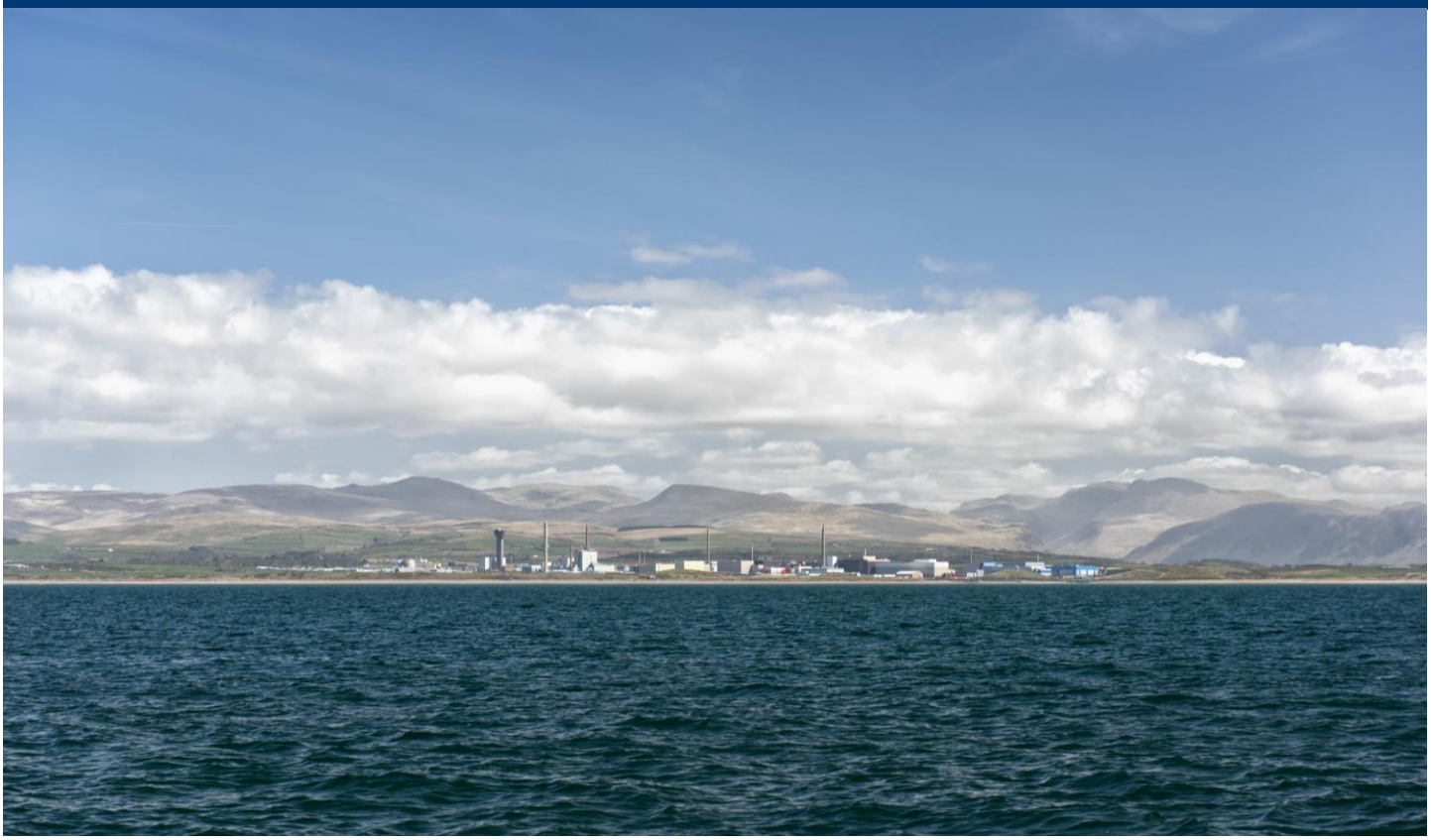
Sellafield Ltd

Sellafield Ltd RSA Environmental Permit

Variation Application

EM/2018/19

October 2018



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1. Introduction

This document is an application for a variation to the Sellafield Ltd (SL) Radioactive Substances Activity (RSA) Environmental Permit KP3690SX ('the Permit'). It is based on a fundamental review of the structure of the Permit and is supported by a review of past discharges and consideration of future discharges from the Sellafield Site after reprocessing ends. This application has evolved through extensive discussion with the Environment Agency (EA), with both parties working to the mutually agreed aim of securing;

"Environmental permits which ensure ongoing protection of the environment, focus on the use of Best Available Techniques (BAT), provide a clear line of sight to permit compliance and facilitate timely Post Operational Clean Out (POCO) of reprocessing facilities and decommissioning of the wider site."

The permit is being reviewed in order to ensure continued effective, proportionate control of discharges and greater focus on the application of Best Available Techniques (BAT) as the Sellafield mission shifts focus to environmental remediation after reprocessing ends.

2. Benefits sought through the variation

The proposals in this application seek the following benefits to SL, to EA and to stakeholders:

- Simplified compliance arrangements, reflecting removal of compliance requirements where discharges have stopped or no longer have or will have any significant environmental impact.
- Reductions in remaining Site Limits, significantly reducing the scope for environmental impacts from the site. Also, demonstration of significant and progressive reduction in discharges to increase stakeholder awareness of the impact of Sellafield discharges.
- Replacement of plants limits with notification levels to ensure close monitoring of discharges and timely notification to EA of increasing discharge trends.
- Improved operational flexibility and facilitation of BAT, maximising use of treatment plants to enable High Hazard and Risk Reduction activities.

- Improved ability to manage future discharges associated with changes to site operating strategy, through the introduction of a tiered limit structure for Site Limits. This enables a lower limit to be routinely in force with a higher limit available subject to suitable justification and EA agreement.
- Improved transparency on the scale of SL discharges compared to the United Kingdom Strategy for Radioactive Discharges (hereafter referred to collectively as the UKSRD)
- Cost savings associated with simplified compliance requirements (reduced frequency of further Permit variations and more efficient monitoring, sampling, analysis and reporting), achieving better value for taxpayer money.

3. Environmental impact of proposed Site Limit changes

This variation application proposes significant reductions to Site Limits reflecting the current levels of discharges and predictions for future discharge reductions from the site. The environmental impact of the proposed variation has been assessed to establish the reductions to potential doses to the critical group. A key concept for assessment of dose to the public is the 'critical group'; the individual members of a population who can realistically be expected to receive the highest dose due to their lifestyle, location and habits. This term is equivalent to the term 'representative person', used by the International Commission on Radiological Protection (ICRP)[1]. A summary of the potential critical group doses at current and proposed Limits and Levels is presented in table 1 below and demonstrates the very low levels of discharge and associated environmental impact.

Table 1[2]

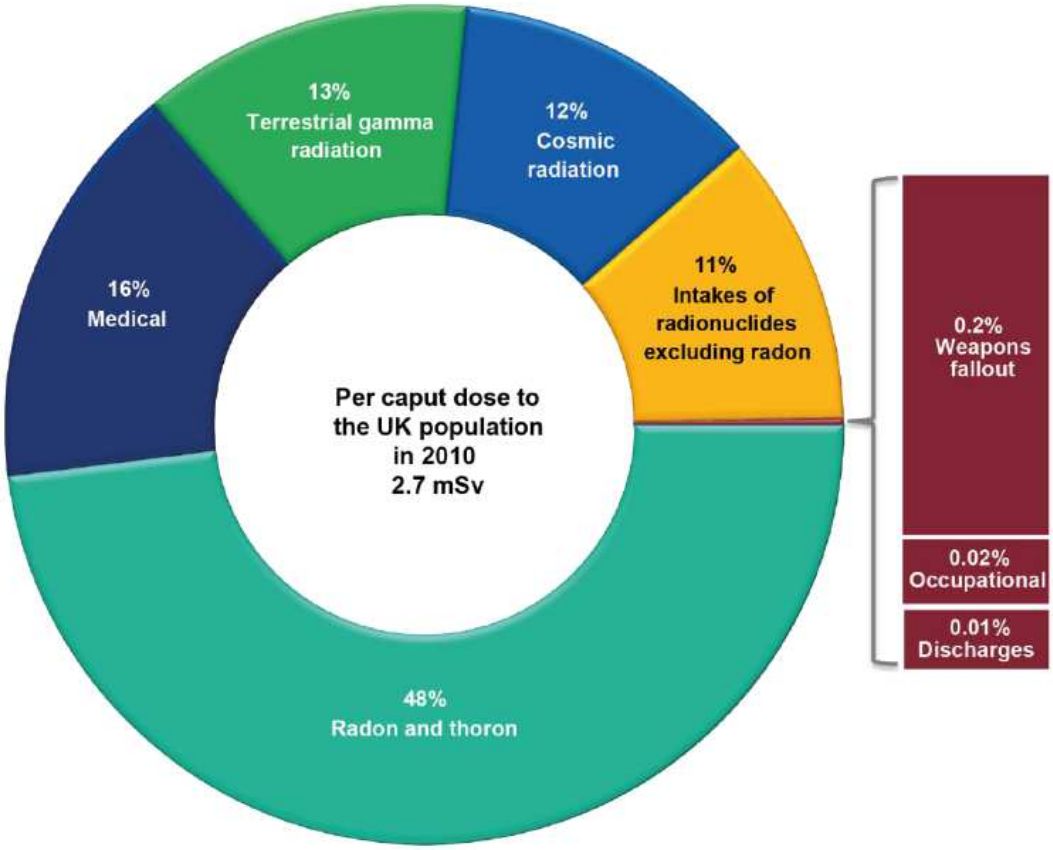
	Aerial		Marine			
Dose Summary (in µSv)*	**Sum of Current Plant Limits**	**Sum of Proposed Notification Levels**	**Current Site Annual Limit**	**Phase 1 Site Limits**	**Phase 2 Upper Tier Site Limits**	**Phase 2 Lower Tier Site Limits**
Max Dose	41	13	210	170	130	90

***Note: This table assumes discharges are made at the respective Site Limits for all marine discharges and Plant Limits or Notification levels for aerial discharges. Aerial doses cannot be calculated at Site Limits due to the variation in dose factors between stacks.**

3.1 Radiological impact perspective

In their most recent review of ionising radiation exposure to the UK population, Public Health England (PHE) provided information relating to the dose received due to cosmic radiation from return flights to popular global destinations from the UK[3]. Typically a flight of 2.5 hours provides an exposure of 10µSv. The 2017 modelled dose impact from the main stack aerial discharge points was 2.5µSv[4]. The modelled dose impact from 2017 liquid discharges was 18µSv[4].

Figure 1. Sources of annual average radiation dose to the UK population[3]



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4. Background

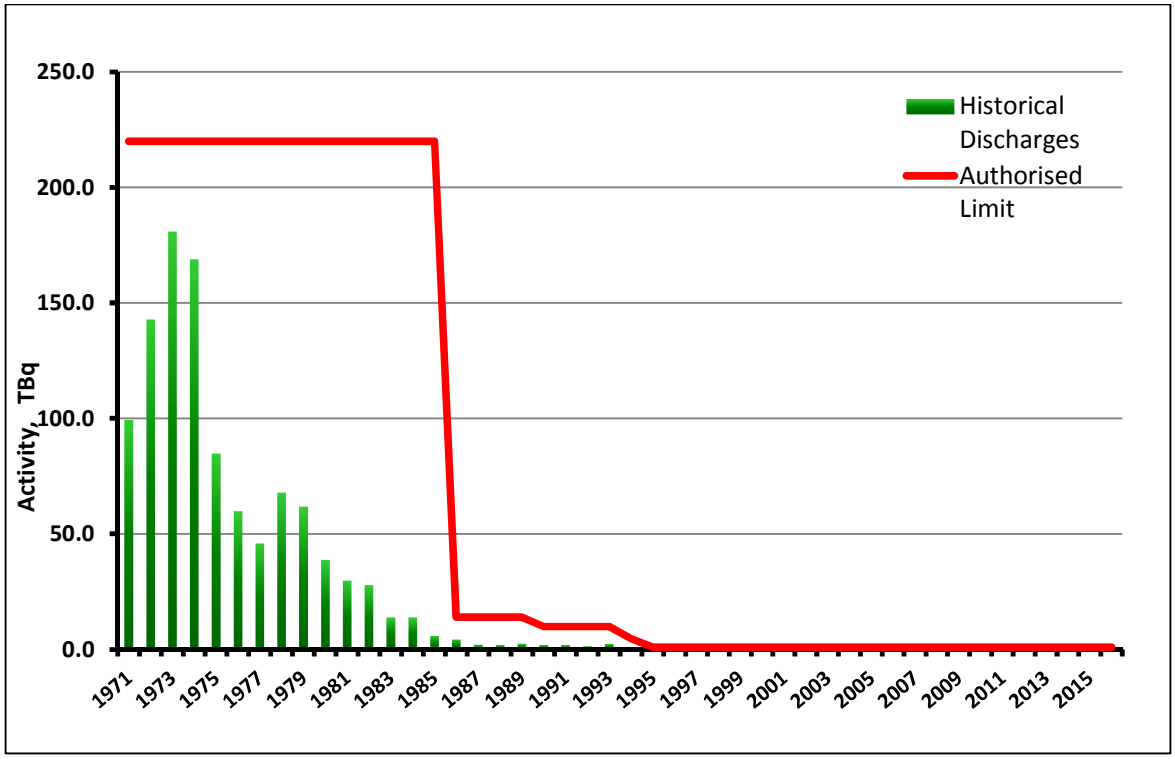
4.1 Site context

Sellafield Ltd is a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA), with responsibility for site operations and management of the Sellafield Site (hereafter referred to as 'Site'). The NDA, as a non-departmental public body of the Department for Business, Energy and Industrial Strategy (BEIS), is responsible for the decommissioning and clean-up of the UK's nuclear legacy.

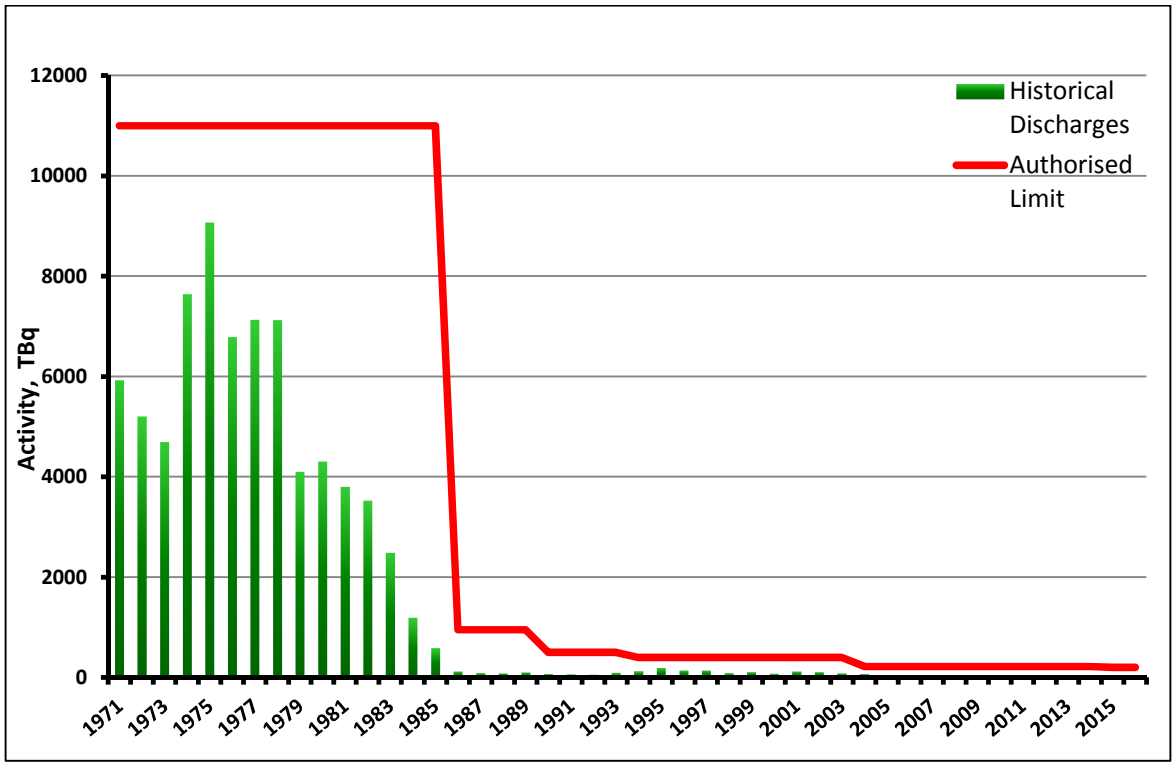
Nuclear activities began on the Site when the Windscale Pile reactors went operational in 1950, producing plutonium for the UK Atomic Weapons project. Since then the site has seen a number of internationally significant milestones such as the operation of the world's first commercial nuclear reactors at Calder Hall, which first supplied electricity to the national grid in 1956, and the construction and operation of the prototype Windscale Advanced Gas Cooled Reactor (WAGR). WAGR paved the way for the UK's second generation of nuclear reactors and safely piloted ground breaking decommissioning techniques. Sellafield also has a long history of supporting the wider UK and international nuclear industry through the reprocessing of spent nuclear fuels in the Thermal Oxide Reprocessing Plant (Thorp) and Magnox reprocessing plants.

Environmental discharges of aerial and liquid radioactive effluents have reduced to a fraction of the peaks seen in the 1970s over the more recent lifetime of the site, as demonstrated by the liquid discharge graphs 1 and 2 below. This has happened for a number of reasons, principally the development and introduction of treatment plants for the most significant discharges and the widespread introduction of abatement equipment and application of BAT.

Graph 1. Historic discharges of total alpha (liquid)



Graph 2. Historic discharges of total beta (liquid)



Reprocessing operations at Sellafield are due to end in the next few years, with the completion of the fuel shearing/ decanning stages of fuel reprocessing (Thorp in 2018 and Magnox 2020) presenting obvious permit variation triggers when aerial volatile discharges reduce. These operational milestones will result in immediate and significant reductions in site aerial radioactive discharges. Consequently the impact from aerial discharges associated with reprocessing operations is expected to drop to negligible levels and will be difficult to detect from most discharge points. There will also be significant reductions to site liquid discharges; however these will occur gradually as liquid discharges will continue to be generated from the chemical stages of reprocessing and from downstream treatment plants. Solid wastes will continue to be generated as site clean-up and remediation progresses.

Following the cessation of reprocessing activities in Thorp and Magnox, SL's mission will focus on the safe and secure environmental remediation of the site to benefit the industry, region and nation. Activities are prioritised around accelerating High Hazard and Risk Reduction in legacy facilities and site clean-up and decommissioning. The mission also includes enduring spent fuel and special nuclear material storage and management.

4.2 RSA environmental Permit and review process

The RSA Environmental Permit allows SL to operate facilities which result in radioactive aqueous and gaseous discharges to the environment and solid waste disposals. The Permit is subject to annual review and frequent variation to ensure it provides appropriate control over the environmental impact of discharges, reflects the latest regulations and standards and meets future business needs. This application follows a thorough review and proposes significant changes to the structure of the Permit and the site and Plant Limits contained therein, reflecting changes in discharges resulting from the end of reprocessing at Sellafield.

This application focusses on simplifying the Permit whilst ensuring it continues to focus on environmental protection. The drive for a simpler Permit is consistent with the principle of proportionate regulation and will encourage optimised management of discharges and their environmental impact through application of BAT. Removing and/or revising the limits in the Permit will enable SL to manage site operations more

flexibly, supporting acceleration of High Hazard and Risk Reduction in legacy facilities and demonstrating substantial and progressive reductions in discharges. This approach to reviewing the Permit is consistent with the principle of BAT, with proposals developed and underpinned through assessments of significance to provide justification for the removal of some limits. A result of these proposals is greater emphasis on the framework of arrangements through which SL demonstrates application of BAT[5].

The public consultation on this application provides an opportunity to increase wider public understanding of the impact of discharges from Sellafield, including how the site is performing against the UKSRD expected outcomes[6].

4.2.1 Basis for the variation application

Proposals for removal or reduction of limits in this application are based on EA limit setting guidance: 'Criteria for setting limits on the discharge of radioactive waste from nuclear sites'[7]. The guidance emphasises the importance of the requirement for operators to use BAT to minimise the generation and disposal of radioactive waste such that the resulting radiological impact to members of the public is reduced to a level that is 'As Low As Reasonably Achievable' (ALARA). Where assessments demonstrate that the impact of discharges is insignificant, and there is no potential to increase in future, this has provided justification for removal of the limit associated with the discharge.

The following three step process was used to define the limits proposed in this application, as agreed with EA:

1) SL assessed discharges associated with future site activities supported by an assessment of BAT to control discharges.

2) SL proposed limits, revisions to existing limits or notification levels based on the discharges estimated in step 1.

3) EA will then assess SL's proposals and set limits and notification levels as appropriate, following public consultation on this application.

As described in the statutory limit setting guidance, EA will set limits based on the use of BAT by operators to minimise disposals and their impact, with the minimum headroom necessary to permit “normal” operation or decommissioning of a facility. “Normal” operation or decommissioning of a facility includes the relevant operational fluctuations, trends and events that are expected to occur over the likely lifetime of the facility, consistent with the use of BAT.

The review process has aimed to set the minimum number of limits and notification levels required to ensure adequate control of discharges and monitoring of process performance. Through the review SL has also proposed replacing plant limits with notification levels for performance monitoring and control purposes. This will ensure timely identification of increasing discharge trends to ensure consideration and understanding and the continued, demonstrable application of BAT.

Liquid and gaseous radioactive and non-radioactive effluents are generated during operational and decommissioning activities at the Sellafield Site. The Sellafield Effluent Management Strategy (SEMS) outlines current and future requirements and recommendations for managing such effluents.

As reprocessing nears completion, the emphasis at Sellafield is shifting to environmental remediation, decommissioning and clean-up of the historical legacy with an increasing degree of uncertainty. The Overall Effluent Strategy Model (OESM) at Sellafield has been developed to predict future discharges from the site, taking into account a complex and varying set of interacting source terms. There is continual improvement in source data and forward predictions, whilst acknowledging the need for flexibility where future operating strategy is not yet fully defined. Better understanding of these uncertainties relating to future discharges is an ongoing aspect of preparation for the retrieval and associated treatment plant capabilities. This is reflected in the OESM predicting to within 20% for well understood flowsheets with predictable performance parameters, confirmed by comparison with historic discharge data. Future effluent predictions are managed by the SEMS team and effectively governed by the Sellafield Flowsheet Working Party. This model has been used to support the proposals on Site Limits presented in this application[8].

The UK Government has recently issued the 2018 Review of the UK Strategy for Radioactive Discharges, providing an update regarding the 2009 UK Strategy for Radioactive Discharges (hereafter referred to collectively as the UKSRD). The UKSRD sets a general expectation that discharges will decrease over time, through the application of BAT. There is recognition that annual discharge data may fluctuate, hence longer term trends allow more meaningful analysis. Clearly permitted limits are not the same as actual discharges, though both SL's forward discharge profiles and the proposed reductions in various Site Limits are consistent with the UKSRD expectation that discharges will decrease over time.

It is important to note that the UKSRD recognises that the UKSRD discharge forecasts are "not intended to be targets" and also that it "does not set targets or individual Site Limits for radioactive discharges". Furthermore the UKSRD recognises that such forecasts are "made with the best available information at the time of writing and therefore performance for any forecast is subject to variability". SL regularly updates its discharge forecasts via the work of the SEMS team and the data supporting the proposals in this paper reflects the best available information at the time of writing, including consideration of uncertainties.

The UKSRD recognises the currently expected completion dates for fuel shearing/ decanning in Thorp (November 2018) and Magnox (around 2020), noting also that if Magnox operations extend beyond 2020 it would not result in discharges to the environment that are inconsistent with the UKSRD obligations. The UKSRD recognises that generally good progress is being made against its key objectives.

Further information relating to the UKSRD can be found via the following link: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718723/2018Rev2009UKStratRadDischargeFin.pdf

SL's proposals for the new Sellafield RSA permit limits can therefore be considered to be consistent with the UKSRD.

4.3 Review of the Compilation of Environment Agency Requirements (CEAR)

The CEAR is a supporting document to the RSA Permit, which sets out additional detail on how SL complies with the conditions contained within the Permit. SL and EA have jointly undertaken a review of the CEAR alongside the development of this variation application, with the aim of CEAR requirements focussing on sitewide demonstration of BAT. The proposed amendments to the CEAR resulting from this review are summarised in Appendix 4.

5. Permit variation proposals

5.1 Permit varied in two phases

The end of reprocessing on the site is a key driver for this Permit Variation application, as it constitutes a significant change in operations and will result in significant reductions in volatile discharges, which dominate the impact of aerial discharges.

Sellafield Ltd reprocesses spent nuclear fuel in two difference facilities. Thorp, where shearing operations will end in 2018, and Magnox, in which decanning operations will end in 2020. SL proposes to amend the RSA permit in two phases through this single variation application. This approach is to ensure efficiency and reflects confidence in future requirements following the end of Magnox Reprocessing in 2020.

5.2 Removal of specified Site Limits

SL is applying for a Permit that sets the minimum number of limits and notification levels, consistent with ensuring adequate control of discharges and monitoring of process performance; and that takes account of the impact of discharges as well as the practicability of monitoring in determining which radionuclides should be limited.

Discharges of some nuclides will cease when fuel shearing and decanning stops and some have already reduced to insignificant levels, meaning that limits are no longer required. See section 6 and tables 2 and 3 for further information.

5.3 Reduced headroom in Site Limits

SL recognises the scope to reduce headroom in the Permit limits, consistent with the EA's limit setting methodology, application of BAT and commitments under the UKSRD. In keeping with these drivers SL has reviewed and is applying for Site Limits which maintain headroom to that required for normal expected operations. The EA's guidance[7] defines "normal" operation or decommissioning of a facility as that which includes the relevant operational fluctuations, trends and events that are expected to occur over the likely lifetime of the facility, consistent with the use of BAT.

Some Site Limits will remain after reprocessing operations due to the potential for significant future radiological impact. In many cases the extent and timing of the discharges are well understood, in other cases future changes to the site operating strategy could result in some discharges becoming more significant. For both of these situations, SL is not applying for the removal of limits. Furthermore, it is known that the impact of some site discharges will remain significant after reprocessing ends, due to the continued chemical processes and ongoing treatment of effluents through downstream plants. Discharges will also be generated from remediation and site clean-up activities. Where these are expected to be very low or may increase, reductions to Site Limits, which will not restrict future business plans, have been proposed.

5.4 Replacement of Plant Limits with Notification Levels

In line with the EA aim "to set the minimum number of limits and notification levels consistent with ensuring adequate control of discharges and adequate monitoring of process performance"[7], SL is applying for Plant Limits to be replaced with Notification Levels set at much lower values to ensure timely notification to EA of increasing trends. Ongoing control and scrutiny of discharges within statutory limits is retained, as total SL discharges must continue to remain within the Site Limits specified within the Permit. This removes the potential of plant limits to unnecessarily constrain operational activities. Removing plant limits will also improve the ability to redirect effluent streams in accordance with BAT, and facilitates increasing treatment plant throughputs if required to enable acceleration of High Hazard and Risk Reduction.

Setting notification levels at lower levels of discharge will improve timely communication with EA and ensure application of BAT. It is expected that where SL exceed these levels it will not constitute a permit breach. Instead, exceedance of a notification level will require SL to provide the EA with an explanation, which may include details of the occurrence, a description of the techniques used to minimise the activity of radioactive waste discharged and a review of those techniques having regard to BAT. Section 6.4 presents the proposed levels, compared with current limits.

The aerial notification level determination has been focussed on changes following the end of Thorp shearing and Magnox decanning, and in particular the volatile species which dominate the environmental impact of site aerial discharges. Particulate aerial discharges across the site are very low for most effluent streams and in many cases discharges are below limits of detection. This is largely due to extensive abatement including High Efficiency Particulate Air (HEPA) filtration. Future reviews of notification levels will consider removal of limits or downgrading the status of stacks. Downgrading refers to the process of transitioning a stacks from an 'Individually Limited Outlet' to an 'Other Outlet' (as referred to in the Permit), which is a minor discharge point agreed on the basis of the insignificance of discharges. These other outlets are listed in the CEAR, rather than the Permit, and have different requirements for monitoring and sampling.

The liquid notification levels have been extensively reviewed because discharges are measurable in all streams and the associated environmental impacts are higher than aerial discharges. The approach to setting notification levels has been to review recent data and remove higher outlying figures, often associated with events, before applying a mean and 3 standard deviations. Consequently, the proposed notification levels are much lower than current limits, and the use of a statistical method results in a notification level set such that a low number of notification levels will be exceeded due to natural variation over the course of a year. These arrangements will be formalised following agreement with EA and captured within SLs Management System and/or CEAR, as required.

Notably this builds on SL's management system arrangements for notifying EA on increased short term discharges through use of internal monthly triggers, which are set just above 'normal' discharge levels. EA are notified of increasing discharges where an individual month's trigger is significantly exceeded; by a factor of 2 for aerial or agreed alternative for liquid streams (for which discharges can be much more variable especially for 'batch' processes) or if two consecutive monthly triggers are exceeded.

In line with the predictions made in OESM, discharges will vary over time. As the notification level is derived on a statistical basis from discharges over the immediate past and schedules for the immediate future, the notification levels will in turn decrease and increase accordingly. Notification levels will therefore require annual review and changes are expected each year. Due to the duration of the permit application process, the figures proposed will require review before implementation, though the methodology will be repeated as described.

5.5 Introduction of a tiered approach to Site Limits

As previously noted, SL discharges and their associated environmental impact will reduce following the end of reprocessing activities. However, site remediation and clean-up activities will continue to generate discharges. Whilst discharges and their impact will be lower, the ability to predict the exact level of discharge will reduce. This is partly because there is more variability in discharges associated with these activities than previous steady state operations and partly because it is difficult to forecast based on limited data. In order to enable greater reductions to Site Limits whilst enabling this crucial work to be carried out, SL is applying for the introduction of a two tier Site Limit structure in Phase 2 of the Variation.

Notably the upper tier limit will always be below the current Site Limit with only one exception, where the proposed upper tier limit is the same as the current Site Limit (see tables 2 and 3). The two tier Site Limit structure will allow a pre-determined increase in the discharge limit providing BAT justification is made to and accepted by the EA prior to the discharges increasing. Lower tier limits will be set at reduced levels to ensure close scrutiny of discharge trends.

This approach enables SL to propose lower Site Limits which will be routinely ‘in force’ with scope to move to a higher limit relatively quickly (weeks) to support and enable site clean-up and High Hazard and Risk Reduction activities, consistent with the requirement to demonstrate use of BAT. Current timescales for altering a Site Limit through permit variation is around 1 year due to the application process and requirement for public consultation and EU approval.

6. Supporting information for proposals

6.1 Proposed variations to Site Limits

As stated in the EA's limit setting methodology[7], Site radionuclide discharge limits should only remain where there is real potential for significant radiological impact. In order to align with this guidance, historic Site aerial and liquid discharges for each individual radionuclide have been assessed to determine the significance of their environmental impact (characterised by annual radioactive dose to a member of the critical group). Based on these assessments alone (shown in appendices 1 and 2), the removal of Site limits is proposed where the impact of discharges is demonstrated to be well below 1μSv per year. However, future discharges must be considered and removal of a Site limit can only be justified where future operating strategies indicate that increases in discharges above this threshold value are unlikely. Where limit removal is not justified, on the basis of past discharges and/ or potential future discharge levels, consideration has also been given to the reducing the 'headroom' between maximum discharges and current limits to align with EA limit setting methodology[7].

Existing RSA Permit conditions require SL to apply BAT to minimise the activity and volume of radioactive waste. In line with BAT, SL is applying to minimise headroom in remaining Site Limits. Applying for substantial and progressive reductions in discharge limits through the Permit Variation allows SL to demonstrate alignment with the requirements of the UKSRD.

The variations to Site Limits which are applied for have been underpinned by data assessment and forecasting of future discharges, as detailed in tables 2 and 3 below. The changes are sought over two phases; Phase 1 acknowledging the end of Thorp shearing (expected 2018) and Phase 2 with the end of Magnox decanning (expected 2020) - alongside the introduction of a tiered limit structure.

This review has examined discharge data since 1990. However, data assessments have been undertaken on monthly reported discharge data from January 2012 – December 2017.

Table 2 Proposed variations to aerial Site Limits

Site Aerial Limits	Phase 1 Limit (MBq)	% reduction from current Site Limit	Phase 2 Upper Limit (MBq)	% reduction from current Site Limit	Phase 2 Lower Limit (MBq)*	% reduction from current Site Limit
H3	7.15E+08	35%	5.50E+08	50%	2.20E+08	80%
C14	2.48E+06	25%	2.31E+06	30%	1.65E+06	50%
Kr85	1.76E+11	60%	Remove Limit			
Sr90	5.68E+02	20%	4.97E+02	30%	4.97E+02**	30%
Ru106	1.96E+04	15%	1.96E+04	15%	1.96E+04**	15%
Sb125	3.00E+04	0%	Remove Limit			
I129	4.90E+04	30%	4.20E+04	40%	2.80E+04	60%
I131	Remove Limit					
Cs137	4.8E+03	17%	4.8E+03	17%	4.8E+03**	17%
Pu alpha	1.52E+02	20%	1.33E+02	30%	1.33E+02**	30%
Pu241	Remove Limit					
Am241+Cm242 (total)	8.40E+01	30%	8.40E+01	30%	8.40E+01**	30%
Alpha	6.60E+02	25%	6.60E+02	25%	4.40E+02	50%
Beta	3.15E+04	25%	3.15E+04	25%	2.10E+04	50%

*** Phase 2 lower limit will be routinely 'in force' with the option to seek approval from EA to move to an upper tier limit where a suitable BAT case has been agreed.**

****The environmental impact of these discharges is so low that a lower tier limit is considered to be unjustified.**

Table 3: Proposed variations to liquid Site Limits

Site Liquid Limits	Phase 1 Limit (GBq)	% reduction from current Site Limit	Phase 2 Upper Limit (GBq)	% reduction from current Site Limit	Phase 2 Lower Limit (GBq)*	% reduction from current Site Limit
H3	1.08E+07	40%	7.20E+06	60%	1.44E+06	92%
C14	1.79E+04	15%	1.05E+04	50%	8.40E+03	60%
Co60	3.60E+03	0%	3.60E+03	0%	3.60E+03	0%
Sr90	3.60E+04	20%	3.15E+04	30%	2.25E+04	50%
Zr95+Nb95 (total)	Remove Limit					
Tc99	9.00E+03	10%	8.00E+03	20%	6.00E+03	40%
Ru106	3.57E+04	30%	1.53E+04	70%	1.02E+04	80%
I129	1.60E+03	20%	8.00E+02	60%	4.00E+02	80%
Cs134	Remove Limit					
Cs137	2.72E+04	20%	2.38E+04	30%	1.70E+04	50%
Ce144	Remove Limit					
Np237	Remove Limit					
PuAlpha	7.00E+02	0%	6.30E+02	10%	4.20E+02	40%
Pu241	2.00E+04	20%	1.75E+04	30%	7.50E+03	70%
Am241	2.70E+02	10%	2.40E+02	20%	1.50E+02	50%
Cm243+244 (total)	Remove Limit					
Alpha	8.10E+02	10%	7.20E+02	20%	4.50E+02	50%
Beta	1.44E+05	20%	1.26E+05	30%	8.10E+04	55%
Uranium	Remove Limit					

***Phase 2 lower limit will be routinely 'in force' with the option to seek approval from EA to move to an upper tier limit where a suitable BAT case has been agreed.**

6.1.1 Consideration of changes to solid waste Site Limits

Within the current SL RSA Environmental Permit there is only one facility permitted for the disposal of solid wastes. This is the Calder Landfill Extension, which is permitted for the disposal of low level activity solid wastes by burial. The facility has low level activity limits in Becquerel per gram (Bq/g) and volume limits in metres cubed (m3), and has different limits for the Main Area and Segregated Area (only the Segregated Area is currently operational). Calder Landfill Extension Segregated Area (CLESA) is located in the south western corner of the Sellafield site, in the north-western part of the Calder Floodplain Landfill.

During the last Permit Variation (1st December 2017) the 'Specified waste type' for the Calder Landfill Extension Segregated Area (CLESA) was increased. This followed an SL Permit Variation Application in March 2017[9], which explained why the changes were required i.e. application of BAT in enabling SL to route higher activity wastes for disposal on site at CLESA instead of sending to off-site landfill, consistent with the proximity principle for waste management. Specifically this was to facilitate the short term waste disposals programme (decommissioning, dismantling and disposal of the Pile 1 Chimney).

Detail explaining the change in specified waste type and increased activity limits and the negligible effect on environmental impact was provided specifically in the Post Closure Radiological Safety Assessment (PCRSA)[10], a document which was reviewed during 2016/17 to ensure optimised use of CLESA's radiological capacity. As part of the March 2017 application SL provided information about higher activities of tritium that could be accommodated at CLESA. The PCRSA shows that for tritium specific disposals, orders of magnitude above 200 Bq/g, the activity limit introduced through the 2017 permit variation, will not significantly impact on doses received. This variation provides an opportunity to support SL's plans to dispose of high concentration tritium wastes through provision of a Specific Tritium Limit for CLESA disposals. A BAT assessment accompanies this variation to justify amendment of the tritium limit for the CLESA[11].

6.2 Explanation for proposals to remove Site Limits

6.2.1 Explanation for proposals to remove Aerial Site Limits

Krypton-85 (Kr85)

- Kr85 discharges result from Thorp and Magnox reprocessing, being released during fuel shearing/ decanning and dissolution.
- Discharges will cease after Magnox decanning has finished and it is proposed that this Site Limit is removed in Phase 2.

Antimony-125 (Sb125)

- Sb125 discharges are dominated by those from Fuel Handling Plant (FHP) as a result of fuel decanning during Magnox reprocessing and consequently discharges will continue through Phase 1. During Phase 2 the source process ends and discharges will cease. The maximum annual discharge in recent years has been less than 46% of the current Site Limit.
- The recent maximum annual discharge equates to a critical group dose of 0.09µSv.
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 1).
- It is proposed that this Site Limit should be removed after Magnox decanning.

Iodine-131 (I131)

- The maximum annual discharge in recent years has been less than 2% of the current Site Limit. This includes many discharge measurements derived from sample results below detectable levels.
- The maximum annual discharge in recent years equates to a critical group dose of 0.05µSv.
- Discharges are dominated by Thorp reprocessing and related Highly Active Liquor (HAL) storage hence significant reductions are expected.
- I131 has a very short half-life of 8.02 days. Any remaining quantities of I131 will continue to reduce and become harder to detect in discharges.
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 1).
- It is proposed that this Site Limit be removed in phase 1.

Plutonium-241 (Pu241)

- The maximum annual discharge in recent years has been less than 12% of the current Site Limit. The corresponding maximum annual critical group dose has been 0.01μSv.
- Separation Area Ventilation (SAV) stack is currently the only limited stack, although 99% of the recently reported discharges have been below the limit of detection (SAV stack has not been operating long so the data period is relatively short; April 2016-April 2017).
- The only measurable discharge is via Analytical Services (AS). Future discharges from AS and Product Finishing and Storage (PF&S) stack will be picked up by alpha and beta monitors and samplers on the stack ensuring that any significant increases will be investigated.
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 1).
- It is proposed that this Site Limit be removed in Phase 1.

6.2.2 Explanation for proposals to remove Liquid Site Limits

Zirconium-95 and Niobium-95 in total (Zr95+Nb95)

- The maximum discharge in recent years has been less than 4% of the current Site Limit.
- Discharges have significantly reduced since the 1990's and are expected to remain insignificant in the future.
- The maximum annual discharge in recent years equates to a critical group dose of 0.1μSv.
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 2).
- It is proposed that this Site Limit be removed in phase 1.

Caesium-134 (Cs134)

- The maximum discharge in recent years has been less than 6% of the current Site Limit.
- The maximum annual discharge in recent years equates to a critical group dose of 0.05μSv.

- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 2).
- It is proposed that this Site Limit be removed in Phase 1.

Cerium-144 (Ce144)

- The maximum discharge in recent years has been less than 7% of the current Site Limit.
- The majority of the reported discharge is from measurements recorded below detectable levels. The maximum annual discharge reported in recent years equates to a critical group dose of 0.14μSv.
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 2).
- It is proposed that this Site Limit be removed in Phase 1.

Neptunium-237 (Np237)

- The maximum discharge in recent years has been less than 6% of the current Site Limit.
- Discharges have been very low since the late 1990's and the majority of discharges are reported from measurements below detectable levels.
- The maximum annual discharge reported in recent years equates to a critical group dose of 0.23μSv.
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 2).
- It is proposed that this Site Limit be removed in Phase 1.

Curium-243 + Curium-244 (Cm243+Cm244)

- The maximum discharge in recent years has been less than 7% of the current Site Limit.
- The maximum annual discharge in recent years equates to a critical group dose of 0.05μSv.
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 2).
- It is proposed that this Site Limit be removed in Phase 1.

Uranium (U)

- The maximum discharge in recent years has been less than 20% of the current Site Limit.
- The maximum annual discharge in recent years equates to a critical group dose of 0.17μSv.
- The concentration of Uranium in SL discharges has negligible effect on the Uranium content of the receiving waters (see appendix 3).
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 2). The Site Limit is presented in Kg and so reported discharges were converted to Bq for the purpose of data assessments (see appendix 2 note 1).
- It is proposed that this Site Limit be removed in Phase 1. Further consideration should be given to whether the chemical impact of Uranium warrants inclusion in non-radiological permitting (SL Installation Permit).

Antimony-125 (Sb125)

- Neither site nor plant discharges of Sb125 are limited (though discharge reporting is currently required).
- The maximum annual discharge in recent years equates to a critical group dose of 0.07μSv.
- Analysis of historic monthly discharge data suggests removal of the requirement to report Sb125 discharges (see appendix 2).
- It is proposed that the requirement to report Sb125 discharges be removed in Phase 1.

Zn-65

- There are no site or plant discharge limits for Zn65, however quarterly discharge reporting is currently required.
- SETP is currently the only contributor to reported Zn65 discharges.
- Changes in reporting methodology (derivation of the minimum detectable activity) introduced in 2012 improved the accuracy of reported SETP Zn65 discharges and significantly reduced the corresponding reported discharges as a result.
- Over the period 2007-2016 95% of Zn65 discharges from SETP were reported at the LOD.

- Over the period 2012 – 2016 the maximum annual critical group dose was 0.89µSv. However, it is important to consider that all the discharges that contributed to this calculated dose were reported at the limit of detection (LOD).
- Further consideration is required as to whether continued reporting of Zn65 discharges adds value, and hence whether a Site Limit should be considered.

6.3 Explanation for proposed reductions to Site Limits

These proposals have been developed in connection with the individual operating areas of site and agreed through various site committees. Significant reductions are proposed which do not threaten future site operations and in particular High Hazard and Risk Reduction activities.

The scale of future discharges is not fully defined; hence SL's application to change the Permit structure through the introduction of tiered limits. Nevertheless headroom may seem high in some areas primarily due to difficulty in predicting future discharges from Post Operational Clean Out (POCO) and site clean-up, and also acknowledging the lag in discharges from downstream plants following the end of reprocessing. Future site clean-up and remediation strategies will focus on BAT and As Low As Reasonably Practicable (ALARP), and it will be important to take opportunities to accelerate High Hazard Risk Reduction activities in accordance with these principles i.e. considering long term, overall environmental impact. In some instances SL may seek to enable reduction of long term, overall environmental impact by justifying short term increases in discharges.

It will be important to continue to review discharges and possible further reductions in Site Limits after this variation.

6.3.1 Explanation for proposals to reduce Aerial Site Limits

As explained, the impact of aerial discharges will reduce significantly after Thorp shearing and Magnox decanning in reflection of the reduced discharges of volatile aerial radionuclides. Consequently, SL is proposing significant reductions in the site Limits for volatile species. However, aerial particulate species are already very low and discharges from across site are generally measured at the analytical LOD. Scheduled Stack limits for the particulate species are already set at levels which correspond to environmental impacts below 1 µSv per year. It is difficult to accurately

predict future discharges based on LOD historic results, but it should also be noted that SL expects remediation activities to generate increased Sr90 and Cs137 discharges. Smaller reductions in particulate limits are proposed and it is not considered necessary to request lower tier limits based on impact. Future reviews of discharges will be undertaken as clean up and retrievals accelerate, with a view to removing limits and downgrading stacks rather than seeking further reductions in limits.

Tritium (H-3)

- The maximum annual discharge in recent years has been less than 14% of the current Site Limit.
- Discharges are dominated by Magnox Reprocessing and are expected to reduce to very low levels in the future after reprocessing ends. However, discharges are likely to continue for some time beyond phase 2 whilst treatment of effluents arising from reprocessing continues.
- The maximum annual discharge in recent years equates to a critical group dose of 0.29μSv
- Analysis of historic monthly discharge data suggests removal of this limit (see appendix 1). However considering uncertainty on the scale of discharges beyond phase 2, a reduced Site Limit is proposed.

Carbon-14 (C-14)

- The maximum annual discharge in recent years has been less than 15% of the current Site Limit.
- Current discharges are dominated by reprocessing throughput hence reductions are expected in the future.
- The maximum annual discharge in recent years equates to a critical group dose of 0.49μSv.
- Considering the continued potential for ongoing discharges whilst HAL stocks remain, plus potential for releases from reprocessing POCO activities, removal of the Site Limit is not being considered at present.

Strontium-90 (Sr-90)

- The maximum annual discharge in recent years has been less than 6% of the current Site Limit.
- The impact of discharges at the cumulative Plant Limits (less than 0.1μSv) is already below the EA's limit setting criteria. Furthermore, the maximum annual discharge in recent years equates to a critical group dose of 0.001μSv.
- Contributions come from FHP, Magnox Swarf Storage Silo (MSSS) and AS&PF&S stacks.
- Sr90 discharges from FHP as a result of Magnox reprocessing are expected to reduce and it is proposed to downgrade the FHP stack in Phase 2.
- AS&PF&S discharges are not expected to reduce over the short term, but these are so low they are not currently subject to a plant limit.
- Discharges from MSSS have also been very low. However, future retrievals operations in MSSS mean that future discharges are expected to increase.
- It is proposed to retain the Site Limit to ensure appropriate monitoring of discharges arising from future High Hazard and Risk Reduction activities.
- Note that a new stack is being built for MSSS with improved abatement including HEPA filters and effluent scrubbing. This should be operational in the next few years and then after a suitable period of operation the Site Limit should be reviewed.

Ruthenium-106 (Ru-106)

- The dose impact of the current cumulative Plant Limits (less than 0.1μSv) is below the EA's limit setting criteria and the maximum annual discharge in recent years equates to a critical group dose of 0.003μSv.
- Waste Vitrification Plant (WVP) is currently the only contributor to reported Ru-106 discharges. Based on historic impacts a justification to remove the Site Limit could be made, however it is realistic that future discharges could be generated if the plant needs to implement potential unblocking activities, which can reasonably be expected to occur in the melters associated with the Vitrification processes.
- It is suggested the Site Limit remains (15% reduction) and that further reduction is unjustified based on impact. Alternatively an increased limit could be made available for unblocking activities.

- SL has a programme of work to develop measures to avoid WVP melter neck blockages and to better recover from such events, but a Site Limit should be retained until suitable measures are secured and implemented.

Iodine-129 (I-129)

- I-129 is a major contributor to the environmental impact of current site aerial discharges. The maximum annual discharge in recent years equates to a critical group dose of 4.1μSv. The maximum annual discharge in recent years has been less than 20% of the current Site Limit.
- I-129 arises from reprocessing and hence discharges are expected to significantly reduce in future. However whilst Thorp and Magnox I-129 discharges will reduce, they will still be generated beyond phase 2 due to the chemical stages of reprocessing and subsequent POCO activities. In addition, treatment of reprocessing liquors through downstream plants, including WVP, Highly Active Liquor Evaporation and Storage (HALES) and Solvent Treatment Plant (STP) will continue to generate I-129 discharges. Optimising throughput on these treatment plants is key to progressing site clean-up and remediation.
- The 60% reduction in the lower tier Site Limit presents a significant reduction in environmental impact (critical group dose) and considers the continued potential for ongoing discharges being generated from reprocessing POCO activities as well as arisings from downstream plants. Based on environmental impact the site I-129 limit will be the focus for future review of aerial discharges.

Americium 241 and Curium 242 in total (Am-241 & Cm-242)

- The maximum annual discharge in recent years has been less than 15% of the current Site Limit.
- The dose impact of discharges at the cumulative Plant Limits (less than 0.2μSv) is already below the EA's limit setting criteria. Furthermore, the maximum annual discharge in recent years equates to a critical group dose of 0.02μSv.
- Analysis of historic monthly discharge data suggests removal of this Site Limit (see appendix 1).
- However, discharges are dominated by the Analytical Services facility and there is the potential for periodic discharges in the future as a result of potential historic

contamination. As a consequence, a reduced Site Limit is proposed (30% in Phase 2).

- Considering the environmental impact, future reductions in the limit do not seem appropriate and consideration for Site Limit removal would be more proportionate.

Caesium-137 (Cs-137)

- The maximum annual discharge in recent years has been less than 4% of the current Site Limit.
- The impact of discharges at the cumulative Plant Limits (0.4 μSv) is already below the EA's limit setting criteria and the maximum annual discharge in recent years equates to a critical group dose of 0.01μSv.
- The main contributors to site discharges are the MSSS stacks, FHP stack is a minor contributor for which the stack is proposed to be downgraded in Phase 2.
- Although discharges from MSSS have been very low, future retrievals operations in MSSS mean that discharges are expected to increase. As a consequence, removal of the Site Limit is not considered at present.
- Considering the low impact of discharges at the current Site Limit, it is proposed to retain headroom in the Site Limit to support High Hazard and Risk Reduction.
- Considering the environmental impact, future reductions in the Site Limit do not seem appropriate and consideration for Site Limit removal would be more proportionate.
- Note that a new stack is being built for MSSS with improved abatement including HEPA filters and effluent scrubbing. This should be operational in the next few years and then after a suitable period of operation the Site Limit should then be reviewed.

Plutonium-Alpha (Pu-Alpha)

- The maximum annual discharge in recent years has been less than 19% of the current Site Limit.
- The dose impact of the cumulative Plant Limits (0.4μSv) is already below the EA's limit setting criteria and the maximum annual discharge in recent years equates to a critical group dose of 0.06μSv.

- Analysis of historic monthly discharge data suggests removal of this Site Limit (see appendix 1).
- However, discharges are dominated by the Analytical Services facility and there is the potential for periodic discharges in the future as a result of potential historic contamination. As a consequence, a reduced Site Limit is proposed (30% reduction).
- Considering the environmental impact, future reductions in the limit do not seem appropriate and consideration for Site Limit removal would be more proportionate.

Alpha

- The maximum annual discharge in recent years has been less than 14% of the current Site Limit (including discharges from open fuel storage ponds and other outlets).
- This limit enforces monitoring and sampling of alpha emitting radionuclide discharges and will indicate any adverse trends or increases in any alpha radionuclides if they should occur. Monitoring and sampling for total 'Alpha' provides reassurance that any abnormal or increasing discharges (individual species) will be investigated. A 50% reduction in the lower tier limit is proposed.

Beta

- The maximum annual discharge in recent years has been less than 3% of the current Site Limit (including discharges from Open fuel storage ponds and other outlets).
- This limit enforces monitoring and sampling of beta emitting radionuclide discharges and will provide an indicator of any adverse trends or increases in any beta radionuclides if they were to occur. Monitoring and sampling for total 'Beta' provides reassurance that any abnormal or increasing discharges (individual species) will be investigated.
- A 50% reduction in the lower tier limit is proposed.

6.3.2 Explanation for proposals to reduce Liquid Site Limits

Carbon-14 (C-14)

- The maximum discharge in recent years has been less than 30% of the current Site Limit. Discharges of C-14 relate to reprocessing and therefore significant reductions are expected in the future. However, the site discharge is also contributed to by downstream effluent treatment which is likely to continue for some time beyond Phase 2, whilst treatment of effluents arising from reprocessing continues.
- The maximum annual discharge in recent years equates to a critical group dose of 5.4μSv. Considering that this impact is greater than the EA's limit setting criteria, removal of the limit is not being considered at present.
- A significant reduction in the Site Limit is proposed (60% reduction to the Phase 2 lower tier Site Limit).

Cobolt-60 (Co-60)

- The maximum discharge in recent years has been less than 2% of the current Site Limit.
- Future discharges from MSSS via SIXEP are expected to increase significantly, therefore removal of the Site Limit is not being considered at present. This reflects a new effluent route from MSSS to SIXEP.
- Predicted discharges suggest discharges could be above the Site Limit in the future, but it is appropriate to collect operational data to assess the risk.

Strontium-90 (Sr-90)

- The maximum discharge in recent years has been less than 6% of the current Site Limit.
- Future sludge retrieval operations in MSSS mean that future discharges may increase significantly. As a consequence, removal of the Site Limit is not being considered at present.
- The maximum annual discharge in recent years equates to a critical group dose of 0.66μSv. Based on this impact, High Hazard and Risk Reduction activities should not be restricted by a Sr-90 limit and therefore reasonable headroom in the Site Limit should be retained.
- A 50% reduction to the Phase 2 lower Site Limit is proposed.

Ruthenium-106 (Ru-106)

- The maximum discharge in recent years has been less than 4% of the current Site Limit.
- The maximum annual discharge in recent years equates to a critical group dose of 2.7μSv.
- An 80% reduction in the Phase 2 lower tier Site Limit is proposed, associated with a large reduction in the environmental impact (critical group dose) of Site Limits.

Iodine-129 (I-129)

- The maximum discharge in recent years has been less than 28% of the current Site Limit.
- I129 discharges are largely dominated by Thorp Dissolver Off Gas (DOG) plant; hence significant reductions are expected after the end of reprocessing. However, arisings are expected to be generated during POCO. Analysis of historic monthly discharge data suggests that this Site Limit is retained (see appendix 2).
- The maximum discharge in recent years equates to a critical group dose of 0.51μSv.
- An 80% reduction in the Phase 2 lower Site Limit is proposed.

Caesium-137 (Cs-137)

- The maximum discharge in recent years has been less than 12% of the current Site Limit.
- Analysis of historic monthly discharge data suggests that this Site Limit is retained (see appendix 2).
- The maximum annual discharge in recent years equates to a critical group dose of 1.9μSv.
- A 50% reduction in the Phase 2 lower Site Limit is proposed.

Plutonium-Alpha (Pu-Alpha)

- The maximum discharge in recent years has been less than 27% of the current Site Limit.
- Future discharges from SIXEP are uncertain and are very likely to continue due to treatment of effluents arising from activities relating to legacy First Generation

Magnox Storage Pond (FGMSP) fuel. As a consequence, removal of the Site Limit is not being considered at present.

- The maximum annual discharge in recent years equates to a critical group dose of 8.2μSv.
- As a key abatement plant for removing Sr-90 and Cs-137 from liquid effluents, SIXEP operations should not be restricted (subject to application and demonstration of BAT) and therefore reasonable headroom in the Site Limit should be retained to support High Hazard and Risk Reduction.
- A 40% reduction in the Phase 2 lower Site Limit is proposed.
- The upper level remains relatively high (10% reduction) because there have been recent increasing trends in SIXEP discharges linked to FGMSP fuel operations. Discharges were high in the early 1990s (above the current limit), when similar operations were being undertaken in FHP.

Plutonium-241 (Pu-241)

- The maximum discharge in recent years has been less than 14% of the current Site Limit.
- The maximum annual discharge in recent years equates to a critical group dose of 3.1μSv.
- Analysis of historic monthly discharge data suggests that this Site Limit is retained (see appendix 2).
- A 70% reduction in the Phase 2 lower Site Limit is proposed.
- The upper tier should be maintained at a relatively high level (30% reduction) to allow future optimisation of SIXEP in future (as per Pu-Alpha).

Americium-241 (Am-241)

- The maximum discharge in recent years has been less than 11% of the current Site Limit.
- The maximum annual discharge in recent years equates to a critical group dose of 1.4μSv.
- Analysis of historic monthly discharge data suggests that this Site Limit is retained (see appendix 2).
- A 50% reduction in the Phase 2 lower Site Limit is proposed.

Alpha

- The maximum discharge in recent years has been less than 29% of the current Site Limit.
- This Site Limit enforces monitoring and sampling of alpha emitting radionuclide discharges and will provide an indicator of any adverse trends or increases if they were to occur in any alpha radionuclides.
- A 50% reduction in the Phase 2 lower Site Limit is proposed.

Beta

- The maximum discharge in recent years has been less than 8% of the current Site Limit.
- This Site Limit enforces monitoring and sampling of beta emitting radionuclide discharges and will provide an indicator of any adverse trends or increases if they were to occur in any beta radionuclides.
- A 55% reduction in the Phase 2 lower Site Limit is proposed.

Tritium (H-3)

- The maximum discharge in recent years has been less than 13% of the current Site Limit.
- The dose impact of the current Site Limit is already below the EA's limit setting criteria and the maximum annual discharge in recent years equates to a critical group dose of 0.03μSv.
- Analysis of historic monthly discharge data suggests removal of this Site Limit in line with EAs limit setting criteria (see appendix 2). However, considering that tritium is a Key UKSRD species, a 92% reduction to the Site Limit is proposed.
- SL proposes that the upper tier limit is maintained at a relatively high level (60% reduction) and reviewed in future. Reprocessing is the dominant source of tritium discharges but the lag in completion of chemical separation and then POCO and generation of downstream plants effluents mean that more significant reductions may not occur until after implementation of phase 2 limits.

Technetium-99 (Tc-99)

- The maximum discharge in recent years has been less than 21% of the current Site Limit.

- Discharges are dominated by EARP. However, as EARP is a key abatement plant reducing the impact of significantly higher risk Alpha streams, throughput should not be restricted by Tc-99 discharges with low impacts.
- The maximum annual discharge in recent years equates to a critical group dose of 0.89μSv.
- Considering that Tc-99 is a key UKSRD species, reducing the Site Limit will maintain the high profile of Tc-99 discharges.
- A 40% reduction in the Phase 2 lower Site Limit is proposed.

6.4 Proposed Changes to Plant Limits

As previously noted, SL proposes that Plant Limits are replaced with Plant Notification Levels. The notification levels will be set at much lower values to ensure early notification to EA of increasing discharge trends. A major benefit of this is the ability to re-route effluents between treatment plants, where this is agreed as the best strategy to optimise waste management and minimise overall environmental impact. Providing discharges remain within Site Limits, this removes the need for a Permit variation. This benefit is more relevant to liquid effluents rather than aerial effluents, as diversion between different treatments routes is more straightforward.

Most aerial discharge stacks employ extensive effluent clean up systems, in particular the use of High Efficiency Particulate Air (HEPA) filtration to reduce the activity particulate discharges and caustic scrubbers to reduce the activity of volatile discharges. A significant difference between aerial and liquid effluent streams is that aerial particulate discharges from the majority of stacks are so low that most reported discharges are derived from results below levels that can be detected by sampling and monitoring equipment, also known as the ‘limit of detection’ (LOD). After reprocessing operations end, volatile discharges will reduce significantly, in addition to the already low level of particulate discharges, though some plants will continue to discharge while they continue to treat effluent arisings from Thorp and Magnox and in support of site clean-up and remediation activities.

Arrangements are already established, through the Sellafield Ltd Management System (SLMS), for notifying EA of increasing short term aerial discharge trends. Monthly triggers are set ‘just above normal’ discharge levels (typically mean plus 3

standard deviations or mean multiplied by 2 for ‘LOD’ streams) and EA are notified if these are exceeded by a factor of 2 or if 2 consecutive monthly triggers are exceeded.

Liquid discharges will also reduce after reprocessing but this will take time due to chemical processes and downstream treatment of effluents. Liquid discharges are rarely below detectable levels, and although their environmental impact is low, it is several times higher than for aerial pathways. Plant Liquid discharges have been thoroughly reviewed and Notification Levels are proposed based on a methodology which looks at monthly discharges, removes any unusual points (especially events or notifications), calculates the mean then adds 3 standard deviations. These figures are presented in the following tables (16 – 23). It should be noted that a similar approach would not be effective for defining aerial Notification Levels, as monthly reported discharges are regularly LOD. Therefore, aerial plant notification levels have been proposed at the value of the monthly trigger, multiplied by 12 (unless otherwise indicated in the tables below).

Consequently, the proposed Notification Levels will be set much lower than current Plant Limits. As a result, it is expected that SL may exceed these levels during normal business and hence will need to notify EA and explain why, either before or immediately after making the reported discharge record. SL operate an internal management trending system to enhance visibility of discharges and this will be used to monitor performance against notification levels to provide EA confidence.

If implemented in the Permit, Notification Levels will require regular review in the future to reflect changing site operations and discharges. It is suggested that SL review annually and include any recommendations for changes to levels in the annual permit review report (CEAR requirement 14).

6.4.1 Proposed Aerial Plant Notification Levels

First Generation Magnox Storage Pond (FGMSP) & Decanning Facility

It is proposed that FGMSP stack be downgraded to an 'other outlet' during phase 1[12].

Original, 1st and 2nd extensions Magnox Swarf Storage Silos (MSSS)

No changes are proposed to the levels in the Permit for this stack. Discharges are expected to increase in the near future with the commissioning of the first waste retrieval machine, and the commencement of waste retrievals from one compartment. Considering the MSSS operating plan for the next two years, at which point HEPA filtration will be available for discharge abatement, it is not sensible to set new notification levels through this variation application. This position will be reviewed once sufficient data has been collected following the commencement of waste retrievals from one compartment.

A new ventilation extract system has been designed for MSSS which incorporates new fans, monitoring equipment, HEPA filtration, and a new discharge outlet. This extract system is currently programmed to be operational in approximately two years, and it is anticipated that discharges will be reduced to levels at or below those experienced during the current quiescent phase of operations. A further review of discharges can therefore be undertaken following a period of waste retrieval under the new extract system, and new notification levels proposed if deemed appropriate.

Table 4

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Strontium-90	3.70E+02	3.70E+02
Caesium-137	1.60E+03	1.60E+03
Alpha-emitting radionuclides associated with particulate matter	2.80E+00	2.80E+00
Beta-emitting radionuclides associated with particulate matter	2.70E+03	2.70E+03

Fuel Handling Plant (FHP)

Based on the scale of current discharges options have been considered to rationalise limits or downgrade the stack. The proposal is to downgrade the stack to 'other outlet' in Phase 2 following the end of Magnox decanning.

Table 5

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Strontium-90	2.00E+01	4.8E+00
Antimony-125	3.00E+04	2.4E+04
Caesium-137	3.00E+02	3.6E+01
Alpha-emitting radionuclides associated with particulate matter	1.60E+00	1.3E+00
Beta-emitting radionuclides associated with particulate matter	3.00E+02	1.3E+02

Waste Vitrification Plant (WVP)

Vitrification supports site High Hazard and Risk Reduction by treating HAL from reprocessing. The plan for treating effluents goes beyond the phase 2 variation. It is important to maximise WVP throughputs together with the application of BAT.

Table 6

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Carbon-14	3.30E+06	2.2E+05
Ruthenium-106	1.90E+04	1.1E+03
Iodine-129	1.40E+03	2.9E+02
Iodine-131	4.80E+03	Site Limit Removed
Alpha-emitting radionuclides associated with particulate matter	7.50E+00	2.4E-01
Beta-emitting radionuclides associated with particulate matter	6.00E+03	1.1E+01

Site Ion Exchange Plant (SIXEP)

It is proposed that SIXEP stack be downgraded to an other outlet during Phase 1[13].

Thermal Oxide Reprocessing Plant (Thorp)

Following the end of shearing reductions in discharges from the Thorp Dissolver Off Gas system are expected, however Vessel ventilation system, Glovebox, and cell ventilation systems will continue to generate discharges as chemical separation continues and then POCO is also expected to generate aerial effluents.

It is expected a case will be made to downgrade the Thorp stack prior to phase 2.

Table 7

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Tritium H-3	4.30E+07	3.6E+07
Carbon-14	7.60E+05	1.50E+05*
Krypton-85	4.40E+11	Plant Limit Removed
Iodine-129	3.80E+04	7.40E+03*
Iodine-131	4.20E+03	Site Limit Removed
Alpha-emitting radionuclides associated with particulate matter	6.00E+01	8.0E+00
Beta-emitting radionuclides associated with particulate matter	1.20E+03	4.5E+01

***Thorp proposals (which are lower than monthly trigger x12)**

Solvent Treatment Plant (STP)

STP throughputs are expected to increase in future, with potential for an associated increase in I129 discharge levels. It is also important to maintain future HALES capacity/ throughputs (Evaporator C and D) which correlate with C14 discharges. Note that HALES aerial effluents are discharged through the STP stack.

Table 8

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Carbon-14	7.60E+05	4.2E+04
Iodine-129	2.10E+04	1.0E+03
Iodine-131	3.40E+03	Site Limit Removed
Alpha-emitting radionuclides associated with particulate matter	3.70E-01	1.7E-01
Beta-emitting radionuclides associated with particulate matter	3.90E+02	1.0E+00

Analytical Services (AS) and Product Finishing and Storage (PF&S)

Discharges and their environmental impact are low, though they are measurable. Rationalisation and stack downgrade have been considered but are not recommended at present based on recent trends. There is also some uncertainty about the future of the facilities and the option to move Analytical Services capability.

Table 9

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Caesium-137	1.70E+02	6.9E+01
Plutonium-alpha	1.90E+02	5.4E+01
Americium-241 & Curium-242 in total	1.20E+02	3.6E+01
Alpha-emitting radionuclides associated with particulate matter	3.70E+02	8.6E+01
Beta-emitting radionuclides associated with particulate matter	6.10E+02	2.3E+02

Waste Encapsulation Plant (WEP)

Discharges from WEP make only small contributions to the Site Limits.

Table 10

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Carbon-14	1.30E+05	1.1E+04
Iodine-129	4.80E+02	1.7E+02
Alpha-emitting radionuclides associated with particulate matter	6.40E+00	5.3E-01
Beta-emitting radionuclides associated with particulate matter	3.90E+02	3.9E+00

3rd extension Magnox Swarf Storage Silos (MSSS)

As noted above, MSSS aerial discharges are expected to increase in future reflecting the plan for future retrievals. MSSS currently has the option to discharge via 2 stacks, and it is proposed that the plant notification levels for this 3rd extension stack should initially be set at similar levels to the current limits. However, it should be noted that there is currently no intention to utilise the 3rd extension stack once discharges have been diverted back to the Original, 1st and 2nd extensions stack, prior to the commissioning of the first waste retrieval machine.

The new stack will replace both current stacks (1st and 2nd extension and 3rd extension) and so in future MSSS will only require 1 set of notification levels.

Table 11

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Strontium-90	4.40E+02	4.40E+02
Caesium-137	4.80E+03	4.8E+03
Alpha-emitting radionuclides associated with particulate matter	1.50E+00	1.50E+00
Beta-emitting radionuclides associated with particulate matter	3.50E+03	3.50E+03

National Nuclear Laboratory (NNL)

Discharges are typically below detectable levels. However this may change as the facility continues to commission new laboratories and vent streams.

Table 12

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Alpha-emitting radionuclides associated with particulate matter	4.80E+01	2.5E-01
Beta-emitting radionuclides associated with particulate matter	2.70E+03	1.4E+00

Decontamination Centre Stack

Review of discharges suggests the stack could be downgraded as discharges from the Decontamination centre have reduced, but this is not being proposed at present whilst the future use of the facility is determined. Most decontamination operations have now been moved to the Effluent Plant Maintenance Facility (EPMF) (switching from unfiltered stack to filtered stack).

Table 13

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Alpha-emitting radionuclides associated with particulate matter	2.90E+00	3.4E-01
Beta-emitting radionuclides associated with particulate matter	3.10E+02	2.6E+00

Separation Area Ventilation (SAV)

Discharges are very low, reflecting the performance of the additional abatement provided by the recently commissioned SAV stack.

Table 14

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Tritium H-3	1.10E+09	1.5E+08
Carbon-14	1.30E+06	8.3E+04
Krypton-85*	1.20E+11	1.3E+10
Iodine-129	1.30E+04	4.4E+03
Iodine-131	3.00E+04	Site Limit Removed
Plutonium-alpha	5.20E+01	Plant Limit Removed
Plutonium-241	2.40E+03	Site Limit Removed
Alpha-emitting radionuclides associated with particulate matter**	3.40E+02	1.8E+00
Beta-emitting radionuclides associated with particulate matter**	6.70E+02	1.2E+01

***It is proposed that the site Kr85 limit be removed during phase 2. Therefore, plant Notification Level will no longer be relevant and will be removed.**

****A review of discharge data has confirmed that aerial particulate discharges are reported at the LOD and it has been proposed to move to reporting standard values for alpha and beta. This will require implementation of management arrangements involving 'initial count' action levels for particulate filter papers. If no abnormal discharges are observed in the alpha or beta monitors or initial count action levels on sample filter papers then they do not be sent for detailed analysis and a standard value can be reported. SL is proposing that a zero value be reported, but this needs to be agreed with the EA prior to setting an appropriate plant notification level[14]. In the event of increased activity being detected, either by alpha/ beta monitors or by an initial count that is recorded above the action level then the sample will be sent for analysis and subsequently actual discharge results will be reported.**

Open Fuel Storage Ponds & Other approved outlets

Discharges from Open Fuel Storage Ponds are expected to increase in future reflecting plans for increased remediation and clean-up activities. Reflecting the low levels of particulate discharges from the stacks on the Sellafield site, open ponds are now the dominant source.

Table 15

Radionuclide	Current Annual Plant Limit (MBq)	Proposed Annual Notification Level (MBq)
Tritium H-3*	2.30E+06	2.3E+06
Carbon-14*	8.40E+04	8.4E+04
Alpha-emitting radionuclides associated with particulate matter	5.00E+02	5.0E+02
Beta-emitting radionuclides associated with particulate matter	1.30E+04	1.3E+04

*** H3 & C14 are only required to be reported during removal of fuel, isotopes or graphite from the Piles 1&2 are ongoing.**

6.4.2 Proposed Liquid Plant Notification Levels

There are a number of plant discharges which are not currently limited, where discharges are reported as part of the site total. In this instance, SL monitors discharge trends in the same way, through monthly triggers. This explains why additional species are included in the tables below with proposed notification levels. It is anticipated that EA and SL will review whether notification levels are required for these species in future.

Segregated Effluent Treatment Plant (SETP)

Discharges from SETP are dominated by the reprocessing facilities and so will decrease once the respective plants have ceased to operate and completed their POCO phases. Discharges during POCO will be subject to routing decisions under the notification level process, in accordance with the application of BAT.

Table 16

Radionuclide	Current Annual Plant Limit (GBq)	Proposed Annual Notification Level (GBq)
Tritium H-3	1.8E+07	2.5E+06
Carbon-14	2.1E+04	6.3E+03
Strontium-90	8.9E+03	8.3E+02
Zirconium-95 & Niobium-95 in total	1.5E+03	Site Limit Removed
Ruthenium-106	1.1E+04	3.9E+02
Caesium-134	1.1E+03	Site Limit Removed
Caesium-137	2.3E+04	2.0E+03
Cerium-144	2.4E+03	Site Limit Removed
Neptunium-237	6.0E+02	Site Limit Removed
Plutonium-Alpha	4.2E+02	8.0E+01
Plutonium-241	1.8E+04	1.8E+03
Americium-241	1.8E+02	1.8E+01
Curium-243+244	3.6E+01	Site Limit Removed
Alpha-emitting radionuclides associated with particulate matter	6.0E+02	1.0E+02
Beta-emitting radionuclides associated with particulate matter	4.2E+04	4.3E+03
Uranium (kg)	2.0E+03	Site Limit Removed
Co60	None	1.8E+01
I129	None	8.0E+01

Enhanced Actinide Removal Plant (EARP)

EARP will continue to operate in support of POCO and decommissioning for an extended period of time, eventually receiving streams currently routed to alternative plants as they shut. EARP also processes historic materials on a campaign basis. Discharges will therefore vary according to the feeds and significant reductions are not anticipated. As the characterisation of specific campaigns varies significantly, EARP will apply an upper and lower notification level. This allows a much lower notification level to be in force when campaigns resulting in higher discharges are not underway, therefore giving EA closer monitoring of ongoing discharges.

Table 17

Radionuclide	Current Annual Plant Limit (GBq)	Proposed Upper[1] Annual Notification Level (GBq)	Proposed[1] Lower Annual Notification Level (GBq)
Tritium H-3	6.3E+05	3.2E+04	3.2E+04
Carbon-14	1.4E+03	8.0E+02	2.7E+01
Cobalt-60	7.0E+02	Plant Limit Removed	Plant Limit Removed
Strontium-90	1.4E+04	1.2E+03	9.6E+02
Technetium-99	1.0E+04	2.3E+03	1.3E+03
Ruthenium-106	4.2E+04	1.7E+03	2.5E+02
Caesium-137	1.0E+03	5.0E+02	2.0E+02
Plutonium-Alpha	2.9E+01	7.0E+00	6.0E+00
Alpha-emitting radionuclides associated with particulate matter	4.5E+01	2.6E+01	1.4E+01
Beta-emitting radionuclides associated with particulate matter	1.2E+05	5.6E+03	3.0E+03
Am241	None	1.7E+01	7.0E+00
Pu241	None	7.0E+01	7.0E+01

Site Ion Exchange Plant (SIXEP)

SIXEP will continue to operate for an extended period of time and new streams arising from POCO and decommissioning tasks are expected to be routed to the plant. It is not therefore expected that reductions in discharges will be visible in the immediate future.

Table 18

Radionuclide	Current Annual Plant Limit (GBq)	Proposed Annual Notification Level (GBq)
Tritium H-3	1.1E+05	2.0E+04
Carbon-14	4.3E+02	Plant Limit Removed
Strontium-90	6.8E+03	1.7E+03
Caesium-137	1.7E+04	2.0E+03
Plutonium-Alpha	4.0E+02	1.4E+02
Plutonium-241	1.5E+04	2.0E+03
Alpha-emitting radionuclides associated with particulate matter	9.0E+02	1.5E+02
Beta-emitting radionuclides associated with particulate matter	9.5E+04	6.7E+03
Co60	Not reported at present	1.8E+01
Ru106	None	1.9E+02
Tc99	None	6.0E+02
Am241	None	4.0E+00

Laundry & Lagoon

The Lagoon will receive significantly less feed as the reprocessing plants shutdown, but cooling, surface and groundwater comprise the majority of radiological content and therefore significant reductions are not anticipated.

Table 19

Radionuclide	Current Annual Plant Limit (GBq)	Proposed Annual Notification Level (GBq)
Caesium-137	4.0E+01	Plant Limit Removed
Plutonium-Alpha	1.7E+00	Plant Limit Removed
Alpha-emitting radionuclides associated with particulate matter	5.1E+00	3.5E-01
Beta-emitting radionuclides associated with particulate matter	3.8E+03	2.3E+03
H3	None	1.0E+01
Am241	None	2.0E-01

Thermal Oxide Reprocessing Plant (Thorp) Receipt & Storage pond

Discharges arise primarily from operations in support of reprocessing. Following cessation of that work it is intended to alter pond conditions such that discharges will reduce.

Table 20

Radionuclide	Current Annual Plant Limit (GBq)	Proposed Annual Notification Level (GBq)
Cobalt-60	3.6E+03	4.0E+01
Caesium-137	7.2E+03	8.5E+02
Alpha-emitting radionuclides associated with particulate matter	1.5E+01	1.1E+01
Beta-emitting radionuclides associated with particulate matter	9.9E+03	9.7E+02
H3	None	7.0E+01
Ru106	None	4.2E+01
PuAlpha	None	9.0E+00
Pu241	None	2.0E+02

Thermal Oxide Reprocessing Plant (Thorp) Carbon-14 removal plant

Thorp Carbon-14 plant discharges are solely related to reprocessing operations. Following POCO, discharges are expected to reduce to levels below the limit of detection. Note that the Levels proposed below (monthly triggers x12 in this case) may not be required by the time the varied permit is issued, as the plant may have stopped operating.

Table 21

Radionuclide	Current Annual Plant Limit (GBq)	Proposed Annual Notification Level (GBq)
Tritium H-3	3.6E+03	1.3E+03
Carbon-14	5.0E+02	2.5E+02
Iodine-129	1.7E+03	7.2E+02
Alpha-emitting radionuclides associated with particulate matter	8.5E-01	2.4E-01
Beta-emitting radionuclides associated with particulate matter	9.7E+02	4.6E+02

Factory Sewer

The Factory Sewer primarily receives surface and ground water feeds. Discharges are expected to increase as site remediation operations lead to more project work across the site.

Table 22

Radionuclide	Current Annual Plant Limit (GBq)	Proposed Annual Notification Level (GBq)
Tritium H-3	6.8E+01	1.0E+01
Alpha-emitting radionuclides associated with particulate matter	3.0E-01	1.5E-01
Beta-emitting radionuclides associated with particulate matter	6.0E+01	7.0E+00

Calder Interceptor Sewer (CIS)

Discharges from the Calder Interceptor Sewer are expected to increase in line with the addition of new effluent streams and/or diversion of existing effluent streams, where it is BAT to do so.

Table 23

Radionuclide	Current Annual Plant Limit (GBq)	Proposed Annual Notification Level (GBq)
Tritium H-3	6.8E+01	1.0E+01
Alpha-emitting radionuclides associated with particulate matter	3.0E-01	1.5E-01
Beta-emitting radionuclides associated with particulate matter	6.1E+00	6.0E+00

7. References

[1]Sellafield Ltd (2016) *Monitoring Our Environment*. Discharges and Environmental Monitoring Annual Report 2016. Sellafield Ltd.

[2]Sellafield Ltd (2018) Assessment of radiological doses to marine and terrestrial representative persons (critical groups) at site limits as proposed for the Sellafield Major Permit Review. Sellafield Ltd.

[3]Oatway, W B, Jones, A L, Holmes, S, Watson, S and Cabianca, T (2016). *Ionising radiation exposure of the UK population: 2010 review.* Public Health England Report PHE-CRCE-026, Crown Copyright.

[4]Sellafield Ltd (2018) *Annual Discharges Review, 2015 - 2017. Demonstration of the progressive reduction in discharges and hazard at Sellafield (NDA EPI Objective 5).* Sellafield Ltd.

[5]Sellafield Ltd (2018) *Major Permit Review Application – Framework of Arrangements for the Demonstration of BAT*. Sellafield Ltd.

[6]Department for Business, Energy & Industrial Strategy (2018) *UK Strategy For Radioactive Discharges 2018 Review of the 2009 Strategy*. London: Department for Business, Energy & Industrial Strategy.

[7]EA (2012) *Criteria for setting limits on the discharge of radioactive waste from nuclear sites*. Version 1.0.

[8]Sellafield Ltd (2018) *DS-005-0179 - Sellafield Effluent Strategy Modelling Discharge Projections in support of the Sellafield Ltd Radioactive Substances Activity Environmental Permit Application Site Limit Proposals*. Sellafield Ltd.

[9]Letter EA-07-8313-60 RSR Permit CLESA Variation Application, March 2017

[10]Post Closure Radiological Safety Assessment, 60493376/MARP003, December 2017

[11]Sellafield Ltd (2018). *Waste/Tech/838.* BAT Justification of a Specific Tritium Limit for CLESA disposals. Sellafield Ltd.

[12]Sellafield Ltd (2018) *Proposal for the Removal of Discharge Limits from the First Generation Magnox Storage Pond Stack.* Sellafield Ltd.

[13]Sellafield Ltd (2018) *Proposal for the removal of discharge limits from the SIXEP stack.* Sellafield Ltd.

[14]Sellafield Ltd (2018) *SAV RSA Major Permit Review.* Sellafield Ltd.

[15]Sellafield Ltd (2013) *SLF 2.11.109.01 Public Dose Factor Tables*. Issue 2. Sellafield Ltd.

[16] Wise Uranium project (2016) *Uranium Radiation Properties.* [ONLINE] Available at: http://www.wise-uranium.org/rup.html.

[17]Department of Energy & Climate Change(2005) *SEA6 Section 5 - Physical and chemical environment.* [ONLINE] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/194659/SEA_6_Section_5_web.pdf (Pg. 3)

[18]Hunt, G. J. (2004) *Radiological assessment of ocean radioactivity*. In Marine Radioactivity, ed. H. Livingston, Radioactivity in the Environment, Vol 6. pp205 – 236.

8. Glossary

ALARA	**As Low As Reasonably Achievable**
ALARP	**As Low As Reasonably Practicable**
AS	**Analytical Services**
BAT	**Best Available Techniques**
BEIS	**Department for Business, Energy and Industrial Strategy**
CEAR	**Compilation of Environment Agency Requirements, Approvals and Specifications**
CIS	**Calder Interceptor Sewer**
CLESA	**Calder Landfill Extension Segregated Area**
DOG	**Dissolver Off Gas**
EA	**Environment Agency**
EARP	**Enhanced Actinide Removal Plant**
EPMF	**Effluent Plant Maintenance Facility**
FGMSP	**First Generation Magnox Storage Pond**
FHP	**Fuel Handling Plant**
HAL	**Highly Active Liquor**
HALES	**Highly Active Liquor Evaporation and Storage**
HEPA	**High Efficiency Particulate Air Filter**
ICRP	**International Commission on Radiological Protection**
LOD	**Limit of Detection**
MSSS	**Magnox Swarf Storage Silo**
NDA	**Nuclear Decommissioning Authority**
NNL	**National Nuclear Laboratory**
PCRSA	**Post Closure Radiological Safety Assessment**
PF&S	**Product Finishing and Storage**
PHE	**Public Health England**

POCO	**Post Operational Clean Out**
RSA	**Radioactive Substances Activity**
SAV	**Separation Area Ventilation**
SEMS	**Sellafield Effluent Management Strategy**
SETP	**Segregated Effluent Treatment Plant**
SIXEP	**Site Ion Exchange Plant**
SL	**Sellafield Ltd**
STP	**Solvent Treatment Plant**
THORP	**Thermal Oxide Reprocessing Plant**
UKSRD	**UK Strategy for Radioactive Discharges**
WAGR	**Windscale Advanced Gas Cooled Reactor**
WEP	**Waste Encapsulation Plant**
WVP	**Waste Vitrification Plant**

9.0 Appendices

9.1 Appendix 1 – Assessment of historic site aerial discharges

The critical group dose equivalent to an aerial radionuclide discharge depends on the effective stack height of the discharging stack. Hence, the critical group dose from a site total discharge (for a single radionuclide) cannot be determined using only one dose factor. As a consequence, for the purpose of this data assessment the individual stack discharges contributing to the site total, were each converted to an equivalent critical group dose and then summed to provide a site total. Therefore, the assessment below shows the calculated critical group dose from Site total aerial discharges, compared with a calculated 'good practice' monthly decision threshold dose impact.

Month	Year	Critical Group Dose from Site Discharge (µSv)													
		Pu241	I131	Sr90	Ru106	PuAlpha[1]	Am241& Cm242	Cs137	H3	C14	Kr85	Sb125	I129	Alpha[1]	Beta[2]
1	2013	0.0002	0.0020	0.0002	0.0002	0.0021	0.0014	0.0014	0.0021	0.0468	0.0160	0.0022	0.1624	0.0042	0.0017
2	2013	0.0002	0.0014	0.0001	0.0002	0.0017	0.0012	0.0015	0.0008	0.0145	0.0021	0.0036	0.0606	0.0042	0.0010
3	2013	0.0007	0.0019	0.0002	0.0003	0.0037	0.0020	0.0011	0.0015	0.0152	0.0289	0.0012	0.1883	0.0078	0.0015
4	2013	0.0002	0.0042	0.0001	0.0002	0.0019	0.0013	0.0006	0.0031	0.0321	0.0308	0.0033	0.2783	0.0042	0.0008
5	2013	0.0002	0.0043	0.0001	0.0002	0.0023	0.0012	0.0008	0.0014	0.0163	0.0059	0.0010	0.1784	0.0048	0.0008
6	2013	0.0002	0.0041	0.0001	0.0002	0.0015	0.0011	0.0015	0.0021	0.0120	0.0012	0.0000	0.0793	0.0040	0.0015
7	2013	0.0003	0.0051	0.0001	0.0002	0.0022	0.0013	0.0010	0.0035	0.0127	0.0062	0.0057	0.0649	0.0046	0.0009
8	2013	0.0002	0.0047	0.0001	0.0002	0.0011	0.0011	0.0008	0.0040	0.0141	0.0420	0.0126	0.3350	0.0032	0.0008
9	2013	0.0002	0.0031	0.0001	0.0002	0.0012	0.0010	0.0006	0.0012	0.0269	0.0133	0.0113	0.1782	0.0036	0.0008
10	2013	0.0006	0.0046	0.0001	0.0002	0.0041	0.0018	0.0022	0.0011	0.0915	0.0171	0.0052	0.1546	0.0074	0.0015
11	2013	0.0002	0.0039	0.0001	0.0002	0.0013	0.0012	0.0010	0.0019	0.1408	0.0374	0.0019	0.2571	0.0037	0.0009
12	2013	0.0002	0.0018	0.0001	0.0002	0.0016	0.0015	0.0003	0.0014	0.0114	0.0214	0.0140	0.2183	0.0046	0.0009
1	2014	0.0008	0.0017	0.0001	0.0002	0.0027	0.0012	0.0004	0.0019	0.0230	0.0244	0.0106	0.2135	0.0056	0.0008
2	2014	0.0008	0.0016	0.0001	0.0002	0.0031	0.0017	0.0004	0.0008	0.0230	0.0099	0.0091	0.1444	0.0060	0.0006
3	2014	0.0003	0.0025	0.0001	0.0002	0.0016	0.0012	0.0020	0.0022	0.0172	0.0571	0.0025	0.4823	0.0053	0.0013
4	2014	0.0003	0.0019	0.0001	0.0002	0.0021	0.0015	0.0016	0.0008	0.0106	0.0091	0.0072	0.1701	0.0045	0.0014
5	2014	0.0004	0.0012	0.0001	0.0005	0.0016	0.0013	0.0013	0.0003	0.0085	0.0004	0.0021	0.0883	0.0039	0.0014
6	2014	0.0003	0.0008	0.0001	0.0002	0.0038	0.0020	0.0009	0.0004	0.0156	0.0003	0.0034	0.0849	0.0068	0.0008
7	2014	0.0002	0.0007	0.0001	0.0002	0.0020	0.0011	0.0003	0.0024	0.0038	0.0114	0.0012	0.1342	0.0042	0.0006
8	2014	0.0004	0.0016	0.0001	0.0002	0.0017	0.0013	0.0003	0.0014	0.0104	0.0322	0.0043	0.3548	0.0045	0.0006
9	2014	0.0006	0.0020	0.0001	0.0002	0.0022	0.0012	0.0004	0.0013	0.0110	0.0194	0.0070	0.2734	0.0044	0.0006
10	2014	0.0005	0.0029	0.0001	0.0002	0.0024	0.0014	0.0012	0.0011	0.0146	0.0143	0.0025	0.1692	0.0054	0.0010
11	2014	0.0004	0.0061	0.0003	0.0002	0.0026	0.0012	0.0008	0.0022	0.0213	0.0547	0.0025	0.4939	0.0048	0.0012
12	2014	0.0004	0.0058	0.0001	0.0002	0.0019	0.0014	0.0004	0.0024	0.0182	0.0433	0.0068	0.4389	0.0049	0.0008
1	2015	0.0004	0.0069	0.0001	0.0002	0.0023	0.0013	0.0015	0.0018	0.0254	0.0329	0.0036	0.3024	0.0042	0.0012
2	2015	0.0004	0.0030	0.0001	0.0002	0.0025	0.0012	0.0008	0.0014	0.0170	0.0340	0.0074	0.2915	0.0056	0.0010
3	2015	0.0010	0.0023	0.0001	0.0002	0.0059	0.0029	0.0004	0.0018	0.0131	0.0163	0.0164	0.2867	0.0106	0.0009
4	2015	0.0006	0.0021	0.0001	0.0002	0.0026	0.0014	0.0005	0.0016	0.0107	0.0345	0.0287	0.2775	0.0050	0.0010
5	2015	0.0003	0.0037	0.0001	0.0002	0.0018	0.0013	0.0003	0.0011	0.0186	0.0155	0.0048	0.1890	0.0038	0.0005
6	2015	0.0002	0.0038	0.0001	0.0002	0.0012	0.0010	0.0002	0.0012	0.0277	0.0238	0.0064	0.2262	0.0035	0.0005
7	2015	0.0007	0.0035	0.0001	0.0002	0.0034	0.0018	0.0003	0.0005	0.0159	0.0003	0.0016	0.1171	0.0066	0.0006
8	2015	0.0002	0.0040	0.0001	0.0003	0.0012	0.0011	0.0003	0.0013	0.0274	0.0112	0.0000	0.1323	0.0033	0.0005
9	2015	0.0002	0.0041	0.0001	0.0002	0.0012	0.0011	0.0003	0.0040	0.0211	0.0469	0.0000	0.3099	0.0036	0.0005
10	2015	0.0003	0.0032	0.0001	0.0002	0.0018	0.0011	0.0005	0.0022	0.0209	0.0503	0.0005	0.4311	0.0044	0.0007
11	2015	0.0013	0.0033	0.0001	0.0002	0.0092	0.0049	0.0003	0.0012	0.0137	0.0187	0.0033	0.1738	0.0146	0.0007
12	2015	0.0029	0.0077	0.0001	0.0002	0.0098	0.0016	0.0002	0.0017	0.0237	0.0570	0.0102	0.3825	0.0117	0.0007
1	2016	0.0004	0.0025	0.0001	0.0002	0.0027	0.0015	0.0014	0.0018	0.0095	0.0531	0.0028	0.3210	0.0051	0.0015
2	2016	0.0005	0.0021	0.0001	0.0003	0.0043	0.0021	0.0008	0.0016	0.0074	0.0473	0.0013	0.3184	0.0076	0.0012
3	2016	0.0003	0.0031	0.0001	0.0002	0.0023	0.0017	0.0004	0.0019	0.0106	0.0556	0.0020	0.3846	0.0045	0.0008
4	2016	0.0004	0.0016	0.0001	0.0002	0.0021	0.0011	0.0006	0.0015	0.0078	0.0129	0.0007	0.1368	0.0037	0.0008
5	2016	0.0002	0.0021	0.0001	0.0002	0.0012	0.0013	0.0006	0.0230	0.0093	0.0370	0.0092	0.2950	0.0043	0.0011
6	2016	0.0003	0.0023	0.0001	0.0002	0.0015	0.0016	0.0002	0.0366	0.0123	0.0782	0.0140	0.3891	0.0038	0.0008
7	2016	0.0003	0.0030	0.0001	0.0002	0.0021	0.0014	0.0003	0.0335	0.0148	0.0691	0.0069	0.4312	0.0046	0.0007
8	2016	0.0003	0.0042	0.0001	0.0002	0.0023	0.0018	0.0002	0.0340	0.0232	0.0751	0.0082	0.4857	0.0068	0.0007
9	2016	0.0004	0.0042	0.0001	0.0002	0.0022	0.0017	0.0002	0.0343	0.0309	0.0269	0.0154	0.3578	0.0052	0.0008
10	2016	0.0003	0.0035	0.0001	0.0002	0.0016	0.0013	0.0003	0.0184	0.0243	0.0005	0.0013	0.1928	0.0051	0.0006
11	2016	0.0004	0.0022	0.0001	0.0002	0.0022	0.0015	0.0002	0.0082	0.0126	0.0029	0.0009	0.1234	0.0050	0.0006
12	2016	0.0002	0.0028	0.0001	0.0002	0.0014	0.0014	0.0007	0.0166	0.0189	0.0487	0.0047	0.4993	0.0040	0.0009
1	2017	0.0007	0.0060	0.0001	0.0002	0.0029	0.0018	0.0001	0.0226	0.0243	0.0344	0.0027	0.2153	0.0062	0.0007
2	2017	0.0010	0.0073	0.0001	0.0002	0.0036	0.0016	0.0002	0.0217	0.0296	0.0408	0.0018	0.2916	0.0058	0.0005
3	2017	0.0005	0.0055	0.0001	0.0002	0.0023	0.0014	0.0001	0.0213	0.0255	0.0027	0.0004	0.1532	0.0046	0.0005
4	2017	0.0009	0.0046	0.0001	0.0002	0.0039	0.0015	0.0001	0.0184	0.0187	0.0349	0.0003	0.2140	0.0064	0.0004
5	2017	0.0011	0.0025	0.0001	0.0002	0.0044	0.0015	0.0001	0.0153	0.0106	0.0082	0.0008	0.1944	0.0065	0.0005
6	2017	0.0005	0.0017	0.0001	0.0002	0.0024	0.0012	0.0001	0.0059	0.0283	0.0277	0.0001	0.1988	0.0041	0.0004
7	2017	0.0005	0.0009	0.0001	0.0002	0.0032	0.0019	0.0001	0.0186	0.0079	0.0140	0.0008	0.1559	0.0059	0.0005
8	2017	0.0004	0.0055	0.0001	0.0002	0.0026	0.0014	0.0001	0.0163	0.0110	0.0493	0.0012	0.2381	0.0046	0.0005
9	2017	0.0012	0.0038	0.0001	0.0002	0.0058	0.0021	0.0002	0.0153	0.0122	0.0069	0.0004	0.1752	0.0096	0.0005
10	2017	0.0017	0.0048	0.0001	0.0002	0.0153	0.0041	0.0002	0.0011	0.0188	0.0023	0.0000	0.0910	0.0213	0.0005
11	2017	0.0008	0.0032	0.0001	0.0002	0.0070	0.0026	0.0002	0.0054	0.0247	0.0107	0.0003	0.0872	0.0102	0.0007
12	2017	0.0009	0.0037	0.0002	0.0002	0.0070	0.0025	0.0002	0.0306	0.0153	0.0253	0.0025	0.1533	0.0120	0.0009

Radionuclide	Pu241	I131	Sr90	Ru106	PuAlpha[1]	Am241& Cm242	Cs137	H3	C14	Kr85	Sb125	I129	Alpha[1]	Beta[2]
Annual Detection Limit (uSv)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Good practice annual decision threshold (uSv)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Good practice monthly decision threshold (uSv)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
% monthly site aerial discharges < good practice monthly decision threshold (calendar year 2017)	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	91.67%	100.00%	0.00%	100.00%	100.00%
% monthly site aerial discharges < good practice monthly decision threshold (Jan 2013 - Dec 2017)	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	95.00%	75.00%	100.00%	0.00%	100.00%	100.00%

Notes: 1 – Assuming a worst case dose factor for Pu239.
2 – Assuming a worst case dose factor for Cs137.
3 – The Dose Factors used for this assessment were taken from SLF2.11.109.01 Public Dose Factor Tables[15].

9.2 Appendix 2 – Assessment of historic site liquid discharges

The critical group dose equivalent to a liquid radionuclide discharge is calculated using one dose factor for each radionuclide regardless of discharge point. Therefore, the contributing discharges from liquid discharge outlets did not require conversion to an associated critical group dose (as for aerial). A site total liquid discharge corresponding to a critical group dose of 1µSv/year per radionuclide was calculated and is shown as the annual detection limit in the table below. The assessment below shows the site total liquid discharge compared with a calculated 'good practice' monthly decision threshold.

		Site Discharge (Bq)																			
Month	Year	Alpha[2]	Beta[3]	H3	C14	Co60	Sr90	Zr95/Nb95	Tc99	Ru106	Sb125[4]	I129	Cs134	Cs137	Ce144	Np237	Pu alpha[2]	Pu241	Am241	Cm243+244	U[1]
1	2013	1.06E+10	8.72E+11	5.46E+13	6.34E+11	4.42E+09	9.06E+10	9.76E+09	1.21E+11	5.34E+10		2.94E+10	3.84E+09	2.24E+11	2.40E+10	9.80E+08	1.06E+10	2.27E+11	1.08E+09	8.00E+07	5.93E+08
2	2013	1.36E+10	8.65E+11	9.86E+13	8.27E+11	4.04E+09	5.62E+10	9.81E+09	1.81E+11	5.35E+10		1.39E+10	5.91E+09	2.55E+11	1.50E+10	2.30E+09	1.40E+10	3.03E+11	1.37E+09	9.00E+07	6.00E+08
3	2013	1.51E+10	5.53E+11	1.30E+14	4.60E+11	3.97E+09	5.41E+10	6.50E+09	9.49E+10	5.06E+10		1.98E+10	6.94E+09	2.72E+11	1.28E+10	2.00E+09	1.57E+10	3.35E+11	1.71E+09	8.00E+07	5.75E+08
4	2013	1.49E+10	5.54E+11	1.31E+14	4.58E+11	3.93E+09	5.81E+10	6.00E+09	9.30E+10	3.34E+10		2.21E+10	3.43E+09	2.72E+11	1.07E+10	8.00E+08	1.55E+10	3.35E+11	3.84E+09	4.00E+07	7.53E+08
5	2013	1.26E+10	8.09E+11	1.38E+14	4.71E+11	4.67E+09	1.05E+11	1.16E+10	1.57E+11	5.88E+10		3.14E+10	8.26E+09	2.44E+11	2.29E+10	1.93E+09	1.17E+10	2.55E+11	1.29E+09	2.00E+08	8.38E+08
6	2013	8.29E+09	4.66E+11	8.18E+12	8.91E+10	3.59E+09	5.51E+10	7.38E+09	6.40E+09	2.97E+10		9.60E+08	4.14E+09	1.75E+11	1.49E+10	1.85E+09	8.55E+09	1.79E+11	8.40E+08	8.00E+07	3.35E+08
7	2013	1.09E+10	4.24E+11	1.01E+13	1.01E+11	4.04E+09	4.39E+10	6.79E+09	6.27E+09	3.48E+10		3.07E+09	3.79E+09	1.91E+11	1.20E+10	2.40E+09	1.10E+10	2.21E+11	1.73E+09	1.00E+08	5.15E+08
8	2013	1.79E+10	1.08E+12	2.30E+14	5.88E+11	5.13E+09	1.19E+11	6.96E+09	1.55E+11	7.94E+10		3.71E+10	8.72E+09	3.11E+11	1.45E+10	6.01E+09	1.64E+10	3.46E+11	1.50E+09	2.00E+08	9.53E+08
9	2013	1.17E+10	9.02E+11	1.94E+14	5.13E+11	5.87E+09	9.49E+10	8.68E+09	4.07E+10	5.90E+10		4.03E+10	1.40E+10	4.45E+11	2.55E+10	7.01E+09	1.10E+10	2.21E+11	1.55E+09	2.30E+08	9.40E+08
10	2013	1.39E+10	9.58E+11	9.31E+13	4.98E+11	4.29E+09	1.28E+11	6.40E+09	1.17E+11	5.60E+10		2.44E+10	1.31E+10	3.76E+11	1.42E+10	2.31E+09	1.22E+10	2.65E+11	1.46E+09	1.90E+08	8.60E+08
11	2013	1.29E+10	8.37E+11	1.57E+14	4.10E+11	3.33E+09	1.78E+11	5.63E+09	4.72E+10	3.15E+10		3.50E+10	6.47E+09	2.40E+11	8.19E+09	2.28E+09	1.21E+10	2.33E+11	1.40E+09	2.00E+08	7.40E+08
12	2013	1.50E+10	6.64E+11	1.28E+14	4.76E+11	3.46E+09	7.99E+10	8.73E+09	8.32E+10	4.31E+10		3.59E+10	5.07E+09	2.37E+11	1.74E+10	4.65E+09	1.40E+10	2.77E+11	1.68E+09	2.80E+08	9.65E+08
1	2014	2.01E+10	1.15E+12	1.49E+14	8.28E+11	2.93E+09	2.20E+11	6.51E+09	1.33E+11	7.00E+10		3.56E+10	7.84E+09	2.46E+11	1.35E+10	4.21E+09	1.75E+10	3.74E+11	1.44E+09	2.70E+08	1.07E+09
2	2014	1.19E+10	7.15E+11	1.05E+14	4.95E+11	2.14E+09	1.37E+11	6.03E+09	8.21E+10	7.43E+10		1.29E+10	5.26E+09	2.27E+11	1.14E+10	2.13E+09	1.11E+10	2.10E+11	1.60E+09	7.00E+07	7.65E+08
3	2014	1.41E+10	6.85E+11	1.48E+14	2.01E+11	3.05E+09	1.05E+11	6.75E+09	1.62E+10	3.53E+10		4.79E+10	4.32E+09	2.06E+11	1.04E+10	9.50E+08	1.16E+10	2.22E+11	1.29E+09	1.10E+08	4.43E+08
4	2014	1.17E+10	1.12E+12	9.02E+13	3.22E+11	3.67E+09	1.80E+11	8.87E+09	8.88E+10	6.50E+10		2.91E+10	5.71E+09	3.71E+11	1.71E+10	4.93E+09	9.78E+09	1.93E+11	1.35E+09	1.50E+08	6.63E+08
5	2014	1.59E+10	5.79E+11	9.60E+13	3.20E+11	4.80E+09	5.26E+10	5.15E+09	1.12E+11	3.17E+10		2.18E+10	2.70E+09	2.22E+11	1.18E+10	1.88E+09	1.44E+10	3.00E+11	1.49E+09	3.20E+08	9.75E+08
6	2014	1.07E+10	3.43E+11	4.00E+12	2.47E+10	4.19E+09	7.38E+10	4.23E+09	5.04E+09	1.73E+10		1.60E+09	2.22E+09	1.42E+11	7.74E+09	5.20E+08	9.53E+09	1.87E+11	9.80E+08	4.00E+07	1.96E+08
7	2014	1.26E+10	5.79E+11	1.47E+13	1.42E+11	4.00E+09	1.26E+11	5.94E+09	3.35E+10	3.23E+10		1.03E+10	1.95E+09	2.16E+11	9.55E+09	1.69E+09	1.26E+10	2.53E+11	1.36E+09	2.00E+08	6.43E+08
8	2014	1.75E+10	6.17E+11	1.44E+14	5.84E+11	6.02E+09	7.16E+10	1.06E+10	2.24E+11	3.96E+10		2.68E+10	3.14E+09	2.04E+11	1.35E+10	6.49E+09	1.53E+10	2.97E+11	1.52E+09	5.00E+07	1.10E+09
9	2014	1.32E+10	1.07E+12	1.30E+14	4.65E+11	4.50E+09	2.05E+11	1.02E+10	1.96E+11	2.84E+11		3.12E+10	5.02E+09	1.85E+11	1.75E+10	2.66E+09	1.17E+10	2.27E+11	1.43E+09	5.00E+07	6.43E+08
10	2014	1.54E+10	1.16E+12	1.11E+14	3.29E+11	4.19E+09	1.92E+11	8.40E+09	4.70E+10	2.20E+11		2.59E+10	3.39E+09	1.83E+11	1.48E+10	2.11E+09	1.23E+10	2.22E+11	3.46E+09	2.60E+08	6.90E+08
11	2014	1.54E+10	8.82E+11	1.56E+14	4.49E+11	3.56E+09	1.25E+11	5.22E+09	1.63E+11	9.43E+10		5.11E+10	7.29E+09	2.56E+11	1.43E+10	5.46E+09	1.26E+10	2.26E+11	2.31E+09	9.00E+07	9.70E+08
12	2014	1.64E+10	8.37E+11	2.01E+14	5.41E+11	3.90E+09	1.44E+11	8.84E+09	1.73E+11	1.01E+11		6.20E+10	6.53E+09	1.89E+11	1.36E+10	2.08E+09	1.30E+10	2.20E+11	3.30E+09	1.70E+08	8.58E+08
1	2015	2.13E+10	9.74E+11	1.39E+14	6.96E+11	3.15E+09	1.80E+11	6.95E+09	2.18E+11	1.77E+11		4.07E+10	7.50E+09	2.79E+11	1.40E+10	2.61E+09	1.33E+10	2.38E+11	5.40E+09	1.40E+08	1.09E+09
2	2015	2.36E+10	1.14E+12	1.66E+14	6.51E+11	2.86E+09	2.41E+11	1.37E+10	2.11E+11	1.35E+11		3.18E+10	7.56E+09	2.95E+11	1.29E+10	4.70E+09	1.73E+10	3.06E+11	5.24E+09	9.00E+07	1.03E+09
3	2015	1.51E+10	7.42E+11	1.88E+14	5.69E+11	4.38E+09	1.45E+11	9.57E+09	2.02E+11	5.01E+10	4.76E+10	4.22E+10	4.45E+09	1.67E+11	1.61E+10	2.70E+09	1.16E+10	2.14E+11	2.46E+09	6.00E+07	8.30E+08
4	2015	1.44E+10	5.80E+11	1.26E+14	6.94E+11	6.22E+09	8.00E+10	6.84E+09	2.89E+11	5.43E+10	4.40E+10	3.21E+10	4.30E+09	1.73E+11	1.20E+10	4.31E+09	1.25E+10	2.32E+11	1.97E+09	9.00E+07	6.08E+08
5	2015	1.25E+10	8.69E+11	1.47E+14	5.15E+11	4.62E+09	2.17E+11	7.22E+09	1.40E+11	4.42E+10	3.16E+10	1.58E+10	6.96E+09	3.34E+11	1.52E+10	3.04E+09	1.06E+10	1.86E+11	1.72E+09	9.00E+07	6.03E+08
6	2015	1.12E+10	8.67E+11	2.45E+14	4.54E+11	5.29E+09	1.04E+11	1.14E+10	1.21E+11	5.08E+10	2.84E+10	3.86E+10	1.14E+10	3.55E+11	2.88E+10	3.12E+09	9.98E+09	1.81E+11	1.58E+09	1.40E+08	6.78E+08
7	2015	1.50E+10	6.40E+11	3.73E+13	2.32E+11	3.83E+09	8.64E+10	8.26E+09	7.40E+10	3.99E+10	9.24E+10	8.80E+09	4.92E+09	2.04E+11	1.32E+10	1.87E+09	1.00E+10	1.73E+11	1.47E+09	2.10E+08	9.10E+08
8	2015	1.06E+10	6.35E+11	2.47E+12	8.48E+10	6.63E+09	9.96E+10	7.84E+09	2.62E+10	4.16E+10	1.24E+11	6.84E+09	3.62E+09	2.57E+11	2.41E+10	1.07E+09	8.14E+09	1.28E+11	1.34E+09	3.00E+07	1.74E+08
9	2015	1.26E+10	4.31E+11	2.47E+13	7.87E+10	4.34E+09	3.89E+10	4.94E+09	2.48E+10	2.10E+10	1.22E+11	2.19E+10	2.12E+09	1.69E+11	1.06E+10	1.46E+09	9.08E+09	1.42E+11	8.60E+08	1.00E+08	1.24E+08
10	2015	1.70E+10	8.55E+11	1.63E+14	8.01E+10	2.87E+09	1.75E+11	7.11E+09	5.14E+10	2.58E+10	2.12E+11	5.72E+10	3.71E+09	2.71E+11	1.60E+10	4.56E+09	1.24E+10	1.65E+11	2.60E+09	1.10E+08	2.95E+08
11	2015	1.40E+10	7.30E+11	8.25E+13	2.78E+11	3.06E+09	8.73E+10	5.48E+09	9.64E+10	2.54E+10	1.56E+11	2.12E+10	3.35E+09	2.98E+11	1.41E+10	2.57E+09	1.02E+10	1.61E+11	1.95E+09	9.00E+07	6.63E+08
12	2015	1.98E+10	1.06E+12	2.19E+14	5.86E+11	4.02E+09	1.36E+11	7.09E+09	2.03E+11	3.80E+10	2.06E+11	4.77E+10	6.78E+09	2.80E+11	1.75E+10	4.48E+09	1.39E+10	2.29E+11	2.14E+09	5.00E+07	1.21E+09
1	2016	3.37E+10	1.51E+12	2.94E+14	6.46E+11	4.05E+09	3.20E+11	7.86E+09	2.13E+11	3.09E+10	1.07E+11	5.64E+10	5.48E+09	3.08E+11	1.41E+10	3.24E+09	1.28E+10	2.32E+11	2.20E+09	3.70E+08	1.04E+09
2	2016	2.38E+10	9.47E+11	1.36E+14	2.77E+11	3.12E+09	6.71E+10	7.01E+09	3.94E+10	3.33E+10	5.34E+10	4.33E+10	2.31E+09	4.31E+11	1.03E+10	2.28E+09	1.07E+10	1.71E+11	1.66E+09	4.00E+07	6.78E+08
3	2016	1.71E+10	1.08E+12	2.39E+14	4.49E+11	4.19E+09	1.54E+11	9.03E+09	1.01E+11	4.64E+10	5.58E+10	5.38E+10	3.33E+09	3.71E+11	1.87E+10	2.84E+09	1.25E+10	2.18E+11	1.44E+09	2.00E+08	8.53E+08
4	2016	1.68E+10	1.51E+12	9.10E+13	1.39E+11	2.74E+09	4.45E+11	1.04E+10	3.61E+10	3.18E+10	6.16E+10	2.10E+10	2.79E+09	3.51E+11	2.32E+10	2.67E+09	1.29E+10	2.07E+11	1.31E+09	9.00E+07	7.60E+08
5	2016	1.84E+10	1.11E+12	1.25E+14	5.93E+11	3.05E+09	9.85E+10	6.08E+09	2.80E+11	7.64E+10	2.81E+11	3.09E+10	7.70E+09	3.70E+11	1.32E+10	3.74E+09	1.75E+10	2.78E+11	1.37E+09	1.40E+08	8.10E+08
6	2016	2.95E+10	8.45E+11	2.82E+14	5.31E+11	3.01E+09	7.42E+10	7.11E+09	3.37E+11	6.69E+10	1.81E+11	5.73E+10	7.09E+09	2.26E+11	1.40E+10	3.10E+09	2.18E+10	4.21E+11	1.66E+09	2.20E+08	7.68E+08
7	2016	1.79E+10	1.13E+12	2.23E+14	5.22E+11	3.22E+09	1.46E+11	1.13E+10	2.40E+11	8.34E+10	1.89E+11	6.50E+10	9.91E+09	2.85E+11	2.41E+10	2.07E+09	1.53E+10	2.55E+11	2.21E+09	1.50E+08	8.10E+08
8	2016	1.96E+10	9.58E+11	1.92E+14	4.05E+11	2.55E+09	8.94E+10	7.37E+09	1.90E+11	1.09E+11	7.37E+10	6.75E+10	7.41E+09	3.47E+11	1.40E+10	2.63E+09	1.82E+10	3.07E+11	2.48E+09	2.30E+08	7.45E+08
9	2016	1.92E+10	1.23E+12	2.57E+14	7.21E+11	2.56E+09	1.54E+11	8.86E+09	2.96E+11	3.08E+11	6.79E+10	3.79E+10	7.82E+09	2.56E+11	1.22E+10	3.09E+09	1.48E+10	2.38E+11	1.68E+09	1.10E+08	8.58E+08
10	2016	1.49E+10	1.46E+12	1.22E+14	1.84E+11	3.01E+09	3.14E+11	9.17E+09	3.45E+10	2.15E+11	3.55E+10	2.54E+10	4.92E+09	3.81E+11	2.62E+10	1.99E+09	1.13E+10	1.91E+11	1.43E+09	8.00E+08	4.68E+08
11	2016	2.70E+10	5.21E+11	1.86E+12	6.72E+10	1.37E+09	4.39E+10	4.66E+09	2.86E+10	4.63E+10	2.44E+10	3.33E+09	1.82E+09	1.77E+11	3.06E+10	1.10E+09	1.92E+10	3.02E+11	6.83E+09	4.50E+08	1.83E+08
12	2016	1.46E+10	7.65E+11	8.51E+13	2.99E+11	2.42E+09	1.00E+11	5.49E+09	1.09E+11	3.94E+10	4.74E+10	6.05E+10	5.00E+09	2.13E+11	1.21E+10	2.63E+09	1.18E+10	1.75E+11	1.51E+09	1.50E+08	5.95E+08
1	2017	1.74E+10	1.40E+12	2.87E+14	5.17E+11	2.81E+09	3.29E+11	7.38E+09	1.76E+11	9.74E+10	5.06E+10	2.46E+10	5.07E+09	2.39E+11	1.33E+10	3.28E+09	1.35E+10	2.02E+11	1.61E+09	3.03E+08	2.57E+10
2	2017	2.06E+10	1.27E+12	1.84E+14	3.40E+11	2.26E+09	8.48E+10	5.89E+09	1.73E+11	3.96E+11	4.37E+10	5.28E+10	4.67E+09	1.95E+11	1.20E+10	4.10E+09	1.39E+10	2.11E+11	3.97E+09	3.01E+08	7.25E+10
3	2017	1.74E+10	1.15E+12	5.68E+13	2.83E+11	2.10E+09	2.65E+11	1.01E+10	1.09E+11	2.25E+11	2.73E+10	1.40E+10	2.99E+09	1.37E+11	1.26E+10	2.73E+09	1.38E+10	1.63E+11	2.36E+09	1.58E+08	3.49E+10
4	2017	1.70E+10	1.10E+12	7.95E+13	3.65E+11	2.29E+09	2.20E+11	7.50E+09	8.98E+10	8.11E+10	7.83E+10	2.12E+10	4.54E+09	2.49E+11	1.16E+10	2.28E+09	1.40E+10	1.70E+11	1.62E+09	8.47E+07	3.72E+10
5	2017	1.76E+10	8.24E+11	1.28E+14	3.34E+11	2.69E+09	1.16E+11	5.68E+09	1.78E+11	4.64E+10	1.28E+11	1.65E+10	4.41E+09	2.42E+11	1.85E+10	2.47E+09	1.38E+10	2.00E+11	1.07E+09	1.37E+08	2.70E+10
6	2017	1.54E+10	7.65E+11	1.14E+14	1.98E+11	3.09E+09	1.27E+11	1.00E+10	1.25E+11	5.11E+10	1.73E+11	2.71E+10	4.42E+09	2.17E+11	1.96E+10	2.61E+09	1.34E+10	2.01E+11	1.21E+09	1.83E+08	1.50E+10
7	2017	1.39E+10	1.39E+12	1.71E+14	3.60E+11	1.36E+09	4.33E+11	2.39E+09	1.38E+11	2.48E+10	7.18E+10	1.90E+10	3.22E+09	2.53E+11	5.94E+09	3.03E+09	1.09E+10	1.63E+11	1.85E+09	1.06E+08	2.31E+10
8	2017	1.56E+10	8.75E+11	6.34E+13	3.35E+11	7.49E+08	1.25E+11	2.89E+09	1.27E+11	2.75E+10	4.59E+10	2.73E+10	1.95E+09	4.40E+11	5.25E+09	5.17E+09	1.28E+10	1.74E+11	1.07E+09	2.00E+08	2.06E+10
9	2017	1.12E+10	5.56E+11	9.12E+13	2.45E+11	5.64E+08	5.28E+10	2.44E+09	1.38E+11	2.17E+10	8.61E+10	2.21E+10	2.23E+09	1.64E+11	5.70E+09	2.94E+09	1.11E+10	1.63E+11	1.61E+09	1.74E+08	2.90E+10
10	2017	1.03E+10	8.11E+11	1.08E+12	1.77E+10	6.57E+08	1.07E+11	2.32E+09	3.51E+10	1.46E+10	6.92E+10	1.62E+09	8.70E+08	4.60E+11	5.13E+09	1.23E+09	8.85E+09	1.26E+11	9.72E+08	7.94E+07	8.60E+09
11	2017	1.22E+10	8.70E+11	7.10E+12	1.86E+11	1.43E+09	9.30E+10	2.94E+09	1.16E+11	1.72E+10	1.02E+11	1.66E+10	3.59E+09	4.76E+11	9.09E+09	2.54E+09	1.10E+10	1.44E+11	1.03E+09	3.52E+07	1.70E+10
12	2017	1.56E+10	1.11E+12	1.15E+14	4.15E+11	1.15E+09	1.68E+11	4.04E+09	1.67E+11	3.14E+10	1.54E+11	1.64E+10	4.41E+09	2.34E+11	5.67E+09	3.94E+09	1.29E+10	1.69E+11	1.84E+09	1.62E+08	3.73E+10

Radionuclide	Alpha[2]	Beta[3]	H3	C14	Co60	Sr90	Zr95/Nb95	Tc99	Ru106	Sb125[4]	I129	Cs134	Cs137	Ce144	Np237	Pu alpha[2]	Pu241	Am241	Cm243+244	U[1]
Dose Factor(µSv/Bq)	4.41E-11	4.76E-13	1.43E-17	8.81E-13	4.32E-12	2.85E-13	9.30E-13	4.29E-13	1.56E-12	3.79E-14	9.10E-13	6.03E-13	4.76E-13	5.84E-13	5.51E-12	4.41E-11	9.13E-13	4.31E-11	1.53E-11	5.00E-13
Annual Detection limit (Bq)	2.27E+10	2.10E+12	6.99E+16	1.14E+12	2.31E+11	3.51E+12	1.08E+12	2.33E+12	6.41E+11	2.64E+13	1.10E+12	1.66E+12	2.10E+12	1.71E+12	1.81E+11	2.27E+10	1.10E+12	2.32E+10	6.54E+10	2.00E+12
Good Practice Annual Decision Threshold (Bq)	1.13E+10	1.05E+12	3.50E+16	5.68E+11	1.16E+11	1.75E+12	5.38E+11	1.17E+12	3.21E+11	1.32E+13	5.49E+11	8.29E+11	1.05E+12	8.56E+11	9.07E+10	1.13E+10	5.48E+11	1.16E+10	3.27E+10	1.00E+12
Good Practice Monthly Decision Threshold (Bq)	**9.45E+08**	**8.75E+10**	**2.91E+15**	**4.73E+10**	**9.65E+09**	**1.46E+11**	**4.48E+10**	**9.71E+10**	**2.67E+10**	**1.10E+12**	**4.58E+10**	**6.91E+10**	**8.75E+10**	**7.13E+10**	**7.56E+09**	**9.45E+08**	**4.56E+10**	**9.67E+08**	**2.72E+09**	**8.33E+10**
% monthly site marine discharges < good practice monthly decision threshold (calendar year 2017)	0%	0%	100%	8%	100%	58%	100%	17%	33%	100%	92%	100%	0%	100%	100%	0%	0%	0%	100%	100%
% monthly site marine discharges < good practice monthly decision threshold (Jan 2013 - Dec 2017)	0.00%	0.00%	100.00%	3.33%	100.00%	68.33%	100.00%	40.00%	13.33%	N/A	80.00%	100.00%	0.00%	100.00%	100.00%	0.00%	0.00%	3.33%	100.00%	100.00%

Notes: 1 - The Site Limit for Uranium is presented in Kg and hence discharges are reported in Kg. For the purpose of data assessments Uranium discharges were converted to a corresponding discharge in Bq, using the activity of 1 gram of natural Uranium taking into account contributions from U234, U235 and U238 isotopes[16].

2 - Assuming a worst case dose factor for Pu239.

3 - Assuming a worst case dose factor for Cs137.

4 - Sb125 liquid discharges were not measured until March 2015.

5 - The Dose Factors used for this assessment were taken from SLF2.11.109.01 Public Dose Factor Tables[15].

9.3 Appendix 3 – Tonnes of natural uranium-238 in the Irish Sea (receiving water of Sellafield Ltd liquid effluent discharges)

Volume of seawater in the Irish Sea[17] = 2430 km^3 (equivalent to 2.43E+12 m^3)

Typical concentration of Uranium-238 in seawater[18] is 0.040 Bq L^{-1}

Mass of Uranium-238 in 1 m^3 is 0.0032 grams
(Based on $A=N\lambda$), where A = activity in Bq,
N = number of atoms
λ = decay constant which is $\ln 2/t_{1/2}$;
$t_{1/2}$ Uranium-238 = 1.41E+17 seconds;
Avogadro's Number is 6.02E+23

Mass of Uranium-238 in the Irish Sea is:
0.0032 g x 2.43E12 m^3 = 7,800,000,000 grams
= 7,800 tonnes

There is approximately 8,000 tonnes of naturally occurring Uranium-238 present in the Irish Sea seawater. This calculation is provided for context, to enable comparison with the currently permitted annual discharge limit of 2 tonnes (note that the maximum discharge in recent years has been less than 20% of the current Site Limit).

9.4 Appendix 4 – Detail of the Proposed Amendments to the CEAR

Permit condition	Requirement number	Summary of Requirement	Proposal
Condition 3.2.5(a)	3.2.5(a)/v007	To list the samples type, frequency, volume and required sample analysis required by the EA, including CLESA Leachate monitoring.	SL has provided a proposal to EA to reduce the duplicate sampling regime by 50%, in line with proportionate regulation and BAT. The following supporting information underpins this proposal: • To date ~10,000 duplicate analyses have been completed by SL. Of these 87% have been in good agreement with the EA's results. The % agreement has risen steadily from low 80s to low 90s. • Discrepant results are dominated by a few analyses, in particular total beta, which is mainly caused by inherent differences in the determination method; we would not expect close agreement of these results with another lab using a different analytical approach. • The performance of SL's ISO17015 accredited lab is stable and is not expected to change. The programme does not lead to changes in analytical methods or reported discharges. EA would be notified of any changes to analytical methods. • There is a significant cost of the programme, ~50% of the analyses are carried out solely for this programme. There is also approximately 6 days of effort per quarter in witnessing the sampling and reporting, in addition to EA's and contractors costs. EA continue to review their policy, which currently states that SLs laboratory must have MCERTs accreditation in order to reduce the duplicate sampling regime, in line with this justification. Paragraph 4 of the requirement will be amended to remove the word 'leachate' so that the requirement applies to everything in the Environmental Monitoring Programme.
Condition 4.2.2	1	Waste Disposal Information	The requirement to submit quarterly waste return information will be amended to an annual submission. This submission will then consist of the single annual submission of the detailed waste return spreadsheet and a single annual submission of the summary info in proforma 7 of the CEAR.

	3	Results of the Environmental Monitoring Programme.	SL proposes to amend the wording for information requirement 3 as detailed below, including the criteria for identifying unusually elevated results provided in the BAT case. 3. The operator shall report the results of the environmental monitoring programme on a quarterly basis; the reports to be provided within 3 months of the end of the quarter to which they refer which they refer, except the third quarter, where the results are to be provided within 3 months and 2 weeks of the end of the quarter, and in accordance with the following: (a) all positive results (ie those exceeding the detection limit) shall be reported with an uncertainty which is at the 95% confidence level (ie 1.96 standard deviations) and includes all analytical uncertainties in accordance with ISO 17025. Where results are less than, or equal to, the detection limit, the detection limit value shall be reported. (See paragraph 1 above for definition of detection limit.); (b) reasons shall be identified for why any: - results are late; - sample has not been obtained; - analysis has not been undertaken; - relevant detection limit has not been achieved; - radiological assessment has used alternatives to the values and relationships given in Annexes II and III to the Council Directive 96/29/Euratom of 13 May 1996. The alternative data used shall be provided. (c) the type(s) of instrument used for contamination monitoring shall be specified; (d) where gamma-spectrometry has been carried out on samples, any positive results for other gamma emitters shall be reported. (e) Any positive result which exceeds the criteria agreed in writing with the Agency and, as far as reasonably practicable, an explanation shall be provided for any such elevated value. (f) The report for the last quarter of each calendar year shall include annual means and annual ranges for each type of measurement at each location.

	4	Monitoring Exceedances	SL proposes to amend the wording for information requirement 4 as follows: 4. The Operator shall notify the Agency: (a) without delay, of: • any positive result which exceeds the investigation criteria agreed in writing with the Agency and details of the investigations the Operator is undertaking to provide an explanation of the result. • instances where the Abnormal Find protocol is triggered. The location of such finds will be recorded with a grid reference of the type 'NY180068' and the item(s) removed, where reasonably practicable, and stored at a safe and secure location; and • any result from the site perimeter air monitoring system which exceeds Sellafield Ltd's action levels and is confirmed on investigation to be due to non-natural radioactivity. • Any positive result in the CLESA leachate monitoring which exceeds the control, action or trigger limits specified in the EMP and, as far as reasonably practicable, an explanation shall be provided for any such elevated value. (b) of any changes to sampling or analytical methods which may result in significant changes in reported environmental monitoring results.
	8, 26, 27, 28	Requirements by which SL must notify EA on breach of a particular trigger.	SL proposes that EA combine current requirements 8, 26, 27 and 28 into a single requirement, by which SL must notify EA upon on breach of the triggers defined therein, as follows. The Operator shall notify the Agency if • plant modification proposals have actual or potential significant environmental implications, prior to their implementation and in writing. • there will be processing of raffinate, associated with the reprocessing of greater than or equal to 200 tonnes (as uranium) of Magnox fuel, in Evaporator C (of the Highly Active Evaporation and Storage plants) in any 12 month period. This notification will advise of the means the Operator proposes to use to limit the activity of the relevant waste discharged. • there is diversion of discharges routinely routed down Sea Line 3 to Sea Line 2 due

			to the inoperability of Sea Line 3. This notification will report the circumstances and advise why Sea Line 3 is inoperable and the period over which the diversion is expected to be in place. During the period of diverted discharges, the Operator shall, on a weekly basis, provide the Environment Agency in writing a progress update with regard to returning Sea Line 3 to service. • Lagoon liquor is pumped to the Factory Sewer due to exceptional storm conditions. During the period of diverted discharges, the Operator shall, on a daily basis, provide the Environment Agency in writing with the approximate volume of Lagoon liquor that has been discharged via the Factory Sewer (by pumping) during the preceding 24 hour period and, if pumping is continuing, a prediction of when pumping operations will cease.
	9	CLESA Report (F)	SL proposes the removal of the requirement for an annual CLESA leachate report, on the basis of the addition of bullet four to requirement 4, relating to monitoring exceedances.
	10	Hydrogeological Risk Assessment Review	The wording of the information requirement will be amended to make it clear that the requirement relates to CLESA.
	15	Submit a written review on best practice for minimising waste disposals.	SL and EA have considered Information Requirements 15, 16, 17 and 18 together, due to the related emphasis on methods for demonstrating application of BAT. A BAT improvement programme is currently underway, supported by EA, through which clarity of SL's arrangements for demonstrating application of BAT with be improved. Once this position has been reached, SL and EA will consider how the arrangements can be provided in a way that meets the intent of the 4 Information Requirements. Progress has already been made in improving the compliance requirements associated with information requirement 18 by providing a routinely scheduled forum for dialogue between EA and SL's innovation and research and development programme lead.
	16	Submit a written review of the means used to assess the activity of radionuclides in disposals.	
	17	Submit a written review of the means used to	

		assess the activity of radionuclides in solid disposals.	
	18	Carry out a programme of research and development with the following deliverables.	
	23	Report relating to operation and management of SIXEP and related plants.	The frequency of submission for the SIXEP submission will be reduced to 5 yearly.
	25	Review and update of BAT assessments for disposal of low level waste and very low level radioactive waste (VLLW).	The requirement will be amended to request provision of documentation related to BAT for the routing of solid waste, as and when it is updated.
	Potential new Information Requirement		EA are currently assessing a Closure and Aftercare Management Plan and associated cap design for CLESA. When this is of sufficient quality, there will be a new requirement to review these documents during the operational phase of CLESA and then at a point before the site is capped and closed.
	Potential new Information Requirement		EA are currently assessing the potential diversion of CLESA leachate to the CIS. Whilst the assessment has not yet concluded, it may involve the need for additional controls that could either be best placed in the CEAR or the permit.

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