continued ONR oversight prior to the permissioning of active waste retrievals:
- Recommendation CE1. The Project Inspector, together with a Civil Engineering Specialist Inspector, should review the experience gathered regarding the frequency and severity of impacts between the extending boom and the containment walls. Experience should be gathered by the duty holder from both the off-site operator training in the compartment mock-up and during the initial stages of Early Retrievals from compartment 5. This experience should be reviewed by ONR both during Early Retrievals from compartment 5 and prior to the subsequent regulatory hold point associated with Full Retrievals;
 - Recommendation CE2. The availability of operator and Duly Authorised Person (DAP) training and instructions relating to operator measures to protect the concrete containment should be confirmed prior to start of Early Retrievals in compartment 5. This should be confirmed by ONR during the compartment 5 active commissioning readiness inspection;
 - Recommendation CE3. The Project Inspector should review the experience gathered regarding the avoidance of creating of shelves, pillars or pits in the waste during retrievals. Avoiding shelves, pits and pillars is a key operational requirement to protect the containment walls, especially the masonry infill panels, from impacts from a swinging grab. Experience should be gathered by the duty holders from both the off-site operator training in the compartment mock-up and during the initial stages of Early Retrievals from compartment 5. This experience should be reviewed by ONR both during Early Retrievals from compartment 5 and prior to the subsequent regulatory hold point associated with Full Retrievals;
 - Recommendation CE4. The record drawings indicating the thickness of the masonry lining to the bottom of compartment 5 should be verified by the duty holder once the masonry becomes exposed as waste retrievals progresses. The information should be provided to the Project Inspector as it becomes available.
34. I support these recommendations and will make arrangements to ensure their resolution as part of the PFCS permissioning strategy. I note that the evidence of interest will only become available during off-site training in the compartment mock-up or during the commissioning.
35. The Civil Engineering Inspector is satisfied (Ref. 29) that, once completed, the project will progress preparations for retrieval of waste and hence will contribute to hazard and risk reduction at Sellafield. The inspector also notes that they are satisfied that SL's civil engineering arrangements within the safety case and associated documentation are appropriate and that the project contributes to hazard and risk reduction in the medium to long term. The inspector supports the issue of the LI giving ONR's agreement to the proposed WRCA installation activity.

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4.1.2 Control & instrumentation

36. The C&I Inspector, having assessed the PCSR in 2017, considered that the claims made against the C&I equipment were appropriate and adequately substantiated (Ref. 22) but they identified areas for improvement relating to the lack of a formal safety claim against the in-silo CCTV system and the justification for the lack of engineered protection against impact of the WRC with the silo wall. This latter finding primarily related to the C&I aspects of the WRC control system but overlapped partly with the Civil Engineering Inspector's finding that the ALARP position for minimising structural damage had not been fully demonstrated at that time. The C&I Inspector raised the following two recommendations in their original AR:
- I recommend that SL undertakes further optioneering to consider the practicability of simple engineered measures that could be implemented to reduce the risk of WRC impacts causing damage to the silo wall. Should SL conclude that no reasonably practicable means exist to further reduce risks by engineered measures, SL should provide a justification of its ALARP position;
 - I recommend that SL assigns an appropriate safety classification to the PFCS process CCTV system that recognises the system's importance to safety, and that SL makes adequate arrangements to manage the system through its lifecycle.
37. In subsequent internal discussion, it was decided that the C&I Inspector would raise a single regulatory issue (RI 5898) with four aspects associated with:
- SL improving the fault analysis to identify the variety of different in-silo impacts together with frequency, potential consequences and available protective measures;
 - SL improving its ALARP justification for the existing potential measures and consideration of further options;
 - Improvement in SL's procedures to ensure wall impacts are detected;
 - The need for SL to properly recognise the safety significance of the CCTV system and assign formal safety classification.
38. After engagement with SL and the submission of further evidential documentation, the C&I Inspector gained sufficient confidence and evidence on the above issues to enable the closure of RI 5898. The inspector (Ref. 30) is now of the opinion that the current retrievals plant and equipment provide adequate defence in depth against silo wall impacts resulting in a loss of bulk waste containment and that SL has demonstrated, for the Early Retrievals project, that the risk has been reduced ALARP. The inspector is also content that SL has recognised the safety significance of the in-silo CCTV system and has assigned an appropriate safety classification and adequately demonstrated the system's reliability.
39. However, whilst not a significant safety concern, the inspector considers that SL should, in the medium term, revalidate its position with regard to in-silo wall impacts prior to Full Retrievals using the knowledge and experience that will be gained during Early Retrievals. The inspector captured this in the following recommendation:
- Recommendation CI1. I recommend that, as part of developing the safety case for the PFCS Full Retrievals project, SL undertakes further risk analysis and optioneering to ensure that the risk of silo wall impacts leading to loss of bulk waste containment are fully understood and are reduced ALARP.
40. I agree with this recommendation. It is part of the ONR permissioning strategy to ensure that SL considers the experience of Early Retrievals as part of the ALARP

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position for the Full Retrievals project, and this will include the further analysis and optioneering of silo wall impacts and protective measures.

41. The C&I Inspector (Ref. 30) supports the issue of the LI giving ONR's agreement to the proposed WRCA installation activity.

4.1.3 Human Factors

42. The HF Inspector undertook a preliminary review of the PCSR (Ref. 24) in 2017 in support of permissioning WCHA installation. As well as a now-resolved concern relating to the WCHA itself (RI 5988 – see Section 3.1) the HF Inspector also identified some concerns relating to their observation of departures from SL's normal HF standards and a need for further evidence to support the human-based safety claims (HBSCs) being placed on the WRCA and its operation. These were captured in the following recommendation and subsequently taken forward in RI 5993:

- SL to provide further evidence in support of the explicit and implicit human-based safety claims and radiological exposure times for PFCS Early Retrievals tasks in the 'upstairs' of the housing (PMP4). This should include:
 - (a) Confirmation of the achievability of maintenance/housekeeping tasks and the feasibility of foreseeable recovery tasks within the waste retrievals and containerisation area;
 - (b) Substantiation of the claims made on the operator to remotely drive and control the WRC and housekeeping robot (including joystick controls);
 - (c) Exploration of additional task support options for operation of the WRC within the silo;
 - (d) Compilation of a list of all man-entry tasks for the MCR and WCTA then liaise with PFCS project HF to ensure the correct exposure times are used in dose assessments.

43. The HF Inspector has completed a further assessment of the PCSR, including the additional supporting documentation provided by SL in response to RI 5993. This additional evidence is judged by the inspector as sufficient to support the closure of the regulatory issue. On the basis of further information acquired during the inspector's engagements with SL on RI 5993, the HF Inspector undertook additional assessment to build on that undertaken in 2017 (Ref. 24), focussing on topics discussed in the following paragraphs.

44. Based on the available design and safety case evidence, the inspector considers that there is confidence in the adequacy of the in-silo views provided by the CCTV system, but judges (against the applicable ONR SAPs and TAGs) that confirmation is needed to support the full substantiation, noting that aspects of this (e.g. CCTV screen refresh rates) will only be available during WRCA commissioning, and recognising that the operators' view of the retrieval operations is needed to ensure the necessary control over WRC movements.

45. The inspector is concerned that the design of a joystick control for the WRC (the control operating the grab) is sub-optimal from an ergonomic design aspect. The inspector is content for SL to proceed with progressing to trials using the sub-optimal design following commitment from SL that alternative joystick designs as well as physical and C&I support tools will be implemented if the physical trials confirm that the current proposal leads to unacceptable errors in control of the WRC grab. I will ensure that ONR is satisfied that SL either successfully demonstrates the appropriateness of the joystick design, or undertakes the necessary design changes prior to giving ONR agreement for active commissioning.

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46. The inspector has raised the following recommendation, which I support and will implement as part of ONR's Project Delivery activity during the commissioning phase:
- Recommendation HF1. ONR to provide oversight of SL's proposed trials of the WRC joysticks to ensure the design adequately supports reliable operations.
47. The inspector considers that whilst SL's case provides an initial demonstration that there is sufficient space within the MCR to undertake remedial work in the event of an unplanned break down, further justification will be needed to support active commissioning. The inspector has secured a commitment from SL to undertake a trial of the bounding activity using the trial facility at Rosyth and has raised a further recommendation:
- Recommendation HF2. ONR HF to consider attending SL's demonstration of the Housekeeping Manipulator replacement task at Rosyth to gain confidence that all risks have been reduced to ALARP and that this maintenance task is proven prior to Active Commissioning.
48. I agree with this recommendation and have already agreed with SL that ONR will be invited to witness the trial activity.
49. In summary, the HF Inspector supports the issue of the LI giving ONR's agreement to the proposed WRCA installation activity, having noted that there are some ongoing uncertainties but that appropriate plans are being made by SL to resolve these issues through the test programme using the trial WRCA at Rosyth.

4.2 Consultation with respect to nuclear security, Conventional Health & Safety, environment and safeguards

50. The ONR CNS Inspector, ONR CHS Inspector and the responsible EA Inspector have all confirmed that they have no objection to the issue of the LI giving ONR's agreement to the proposed WRCA installation activity (Refs. 32-34 respectively).

5 CONCLUSIONS

51. This report presents the findings of ONR's assessment of SL's proposal for installation and setting to work of the WRCA as part of the PFCS Early Retrievals project.
52. PFCS is hazardous facility and an intolerable risk to the public. WRCA installation is a major step towards providing a capability to retrieve the waste from silo and to eliminate most of this hazard. There are no significant nuclear safety risks associated with the installation and setting to work activities. However, given the importance of the hazard and risk reduction programme, and the nuclear safety significance that will be involved in the eventual operation of the waste retrievals route, ONR's assessment has focussed on ensuring a compliant and fit-for-purpose design that will be able to undertake timely and effective compartment 5 waste retrievals whilst keeping risks ALARP.
53. I consider that the PCSR is suitable and sufficient to justify the installation of the plant as designed. ONR is confident in the adequacy of the risk assessment and the identification of key safety functions and controls. Whilst a number of minor shortfalls had been identified during ONR's initial review of the PCSR in 2017, these have been adequately addressed by SL during the course of 2018, and the associated regulatory issues closed on the basis of additional evidence presented by SL. This view is underpinned by assessments undertaken by ONR nuclear safety specialist inspectors. I have had no objections to SL's proposal raised by the ONR CHS or CNS inspectors, or by the EA.

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54. I am satisfied with the claims, arguments and evidence laid down within the safety case supporting the design of the WRCA, noting that further development of the case is expected as experience from trials is gained, in order to support commissioning and then ongoing operations. ONR will retain oversight as the case continues to develop during this period and will be undertaking further permissioning before nuclear safety significant active commissioning is undertaken.

6 RECOMMENDATIONS

55. I recommend that ONR issues LI 517 giving agreement to SL for installation and setting to work of the WRCA, in response to its request to ONR under its LC 22(1) arrangements.
56. I have prepared the appropriate LI to implement this recommendation (Ref. 35).

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