# OFFICE FOR NUCLEAR REGULATION
# PROJECT ASSESSMENT REPORT

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| Site | : Sellafield - High Level Waste Plants |
| Project | : HAL Stocks Specification No. 793 |
| Title | : Revision of HAL Stocks Specification |
| Licence Number | : 31G |
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## PROJECT ASSESSMENT REPORT – EXECUTIVE SUMMARY

**Title:**

Sellafield - High Level Waste Plants

Licence Instrument Number: 793

Revision of HAL Stocks Specification

**Licence Instrument for the revision of the HAL Stocks Specification:**

This Project Assessment Report has been written in support of issuing Licence Instrument 793 to address two of the matters outstanding from NII's 2008 HAL Stocks Biennial Review, i.e. the form and the level of the HAL Stocks Specification.

**Background:**

Prior to the commencement of the 2010 Biennial Review of HAL Stocks, Sellafield Ltd (SL) and NII agreed to close out two of the matters outstanding from the 2008 Review, i.e. the form of the HAL Stocks Specification and the level at which it should be set post July 2015. (The "steady-state" element of the specification)

Although NII's 2008 Biennial Review recommended replacing the current volumetric limit with an equivalent mass limit (teU), and also recognised the need for a relaxation of the steady-state portion of the HAL Stocks Specification, the new teU based limit could only be determined following further detailed analysis by Sellafield Ltd.

SL has completed the further analysis, and has argued for a substantial increase of the Steady-State limit post 2015, in order to prevent the cessation (or significant curtailment) of reprocessing, which 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.

SL's analysis suggests the 'total Magnox + Oxide' Specification needs to be increased to 6,400 teU total, and the 'Oxide' Specification increased to 2,000 teU Oxide. These limits are almost three times the current limits defined under Specification 679.

NII'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.

The 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 site wide and national hazard reduction, nor necessarily to support operations in the best interests of safety. Consequently, the Office for Nuclear Regulation has developed a modified regulatory strategy that has two principal 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.

Note: The Nuclear Installations Inspectorate (NII) was the nuclear regulatory body in place up to 1st April 2011, on which date it evolved into the Office for Nuclear Regulation (ONR). Given that the majority of the work carried out in support of the revision of the HAL Stocks Specification was completed prior to 1st April 2011, this PAR refers in most instances to the NII. The PAR refers to the ONR for all matters related to the period following 1st April 2011.

**Assessment and inspection work carried out by NII:**

Throughout the assessment of SL's analysis, NII has remained consistent with its long-term aims:

i. to ensure that HAL stocks are maintained as low as reasonably practicable.

ii. to ensure that Sellafield Ltd continues to reduce hazard potential across the Sellafield site and nationally.

NII has completed the following work in support of this Project Assessment Report:

- Sampled assessment of Sellafield Ltd's underpinning HAL Stocks modelling reports
- Meetings and discussions:
  - For SL to present the results of its Operations Research modelling work.
  - For NII to feed back its assessment findings, and to communicate the proposed limits and form of the Specification.
  - For SL to evaluate the operational practicality of running HALES according to NII's proposed Specification and to overcome those difficulties identified.
- Sampled assessment of SL's validation and verification of its Operations Research model.

**Matters arising from NII / ONR's work:**

Steady-State Specification:

ONR recommends that the Steady-State Specification should be set at an 'absolute limit' which enables SL to progress its reprocessing and vitrification programme according to the site's current plan, but including sufficient allowance to accommodate plausible acceleration options.

The two components of the HAL Stocks Specification should be set at:

- 'Total Magnox + Oxide': 5,500 teU (i.e. approx. 1,000 teU lower than suggested by SL)
- 'Oxide': 2,000 teU (the same as suggested by SL)

This will allow SL to accelerate its reprocessing of legacy fuels and wastes without the need to reset the Specification each time SL revises its plans.

Additional "limits in the interest of safety": (set at values below the Steady-State Specification)

The revised HAL Stocks Specification does not alter Sellafield's legal obligation, under its Licence Conditions, to "make and implement adequate arrangements for minimising so far as is reasonably practicable the rate of production and total quantity of radioactive waste accumulated on the site at any time." (LC(32))

NII's examination of SL's underpinning HAL Stocks modelling reports revealed the proportionality between 'reprocessing & vitrification throughputs' and 'stocks of HAL required'.

Therefore, and in order to ensure compliance with its Licence Condition obligations, SL has agreed in principle that by 1st July 2015 (the start date of the steady-state portion of the HAL Stocks Specification), it will have put in place additional "limits in the interest of safety" which control and maintain SL's Stocks of HAL at the minimum possible level compatible with its reprocessing and vitrification throughputs.

Furthermore, Sellafield will need to provide a clear justification demonstrating how it considers its Licence Condition duties are met, and in particular how risks arising to its workers and other persons are reduced so far as is reasonably practicable.

ONR may decide in future to use its regulatory process to freeze these additional limits by using its powers under the Licence Conditions.

Past and predicted HAL Stocks performance:

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.

Forward predictions show that 'total stocks of HAL' will continue to reduce over the remaining lifetime of the reprocessing plants, until steady-state levels are reached.

Stocks of 'Oxide HAL', which reduced significantly following the 'THORP Feed Clarification Cell event' in 2005, are however predicted to rise as Oxide reprocessing throughputs are ramped up, before steady-state levels are attained.

However, the new Specification (793) for the period up to July 2015 is set at similar levels of safety and hazard reduction as the volume based limits defined in Specification 679, and is actually set more conservatively between 2011 and 2014.

**Conclusions:**

The revised HAL Stocks Specification comprises of an 'absolute limit', specified by ONR at a value which enables SL to progress its reprocessing and vitrification programme according to the site's current plan, but includes sufficient allowance to accommodate plausible acceleration options.

To ensure compliance with its Licence Condition obligations, SL has agreed in principle that by 1st July 2015 (the start date of the steady-state portion of the HAL Stocks Specification), it will have put in place additional "limits in the interest of safety", set at values below the 'absolute limit', to control and maintain its Stocks of HAL at the minimum possible level compatible with its reprocessing and vitrification throughputs.

**Recommendations:**

ONR should issue Licence Instrument 793 and covering letter SEL 77170 to Sellafield Ltd, to specify revised HAL Stock limits as outlined above.

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## INTRODUCTION

1. NII's Specification No. 679 [Ref 1], issued in October 2007, requires SL to reduce its accumulation of Highly Active Liquor (HAL) waste in the High Active Liquor Evaporation and Storage (HALES) plant at Sellafield according to a prescribed programme.

   The Specification has two principal elements: to limit the total volume ($m^3$) of HAL that may be stored and to restrict the quantity (teU) of the more hazardous Oxide HAL.

   Specification 679 is a revision of Specification 343, previously issued in January 2001 to lock-in the reductions in HAL stocks arising from the long-term outage at THORP in the wake of the Feed Clarification Cell (FCC) event of 2004/5 and to change the form of the Oxide limit to teU in the light of operational experience from complying with the original form of limit.

2. In the Addendum to the 2000 Report on the storage of HAL [Ref 2, para 129], NII committed to "carry out a critical review of the [HAL stocks] strategy and overall programme every two years in order to identify any further reasonably practicable stock reductions" and "to take account of technological advances and the changing circumstances of [the Licensee's] own business plans".

   Since then, biennial reviews have been undertaken in 2002 [Ref 3], 2004 [Ref 4], 2006 [Ref 5], and 2008 [Ref 6 & 7], leading to public-domain statements [Ref 8 to 11].

3. Prior to the commencement of the 2010 biennial review, SL and NII agreed to close out two of the matters outstanding from the 2008 review, i.e. the form of the HAL Stocks Specification and the level of the 'Steady-State' Specification.

4. NII's 2008 biennial review [Ref 6] drew the following conclusions:

   "NII is minded to revise the HAL Stocks Specification, replacing the current volumetric limit with an equivalent limit in safety terms based on the mass of uranium in the unprocessed fuel from which the HAL was derived (teU). This new form of limit will better reflect 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. The precise details of this conversion are subject to <u>further analysis</u> currently being undertaken by Sellafield Ltd."

   "Although HAL stocks are at their lowest levels in decades, and significantly below the current limit, NII does not believe that a further tightening of the Specification akin to that applied in 2007 is appropriate on this occasion. This is because imposing a tighter limit would not have any positive regulatory effect."

"NII accepts that the current Steady-State Specification limit is set too tightly to allow efficient operation of WVP and so needs to be relaxed. However, the extent of any relaxation depends on further analysis currently being undertaken by Sellafield Ltd." "NII has developed six principles to govern [the assessment of] Sellafield Ltd's analysis."

"The timing of any update to Specification 679 depends on Sellafield Ltd completing its further analysis to [NII's] satisfaction."

"NII intends to make a single change to the Specification to address both the change to teU and the resetting of the steady-state limit."

5. SL has now completed the further analysis referred to above, and has produced extensive Operations Research modelling work [Ref 14 to 19] in support of its argument for a loosening of the Steady-State Specification, in order to prevent delays to the reprocessing and vitrification programmes.

Purpose of this PAR:

6. The purpose of this Project Assessment Report is to report NII findings and conclusions following its assessment of SL's submission [i.e. Ref. 14 to 19], and to consider a new HAL Stocks Specification expressed in teU with revised steady-state limits. This Project Assessment Report will be used to inform a public statement on HAL stocks reduction to be published in a forthcoming West Cumbria Sites Stakeholder Group quarterly report.

7. Over the past 18 months, NII and SL have been engaged in a number of meetings and discussions [Ref 20 to 24] :
    - For SL to present the results of the extensive Operations Research modelling work reported in references 14 to 19.
    - For NII to feed back preliminary findings from its assessment of these documents, and to communicate the limits and form of the Specification.
    - For SL to evaluate the operational practicality of running HALES according to NII's proposed Specification, and to overcome those difficulties identified.

Forthcoming 2010 biennial review:

8. NII's 2010 biennial review will be the subject of a separate ONR Assessment Report, which will be produced over the next few months, once the assessment of SL's 2010 submissions has been completed. NII's 2010 biennial review will be used to inform a public statement on HAL stocks reduction to be published in a future West Cumbria Sites Stakeholder Group quarterly report.

9. The scope of NII's 2010 biennial review has been reviewed and agreed by NII's HLWP IPG. [Ref 12]

   SL's 2010 biennial review is expected to be a continuation of the work carried out and reported in the 2008 review and assessed by NII's xxx [Ref 6] and xxx [Ref 7]. As such, SL's 2010 biennial review is expected to report on progress and developments since the 2008 review, to define the current status, to define future strategies, and to provide clear forward plans / programmes.

   In view of the detail and breadth of the work carried out in previous reviews, the scope of NII's 2010 biennial review will be limited to the re-examination of the HAL Stocks Specification in the light of the latest information submitted by SL as part of its review. The 2010 biennial review will not however result in a further revision of the HAL Stocks Specification.

## LICENSEE'S POSITION

### Issue 1: Form of limit used

10. SL's 2008 review highlighted several concerns [Ref 6] with the continuing use of volume as the headline (or total 'Magnox + Oxide') limit.

    Its main concern [Ref 11] is that, "as HALES is progressively emptied of HAL, the long term Specification limit (200 $m^3$ post July 2015) will not be sufficient even to accommodate the wash-out heels left in the near-empty tanks."

    "These wash-out heels are mostly water and acid left over from washing out the tanks, and present a very low hazard and risk compared to HAL."

    "However, as they contain some HAL (albeit greatly diluted), they still contribute towards the volume limited by the Specification."

11. SL's 2008 review also notes that the existing form of the Specification [Ref 1], i.e. using volume as the form of the 'total Magnox + Oxide' limit, "discourages [Ref 11] Sellafield Ltd from adding or using water or acid to, for example:

    - Maintain its 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 Operations Clean Out of empty HASTs."

    "Discouraging these and other activities, all of which are legitimate and appropriate for the safe operation of HALES, is an unintended ramification of applying the Specification in its current form."

12. "Overall, SL is now confident that it is able to operate applying a limit set in terms of the mass of uranium in the unprocessed fuel from which the HAL was derived (hereafter referred to as tonnes of uranium – teU), as a better alternative to liquor volume as currently used.

    This confidence stems in part from Sellafield Ltd's experience working with the Oxide limit, which was recast in terms of teU at the previous revision to the Specification in October 2007." [Ref 11]

13. In view of this, SL's 2008 review proposed [Ref 6] "changing the form of the HAL Stock Specification to describe all HAL in terms of the mass of the original spent fuel (teU)".

**Issue 2: Steady State Specification Limit**

Background / History:

14. "Specification 679 sets a limit restricting the quantity of HAL stored over time. This limit reduces every year until July 2015, when a steady-state level is reached restricting the site's HAL stocks to a maximum inventory of 200 $m^3$ (including wash-out heels).

    200 $m^3$ was based on analysis by the then Licensee (BNFL) dating from the time Specification 343 was set, and assumed HALES would by then be operating with only two HASTs in routine service.

    Sellafield Ltd's subsequent experience operating HALES and WVP has however demonstrated to NII's satisfaction that vitrification cannot be undertaken efficiently or effectively with just two HASTs." [Ref 11]

    SL concludes that "it is not feasible to deliver the programmed WVP performance with a 200$m^3$ steady-state volume", as such a limit "will lead to a significant programme extension". This problem is predicted to arise either because HALES cannot produce appropriately blended and concentrated HAL fast enough for WVP (so the latter would often be idle), or the feed to WVP would be so dilute, or of the wrong blend, that WVP could not be run efficiently (i.e. resulting in a reduced number of containers before each melter needs replacing, or producing containers with low waste incorporation). [Ref 6]

    "Consequently NII now accepts that the current limit is set too tightly and needs to be relaxed.

    The extent of this relaxation depends amongst other factors on the minimum number of HASTs in routine service that Sellafield Ltd considers reasonably practicable.

    Determining this number requires the completion of <u>further analysis</u> currently being undertaken by Sellafield Ltd." [Ref 11]

SL's suggested revised HAL Stocks Specification:

15. SL has now completed the further analysis referred to above, and has produced extensive Operations Research modelling work [Ref 14 to 19] to help in judgements as to where the Specification should reasonably be set once the historic accumulation of HAL has been worked-off.

16. Sellafield Ltd has completed in excess of 1000 model runs on the HAST Emptying and Management (HEMAN) Model, to calculate the teU in the HASTs at steady-state under a number of potential Magnox and THORP reprocessing scenarios. [Ref 14]

    The scenarios run were constructed to consider the impact of reducing tank numbers, ranging from 6 down to 3 tanks, and the impact of the feed concentration to WVP, which was varied from 135 g/L Waste Oxide to completely unconstrained dilute feed.

17. Based on its detailed technical analysis [Ref 14 to 19], Sellafield Ltd concludes that it requires a total steady-state working limit of 5,000 teU across 5 operational HASTs.

    Within this total steady-state teU limit, a limit of at least 2,000 teU Oxide is required.

    These limits would allow HALES to support up to 1,000 te per annum with Magnox only reprocessing, or up to 600 te per annum of Oxide only reprocessing, or up to 320 te per annum Oxide coincident with 840 te Magnox.

    This reprocessing at steady-state could produce on average 230 WVP containers per annum.

    An additional allowance of 1,400 teU is also sought to account for the teU inventory held within heels in non-operational New Side tanks. [Ref 14]

18. Therefore, based on this technical underpinning work, SL is seeking a revised 'total' limit of approximately 5,000 teU + 1,400 teU for heels, i.e. a total of approx. 6,400 teU.

    In effect, SL is therefore confirming its previous request for the limit to be raised by a factor of approximately three. [see also Ref 6]

Impact of 'dilute feed' to WVP:

19. SL concluded on the basis of its HEMAN model runs that the steady-state teU working buffer limit is very sensitive to the minimum concentration of HAL that can be fed to WVP. The lower the feed concentration, the lower the required stock of HAL.

    To date, feed concentrations to WVP lower than 135 g/L Waste Oxide remain unproven, and the Licensee's position is that HAL Stock reductions which may be possible below that concentration should not be built into the definition of the Specification.

## STANDARDS AND CRITERIA

20. The following SAPs are considered to be important to the present assessment:

- RW.6: Radioactive waste should be processed into a passively safe state as soon as is reasonably practicable
- RW.1: A strategy should be produced and implemented for the management of radioactive waste on a site
- RW.3: The accumulation of radioactive waste on site should be minimised
- RW.2: The generation of radioactive waste should be prevented (etc.)
- DC.3: Decommissioning should be carried out as soon as is reasonably practicable taking relevant factors into account

21. In addition to these however, the overriding criteria for deciding where and how to set the HAL Stocks Specification has been to regulate so that overall risks are reduced to ALARP and the need to comply with HSE's Enforcement Policy Statement. [Ref 13]

## NII REVIEW

### General Considerations

22. Work carried out by NII for the present report has included:
    - Detailed reading of SL's "Summary of Operations Research modelling work underpinning the HAST teU inventory required under steady-state teU working conditions". [Ref 14]
    - Sampled reading of SL's underpinning reports [Ref 15 to 19] for WVP feed concentrations of 135, 120, 102, 90 g/L, and for unconstrained feed concentration to WVP.
    - Meetings and discussions [Ref 20 to 28] :
        - For SL / NII to agree the methodology for converting the current Specification (LI 679), without either loosening or tightening, from $m^3$ to teU.
        - For SL to present the results of the extensive Operations Research modelling work reported in references 14 to 19.
        - For NII to feed back preliminary findings from its assessment of those documents, and to communicate the limits and form of the Specification.
        - For SL to evaluate the operational practicality of running HALES according to NII's proposed Specification, and to overcome those difficulties identified.
    - Assessment of SL's validation and verification of the HEMAN model.

### Issue 1: Review of Form of Limit and of SL's Recent Operational Experience

23. NII's 2008 biennial review [Ref 6] reported that "the Specification (LI 679, Oct 2007 [Ref 1] ) to limit Oxide derived HAL in terms of the mass of the original spent fuel (teU) has been successfully implemented by Sellafield Ltd, which provides confidence that both forms of the Specification, volume ($m^3$) and mass of original spent fuel (teU) can be successfully implemented to demonstrate compliance".

24. SL's biennial review process [Ref 12] requires it to produce a report demonstrating compliance with the current HAL Stocks Specification [Ref 1].

SL's 2010 report will be produced within the normal timescales for this year's biennial review, and will be submitted to the NII for assessment towards the end of 2010. This will be the subject of a separate AR.

25. In addition to the biennial reviews, ONR continues to monitor SL's compliance with the Specification on the basis of the monthly "HAL stocks reports" issued by Sellafield Ltd to the ONR.

26. Charts 1 and 2 below compare SL's total holding of HAL and its holding of Oxide HAL against the two Specification limits. Given the ongoing problems with evaporative capacity, there have been considerable margins to the limits compared to the past, particularly in regard to Oxide. This is despite NII's tightening of the Specification at the 2006 biennial review.

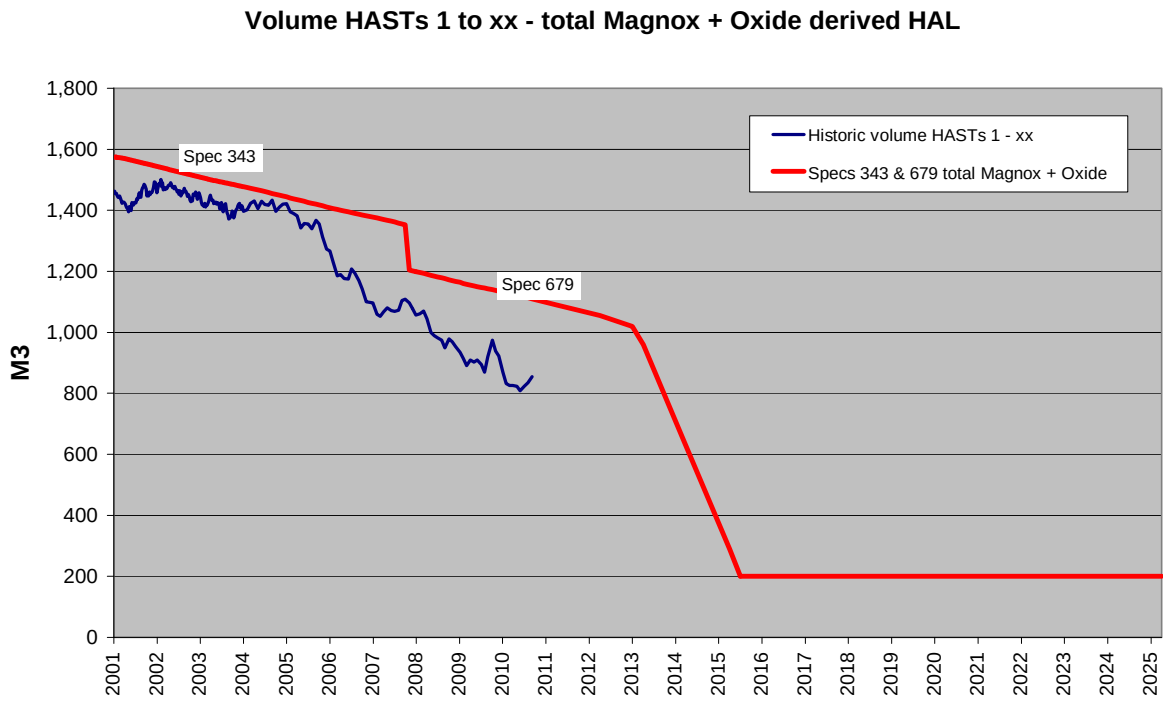



**Chart 1 [Ref 32] – Historic volumes of 'Magnox + Oxide' derived HAL held in HASTs 1 to xx – versus HAL Stocks Specifications 343 and 679**

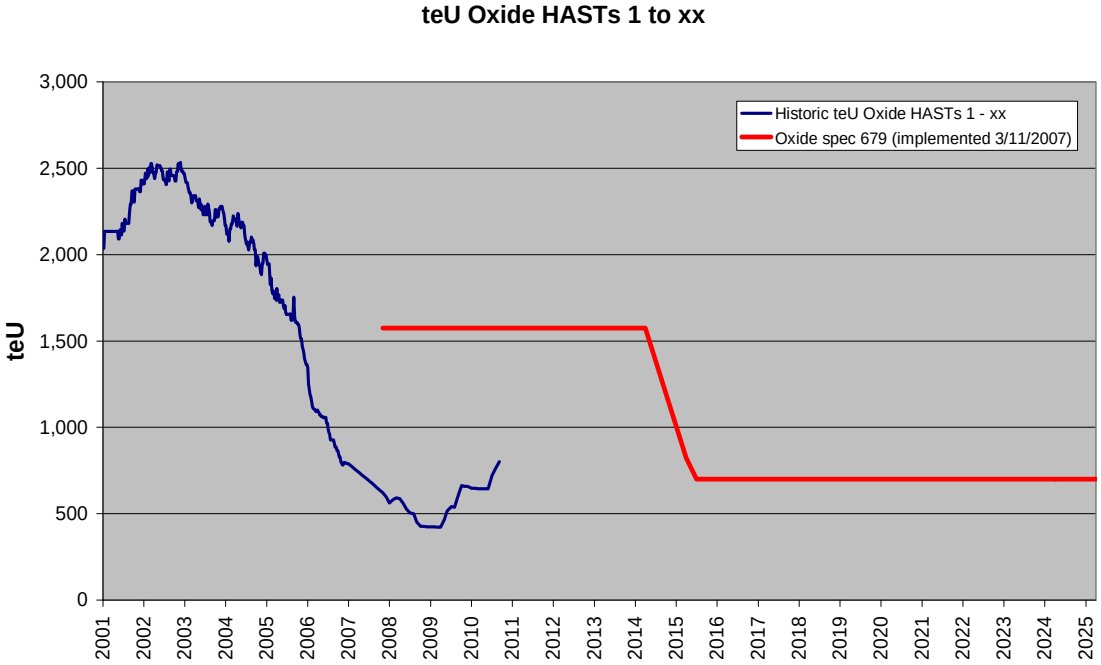



**Chart 2 [Ref 32] – Historic teU Oxide HASTs 1 to xx – versus HAL Stocks Specification 679**

Confidence in SL's HAL stocks accountancy process:

27. Previous NII inspections [Ref 6] into the detail of how SL accounts for its HAL concluded that SL has generally adequate procedures for HAL stocks accountancy, albeit with identified minor areas for improvement.

28. NII [Ref 6] fully supports SL's proposal, made in its 2008 biennial review, to "change the form of the HAL Stock Specification to describe all HAL in terms of the mass of the original spent fuel (teU)".

    This new form of Specification not only facilitates the activities necessary in the interests of safety described in paragraph 11, but also allows NII to set the limit in terms that more accurately reflect the true hazard, bringing the total HAL and Oxide limits into a common form.

    "Moreover, NII now considers that the benefits of a teU limit outweigh the transparency, consistency and accountability advantages of continuing with a volume limit." [Ref 11]

**Issue 2: Steady State Specification Limit**

29. Since the completion of its 2008 biennial review, SL has performed in excess of 1000 model runs [Ref 14 to 19] using its HEMAN model to define the minimum teU HAL required at steady-state under a number of Magnox and Oxide reprocessing scenarios.

    The scenarios modelled [Ref 14 to 19] considered a wide range of Magnox and Oxide reprocessing throughputs, using varying numbers of HAST tanks (6 down to 3), and WVP feed concentrations ranging from 135 g/L to completely unconstrained dilute feed.

30. SL has performed a detailed analysis of the above Operations Research modelling work, and has concluded [Ref 14] that it requires a total steady-state limit of 5,000 teU across 5 operational HASTs to support its reprocessing programme.

    An additional limit of 1,400 teU is claimed to account (principally) for the teU inventory held within heels in non-operational New Side tanks." [Ref 14]

    Within this total steady-state teU limit, a limit of at least 2,000 teU Oxide is required.

    (Further detail of SL's suggested HAL stocks limits is provided in appendix 1)

31. In summary, based on this latest technical underpinning work, SL is seeking:

    - A revised 'total' limit of 5,000 teU + 1,400 teU for heels, i.e. a total of 6,400 teU.
    - A revised 'Oxide' limit of 2,000 teU. (included within the 'total' 6,400 teU above)

    These new limits are almost three times larger than the current limits, defined under Specification 679 [Ref 1].

32. NII's previous biennial review assessment [Ref 6] accepted the need for a relaxation of the steady-state portion of the HAL Stocks Specification, to avoid restricting the overall rate of hazard reduction. However, it was NII's expectation that the revision to the Specification would not need to be as significant as sought by SL.

    A minimum inventory of 40 $m^3$ is held in operational and non-operational HASTs to enable the routine re-suspension of solids using the air driven ballast mixers. The re-suspension system is not able to operate with reduced liquor levels, and failure to agitate would eventually result in the accumulation of solids at the bottom of the tanks, leading to tank 'hot spots' and ultimately unnecessarily complex final emptying and decommissioning of the HASTs.

There are xx operational and non-operational HASTs on the 'New side' alone, and the summation of the minimum heels of those xx HASTs equals 400 $m^3$, which confirms the inadequacy of the 200 $m^3$ post-2015 steady-state volume specified in LI679. Moving to a mass-based limit (teU) will ultimately address the problem of heel volumes.

33. NII Specification 343, later amended by 679, was based on BNFL's own analysis and was set much tighter than SL now acknowledges it is able to deliver. The erroneous presumption was made that operation on 2 HASTs would be sufficient to support the required post-2015 reprocessing throughputs, which by then would be Oxide-only. Furthermore, heels seem to have been omitted from the calculations used to set the Steady-State HAL Stocks Specification.

    SL's explanation [Ref 6 & 14] is that the discrepancy was due to a number of issues which were not known or fully appreciated in 2000 / 2001, i.e.:

    - The extension of the Magnox and THORP reprocessing programmes. (The understanding in 2000 / 2001 was that the Magnox Operating Plan (MOP) would complete in 2013 and the THORP Lifetime Plan (LTP) in 2015. Due to a number of operational issues in both THORP and Magnox, these dates have been extended and there are still significant amounts of Oxide and Magnox fuel to reprocess. Following the Feed Clarification Cell event in April 2005, THORP was shut down for nearly two years and has since then been operating on reduced throughput due to constraints over evaporator capacity." [Ref 31] According to Lifetime Plan 10, THORP reprocessing will continue until 2020. If successful, acceleration options may however bring this date forward.)
    - The requirement, since the HAST foaming in 2001, for 4 weeks' settling time on receipt of fresh Oxide HAL (2 weeks for Magnox) in order to prevent any possibility of foaming.
    - Reduced in-tank evaporation rates, due to the lower heat content of the HAL.
    - An improved understanding of the necessary programme of work required to allow dilute HAL to be fed to the Waste Vitrification Plant. (The original calculations assumed that no 'in-tank evaporation' was required in HALES, and that HAL could be fed at concentrations down to 100 g/L to WVP. Recent work in conjunction with Areva has revealed the full extent of the development programme required prior to the implementation of a 'dilute feed' strategy)
    - A better appreciation of WVP downtimes.
    - A developing understanding of heel volumes in the light of operational POCO experience.

34. Given the size of the increase in the Steady-State Specification sought by SL, NII's assessment has focused on the following key aspects of SL's technical underpinning work, i.e.:

    - Minimum concentration of HAL feed to WVP: 135 g/L.
    - Relationship between 'HAL stocks required' and 'Magnox and Oxide reprocessing throughputs'.
    - Minimum number of HASTs required to support the reprocessing programme.

- Margins and / or conservatisms included in SL's calculations.
- Validation and verification of the HEMAN model.

These points are addressed in further detail in the following paragraphs of this report.

Minimum concentration of HAL feed to WVP: 135 g/L

35. SL's Operations Research modelling work [Ref 14 to 19] considered a wide range of WVP feed concentrations, from 135 g/L down to approximately 60 g/L (cf. 'unconstrained dilute feed scenarios' [Ref 19])

36. As illustrated in Chart 3 below, the HEMAN model runs show that the adoption of a 'dilute feed strategy' reduces the quantity of HAL that needs to be stored within HALES significantly. Therefore HALES could comply with a far more stringent Steady-State Specification limit. [Ref 25]

    Indeed, the residence time (and hence the inventory) in the HAST tanks is dominated by the 'in tank evaporation' required to increase the concentration of HAL up to a value compatible with the WVP process.

    In effect, a 'dilute feed' strategy would transfer some of the burden of evaporation from HALES to WVP.

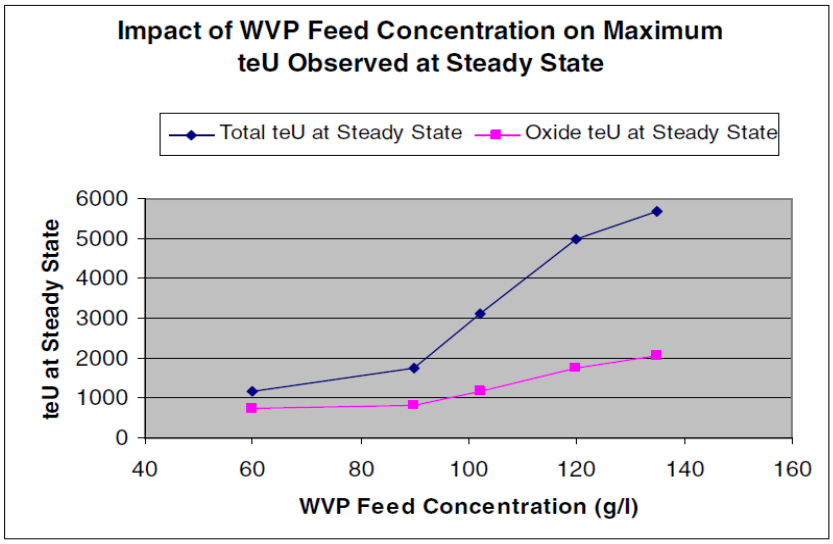



**Chart 3 – Impact of WVP feed concentration on 'total' and 'Oxide' HAL stocks required (across full data set for all tanks and reprocessing scenarios)**

37. Subject to further development work and the implementation of a number of plant modifications, WVP has some margin which would allow it to accept more dilute feeds, perhaps down to 90 g/L.

    However, dilute feeds increase dust generation in the calciner, which will require additional 'rodding out' operations.

    It is therefore likely that longer and more challenging WVP outages would be required for dilute washing, and that there would be an increase in 'Medium Active' solid and liquid effluent wastes.

38. Historically, SL has maintained feed concentrations of approximately 150 – 160 g/L to WVP [Ref 26], and, to date, has had no experience of feeding HAL at concentrations lower than 130 – 135 g/L Waste Oxide. [Ref 14] Anecdotally, operation at lower waste oxide concentrations in this range has resulted in frustrating, but not insurmountable problems with dust.

39. 135 g/L is the minimum WVP feed concentration at which SL currently has sufficient confidence to proceed. Consequently, SL has based its analysis of the revised Steady-State Specification on the output of its 135 g/L Operations Research modelling scenarios.

    SL recognises however that "significant reductions in the required buffer working inventory could be realised if the technical work and plant modifications required in WVP to operate with dilute feeds are completed." [Ref 14]

40. I support SL's argument to base the definition of the HAL Stocks Specification on HAL feed concentrations which are within WVP's current proven operating envelope, and therefore on the output of the 135 g/L Operations Research modelling runs. A Specification based on more dilute assumptions would not be reasonably practicable, and may need later to be re-set at a higher value.

41. However, given the opportunity to achieve significant further reductions in HAL stocks through the implementation of a 'dilute feed' strategy, NII needs to ensure that strong drivers remain in place for SL to continue its WVP dilute feed development and implementation programme, whilst taking due consideration of the requirement for waste generation and potential disposals to the environment to be maintained at ALARP levels.

42. During an NII visit to SL's Vitrification Test Rig (VTR) [Ref 27], SL demonstrated the actual progress which is currently being made on the WVP development programme, which includes dilute feed, increased throughputs and improved on line time. Further details can be found in Reference 27.

43. NII's examination of the VTR development work provides confidence that SL is intent on developing and implementing the necessary changes for WVP to accept dilute feeds.

    SL is aiming for a completion date of 2011, based on the assumption that the scope for developing and implementing 'dilute feed' turns out to be small. [Ref 33]

    However, examination of SL's Lifetime Plan documents does not provide the same degree of confidence. The Lifetime Plan forecasts a completion date of 2013, based on generic timescales for "standard medium sized projects".

44. In view of the significant further reductions in HAL stocks which could be achieved through the implementation of a 'dilute feed' strategy, ONR will need to continue close monitoring of SL's progress on the WVP development programme, which includes dilute feeds.

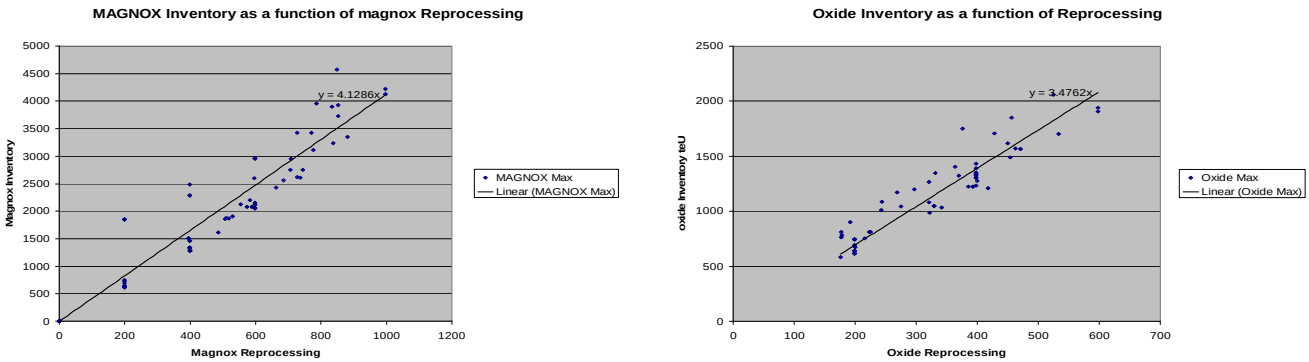
    To that effect, dilute feeds have specifically been included in the scope of the 2010 biennial review [Ref 12] , and the relevant documents will be submitted to ONR for assessment.

    Finally, SL's position on dilute feeds is expected to form part of the ALARP argument which SL will generate on an annual basis in support of its proposal for HAL stocks 'Operating Rules'. *(see later paragraphs)*

<u>Impact of reprocessing throughputs:</u>

45. Charts 4 and 5 below [Ref 28], derived from SL's detailed Operations Research modelling work [Ref 14 to 19], illustrate the relationship between Magnox and Oxide reprocessing throughputs and the stocks of HAL required to support those throughputs.

    Indeed, as reprocessing throughputs increase, so do the volumes of HAL requiring 'in-tank evaporation', and therefore also the inventories of HAL.




**Charts 4 and 5 – HAL stocks required (teU) as a function of Magnox and Oxide reprocessing throughputs**

<u>Important note</u>: These charts have been derived from 'all data', i.e. all combinations of Magnox and Oxide throughputs, for all WVP feed concentrations and all numbers of HASTs. They have been presented for illustration only.

46. Therefore, the definition of the Steady-State portion of the HAL Stocks Specification requires careful evaluation of appropriate Magnox and Oxide reprocessing throughput assumptions.

    The lower the assumed reprocessing throughputs, the lower the stocks of Magnox and Oxide HAL required. However, low reprocessing throughputs result in spent fuel residing for longer than necessary in ponds, which has fuel corrosion and hence ALARP implications.

    Conversely, higher reprocessing throughputs result in larger stocks of HAL, but allow SL to maintain progress in line with the Magnox and Oxide Operating Plans (MOP & OOP), and, under accelerated options, to bring forward the reduction in the quantities of spent fuel stored in ponds.

47. SL's detailed Operations Research modelling work [Ref 14 to 19] has allowed HALES' technical team to determine the minimum inventories of HAL required to support the combinations of Magnox and Oxide throughputs listed in the table below.

| **Date** | **Reference Case** | | | **Accelerated Option A** | | | **Accelerated Option B** | | |
|---|---|---|---|---|---|---|---|---|---|
| FY beginning April | Reprocessing | | WVP Ctn/yr | Reprocessing | | WVP Ctn/yr | Reprocessing | | WVP Ctn/yr |
| | Mag | Oxide | | Mag | Oxide | | Mag | Oxide | |
| 2009 | 499 | 147 | 300 | 499 | 147 | 300 | 499 | 147 | 300 |
| 2010 | 730 | 200 | 300 | 730 | 300 | 300 | 730 | 300 | 330 |
| 2011 | 525 | 300 | 300 | 525 | 300 | 300 | 525 | 450 | 330 |
| 2012 | 703 | 300 | 260 | 703 | 300 | 300 | 703 | 450 | 330 |
| 2013 | 737 | 300 | 260 | 737 | 300 | 280 | 737 | 450 | 330 |
| 2014 | 491 | 296 | 260 | 491 | 296 | 280 | 491 | 450 | 330 |
| 2015 | 705 | 411 | 260 | 705 | 450 | 270 | 705 | 450 | 330 |
| 2016 | 370 | 434 | 250 | 370 | 600 | 260 | 370 | 450 | 320 |
| 2017 | 0 | 450 | 250 | 0 | 600 | 260 | 0 | 198 | 320 |
| 2018 | 0 | 450 | 170 | 0 | 52 | 170 | | | 131 |
| 2019 | 0 | 432 | 170 | | | 170 | | | |
| 2020 | 0 | 105 | 170 | | | 162 | | | |
| 2021 | | | 170 | | | | | | |
| 2022 | | | 111 | | | | | | |

**Projected Magnox and Oxide reprocessing throughputs (teU / annum) scenarios [Ref 14] for HEMAN model calculation of HAL stock requirements.**

(Note: 'Reference case' is equivalent to Lifetime Plan 10 (LTP10) and Lifecycle baseline 10 LCB10)

48. In view of the link between reprocessing throughput and HAL Stocks, ONR should set the Steady-State Specification at a level which allows SL to progress its most realistic reprocessing and vitrification programme.

    In addition, the Specification should allow sufficient scope for SL to pursue accelerated options in recognition of the fact that vitrified waste is preferable to spent and / or legacy fuel residing for longer than necessary in ponds.

    However, the approach taken needs to achieve an appropriate balance between the additional benefits of achieving higher throughputs (and thus more rapid reprocessing and vitrification of waste into a safe passive form), and the additional stocks of HAL required to support the higher throughputs. (see also ALARP justification in para 84)

    In addition, ONR needs to avoid creating a situation where the Specification is set at a level which allows acceleration, but where 'actual' reprocessing and vitrification throughputs are low due to various plant availability issues. Such an approach could allow a return to the situation where SL's holding of HAL is not ALARP.

49. Furthermore, the definition of the HAL Stocks Specification needs to be as simple as possible, whilst still reflecting the link between 'HAL stocks required' and 'throughputs'.

    Indeed, the simpler the Specification, the easier it will be to understand, and therefore to communicate internally and to the public.

50. In view of these considerations, three options were proposed to the HLWP IPG:

    a) Specification in line with LCB10: set the Specification in line with SL's LCB10 proposals (termed 'reference case' in para 47), and relax the setting at a later date (by re-issue) if and when SL is able to commit to one of its accelerated options.

    b) 'Formula agreed upfront': define the Specification in terms of throughputs via a simple formula.

    c) 'Absolute limit': set an 'Absolute limit' at a value which enables SL to progress plausible acceleration options. In tandem with this and in line with its legal obligation to maintain HAL stocks to ALARP levels, SL should be asked to define 'Operating Rules' (which ONR may choose to Approve), related to throughput, requiring it to maintain HAL stock levels below pre-defined limits set below the Specification limit. SL would then be able to reset its own limits in line with its changing reprocessing plans without the need for ONR to reset the Specification. ONR would however maintain visibility of the process through our oversight of SL's changing Operating Rules.

51. The HLWP IPG decided to pursue option c), which clearly places the responsibility on the Licensee to maintain its stocks of HAL 'as low as reasonably practicable' and in line with reprocessing throughputs.

    This option also avoids the complexities and regulatory burden inherent to options a) and b).

Required number of High Active Storage Tanks:

52. As previously discussed (see para 45), there is a relationship of proportionality between Magnox and Oxide reprocessing throughputs and the stocks of HAL required to support those throughputs.

    In addition to this, for a given throughput, HAL stocks show a significant increase with the number of operational HASTs. [Ref 34]

    This relationship is illustrated in the Magnox and Oxide charts below, derived from the output of the HEMAN model.

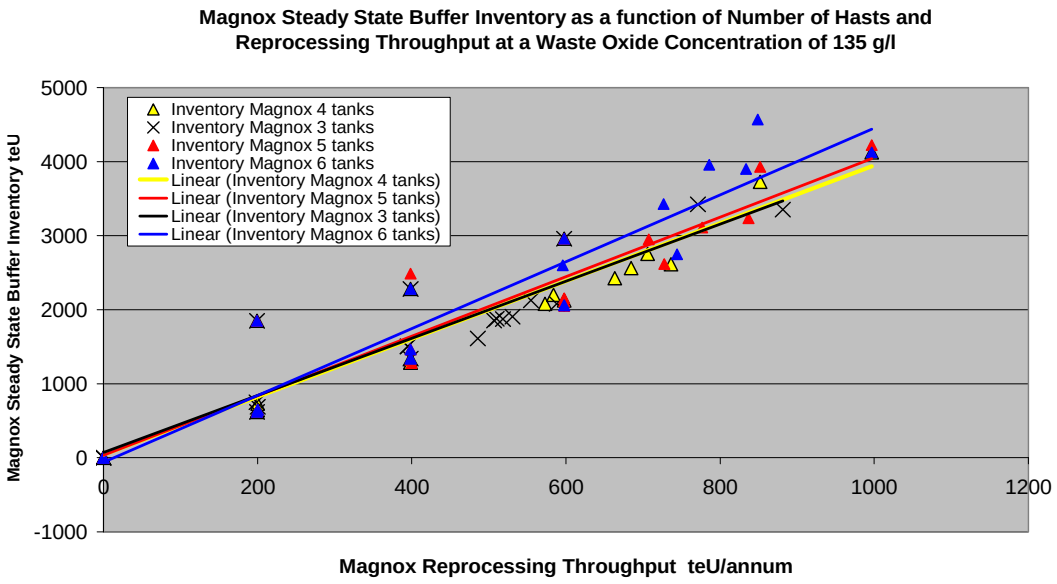



**Chart 6 – Impact of number of HASTs on Magnox HAL stocks required**

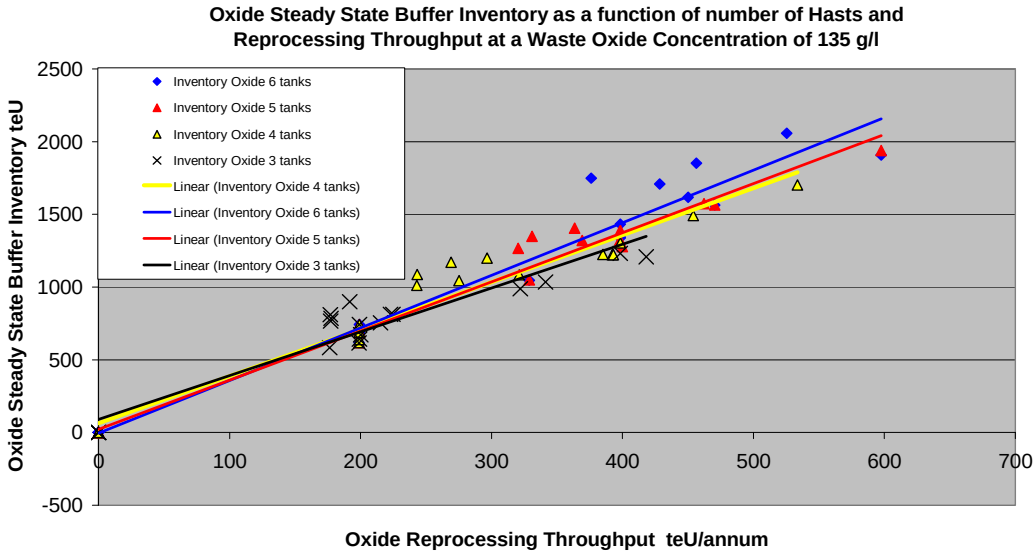



**Chart 7 – Impact of number of HASTs on Oxide HAL stocks required**

53. I have analysed the data provided by SL [Ref 15] to establish the minimum number of HASTs required to support the various combinations of Magnox and THORP reprocessing throughputs presently envisaged.

54. This analysis has concluded [Ref 22] that projected LCB10 throughputs (see table in para 47) fall marginally outside of the capability defined for 4 HASTs.

    Furthermore, accelerated options A and B fall significantly outside of the Magnox and Oxide throughputs which 4 HASTs are able to support.

    Further detail and illustration is provided in appendix 2.

55. However, operation with 5 HASTs is able to support the LCB10 projected throughputs, and also the majority of accelerated options A & B. (see details in appendix 3)

56. SL's own analysis [Ref 15] indicates that although operation with 6 HASTs supports all LCB10 scenarios, plus accelerated options A & B with considerable margins, it is hard to justify the additional stocks that a further HAST would entail.

57. Therefore, based on the above assessment, I agree with SL's conclusion [Ref 14] that 5 HASTs is the optimum tankage required to support its future reprocessing programme.

HAL Stocks Specification – 'Absolute limit'

58. Previous paragraphs provide justification for basing the definition of the HAL Stocks Specification on a WVP feed concentration of 135 g/L and operation with 5 HASTs.

59. In search of a simple correlation linking 'HAL stocks' to 'Magnox and Oxide reprocessing throughputs', NII analysed SL's Operations Research modelling results for the 135 g/L WVP feed and '5 HASTs' scenarios [Ref 15].

    Various forms of correlation were tested, and it was found that the essential output of the HEMAN model could be reduced [Ref 22] to a simple linear formula of the form:

    HAL stock required (teU) = 3.7 x (Magnox throughput) + 3 x (Oxide throughput)

    This form of correlation meets the previously stated requirement for simplicity, and to facilitate understanding and communication.

    More complex correlations offered no appreciable improvement in precision / accuracy compared with the simple correlation above.

60. Applied to the reference and accelerated throughputs tabled in paragraph 47, the simple correlation estimates the 'total' HAL stocks required to support all projected combinations of Magnox and Oxide throughputs to be approximately 4,000 teU. (see appendix 4 and reference 22 for details)

    An 'absolute limit' of 4,000 teU would provide sufficient margin for SL to progress its accelerated options.

61. In addition to the above, margins need to be added to account for existing heels in non-operational HASTs (1,171 teU), and to provide a working buffer in the event of WVP shutdowns / outages (327 teU). [Ref 22]

    Including an allowance for WVP shutdowns / outages is beneficial in view of the frequent periods 'off-line' experienced by the vitrification plants.

    327 teU has been calculated based on 4 months' WVP production (all 3 lines) at reference case throughputs, which is judged to be a reasonable level based on the plants' likely outages.

    (Note: The 327 teU allowance represents a slight tightening relative to SL's suggested 500 teU margin. NII also challenged and has omitted 2 margins suggested by SL, i.e. 180 teU self-siphon from evaporators A & B into HAST x (due to double-counting), and 50 teU margin for rounding.)

62. In summary, the 'absolute limit' for total Magnox + Oxide HAL stocks proposed is:

    - 4,000 teU (throughput element)
    - 1,171 teU (existing heels)
    - 327 teU (margin for WVP outage)

    i.e. a total 5,498 teU 'absolute limit', rounded to 5,500 teU (to be compared with SL's suggested limit of 6,400 teU)

63. Similarly, the correlation in paragraph 59 can be used to estimate the stock of Oxide HAL required to support SL's reprocessing programme.

    Appendix 4 shows that an 'Oxide' absolute limit of 1,800 teU is sufficient for all projected combinations of Magnox and Oxide reprocessing throughputs, including the accelerated options.

    It should be noted that, as per previous Specifications, the 'Oxide' limit covers all HAL liquors derived from the reprocessing of Oxide fuel, plus all blends of Magnox and Oxide liquors. However, by adopting a mass-based (teU) approach, accounting for blends is now far simpler.

64. As above, margins for Oxide liquors also need to be added to account for existing heels in non-operational HASTs (67 teU), and to provide an allowance for WVP shutdowns / outages (148 teU)[Ref 22], both figures being calculated as in para 61.

65. The proposed 'absolute limit' for 'Oxide' HAL stocks is thus:

    - 1,800 teU (throughput element)
    - 67 teU (existing heels)
    - 148 teU (margin for WVP outage)

    i.e. a total 2,015 teU 'absolute limit', rounded to 2,000 teU. (which is the same as SL's proposed limit of 2,000 teU)

Supporting 'Operating Rules' (set at values beneath the 'absolute limit')

66. Paragraph 51 stated the HLWP IPG's preferred form of Specification, i.e. an 'Absolute limit' set at a value which enables SL to progress plausible acceleration options, supported by 'Operating Rules' related to throughput, set by SL year by year in line with its legal obligation to maintain HAL stocks to ALARP levels.

67. SL has tested a number of scenarios and combinations of Magnox / Oxide throughputs to assess the feasibility of operating HALES within various Operating Rules related to reprocessing throughputs.

    In particular, SL has assessed the practicality of adopting the simple correlation derived by NII during our assessment of SL's HEMAN model results, i.e. HAL stock required (teU) = 3.7 x (Magnox throughput) + 3 x (Oxide throughput)

68. There was much discussion during meetings over how to derive Operating Rules from past and forecast reprocessing throughputs, and over various scenarios for the dynamic evolution of Operating Rules as throughput proposals change.

69. Ideally, and to maximise confidence that the limits will be set at the right level, the Operating Rules should be linked to actual throughputs achieved, whilst providing sufficient flexibility to enable ramp up and / or recovery from a plant shut down / outage.

70. Further attributes essential for the definition of Operating Rules were agreed with SL, i.e. they must:

    - be fair, reasonable and unbiased
    - practicable, implementable
    - Approvable by ONR, i.e.
        a) well-defined
        b) something ONR can support
        c) legally tenable
    - facilitate SL responsibility for keeping stocks ALARP
    - include appropriate margins

71. Following its assessment of a number of scenarios, SL recommended that the Operating Rules should be defined on the basis of the higher of 'recent historic throughputs' and 'forecast throughput'.

72. SL also evaluated a number of options to overcome 'pinch points', where 'cliff edge' reductions in the Operating Rule exceed SL's ability to reduce the HAL stocks.

    NII challenged and rejected SL's recommendation to incorporate an 'end of life plateau' to limit the reduction in the HAL Stocks Specification. This option would have resulted in a post-2015 steady-state limit set at an unjustifiably high level.

    NII proposed two alternatives ('glide rule' and 'threshold at low throughputs') to overcome the problem of pinch points.

73. NII also challenged and rejected SL's request for a significant additional margin of 417 teU, justified on the basis of the safety case requirement for

WVP and Bxxx to transfer liquors to HALES in the event of a prolonged shut down. [Ref 24]

74. NII cautioned SL against defining Operating Rules on the basis of overly conservative considerations. Operating Rules should be based as far as possible on 'normal operations', and not on extreme scenarios, and should not include margins and allowances to bound every single design basis fault.

    From a 'Nuclear Safety' perspective, making the correct responses to fault conditions, perhaps triggered by the breach of an Operating Rule, is the most important consideration. [Ref 42]

75. SL has not yet completed its work on the definition of Operating Rules.

    However, the revision of the HAL Stocks Specification ('absolute limit') and the detailed definition of the supporting Operating Rules do not necessarily need to follow the same timescale. (This point is discussed later in this document, under 'timescales for implementation')

76. Based on the assessment work conducted to date and on the various interactions with HALES, ONR has gained sufficient confidence that SL will be able to adopt appropriate Operating Rules meeting the attributes listed in paragraph 70.

Legal standing of Operating Rules

77. Following initial concerns by SL about how HAL stocks limits defined by Operating Rules could be implemented in practice on the HALES plant, SL and NII reached agreement on the most appropriate way of implementing the Operating Rules.

78. SL's primary concern was that limiting HAL stocks according to Operating Rules could potentially create a conflict with SL's current procedures whereby Duly Authorised Persons (DAPs) on HALES are trained to operate within the boundaries imposed by the "Production Campaign Assessment Document (PCAD)", which maintains operations within safe limits defined in the safety case.

79. NII provided clarification of the legal definition of Operating Rules and Safety Case. Under Licence Condition 23(1), Operating Rules are defined as 'any conditions and limits necessary in the interests of safety'. The 'Safety Case' represents the totality of the documents the Licensee needs to demonstrate the safety of its Operations (see LC 23(1) and Ref 42), and so includes Hazans, DARs, Clearance Certificates, the PCAD, etc… This

list is larger than the documents SL currently considers to form the Safety Case.

80. In order to achieve closer alignment with its processes and procedures, SL would like to refer to the limits by a name other than 'Operating Rules', which is compatible with the approach Recommended in reference 42. However, SL is aware that for the purposes of legal compliance, these HAL stocks limits are indeed 'Operating Rules', as defined in Licence Condition 23(1), whatever label is attributed. [Ref 39]

81. SL therefore proposes to put in place limits, derived from formulae which correlate reprocessing / vitrification throughputs with the HAL stocks limits. These limits will be considered as Operating Rules from a legal perspective.

    The Duly Authorised Persons will continue to operate according to PCAD limits, which maintain operations within safe limits defined in the safety case.

    SL stated its intention to implement a 12 month period of "shadow operation" under the new Operating Rule regime, for the purposes of training and identifying / eliminating any remaining problems.

    I judged this approach to be acceptable.

Timescales for implementation

82. The revision of the HAL Stocks Specification ('absolute limit') and the detailed definition of the supporting Operating Rules do not necessarily need to follow the same timescale.

    Whereas it is intended to revise the HAL Stocks Specification at the earliest opportunity, it is possible to leave open the detailed arrangements for the supporting Operating Rules, as they only need to be put in place 12 months before 1st July 2015. (the start date of the steady-state portion of the Specification)

83. However, given that the achievement of a sustained reduction in HAL stocks is by definition a long-term operation which requires long-term planning, SL will need to make sufficient progress on the definition of the Operating Rules to allow planning of the year on year reduction in HAL stocks between now and 2015.

ALARP justification:

84. Previous paragraphs have explained the HLWP IPG's preferred form of HAL Stocks Specification, i.e. an 'Absolute Limit', supported by Operating Rules.
    - o ONR specifies the absolute limit
    - o SL defines the Operating Rules, which ONR may choose later to Approve

85. NII has emphasised that when SL submits the Operating Rules for assessment and possible approval, NII / ONR will be looking for SL to demonstrate that its proposals are ALARP, i.e. the HAL inventory is favourably balanced by the reprocessing and vitrification throughputs achieved, so that its holding of HAL is justified by the reduction in overall risk.

86. Even though accelerated reprocessing of spent fuel is implicitly understood to be preferable to long-term storage in ponds, ONR will expect SL to bring these arguments out explicitly, i.e. to demonstrate that the HAL inventory is favourably balanced by the overall reduction in hazard afforded by reprocessing according to LCB10 and potential accelerations.

87. This is an advantage of the Operating Rules approach being proposed, in that Operating Rules are limits and conditions derived from the safety case, and a prime purpose of safety cases is to demonstrate that risks are ALARP. Hence, NII will expect SL's proposal for Operating Rules to include a justification that the strategies proposed reduce risks to ALARP.

88. The ALARP arguments referred to above amount to a justification that the risks at stream level, i.e. pond storage of spent fuel, reprocessing, evaporation, storage and vitrification, have been reduced to 'as low as reasonably practicable'. This stream ALARP justification is sometimes colloquially referred to as 'overall ALARP'.

Revised HAL Stocks Specification

89. In brief, the revised Steady-State HAL Stocks Specification comprises an 'absolute limit', specified by ONR at a value which enables SL to progress plausible acceleration options, supported by Operating Rules, defined by

SL in line with its legal obligation to maintain HAL stocks at ALARP levels. (see para 50)

90. The 'absolute limits' for 'total Magnox + Oxide' and for 'Oxide only' were defined in paragraphs 62 and 65 respectively as:

    - 'Total absolute limit' = 5,500 teU
    - 'Oxide absolute limit' = 2,000 teU

    These revised limits will come into force on 1st July 2015, which is consistent with the timescale for steady state operation imposed by current Specification 679. [Ref 1]

91. SL is progressing work on the definition of its Operating Rules, and also on the preparation of the ALARP justification required to support the Operating Rules.

    The Operating Rules need to come into force by 1st July 2015, but will probably be implemented earlier than this, initially through shadow working.

92. Given the relationship between 'HAL stocks required' and 'reprocessing throughputs', NII has asked SL during the various progress meetings [Ref 20 to 25] to build the relationship used for the absolute limit into the formulae for its Operating Rules.

    This relationship is based on a simple correlation, derived from the assessment of SL's Operations Research modelling work, i.e.:

    *HAL stock required (teU) = 3.7 x (Magnox throughput) + 3 x (Oxide throughput)*

93. There is now mutual confidence that a simple formula, of the type proposed above, can be applied for the definition of the Operating Rules.

    Adjustments will however be required to the coefficients of the formula, and / or of the glide / transition arrangements to prevent breaches when there are sudden drops in the calculated value of the Operating Rule.

94. SL has also examined several options for the definition of reprocessing throughputs, in an attempt to identify a workable option, linked to actual reprocessing throughputs achieved, whilst providing sufficient flexibility to enable ramp up and / or recovery from a plant shut down / outage.

95. SL's proposal is to base its Operating Rules on the 'Highest of 2 values', i.e. the highest of:

    - '3 year historic average', which is the average of the Magnox and Oxide reprocessing throughputs achieved in the 3 years prior to when the Operating Rule is being reset. 3 years is

appropriate as this is a typical residence time for HAL during steady state working.

- o ‘Current forecast reprocessing’, which is the reprocessing throughput forecast for Magnox and Oxide over the year following the reset. (i.e. the coming year)

SL is still experimenting with various glide rules / transition arrangements.

96. SL’s representation (see charts 8 and 9 below) of the proposed ‘Operating Rules’ and the ‘forecast inventories in HASTs 1 to xx’ shows that these proposals are in principle viable. The second chart, teU Oxide, illustrates that the Operating Rules currently under consideration would be breached towards 2023, unless pre-emptive operational action is taken. This illustrates why SL intends to carry out further work to refine the definition of the Operating Rules.

    However, it is noted that instances such as this are probably not as problematic as SL currently considers them to be. (in view of the operational control SL has to temporarily reduce the liquors being sent to HALES when Operating Rule limits are approached)

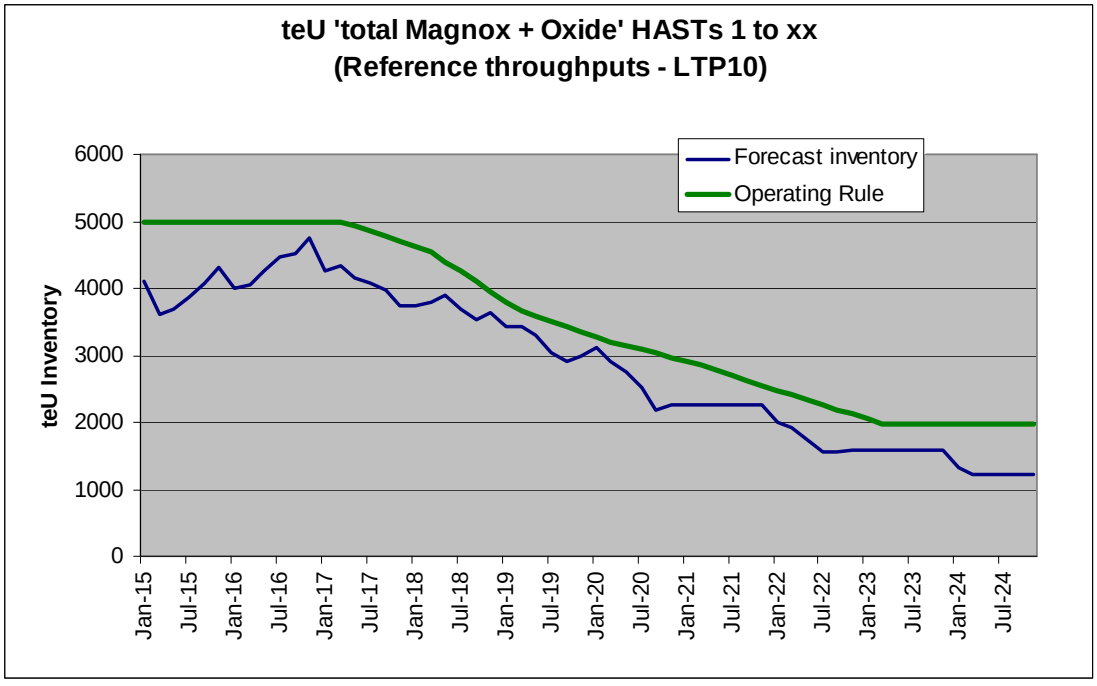



**Chart 8** [Ref 30] **: ‘teU total Magnox + Oxide’, including SL’s proposed ‘Operating Rules’ and ‘forecast Magnox and Oxide inventories in HASTs 1 to xx’, Reference (or LTP10) throughputs (see para 47)** (Note: this chart is shown for illustration purposes only, and represents work in progress. Sellafield Ltd is continuing to refine the definition of the Operating Rules)

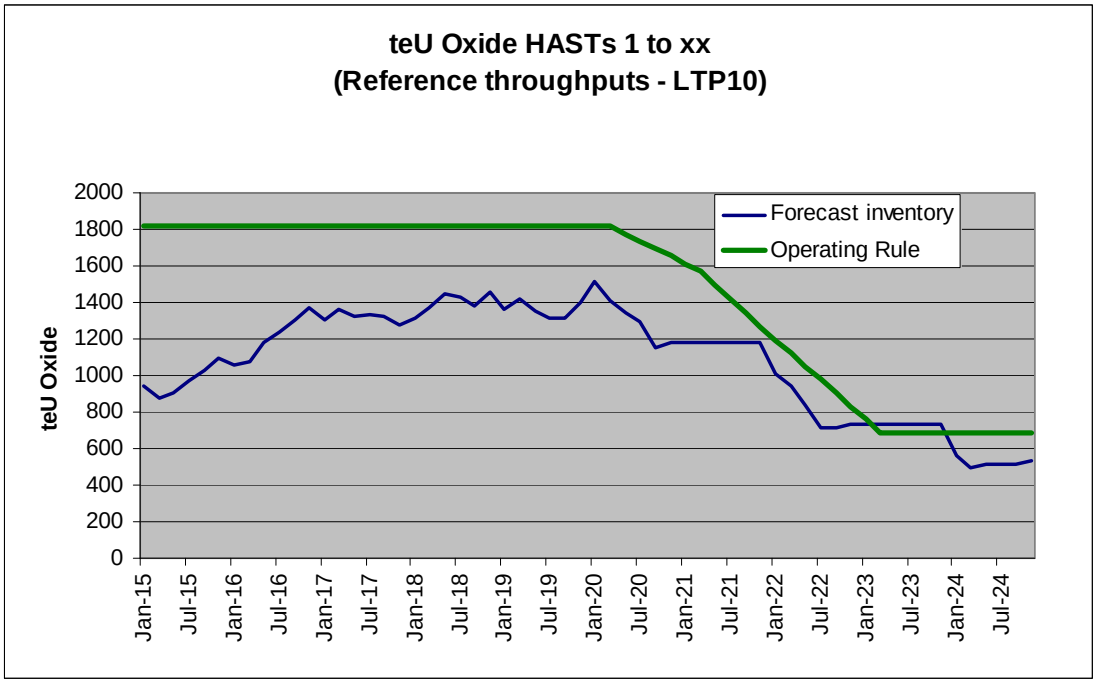



**Chart 9** [Ref 30] **: 'teU Oxide', including SL's proposed 'Operating Rules' and 'forecast Oxide inventories in HASTs 1 to xx', for reference (or LTP10) throughputs (see para 47)** (Note: this chart is shown for illustration purposes only, and represents work in progress. Sellafield Ltd is continuing to refine the definition of the Operating Rules)

97. The corresponding charts for accelerated options A and B are presented in appendices 5 and 6 respectively. Similar potential breaches of the Operating Rule are predicted here also, unless pre-emptive controlling action is taken by SL at the time.

98. The various charts and discussions from previous paragraphs have been consolidated into chart 10 below, to provide an overview of historic and predicted performance, and current and proposed HAL Stocks Specifications and Operating Rules. [Ref 32] (Note: the charts for accelerated options A and B are displayed in appendix 7)

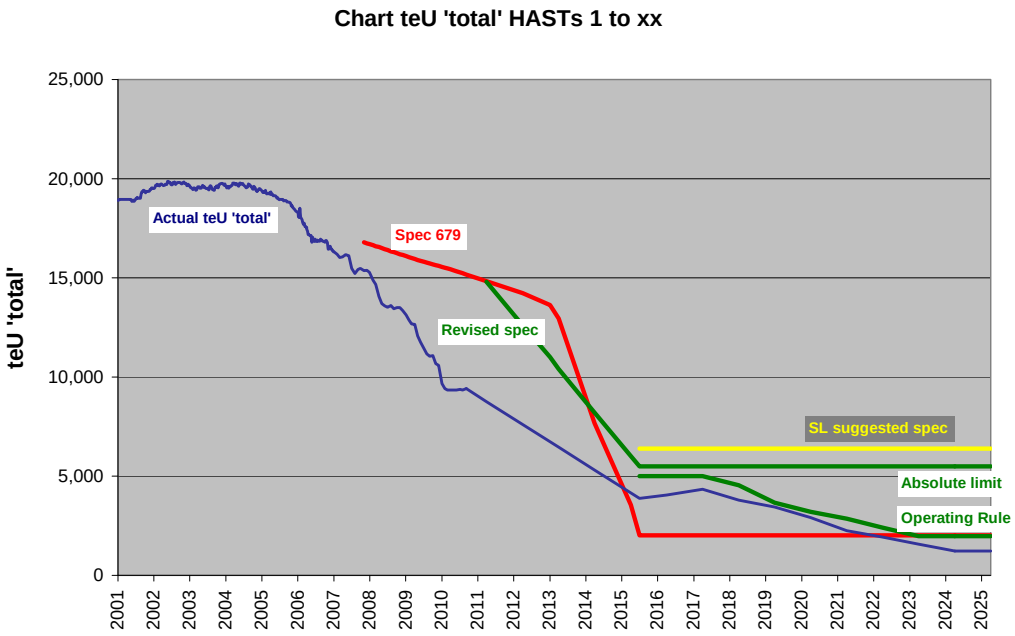



**Chart 10 [Ref 32]: consolidated chart teU total Magnox + Oxide (LTP10 scenario)**

99. The dark blue curve marked 'Actual teU total' illustrates the historic downward trend in 'total Magnox + Oxide' HAL stocks inventory over the past 10 years, i.e. over the period of implementation of Specifications 343 and 679.

    The dark blue curve has been extended into the future on the basis of linear interpolation (period 2010 to 2015) and outputs of the HEMAN model for LTP10 (period beyond 2015).

100. The red curve represents Specification 679, converted from $m^3$ to teU.

    The conversion from $m^3$ to teU (used for determining the new Specification, see paras 10 to 13) has been derived assuming that, under ideal conditions, 1 tonne of uranium originally present in the upstream magnox fuel gives rise to 45 litres of liquid HLW and similarly that 1 tonne of oxide fuel gives rise to 200 litres of liquid HLW.

    Ideal conditions cannot be achieved in reality. Therefore, dilution factors, based on an analysis of data [Ref 6], have been applied to reflect operating conditions in HALES, plus a 6% scaling factor [Ref 43] to ensure that Specification 679, whether expressed in $m^3$ or te(U), remains equally demanding.

    How to convert the pre-Steady-State portion of the Specification from the existing $m^3$ to teU was the subject of detailed debate with SL. The

methodology to be adopted, including the 6% scaling factor, has now been agreed as a like-for-like replacement.

101. The yellow line is the HAL Stocks Specification (6,400 teU 'total') suggested by Sellafield Ltd [Ref 14], on the basis of the extensive simulation work carried out with the HEMAN model. SL's limit is approximately three times higher than the current steady-state limit (Spec 679).

102. Based on the assessment of SL's supporting documents and on subsequent discussions, this report recommends that the post-2015 (steady-state) stocks of HAL should be maintained below an 'absolute limit' of 5,500 teU, i.e. almost 1,000 teU lower than initially suggested by Sellafield Ltd.

The lower value recommended here is the result of various questions and challenges regarding margins and conservatisms built into SL's analysis. (see para 61)

103. The revised HAL Stocks Specification is shown on the chart as a green line. The steady-state element of the revised specification will come into force on 1st July 2015, which is consistent with the timescale imposed by current Specification 679.

104. It is proposed to bring into force the revised HAL Stocks Specification at the start of Sellafield's forthcoming financial year, i.e. on 1st April 2011. The precise timing is however unimportant given the large margins that currently exist.

The value of the revised HAL Stocks Specification on 1st April 2011 will be the teU equivalent of current Specification 679, i.e. 14,800 teU 'total'.

Values between 1st April 2011 and 1st July 2015 will be obtained by linear interpolation, rounded to the nearest 100. [Ref 41] This is consistent with previous practice.

The revised Specification thus imposes a more rapid reduction in HAL inventory between 2011 and 2014, and connects on 1st July 2015 with the steady-state value of 5,500 teU proposed above.

105. Beneath the 'absolute limit', specified by ONR at a value sufficient to enable SL to progress plausible acceleration options, sits an Operating Rule, defined by SL in line with its legal obligation to maintain HAL stocks to ALARP levels. The Operating Rule shown is for illustration purposes, as the rule applied will be reset each year as explained above, and the formula to be used by SL has yet to be finalised.

As previously discussed, it is possible to leave open the detailed arrangements for the supporting Operating Rules, as they only need to be put in place a suitable time ahead of 1st July 2015. (the start date of the steady-state portion of the Specification)

106. However, having established the relationship between 'HAL stocks required' and 'Reprocessing throughputs', NII has asked SL during the various progress meetings [Ref 20 to 25] to build in the relationship we are to use for the absolute limit into the formulae used for its Operating Rules. Our expectations in this regard have been included in the letter accompanying the revised HAL Stocks Specification.[see Ref 41]

This approach ensures that the inventories of HAL are always maintained at minimum values consistent with reprocessing throughputs, whilst allowing sufficient flexibility to recover from a period of plant shut down.

107. Similarly, 'oxide' stocks and limits have been consolidated into chart 11 below, to provide an overview of historic and predicted performance, and current and proposed HAL Stocks Specifications and Operating Rules. [Ref 32]

**Chart teU Oxide HASTs 1 to xx**

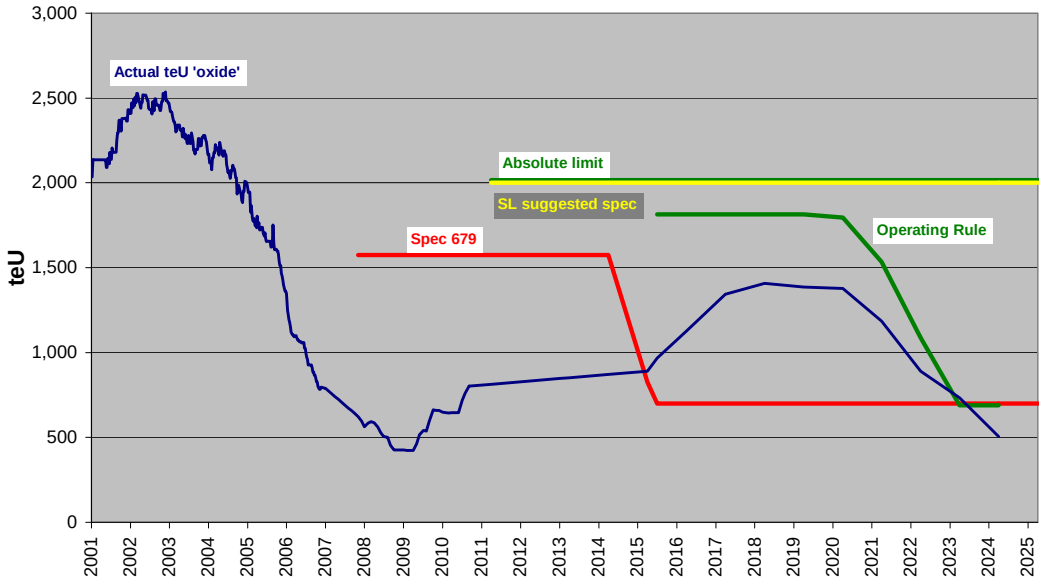



**Chart 11 [Ref 32]: consolidated chart teU Oxide (LTP10 scenario)**

108. The dark blue curve marked 'Actual teU Oxide' illustrates the historic downward trend in 'Oxide' HAL stocks inventory over the past 10 years, i.e. over the period of implementation of specifications 343 and 679.

The dark blue curve has been extended into the future on the basis of linear interpolation (period 2010 to 2015) and outputs of the HEMAN model for LTP10 (period beyond 2015).

109. The steep reduction in 'Oxide' inventory between 2005 and 2010 is attributed partly to the Feed Clarification Cell event of April 2005, when THORP was shut down for nearly two years, and partly due to constraints over evaporator capacity. [Ref 31]

The reference forward plan (see para 47) aims to ramp up Oxide reprocessing over the next few years, reaching a peak of 450 teU Oxide per annum in 2017 / 2018.

The peak predicted 'Oxide' inventory of approximately 1,400 teU remains below the inventory held in 2005 at the time of the Feed Clarification Cell event.

110. The red curve represents Specification 679. No unit conversion from $m^3$ to teU is required, since the oxide component of LI679 is already expressed in teU.

111. The yellow line represents the HAL Stocks Specification (2,000 teU 'Oxide') suggested by Sellafield Ltd [Ref 14], on the basis of the extensive simulation work carried out with the HEMAN model. SL's suggested limit is approximately three times higher than the current steady-state limit (Spec 679).

112. Based on the assessment of SL's supporting documents and on subsequent discussions, NII derived an 'absolute limit' of 2,000 teU Oxide [Ref 22], which is the same as the figure suggested by SL.

113. The revised HAL Stocks Specification is shown on the chart as a green line, starting on 1st April 2011 and continuing beyond 1st July 2015. As previously discussed, the Operating Rule shown is for illustration purposes, as the rule applied will be reset each year, and the formula to be used by SL has yet to be finalised.

114. Adopting the same approach, ONR has asked SL to build in the relationship used for the absolute limit into the formulae for its Oxide Operating Rules. This approach ensures that the inventories of HAL are always maintained at minimum values consistent with reprocessing & vitrification throughputs.

115. For illustration purposes only, the Operating Rule shown in green in chart 11 shows the typical downward evolution of the HAL stocks limit as the Oxide reprocessing programme progressively comes to an end.

SL's definition of the Operating Rule is still 'work in progress', which will be submitted to the ONR for assessment prior to implementation.

116. Similar consolidated charts have been developed for Accelerated Options A and B (see appendix 8). SL is optimising the definition of the Operating Rules to ensure that stocks of Oxide HAL are maintained at the lowest possible values, whilst avoiding breaches of the limit, as can be seen on the charts in appendix 8.

Assessment against NII's 6 overarching principles

117. NII's 2008 review [Ref 6] recommended 6 overarching principles to be used for the assessment of SL's proposals for revised HAL Stocks Specifications.

118. Principle P1 – "To prevent any return to excessive accumulated stocks, i.e. more than could be worked off within a few months at nominal full production levels."

Assessment: The revised HAL Stocks Specification, comprising of an ONR imposed Absolute Limit, supplemented by Operating Rules defined by SL and related to reprocessing & vitrification throughputs, will prevent any return to excessive accumulated stocks. The current proposal thus meets this principle. Margins within the Operating Rule methodologies discussed to date are judged to meet the "few months" criterion.

119. Principle P2 – The specification should be set "above the absolute minimum so that SL:

a) takes responsibility for ensuring its stocks are maintained ALARP

b) has reasonable operational flexibility to carry out its legitimate reprocessing activities"

Assessment: The form of Specification selected by the ONR ensures that elements a) and b) of Principle P2 are satisfied. Indeed, the Specification comprises of an 'Absolute limit' set at a value which enables SL to progress plausible acceleration options, supported by 'Operating Rules' related to throughput, set by SL in line with its legal obligation to maintain HAL stocks to ALARP levels.

120. Principle P3 – The specification should be set 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 particularly.

Assessment: The 'absolute limit' defined by ONR provides Sellafield Ltd with the latitude required to pursue plausible acceleration options, and thus to maximise the overall rate of hazard reduction. The Specification does not constrain WVP.

121. Principle P4 – The specification should be set "to encourage POCO of redundant HASTs."

Assessment: Both the 'total' and 'Oxide' elements of the new HAL Stocks Specification will be expressed in terms of the mass of Uranium originally present in the front-end fuel from which the stored HAL was derived.

This change of form of Specification will allow SL to pursue POCO activities, which involve additions of water and / or acid, without being constrained by the volume component of the Specification.

The ONR will continue to monitor SL's forward programmes and progress on Post-Operational Cleanout through the biennial review process.

122. Principle P5 – The specification should be "based on the 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."

Assessment: The new HAL Stocks Specification is based on extensive Operations Research modelling work [Ref 14 to 19] which has been assessed by NII. All Operations Research modelling runs were carried out for the existing fleet of HASTs.

"Replacement HASTs" is a separate project which is being separately assessed by the ONR. The ONR will also continue to monitor SL's progress on Replacement HASTs through the biennial review process, and will consider the ramifications of this on the Specification prior to any new HASTs being put into service.

123. Principle P6 – The specification should be set "in a manner that aligns with HSE's Enforcement Policy Principles of Proportionality, Consistency, Targeting, Transparency and Accountability."

Assessment: HSE's Enforcement Policy Principles are judged to have been applied throughout all work leading up to the definition of the revised HAL Stocks Specification.

124. Therefore, the revised HAL Stocks Specification is judged to be consistent with the 6 overarching principles for assessment defined in NII's 2008 biennial review [Ref 6].

Assessment of SL's validation, verification and accreditation of the HEMAN model

125. The detailed analysis which SL conducted in support of its suggested revised steady-state limits is based on the output of extensive Operations Research modelling work [Ref 14 to 19] conducted with the HEMAN model. (see paras 15 & 16)

126. Given the significant reliance we need to place on the results of this model, NII has carried out an assessment [Ref 35] of SL's own Validation, Verification and Accreditation (V,V&A).

127. Based on a sampled examination of the documents supplied by SL, which included an independent 'simplified' Excel calculation, NII has concluded that there is "no reason to believe that the HEMAN model is not fit for the purpose of helping us to define the revised Steady-State Specification." [Ref 35]

128. However, NII's assessment identified a number of gaps in the V,V&A documentation submitted by Sellafield Ltd, which it proposes to address and close out as part of the 2010 biennial review. The nature and scale of these gaps does not justify delaying the issue of the Licence Instrument for the revised HAL Stocks Specification.

Other Government Departments:

129. Both the Office of Civil Nuclear Security and the Environment Agency have reviewed this PAR, and have returned statements of "no objection" to ONR's proposal. [Ref 36, 37, 38]

130. "Treasury Solicitors" provided guidance and advice [Ref 40] for paragraphs 77 to 81 of this PAR, and for the drafting of the Licence Instrument and the Cover Letter. (see appendix 9 for Letter and LI)

The values in tables 1 and 2 of the HAL Stocks Specification (see appendix 9) reflect Charts 10 and 11 previously discussed in paragraphs 98 and 107 respectively.

## IIS Rating

131. An IIS rating of 3 (Green, Adequate) has been awarded for this assessment since SL's detailed analysis [Ref 14 to 19] was thorough and of good quality.

A higher rating of 2 could have been awarded if SL had succeeded in completing the definition of the Operating Rules in time for the writing of this Project Assessment Report, and in advance of the publication of the new HAL Stocks Specification.

## CONCLUSIONS AND RECOMMENDATIONS

132. Prior to the commencement of the 2010 biennial review, SL and NII agreed to close out two of the matters outstanding from the 2008 review, i.e. the form of the HAL Stocks Specification and the level of the 'Steady-State' element of the Specification (i.e. the post-1st July 2015 portion of the Specification).

133. Although NII's 2008 biennial review [Ref 6] recommended replacing the current volumetric limit with an equivalent mass limit (teU), and also recognised the need for a relaxation of the HAL Stocks Specification to allow efficient operation of WVP, the new teU based limit could only be determined following further detailed analysis by Sellafield Ltd.

134. SL has completed the further analysis [Ref 14 to 19] referred to above, and has suggested a substantial loosening of the Steady-State Specification, in order to prevent delays to the reprocessing and vitrification programmes.

SL suggests that the 'total Magnox + Oxide' Specification should be increased to 6,400 teU total, and the 'Oxide' Specification to 2,000 teU Oxide. These suggested limits are almost three times larger than the current limits, defined under Specification 679.

135. ONR has assessed SL's proposals, and has opted to set the Specification at a value which enables SL to progress its reprocessing and vitrification programme according to the lifetime plan, but including sufficient allowance to accommodate plausible acceleration options.

136. Based on the assessment of SL's supporting documents and on subsequent discussions, I recommend that the Steady-State Specification should be set at the following values:

- 5,500 teU 'total Magnox + Oxide' (~ 1,000 teU lower than suggested by SL)
- 2,000 teU 'Oxide' (the same as suggested by SL)

The lower 'total' value proposed here is the result of various questions and challenges regarding margins and conservatisms built into SL's suggested limits.

137. In line with its legal obligation under Licence Condition 32(1) to "… make and implement adequate arrangements for minimising so far as is reasonably practicable the rate of production and total quantity of radioactive waste accumulated on the site …", SL plans to put into place 'Operating Rules', as defined under LC23 and related to throughput, requiring it to maintain HAL stock levels below pre-defined limits, set beneath the Specification.

138. Given that the “minimum stock of HAL required” is directly proportional to the “reprocessing throughput” achieved (see para 45), and to maximise confidence that the limits are set at the right level, ONR has asked SL to include a relationship of proportionality into its Operating Rules.

139. Various formulae were discussed during the course of this assessment ; however, it is not ONR’s intention to impose any particular correlation.

LC23 places the responsibility on Sellafield Ltd to “… identify the limits and conditions necessary in the interests of safety, … referred to as Operating Rules.”

140. At the time of writing, SL is continuing to progress work on the definition of the Operating Rules, set sufficiently close to the minimum stocks strictly necessary whilst affording sufficient margins to allow the reprocessing and vitrification programmes to be progressed without undue constraints.

141. It is possible to leave open the detailed arrangements for the supporting Operating Rules, as they only need to be put in place by 1st July 2015, i.e. the start date of the steady-state portion of the Specification. However, SL hopes to have Operating Rules in place at least a year before this date to enable a period of shadow working.

ONR has agreed with SL some general attributes essential for the definition of the Operating Rules, i.e. these should:

- be fair, reasonable and unbiased
- practicable, implementable
- Approvable by ONR, i.e.
    - a) well-defined
    - b) something ONR can support
    - c) legally tenable
- facilitate SL responsibility for keeping stocks ALARP
- include appropriate margins

The Operating Rules need to strike the appropriate balance between the desire to impose tight limits to maximise confidence that SL is operating at minimum levels of HAL stocks, and allowing sufficient flexibility to allow rapid vitrification of highly active liquid wastes into a safe passive vitrified form.

142. Sellafield Ltd plans to update and define these Operating Rules annually, on the basis of the reprocessing & vitrification performance of the past 3 years, and the ‘realistic’ reprocessing & vitrification programme for the coming year. SL’s proposal for Operating Rules is to include a justification that the strategies proposed reduce risks to ALARP. (see para 84)

Past and predicted HAL Stocks performance:

143. 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. (see para 98)

144. Forward predictions show that 'total stocks of HAL' will continue to reduce over the remaining lifetime of the reprocessing plants. (see para 98)

Stocks of 'Oxide HAL', which reduced extremely significantly following the 'THORP Feed Clarification Cell event' in 2005, are predicted to rise as Oxide reprocessing throughputs are ramped up, but will reduce significantly at the end of reprocessing.

145. The revised HAL Stocks Specification, supported by Operating Rules defined by SL, should be viewed in the context of a long-term trend of reducing HAL Stocks.

146. Finally, the revised HAL Stocks Specification is judged to be consistent with the 6 overarching principles recommended for assessment in NII's 2008 biennial review [Ref 6]. (see para 117)

147. On the basis of the above considerations, it is therefore my recommendation that Licence Instrument 793 and cover letter SEL 77170 should be signed and issued to Sellafield Ltd.

## ABBREVIATIONS

| | |
|---|---|
| ALARP | As Low As Reasonably Practicable |
| AR | Assessment Report |
| BNFL | British Nuclear Fuels |
| BNGSL | British Nuclear Group Sellafield Limited |
| CR | Contact Report (NII) |
| DAP | Duly Authorised Person |
| DAR | Design Assessment Report |
| FCC | Feed Clarification Cell |
| FEL | Front End Loading (stage gated process used by SL) |
| FY | Financial Year |
| HAL | High Active Liquor |
| HALES | High Active Liquor Evaporation and Storage (plant) |
| HAST | Highly Active Storage Tank |
| HEMAN | HAST Emptying and Management Model |
| HLWP | High Level Waste Plants |
| HSE | Health & Safety Executive |
| IIS | Integrated Intervention Strategy |
| IPG | Intervention Progress Group |
| LC | Licence Condition |
| LCB | Lifecycle Baseline |
| LI | Licence Instrument |
| LTP | Lifetime Plan |
| MOP | Magnox Operating Plan |
| 'New side' | Generic name attributed to HASTs x to xx |
| NII | Nuclear Installations Inspectorate (former nuclear regulatory body, replaced by ONR on 1st April 2011) |
| OCL | Operational Control Limit |
| OCNS | Office of Civil Nuclear Security |
| 'Old side' | Generic name attributed to HASTs x to x |
| ONR | Office for Nuclear Regulation, established as an agency of HSE from 1 April 2011, pending planned legislation to establish it as a statutory body. ONR seeks to secure the protection of people and society from the hazards of the nuclear industry by ensuring compliance with relevant legislation and by influencing the nuclear industry to create an excellent health, safety and security culture. ONR brings together in a single new regulator the regulatory functions for safety, security and conventional health and safety at nuclear sites, and will incorporate the regulation of radioactive materials transportation at a later date in 2011. |
| OOP | Oxide Operating Plan |
| OR | Operations Research<br>Or Operating Rule |
| OU | Operating Unit |
| PAR | Project Assessment Report |
| PCAD | Production Campaign Assessment Document |
| POCO | Post Operations Clean Out |
| SI | Superintending Inspector |
| SL | Sellafield Ltd |
| te | Tonne |
| THORP | Thermal Oxide Reprocessing Plant |
| UKAEA | United Kingdom Atomic Energy Authority |

| | |
|---|---|
| VTR | Vitrification Test Rig |
| V,V&A | Validation, Verification and Accreditation |
| WEDD | Waste and Effluent Disposition Directorate |
| WVP | Waste Vitrification Plant |

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**Appendix 1**: Summary of SL's recommendations [Ref 14] for the revision of the Steady-State HAL Stocks Specification

I. SL's suggested HAL Stocks Specification:
   - 6,400 teU total Magnox + Oxide
   - Of which 2,000 teU Oxide

   Based on 135 g/L feed to WVP and 5 HASTs

II. Constituents of 6,400 teU HAL Stocks Specification

   - 4,500 teU total Magnox + Oxide:
     i. based on results of HEMAN model
     ii. assumes 5 HASTs (of 145 $m^3$ nominal capacity)
     iii. supports 997 teU Magnox only, 598 teU Oxide only, combined 837 Magnox / 320 Oxide [page 13 of Ref 14]

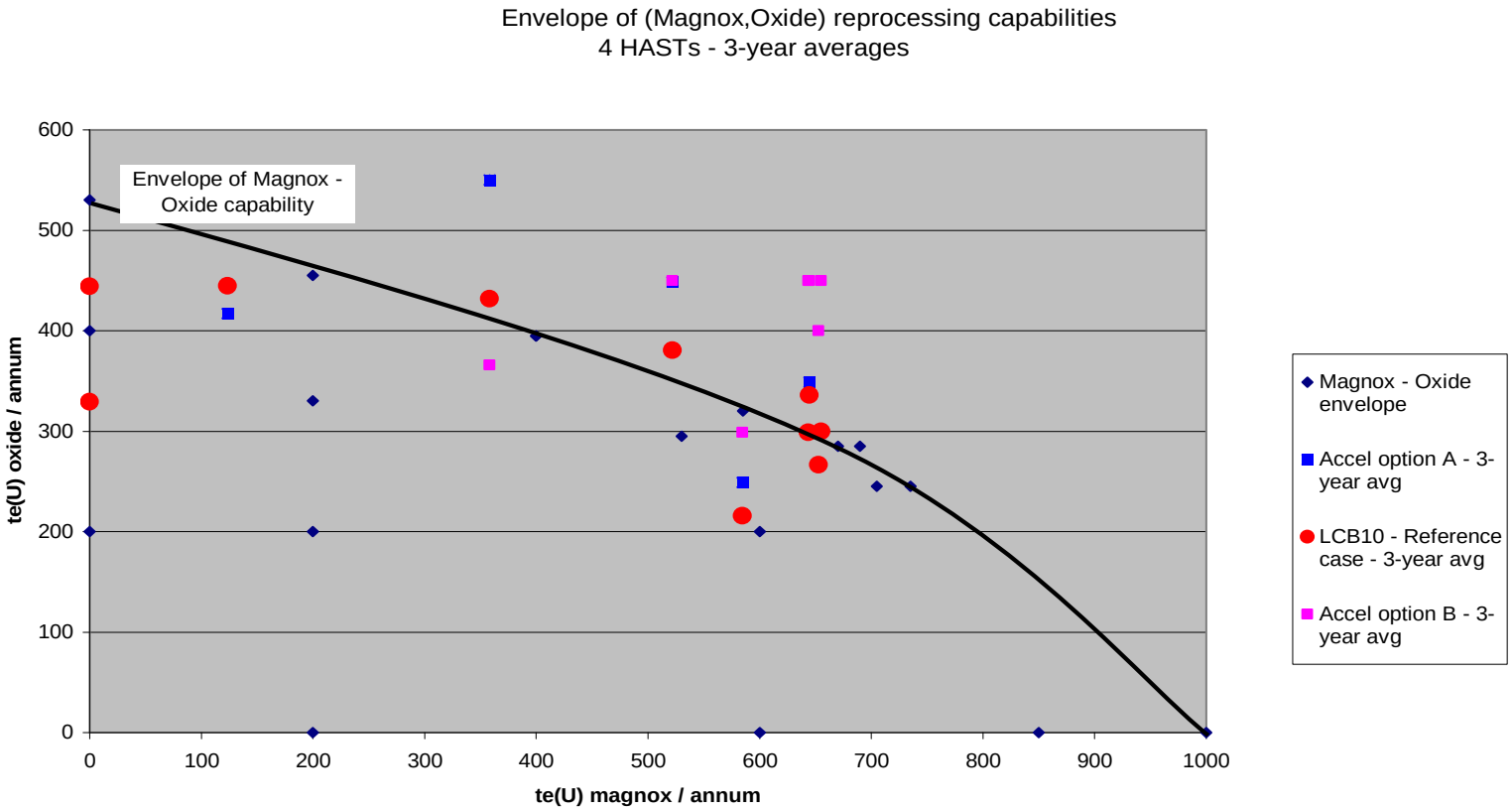
   - 1,400 teU additional to account for:
     i. 1,171 teU for heels non-operational HASTs new side
     ii. 180 teU for 1 self-siphon batch transfer from Evap A or B to HAST x
     iii. 50 teU additional headroom

   - 500 teU additional margin
     i. to account for generic uncertainty in the modelling
     ii. buffer capacity for WVP downtime (500 te = 4 months' throughput of WVP vitrification)
     iii. margin to ensure SL operates within steady-state limit

     Note: no additional teU are required to account for old side heels, because they are assumed to be transferred to the new side, and to be accounted for as part of the new side steady-state teU.

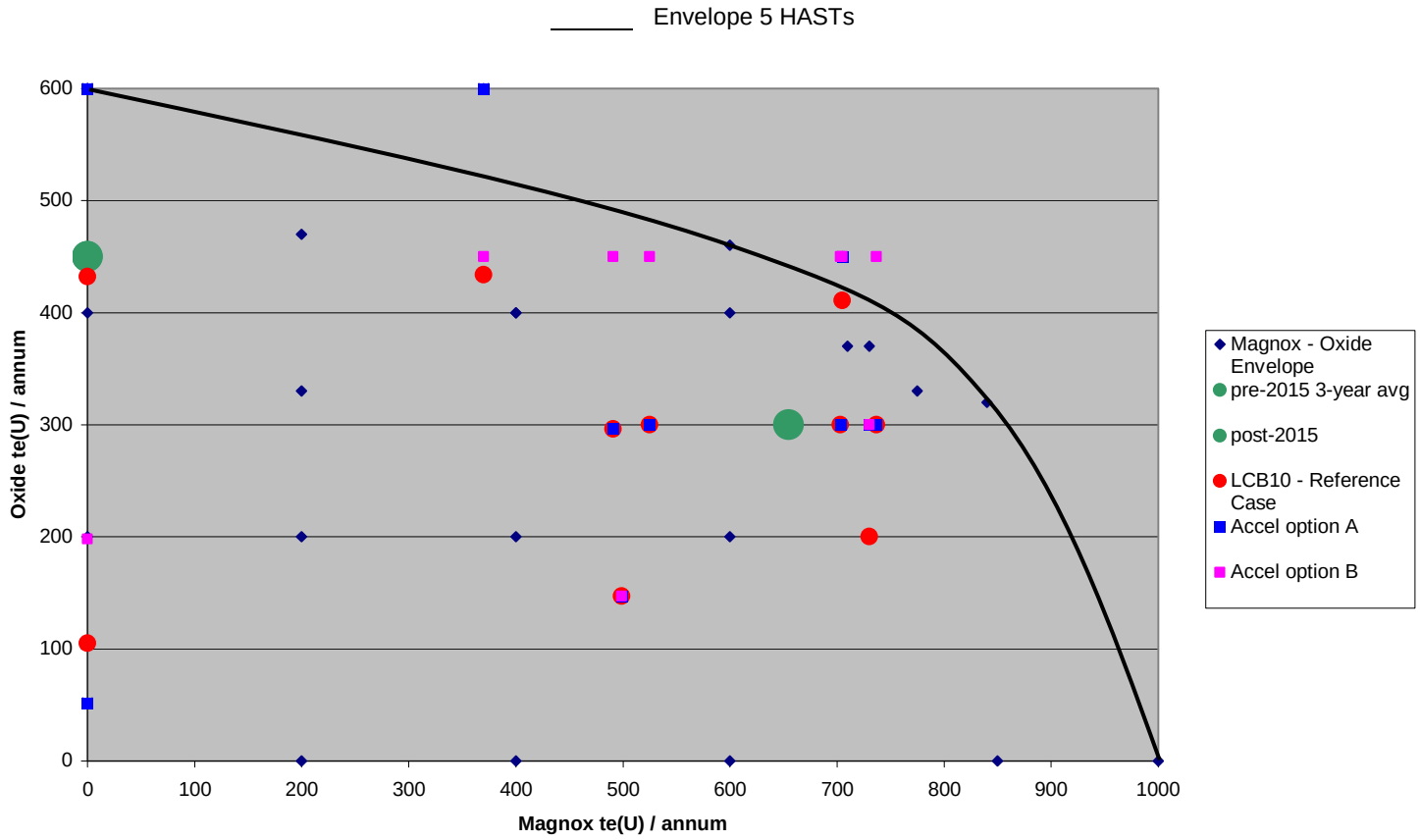
**Appendix 2**: (see Ref 22 for details)

- The black envelope curve represents the maximum Magnox and Oxide reprocessing throughputs which operation with 4 HASTs is able to support. The curve is based on the output of the HEMAN model for the "135 g/L, 4 HASTs" scenario, reported in reference 15.
- All projected reprocessing throughputs (i.e. reference case or LCB10, accelerated options A & B) have been included as 3-year averages on the chart, to account for the 3-year typical cycle through HALES.
- Conclusions:
    - The LCB10 reference case falls marginally outside of the capability defined for 4 HASTs by the envelope curve.
    - Accelerated options A and B are significantly outside of the envelope for 4 HASTs, for extended periods.



**Appendix 3**: (see Ref 22 for details)

- As per Appendix 2, the black envelope curve represents the maximum Magnox and Oxide reprocessing throughputs which operation with 5 HASTs is able to support. The curve is based on the output of the HEMAN model for the "135 g/L, 5 HASTs" scenario, and reported in reference 15.
- The projected reprocessing throughputs have also been included, but without three-year averaging. (i.e. this is the raw, year by year data)
- It is concluded that operation with 5 HASTs:
    - Supports all the LCB10 planned throughputs, even the more extreme (705,411) scenario for 2015.
    - Supports accelerated options A & B in most years, except the most extreme years (e.g. Option A in 2016, which is (370,600))



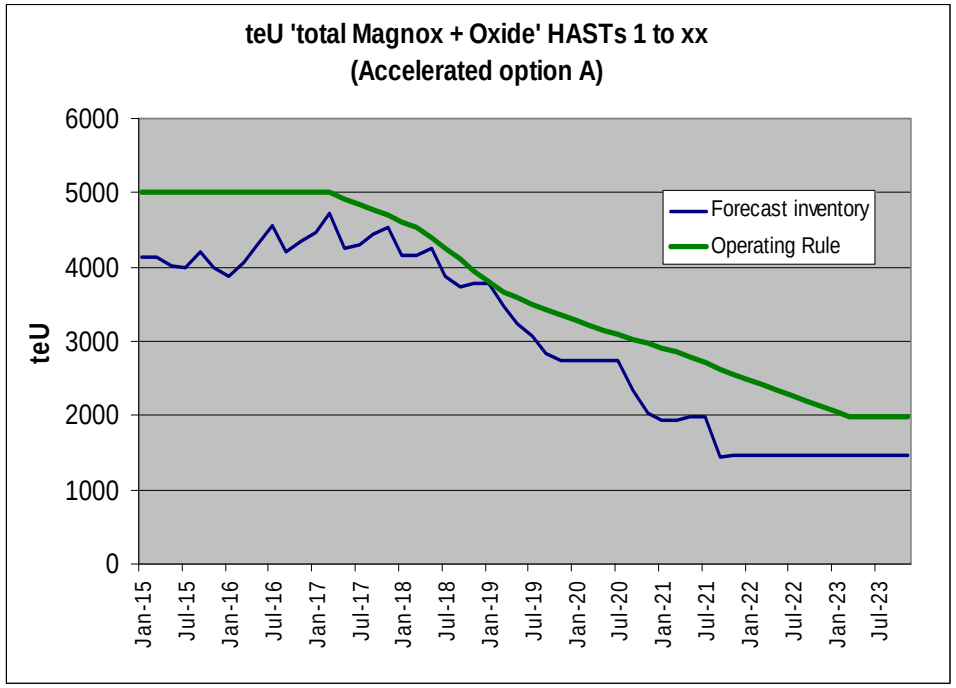
**Appendix 4**: (see also TRIM Ref: 2010/319865)

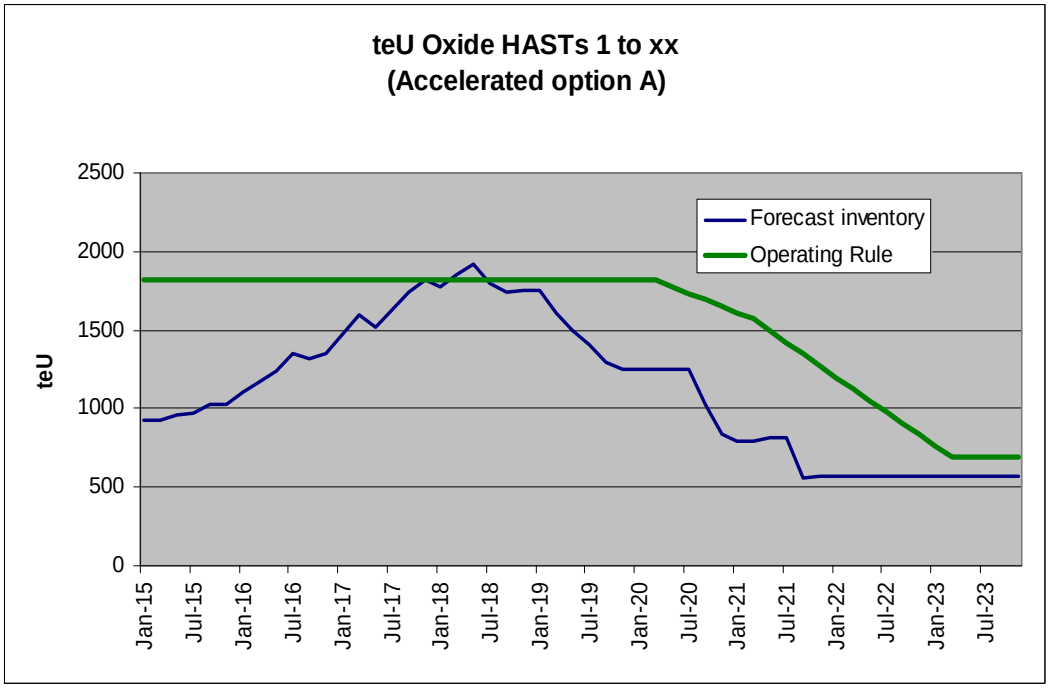
| | Reference case or Lifecycle Baseline 10 (LCB10) | | | Calculated spec | |
|---|---|---|---|---|---|
| | Magnox | Oxide | | total spec: 3.7 x Magnox + 3 x Oxide | oxide spec: 3 x Oxide |
| | te(U) | te(U) | | | |
| 2009 | 499 | 147 | | 2,287 | 441 |
| 2010 | 730 | 200 | | 3,301 | 600 |
| 2011 | 525 | 300 | | 2,843 | 900 |
| 2012 | 703 | 300 | | 3,501 | 900 |
| 2013 | 737 | 300 | | 3,627 | 900 |
| 2014 | 491 | 296 | | 2,705 | 888 |
| 2015 | 705 | 411 | | 3,842 | 1233 |
| 2016 | 370 | 434 | | 2,671 | 1302 |
| 2017 | 0 | 450 | | 1,350 | 1350 |
| 2018 | 0 | 450 | | 1,350 | 1350 |
| 2019 | 0 | 432 | | 1,296 | 1296 |
| 2020 | 0 | 105 | | 315 | 315 |
| 2021 | | | | | |
| 2022 | | | | | |

| | Accelerated Option A | | | Calculated spec | |
|---|---|---|---|---|---|
| | **Magnox** | **Oxide** | | **total spec: 3.7 x Magnox + 3 x Oxide** | **oxide spec: 3 x Oxide** |
| | **te(U)** | **te(U)** | | | |
| 2009 | 499 | 147 | | 2,287 | 441 |
| 2010 | 730 | 300 | | 3,601 | 900 |
| 2011 | 525 | 300 | | 2,843 | 900 |
| 2012 | 703 | 300 | | 3,501 | 900 |
| 2013 | 737 | 300 | | 3,627 | 900 |
| 2014 | 491 | 296 | | 2,705 | 888 |
| 2015 | 705 | 450 | | 3,959 | 1350 |
| 2016 | 370 | 600 | | 3,169 | 1800 |
| 2017 | 0 | 600 | | 1,800 | 1800 |
| 2018 | 0 | 52 | | 156 | 156 |
| 2019 | | | | 0 | 0 |
| 2020 | | | | 0 | 0 |
| 2021 | | | | | |
| 2022 | | | | | |

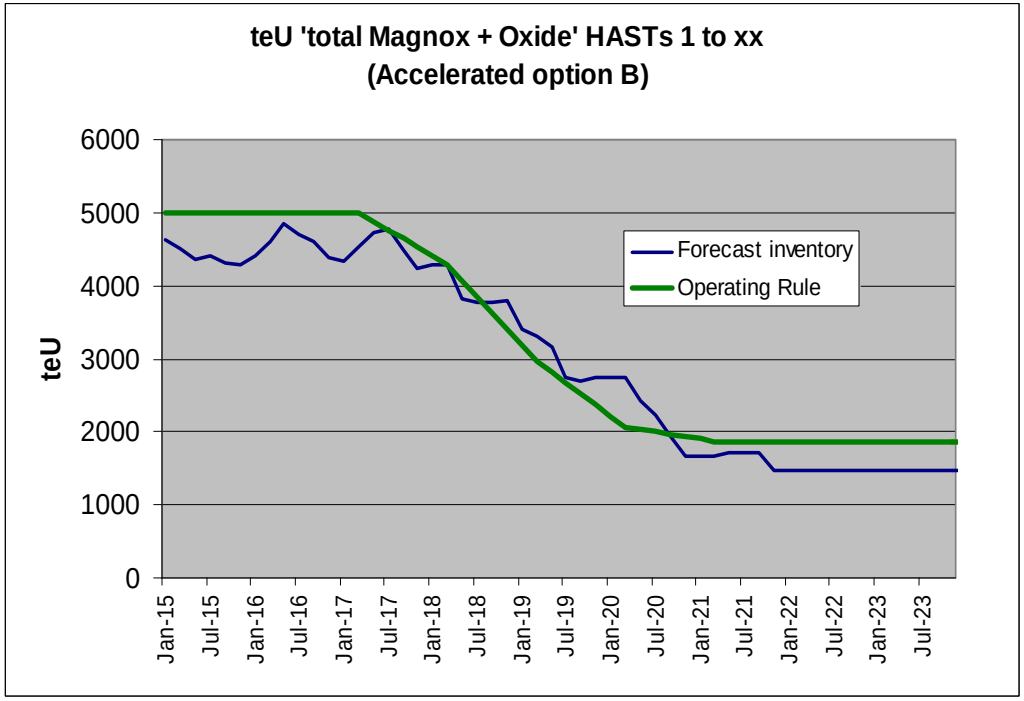
| | Accelerated Option B | | | Calculated spec | |
|---|---|---|---|---|---|
| | **Magnox** | **Oxide** | | **total spec: 3.7 x Magnox + 3 x Oxide** | **oxide spec: 3 x Oxide** |
| | **te(U)** | **te(U)** | | | |
| 2009 | 499 | 147 | | 2,287 | 441 |
| 2010 | 730 | 300 | | 3,601 | 900 |
| 2011 | 525 | 450 | | 3,293 | 1350 |
| 2012 | 703 | 450 | | 3,951 | 1350 |
| 2013 | 737 | 450 | | 4,077 | 1350 |
| 2014 | 491 | 450 | | 3,167 | 1350 |
| 2015 | 705 | 450 | | 3,959 | 1350 |
| 2016 | 370 | 450 | | 2,719 | 1350 |
| 2017 | 0 | 198 | | 594 | 594 |
| 2018 | | | | 0 | 0 |
| 2019 | | | | 0 | 0 |
| 2020 | | | | 0 | 0 |
| 2021 | | | | | |
| 2022 | | | | | |

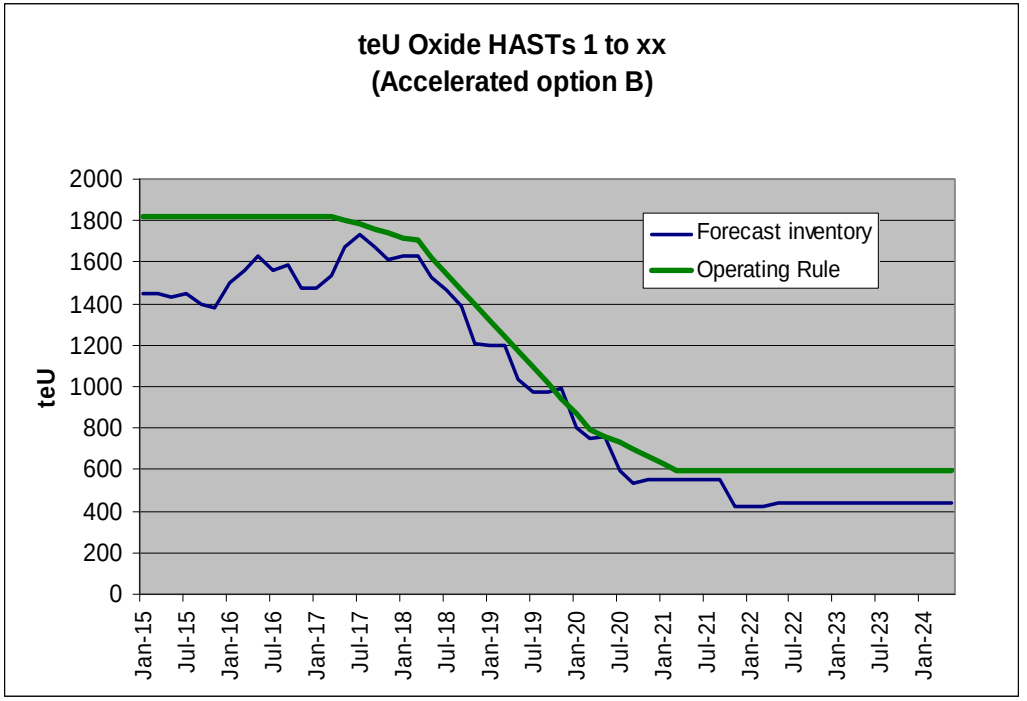
**Appendix 5**: Charts [Ref 30] 'teU total Magnox + Oxide' and 'teU Oxide', including SL's proposed 'Operating Rules' and 'forecast inventories in HASTs 1 to xx', Accelerated option A (see para 47) (Note: these charts are shown for illustration purposes only, and represent work in progress. Sellafield Ltd is continuing to refine the definition of the Operating Rules)



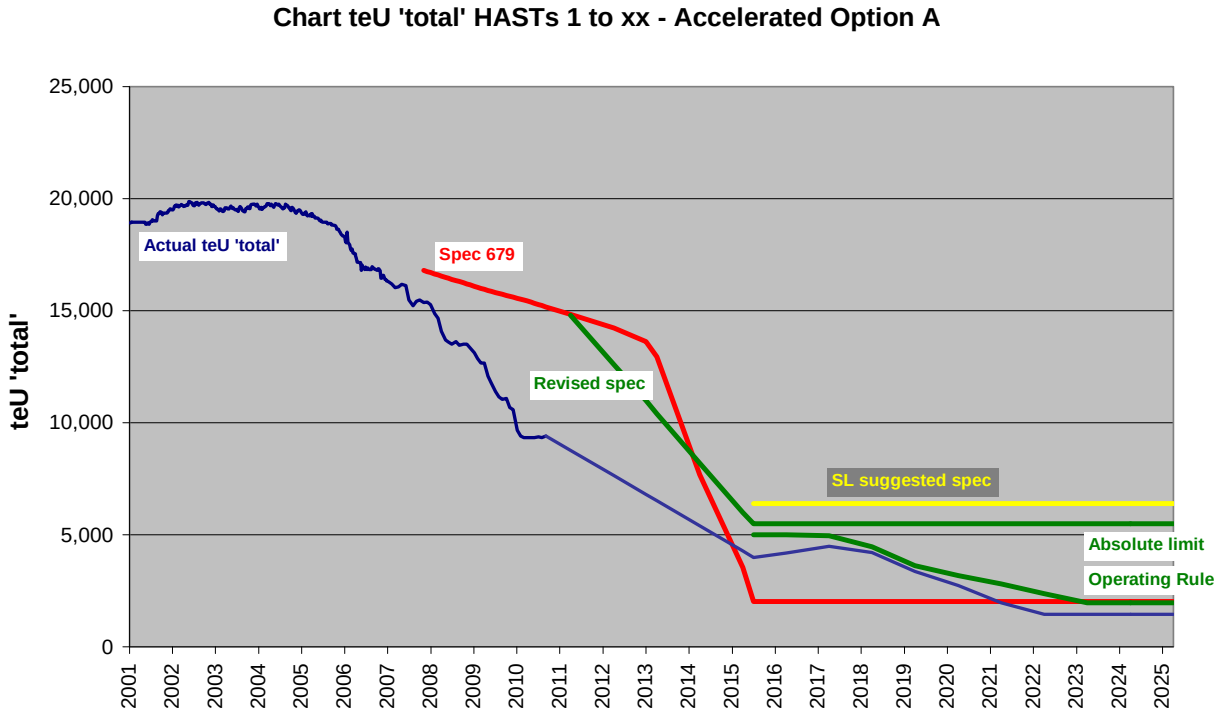



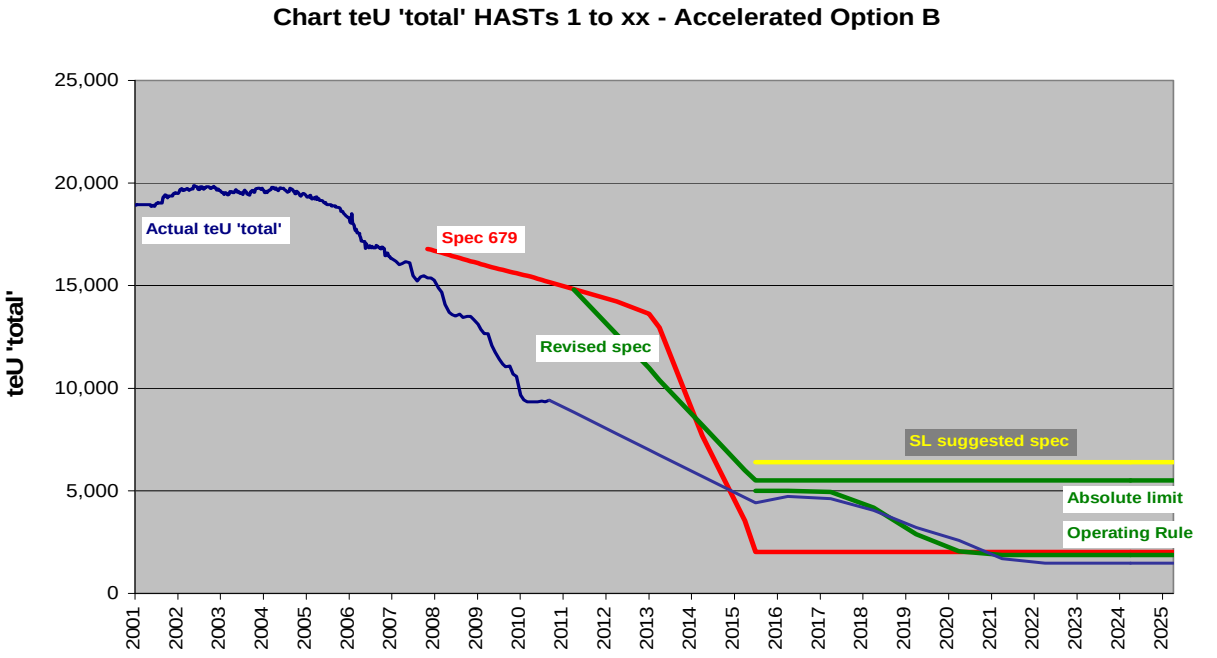
**Appendix 6**: Charts [Ref 30] 'teU total Magnox + Oxide' and 'teU Oxide', including SL's proposed 'Operating Rules' and 'forecast inventories in HASTs 1 to xx', Accelerated option B (see para 47) (Note: these charts are shown for illustration purposes only, and represent work in progress. Sellafield Ltd is continuing to refine the definition of the Operating Rules)



**Appendix 7**: [Ref 32] Consolidated charts teU 'total' HASTs 1 to xx - Accelerated Options A & B (see para 47)



**Appendix 8**: [Ref 32] Consolidated charts teU Oxide HASTs 1 to xx - Accelerated Options A & B (see para 47)

**Chart teU Oxide HASTs 1 to xx - Accelerated Option A**

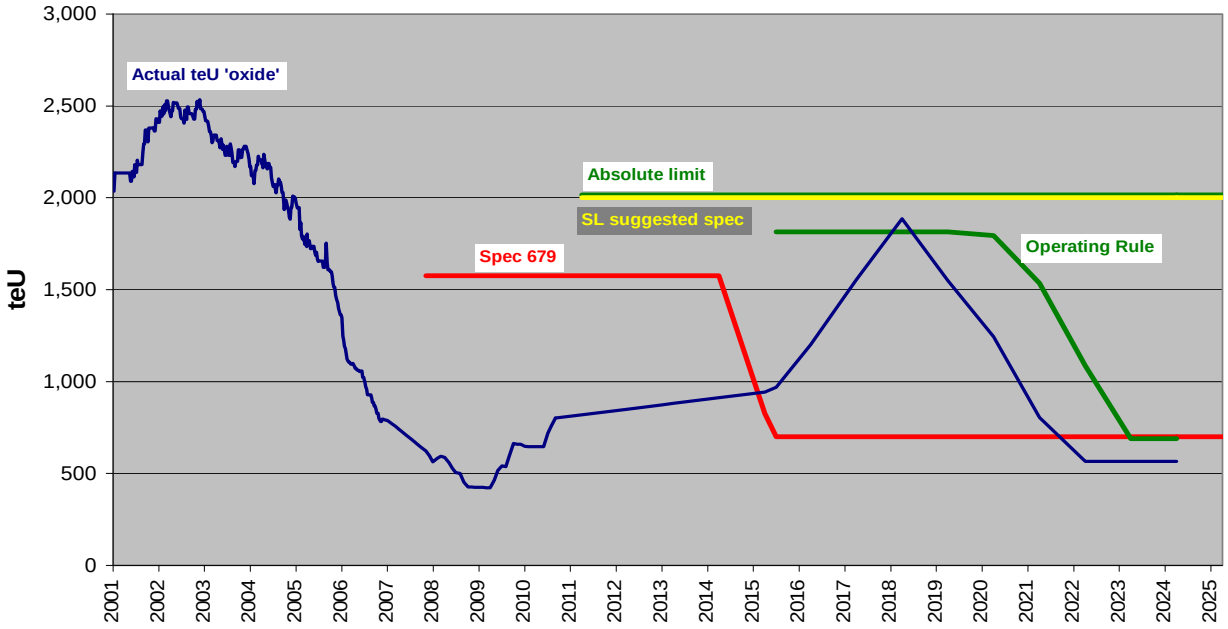
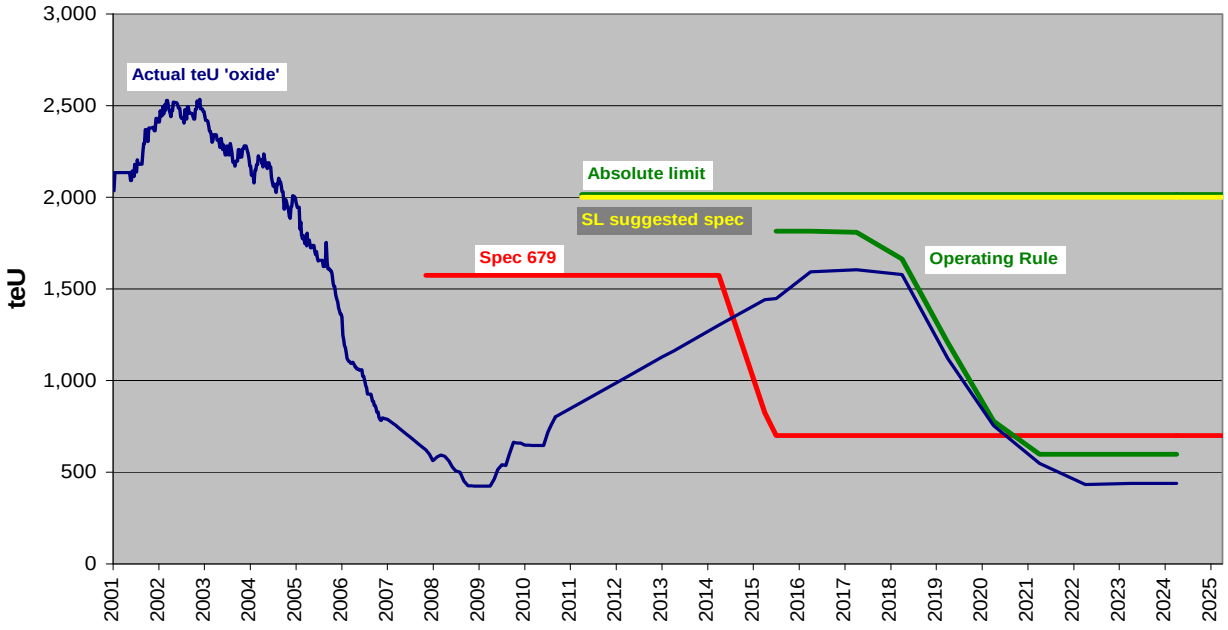



**Chart teU Oxide HASTs 1 to xx - Accelerated Option B**



**Appendix 9**: Covering Letter SEL77170 and Licence Instrument LI793

**Mr xxx xxxxxx**
HM Superintending Inspector

Office for Nuclear Regulation
4N.1 Redgrave Court
Merton Road
Bootle
Merseyside L20 7HS

Tel: xxxxxxxxx

xxx.xxxx@hse.gsi.gov.uk

www.hse.gsi.gov.uk

The Company Secretary
Sellafield Ltd
xxxxx xxx
xxxxx xxx
xxxxxxx
xxxxxx
xxx xxx

8th July 2011

**Our Ref:** SEL77170
**Unique No:**

**Files** xxxxxxxxxx

**HEALTH AND SAFETY AT WORK ETC. ACT 1974**
**NUCLEAR INSTALLATIONS ACT 1965 (AS AMENDED)**
**NUCLEAR SITE LICENCE NO. 31G**
**LICENCE CONDITION 32 (ACCUMULATION OF RADIOACTIVE WASTE)**
**REVISION TO THE HAL STOCKS SPECIFICATION**

Dear Sir,

Pursuant to Licence Condition 32(4), I attach the Health and Safety Executive's (the Executive) specification of limits to the stock of liquid High Level Waste (HLW) stored in the Bxxx xxxxx plant at Sellafield.

Please note that the limits set out in Tables 1 and 2 attached to the Specification have been derived assuming that:

(a) 1 tonne of uranium originally present in the upstream magnox fuel will give rise to 45 litres of liquid HLW when stored at optimal conditions; and

(b) 1 tonne of uranium originally present in the upstream oxide fuel will give rise to 200 litres of liquid HLW when stored at optimal conditions.

In the event that operations lead to either of the ratios above being exceeded for extended periods, the Executive may consider resetting the limits in Tables 1 and 2.

The revised limits in the attached specification do not alter Sellafield's obligations under Licence Condition 32(1) to make and implement adequate arrangements for minimising so far as reasonably practicable the rate of production and total quantity of radioactive waste accumulated on the site at any time. Nor do they alter the requirements in Licence Condition 23 (operating rules).

Sellafield must ensure not only that it operates within the limits specified in the Tables to the attached Specification but that the limits at which it operates comply with the requirements of Licence Conditions 23 and 32.

The Executive expects that by 1st July 2015 (steady state start date), Sellafield will, to ensure compliance with Licence Conditions 23 and 32, have put in place operating rules which control and maintain Sellafield's stocks of HAL at the minimum possible level compatible with its reprocessing and vitrification throughputs.

The Executive expects that for compliance with the obligations in Licence Conditions 23 and 32 to be achieved the levels of HAL stocks would be referable to actual, as well as planned, reprocessing and vitrification throughputs. The levels of HAL stocks should be those which are necessary to achieve the relevant reprocessing and vitrification throughputs with the minimum flexibility allowed to enable recovery following a period of shut down.

There should be a clear justification for the operating rules which are put in place for 1st July 2015. The Executive would expect this justification to demonstrate how Sellafield considers its duties under Licence Conditions 23 and 32 are met, as well as how these operating rules ensure compliance with its wider duties under HSWA 1974 to ensure that risks arising from its work to workers and other persons are reduced so far as is reasonably practicable.

The Executive may in due course require the operating rules to be submitted to it under Licence Condition 6 or submitted to it for approval under LC23(4).

I am copying this letter to the Regulator Liaison Office for onward transmission to xx xxx xxxx and also to the Trade Union Safety Representatives Mr xx xxxx, xxx xx xxx and xxx xx xxxx.

xxx xx xxx
HM Superintending Inspector

Distribution

| | |
|---|---|
| Paper: | The Company Secretary, Sellafield Ltd<br>Regulator Liaison (3 copies)<br>4.4.2.6154. (Licence Instruments) |
| Electronic: | 5.1.3.984. (Outgoing letters)<br>4.6.642. (HAL Stocks)<br>4.4.1.1235. (xxxxx Assessment)<br>WEDD IPG<br>xx xx xxx (Environment Agency) |

**NUCLEAR INSTALLATIONS ACT 1965 (AS AMENDED)**

**SPECIFICATION**

Issued under Condition 32(4) of

Schedule 2 attached to

Nuclear Site Licence No: 31G

**SELLAFIELD (WINDSCALE WORKS AND CALDER WORKS)**

The Health and Safety Executive, for the purposes of Condition 32(4) of Schedule 2 attached to Nuclear Site Licence No: 31G, specifies that the licensee shall ensure that the following radioactive waste accumulated or stored on the licensed site complies with limitations as to quantity, type and form as follows:

a) the total quantity[1] of liquid High Level Waste (HLW) stored in the Bxxx xxxxxx plant shall be limited at the dates set out in Table 1 attached to this specification to the values set out in that table, and at all other points in time shall be limited to values defined by linear interpolation between these tabulated values.

b) the total quantity[2] of Oxide-derived liquid HLW stored in the Bxxx xxxxx plant, whether segregated or blended with other liquid wastes, shall be limited at the dates set out in Table 2 attached to this specification to the values set out in that table, and at all other points in time shall be limited to values defined by linear interpolation between these tabulated values.

These limits replace those specified in Licence Instrument No: 679, dated 29th October 2007.

Dated: 8th July 2011

For and on behalf of the Health and Safety Executive

Signed:

xxx xx xxx

A person authorised to act in that behalf

Notes

1. The total quantity specified in a) above shall be defined as the summation of the quantities of all types of highly active liquor stored within Highly Active Storage Tanks (HASTs) 1 to xx inclusive. For these purposes, the quantity of highly active liquor shall be evaluated in terms of the mass of Uranium originally present in the front-end fuel from which the stored liquid HLW was derived.

2. The total quantity specified in b) above shall be defined as the summation of the quantities of Oxide-derived liquid HLW stored within HASTs 1 to xx inclusive. For these purposes, the quantity of Oxide-derived liquid HLW shall be evaluated in terms of the mass of Uranium originally present in the front-end Oxide fuel from which the stored liquid HLW was derived.

Table 1. Maximum total quantity of all types of highly active liquor stored within Highly Active Storage Tanks 1 to xx inclusive

| Date | 1 Apr 2011 | 1 Apr 2012 | 1 Apr 2013 | 1 Apr 2014 | 1 Apr 2015 | 1 Jul 2015 | After 2015 |
|---|---|---|---|---|---|---|---|
| Front-End Uranium Mass (tonnes (U)) | 14,800 | 12,600 | 10,400 | 8,200 | 6,000 | 5,500 | 5,500 |

Table 2. Maximum total quantity of Oxide-derived liquid HLW stored within Highly Active Storage Tanks 1 to xx inclusive

| Date | 1 Apr 2011 | 1 Apr 2012 | 1 Apr 2013 | 1 Apr 2014 | 1 Apr 2015 | 1 Jul 2015 | After 2015 |
|---|---|---|---|---|---|---|---|
| Front-End Uranium Mass (tonnes (U)) | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |