Pile Fuel Cladding Silo

Agreement to commence deflector plate removal/size reduction operations using high pressure water jet cutting

Project Assessment Report ONR-SDFW-PAR-16-011
Revision 0
16 September 2016

EXECUTIVE SUMMARY

Title

Agreement to commence deflector plate removal/size reduction operations using high pressure water jet cutting.

Permission Requested

The licensee, Sellafield Limited (SL), has requested the Office for Nuclear Regulation's (ONR) agreement under its Licence Condition (LC) 22(1) arrangements to commence deflector plate removal/size reduction operations using high pressure water jet cutting. This activity will take place within the Pile Fuel Cladding Silo (PFCS) on the Sellafield site.

Background

PFCS is a legacy waste storage facility that is one of the largest hazards on the Sellafield site and is considered to present an intolerable risk. Deflector plate removal (DPR) is a key enabling activity within the programme of work to access the silo and retrieve the waste.

The deflector plates are inverted v-shaped steel plates supported by two parallel steel beams running through the upper part of the compartmentalised silo. DPR involves dismantling these deflector plates and the associated supporting beams by cutting them into smaller pieces that will be allowed to fall into the silo onto the existing waste mass. They will ultimately be removed as part of the waste retrieval process. SL has selected remote water jet cutting (WJC) as the technology with which it will cut the plates and beams. Argon inerting will be maintained at all times with the exception of the brief periods during which the long-reach WJC tooling is installed or removed. The tooling will be inserted through existing small holes in the north and south side walls of the silo, controlled from existing elevated access platforms outside the silo compartments.

A key advantage of WJC is the avoidance of sparks or high temperatures and no requirement for electricity, hydraulic fluid or sharp moving parts inside the silo. The main disadvantage is the introduction of water onto the waste mass, which could accelerate the corrosion of Magnox or react with some of the other materials that may be present. The resulting hydrogen gas produced could lead to the formation of a flammable atmosphere in the event of the failure of the argon inerting.

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

ONR has carried out a programme of work to assess the activities proposed by SL and the supporting safety case. The safe management of the fire and hydrogen hazard has been the primary focus of ONR’s assessment.

I have sought specialist support in the following nuclear safety assessment disciplines: fault studies, chemical engineering, civil engineering, mechanical engineering, control and instrumentation and human factors. ONR’s assessment of the safety case has been supported by a number of engagements with the licensee, a visit to the full-scale WJC test rig and the findings from a number of recent relevant ONR inspections. I have also gained confidence through an independent readiness review undertaken by the SL Internal Regulator.

I have consulted with ONR specialists in conventional health and safety and civil nuclear security, and with the Environment Agency.

Matters arising from ONR's work

ONR specialist inspectors have engaged with the licensee to resolve a number of minor clarifications and apparent shortfalls. In particular, additional assessment was needed to understand some safety case changes resulting from a change in the type of hydrogen measurement technology and to gain further confidence in human factors aspects. Following engagement with the licensee, the specialist inspectors had no remaining concerns that would prevent their support to agreeing to the licensee's proposal.

No objections to the licensee's proposal were raised by the ONR conventional health and safety or civil nuclear security inspectors, or by the Environment Agency.

Conclusions

PFCS represents an intolerable nuclear safety risk in its current state and DPR is a critical enabler to the longer-term hazard and risk reduction programme that will eventually eliminate the hazard by removing the waste. For a short period of time, DPR increases the risk presented by PFCS, as an unavoidable consequence of needing to temporarily add or withdraw tooling through the containment boundary, in introducing water into the silo and in causing some waste disruption as a result of the pieces of deflector plate falling onto the waste mass below. Noting the additional safety precautions, extensive testing and close supervision of the work proposed by the licensee, I judge that the risk increase is acceptable when compared to the background risk posed by the building.

I am satisfied with the claims, arguments and evidence laid down within the PFCS DPR safety case. I am of the opinion that the decision by the licensee to undertake DPR using high pressure water jet cutting, together with the supporting arrangements and additional safety measures, in particular those to manage any evolved hydrogen gas and to provide defence in depth against a fire, minimise the overall level of risk to be As Low As Reasonably Practicable.

Recommendation

I recommend that ONR issues Licence Instrument 903 giving agreement to the commencement of deflector plate removal/size reduction operations using high pressure water jet cutting, in response to the licensee's request to ONR under its licence condition 22(1) arrangements.

LIST OF ABBREVIATIONS

ALARP	As low as reasonably practicable
C&I	Control and Instrumentation
CHS	Conventional Health and Safety
CNS	Civil Nuclear Security (ONR)
DJR	Design Justification Report
DPR	Deflector Plate Removal
HF	Human Factors
HOW2	(Office for Nuclear Regulation) Business Management System
MSC	Management Safety Committee
NSC	Nuclear Safety Committee
ONR	Office for Nuclear Regulation
OSM	Operational Safety Memorandum
PFCS	Pile Fuel Cladding Silo
RGP	Relevant Good Practice
SAP	ONR Safety Assessment Principle(s)
SDFW	Sellafield, Decommissioning, Fuel and Waste (ONR Programme)
SL	Sellafield Limited
WJC	Water Jet Cutting

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PERMISSION REQUESTED

1. The licensee, Sellafield Limited (SL), has requested the Office for Nuclear Regulation's (ONR) agreement (Ref. 1) under its Licence Condition (LC) 22(1) arrangements to commence deflector plate removal/size reduction operations using high pressure water jet cutting. This activity will take place within the Pile Fuel Cladding Silo (PFCS) on the Sellafield site.

2. This project assessment report (PAR) records ONR's judgment on the proposed activity and permissioning decision as set-out in the SL plant modification proposal (PMP; Ref. 2). It has been produced in accordance with ONR corporate-level guidance (Ref. 3) and programme-specific permissioning guidance (Ref. 4). The decision record (Ref. 5) setting-out the permissioning strategy for this regulatory hold point (PFCS Hold Point 5) has been previously agreed with the ONR Sellafield, Decommissioning, Fuel and Waste (SDFW) Sellafield Project Delivery Sub-Programme Delivery Lead.

3. Deflector plate removal (DPR) is a key enabling activity to the retrieval of waste from PFCS which is needed to reduce the intolerable hazard currently posed this legacy facility. Hazard and risk reduction at the Sellafield legacy ponds and silos is the top priority within the ONR Annual Plan and, more specifically, is Objective 2 of the SDFW Programme Strategy.

1 BACKGROUND

1.1 History and hazard

4. PFCS is a legacy waste storage facility that is one of the largest hazards on the Sellafield site. The exact composition of the waste it contains is uncertain. The bulk of it is made-up from Magnox and aluminium fuel element cladding along with graphite. It also contains slivers of uranium metal upon which pyrophoric uranium hydride may have formed. Other miscellaneous items are known to have been tipped into the silo including textiles and cans containing metallic sodium.

5. PFCS was commissioned in 1952 and routine disposals to the silo 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 when it has been 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 containing such a hazardous inventory. An assessment carried out by ONR (Ref. 6) concluded that the overall risk arising from this ageing building is intolerable with respect to the current ONR Safety Assessment Principles (SAPs; Ref. 7).

7. The retrieval of the waste inventory is the key to reducing the hazard presented by PFCS. The decommissioning programme for PFCS contains a number of stages: deflector plate waste clearance, DPR, creating the retrievals access penetrations (also known as hole cutting), early waste retrieval operations in one compartment (to demonstrate and refine the approach) and then full waste retrieval from the remaining compartments.

1.2 Deflector plate removal

8. The deflector plates are inverted v-shaped steel plates supported by two parallel steel beams running through the upper part of the silo. Their original function was to direct

the incoming waste, which was tipped through charge holes in the roof, between the north and south sides of each compartment. Deflector plate waste clearance was successfully completed in the latter part of 2015 and early 2016, clearing the plates of the accumulated waste that had built up on the surface.

9. The next stage of the work, which is the subject of this PAR, is to dismantle the deflector plates and support beams by cutting them into smaller pieces that will be allowed to fall into the silo onto the existing waste mass. They will ultimately be removed as part of the waste retrieval process. SL has selected remote water jet cutting (WJC) as the technology with which it will cut the plates and beams. Argon inerting will be maintained at all times with the exception of the brief periods during which the long-reach WJC tooling is installed or removed. The tooling will be inserted through existing small holes in the north and south side walls of the silo, controlled from existing elevated access platforms outside the compartments.

10. WJC cuts using a tightly-focussed, high pressure mixture of water and entrained abrasive particles. It is not a novel technology and the equipment has been largely purchased commercially off-the-shelf and tested by SL at a full-scale mock-up of part of the interior of the silo. A key advantage of WJC is the avoidance of sparks or high temperatures and no requirement for electricity, hydraulic fluid or sharp moving parts inside the silo. The main disadvantage is the introduction of water into the waste mass, which could accelerate the corrosion of Magnox or react with some of the other materials that may be present to form hydrogen gas. If uncontrolled and not inerted, this could lead to the formation of a flammable atmosphere.

1.3 Basis of safety

11. In addition to the existing argon inerting system, oxygen monitoring and a recently-introduced metal firefighting capability (see Refs. 8 and 9 for details); SL has installed hydrogen measurement instrumentation to the silo. The safety case for WJC states that the addition of water to the silo during WJC will be carefully controlled. Water will be introduced in separate batches followed by defined periods of increased argon supply to ensure that any hydrogen produced is flushed out of the waste mass. The addition of further water will only be permitted if the hydrogen level is within safe limits. The safety limit ensures, with some margin, that a flammable atmosphere cannot occur, even in the event of a loss of argon inerting with significant air ingress.

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

12. ONR has carried out a programme of work to assess the activities proposed by SL and the supporting safety case. SL's request for permission to commence DPR (Ref. 1) is supported by a plant modification proposal (PMP) comprising the following tasks:

- implementation of new hydrogen management arrangements, including a new operating rule on the maximum safe hydrogen concentration;
- implementation of modifications to the effluent system and drainage procedures to accommodate the additional water run-off from the silo;
- to erect scaffolding and other undertake other external preparatory work, deploy cameras and tooling into the silo and to undertake WJC itself;
- to adjust argon flow rates following a WJC campaign in order to optimise argon usage whilst still maintaining a safe hydrogen concentration;
- on completion of WJC, to re-baseline the argon flow rates and allowable argon isolation times based on the measured hydrogen levels and behaviour within the individual compartments.

13. The safety case is based on the following key reports (full details and references are provided in Ref. 10):

- plant modification proposal (PMP) and appendices;
- safety assessment summary report;
- hydrogen management operational safety memorandum (OSM);
- DPR operations OSM;
- hydrogen management design justification report (DJR);
- DPR operations DJR;
- formal notes for the record and responses capturing clarifications and supplementary arguments.

14. The safety case has been designated by SL as Category A on the basis of the significant on- and off-site doses that could arise in the event of a major silo fire. The safety case has been subject to the scrutiny and approval of PFCS Management Safety Committee (MSC) and the SL Nuclear Safety Committee (NSC).

15. The safe management of the fire and hydrogen hazard has been the primary focus of ONR's assessment work:

- Hydrogen management. Sufficient hydrogen evolution in conjunction with sufficient air ingress could produce an atmosphere that would support a hydrogen deflagration and lead to a fire and/or loss of containment. As the introduction of water into the silo during WJC increases the risk of hydrogen evolution, this has been ONR's main focus.

- Non-hydrogen related fire. A fire involving the flammable content of the silo, unrelated to hydrogen, is a risk that exists within PFCS prior to as well as during DPR in the event of sufficient air ingress and an ignition source; but DPR increases the risk due to unavoidable waste disruption and the need for temporary breaches of the containment boundary.

16. Areas of secondary assessment focus have been:

- Safe operation of the engineered effluent route. The effluent route is a series of modifications to the existing drainage system used to drain water away from the bottom of the silo. The drainage system has been modified so that it can support the drainage of any water introduced by WJC. Any liquor is not expected to be highly active but could still represent a radiological hazard.

- Maintenance of structural stability. The ongoing structural stability is important to maintaining containment and thus the inerted atmosphere.

- Effectiveness and efficiency of DPR operations. DPR represents a period of elevated risk and should the WJC process take longer and/or use more water the both the magnitude and duration of this risk would be increased. Time delays will also have a knock-on impact on the overall decommissioning schedule, extending the time to waste retrieval and delaying the remediation of the facility.

17. Given the significant risks associated with PFCS, I judged it proportionate to obtain specialist inspector advice. I therefore sought assessment of the submitted safety case from the following specialist areas:

- Fault studies. This has been to assess the fault analysis aspects of the safety case, the overall risk profile and control measures against key faults.

- Chemical engineering. This has been to assess the arrangements for argon inerting and oxygen control, and the strategy for managing hydrogen.

- Mechanical engineering. This has been to assess the WJC technology choice and its effectiveness and efficiency. The liquid effluent drainage route and the adequacy of the existing filtered off-gas route was also considered.

- Civil engineering. This has been to assess the structural implications due to the removal of the beams/plates and the weight of the added water.

- Control and instrumentation (C&I). This has been to assess the instrument aspects of the oxygen and hydrogen monitoring instrumentation and their substantiation.

- Human factors (HF). This has been to assess the case for human-based safety claims given the reliance on operator actions under normal and fault conditions.

18. In agreement with the specialist inspectors involved and based on their involvement in some of the early engagement with the licensee (see Refs. 11 and 12), I did not consider it necessary to request formal safety assessment in the following areas, but sought advice as to our expectations of the licensee's approach.

- Radiological protection. To provide advice on the case for radiation and contamination control arrangements.

- Internal hazards. The only significant internal hazard relates to the fire risk. This has already been considered in detail by the Chemical Engineering Inspector and Fault Studies Inspector.

- Nuclear liabilities. To provide advice on the case for the disposal of the waste that will be generated by DPR, the addition of the deflector plate pieces to the silo waste, and the effect of WJC on the characteristics on the waste.

19. I have consulted with ONR specialists in conventional health and safety (CHS) and in civil nuclear security (CNS). I also have consulted with the Nuclear Regulator for Sellafield Decommissioning at the Environment Agency (EA). The licensee's PMP does not relate to the transport or safeguarding of nuclear material, therefore I have not consulted with ONR inspectors in these areas.

20. In addition to the above and to support the permissioning decision, ONR has taken note of the findings of an SL readiness inspection of PFCS to assess the implementation of the DPR safety case and its associated modifications. This inspection was carried out by a team of SL staff independent from the PFCS facility, including the SL Internal Regulator for PFCS.

2.1.1 Recent relevant ONR inspection and engagement activity

21. ONR has recently undertaken a number of on-site inspections/visits relevant to two of the safety systems and arrangements important to DPR. The positive findings provide additional confidence in argon inerting system, metal firefighting capability, emergency arrangements and the WJC arrangements.

- Systems-based inspection of the PFCS argon inerting system. This inspection (Ref. 13) concluded that the licensee had adequately implemented the safety case and the formal arrangements for LCs 10, 23, 24, 27 and 28 (covering training; operating rules; operating instructions; safety mechanisms, devices and circuits; and examination, inspection, maintenance and testing).

- Essential operations inspections of the PFCS metal firefighting capability. Following the two inspections (Refs. 8 and 9), ONR concluded that a suitable and sufficient metal firefighting capability had been attained and that it could be deployed in a timely manner. Some minor remaining issues were followed-up by the Sellafield Internal Regulator and the associated regulatory issue (number 3282) was closed in July 2016.

- Licence condition 11 (emergency arrangements) inspection. This inspection (Ref. 14) concluded that the licensee had adequately implemented its arrangements for LC11 at PFCS. Good practice was recognised in some areas but some minor improvements were also noted. These minor improvements have been followed-up by the SL Internal Regulator (see Ref. 15).

22. ONR has also undertaken a number of engagement meetings with SL (Contact Record Refs. 11, 17 to 21) and a visit to the full-scale WJC test rig (Ref. 22) to gain understanding of the technology, training, operating arrangements, safety arguments and to meet the personnel who will be undertaking and supervising the work.

23. I did not consider it necessary to undertake an ONR-led readiness inspection in support of this permissioning decision. This was as a result of the extent of engagement with the licensee, recent relevant inspections, a visit to the full-scale WJC test rig and given the confidence gained through the SL Internal Regulator independent readiness review (see Section 2.2 below).

2.2 Sellafield Internal Regulator independent readiness review

24. The Sellafield Internal Regulator, which now incorporates the former Sellafield Decommissioning Assurance Review Team, has undertaken an independent readiness review of the PFCS DPR project. ONR has had oversight of the scope of this review (Ref. 23) and I am content that it addressed all of the key aspects of people, plant and process associated with the implementation of the DPR PMP.

25. The review found a number of outstanding items that required addressing before the start of WJC, particularly relating to the final sign-off of a number of documents and the completion of some operator training and plant preparation activities; however, given the relatively early timing of the review, this was as expected by the review team.

26. The remaining Category A findings (considered by the review team to require completion prior to commencing WJC) were closed-out on 16 September 2016 (Ref. 24) with the exception of one finding noting that the ONR LI is required and one finding noting that final SL authorisation to proceed with the PMP is required.

3 MATTERS ARISING FROM ONR'S WORK

3.1 ONR nuclear safety assessment

3.1.1 Fault studies

27. The Fault Studies Inspector concludes that the risk of a hydrogen deflagration is acceptably low and that the risk of a non-hydrogen related fire involving the waste (due

to air ingress coincidental to spontaneous waste collapse or the disturbance resulting from a tool drop or as a result of deflector plate off-cut drops) is also acceptably low (Ref. 25). A review against the relevant SAPs (Ref. 7) showed that the safety case met ONR requirements in most regards, but that the quantitative fault analysis was a weakness. This, in the opinion of the Fault Studies Inspector, is not significant enough to prevent ONR's agreement to the start of DPR. ONR is seeking improvement for future submissions as part of a broader programme of work relating to the quality of SL safety cases under SDFW Programme Objective 1 for 2016/17.

28. The Fault Studies Inspector reviewed the ALARP argument for DPR and accepts that no further reasonably practicable improvements are apparent and the short term risk increase is outweighed by the long term risk reduction that will be achieved by the retrieval of waste from the silo, for which DPR is a critical enabling activity. The Fault Studies Inspector does not object to the issue of an LI giving ONR's agreement to the commencement of DPR.

29. Subsequent to the completion of the fault studies assessment, SL confirmed a decision to change to using a mass spectrometer as the hydrogen measurement instrument in place of the katharometers that had been the original intent. As much of the safety case, including those aspects of most interest to the Fault Studies Inspector, was deliberately written to refer to a generic hydrogen detection system rather than to reference the technology choice, this change is largely inconsequential. However, in addition to moving to the mass spectrometer, SL also took a decision to no longer categorise this hydrogen detection device as a 'safety mechanism' and instead designated it as 'normal plant'. There were then some changes in the safety case documentation to reflect this change. The Fault Studies Inspector undertook additional engagement with SL and further consideration of the safety case to assess this positon.

30. The Fault Studies Inspector judged that the updates to the safety case were acceptable and that there was sufficient defence in depth in terms of protection against an unexpected rise in hydrogen concentration (Ref. 26). He also re-confirmed that, in his opinion, the position remained ALARP.

3.1.2 Chemical engineering

31. The Chemical Engineering Inspector notes that the licensee's safety case for the management of hydrogen during deflector plate removal operations is based on maintaining an argon inert atmosphere within the silo at all times and performing water addition in batches to prevent hydrogen reaching flammable levels (Ref. 27). The Inspector has assessed this case against the requirements of the Dangerous Substances and Explosive Atmospheres Regulations 2002 and the ONR SAPs (Ref. 7).

32. The Chemical Engineering Inspector judges that the licensee's position is ALARP in terms of inerting the silo using argon to exclude oxygen and dilute any hydrogen. He accepts SL's assertion that there are no further reasonably practicable preventative actions in addition to the argon atmosphere that it could take to further reduce this risk.

33. The Chemical Engineering Inspector concludes that SL has adequate provisions to prevent a flammable atmosphere from forming within the silo, prior to, during and following deflector plate removal operations and supports the issue of an LI giving ONR's agreement to the commencement of DPR.

34. Following the SL decision to designate the hydrogen detector as normal plant (see Section 3.1.1 above) rather than as a safety mechanism, the Chemical Engineering

Inspector was able to confirm that this had no impact upon his assessment or conclusions (Ref. 28). He remained in support of issuing an LI but advised that the potential impact on the integrity of the associated maintenance arrangements for the mass spectrometer should be considered. This aspect was addressed by the C&I Inspector, who concluded that he was satisfied with the maintenance arrangements (see Section 3.1.5 below).

3.1.3 Mechanical engineering

35. The Mechanical Engineering Inspector considered the selection of WJC technology and the proposed cutting arrangements, equipment commissioning, potential fault conditions and their recovery. He also examined the existing argon inerting and silo off-gas systems and the effluent drain modifications (Ref. 29).

36. The Mechanical Engineering Inspector concludes that SL's mechanical engineering arrangements, within the safety case and associated documentation sampled, are appropriate and that the project contributes to hazard and risk reduction in the medium to long term. He is of the opinion that the decision to use WJC, together with the mechanical engineering aspects of the arrangements in place to implement it, minimise the risk to be ALARP. The Inspector supports the issue of an LI giving ONR's agreement to the commencement of DPR.

3.1.4 Civil engineering

37. The Civil Engineering Inspector is of the opinion that suitable and sufficient civil engineering arrangements have been detailed in the safety case and associated documentation to demonstrate that these aspects of the risk to be reduced ALARP (Ref. 30). The Inspector concludes that the project contributes to hazard and risk reduction in the medium to long term and supports the issue of an LI giving ONR's agreement to the commencement of DPR. Two assessment recommendations were raised:

    Recommendation CE1: Consideration should be given to having the emergency patch repair equipment on site and ready for deployment when the beams within compartment 1 are cut. This would minimise the potential consequences in event of failure of the grout pocket in the external containment wall.

    Recommendation CE2: The specification for the new scaffold elements to the south side platform should define the requirement for suitable and sufficient plan bracing at runway beam level. Alternatively, a readiness inspection should be undertaken after the modifications to the platform have been completed but before the equipment is installed to verify the presence of suitable and sufficient bracing.

38. With respect to Recommendation CE1, I have sought further information from the licensee (Ref. 31) which has reported that emergency repair equipment is already locally available to PFCS and supported by emergency arrangements. SL has considered whether the equipment needs to be immediately ready and in place next to the silo but concluded that this would be unnecessary, particularly given the congested nature of the space around the building. The licensee intends to monitor oxygen levels closely and has the capability to greatly increase the argon flow rates to compensate for any minor breach in containment, which, in the case of the deflector plate beam pockets, would be some metres above the waste mass. In addition, the safety case requires that WJC would be stopped immediately in the event of any containment breach so there should be no further waste disturbance. On this basis I consider that the licensee's response to Recommendation CE1 is appropriate.

39. Recommendation CE2 has been closed-out through the provision of further information from the licensee (Ref. 32) which the Civil Engineering Inspector has used to conclude that the new south side access platform scaffold elements are adequate (Ref. 33).

3.1.5 Control and instrumentation

40. The C&I Inspector examined the overall plant design and role of control and instrumentation, focussing on the hydrogen detection technology and the instrumentation supporting argon inerting and oxygen measurement (Ref. 34).

41. The C&I Inspector engaged with the licensee following its decision to move away from katharometer hydrogen detectors to using a mass spectrometer. He concludes that SL's decision to use the mass spectrometer and that the claim that the instrument will deliver sufficiently accurate hydrogen readings have been adequately justified. The C&I Inspector, noting the views of the Fault Studies and Chemical Engineering Inspectors, considered that the decision to modify the safety case to remove the safety mechanism designation from the spectrometer was acceptable noting the overall balance of safety measures and the point-in-time proving of the spectrometer using calibrated argon/hydrogen text gas mixtures.

42. Subject to resolution of the recommendations below, the C&I Inspector supports the issue of an LI giving ONR's agreement to the commencement of DPR:

43. Recommendation CI1: My assessment was based upon information provided within a number of draft safety case documents which had not completed SL due process. It should be confirmed that any changes made to these documents prior to formal issue do not compromise the basis of my conclusions.

44. Recommendation CI2: An HF assessment of the mass spectrometer calibration and measuring procedure should be performed.

45. With regard to recommendation CI1, I have confirmed that the revised safety case documents have now completed SL due process and that the issued documents reflect the advanced drafts supplied to the extent that the conclusions remain valid. I have confirmed this with the C&I Inspector (Ref. 35).

46. With regard to recommendation CI2, the licensee has confirmed that an HF 'walkthrough' of the mass spectrometer calibration and measuring procedure, as documented in an SL maintenance instruction has been completed (Ref. 36). The ONR HF Inspector has also considered this area (see Section 3.1.6 below).

3.1.6 Human factors

47. The HF Inspector notes the proposed activities are largely manual in nature and there is significant reliance upon operator action and administrative controls to prevent errors and respond to faults (Ref. 37). The existing safety arrangements (such as argon inerting and continuous monitoring) are called upon alongside new administrative controls to prevent unnecessary waste disturbance (for example through the inadvertent dropping of tooling into the silo) and manage the addition of water so that hydrogen levels can be managed.

48. The HF Inspector supports the licensee's claim that the operators have become efficient and effective in using WJC through the training undertaken at the full-scale test rig that was constructed to replicate the upper portion of a PFCS compartment. The HF Inspector notes the positive design features of the physical tasks and associated administrative controls and is content that arrangements supporting various

aspects of tool insertion and removal, water addition, setting and monitoring argon flow, control of argon outage, maintenance tasks and the WJC 'dashboard' tool and control and supervision are adequate to support the proposed activities.

49. Some shortfalls against Relevant Good Practice (RGP) were identified in the application of a formal human factors integration process to the design of the project and the adequacy of substantiation of some aspects of administrative controls These issues are already the subject of a broader ONR regulatory issue (number 4450) that is being taken forward with SL. For DPR, the HF Inspector has been able to assemble sufficient evidence through further engagement with the licensee to gain confidence that the design of tasks and administrative controls is fit for purpose and that the identified methodological shortfalls in HF approach has not resulted in a safety gap.

50. To conclude, the HF Inspector is satisfied that the licensee has provided sufficient evidence to underpin the HF claims made within the safety case that is broadly aligned with the SAPs (Ref. 7). The HF Inspector has no objection to the issue of an LI giving ONR's agreement to the commencement of DPR.

3.2 Conventional safety aspects

51. Although this PAR and the associated LI agreement is focussed on the nuclear safety hazard, I have engaged with an ONR CHS inspector to seek advice on the adequacy of the proposed control measures against a number of conventional hazards, including: working at height, asphyxiation due to argon gas leakage and the use of high pressure WJC. The CHS Inspector provided advice on RGP for the control measures and I have engaged with the licensee to seek proportionate assurance that suitable and sufficient arrangements are in place (Refs. 38 to 40).

3.3 Civil nuclear security aspects

52. Although this PAR and the associated LI agreement is focussed on the nuclear safety hazard, I have engaged with an ONR CNS inspector and he has confirmed that there are no objections, from a security perspective, to the issue of the LI. (Ref. 41).

3.4 Consultation with the Environment Agency

53. I have consulted with the EA which has confirmed that it has no objection to the issue of the LI (Ref. 42)

3.5 SL internal governance

54. SL has applied its internal governance process as applicable to a Category A PMP. The proposal has been subject to independent nuclear safety assessment, approved by the PFCS MSC and then subsequently considered and supported by the SL NSC (Ref. 43). The NSC Chairman asked for the DPR project team to undertake a final discussion prior to the commencement of DPR. This was completed as requested (Ref. 44) and recorded in an annex to the original NSC paper (Ref. 45).

4 CONCLUSIONS

55. This report presents the findings of ONR's assessment of the safety case associated with the licensee's request to commence deflector plate removal/size reduction operations using high pressure water jet cutting within the Pile Fuel Cladding Silo (PFCS) on the Sellafield Site.

56. PFCS represents an intolerable nuclear safety risk in its current state and DPR is a critical enabler to the longer-term hazard and risk reduction programme that will eventually eliminate the hazard by removing the waste. For a short period of time, DPR increases the risk presented by PFCS, as an unavoidable consequence of needing to temporarily add or withdraw tooling through the containment boundary, in introducing water into the silo and in causing some waste disruption as a result of the pieces of deflector plate falling onto the waste mass below. Noting the additional safety precautions, extensive testing and close supervision of the work proposed by the licensee, I judge that the risk increase is acceptable when compared to the background risk posed by the building.

57. I am satisfied with the claims, arguments and evidence laid down within the PFCS DPR safety case. I am of the opinion that the decision by the licensee to undertake DPR using high pressure water jet cutting (WJC), together with the supporting arrangements and additional safety measures, in particular those to manage any evolved hydrogen gas and to provide defence in depth against a fire, minimise the overall level of risk to be ALARP.

58. This view is underpinned by support from nuclear safety specialist inspectors who have assessed specific areas of the case. ONR conventional health and safety, ONR civil nuclear security and the Environment Agency have been consulted, and have raised no objections to ONR agreeing to the licensee's proposal.

5 RECOMMENDATIONS

Recommendation 1: I recommend that ONR issues Licence Instrument 903 giving agreement to the commencement of deflector plate removal/size reduction operations using high pressure water jet cutting, in response to the licensee's request to ONR under its licence condition 22(1) arrangements.

59. I have prepared the appropriate licence instrument (LI 903 in letter with unique number SEL77583N; Ref. 46) to implement this recommendation.

6 REFERENCES

1. Application for agreement to commence deflector plate removal/size reduction operations using high pressure water jet cutting. Letter from Sellafield Limited to ONR. ONR/16/11866/03. 15 September 2016. TRIM 2016/363692.

2. PFCS Plant Modification Proposal Issue 1 – Deflector plate removal/size reduction operations using high pressure water jet cutting. B** Stream/B**/0165. 5 September 2016. TRIM 2016/358826.

3. ONR HOW2 Permissioning Inspection – Assessment – Guidance Resources http://www.onr.org.uk/operational/assessment/index.htm.

4. SDFW Programme – Sellafield Permissioning Guidance. TRIM 2014/459482.

5. SDFW Programme Decision Record – PFCS HP5 Agreement to commence deflector plate removal – HPCP Line No. 41. ONR-SEL-DR-15-032 Rev 1. 28 January 2016. TRIM 2015/388760.

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