Office for Nuclear Regulation

HPCP 487 - Waste Vitrification Plant – Line 3 Throughput Improvements

Agreement to WVP Line 3 HAL Feed Rate Increase – Implementation of Safety Assessment (RP/B868/SAFE/00197/B) and Revised Operating Rules to Support an Increase in WVP Line 3 Feed Rate up to 70 l/hr via PMP WVP/B868/1071 Issue 1

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EXECUTIVE SUMMARY

Title

Agreement to 'WVP Line 3 HAL Feed Rate Increase – Implementation of Safety Assessment (RP/B868/SAFE/00197/B) and Revised Operating Rules to Support an Increase in WVP Line 3 Feed Rate up to 70 l/hr via PMP WVP/B868/1071 Issue 1'.

Permission Requested

The Licensee, Sellafield Limited (SL) has requested the Office for Nuclear Regulation's (ONR's) agreement to 'WVP Line 3 HAL Feed Rate Increase – Implementation of Safety Assessment (RP/B868/SAFE/00197/B) and Revised Operating Rules to Support an Increase in WVP Line 3 Feed Rate up to 70 l/hr via plant modification proposal (PMP) WVP/B868/1071 Issue 1' in accordance with its arrangements made under Licence Condition (LC) 22(1): Modification or experiment of existing plant.

This proposal has been Categorised by SL as Category B and the permission requested under ONR's derived powers through SLs LC22 arrangements.

Background

The Sellafield site Waste Vitrification Plant (WVP) has been in service since 1991 and has three production lines (1, 2 and 3). The plant receives Highly Active Liquor (HAL) from the Highly Active Liquor Evaporation and Storage (HALES) facility. The liquor is then dried, mixed with glass frit, heated until molten and fed into stainless steel containers. The containers are then held in the Vitrification Product Store pending long-term storage in a future geological disposal facility (UK-generated material) or return to the licensee's customers.

Processing of HAL, which contains 99% of the radioactivity from spent nuclear fuel, into vitrified form allows the waste to be stored passively, i.e. without active cooling, and is a key step in reducing risks associated with treating HAL stocks on the site and supports the NDA Magnox Operating Plan (MOP) for management of spent Magnox fuel. The processing of HAL is therefore important to hazard and risk reduction on the Sellafield site.

Since the end of THORP reprocessing in 2018, the concentration of the higher thermal output oxide derived waste within the HAL waste feed to WVP has decreased. The amount of upstream evaporation/concentration has also reduced to better protect cooling components in the HAL storage tanks. Consequently, it takes longer to produce a Product Container than when the WVP facility first operated. Since 1996 the rolling average mass per litre of oxide waste has roughly halved. This corresponds to an almost doubling in the time to produce a product container. The feed rate to the calciner (a cylindrical steel furnace) is the limiting factor in production rates.

SL has undertaken a "Vitrification Assist Programme" to assess options to increase throughput. This programme was conducted in collaboration with operators of similar plant in Europe and therefore sought to learn from their experience. The programme identified the option to increase the feed rate for WVP Line 3 and modifications necessary to implement. A system engineering and operations review established optimisations that could be made to the Operating Rules (ORs) including the need to reconfirm the derivation of OR7, which set out the HAL feed rate limit.

It is estimated that the increased feed rate proposed could accelerate the HAL programme by up to 2 years, which would be a benefit to the strategic objective of site-wide hazard and risk reduction. This is reflected by the proposal in the top level safety case claim: "*There is an*

overall benefit to the HAL Programme through delivery of the 70 litres and Throughput Stability Improvements and risks are demonstrated to be tolerable and ALARP"

SL has concluded that such an increase in feed rate can be accommodated with minimal impact on the existing safety case. SL claims that there is no significant increase in risk to the workers or public because of the increased HAL volume feed rate. As part of this proposal, opportunity is taken to modify three conditions and limits (Operating Rules) within the safety case to accommodate the change in feed rate and improve clarity.

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

The SL proposal was brought to the attention of ONR through the hold point control plan and therefore forms part of the planned work in assessment of LC22 modifications on the Sellafield site.

ONR's assessment has been focused on the adequacy of the revised safety assessment in support of the revised throughput and the controls for implementation of the modification to the plant and processes. Specialist assessments have been carried out for Fault Studies, Chemical Engineering and, Control and Instrumentation (C&I).

Physical plant modifications are to be implemented during a planned outage and are not judged to be complex in nature. Changes to ORs will be delivered through modifications to operational documents. It was therefore judged that an LC22 readiness intervention was not proportionate in support of this permission.

The licensee has confirmed to my satisfaction that its proposal has been subject to its internal governance by Independent Nuclear Safety Assessment (INSA). No objections were made to the proposed modification, which provides additional regulatory confidence.

Matters arising from ONR's work

The Fault Studies assessment sought to gain assurance that the Licensee has undertaken and captured an adequate analysis of the nuclear safety hazards, has adequate protective measures in place, and that risks are acceptable and reduced As Low As Reasonably Practicable (ALARP).

The Fault Studies inspector was satisfied that SL's proposed Operating Rule changes are adequately justified and underpinned. He concluded that these changes represent an improvement through making the ORs more intelligible to the operator. It was concluded that SL has adequately re-evaluated the risk associated with the increased throughput rate for WVP Line 3 and demonstrated that any increases in risk are acceptable. This conclusion is made on the basis that the proposed improvements have a beneficial impact on the safety, through the acceleration of passivation of HAL stocks on site, and risks are reduced ALARP and adequately controlled.

The Chemical Engineering assessment focussed on the proposed changes to ORs. This was to determine whether SL had adequately justified the safe operating envelope for the calciner (a cylindrical furnace), and that after the modification has been implemented operations will remain within that safe operating envelope.

The Chemical Engineering inspector concluded:

- that the increased flowrate, and therefore WVP line 3 throughput represents an opportunity to accelerate hazard and risk reduction.
- the benefit of this accelerated hazard and risk reduction balances the increased risk associated with a higher flowrate.

- the claims, arguments and evidence laid down within the Licensee's safety case are adequate.

The C&I assessment focused on modifications to the control system set points, alarm limits, commissioning and testing and the impact of revised operating limits on the existing safety related C&I requirements.

The C&I Inspector concluded that the proposed modifications to WVP line 3 throughput maintain the required behaviour of the existing safety systems while facilitating an increased rate of hazard and risk reduction. A regulatory issue was raised to track SLs review of faults related to variable speed drives as part of routine regulatory business and does not require resolution before permission may be granted for this modification.

Technical queries raised by ONR during the assessment process have all been adequately responded to and therefore closed.

The starting point for demonstrating that risks are ALARP and safety is adequate is that the normal requirements of good practice and engineering, operation and safety management are met. This is a fundamental expectation for safety cases in the ONR SAPs. The ONR assessments have concluded that safety is adequately demonstrated, and appropriate standards met. The SAPs also expect that relevant good practice (RGP) is considered and applied where practicable. I am satisfied that appropriate relevant experience has been sufficiently considered in establishing the options for improving the efficiency of the HAL programme, which has led to the development of this proposal. I have come to the judgement that SL has adequately demonstrated that risk is reduced SFAIRP when considered against the high-level principles of the ONR SAPs.

Conclusions

Based on the evidence sampled, I am of the judgement that SL has provided adequate claims, arguments and evidence within the modification proposal to:

- Show that there is an overall benefit through accelerated risk reduction in HALES brought about by the increased rate of vitrification of HAL.
- Demonstrate that the potential risk increase as a result of increased HAL feed rate to 70 l/hr has no significant impact on the existing safety case for WVP Line 3.
- Give confidence that the proposed modification ensures that risks are maintained ALARP.

Informed by the advice from the ONR specialist assessments, I am satisfied that the safety submission presented by SL provides an adequate justification for the proposed modification to the WVP Line 3 throughput and operating rules. I am therefore satisfied with the claims, arguments and evidence laid down within the safety case.

No objections to ONR granting permission for the proposal have been raised by ONR Civil Nuclear Security or by the EA.

Recommendation

I recommend that ONR issues Licence Instrument 532 giving agreement to SL for the implementation of the increase in WVP Line 3 feed rate, in response to its request to ONR under its LC22(1) arrangements.

LIST OF ABBREVIATIONS

AFS	Acid Feed System
AFLT	Acid Feed Long Term
ALARP	As low as reasonably practicable
ARI	Alarm Response Instruction
C&I	Control and Instrumentation
CAE	Claims, Arguments, Evidence
CNS	Civil Nuclear Security (ONR)
CVF	Constant Volume Feed
DCS	Distributed Control System
EA	Environment Agency
FSIF	full-scale inactive facility
HAL	Highly Active Liquor
HALES	Highly Active Liquor Evaporation and Storage
HPCP	Hold Point Control Plan
HLWP	High Level Waste Plant(s)
HOW2	(Office for Nuclear Regulation) Business Management System
MOP	Magnox Operating Plan
NDA	Nuclear Decommissioning Authority
OA	Operating Assumption
ONR	Office for Nuclear Regulation
OR	Operating Rule
OSP	Overarching Strategy Paper
PAR	Project Assessment Report
PMP	Plant Modification Proposal
POG	Primary Off Gas
RGP	Relevant Good Practice
SAP	Safety Assessment Principle(s)
SFAIRP	So far as is reasonably practicable
SM	Safety Mechanism
SL	Sellafield Limited
SRE	Safety Related Equipment
TAG	Technical Assessment Guide (ONR)
TEL	Total Evaporative Load
VAP	Vitrification Assist Programme
VSD	Variable Speed Drive
WFLT	Water Feed Long Term
WVP	Waste Vitrification Plant

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1 PERMISSION REQUESTED

1. The Licensee, Sellafield Limited has requested (Ref. 1) the Office for Nuclear Regulation's (ONR's) agreement to 'WVP Line 3 HAL Feed Rate Increase – Implementation of Safety Assessment (RP/B868/SAFE/00197/B) and Revised Operating Rules to Support an Increase in WVP Line 3 Feed Rate up to 70 l/hr via plant modification proposal (PMP) WVP/B868/1071 Issue 1' in accordance with its arrangements made under Licence Condition (LC) 22(1): Modification or experiment of existing plant.

2. This project assessment report (PAR) records my judgement on the safety of the proposed modification, as described in the SL 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 organisation-level guidance (Ref. 3) and Division-specific permission granting guidance (Ref. 4). The decision record (DR); (Ref. 5) sets-out the permission granting and assessment strategy for this regulatory hold point (WVP HPCP Line 487).

2 BACKGROUND

2.1 FACILITY INFORMATION AND BACKGROUND

3. The Sellafield site Waste Vitrification Plant (WVP) has been in service since 1991 and has three production lines (1, 2 and 3). The plant receives Highly Active Liquor (HAL) from the Highly Active Liquor Evaporation and Storage (HALES) facility. The liquor is then dried, mixed with glass frit, heated until molten and fed into stainless steel containers. The containers are then held in the Vitrification Product Store pending long-term storage in a future geological disposal facility (UK-generated material) or return to the licensee's customers.

4. Processing of HAL, which contains 99% of the radioactivity from spent nuclear fuel, into vitrified form allows the waste to be stored passively, i.e. without active cooling, and is a key step in reducing risks associated with treating HAL stocks on the site and supports the NDA Magnox Operating Plan (MOP) for management of spent Magnox fuel.

5. Since the end of THORP reprocessing in 2018, the concentration of the higher thermal output oxide derived waste within the HAL waste feed to WVP has decreased. The amount of upstream evaporation/concentration has also reduced to better protect cooling components in the HAL storage tanks. Consequently, it takes longer to produce a Product Container than when the WVP facility first operated. For comparison, in 1996 the rolling average reached a maximum of 234g/litre. It has since dropped steadily and is now typically 106g/litre. This reduction, and target incorporation rates mean that while in 1996 a product container could be produced every 14 hours, currently it takes approximately 21 hours. The feed rate to the calciner (a cylindrical steel furnace) is the limiting factor in production rates.

6. The Licensee has undertaken a "Vitrification Assist Programme" (VAP) study to assess options to increase throughput. This was initiated in 2010 in collaboration with Areva (now Orano) to learn from their experience of modification to increase throughput at the La Hague vitrification plant in France. After the VAP a process engineering study (reported within Ref 8) considered work done on the vitrification test rig. A system engineering and operations review established optimisations that could be made to the Operating Rules (ORs) including the need to reconfirm the derivation of OR7.

2.2 LICENSEES PROPOSAL

7. SL has identified an opportunity to increase HAL throughput and reduce the time to produce a Product Container by circa 25%. This will allow existing (and future) HAL stocks to be processed into a passive form more quickly and therefore accelerate risk reduction on the Sellafield site. This is expected to reduce the duration of the HAL programme by up to 2 years because a fixed quantity of waste remains.

8. In order to justify the required increase in throughput, SL has assessed the impact of increasing the HAL feed to the WVP Line 3 calciner from up to 30 litres/hour to up to 70 litres/hour. This rate change takes account of the reduced specific activity of future feeds. SL has concluded that such an increase can be accommodated with minimal impact on the existing safety case. SL claims that there is no significant increase in risk to the workers or public because of the increased HAL volume feed rate. As part of this proposal, opportunity is taken to modify three conditions and limits (Operating Rules) within the safety case to accommodate the change in feed rate and improve clarity.

9. The submission made under Hold Point 487 comprises one of a suite of Plant Modification Proposals (PMPs) supporting this modification to plant. The strategy for delivery of the totality of the modifications is captured in a separate overarching paper (Ref 8).

10. The licensee's case is laid out in the following documents:

- Overarching Strategy Paper (OSP) for the Implementation of the 70l/h Project (Ref. 8)
- WVP L3 Safety Case Review of the Implications of an Increase in HAL Feed Rate to 70l/h (ref. 9)
- PMP WVP/B868/1071 Implementation of Safety Assessment (RP_B868_SAFE_00107_B) and Revised Operating Rules to Support an Increase in WVP Line 3 HAL feed rate up to 70l/hr – Issue 1 (Ref. 2).

11. PMP WVP/B868/1071 (Ref 2) is categorized as Cat B. A suite of lower tier PMPs implement physical changes to the plant. This structure is presented in Figure 1 of Ref 2.

12. To implement the change in WVP Line 3 throughput the licensee is proposing to modify the following ORs:

Existing Operating Rule (OR)	**Proposed modification**
OR 7 Measured calciner feed rate shall not exceed 128 ℓ /h. *Safety Function. In order to prevent a calciner seals release therefore preventing a significant dose to the public or workforce.*	Remove (NB this OR refers to TEL rate – an alternative Operating Assumption (OA) is listed below which refers to HAL feed rate only. It is not a direct replacement for OR-7)
OR 8 When in HAL feed the vessel ventilation and primary off-gas pressure relative to the C5 cells must be controlled at less than 0 mBar. *Safety Function. In order to prevent a calciner seals release therefore preventing a significant dose to the public or workforce.*	**OR 8** All process and wash feeds to the WVP Line 3 Calciner are terminated on unavailability (or loss) of the Primary Off-Gas or Vessel Vent Extract Systems. *Safety Function: To prevent a significant dose uptake to the public or workforce resulting from a sustained Calciner seals lift*

OR 9 HAL feed must be suspended if the C5 cell pressure relative to the C3/C2 areas is greater than 0 mBar. *Safety Function. In order to minimise any activity release from the Primary Off Gas (POG) and Vessel Ventilation systems to the C5 cells.*	**OR 9** HAL feed is terminated and a building evacuation initiated on unavailability (or loss) of the C5 Cell Ventilation Extract System. *Safety Function: To protect the workforce from excessive dose update in the event of loss of C5 vent*
N/A	**Operating Assumption (new)** - The feed of HAL to the calciner in WVP L3 is normally up to 70 ℓ /h (NB this OA refers to HAL feed rate) *Safety Function: Basis of assessment.*

Table 1: Proposed changes to WVP Line 3 Operating Rules

13. The replacement of OR7 (limiting total feed rate to the Calciner) with an OA defining an increased HAL feed-rate limit is the most significant change as this is where the modification to the vitrification operation is implemented. The total feed rate makes up the Total Evaporative Load (TEL). The TEL consists of recycle flow from the dust scrubber in the primary off-gas system, sugar feed and HAL. To protect the Calciner when not in HAL feed either acid is fed from the acid feed long term (AFLT) or water from the water feed long term (WFLT).

14. SL considers that faults that may give rise to increased total feed flow and consequential pressurisation of the Calciner do not necessarily involve a flow that is measured by the operator or Distributed Control System (DCS), such as wash feeds or overflows, which are not restricted. SL have concluded that the sustained evaporative limit is governed by power input to the Calciner rather than the feed rate, i.e. off-gas production is a result of heat input leading to evaporation rather than directly related to flow rate. Furthermore, SL have highlighted that the OR7 limit of 128 litres/hour total feed represents a maximum value tested during commissioning and not a precise figure that would result in sustained pressurisation, it reflects the extent of the available test data at the time of commissioning.

15. The changes to the ORs above are proposed by SL in the light of the recognition that calciner pressurisation could occur as a result of the failure of the POG system even if compliance with the original feed limit of 128 ℓ/h was maintained.

16. The evaporative limit of the Calciner, rather than the total feed rate, is the limiting factor with respect to avoiding overwhelming of the POG system. Although it might be possible to establish a greater total feed limit setting down where pressurisation leading to seals release could occur and accounting for the increased HAL feed proposed, SL concluded that such a limit only considers the measured flow rates, therefore, it is not helpful to the operator to diagnose and respond to abnormal conditions, which could arise due to faults leading to unmeasured feeds (e.g. washing). The response to high pressure readings is therefore to stop feed rather than to try to bring the flow rate back under the OR7 limit. Therefore, SL considers that an OA for HAL feed is more appropriate than OR7 for total feed, as it sets out the basis of the assessment that has been used to demonstrate safety rather than an operational control that should be continually monitored. Feed rates of liquors that make up the TEL are closely controlled by the DCS and over pressure faults have trips in the protection system that will respond to stop operation and maintain safety.

17. The submission and modifications to plant and operating procedures identified set out to provide a stable operating envelope which then supports an increase in the

maximum WVP Line 3 Calciner HAL feed rate. The claims, arguments and evidence structure and ALARP case are presented in Ref 8.

18. When considering ALARP SL notes that:

"The HALES facility currently has one of the highest Safety and Environmental Detriment (SED) scores on the Sellafield site. The consequences of any loss of containment would be orders of magnitude higher than for any other hazard on the site. As such the programme to vitrify the HA liquor is the highest programme priority for Sellafield Ltd (noting that Sellafield Ltd.'s overriding priority is the ongoing safety and security of all nuclear facilities)."

19. Therefore, SLs ALARP case balances the benefit in terms of risk reduction through accelerated stabilisation of HAL against the potential increase in risk brought about by increasing throughput. SL claim that any risk increase is not significant and therefore does not have a significant impact on the existing safety case. The high level claim structure is as follows:

Top Claim: There is an overall benefit to the HAL Programme through delivery of the 70 litres and Throughput Stability Improvements and risks are demonstrated to be tolerable and ALARP

Sub Claim 1: Risk reduction in HALES is accelerated if WVP Throughputs can be increased.

Sub Claim 2: Increase in the HAL Feed Rate / TEL to WVP Line 3 calciner to 70 litres/hour has no significant impact on the existing WVP Line 3 Safety Case.

Sub Claim 3: Delivery of the 70 litres and Throughput Stability Improvements is a right option to support the HAL programme.

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

20. The PMP (Ref. 2) associated with the safety submission has been designated by SL to have a radiological safety category of B, in line with its categorisation process. This means that it "may have more than a minor radiological safety significance".

21. Taking into account the nature of the material involved, the significance of the WVP to Sellafield site hazard and risk reduction, the potential doses to operators and the public and the proposed changes to ORs, a derived power Licence Instrument is considered appropriate for permissioning the implementation of the increased throughput of WVP line 3. This decision was recorded in Ref 5.

3.1 ONR ASSESSMENT

22. In line with the DR (Ref 5) for this permission, I have focused ONR's assessment attention on the adequacy of the revised safety assessment in support of the revised throughput and the controls for implementation of the modification to the plant and processes. As set out in the DR, ONR assessments have been carried out for Fault Studies, Chemical Engineering and, Control and Instrumentation.

23. Physical plant modifications are expected to be implemented during a planned outage and are not judged to be complex in nature. OR changes are delivered through modifications to operational documents. In my judgement, an LC22 readiness intervention was not proportionate in support of this permission.

24. The ONR assessment has set out to challenge and confirm the basis of the Claims, Arguments and Evidence safety case from SL. Since the risk reduction benefit from accelerating the stabilisation of HAL is apparent, the assessment has focused on confirming that the modification does not undermine the existing safety case, that any risks are well understood and remain within accepted limits, and that implementation will be effectively controlled.

25. The Fault Studies inspector has focused on gaining assurance that SL has undertaken and captured an adequate analysis of the nuclear safety hazards, has adequate protective measures in place, and that risks are acceptable and reduced ALARP. This has been reported in a major assessment report (Ref 12).

26. The Chemical Engineering inspector focussed the scope of assessment on the proposed changes to ORs. This was to determine whether SL had adequately justified the safe operating envelope for the calciner, and that after this modification has been implemented operations will remain within that safe operating envelope. This has been reported in a major assessment report (Ref 13).

27. The Control and Instrumentation inspector has focused on modifications to the control system set points, alarm limits, commissioning and testing and the impact of revised operating limits on the existing safety related C&I requirements. This has been reported in a routine assessment report (Ref 14).

3.2 Consultation with respect to nuclear security, environment and safeguards

28. To inform this permissioning decision I have consulted with the ONR Civil Nuclear Security (CNS) Inspector (Ref 10), and the Environment Agency (EA) (Ref 11) and confirmed that they are content that ONR grants permission for the modification requested, subject to an acceptable assessment outcome. The Licensee's PMP does not directly relate to the safeguarding of nuclear material although there are potential safeguarding considerations during processing of wastes.

4 MATTERS ARISING FROM ONR'S WORK

29. The process employed by ONR in carrying out its permissioning activities is defined in ONR procedures (Ref. 3). As in all aspects of its regulatory activities, ONR employs a sampling regime in the assessment of safety cases focussing on areas such as higher risks, process novelty, complex activities or areas informed through operational experience. Specialist inspectors have applied appropriate national and international standards, the relevant ONR Safety Assessment Principles (SAPs) (Ref. 6) and ONR Technical Assessment Guides (Ref. 7). Having sought ONR specialist assessment advice on claims, arguments and evidence presented with regard to SL's safety submission, the advice, any matters arising and conclusions provided are summarised below.

4.1 ONR NUCLEAR SAFETY ASSESSMENT FINDINGS

4.1.1 FAULT ANALYSIS

30. The Fault Studies inspector has conducted an assessment (Ref 12) to seek assurance that the Licensee has undertaken and captured an adequate analysis of the nuclear safety hazards, has adequate protective measures in place, and that risks are acceptable and reduced ALARP. To this end, a sampling approach has been adopted to consider the adequacy of the following areas of the submission:

- SL's dose consequence review.
- SL's conclusion that there are no new or unprotected fault sequence groups because of this change.

- SL's changes to the definition of its safe operating envelope in the context of the modification (including relevant conditions and limits).
- SL's overall balance of risk arguments.

31. The Licensee's safety case adopts a claims/arguments/evidence approach to its presentation, and in the judgement of the Fault Studies inspector, this clearly sets out the basis of the change.

32. The Fault Studies inspector judged that SL's consequence review supports its conclusions that, when taking account of the reduced specific activity of future feed to WVP, the increase in HAL throughput in WVP line 3 can be accommodated with no significant increase in radiological risk from relevant faults.

33. During the assessment, minor errors were identified in SL's safety case documentation brought about by a calculational error not identified during verification of dose calculations. SL responded by producing an updated safety case (including revised calculations) and providing reassurance that additional independent verification of all consequence calculations had been carried out. SL also raised a Condition Report (CR) and commenced an internal basic cause investigation (BCI) to understand the causes of this error and improve the safety case production process. The fault studies inspector has considered the updated safety case within his assessment and is satisfied with SL's response to the event.

34. The fault studies assessment has obtained adequate assurance there are no new or unprotected fault sequence groups that have not been considered by SL's safety case. The assessment noted that a further safety case modification (under a further PMP) is required to support replacement of an orifice plate on the 'acid feed long term' feed to the calciner (a 'Safety Feature' under SL's safety case methodology). However, this was confirmed to be a relatively simple modification that is well understood by SL. The Fault Studies inspector was satisfied that the impact on the extant protective measures and numerical risk claims is not significant. It was not considered to be proportionate to request this future PMP for review and consideration.

35. The Fault Studies inspector was satisfied that SL's proposed Operating Rule changes (including introduction of a new Operating Assumption as an alternative control to an Operating Rule) are adequately justified and underpinned and concluded that these changes represent an improvement in making the Operating Rules more intelligible to the operator.

36. The Fault Studies assessment concluded that SL has adequately re-evaluated the risk associated with the increased throughput rate for WVP Line 3 and demonstrated that any increases in risk are acceptable. This conclusion is made on the basis that the proposed improvements have a beneficial impact on the safety, through the acceleration of passivation of HAL stocks on site.

37. Overall, the fault studies assessment recommends, that based on the sample of the Fault Studies inspector, the implementation of the modification and granting of a Licence Instrument to release the hold point is supported.

4.1.2 CHEMICAL ENGINEERING

38. The scope of the Chemical Engineering assessment (Ref 13) focussed on the proposed changes to operating rules (ORs). Specifically, on the removal of OR 7, and the Modification to OR 8. This was to determine whether SL can adequately justify what the safe operating envelope for the calciner is, and that after this modification operations will remain within that safe operating envelope.

39. In the opinion of the Chemical Engineering inspector the licensee's case has identified the pressurisation of the calciner as the key hazard. Therefore, with respect to the removal of OR7, and the proposed increased feed-rate the Chemical Engineering assessment has considered two areas:

- Whether a higher feed-rate to the calciner could lead to the initiation of other hazards.
- Whether a higher feed-rate would increase the likelihood of a pressurisation event.

40. To explore the potential for higher feed-rate to the calciner to initiate other hazards the Chemical Engineering assessment reviewed the process flow (associated with feed to the calciner) and sampled specifically whether or not an increased flow rate could lead to a loss of containment of HAL due to an overflow of liquor. The inspector was able to review the engineering flow diagrams to examine the overflow routes and confirm that inherent safety features are designed into the facility. The assessment concluded that overflow protection remains adequate.

41. Once liquor has reached the Calciner there is no further over-flow protection. Therefore, the assessment also explored the potential consequences of a loss of feed control that could overfill the Calciner and then Melter. SL also explained that based on historic experience with water feeds at the full-scale inactive facility, a grossly excessive HAL feed reaching the Melter would cause a calciner pressure spike sufficient to cause seal lift (and release some activity to the cell, for which there is existing mitigation via filters and ventilation) but that no physical damage to the plant would be expected. Pressurisation through feed reaching the Melter is an existing fault sequence for which there is an engineered protection to prevent feeds and terminate the fault. The Chemical Engineering inspector took confidence from these answers that the licensee's focus in their submission for this permission on pressurisation was appropriate.

42. With respect to the potential for a higher feed-rate to increase the likelihood of pressurisation the Chemical Engineering assessment explored the removal of OR7. SL's position is that there is engineered protection to prevent the excess feeds and terminate an over feed fault. Therefore, the operating rule has no benefit to the protection which is provided by safety feature designated overflows and safety mechanism designated trips.

43. In addition, SL noted that if the purpose of the OR is to put in place a limit which stops seals lifts / significant pressurisation events then it is not effective. A Primary Off Gas (POG) system failure at any TEL is expected to result in a short-term pressurisation event until the resulting feed trips have stopped feeds and all excess liquor has evaporated. SL confirmed that the evaporative capacity of the calciner is the limiting factor rather than the feed-rate as pressurisation is caused by off-gas generation. The safety case assumes that additional off-gas would be produced if excess feeds reach the Melter but that this situation would lead to a short-term pressure spike. SL also identified that rapid changes in feed rate (below the maximum feed limit set by OR7) could lead to short term pressurisation and therefore OR7 was not effective in preventing overpressure.

44. With respect to the modification to the wording of OR8 the Chemical Engineering assessment considered the adequacy of the protection systems identified by the licensee against a pressurisation. These were confirmed to be existing substantiated hardwired trips. SL also confirmed that there is an operator response associated with OR8 as detailed in an Alarm Response Instruction (ARI) and that this is not subject to change.

45. Based on the evidence sampled by the Chemical Engineering inspector it was concluded that the removal of OR 7 and the modification to OR 8 represent a rationalisation of the controls protecting against calciner pressurisation. The protections rely on hard wired trips. These hardwired trips are designated and already substantiated as existing safety mechanisms within the extant safety case. The licensee has determined that the fault remains within the same consequence bands (sampled within the Fault Studies assessment). Based on the evidence sampled and discussions with the licensee as part of the assessment process the Chemical Engineering inspector judged that the protection systems against a pressurisation of the Calciner remain adequate.

46. The assessment considered the adequacy of the process the licensee has undertaken to identify which physical modifications are required to support the increased normal feed-rate. Confidence was taken from the use of external experience and actual plant data from a similar plant in France. Based on the review of this supporting evidence the Chemical Engineering inspector was content with the process the licensee has taken to identify which physical modifications are required to support the increased normal feed-rate.

47. The Chemical Engineering inspector concluded:

- that the increased flowrate, and therefore WVP line 3 throughput represents an opportunity to accelerate hazard and risk reduction.
- the benefit of this accelerated hazard and risk reduction balances the increased risk associated with a higher flowrate.
- the claims, arguments and evidence laid down within the Licensee's safety case are adequate.
- based on the sample of evidence, recommended that the project inspector should release the hold point.

48. Further to the conclusions above, the Chemical Engineering inspector recommended that the site inspector for WVP should consider sampling the software trips associated with the line 3 POG system as part of the scope of a planned system based inspection on high-level waste plants (HWLP) in 2021/22. This recommendation requires no action with respect to permission granting of the current modification.

4.1.3 CONTROL AND INSTRUMENTATION

49. The Control and Instrumentation specialist assessment report (Ref 14) focuses on two key aspects:

- The C&I activities covered in PMPs 2 and 3 (that support implementation under PMP1, Ref 2). This includes control system modifications to the HAL constant volume feed (CVF) and acid feed system (AFS) flow rate set point, alarm limit and timer, and subsequent commissioning and testing.
- The effect of the updated safety case operating limits and conditions on the existing C&I safety systems and safety related systems requirements noted in PMP 1 (Ref 2).

50. The assessment has sought to consider the expectations of the SAPs with respect to:

- Acid feed system and HAL constant volume system modifications.
- Hardwired safety measure trips.
- VSD failure modes.

51. The assessment drew the following conclusions and judgements with respect to the modification and supporting safety assessment:

- The modification proposed does not have an impact on the existing classification of the associated safety and safety related systems.
- With respect to the existing safety system, the safety measure trip limits will not be affected and therefore existing trip parameters remain valid for the increased flow rate.
- That the reliablity of the safety functions is unlikely to deteriorate. SL's comissioning and testing arrangements, help ensure the existing reliability claims of the safety systems are still achieved.
- That the re-ranging of the existing flowmeter (a smart device) for the acid feed system will not be detrimental to it performing its function as safety related equipment (SRE).
- That the commissioning strategy and test specifications are fit for purpose and that SL's commissioning and testing arrangements satisfy the expectations of SAP ECM.1.
- That the provision for end-to-end functional testing of the modifications satisfy the expectations of SAP EMT.7.
- That there are no changes to the existing safety measure trips as a result of the changes to ORs, the existing trip limits continue to fit the current safety envelope and therefore the safety classifications of these systems have not changed.
- That the specified limits for the existing safety measures remain adequate.
- No new safety mechanisms (SMs) are introduced and no changes are made to existing SMs. This is confirmed as there are no new initiating events or changes to the fault schedule.

52. During this assessment the C&I Inspector considered the application of SL's current variable speed drive (VSD) design guide. Although outside the immediate scope of assessment this modification drew attention to the need for this guidance to be adequately considered, as fault initiated by VSDs may not have been considered previously. SL recognised that there is a need to formally review the fault analysis for all VSDs used in the HLWP in line with the guidance. However, it was confirmed that all foreseeable HAL CVF distributed control system (DCS) and VSD initiated faults are protected by the existing safety measures. Therefore, it was judged that the risk is sufficiently low to proceed with the plant modification to realise the benefits through hazard and risk reduction. To track SL's review of the fault analysis for all VSDs used within HLWP the C&I Inspector has raised regulatory issue 8565, which will be followed up through routine regulatory business and requires no action with respect to this project.

53. The C&I specialist assessment concluded that the proposed modifications to WVP line 3 throughput maintain the required behaviour of the existing safety systems while facilitating an increased rate of hazard and risk reduction. It was recommended that ONR provides agreement to SL for the modification proposed.

4.1.4 PROJECT INSPECTOR ASSESSMENT

54. In addition to the specialist assessments I have reviewed the submission with respect to:

- Governance and internal regulation
- ALARP and relevant good practice (RGP)

55. In conjunction with the submission PMP and supporting references, SL have provided evidence of the Independent Nuclear Safety Assessment (INSA)process conducted and the Management Safety Committee (MSC)governance in approval of the proposal. The INSA and approval records are numerous, were provided with the documents when submitted to ONR and are not individually referenced here.

56. The licensee has confirmed to my satisfaction that its proposal has been subject to its internal governance by INSA and MSC. The INSA certificate is recorded in Ref 7.

57. During the assessment process ONR maintained a log of technical queries (TQ) with respect to the specialist assessments (Ref 16). SL have adequately responded to all TQs raised by the specialist inspectors to enable them to complete their assessments.

58. Due to the COVID19 pandemic variations have been made to the SL document control and safety case production processes in relation to the requirement for ink signatures. As such, when required, SL have utilised email trails as evidence of verification, INSA and MSC approval. I have confirmed with the ONR Corporate Inspector that this is an appropriate use of the SL variation to arrangements. In my judgement, the electronic record of sign off and approval of documents provided for this permission is fit for purpose considering the need to reduce numbers of staff on the Sellafield site to enable effective social distancing but continue hazard and risk reduction activities.

59. An area of concern arose as a result of the evidence sampled by the fault studies assessment. The Fault Studies inspector identified an error in a dose calculation within Ref 2. This document had been subject to the complete SL governance and verification process. However, it is important to recognise that each barrier in any quality assurance process is imperfect so there is a small probability that errors will not all be caught. SL have responded positively to the identification of this error and corrected the analysis. Assessed doses have increased as a result but SL confirmed that this change did not result in a change in the dose band consequences of the associated fault and therefore did not undermine the claims and arguments made in the safety case. The subject of this permission is therefore the revised version (version B) of the safety assessment while the supporting ONR specialist assessments have predominantly sampled version A. The Fault Studies assessment (Ref 12) has reviewed the changes between versions in detail and therefore assessed the updated submission. In my judgement, this is acceptable as the changes to the submission only had a material effect on fault analysis.

60. In follow up to this apparent quality issue ONR requested that SL confirm that a condition report is raised. I have subsequently raised the matter with the ONR safety case lead for Sellafield to consider for future discussion with SL to ensure that the event is adequately investigated, and any appropriate actions taken to improve SLs processes.

61. The Fault Studies assessment (Ref 12) has considered ALARP. Further to this I have considered the strategic purpose of the proposal in terms of balance of risk and reducing risk SFAIRP. In summary, the following points set out the ALARP case for the modification proposed:

- The SL OSP (Ref 8) and CAE structured safety case has shown that increasing WVP line 3 throughput is beneficial to the Sellafield site safety through risk reduction by accelerating the stabilisation of HAL. This acceleration could bring forward the end of the HAL programme by up to 2 years to 2031.
- Shortening the necessary operational lifetime for which the WVP plant is required to operate also reduces the total amount of maintenance and time at risk for the ageing facility.
- The Fault Studies Assessment (Ref 12) has considered the potential risk increase from the increased throughput of HAL and found that it has been demonstrated to be acceptable and consequences are not significantly increased from the existing safety case.
- The implementation of the modification to the plant is not complex or novel. The Process Chemistry (Ref 13) and C&I assessments (Ref 14) have

confirmed that the proposal is adequate with respect to the proposed implementation.

- SL has explored what has been done elsewhere on similar plants via a study supported by a contractor with experience in design and operation of waste vitrification plants (Ref 15). This operational experience has been used to inform the options available and necessary modifications to the plant and operations.
- The modification is reversible. The changes to ORs and throughput can be undone, and throughput could be reduced through normal operating procedures if necessary, in the event that the plant does not respond as expected. The feed rate will be raised incrementally to confirm operation is as predicted.

62. The starting point for demonstrating that risks are ALARP and safety is adequate is that the normal requirements of good practice and engineering, operation and safety management are met. This is a fundamental expectation for safety cases in the ONR SAPs. The ONR assessments have concluded that safety is adequately demonstrated, and appropriate standards met. The SAPs also expect that RGP is considered and applied where practicable. In my opinion, appropriate relevant experience has been sufficiently considered in establishing the options for improving the efficiency of the HAL programme, which has led to the development of this proposal. Therefore, on balance, I have come to the judgement that SL has adequately demonstrated that risk is reduced SFAIRP when considered against the high-level principles of the ONR SAPs.

5 CONCLUSIONS

63. This report presents the findings of ONR's assessment of SL's proposal for implementation of increased throughput of HAL feed to 70 l/hr on WVP Line 3.

64. Informed by the advice from the ONR assessments summarised in section 4 above, I am satisfied that the safety submission presented by SL provides an adequate justification for the proposed modification to the WVP Line 3 throughput and operating rules.

65. Based on the evidence sampled, I am of the judgement that SL has provided adequate claims, arguments and evidence within the modification proposal to:

- Show that there is an overall benefit through accelerated risk reduction in HALES brought about by the increased rate of vitrification of HAL.
- Demonstrate that the potential risk increase as a result of increased HAL feed rate to 70 l/hr has no significant impact on the existing safety case for WVP Line 3.
- Give confidence that the proposed modification ensures that risks are maintained as Low As Reasonably Practicable (ALARP).

66. I am therefore satisfied with the claims, arguments and evidence laid down within the safety case.

6 RECOMMENDATIONS

67. I recommend that ONR issues Licence Instrument 532 giving agreement to SL for the implementation of the increase in WVP Line 3 feed rate, in response to its request to ONR under its LC22(1) arrangements.

68. I have prepared the appropriate LI to implement this recommendation (Ref. 17).

7 REFERENCES

1. Letter from Sellafield Limited to ONR. Application for the agreement under site licence condition 22(1): WVP Line 3 HAL Feed Rate Increase – Implementation of Safety Assessment (RP/B868/SAFE/00197/B) and Revised Operating Rules to Support an Increase in WVP Line 3 Feed Rate up to 70 l/hr via PMP WVP/B868/1071 Issue 1. ONR/21/12753/01. 27/01/2021. 2021/9221.
2. PMP WVP/B868/1071 Implementation of Safety Assessment (RP_B868_SAFE_00107_B) and Revised Operating Rules to Support an Increase in WVP Line 3 HAL feed rate up to 70l/hr – Issue 1. 2021/0009945.
3. ONR HOW2 Guide - Purpose and Scope of Permissioning - NS-PER-GD-001 Revision 4. March 2020. http://www.onr.org.uk/operational/assessment/index.htm
4. Sellafield Decommissioning Fuel & Waste Division – Sellafield Permissioning Guidance. 2014/459482.
5. Decision Record. ONR-SDFW-DR-18-056 Waste Vitrification Plant Line 3 Throughput Improvement (HPCP 487), Approved 13/02/2019. 2019/42519.
6. *Safety Assessment Principles for Nuclear Facilities*. 2014 Edition, Revision 1. January 2020. http://www.onr.org.uk/saps/saps2014.pdf.
7. Record of Independent Nuclear Safety Assessment of Safety Case Documentation, NI&IO INSA 3108 Issue 1, 26/01/2021. 2021/11677.
8. HLWP MSC P(20) 14 Revision 1 – Sellafield WVP Line 3 Overarching Strategy Paper for the Implementation of the 70l/h Project, 23/09/2020, 2020/297080.
9. RP_B868_SAFE_00107_B Revision number HLWP MSC P(20)18 - WVP L3 Safety Case Review of the Implications of an Increase in HAL Feed Rate to 70l/h – 2021/11677.
10. ONR Internal email, ONR Security confirmation of no objection for HPCP 487 WVP Line 3 Throughput Increase, 05/01/2021 - 2021/753.
11. Environment Agency email, confirmation of no objection for HPCP 487 WVP Line 3 Throughput Increase, 29/02/2021 - 2021/0011907.
12. ONR-SDFW-AR-20-052 Revision 0, Fault Studies Assessment of modifications supporting Waste Vitrification Plant Line 3 throughput improvement. February 2021, 2021/6257.
13. ONR-SDFW-AR-20-048 Revision 0, Chemical Engineering Assessment of the Waste Vitrification Plant Line 3 Throughput Improvements, February 2021, 2021/8591.
14. ONR-SDFW-AR-20-055 Revision 0, Control and instrumentation assessment of waste vitrification plant line 3 throughput improvement, February 2021, 2021/13258.
15. NT/100429/00/0001/A, AREVA WVP Dilute Feed Study, February 2010, 2020/303183.
16. ONR, SDFW ONR HPCP 487 WVP Line 3 Throughput Increase Technical Query and Document Tracker, 2020/302317.
17. Letter from ONR to SL. Licence Instrument 532. Agreement to WVP Line 3 HAL Feed Rate Increase – Implementation of Safety Assessment (RP/B868/SAFE/00197/B) and Revised Operating Rules to Support an Increase in WVP Line 3 Feed Rate up to 70 l/hr via PMP WVP/B868/1071 Issue 1. SEL77758N. 2021/16078.