

The Storage of Liquid High Level Waste at Sellafield: Revised Regulatory Strategy

Summary:

The Office for Nuclear Regulation (ONR) has revised its strategy for providing regulatory control of the Highly Active Liquor (HAL) stocks at Sellafield.

ONR's aims continue to be:

1. to ensure that HAL stocks are maintained as low as reasonably practicable.
2. to ensure that Sellafield Ltd continues to reduce hazard potential across the Sellafield site.

In order to achieve (2) above, Sellafield Ltd will need appropriate operational flexibility to accelerate reprocessing and vitrification programmes.

ONR's previous strategy was to specify limits, which reduced over time, on the quantities of HAL which may be stored on the Sellafield site. The original Specification was set at a time when reprocessing was expected to have been completed by about 2015, at which time a minimal working "buffer stock" level would have been reached.

ONR's regulatory approach has been very successful. Sellafield Ltd has fully complied with the Specifications since their introduction in 2001. HAL stocks have been reduced significantly and are now at their lowest levels since the 1980s, and well within current Specification limits.

However, because of continuing reprocessing and vitrification, the Specification does not provide Sellafield Ltd with the flexibility required to achieve the aim of overall hazard reduction, nor necessarily to support operations in the best interests of safety.

ONR's new regulatory strategy has two components, i.e.:

1. a revised Specification that better reflects the hazard potential of HAL, and increases the buffer level to an extent which provides Sellafield Ltd with the flexibility to accelerate the hazard reduction.
2. Additional regulatory controls under the nuclear site licence for Operating Rules, to ensure that HAL stocks are kept as low as reasonably practicable.

ONR believes that this revised strategy will continue to provide effective regulatory control of HAL stocks consistent with our aim that Sellafield Ltd continues to reduce hazard potential on the site.

Introduction

1. Highly active liquor (HAL) is produced at Sellafield from the evaporation of raffinates. The raffinates are a waste stream from the nuclear reprocessing plants and contain the fission products and waste actinides extracted from spent fuel. The safety of the storage of these heat-generating wastes has been a matter of public interest for many years. Recognising this, the Health and Safety Executive (HSE) published a series of reports ^[Ref 1,2,3,4] outlining the key safety issues associated with HAL storage and our regulatory approach to these.
2. The HAL is stored in a number of Highly Active Storage Tanks (HASTs) located in the HAL Evaporation and Storage plant (HALES) at Sellafield. In 1990, the Waste Vitrification Plant (WVP) began converting the HAL into glass to retain the hazardous radioactivity in an immobile form. Vitrification enables long-term passive storage of the waste.
3. In January 2001, HSE's Nuclear Installations Inspectorate (NII) used its legal powers under the nuclear site licence to place limits on the quantity of HAL stored at Sellafield. Specification 343 required the backlog of HAL stocks accumulated since reprocessing began in the 1950s to be reduced to a minimal working level, known as the buffer volume, by 2015. The Specification set a limit on the total amount of HAL stored and a secondary limit for Oxide HAL (liquors arising from the reprocessing of Oxide fuel). This secondary limit was imposed because of the higher hazard associated with the Oxide HAL.
4. In October 2007, NII replaced Specification 343 with Specification 679, which prescribed tighter limits on HAL stocks. These tighter limits locked in the reductions that had arisen from the unplanned, long-term shutdown of the Thermal Oxide Reprocessing Plant (THORP) after the discovery in April 2005 of a leak ^[Ref 5]. Specification 679 also changed the units applied to 'Oxide HAL' limits, from volume (m³) to the mass of Uranium (tonnes Uranium, or teU) in the unprocessed fuel from which the HAL was derived. This change in limit form was necessary since the volumetric restriction used in Specification 343 is a relatively poor measure of hazard potential and had led to conflicts between the legal requirement and operating the plant in the best interests of safety.
5. Sellafield Ltd has fully complied with our Specifications since their introduction in 2001. HAL stocks have been reduced significantly and are now below 900m³, their lowest levels since the 1980s, and well within

current Specification limits. However, the most recent low levels are in part due to Sellafield Ltd's ongoing problems with evaporative capacity, which has resulted in less raffinate being received by HALES than required by Sellafield's reprocessing programmes. Levels may thus rise again over the coming years, while remaining within the limits imposed by the Specification. Overall however, Sellafield Ltd's programme over the past decade to reduce its HAL stocks has been highly successful.

Biennial Reviews

6. HSE's 2001 public report ^[Ref 4] stated that the Licensee at Sellafield (now Sellafield Ltd, SL) should provide an annual report to NII on its progress in reducing the HAL stocks compared to the specified limits and against its programme of committed improvements to plant and procedures. In addition, to take account of technological advances and any changes in circumstance, we carry out a critical review of the Licensee's strategy and overall programme every two years in order to identify reasonably practicable HAL stocks reductions.
7. In line with these commitments, HSE's quarterly reports to the West Cumbria Sites Stakeholder Group (WCSSG) have included information on the Licensee's performance against our Specifications, details of safety and operational issues at HALES and the outcomes of our 2002, 2004, 2006 and 2008 biennial reviews. ^[Ref 6 to 9]
8. NII's 2008 biennial review ^[Ref 9] recommended replacing the current volumetric total HAL limit with an equivalent mass limit (teU), bringing this into line with the Oxide limit. It also accepted the need for a relaxation of the long-term steady-state (buffer volume) limit in order to prevent unacceptable delays to vitrification (and therefore overall hazard reduction).

These aspects are discussed in more detail in the following paragraphs.

Change of form of limits (or Units)

9. Specification 679 comprises two elements: limits on the total volume (m³) of HAL that may be stored and limits on the quantity (teU) of the more hazardous Oxide HAL.
10. Unfortunately, the limits imposed on the total volume (m³) of HAL unintentionally discourage Sellafield Ltd from carrying out basic operations

required in the interests of safety, and to embark on the wash-out and clean-out of near-empty tanks.

11. Moreover, as HALES is progressively emptied of HAL, Specification 679's long term limit (200 m³ post July 2015) is not even sufficient to accommodate the wash-out heels, i.e. the residual liquors left over in the near-empty tanks when these are taken out of front line service as storage requirements reduce. These wash-out heels are mostly water and acid left over after washing out the tanks, and so present an insignificant hazard and risk compared to HAL. However, as they contain some HAL (albeit greatly diluted) they still contribute towards the liquor volume limited by Specification 679. Under the present arrangements, each redundant HAST contributes several tens of m³ towards the Specification limit without adding any significant risk or hazard.
12. Continuing to constrain by volume discourages Sellafield Ltd from adding or using water or acid to, for example, maintain the HASTs in optimal operating conditions, attempt to unblock equipment, move HAL from tank to tank in order to prepare batches for vitrification, or embark upon the Post-Operational Cleanout (POCO) of empty HASTs. Discouraging these and other activities, all of which are legitimate and appropriate for the safe operation of HALES, is an unintended and unforeseen consequence of setting the original Specification in terms of liquor volume.
13. In order to remedy these anomalies, we have now issued a revised HAL Stocks Specification (Spec 793), which brings the units of both limits ('total amount of HAL' and 'Oxide HAL') into a common form, expressed in terms of the mass of Uranium (teU) in the unprocessed fuel from which the HAL was derived. The new form of limit more accurately reflects the true hazard. This change is simply an improvement in the means by which the HAL inventory is measured. The new Specification for the period up to July 2015 is set at similar levels of safety and hazard reduction to the previous volume-based limits defined by Specification 679.

Revised long term steady-state (buffer volume) limits (post July 2015)

14. Our HAL Stocks Specifications impose limits restricting the quantity of HAL stored at Sellafield year by year. The limits reduce until July 2015 when steady state conditions need to be reached. Specification 679 applied a steady state limit of 200 m³ (including wash-out heels) based on analysis dating from the time Specification 343 was set, carried out by the then Licensee (BNFL). BNFL's analysis assumed HALES would by then be operating with only two HASTs in routine service, processing only Oxide

raffinates (Magnox reprocessing was at that time scheduled to shut down in 2013). Sellafield Ltd's current operating plans now indicate dual processing of Oxide and Magnox raffinates will need to continue in HALES for several years beyond 2015. We are satisfied that, based on Sellafield's operating experience and analysis, dual processing cannot be undertaken efficiently or effectively with just two HASTs.

15. In consequence, NII accepted in our 2008 biennial review that the limits imposed by Specification 679 were too tight and needed to be relaxed ^[Ref 9]. The extent of the relaxation depends primarily on the minimum number of HASTs required to continue efficient reprocessing and vitrification. Determining this number however required detailed additional analysis by Sellafield Ltd of its HALES operations and reprocessing plans.
16. In deciding where to set the revised steady state limit, we needed to ensure that the Specification was not too tight so as to 'force' the cessation (or significant curtailment) of reprocessing – this would not be in the best interests of safety, as there is currently no viable alternative to reprocessing existing stocks of irradiated Magnox or AGR fuel within reasonable timescales. Equally, we also needed to ensure that limits are not set so loose as to undermine the original intent of Specification 343, which was to regulate Sellafield's historic accumulation of HAL stocks down to reasonably practicable minimal steady-state working levels by mid-2015.
17. In view of these considerations, NII developed six principles to govern our thinking when considering new steady state limits. These were communicated in our 2008 biennial review report ^[Ref 9] to the West Cumbria Sites Stakeholder Group. The principles seek steady state limits set:
 - P1** To prevent any return to excessive accumulated stocks, i.e. more than could be worked off within a reasonable period at nominal full WVP production levels.
 - P2** Above the absolute minimum so that Sellafield Ltd:
 - i. takes responsibility for ensuring its stocks are maintained at levels as low as reasonably practicable (ALARP), but
 - ii. has reasonable operational flexibility to carry out its legitimate reprocessing activities.
 - P3** To facilitate the maximum overall rate of reduction of site wide and national hazard potential without creating excessive waste volumes. In particular, the Specification should not limit WVP vitrification to any significant extent.

P4 To encourage POCO of redundant HASTs.

P5 Based on Sellafield Ltd's existing fleet of HASTs, i.e. not taking the possibility of replacement HASTs into account until there is appropriate confidence in how these will perform (it is anticipated that the replacement HASTs will be smaller than the existing tanks, raising the possibility of operation with lower stocks of HAL once these are brought into operation).

P6 In a manner that aligns with HSE's Enforcement Policy Principles ^[Ref 10] of Proportionality, Consistency, Targeting, Transparency and Accountability.

18. Maintaining the same approach as previous NII specifications (343 and 679), we have used these principles to review Sellafield's detailed analysis of HALES operations and determine new steady state Specification limits for total and stored Oxide HAL beyond July 2015.
19. Our analysis has shown that the setting of steady state limits depends significantly on Sellafield Ltd's planned reprocessing throughputs. Higher levels of reprocessing require larger storage requirements. In line with principle P2, and to avoid repeated re-setting of the Specification to accommodate the Licensee's changing plans, we have chosen to adopt a new dual strategy for regulating Sellafield Ltd's quantity of HAL stocks. Our dual strategy continues to apply a Specification to set upper limits for the HAL stocks; these have been set at a level designed to accommodate Sellafield's most ambitious plans regarding its reprocessing programmes, and so removes a barrier to improving the rate of hazard reduction, both on site and nationally.
20. However, recognising that Sellafield Ltd may not necessarily be able to deliver accelerated reprocessing (which could mean that the revised Specification would permit higher than minimal stocks holdings), we have instructed the Licensee to develop and implement additional limits set at a level lower than the ONR specified absolute limit. These lower limits will be set year by year in line with Sellafield Ltd's reprocessing performance and will also take into account ongoing vitrification performance. They will be based on assessments of the lowest reasonably practicable HAL stocks levels needed for efficient and effective vitrification, ensuring that HAL stocks are always kept at minimum levels necessary to service the site's ongoing reprocessing activities.
21. As the new lower limits will be classed as "conditions and limits necessary in the interests of safety" derived from the safety case, complying with them is a legal duty under Site Licence Condition 23. Moreover, Site

Licence Condition 32 imposes a further legal duty on Sellafield Ltd to minimise, so far as is reasonably practicable, its total quantity of HAL stocks. We intend to use the lower limits as part of our regulation of this duty.

22. Sellafield Ltd continues to develop the formulae that will be used to set the lower limits, which it plans to implement in advance of July 2015. We will assess Sellafield Ltd's methodology in due course, using our permissioning powers as necessary. We are however content with the Licensee's early proposals for the formulae to be adopted.
23. These new, legally-enforceable limits provide us with the flexibility to reset the steady state portion of the Specification at a level which facilitates acceleration of Sellafield Ltd's hazard reduction programmes, whilst avoiding the need for future revisions to the Specification.
24. The new steady state Specification is based on operating HALES with five in-service tanks, and result in limits set at approximately three times the current levels (which were set based on two in-service tanks). In reality, actual HAL stocks beyond July 2015 will be below these levels and will only increase when Sellafield Ltd is in a position to increase its reprocessing rates. While increased steady state HAL stocks are undesirable, we judge that allowing such increases is appropriate in view of the overall risk reductions that result from faster reprocessing of the nation's stock of irradiated reactor fuel. As reprocessing progressively comes to an end, the additional limits (set under Licence Condition 23) will commensurately reduce to very low levels, and ultimately to zero.

Past and predicted HAL Stocks performance:

25. Records show that there has been a continuous and significant downward trend in the stocks of HAL since the implementation of NII Specifications in January 2001. Current stocks of HAL are less than half those which were stored in 2001, and we will continue to monitor Sellafield's performance and compliance with the Specification and other related legal duties as stocks are reduced down to steady state working levels.
26. Forward predictions show that 'total stocks of HAL' will continue to reduce over the remaining lifetime of the reprocessing plants. Stocks of 'Oxide HAL', which reduced significantly following the 'THORP Feed Clarification Cell event' in 2005 ^[Ref 5], are likely to rise as Oxide reprocessing throughputs are ramped up, before finally reducing as reprocessing comes to an end.

2010 biennial review

27. We are currently in the process of assessing the suite of documents which Sellafield Ltd recently submitted in support of its 2010 biennial review process. These documents cover a wide range of topics related to the storage of HAL, POCO and HALES' operational contingencies. On completion, we intend to produce a further public statement to communicate the main findings of our assessment.

Conclusions:

28. Sellafield Ltd continues to reduce its historic accumulation of HAL in line with our Specifications and will achieve steady state working levels before July 2015.

29. We have revised the HAL stocks Specification, replacing the current volumetric limit with an equivalent limit in safety terms based on the mass of uranium (te(U)) in the unprocessed fuel from which the HAL was derived. This new form of limit better reflects the true hazard posed by the HAL and has become necessary because the present form of limit does not always promote operations in the best interests of safety.

30. In addition, we have raised the long-term steady-state limits (which will apply after July 2015) in order to prevent unacceptable delays to vitrification, and therefore site and national hazard reduction. Our approach follows a dual strategy of a revised HAL Stocks Specification set at values which will enable Sellafield Ltd to accelerate its reprocessing and vitrification programmes, supported by new, lower, legally enforceable limits set to regulate HAL stocks to levels as low as reasonably practicable. The settings of these lower limits will change year by year in line with Sellafield Ltd's reprocessing plans and vitrification performance.

References

1. HM Nuclear Installations Inspectorate, Safety of the storage of liquid high-level waste at BNFL Sellafield, Sudbury: HSE Books, 1995.
2. HM Nuclear Installations Inspectorate, The storage of liquid high level waste at BNFL Sellafield: an updated review of safety, Bootle: HSE, February 2000

3. HM Nuclear Installations Inspectorate, Progress on BNFL's Response to Three Reports Issued by HSE on 18th February 2000: February 2001
4. HM Nuclear Installations Inspectorate, The storage of liquid high level waste at BNFL, Sellafield: addendum to February 2000 report, Bootle: HSE, August 2001
5. Report of the Investigation into the leak of dissolver product liquor at the Thermal Oxide Reprocessing Plant (THORP), Sellafield, notified to HSE on 20 April 2005
6. HM Installations Inspectorate, BNFL Sellafield and Drigg and UKAEA Windscale Local Liaison Committee Report. Quarterly Report for 1 October to 31 December 2002
7. HM Installations Inspectorate, BNFL Sellafield and Drigg and UKAEA Windscale Local Liaison Committee Report. Quarterly Report for 1 October to 31 December 2004
8. HM Installations Inspectorate, BNFL Sellafield and Drigg and UKAEA Windscale Local Liaison Committee Report. Quarterly Report for 1 January to 31 March 2007
9. West Cumbria Sites Stakeholder Group: Sellafield, Calder Hall and Windscale, Quarterly report for 1 April 2009 - 30 June 2009, <http://www.hse.gov.uk/nuclear/lc/2009/wcssg2.htm>
10. HSE Enforcement Policy Statement