RADIOACTIVE SUBSTANCES ACT 1993

SCOTTISH ENVIRONMENT PROTECTION AGENCY

DECISION RELATING TO APPLICATION BY DOUNREAY SITE RESTORATION LIMITED FOR AUTHORISATION FOR DISPOSAL OF RADIOACTIVE WASTE TO PROPOSED LOW LEVEL WASTE FACILITIES AT DOUNREAY

Non-Technical Summary

The purpose of this document is to record SEPA's considerations and rationale which underpins SEPA's decision in respect of the application from DSRL for an Authorisation under RSA93 for disposal of solid low level radioactive waste at the LLWF adjacent to Dounreay Site, Caithness, KW14 7TZ.

Dounreay Site Restoration Limited (DSRL) applied to the Scottish Environment Protection Agency (SEPA) in 2008, and resubmitted with a substantially revised application in 2010, for authorisation for the disposal of solid radioactive low level waste in a series of near surface concrete vaults to the east of the Dounreay nuclear site. SEPA is now minded to grant this Authorisation subject to a Schedule of Conditions and Limitations.

Under Section 13 of the Radioactive Substances Act 1993 (RSA93) SEPA is made solely responsible for authorising the disposal of radioactive waste.

SEPA considers the near surface disposal of the radioactive waste requires a bespoke Authorisation, which combines the regulatory controls appropriate for both the radioactive and the hazardous properties of the waste.

SEPA is required to carry out its regulatory duties in accordance with legislation taking account of government policy. In determining this application SEPA has reviewed how DSRL have applied the principles of sustainable development, the UK Low Level Waste Policy, Radioactive Waste Management Policy, the UK Strategy for Radioactive Waste Discharges and the application of Best Practicable Means.

The "Near Surface Disposal Facilities on Land for Radioactive Wastes – Guidance on Requirements for Authorisation" ("the GRA") sets out the framework within which near surface disposal facilities will be regulated. It explains the requirements that SEPA expects DSRL to fulfil when it applies for an Authorisation to develop and operate the proposed facility, and explains SEPA's regulatory process that leads to a decision on whether to authorise the disposal.

The basis for the GRA is the Fundamental Protection Objective. This is intended to ensure that all disposals of solid radioactive waste to facilities on land are made in a way that protects the health and interests of people and the integrity of the environment, at the time of disposal and in the future, whilst inspiring public confidence and taking account of costs.

The Fundamental Protection Objective is achieved by the application of the 5 Principles and the 14 Requirements described in the GRA. Although the GRA is non-mandatory, the term 'Requirement' is used to emphasise items that are particularly important from SEPA's perspective, and SEPA's strong expectation is that these will be met by DSRL.

The five principles are summarised as:

1. Level of protection against radiological hazards. Radiological risks associated with the disposal, both at the time of disposal and in the future, should be consistent with the national standard at the time of disposal.

2. Optimisation. Radiological risks associated with the disposal shall be as low as reasonably achievable under the circumstances prevailing at the time, taking account of economic and societal factors, radiological risks to other living organisms and any non-radiological hazards.
3. Level of protection against non-radiological hazards. The level of protection of people and the environment from the non-radiological hazards associated with the disposal, both at the time of disposal and in the future, should be consistent with the national standard at the time of disposal for wastes that present non-radiological hazards.
4. Reliance on human action. Disposal should be made so that unreasonable reliance on human action to protect people and the environment against radiological and non-radiological hazards is avoided both at the time of disposal and in the future.
5. Openness and inclusivity. For any disposal the relevant agency shall establish ways of informing any interested party and the public about regulatory goals, processes and issues and consult in an open and inclusive way.

The Principles are underpinned by the fourteen Requirements which, if fulfilled proportionately to the hazard presented by the waste, should ensure that the principles are applied properly. These are discussed further below.

Requirement 1: Process by agreement.

DSRL has engaged actively with SEPA in developing their Environmental Safety Case. There has been a number of iterations leading to Environmental Safety Case 2010 (ESC 2010), which have been discussed in technical meetings and reviewed by SEPA. Whilst the engagement has not provided regulatory certainty, it has ensured that sufficient attention has been focussed on the regulatory requirements at the early stages of DSRL's work.

Requirement 2: Dialogue with potential host communities and others.

Throughout the development of their Environmental Safety Case DSRL has engaged widely with the public and other stakeholders. This has included the local community, Dounreay Stakeholder Group, Scottish Government, the Highland Council and other bodies. DSRL has used a range of media in its engagement including meetings, letters, DSRL website and a public walk-in centre.

Requirement 3: Environmental Safety Case.

DSRL has prepared ESC 2010 in support of its application, under RSA 93, to dispose of solid radioactive waste. This provides and substantiates a set of claims concerning the environmental safety of their planned disposal. SEPA has reviewed ESC 2010 and its previous iterations and is satisfied that, for this stage of the facility development, it demonstrates consistency with the Principles and Requirements set out in the Near-surface Disposal Facilities on Land for Solid Radioactive Wastes Guidance on Requirements for Authorisation (GRA). ESC 2010 demonstrates that the health of members of the public and the environment are protected. There will be future iterations of the ESC as DSRL proceeds through the operational and closure stages of their facility. SEPA's draft Authorisation includes a Condition that DSRL maintain an Environmental Safety Case.

Requirement 4: Environmental safety culture and management system.

ESC 2010 describes DSRL's environmental safety culture and management systems. DSRL already hold three Authorisations under RSA 93 for the Dounreay Nuclear Licensed Site. The management systems associated with these Authorisations are routinely inspected by SEPA. DSRL propose to use its current management systems as a basis from which to develop the management systems for the disposal facility. SEPA's draft Authorisation contains Conditions requiring management systems and provision of a management plan.

Requirement 5: Dose constraints during the period of authorisation.

DSRL state that there will be no direct discharges to the environment during the period of Authorisation of the facility. With the exception of sky shine, which is the scatter of radiation from the facility in the atmosphere, there will be no doses to the public. DSRL has prepared an assessment of the potential doses arising from sky shine and assessed the doses as trivial in comparison to doses from background radiation.

SEPA's draft Authorisation includes a Condition requiring DSRL to undertake environmental monitoring to demonstrate compliance with the Authorisation and assumptions of the Environmental Safety Case.

Requirement 6: Risk guidance level after the period of authorisation.

DSRL has used international best practice to model the performance of the facility after the period of authorisation, when the facilities have been closed and following a period of institutional control, to show consistency with the risk guidance level as discussed in the GRA.

This type of modelling is known as a performance assessment (PA). The PA forms a key component of DSRL's safety case and they have engaged frequently with SEPA during its development. SEPA is of the view that DSRL's approach to the development of the PA has been transparent and systematic. DSRL have had their PA methodology peer reviewed and SEPA have commissioned its own review by independent experts. SEPA's review concluded that the DSRL's approach was compliant with regulatory requirements and international standards.

DSRL's assessment considered a scenario where the disposal facility remained undisturbed after its closure as well as scenarios where the facility is disturbed at some point in the future. Disturbances to the facility considered include the effects of climate change and sea level rises, coastal erosion, glaciation and ground rupture following an earthquake. The effects of inadvertent human intrusion are considered under Requirement 7.

The results of the PA are described by DSRL as being illustrative of potential consequences and are intended to aid understanding and demonstrate safety. The results of the PA are discussed in ESC 2010. For the undisturbed scenario none of the iterations of the PA have shown calculated doses in excess of the dose equivalent to the risk guidance level over the timescale of assessment. Peak doses occur after tens of thousands of years and fall beyond 50,000 years. A crofter family living and farming on the facility is considered to be the most exposed group. None of the disturbed scenarios

result in a dose to the crofter, or any other group, that exceeds the dose equivalent to the risk guidance level in the GRA.

The PA will be refined to reflect further characterisation of the site, ongoing facility design and optimisation studies. This will be reflected in future iterations of the Environmental Safety Case.

Requirement 7: Human intrusion after the period of authorisation.

DSRL has assessed the impacts of inadvertent human intrusion in a manner consistent with the GRA. DSRL has considered a scenario where the top few metres of the facility are excavated for redevelopment as a residential area, leisure development, road building or the like. The excavated material is then mixed with soil and used for agricultural purposes to support crofting. DSRL is confident that this scenario would result in higher potential doses to the site user than any other use of land after redevelopment. Despite the conservative assumptions used in the assessment, the calculated annual doses are below the dose guidance level for prolonged exposure given in the GRA.

The potential impact of extracting contaminated groundwater through a well or borehole has also been considered. The assumptions used by DSRL are conservative and the approach is transparent. Drinking water from a well or borehole just downstream of the facility has been assessed as not resulting in an exposure to the public that exceeds either the risk guidance level or the dose guidance level for prolonged exposure given in the GRA.

Requirement 8: Optimisation.

Optimisation is a fundamental concept in the GRA where it is considered both as a Principle and a Requirement. ESC 2010 discusses optimisation primarily in the context of decision making relating to facility design as this has been the central focus of DSRL's studies to date. Initial facility designs are based on international best practice with design options being analysed in terms of their implications for the environmental safety case.

SEPA has discussed optimisation extensively with DSRL during technical meetings and reviewed the optimisation papers prepared to date. DSRL will continue to undertake optimisation studies during the lifecycle of the facility as a key component of the maintenance of the ESC.

Requirement 9: Environmental radioactivity.

DSRL has undertaken a series of assessments to investigate the affects of the facility on the accessible environment. These considered the impact of releases of the radioactivity from the facility, as derived from the PA, on non-human biota. In all instances the assessments show that the impact will be negligible to organisms in the marine, freshwater and terrestrial environments.

Requirement 10: Protection against non-radiological hazards.

The GRA recognise that the wastes to be disposed to a facility may be harmful because of their non-radioactive hazardous properties. ESC 2010 discusses the hazardous waste component of the inventory to be disposed in the facility. DSRL argue that the level of engineering of the vaults is considered to provide long-term protection of the environment that is no less stringent than that provided by national standards for disposing of hazardous waste. SEPA has imposed stringent waste acceptance criteria to control the disposal of waste to the facility.

SEPA's draft Authorisation includes Conditions that DSRL will demonstrate that this level of protection is met.

Requirement 11: Site investigation.

DSRL has undertaken an extensive programme of site investigation to inform their Environmental Safety Case and to support their facility design and construction. This work is ongoing and DSRL is currently on their third phase of characterisation. The characterisation has been discussed at technical meetings with SEPA and amended to reflect the outcome of these discussions. SEPA is satisfied that the scope of the characterisation meets adequately the requirements of the GRA and has been approached in a manner that is proportionate to the hazard presented by the waste.

Requirement 12: Use of site and facility design, construction, operation and closure.

DSRL's approach to the use of the site and to the facility design, construction, operation and closure has to be proportionate to the hazard presented by the waste. This has been the focus of discussions between SEPA and DSRL at a number of technical meetings. ESC 2010 describes DSRL's ongoing design process and the individual design components of the facility along with their function.

DSRL is finalising the detailed design of the facility and preparing the associated excavations. This area of work is ongoing and this is recognised in the Forward Programme discussed in ESC 2010

SEPA's draft Authorisation has Conditions to ensure that the facility is designed, constructed and operated in accordance with the assumptions made in the Environmental Safety Case.

Requirement 13: Waste acceptance criteria.

DSRL will hold Authorisations for both the consignor, Dounreay Licensed Site, and the recipient, low level waste disposal facility. It is SEPA's view that robust waste acceptance criteria (WAC) are needed to manage the disposal of waste and demonstrate consistency with the Environmental Safety Case.

Following the review of ESC 2010, SEPA has defined WAC as part of the Limitations and Conditions in the draft Authorisation. These limit the activities of radionuclides to be disposed to the facility to those recorded in the Dounreay Radioactive Waste Inventory 2009 as shown in ESC 2010.

Requirement 14: Monitoring.

DSRL has developed a Monitoring Plan to fulfil the requirement to monitor for changes caused by the construction, operation and closure of the facility. The approach has been reasoned and transparent. Included in the objectives of the Plan is monitoring in support of the operational and long-term safety case.

SEPA's draft Authorisation includes a Condition that DSRL prepare, maintain and implement a management plan that includes environmental monitoring of the facility to demonstrate compliance with the Authorisation and assumptions of the Environmental Safety Case.

Other Considerations

SEPA is required to further the conservation of biodiversity when exercising its regulatory functions and to identify any significant biodiversity interests that may be affected. No significant biodiversity interests were identified as being affected by the disposal of radioactive waste to this facility.

The provisions of the European Convention on Human Rights incorporated in Scots law must be considered by SEPA in respect of its decision making process, and any potential or actual breach of a convention right identified and considered in that decision making process. No breach of any convention rights have been identified in relation to this authorisation activity.

SEPA's Decision

SEPA has determined DSRL's application for an Authorisation, under RSA 93, for disposal of solid low level radioactive waste. DSRL's application is supported by the latest iteration of their Environmental Safety Case (ESC 2010) which provides and substantiates a set of claims concerning the environmental safety of the planned disposal. SEPA has reviewed ESC 2010 and supporting documentation against the requirements and guidance in the GRA.

SEPA is satisfied that ESC 2010 meets the requirements, and therefore the principles, set out in the GRA to the extent possible at this stage of the facility development. It is accepted that as DSRL move on from the detailed design and construction stages of the facility, future iterations of the Environmental Safety Case will be produced. It is SEPA's expectation that these future iterations will reflect DSRL's enhanced characterisation of the site, the optimisation of the facility design and waste inventory and the further development of operational procedures.

DSRL's application for an Authorisation and accompanying Environmental Safety Case also addresses the determination considerations outlined in Section 5.

SEPA is minded to grant an Authorisation for the low level waste facilities proposed by DSRL. SEPA considers the near surface disposal of the radioactive waste requires a bespoke Authorisation which includes regulatory controls intended to ensure that DSRL design, construct, operate and close the facility in a manner consistent with the Environmental Safety Case.

1. Introduction

1.1 Introduction

Dounreay Site Restoration Limited (DSRL) currently holds Authorisations under the Radioactive Substances Act 1993 (RSA93) to dispose of radioactive waste from premises at Dounreay, Caithness.

DSRL is a limited company with company number SC307493 and has its registered office at Building D2003, Dounreay, Thurso, Caithness KW14 7TZ.

In 2008, the Scottish Environment Protection Agency (SEPA) received an application from DSRL for an Authorisation under RSA93 to dispose of solid radioactive low level waste (LLW) in proposed Low Level Waste Facilities to be constructed adjacent to the site at Dounreay (LLWF). SEPA has now determined to grant this Authorisation, subject to a number of Conditions included as a schedule to the Authorisation.

1.2 Purpose of the Document

The purpose of this document is to record SEPA's considerations and rationale which underpins SEPA's decision in respect of the application from DSRL for an Authorisation under RSA93 for disposal of solid low level radioactive waste at the LLWF adjacent to Dounreay Site, Caithness, KW14 7TZ.

1.3 SEPA's Remit and Duties

SEPA is the body responsible for environmental protection in Scotland. SEPA was established by the Environment Act 1995. It became operational on 1 April 1996. The Environment Act 1995 also sets out SEPA's powers and responsibilities.

In broad terms SEPA regulates:

- activities that may pollute water
- activities that may pollute air
- storage, transport and disposal of waste
- keeping, use and disposal of radioactive substances

1.4 The Radioactive Substances Act 1993

The control over radioactive substances and radioactive wastes in Scotland is exercised via RSA93. Section 13 of RSA93 makes it an offence to dispose of any radioactive waste, or permit it to be disposed of, unless it is in accordance with an Authorisation granted under that Section, or it falls into one of the categories of radioactive waste specifically excluded from the requirements of this Section. RSA93 makes SEPA solely responsible for authorising the disposal of radioactive waste in Scotland under Section 13.

SEPA grants an Authorisation subject to such Limitations and Conditions as it sees fit. This Authorisation is described in a certificate. The Limitations and Conditions are imposed to ensure that where the generation of radioactive waste cannot be avoided, it is disposed of in a safe and controlled manner in accordance with Government Policy.

The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) apply to activities that directly, indirectly or are likely to have a significant adverse impact on the waste environment, which includes disposals of radioactive waste. CAR deems an RSA93 Authorisation to be a CAR Authorisation and places a legal duty on SEPA to ensure that any Authorisations granted under RSA93 are consistent with the requirements of the European Directives relating to the water environment.

1.5 Proposed LLWF Site

The application was made in respect of land adjacent to the eastern boundary of the existing Dounreay nuclear site. These premises, on which the LLWF will be located, are shown outlined in red in Appendix 2 of the draft Authorisation.

1.6 Dounreay Site

Dounreay Nuclear Power Development Establishment was established in 1955 and is Britain's former centre of fast reactor research and development. The location of Dounreay is shown in Appendix 1 of the draft Authorisation. The facilities at Dounreay included:-

- the Prototype Fast Reactor, a research facility which also provided power to the national electricity grid;
- the Dounreay Fast reactor, an experimental fast breeder reactor built in the 1950's to test the concept and which also provided electricity to the national grid;
- the Dounreay Materials Test Reactor, the first operational reactor in Scotland, which was constructed to test the effects of irradiation on metals.

The Dounreay Materials Test Reactor was shut down in 1969, the Dounreay Fast Reactor in 1977, the Prototype Fast Reactor in 1994 and Nuclear Fuel Reprocessing ceased in 1996..

Decommissioning generates different types of waste, from conventional industrial wastes to potentially hazardous materials such as asbestos and radioactive waste. All these waste types require to be safely managed.

1.7 Vulcan NRTE

The Vulcan Naval Reactor Test Establishment (NRTE) is a Ministry of Defence (MoD) establishment at Dounreay. It is part of the Royal Navy's nuclear submarine propulsion program, and is currently operated by Rolls Royce on behalf of MoD. NRTE has agreement to consign all its solid LLW to DSRL for subsequent disposal. This waste stream is included in the Dounreay inventory used in the preparation of this application by DSRL.

1.8 Guidance on Requirements for Authorisation

The UK environment agencies have produced guidance entitled *Near-Surface Disposal Facilities on Land for Solid radioactive Wastes: Guidance on Requirements for Authorisation* (the GRA). It is intended principally for the developers or operators of proposed or existing near-surface facilities for the disposal of radioactive wastes and explains the requirements expected of an operator or developer when they apply for an authorisation. This includes the need to show that their approach to developing the facilities and the location, design, construction, operation and closure will meet the principles and requirements set out and discussed in the GRA.

The GRA also describes how SEPA interprets the principles and requirements and provides information about the associated framework of legislation, government policy and international obligations.

The GRA includes a requirement for the developer or operator to produce and environmental safety case (ESC). The ESC is intended to demonstrate how the disposal facility will meet the requirements set out in the GRA and show that people and the environment are protected from the hazards associated with disposals to the facility.

DSRL's 2010 iteration of their ESC is the principal supporting documents for DSRL's application for a RSA93 Authorisation and is discussed further in the context of the GRA in Chapter 4 below.

2 Application for Authorisation

2.1 Background to Application

DSRL operates the Dounreay site under contract to the Nuclear Decommissioning Authority (NDA), the statutory body with responsibility for decommissioning and cleaning up civil nuclear facilities and ensuring that all waste products, both radioactive and non-radioactive, are safely managed.

DSRL have managed Dounreay, and have held the RSA93 Authorisation and other legal permits, since 1st April 2008. Prior to this, the site had been managed by United Kingdom Atomic Energy Authority (UKAEA).

In 2002, UKAEA applied for Authorisation under RSA93 to dispose of radioactive waste to the Low Level Waste Repository in West Cumbria. This application was refused by SEPA, under direction from Scottish Ministers, dated 10 May 2005.

The principal influences for Scottish Government's decision to direct SEPA to refuse the authorisation were the Review of LLW Policy by the UK government and the devolved administrations and the publication of the Dounreay Solid Low Level Waste Strategy Development - Overall Strategy (9 March 2005) for managing its LLW in the long term.

Other factors included the creation of the NDA, the use of the LLW Facility at Drigg and concerns about the transportation of waste from Dounreay as well as the decommissioning of Dounreay and other sites. The Scottish Ministers did not wish to pre-empt the outcome of the NDA's LLW Review which addressed many issues including the capacity of the Facility at Drigg, transportation of waste and on-site disposal. Ministers also recognised that the long term strategy for Dounreay LLW was the creation of an on-site disposal facility.

Further, it had long been proposed, and had been stated publicly on many occasions, including in the Dounreay Site Restoration Plan, that the best practicable environmental option in the long term for LLW produced at Dounreay would be a disposal facility on the site. Ministers wanted to support the long stated intent that LLW produced at Dounreay should be dealt with by a facility onsite and believed that it was essential that all involved proceeded to develop this proposal.

2.2 Planning Consent

DSRL applied to The Highland Council for planning permission for construction of six shallow sub surface vaults, along with a grouting plant, administration building and associated infrastructure which are outwith the scope of RSA93, on 30 June 2006.

Planning consent was granted on 27 April 2009, subject to the development beginning within 5 years of the planning permission being granted and 26 other conditions considered appropriate by the planning authority.

SEPA provided feedback to The Highland Council on the planning application as a consultee to the planning process. SEPA notified The Highland Council on 8 July 2008

that it did not object to the planning application, provided a number of issues were addressed by planning conditions. Those issues related to site monitoring, contaminated land assessment, environmental protection during construction, the need for Phases 2 and 3 of the development and a programme of restoration. A full copy of SEPA's planning response is available at;

http://www.sepa.org.uk/radioactive_substances/decommissioning/dounreay/proposed_llw_facilities.aspx

SEPA provided further feedback to The Highland Council in response to DSRL's assertions it had met the requirements of certain planning conditions which had to be met ahead of construction beginning. SEPA provided The Highland Council with feedback on 20 October 2011 in relation to planning conditions covering areas within SEPA's remit, indicating SEPA was content for the planning conditions to be discharged in respect of those interests falling within SEPA's remit only.

2.3 Description of Premises

The Authorised Premises consists of the areas delineated in red on the plan forming Appendix 2 of the RSA93 Authorisation.

The LLWF will consist of up to six vaults for disposal of LLW. It is recognised by SEPA that the facilities are to be developed by DSRL in a phased manner, depending on volumes of waste arising from Dounreay site decommissioning, and that only Phase 1, consisting of one LLW vault and one Demolition waste vault is being constructed at the time of Authorisation.

SEPA expect further iterations of the ESC demonstrating the facilities to be optimised in line with Requirement 8 of the GRA throughout the operation and post closure phases of the development. It is considered likely that, through the lifetime of the facilities, DSRL will require to apply for and have the Authorisation varied (or SEPA may choose to vary the Authorisation) in line with Section 17 of RSA93.

2.4 Application

DSRL applied for Authorisation under Section 13 of RSA93 for the disposal of LLW on 15 September 2008. SEPA considered this application contained insufficient detail to allow determination of the application; therefore an extension to the statutory 4 month determination period was agreed with DSRL in order to allow DSRL sufficient time to prepare a revised application and supporting documentation. DSRL submitted the revised and updated application to SEPA on 29 October 2010. SEPA reviewed the revised application for completeness and informed DSRL the application was accepted as Duly Made on 6 January 2011**.**

In line with the GRA Requirement 1 for process by agreement SEPA accepted further supporting information from DSRL beyond that point in support of the application for Authorisation. For ease of reference SEPA has include a link to DSRL's website which has available a copy of the ESC and key supporting information.

http://www.dounreay.com/waste/radioactive-waste/low-level-waste/new-low-level-waste-facilities

2.4.1 Associated Applications

Although the purpose of the facility is the disposal of LLW, authorisation is required under other legislative regimes falling within SEPA's remit to support the construction and operation of the facilities. For completeness, a short summary of the rationale underpinning the need for each of those environmental permits has been included here.

The long term storage of rock excavated during the formation of the vaults requires permitting under the Pollution Prevention and Control (Scotland) Regulations 2000 (PPC Regulations), under Section 5.2, as a landfill. The PPC Regulations implement the requirements of The Landfill (Scotland) Regulations 2003 (LF Regulations), which are discussed further in paragraph 4.10, indicating the technical standards and requirements for construction and operation of a landfill.

A landfill as defined in the Regulations includes "a permanent site, operating for more than one year, which is used for the temporary storage of waste". SEPA is currently determining an application from Graham Construction for excavated rock storage facility and will consult on its determination at the appropriate time as part of the due process for determining that application. Graham Construction is required to hold the permit as they will be the operator of the landfill through the Phase 1 construction process. SEPA understands it is DSRL's intention to apply to have the Permit transferred to them at the end of Phase 1 construction, through the legal transfer process set out in the PPC Regulations.

Through its early engagement process, in 2007 SEPA considered the possibility that the Landfill Regulations should apply to LLWF vaults. It was conclude following advice from SEPA's Legal and Policy functions that the LF Regulations did not apply as radioactive waste is specifically excluded from the scope of the Waste Framework Directive 2006/12/EC if covered by other legislation. In the case of the LLWF vaults RSA93 covers the disposal of radioactive waste to the facility and therefore the LF Regulations do not apply. SEPA wrote to the Scottish Government on 2 July 2008 advising that it would follow this approach unless advised otherwise, which it was not.

This decision is underpinned by GRA Requirement 10 which requires a demonstration from the applicant that a level of protection equivalent to that which would be expected for the disposal of the waste had it not been radioactive waste is required. The process followed for making that demonstration by DSRL is to apply the equivalent engineering standards to construction of the vaults as the LF Regulations require for a hazardous waste landfill.

Abstraction of Groundwater from the excavations during construction (and through the operational period) of the facility required authorisation under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR). Graham Construction applied for a licence for the dewatering of the excavations by means of abstraction and were granted a simple licence by SEPA on 6 January 2011 for this activity. Abstracted water is to be returned to the natural environment using Sustainable Urban Drainage Systems (SUDS) principles, which is in line with SEPA's expectations for the return of abstracted water to the environment. This licence will remain in place until such time as the vaults are closed and the excavation backfilled. Following construction of Phase 1, DSRL intend to apply to SEPA to transfer responsibility for compliance with the abstraction licence to DSRL from Graham construction through the formal process set out in CAR.

2.5 Authorisation style

Due to the wide range of factors to be considered in the determination of this application, SEPA formed a team of internal assessors who could provide the range of skills required to review DSRL's submissions. The project team made use of external contractors to provide additional technical input to SEPA on the Post-closure Criticality Safety Assessment and provide an additional independent review of the Performance Assessment.

SEPA considers the near surface disposal of the radioactive waste as requiring a bespoke Authorisation combining the regulatory controls appropriate for both the radioactive and hazardous properties of the waste.

SEPA took account when drafting the Authorisation that it is being granted ahead of construction of the facility being completed. SEPA has therefore included requirements in the Authorisation that DSRL make demonstration the facility has been constructed in line with the claims and assumptions made in their ESC. The Authorisation requires that DSRL have in place appropriate management systems along with operation processes and procedures ahead of emplacement of waste. SEPA recognised that while these areas must be addressed prior to the operational phase of the facility beginning, it was not necessary to have them in place during construction.

3. Determination Process

SEPA is required to carry out its regulatory duties in accordance with legislation taking account of government policy. In determining this application SEPA has reviewed how DSRL have applied the principles of sustainable development, the UK Low Level Waste Policy, Radioactive Waste Management Policy, the UK Strategy for Radioactive Waste Discharges and the application of Best Practicable Means.

3.1 Determination Process

Operators wishing to dispose of radioactive waste must apply to SEPA for an Authorisation. For applications received for the disposal of waste originating from a Nuclear Licensed Site, Section 16 of RSA93 requires that SEPA carry out statutory consultation with the Health and Safety Executive (Office for Nuclear Regulation) and the Food Standards Agency (FSA) on the application. The application is also provided to the Scottish Government to allow Scottish Ministers the opportunity to exercise their powers under Section 24 of RSA93 to call in the application.

SEPA will consult on the terms of the draft authorisation and decision document for a period of 8 weeks. Consultees will be those organisations that have a genuine interest or could provide valuable information as well as local residents and the general public.

3.2 External Consultation to date

SEPA consulted with Food Standards Agency, Office for Nuclear Regulation (ONR) as required under Section 16 of RSA93, and also consulted with the Scottish Government on the application received in 2008.

On receipt of the revised 2010 application, SEPA sent copies of to the Scottish Government, FSA and ONR on 16 December 2010. Response was received from the FSA on 10 January 2011 confirming they had no objection to the proposed facility. ONR made no representation to SEPA in their response to the consultation and SG responded on 11 July 2011 indicating they saw no reason to intervene in SEPA's Authorisation process at that time.

3.3 SEPA Governance of the Determination of the Application

SEPA has a due process which is followed for the determination of applications made under RSA93 to ensure a full and legally compliant determination of the application is made.

It was identified early in the process that this application merited formation of a dedicated project team due to the novel nature, in terms of radioactive waste management in Scotland, of the application.

The Project team evolved through the project as required, calling on the range of specialist knowledge available within SEPA. The core team consisted of a project manager and three regulatory officers from SEPA's Radioactive Substances Unit. At appropriate times through the determination process this team was augmented by

SEPA's legal, policy, hydrology, hydrogeology staff and other regulatory specialists from within the local operations team and the Radioactive Substances Unit as required.

The Project team was overseen by SEPA Project Board chaired by SEPA's Director of Operations. The Project Board contained representation from SEPA's operations, science and project management functions. The Scottish Government also had representation on the board. Over the duration of the project the individuals on the board changed due to personnel changes within SEPA, but breadth of representation across the organisation remained.

An External Advisory Group was formed to provide independent scrutiny of the processes being utilised by SEPA concerning both the planning application and the authorisation of the proposed facility. The extensive technical knowledge of the Advisory Group qualified them to challenge SEPA on the appropriateness of the scientific and technical methods used in the determination of the Authorisation, and if necessary, to recommend alternative approaches. The Advisory Group members were:

- Professor Simon Harley FRSE, member of CoRWM (Committee on Radioactive Waste Management) Professor of Lower Crustal Processes in the School of GeoSciences, University of Edinburgh.

- Dr Mark Dutton, member of CORWM

- Professor Brian Clark MBE, member of CORWM, previously served SEPA main board and chaired SEPA North Region board.

- Sir Laurie Hunter, Professor of Applied Economics in the University of Glasgow from 1970- 1999, and now Emeritus Professor and Honorary Senior Research Fellow in the School of Business and Management.

The group met as required through the determination period and the advice and recommendations of the group were recorded by SEPA. They reported favourably to the SEPA Project Board on the structure of the approach that has been adopted by SEPA in formulating the response to DSRL's planning application and in commencing work on the Authorisation and noted that the relationship between the Project Board and those conducting the technical studies appeared to be effective and fit for purpose. They also noted that there were sufficient and diverse resources within SEPA to provide the expertise required and, when not available, appropriate consultants have been appointed. The EAG concluded that SEPA appeared to have committed sufficient manpower, quantitatively and qualitatively, to the project and conducted a robust process.

3.4 External Consultants

SEPA engaged the services of external consultants to provide additional specialist technical input as required through the determination process, when that knowledge was not available within the organisation. The two specific areas were the Performance Assessment (PA) and the Criticality Safety Case (CSC) prepared and submitted to SEPA by DSRL.

SEPA's process for selecting contractors included a requirement that the selected contractor show a high degree of independence from DSRL in respect of the LLWF project to ensure no conflict of interest.

Brenk Systemplanung GmbH was awarded the contract to review the PA on behalf of SEPA and RPS Group to undertake independent review of the CSC. Feedback was provided to SEPA by the relevant contractor and used to inform SEPA's discussions with DSRL.

3.5 Stakeholder Engagement

SEPA's project team and board recognised from the outset the importance of engaging with local stakeholders and keeping members of the public informed of SEPA's role in the LLWF project.

SEPA adopted multiple approaches to meet this need starting at the highest level with a dedicated page on SEPA's website. This webpage is updated periodically and is available to everyone at:

http://www.sepa.org.uk/radioactive_substances/decommissioning/dounreay/proposed_llw_facilities.aspx

SEPA provided updates on the regulatory processes and its interactions with DSRL in respect of the LLWF to the Dounreay Stakeholder Group. SEPA's Radioactive Substances Unit Manager made a detailed presentation on progress and the proposed Authorisation consultation process at the 18 March 2009 Stakeholder Group Meeting. The view given at that meeting by the Stakeholder Group was that any consultation should be simple and focussed and that the timing should avoid both the Christmas and Summer holiday periods.

SEPA's Project Team took the comments received from the Stakeholder Group and decided that it would be more appropriate to follow the PPD model as discussed in Paragraph 3.1. This decision was endorsed by SEPA's Project Board.

The members of the public closest to the facilities live in a small community at Buldoo, adjacent to the Dounreay Nuclear site and the LLWF. SEPA began engagement with the residents in 2007. SEPA has engaged with Buldoo on all aspects of the project since that time, including face to face meetings to explain SEPA's position with respect to its response to the planning consultation, environmental regulation, the associated environmental permits and to answer any queries they may have on SEPA's remit. The Buldoo Residents are also represented on the Dounreay Stakeholder Group.

Consultation was undertaken with the European Community under the requirements of Article 37 of the Euratom Treaty in relation to the facility. This requirement lays downs that each member state shall provide the Commission with general data relating to any plans for the disposal of radioactive waste that is liable to result in radioactive contamination of water, soil or airspace of another Member State.

SEPA provided the Scottish Government with technical support on content of and in reviewing DSRL's submission prior to it being submitted to Europe. Following its review

of the submission the Commission concluded the facility was not liable to result in contamination of another member states water, soil or airspace.

3.6 Technical Meetings

SEPA and DSRL commenced a series of regular technical meetings in 2007 which are still ongoing to date. This was intended to allow SEPA and DSRL to discuss the suitability of the proposed site, SEPA to give advice on potential environmental concerns and DSRL to develop their Environmental Safety Strategy before proceeding with their application for an Authorisation under RSA 93. This dialogue, however, was not intended to provide any regulatory certainty.

Broadly speaking the meetings have been divided into three areas; programme issues, stakeholder issues and technical issues. The programme issues related primarily to DSRL's project timeline and projected dates for key deliverables whilst stakeholder issues included those relating to project management, local communities and other stakeholders including the NDA and Scottish Government.

Technical discussions were broad in scope and initially related primarily to site characterisation, the siting of the facility within the planning footprint, hydrogeological characterisation and the development of the hydrogeological models. As DSRL have progressed their site characterisation and models the discussions have focused more on the inventory to be disposed, facility design, the performance assessment assumptions, proposed monitoring programmes and DSRL's ongoing optimisation studies.

4 Requirements for Authorisation

4.1 Guidance on Requirements for Authorisation

In February 2009, the UK Environment Agencies jointly issued the "Near Surface Disposal Facilities on Land for Radioactive Wastes – Guidance on Requirements for Authorisation" ("the GRA"). The purpose of the GRA is to set out the framework within which near surface disposal facilities, such as the facilities proposed by DSRL, will be regulated.

The GRA is intended principally for the developers or operators of proposed or existing near-surface facilities for the disposal of radioactive wastes. It explains the requirements that SEPA expects DSRL to fulfil when they apply for an Authorisation to develop and operate their proposed facility. The GRA sets out the radiological protection requirements and explains SEPA's regulatory process that leads to a decision on whether to authorise radioactive waste disposal. The Environmental Safety Case (ESC) expected from DSRL is also described and discussed.

The GRA is focussed on five principles of solid waste disposal and fourteen more specific requirements which, if fulfilled proportionately to the hazard presented by the waste, should ensure that the principles are applied properly. These are discussed further below.

Although the GRA is non-mandatory, the term 'Requirement' is used to emphasise items that are particularly important from SEPA's perspective and SEPA's strong expectation that these will be met by DSRL.

The GRA describes the overall framework of legislation, government policy and international obligations relevant to solid low level waste management. It also provides a more specific summary of the main legal provisions under which SEPA will regulate DSRL's proposed facility.

The basis for the GRA is the Fundamental Protection Objective. The Fundamental Protection Objective is to ensure that all disposals of solid radioactive waste to facilities on land are made in such a way that protects the health and interests of people and the integrity of the environment, at the time of disposal and in the future, inspires public confidence and takes account of costs.

The Fundamental Protection Objective is achieved by the application of the 5 Principles and the 14 specific Requirements described in the GRA.

4.2 Principles

4.2.1 Principle 1 - Level of Protection against radiological hazards

Solid radioactive waste shall be disposed of in such a way that the level of protection provided to people and the environment against the radiological hazards of the waste both at the time of disposal and in the future is consistent with the national standard at the time of disposal.

4.2.2 Principle 2 – Optimisation

Solid radioactive waste shall be disposed of in such a way that the radiological risks to individual members of the public and the population as a whole shall be as low as reasonably achievable under the circumstances prevailing at the time of disposal, taking into account economic and societal factors and the need to manage radiological risks to other living organisms and any non-radiological hazards.

4.2.3 Principle 3 - Level of protection against non-radiological hazards

Solid radioactive waste shall be disposed of in such a way that the level of protection provided to people and the environment against any non-radiological hazards of the waste both at the time of disposal and in the future is consistent with that provided by the national standard at the time of disposal for wastes that present a non-radiological but not a radiological hazard.

4.2.4 Principle 4 - Reliance on human action

Solid radioactive waste shall be disposed of in such a way that unreasonable reliance on human action to protect the public and the environment against radiological and any non-radiological hazards is avoided both at the time of disposal and in the future.

4.2.5 Principle 5 - Openness and inclusivity

For any disposal of solid radioactive waste, the relevant environment agency shall:

- establish ways of informing interested parties and the public about regulatory goals, processes and issues; and
- consult in an open and inclusive way.

4.3 Requirements

The five Principles lead on to 14 more specific Requirements. Meeting these Requirements ensures that the five principles are fulfilled, and these are discussed in detail in Section 6.

4.3.1 Requirement 1 – Process by agreement.

The GRA states:

The developer should follow a process by agreement for developing a disposal facility for solid radioactive waste.

DSRL entered into early discussions with SEPA and The Highland Council regarding its proposals for a disposal facility. .This dialogue was intended to ensure that sufficient attention was focussed on regulatory requirements in the early stages of the development of the disposal facilities. The dialogue was not intended to provide regulatory certainty but to allow SEPA and DSRL to discuss the potential suitability of the proposed site and to allow SEPA to give advice on possible environmental concerns so that DSRL could develop their Environmental Safety Strategy before proceeding with their application for an Authorisation under RSA 93.

Before submitting the first iteration of their ESC, DSRL (then UKAEA) kept SEPA informed of their developing solid low level waste management strategy and the outcome of their Best Practicable Environmental Option (BPEO) study (1).

DSRL submitted the first iteration version of their ESC to SEPA in 2006. SEPA was able to review this during 2007/2008 to support our response, provided in 2008 (2), to the Highland Council's planning consultation.

Further iterations have been, and will continue to be, developed by DSRL to account for dialogue with SEPA and the development of their disposal facility as part of DSRL's Forward Programme as described in ESC 2010.

The dialogue between SEPA and DSRL has been conducted through electronic and paper correspondence as well as through a series of technical meetings which, to date, are ongoing.

Conclusion

The process by agreement is an ongoing requirement and SEPA and DSRL will continue their dialogue as DSRL move from the construction of their proposed facility, through its operation and subsequent closure.

SEPA considers that this Requirement has, to date, been met satisfactorily. SEPA and DSRL will continue to engage as the project develops.

4.3.2 Requirement 2 - Dialogue with potential host communities and others

The GRA states:

The developer should engage in dialogue with the planning authority, local community, other interested parties and the general public on its developing environmental safety case.

DSRL discuss their interaction with stakeholders in ESC 2010. Initially this constituted part of their BPEO study (1). Later DSRL consulted a range of stakeholders during the Environmental Impact Assessment (EIA) process (3). As part of the scoping exercise for the EIA, SEPA, Scottish Natural Heritage, Scottish Ministers, Caithness West Community Council, Transport, Environmental and Community services, Highland Council archaeologists and Historic Scotland were asked, as statutory consultees, for opinion on the project.

DSRL provided the Environmental Statement to local Community Councils, Caithness Business Club, the Chamber of Commerce, Caithness Field Club, Caithness West Community Council, Members of Parliament, Members of the Scottish Parliament, ONR (the Office for Nuclear Regulation, formerly HSE's Nuclear Installations Inspectorate), the Vulcan facility, Scottish Water, Orkney Council, Shetland Council and the local SEPA office. In addition press releases and letters were published in the local press.

DSRL has held, and continues to hold liaison meetings with the residents at Buldoo, the closest members of the public to the facility, and other local community members.

Dialogue has been maintained with the broader community through the Dounreay Stakeholder Group.

Meetings have been held with MPs and MSPs both individually at the Dounreay site and through a presentation at the Scottish Parliament. DSRL has also been involved in the Dounreay Low Level Waste Strategy Implementation meetings hosted by the Scottish Government which were also attended by the Highland Council, SEPA and the Nuclear Decommissioning Authority. As discussed under Requirement 1, a series of routine technical meetings have been held with SEPA's radioactive substances regulatory team and the Office for Nuclear Regulation.

As part of their Forward Programme, DSRL is committed to ongoing stakeholder dialogue and their ESC discusses their Stakeholder Engagement Plan (4). All documentation for the project is available to the public through DSRL's website. DSRL also operate a walk-in information centre in Thurso.

Conclusion

SEPA considers that this Requirement has been met satisfactorily. It is anticipated that DSRL will continue to engage in dialogue with their stakeholders as required.

4.3.3 Requirement 3 – Environmental Safety Case

The GRA states:

"An application under RSA 93 relating to a proposed disposal of solid radioactive waste should be supported by an environmental safety case."

An ESC is described in the GRA as a set of claims concerning the environmental safety of disposals of solid radioactive waste which is substantiated by a structured collection of arguments and evidence. It should demonstrate that the health of members of the public and the integrity of the environment are protected adequately and should be designed to demonstrate consistency with the principles and requirements set out in the GRA.

Requirement 3 and chapter 7 of the GRA provides detailed guidance on what an ESC should demonstrate, include and achieve. This can be summarised as:

- Demonstrate a clear understanding of the facility in its geological setting ("the disposal system") as it evolves.
- Include an Environmental Safety Strategy supported by detailed arguments, evidence, analysis and assessment to demonstrate environmental safety. This should include the consideration and management of uncertainties, now and in the future, and demonstrate confidence in the safety case notwithstanding the uncertainties.
- Describe all aspects that may affect environmental safety including geology, hydrogeology, surface environment, waste characteristics, facility design and the approach to constructing, operating and closing the facility.
- Make use of multiple lines of reasoning based on a variety of evidence leading to complementary environmental safety arguments. The evidence can be qualitative and quantitative and should be supported, where appropriate, by robust numerical

evidence. Quantitative environmental safety assessments should cover the period of authorisation and afterwards, extending into the future until the radiological risks have peaked or until uncertainties are so great that quantitative assessment ceases to be meaningful.
- Describe the developer or operator's arguments for having confidence in the safety case.

Other aspects that the GRA considers to be particularly important include the consideration of fissile materials in the waste and the effect of climate change on the evolution of the disposal facility. The GRA also provides guidance on updating, presenting and preserving the ESC and how it can be used to aid in specifying a forward programme of improvement work.

DSRL's approach to developing their ESC has involved frequent engagement with SEPA. Its production has been iterative with issues being produced in 2006, 2007, 2008 and 2009. These iterations were discussed in detail at technical meetings held between SEPA and DSRL. ESC 2010 supports the application for an Authorisation under RSA 93 to which this decision document relates. DSRL will produce further issues of their ESC as the project proceeds, which will be linked with implementation phases of the project such as site characterisation, design and safety assessment.

ESC 2010 has been developed by DSRL as a single over-arching document which encompasses the main arguments that make up their safety case. It is stand-alone with regard to all of the key arguments but more detail underlying the development of these arguments is to be found in the supporting references. It is structured into chapters which address eight key themes derived from the 1997 version of the GRA. DSRL have demonstrated the relevance of these themes to addressing the 5 principles and 14 requirements of the 2009 version of the GRA. These chapters are:

- Waste characterisation.
- Facility design.
- Site characterisation.
- Quantitative safety assessment.
- Additional safety considerations.
- Monitoring.
- Institutional control.
- Administrative issues.

In addition ESC 2010 details the scope of their safety case, the safety strategy and conformity to the principles of radioactive waste management, a summary of the safety case and the forward programme.

ESC 2010 addresses explicitly and systematically the 14 Requirements described in the GRA to the extent possible at this stage of the facility's development. DSRL demonstrate their understanding of the facility in its geological setting through their extensive site characterisation work undertaken to support facility design and construction. Site characterisation has also informed the development of the conceptual models used in their performance assessment

Future work considered necessary to meet these Requirements is identified and highlighted throughout and summarised in Chapter 13. The adequacy with which ESC 2010 addresses the Requirements of the GRA is discussed in detail in the context of each individual Requirement. Appendix 2 of ESC 2010 contains a "regulatory crosswalk" which presents a summary in table form of all 14 Requirements in the GRA (and over 200 detailed sub-requirements) identified by their paragraph number from the GRA. It identifies where these have been addressed in ESC 2010 by chapter or paragraph number and whether the Requirement has been completed or is ongoing or pending. Where a Requirement is ongoing or pending its location in DSRL's Forward Programme is noted. Requirements that have been addressed but will need to be revisited periodically as the project develops are labelled as addressed/ongoing.

ESC 2010 sets out DSRL's Environmental Safety Strategy and makes arguments and demonstrations in its support. The strategy includes:

- Sound and open process (e.g., flexible, step-by-step development, extensive stakeholder dialogue, and peer review of key documents).
- A positive environmental safety culture supported by an appropriate management system.
- Use of robust and demonstrable safety measures (e.g., proven, well understood engineering technology, and long-term stability of the site).
- Strength in depth in the design through the use of multiple barriers and no sole reliance on single components or processes for regulatory compliance.
- Reliance on passive safety measures in the long term (after active measures are withdrawn, safety is inherent in the disposal system design, and is not reliant on human actions).
- Structured, transparent and traceable demonstration of environmental safety during the authorisation and post-authorisation periods, using internationally recognised assessment methods and tools.

ESC 2010 states that DSRL's disposal system concept fulfils three functions to attain both long and short-term safety:

- Isolation of the waste from humans and the environment
- Containment to prevent or reduce the release of contaminants from the facilities until the radioactive waste has decayed significantly.
- Delay and attenuation (retardation) of contaminants within the disposal system and reducing their rate of release to the human environment.

DSRL discuss how the facility design includes multiple barriers and a reliance on passive safety. This includes the use of waste containers, low permeability grout and backfill with alkaline chemistries to retard radionuclide migration, a concrete wall to limit water ingress, a high permeability channel around the vault walls and low permeability, anti-intrusion cap. DSRL have used their PA to evaluate uncertainty in the performance of these barriers, demonstrating compliance with regulatory safety guidance.

Multiple engineered barriers give reassurance that even if one barrier fails, other barriers will ensure that the required overall performance is achieved. The barriers include the concrete box structure of the facilities and the cap, which inhibit migration of groundwater into and out of the vaults. Within the LLW vaults, individual packages will

be grouted in place using a cementitious material. The waste itself will be encapsulated in grout and contained within mild-steel packages. The grout acts both to reduce groundwater movement within the facility and as a chemical inhibitor to radionuclide migration. In the alkaline chemical environment provided by the grout, the steel packages will only corrode slowly, thereby acting as an additional barrier between the waste and groundwater for a significant period. As part of their optimisation studies DSRL have assessed their Demolition LLW as not requiring conditioning or backfilling with grout owing to the very low hazard associated with it.

ESC 2010 claims that the barriers will ensure that releases of radioactivity remains low for tens of thousands of years under undisturbed conditions and that locating the wastes below the surface and over 200m inland from the coast significantly reduces the risk of disruption of the facilities during this period by inadvertent human actions and coastal erosion. The cap will also be designed to deter disruptive activities. Provided the facilities are not disrupted, the majority of releases will be through seepage into groundwater which will migrate toward the sea. Even with pessimistic assumptions on barrier performance, DSRL claim that less than 1% of the total activity initially placed in the facilities will leach to groundwater over a 100,000-year period. Further, they argue that the maximum annual flow or release of radioactivity from the facilities to groundwater will be only a small fraction of the flow of naturally occurring radioactivity that is currently migrating through the rock at Dounreay.

ESC 2010 presents a detailed performance assessment to demonstrate quantitatively the environmental safety of the facility during the period of Authorisation and afterwards. DSRL have used the IAEA's ISAM methodology which is recognised as best practice internationally (5) to identify and screen phenomena that are potentially relevant to the performance of the disposal facility. These are referred to as Features, Events and Processes (FEPs) and include factors such as geological and climatic processes, human actions as well as those relating to the waste, facility engineering features and the migration, release rates and exposure factors for radionuclides. FEPS aid in the development of scenarios for the evolution of the disposal system over time.

ESC 2010 identifies an undisturbed evolution scenario for their disposal facility where the facility engineering degrades gradually over time. The radioactivity decays and is either retained in the facility and surrounding geology or is released as gas or seeps through groundwater and into the biosphere. The impacts of climate change and limited coastal erosion are considered in the undisturbed evolutions scenario.

Several disturbed performance scenarios are also presented in ESC 2010. These include inadvertent human intrusion, groundwater extraction, glaciation, coastal erosion and ground rupture.

ESC 2010 presents a number of additional qualitative safety considerations intended to be complementary to DSRL's PA. This includes discussing the significance of the radiological impacts calculated in the PA in the context of background radiation levels in the UK and a comparison of the assessed peak annual dose from the facilities against the average dose received from background radiation in the Scottish Highlands. Assessed cumulative releases from the facilities over 50,000 years have been compared against reported annual discharges from the Dounreay site between 1957 and 2000 and the assessed peak fluxes from the facilities have been compared against present day

radionuclide fluxes and concentrations in the Dounreay environment. In all instances DSRL state that these compare favourably.

DSRL claim consistency with IAEA guidance (6) and that confidence in their PA is provided through a number of means as listed below:

- The applications of sound science.
- Adoption of a formal PA methodology requiring structured consideration of uncertainty and good communication.
- Adopting conservative modelling assumptions where necessary to address uncertainty.
- Parallel development of independent sets of PA models for the first run, comparisons between run 1 PA and runs 2 and 3 and comparison with PA calculations undertaken for the National Low Level Waste Repository in Cumbria.
- Verification of computer models.
- Validation of PA models through site characterisation, experiments and analogue studies.
- Peer and regulatory review of the PA and ESC.

DSRL intend to implement a PA Validation Plan (7) which considers building further confidence in the PA models and supporting parameter values.

DSRL's approach to managing uncertainties is discussed ESC 2010 in the context of their quantitative safety assessments. Broadly speaking uncertainty and sensitivity analyses, including a mixture of probabilistic analyses and deterministic 'what-if' analyses have been conducted for each iteration of the PA. This is discussed in more detailed in the review of DSRL's quantitative assessment of safety (Requirement 6).

Conclusion

SEPA has reviewed several iterations of DSRL's ESC and is satisfied that ESC 2010 meets the scope discussed in Chapter 7 of the GRA. ESC 2010 is structured to set out as clearly as possible DSRL's responses to the individual requirements and sub-requirements of the GRA and this is facilitated by their regulatory crosswalk. Further, ESC 2010 is self-contained to the extent that safety arguments are made without reliance on supporting references.

SEPA is also satisfied that DSRL have a Forward Programme and project plan which addresses adequately the need to maintain an updated ESC. The timing and scope of subsequent iterations of the ESC will be agreed with DSRL as the project progresses. SEPA's draft Authorisation for the disposal facility includes a condition requiring DSRL to provide and update their Environmental Safety Case during the development of the disposal vaults and at suitable intervals during the period of authorisation in agreement with SEPA.

4.3.4 Requirement 4 - Environmental safety culture and management system

The GRA states:

The developer/operator of a disposal facility for solid radioactive waste should foster and nurture a positive environmental safety culture at all times and should have a management system, organisational structure and resources sufficient to provide the following functions: (a) planning and control of work; (b) the application of sound science and good engineering practice; (c) provision of information; (d) documentation and record-keeping; (e) quality management.

ESC 2010 chapter 11 addresses the requirement for an environmental safety culture and management system. The Authorisation for the disposal facility will be held by DSRL who currently hold three RSA 93 Authorisations for the Dounreay Nuclear Establishment. SEPA inspects routinely DSRL's management systems for compliance with the Conditions within these Authorisations.

ESC 2010 describes the current management systems which are being used for the planning and control of work both on the Dounreay site and at the site of the disposal facility. DSRL have an integrated and documented Health, Safety, Environment and Quality Management System which is currently accredited to ISO 9001, ISO 14001 and OHSAS 1801. The system contains a number of documents at the corporate level:

- Management system manual.
- Policies.
- Procedures.
- Quality programmes.
- Guidance notes.

The details of how the Dounreay site and projects implement the corporate policies are maintained in divisional management system manuals which also point to specific procedures and manuals.

It is anticipated that the management systems and safety culture for the proposed LLWF will have the same basis as those systems currently used at the Dounreay Nuclear Establishment which have been inspected frequently by SEPA.

ESC 2010 states that all projects at the Dounreay site must proceed through planning, review and implementation procedures that involve setting objectives, evaluating options and strategy, identifying funding, project management and contractual arrangements and obtaining sanction.

A Project Management Plan (PMP) was developed at the start of the low level waste disposal project. This sets out how DSRL plans and controls the project and will continue to be updated as necessary. This includes the project scope, a stakeholder engagement plan, assurance of the competencies of project team members, a cost breakdown structure, a contracting strategy, safety, health and environment planning, maintenance of a project risk register and arrangements for project monitoring, review and control. Key project decisions are generally managed though workshops involving DSRL technical staff and their contractors following a formalised optimisation/BPM methodology.

DSRL have set out to ensure the application of sound science through peer review and the use of internationally experienced contractors to undertake the Performance

Assessment (PA) and other key areas of their ESC. Further, project team members, including contractors employed over the lifetime of the project to date, maintain an awareness of scientific developments in low level waste management and PA at both the national and international level. This informs optimisation studies, including the review of past decisions, and planning.

ESC 2010 states that documents and records are managed in accordance with procedures set down by the DSRL Record Management Service to meet the needs of the Public Records Act. Key project information is available through DSRL's website.

Conclusion

SEPA's draft Authorisation for the disposal facility includes limitations and conditions relating to its operation and management. These require that the facility will be operated in accordance with the assumptions in DSRL's ESC and that DSRL will prepare, maintain and implement a Management Plan, contingency arrangements and an emergency plan. Any amendments to these plans should be approved by SEPA in advance of their implementation. These limitations and conditions are in addition to the standard conditions relating to management that are included in all of SEPA's RSA 93 Authorisations.

SEPA considers that DSRL have met satisfactorily the GRA's requirement for an environmental safety culture and management system at this time.

4.3.5 Requirement 5 – Dose constraints during the period of authorisation

The GRA states:

During the period of authorisation of a disposal facility for solid radioactive waste, the effective dose from the facility to a representative member of the critical group should not exceed a source-related dose constraint and a site-related dose constraint.

The facility will be authorised under RSA 93 for the period of operation and institutional control. As discussed in the GRA, dose constraints, placing an upper bound on radiation exposures to the public from the facility, will apply during the period of authorisation. The dose constraints are:

- 0.3 mSv per year from any source from which radioactive discharges are made; or
- 0.5 mSv per year from the discharges from any single site.

The Health Protection Agency has recommended that an annual dose constraint of 0.15 mSv should apply to exposure to the public from a new disposal facility for radioactive waste (8).

DSRL's application for an Authorisation under RSA 93 states that there will be no discharges to the atmosphere or to the water environment and their facility design reflects this. ESC 2010 does not consider operational safety issues and states that the only possible pathway of exposure to the public during operations is skyshine resulting

from the scattering of very low levels of radiation from the packaged waste as it passes through the atmosphere above the facility.

Operational controls combined with the roof and walls of the disposal vaults will prevent the release of contaminated dusts associated with the disposals. Water ingress to the vaults during operations will be prevented and any accidental ingress will be controlled and monitored. Operational worker safety, worker exposures, and accidental releases are not subject to authorisation under RSA 93. Any releases from the grouting facility will be covered by the RSA 93 Authorisation for the Dounreay site.

DSRL have assessed the potential annual doses through skyshine from one low level waste disposal vault in various scenarios ranging from an individual spending 4 hours per day outdoors at a distance of 660m from the site (the nearest house), to a farmer working 2 days a week in a field between the vault and the nearest house and to an individual spending 24 hours a day outdoors 660m from the vault. All the calculated doses are around a thousand times below the source-related dose constraint.

Conclusion

SEPA's Authorisation for the facility specifically prohibits discharges of radioactive gaseous and aqueous wastes. Furthermore, SEPA has included conditions that require DSRL to produce, maintain and implement contingency arrangements and emergency plans for reasonably foreseeable events including, but not restricted to corrosion, explosion, flooding, fire and loss of containment of the waste. The Authorisation also requires DSRL to prepare, maintain and implement a monitoring plan for the site and the facility, to detect any unexpected releases of radioactivity into the environment.

SEPA considers that ESC 2010 meets satisfactorily Requirement 5 of the GRA.

4.3.6 Requirement 6 – Risk guidance level after the period of authorisation

The GRA states:-

After the period of authorisation, the assessed radiological risk from a disposal facility to a person representative of those at greatest risk should be consistent with a risk guidance level of 10^{-6} per year (i.e. 1 in a million per year).

The period which the risk guidance level applies to is that period after the closure of the facility and the cessation of institutional control. The term "risk guidance level" is used because it indicates the standard of environmental safety SEPA is looking for, but does not suggest that there is an absolute requirement for this level to be met. The value of 10^{-6} per year is consistent both with the Solid Low Level Waste Policy (9) and with advice given in the HSE publication "Reducing Risks, Protecting People" (10). HSE identifies this value as "a very low level of risk" which should be used as a guideline for the boundary above which people are prepared to tolerate risks in order to secure the benefits from the activities giving rise to the risks and below which risks are broadly accepted by society because they are generally regarded as insignificant.

Performance Assessment

ESC 2010 addresses Requirement 6 in chapter 7 which discusses the approach, methodology and results of DSRL's quantitative assessment of safety, which it refers to as a performance assessment (PA).

DSRL's initial PA, Run 1 PA, was undertaken between 2000 and 2002, in support of their BPEO process, with two independent sets of calculations being undertaken by two different contractors possessing internationally-acknowledged experience of the development of PAs. This was intended to build confidence in the PA results and provide a means of evaluating the differences and similarities between the different PA methodologies and tools. A second iteration of the PA, Run 2 PA, was conducted in 2007/8 to reflect changes in the location and layout of the facility and the improved understanding geology and hydrogeology resulting from site characterisation work.

Given the highly specialised technical nature of the PA models, SEPA commissioned a review of the second PA and ESC 2008 by Brenk Systemplanung GmbH, a German consultancy with extensive relevant experience. The review was broadly favourable, concluding that DSRL's approach to the PA was compliant with regulatory requirements and international standards.

A third iteration of the PA, Run 3 PA, was undertaken to support ESC 2010 and to account for project developments since 2008, such as the refined disposal inventory and specific comments arising from the Brenk Systemplanung GmbH review.

All iterations of DSRL's PA have used a formalised and systematic methodology which is clear and transparent so as to build confidence in the results. The approach to Run 3 PA is described in DSRL's PA documentation (11). Runs 2 and 3 of the PA followed internationally-recognised good practice in this field, described in the ISAM methodology (5) published by the International Atomic Energy Agency (IAEA), whilst Run 1 PA was approached by both contractors in a manner consistent with the ISAM methodology.

Run 3 PA describes the disposal system according to its main components or barriers:

- The near-field, which includes the waste, the disposal area, the engineered barriers of the disposal facility, and the disturbed zone of the natural barriers that surround the disposal facility.
- The geosphere, consisting of rock and other material that lies between the near-field and the biosphere.
- The biosphere which consists of physical media such as air, soil, waters and sediments and the organisms, including humans, that interact with them.

Assumptions concerning the future evolution of the facility and the potential impacts of climate change and other external factors are addressed as part of the scenario development process.

Scenario Development

Scenario development is intended to determine which phenomena and components of the disposal system are to be addressed in the PA. The phenomena and components are usually referred to as Features, Events and Processes (FEPs). The scenarios can be considered as broad descriptions of alternative futures of the waste disposal system which may occur over time.

DSRL's scenario development methodology has been consistent with that set out by a Nuclear Energy Agency (NEA) working group (12) and DSRL have defined two main classes of scenario. The first is the undisturbed performance scenario based on the FEPs that are likely to occur over the assessment timeframe and the second is the disturbed performance scenarios. The disturbed performance scenarios consider one or more FEPs that could be potentially significant to the performance of the disposal system and capable of bypassing or eliminating one or more of the disposal system barriers.

The modelling of the undisturbed performance is detailed in ESC 2010. To summarise, a combination of chemical and physical processes degrade gradually the near-field engineered barriers, leading to changes in hydrological, chemical and mechanical conditions. Radioactivity is either retained in the near-field until it has decayed or it is released in the form of gas or liquid. Radionuclides released in the liquid phase migrate through the geosphere through a range of pathways to the biosphere. Releases of gas are assumed to move directly to the biosphere.

The timescale for the PA for the undisturbed performance extends until the peak or maximum risk to the identified and defined potential exposure groups (PEGs) has passed and the subsequent risk is insignificant. DSRL report that their PA has been run to 100,000 years into the future but the peak dose from the natural groundwater pathway is calculated to have passed by 50,000 years.

DSRL have identified and assessed the following disturbed performance scenarios:

- Inadvertent human intrusion;
- Groundwater extraction;
- Glaciation;
- Coastal Erosion; and
- Ground Rupture.

DSRL's consideration of the inadvertent human intrusion and the groundwater extraction scenarios is discussed in the context of Requirement 7 of the GRA below.

ESC 2010 considers that, on the basis of a range of possible future emissions of anthropogenic greenhouse gases, glaciation is not expected to affect the Dounreay area in the next 50, 000 to 100, 000 years. The next glacial maximum is thought to be around 180,000 years from now (13). Although there is a high degree of uncertainty in the timing of the next period of glaciation, DSRL assert that after 50, 000 to 100, 000 years most of the radioactivity in the facility will have decayed. The glaciation is assumed to disturb the waste from the facility and mix it with a larger volume of material than considered in the human intrusion disturbed performance scenario. For simplicity, therefore, DSRL have considered the same calculation undertaken for inadvertent human intrusion as an upper bounding or maximum case for the glaciation scenario.

The coastal erosion scenario considers the possibility of an extended period of high sea level and/or an increased rate of erosion leading to the complete erosion the facility onto the foreshore and then into the sea.

The ground rupture scenario considers movement of one or more faults near or beneath the facility causing rupture of the barriers around the vaults and cracking of the grouted waste after active institutional control has ceased.

DSRL have extended their modelling of the ground rupture and coastal erosion scenarios until the maximum risk has passed following the disruptive event. The glaciation disruptive event has been considered by DSRL at 100, 000 years only to illustrate the low consequences at this timescale irrespective of the uncertainty over the exact timing of the event.

ESC 2010 discusses DSRL's audit of the scenarios considered in their Run 3 PA against a list of scenarios modelled for other low level waste facilities worldwide (5) and have identified no gaps or omissions.

PA Conceptual Model Development

ESC 2010 describes the near field conceptual models in terms of groundwater flow and chemistry. The model reflects the facility design to date and the transport of radionuclides out of the vaults as the concrete and waste forms degrade slowly through a combination of physical, chemical and mechanical processes. It is assumed conservatively that the radionuclides will dissolve instantaneously on contact with water in the grouted waste form. Release from containment is delayed until such time as the facility is assumed to saturate and the waste containers are assumed to have been breached.

For the geosphere DSRL's conceptual model considers two parallel paths running northwards from the facility with one covering releases from the low level waste vaults and the second from the demolition waste vaults. Pathways through the geosphere are considered as a series of compartments containing four differing geological layers. The flows in the geosphere are based on the present day local scale hydrogeological model for the area (14).

The impact of future climates and in particular a warming climate on sea level rise is represented as a period of coastal erosion. At some point, a gradual cooling of the climate is expected and the sea level will start to fall due to a build up of ice volumes resulting in the emergence of new land off the Dounreay coastline. Mixing and dispersion in the marine environment is considered using a model previously used to assess the performance of the shaft on the Dounreay site.

The biosphere model considers how humans might be exposed to radioactivity released from the facility. The GRA requires consideration of different groups of people that could be at risk of exposure (known as potentially exposed groups or PEGs) in order to identify those people at greatest risk at a given time. The choice of PEGs is considered reasonable having used a methodology based on recommendations by the IAEA (15). They are based on observations of present day activities in the area as described in the 2003 Dounreay habits survey conducted for SEPA (16).

Owing to uncertainties as to how the climate and society will evolve in the long-term, ESC 2010 also adopts a hypothetical PEG based on a breakdown of society and return to a subsistence lifestyle in a temperate climate. This crofter PEG is exposed to pathways through the use of the contaminated area to support a subsistence lifestyle.

DSRL avoids using extreme or unlikely habits but assumes that a self-sustaining crofting community could arise in the future on the coastal strip of agricultural land extending north east from the facility and south west toward Sandside bay. DSRL assume that the community consists of a number of crofts each of which is large enough to allow the production of a range of foodstuffs. Bartering between crofts would enable the community to be self sustainable. One croft is assumed to be situated on the site of the facility using an area for arable farming, one for the stocking of cattle and a third area of poor quality land for grazing sheep.

The crofter PEG is assumed to live in a house on the cap of the facility and to derive all meat (beef, lamb and chicken) and eggs from livestock grazed on contaminated pasture and water and consume all their required green and root vegetables from produce grown on contaminated arable land. Additionally, it is assumed that the crofter PEG obtains fish, crustacean and molluscs from the contaminated foreshore and the sea offshore from the facility. Meat and potatoes are assumed to be eaten at the critical group rate derived from the SEPA habit survey and the remainder of the foodstuffs at the average UK rate. The average crofter PEG is assumed to receive one third of their calorific intake from contaminated foods.

The GRA requires assessment of the impact of gas pathways. Radon will be formed from the decay of radium and there is an assumed a flux for gaseous C-14 and H-3 based on a fraction of the disposed inventory divided by the timescale over which the gas production is assumed to occur. The concrete walls and fractured rocks could have sufficiently high permeabilities to allow gas escape.

Given the short half life of radon, the characteristics of its emanation and transport have been considered in greater detail by DSRL. The presence of the facility cap and local geology leads DSRL to suggest that significant radon migration from the waste or groundwater into a dwelling is unlikely.

DSRL's PAs have all used standard, internationally recognised uptake and transfer factors and dose coefficients to calculate doses arising from the activity concentrations modelled in foodstuffs and environmental media in each of the assessed biosphere exposure pathways.

ESC 2010 describes how other modelling parameters have been formally documented in a parameter database (in ESC 146) providing an auditable trail for the parameter value derivation. The database contains, where possible, maximum, minimum and best estimate values to support uncertainty analysis. Data are a mixture of site specific and generic, favouring the former where it is available. Data sources are either literature from international programmes including those organised by the IAEA or reports prepared by contractors to DSRL in support of the ESC.

Run 3 PA has been conducted using the GoldSim-RT modelling tool (17' 18) which has been recommended for use by the Environment Agency for England and Wales (19). ESC 2010 explains further the models capabilities and use.

Results

The results of Run 3 PA, and previous PAs, are described by DSRL as being illustrative of potential consequences to aid understanding and demonstrate safety. They do not

represent reality; rather they represent a set of modelling assumptions. The simplifying assumptions made in Run 3 PA are generally cautious thereby increasing calculated doses.

ESC 20210 presents the results of Run 3 PA in terms of radiological dose as opposed to risk. DSRL argues that rather than assign probabilities to scenarios, given the uncertainty over climate change, risks have been equated to calculated doses in the Run 3 PA results using the dose to risk conversion factor of 0.06 per Sv given in the GRA. The risk guidance level in the GRA of 10^{-6} (or 1 in a million) has been equated to a 'dose target' of 0.02 mSv per year. This assumes conservatively that the probability of any exposure occurring is 1 i.e. it is certain to occur.

Undisturbed Performance

ESC 2010 states that none of the PA runs for the undisturbed performance scenario have shown calculated doses in excess of the dose equivalent to the GRA risk guidance level. The most exposed PEG is assessed as being the crofter and peak doses occur after tens of thousands of years after closure. DSRL argue that the engineering of the facility clearly limits the release of radionuclides and consequent exposure in early times and the calculated doses start to rise after a few thousand years when most of the radioactivity will have decayed. These doses are dominated by the release of long-lived actinides once the engineering of the facility has degraded significantly.

ESC 2010 presents graphically the calculated annual doses to all PEGs, the exposure pathways to the crofter PEG and the contribution to the calculated annual dose to the crofter PEG from individual radionuclides.

The key exposure pathway to the crofter PEG is through the consumption of livestock raised on contaminated pasture. The consumption of eggs and irradiation due to occupancy are other pathways that are significant in terms of the crofter PEG exposure compared that of a livestock farmer PEG who is also assumed to consume livestock.

The dilution of the groundwater and surface waster discharges in the marine environment results in low concentrations of radionuclides in the marine environment, fish and crustaceans. As a result the dose to the angler and potter PEGs are very low. In comparison the ESC 2010 suggests higher radionuclide activities in the foreshore and intertidal area where eroding material and discharged groundwater can reside for some time before being washed in to the sea. The winkler PEG therefore receives a higher dose than the potter or angler PEGs and it is the winkle consumption pathway that dominates the exposure of the crofter PEG through consumption of marine foods.

The main radionuclides contributing to the dose to the crofter PEG are Pb-210, Po-210 and Ra-226 as a result of U-234 and the long-lived daughter Th-230 migrating from the facility over long timescales and accumulating in the geosphere. At earlier times in the assessment Se-79 is the key contributor to dose. For all foodstuffs in all ingestion pathways for all PEGs Pb-210, Po-210 and Ra-226 are dominant in varying proportions. The assumption that Po-210 has the highest uptake results in it being the dominant radionuclide in the total dose to the crofter PEG.

Peak dose from the gas pathway are reported to be to residents in a house built on the cap over the LLW vaults. Doses from H-3 in hydrogen gas generated from the corrosion

of steel are assumed to drop quickly after closure due to radioactive decay during an assumed period of active institutional control of 300 years. Similarly, assuming high cellulose degradation rates, the generation of methane will have ceased by 100 years after closure. The calculated annual doses from radon inhalation in a house built on the facility cap peak some tens of thousands of years after closure. DSRL states that this would be several times smaller than the lowest radon dose from natural radium in the soil.

Disturbed Performance

ESC 2010 presents two calculations for the coastal erosion scenario to account for uncertainty in erosion rates. A pessimistic rate of 50 mm per year and a best estimate of 10 mm per year have been used. The assessed annual dose to the crofter and livestock PEGs decreases, compared to those for the undisturbed performance scenario, as a result of the erosion of land suited for livestock and arable crops. Calculated dose to the PEGs using the foreshore do increase during the erosion but at very low levels.

It is assumed that glaciation of the Dounreay area will likely be over 150,000 years into the future and a significant part of the radioactive inventory will have decayed or leached into the groundwater. The assessment of glaciation considers, as in the human intrusion scenarios, a site resident PEG building a house and farming on top of the material left by the glacier and depends on an assumption of how much activity had leached from the facility. The calculated dose based on leaching levels from the undisturbed performance reference calculation is four orders of magnitude below the dose that is equivalent to the GRA's risk guidance level.

The ground rupture scenario assumes the cracking of the grouted waste and vault walls 200 years after closure. DSRL's PA showed there was little difference in peak annual dose to the crofter PEG between the ground rupture scenario and the undisturbed performance scenario.

Uncertainty analysis

The GRA recognises that the management of uncertainties is a necessary and important part of establishing an environmental safety case. Whilst uncertainties in themselves are not obstacles to establishing the safety case they need to be accounted for explicitly, their possible consequences analysed and consideration should be given to whether they can be reduced or their effects lessened or compensated for.

To account of uncertainties DSRL have used cautious modelling assumptions to illustrate the potentially most significant consequences of a given pathway or combination of pathways. In particular, cautious assumptions have been adopted regarding leaching of radioactivity into infiltrating groundwater (rapid failure of containers, instantaneous dissolution of radionuclides), migration of radioactive gases (instant release), and behaviour of potentially exposed humans (deriving key foodstuffs from the small area of land potentially contaminated by releases from the facility) (20).

ESC 2010 also considers uncertainties in three categories:

- Scenario uncertainty relating to the future evolution of the disposal system.

- Model uncertainty introduced by the inevitable assumptions and simplifications in the conceptual, mathematical and numerical models.
- Parameter uncertainty relating to parameters used in the modelling programme.

Where possible the uncertainties have been addressed in terms of parameter value ranges. However where these reach a limit that causes a fundamentally different future evolution this is treated as a scenario uncertainty. Model and scenario uncertainties have been considered by the use of alternative deterministic calculations using best estimate parameter values to illustrate the potential consequences of each scenario or alternative model. Where uncertainties are considered difficult or impossible to quantify reliably and relate to events that could impact significantly on the disposal system they have generally been defined as separate scenarios. These include disturbed performance scenarios such as coastal erosion and ground rupture.

Generally speaking uncertainties in the undisturbed performance scenario relate to chemical, hydrogeological or degradation rates for the near-field, geosphere and biosphere compartments.

For the disturbed performance scenarios only one model and one set of parameter uncertainties have been identified for each scenario. For example, for the inadvertent human intrusion scenario and that for groundwater extraction, the calculation is made for the disruptive event occurring each year after closure up to 100, 000 years.

A number of calculations have been undertaken for the Undisturbed Performance scenario to evaluate model and parameter uncertainties. The effects of most uncertainties on calculated dose from groundwater releases are minimal. The most significant uncertainties are as follows:

- The uncertainties in the soil retardation properties and the biosphere uptake factors have been evaluated probabilistically, and can create a two-order and one-order of magnitude variation in the calculated annual doses, respectively. In each case, the top end (95th percentile) of the calculated dose range is close to, or slightly above, the dose equivalent to the GRA's risk guidance level. These are still considered to be broadly acceptable by SEPA as the guidance level can, according to the GRA, be exceeded and the conservative assumptions used in the models will result in high assessed doses.

- The calculated annual dose is more sensitive to the degree of accumulation (i.e. net concentration) of the key radionuclides in the soil, rather than the time it takes for the parents of the key radionuclides to travel through the geosphere to the biosphere.

- Lower doses are calculated if upward flows in the geosphere are significantly reduced between the unweathered bedrock and the near-surface groundwater system or between the near-surface groundwater system in the weathered bedrock and the soil. Given the obvious benefit in terms of potential long-term dose, future cap design and optimisation studies will consider measures to minimise upward flows to the surface. SEPA and DSRL are continuing discussions in this area.

With regard to the gas pathway, the key uncertainties associated with the calculation of dose from H-3 and C-14 are the gas generation rates and assumptions about the gas migration pathway and the proportion of the inventory that is released with the gas phase. Variation of these parameter values could give calculated peak doses around 0.02 mSv per year. However, this would require the PEG to be occupying a house on top of the facility shortly after closure, which is not considered credible since active institutional control will prevent occupancy on the cap at early times.

The key uncertainties associated with the peak dose from Rn-222 are the degree of accumulation of Ra-226 (from parent radionuclides) in soils at times far into the future following closure and the assumptions about the Crofter PEG incurring the dose. The latter are highly conservative, whereas the former would depend on groundwater leaching from the facility. ESC 2010 states that optimisation studies will be considered to reduce potential long-term dose and any option that reduces groundwater releases from the facility would also result in lower doses from Rn-222, especially at times far into the future.

Conclusion

SEPA considers that ESC 2010 presents a formalised and systematic approach to Run 3PA which is clear and transparent and meets international best practice. This view is supported by the review of ESC 2008 and the associated PA undertaken by Brenk Systemplanung GmbH.

It is recognised that the results of Run 3PA are illustrative of the potential consequences of the future development of the facility in both the undisturbed and disturbed scenarios. The assumptions used are suitably conservative and do not present an optimistic assessment of consequences. The crofter PEG presents a pattern of human behaviour that is conservative and likely to result in doses that are higher than those for other PEGs. In particular SEPA considers the likelihood of a crofter PEG obtaining so much of its food from the area of land contaminated by the facility as unlikely and their exposure is likely to be much lower than that presented in ESC 2010 which is still consistent with the risk guidance level.

ESC 2010 considers uncertainty in a transparent and systematic fashion. Whilst uncertainty analysis of soil retardation properties and biosphere uptake results in exposures close to or in excess of the risk guidance level SEPA still has confidence in the assessment due to the conservative assumptions used and the fact that meeting the risk guidance level is not necessarily an absolute requirement.

It is SEPA's expectation that future versions of the ESC will be supported by further iterations of the PA refined to reflect DSRL's optimisation studies and increased understanding of the site, facility design and the wastes to be disposed. Optimisation studies will likely reduce assessed doses to the PEGs and uncertainties further. With this in mind, SEPA considers that ESC 2010 meets the Requirement 6 of the GRA at this time.

4.3.7 Requirement 7 - Human intrusion after the period of authorisation

The GRA states:-

The developer/operator of a near-surface disposal facility should assess the potential consequences of human intrusion into the facility after the period of authorisation on the basis that it is likely to occur. The developer/operator should, however, consider and implement any practical measures that might reduce the chance of its happening. The assessed effective dose to any person during and after the assumed intrusion should not exceed a dose guidance level in the range of around 3 mSv/year to around 20 mSv/year. Values towards the lower end of this range are applicable to assessed exposures continuing over a period of years (prolonged exposures), while values towards the upper end of the range are applicable to assessed exposures that are only short term (transitory exposures).

The GRA considers the assessment of the impact of inadvertent human intrusion as a separate requirement from that relating to the post-closure radiological risk assessment (Requirement 6).

The GRA requires that human intrusion is assessed in terms of dose as opposed to risk because the likelihood of an intrusion event cannot reliably be assessed. Assessments should be made of exposures from a range of possible intrusion scenarios, including the consequences of emissions of gases, such as radon. The assessments should also demonstrate that dose thresholds for severe deterministic injury are not exceeded as a result of the intrusion.

The GRA regards human intrusion as falling into three classes:

- Intrusion with full knowledge of the existence, location, nature and contents of the facility;
- Intrusion without prior knowledge; and
- Intrusion with knowledge of the underground workings but without understanding what they contain.

Requirement 6 applies only to inadvertent human intrusion i.e. intrusion that falls into the latter two classes. Intrusion of the first class would be expected to be undertaken only with full awareness of and responsibility for the consequences.

DSRL have assessed human intrusion as a disturbed performance scenario in Run 3PA. Several FEPs have been considered, along with present day activities, in developing the following activities that may lead to inadvertent intrusion into the cap and wastes of the facilities:

- Quarrying for flagstones, rock or concrete;
- Drilling and small scale excavation activities for farming, archaeology or as a precursor to other activities;
- Residential, industrial, leisure and transport construction activities.

Intrusion by burrowing animal or plants has not been assessed on the grounds of the robustness of the anti-intrusion cap, the depth of the facilities and the lack of trees on the coastal area at Dounreay. SEPA is broadly in agreement with this assumption.

Given the difficulties in assessing the likelihood and nature of any inadvertent intrusion Run 3 PA uses a stylised human intrusion scenario which bounds the potential consequences of the largest possible intrusion associated with all possible activities.

There is no assumed period of active institutional control before the complete excavation of the top few metres of the below-surface facilities, to capture the potential effects of bulldozing of the facility for redevelopment as a residential area, leisure development, road building, or the like. The excavated waste is assumed to be mixed with soil over an area sufficient to support subsequent use of the soil for agricultural purposes. This ensures that the dose calculated to a user of the site is higher than that which might result from any other land use after redevelopment. Similarly, assumptions about the exposure of an intruder to the waste during the excavation are made to ensure an upper bounding potential dose is calculated. The calculations are repeated for different times of intrusion after closure.

The waste is assumed to be spread over a soil area sufficient to support crofters PEG specified for the undisturbed performance scenario. The waste activity is diluted by 1:4 to account for the minimum dilution that is likely during any development. It is likely that the soil improvement that would be required to develop the excavated material into a form suitable for agriculture would require much greater dilution. Also considered is the dose to site excavator PEG undertaking the excavation who are assumed spend a full year undertaking the work and are exposed to raw waste directly for 10% of their working time.

The doses are calculated for the year after closure that the excavation takes place and it is assumed that the peak dose for any single event will occur at the time of the event. The waste activity used in each calculation is based on the activity in the near-field at the time of excavation allowing for decay and leaching of the waste up to. The conservative position of assuming no leaching of the waste prior to intrusion has been adopted. The redistribution of Ra-226 from the waste into the soil during excavation removes the attenuation of radon by the cap in the undisturbed performance scenario and increases the potential for exposures to radon through accumulation in the dwelling of the site resident PEG.

The calculated annual doses from inadvertent human intrusion immediately after closure of the facilities are below the lower dose guidance level of 3 mSv/y; the level for prolonged exposures. This includes the dose from radon inhalation. This represents the upper bounding or maximum case for the doses that might be received. Calculated doses fall rapidly in the first hundred years as the short-lived radionuclides in the facilities decay, and thereafter decline slowly as only long-lived radionuclides remain in the facilities.

DSRL cites HPA (21) as stating that for near-surface disposal facilities, the annual dose range of 3-20 mSv/y will "*ensure that the doses from inadvertent human intrusion are well below the level that could give rise to severe deterministic effects.*" DSRL argues that, as all of the calculated effective doses from inadvertent intrusion into the facilities are below 3 mSv/y, the dose thresholds for severe deterministic injuries will not be exceeded and it is unnecessary to undertake further calculations to determine doses to individual organs. The site excavator PEG is assumed to work in an excavation in the waste for an entire year and, over such a period, exposures to localised elevated activities for one or two weeks would likely be moderated by exposures to less active

wastes for the rest of the time. The calculated doses are considered to be a reasonable average for annual exposure to a range of waste activities.

The possibility of extracting groundwater contaminated by radioactive releases from the facilities cannot be completely ruled out. At SEPA's request DSRL's Run 3 PA models the potential consequences of this highly uncertain possibility by considering a stylised scenario where drinking water and water for livestock are abstracted from a borehole/well into the groundwater zone with the highest levels of contamination from the facilities.

The groundwater extraction scenario considers drilling of a borehole/well into the most contaminated groundwater, and abstraction of this water for drinking without dilution. Sufficient water is assumed to be available only to support the one crofter PEG family. A shallow well is assumed to be dug into the weathered bedrock to a depth of a few metres; and a deep well is assumed to be drilled into the highest area of contamination in the unweathered bedrock at a depth of 10-20 m. ESC 2010 presents two alternative performance measures for this scenario:
DSRL have made an assessment against the risk guidance level in the GRA using conservative assumptions of the probability of a well being used based on the recent SEPA habit survey of the Dounreay area. They report that calculated risks from deep and shallow wells, assuming the conservative probabilities, peak at one and two orders of magnitude below the GRA risk guidance level respectively.

The stylised nature of the calculation and the assumption that the borehole bypasses the geosphere barrier of the disposal system have lead DSRL to also compare the consequences to the GRA dose guidance level proposed for assessing inadvertent human intrusion. This removes the need to speculate about the likelihood of the scenario. The calculated doses are well below the GRA dose guidance level for prolonged exposure (3 mSv/year).

DSRL addresses the main uncertainties related to inadvertent human intrusion by using upper bounding, or maximum, stylised calculations with conservative assumptions including a lack of institutional control with doses assessed immediately after the facility closure and low levels of waste dilution in the soil. Exposure of the site excavator PEG is considered to be a reasonable average for annual exposure to a range of waste activities.

The drinking water borehole in the groundwater extraction Disturbed Performance scenario is located in the most contaminated groundwater zone, just downstream of the LLW vaults. Therefore, the calculated doses from drinking water are bounding or maximum consequences with respect to the location of the borehole. However, there is uncertainty over the dilution that the leachate from the facilities will undergo and it is assumed that dilution is necessary to make the water drinkable. DSRL's use of a 50-m wide strip of groundwater is considered reasonable. Reducing the width of the mixing zone might increase concentrations and calculated doses two-fold, but the doses would still be well below the regulatory performance measures.

Conclusion

DSRL have developed a reasoned and conservative assessment scenario for inadvertent human intrusion. Despite the conservative assumptions made, the short and

long term doses to the crofter and site excavator PEGs do not exceed the GRA's dose guidance levels. DSRL have also argued that there is no likelihood of severe deterministic effects from intrusion. Further, the sinking of a well or borehole does not result in exposure exceeding the dose or risk guidance levels. SEPA considers that ESC 2010 addresses Requirement 7 adequately at this stage.

4.3.8 Requirement 8 - Optimisation

The GRA states:

The choice of waste acceptance criteria, how the selected site is used and the design, construction, operation, closure and post-closure management of the disposal facility should ensure that radiological risks to members of the public, both during the period of authorisation and afterwards, are as low as reasonably achievable (ALARA), taking into account economic and societal factors.

Optimisation is a fundamental concept in the GRA, where it is expressed both as a Principle and a Requirement.

In this instance, given that the project for the development of the disposal facility began before publication of the current GRA, the terms best practicable means (BPM) and optimisation can be considered largely interchangeable.

Optimisation is a continuing, forward looking and iterative process aimed at maximising the margin of benefit over harm, whilst taking account of both technical and socio-economic factors. Optimisation should provide a radiological risk that is at a suitably low level but not necessarily the lowest possible radiological risk. Careful consideration needs to be paid to optimisation in a way that is proportionate to the radiological hazard. It should be considered at all stages of the lifecycle of a disposal facility, from the design stage to the end of the period of Authorisation.

SEPA expects DSRL to provide a written record, demonstrating that they have properly considered optimisation at each decision making and implementation stage, in their Environmental Safety Case.

ESC 2010 discusses optimisation primarily in the context of facility design decisions, as these had been the central focus of DSRL's best practicable means (BPM) studies to date. It includes a summary table which outlines the BPM/optimisation analysis undertaken by DSRL and this is presented below. The decision on the long-term management strategy for Dounreay's LLW was supported by the BPEO study (1) which compared and consulted on different strategic options. Initial facility designs were based on international best practice (22) with design options being analysed in terms of their implications for the Environmental Safety Case.

Subsequent BPM/optimisation studies have been undertaken by DSRL in a formalised and iterative manner consistent with DSRL's Dounreay site procedures (23) and regulatory guidance (24). The scope of these assessments reflects both the high level stage of the design and the need to address a wide range of factors including those raised by SEPA during technical meetings. The analyses are tailored according to the options considered and include issues such as:

- The number of people (workers and public) and other environmental targets that may be exposed to radiological risk.
- The chance they could be exposed to radiation, where exposure is not certain to happen.
- The magnitude and distribution, spatially and temporally, of radiation doses that they will or could receive.
- Nuclear safety and safeguards requirements.
- Issues similar to the above but relating to non-radiological hazards.
- Economic, societal and environmental factors.
- Uncertainties in any of the above.

In ESC 2010, DSRL considers the current facility design to be the optimised solution at this stage in the development of the project, being proportionate to the hazard posed by the wastes and representing best practice for near-surface waste disposals. The engineering is intended to ensure the waste is contained in the first few hundred years, during which the short-lived radionuclides will have decayed significantly, and to limit long-term risks to acceptably low levels. Placing the vaults underground and installing a thick cap are measures considered to reduce sufficiently the likelihood of human intrusion. The impacts of construction and operation on the nearest neighbours are considered by DSRL to have been mitigated as far as possible, taking account of future coastal erosion and sea level rise.

DSRL's forward programme states that as the design process progresses to a greater level of detail, more design optimisation work will be undertaken and reported in further iterations of the ESC. This work will cover waste acceptance criteria, waste packaging, drainage, flood management, ventilation, the capping system, drainage and closure.

Conclusion

SEPA have discussed optimisation extensively with DSRL during technical meetings and have reviewed DSRL's BPM documentation (25, 26, 27, 23). DSRL will continue to undertake BPM/optimisation studies in support of their decision making during the lifecycle of the facility.

SEPA's draft Authorisation includes a condition requiring DSRL to undertake reviews, at a frequency agreed in writing with SEPA, to demonstrate optimisation of radioactive waste disposals. Recognising that the optimisation process is an ongoing requirement, SEPA considers, at this stage of the facility design process, that Requirement 8 has been met.

Areas of BPEO/BPM and Optimisation Assessments Undertaken by DSRL in the Initial Stages of the Project (ESC 2010).

Design Area	BPEO 2004	BPM 2006	BPM 2007	BPM 2008	Optimisation 2010	Planned Studies
Strategy	All management options	N/A				
Facility Type	A wide range of disposal and storage options	Disposal options – deep cavern, below-surface vaults, above-surface vaults				
Facility Location	A range of options, screened to exclude non-UK locations	Restricted to NDA-owned land at Dounreay		Site selection review taking account of site characterisation and geophysical survey	Borehole monitoring and local-scale hydrogeological modelling	
Construction Design		Waste type, waste form, waste container, backfill, wall/base material, cap type	Waste container (Demolition LLW)	Design review taking account of site selection review and site investigation results	Vault walls and base materials	Grout mixture, vault loading strategy
Operational Approach		Temporary roof cover, waste package grouting system, Demolition LLW emplacement, drainage	Vault ventilation, Demolition LLW emplacement, drainage	Drainage and flood management, waste emplacement	Waste classification	Waste Acceptance Criteria, waste packaging, drainage, flood management, ventilation
Closure approach			Infilling, grouting sequence, backfilling requirements, vault lid, roof removal, final cap, drainage closure, reinstatement		Backfilling between vault walls and rock	Capping system, drainage closure

4.3.9 Requirement 9 – Environmental radioactivity

Requirement 9 states:

The developer/operator should carry out an assessment to investigate the radiological effects of a disposal facility on the accessible environment both during the period of authorisation and afterwards with a view to showing that all aspects of the accessible environment are adequately protected.

The release and migration of radionuclides from a disposal facility might have a detrimental effect on the accessible environment, through effects on non-human species or through more general environmental effects such as damaging habitat quality. This requirement aims to ensure that all aspects of the accessible environment are protected.

People are protected from the radiological effects of a disposal facility through application of the dose constraints (see Requirement R5), the risk guidance level (see Requirement R6), and the assessment of the potential impact of human intrusion (Requirement R7) and the optimisation requirement (Requirement R8). Although there is no specific evidence that there might be a threat to populations of non-human biota where it is demonstrated that the public are protected, there may be times when there are no people near a disposal facility and such a demonstration is not possible. Environmental damage might also occur in areas and habitats that are not extensively exploited by people. Furthermore, there is a specific need to be able to demonstrate that non-human species are protected under legislation related to conservation, for example that derived from the EC Habitats Directive (28).

ESC 2010 discusses the use of the concentrations of radionuclides in the environment calculated in Run 1 PA and a method for deriving estimates of radiological doses to biota developed by the Environment Agency and English Nature in 2001 (29) to estimate dose to non-human biota (30). This approach was supplemented by a number of other methodologies to accommodate the full range of radionuclides considered in the source term. Calculated concentrations of radionuclides in the environment are extremely low, as discussed below, and the calculated doses were less than 1% of the limits proposed for discussion by IAEA and less than 10% of the screening thresholds proposed by the Environment Agency and English Nature to determine potential impacts requiring more detailed consideration.

Run 3PA output has since been used along with the ERICA Integrated Approach to assess radiological risks to terrestrial, freshwater and marine biota (31) and demonstrate the protection of non-human biota (32). This approach is based on a comparison of dose rates to a range of organisms in different ecosystems to specified radiological criteria. The approach uses a series of assessment tiers (Tiers 1 to 3), with increasing model detail, and related data requirements, in successive tiers. The Tier 1 assessment is designed to be simple and conservative, requiring a minimum of input data. A Tier 2 assessment is more interactive, potentially modifying the default Tier 1 assessment parameters and calculating the potential doses for specific reference organisms. A comparison can then be performed for the selected reference organisms directly against the screening dose rate. Tier 3 is a probabilistic risk assessment in which uncertainties within the results may be determined using sensitivity analysis

DSRL report that their assessments of potential dose rates to non-human biota showed that, owing to dilution, the risk to non-human biota in the marine ecosystem

from releases from the facility can be considered to be negligible without further assessment.

The results of a Tier 1 assessment for the freshwater ecosystem demonstrate that for a period of 5000 years after closure, environmental concentrations will be sufficiently low that the dose rate to any organism will not exceed the ERICA screening dose rate criterion of 10 μGy h^{-1}. Therefore, the risk to non-human biota is negligible over this period.

Beyond 5000 years, increases in environmental concentrations of some radionuclides mean that the results of the Tier 1 assessment for the freshwater ecosystem do not allow a conclusion to be drawn regarding dose rates for some organisms. A Tier 2 assessment for the freshwater ecosystem demonstrated that dose rates to these organisms will be sufficiently low for the risk to non-human freshwater organisms to be considered negligible over the entire assessment period.

The results of a Tier 1 assessment for the terrestrial ecosystem demonstrated that environmental concentrations under undisturbed conditions will be sufficiently low that the dose rate to any organism will not exceed the ERICA screening dose rate, and the risk to non-human organisms in the terrestrial ecosystem is negligible. Similarly, a Tier 1 assessment demonstrates that there will be no significant harm to non-human species from concentrations of radionuclides in soil following inadvertent intrusion of the facilities by humans.

ESC 2010 also compares radionuclide concentrations in various media modelled in the successive PAs to naturally occurring background levels. Concentrations of radionuclides in the environment arising from the facilities are reported to be low compared to measured present day activities in grasses and fluxes and groundwater discharges at the Dounreay site.

Conclusion

It is SEPA's expectation that future versions of the ESC will be supported by further iterations of the PA refined to reflect DSRL's optimisation studies and increased understanding of the site, facility design and the wastes to be disposed. Optimisation studies will likely reduce fluxes of radioactivity in the environment and the resulting potential doses to non-human biota further.

SEPA have included a condition in the Authorisation requiring DSRL to undertake an agreed programme of environmental monitoring to demonstrate the protection of the public and environment. It is SEPA's view that ESC 2010 meets Requirement 9 of the GRA at this time.

4.3.10 Requirement 10 – Protection against non-radiological hazards

The GRA states:-

The developer/operator of a disposal facility for solid radioactive waste should demonstrate that the disposal system provides adequate protection against non-radiological hazards.

Wastes disposed to a facility receiving solid radioactive waste may be potentially harmful wholly or partly because of their non-radioactive properties. There are nationally accepted standards for disposing of hazardous waste. However it may not be suitable to apply these to waste that presents both radiological and non-

radiological hazards. Accordingly, these standards need not necessarily be applied, but a level of protection should be provided against the non-radiological hazard that is no less stringent than that which would be provided if the standards were applied.

ESC 2010 discusses the inventory of potentially hazardous components of Dounreay low level waste, based upon best estimates of their masses taken from Dounreay Radioactive Waste Inventory 2009. DSRL argues that the small inventory and high standard of engineering of the vaults are considered to provide a level of long-term protection of the environment against non-radiological hazards that is no less stringent than that provided by national standards for disposing of hazardous waste. The facilities will be at least equivalent to a hazardous waste facility in five key areas:

- The engineering design standards will ensure that the bases and walls of the vaults are a minimum of 0.5 meters of concrete thickness with a suitably low permeability ($< 10^{-10}$ m/s). These are considered to be equivalent to the requirements for a hazardous waste facility under The Landfill (Scotland) Regulations 2003.
- DSRL anticipate that few hazardous contaminants will be present in the LLW in any significant quantity and these will be rendered immobile for the first few hundred years after closure by the waste conditioning and packaging. An appropriate level of protection of the water environment is expected to be provided by the containment facilities during this time. This will be due to the engineered barriers impeding water ingress to the waste and the low level of leachability of the grouted waste form. DSRL anticipate that there will be even fewer and lower quantities of hazardous contaminants present in demolition low level waste. DSRL will construct the bagged demolition low level waste vaults to the same standard of permeability as the LLW resulting in containment of the hazardous contaminants over a similar timescale.
- DSRL's proposed WAC for the facilities stipulate that the chemical characteristics of the disposed wastes must not breach conventional waste management regulations or compromise safe management during the transport, disposal, closure, and post-closure phases. Potentially hazardous materials in the radioactive wastes will be identified and controlled in compliance with conventional waste management regulations. The WAC for disposal of LLW and Demolition LLW packages been set on the basis concentration targets with respect to raw waste weights: <0.1 wt% for "very toxic substances"; and <3 wt% for "toxic substances". DSRL state that asbestos is the only potentially "very toxic substance" likely to be present in the waste. Information provided by the waste consignor will record the presence of potentially "very toxic substances", which would trigger appropriate treatment before acceptance for disposal is approved.
- DSRL's management plans are discussed under Requirement 4. Authorisation conditions will require DSRL to prepare, maintain and implement a Management Plan which will include WAC implementation and waste receipt and disposal. These will be intended to ensure that the waste packages received comply with the WAC.
- DSRL's monitoring plan is discussed under Requirement 14. In order to provide reassurance that post-closure performance standards will be met, appropriate environmental monitoring programmes will be implemented during the period of institutional control.

<u>Conclusion</u>

SEPA and DSRL have discussed this issue at a number of technical meetings. SEPA is satisfied that DSRL's approach provides a level of protection that is no less stringent than the requirements of the Landfill (Scotland) Regulations 2003. DSRL expect the containment functions of the vaults to be maintained for at least several hundreds of years. SEPA's draft Authorisation includes conditions relating to the design and construction of the facilities intended to ensure that this level of protection is met. SEPA considers, at this stage of the facility design process, that Requirement 10 has been met.

4.3.11 Requirement 11 – Site investigation

The GRA states:

The developer/operator of a disposal facility for solid radioactive waste should carry out a programme of site investigation and site characterisation to provide information for the environmental safety case and to support facility design and construction.

The length, complexity and detail of the site investigation need to be appropriate for the information requirements of the environmental safety case and in turn proportionate to the hazard presented by the waste. The site investigation should be presented as part of a structured programme. Characterisation should demonstrate that the geological, hydrogeological and other characteristics of the site under present and reasonably foreseeable future conditions will allow the environmental safety case for the facility to be made. This demonstration should include the release and transport of radionuclides in the gaseous phase.

Any actual or potential valuable resources near the site should be identified and an assessment made for the site to be disturbed including the implications for the integrity of the disposal system and inadvertent human intrusion.

SEPA expects DSRL's knowledge of the site characteristics to increase progressively through the site investigation and the facility development phases. We shall be proportionate in our assessment of the adequacy of the site characterisation information presented in the context of an evolving environmental safety case.

ESC 2010 describes how the first iteration of the ESC was accompanied by a Site Characterisation Plan (SCP) (33) covering two phases of activity up to the start of construction. Phase 1 was specified in detail whilst activities under Phase 2 were only outlined. DSRL's intention was that the SCP would be reviewed periodically in light of ongoing work and stakeholder comments and the Phase 2 activities would be refined accordingly. The results and interpretation of the Phase 1 site investigations were summarised in the Site Characteristics Summary and Site Characterisation Plan 2007 (34), which also presented a review of the SCP for ongoing site characterisation work. Several short-term studies were undertaken to resolve uncertainties and issues that had arisen during implementation and interpretation of the Phase 1 results.

Following dialogue with SEPA in 2008, it became apparent that the arrangement of boreholes drilled during Phase 1 would be insufficient to provide a groundwater monitoring network for the site and a new suite of boreholes was drilled at the beginning of 2009. Phase 2 of site characterisation ended in 2011 and DSRL propose that Phase 3 will run in parallel with the detailed design and construction of the facilities. Site Characteristics Summary 2010 (35) supports ESC 2010 and is

based on the investigations to date. An update to the SCP detailing the remaining activities has also been developed (36).

ESC 2010 outlines the main investigations undertaken and these include trenching, multiple sets of boreholes, water balance studies, geophysical surveys, a baseline radiological survey and an assessment of environmental radioactivity in waters from the study area.

Site characterisation, to date, is discussed in ESC 2010 under six topics described in relation to the details of Requirement 11 in the GRA. These are summarised below:

Physiography and Land Use

This describes the coastal site of the facilities adjacent to the Dounreay nuclear licensed site and north of a redundant airfield runway and its current use predominantly as rough grazing for cattle and sheep. Further discussion of local land use is based on SEPA's 2003 habits survey around the Dounreay area (16) It is not believed that the foreshore area is currently actively fished and given the quality of the land between the facilities and the coast, only farming of livestock is considered a realistic land use for the site.

Geology

ESC 2010 provides detailed descriptions of the geological succession, the jointing and bedding of the study area. The geology of the LLW study area is described as relatively simple, consisting of a thin layer of superficial Quaternary deposits overlying Devonian bedrock which is mainly siltstone and fine sandstone. It is anticipated that the revealed geology following excavation of the vaults will inform the geological characterisation further. Understanding the geology of the site is an important aspect of the safety case given that the geosphere constitutes one of the main components or barriers of the disposal system

Climate

The current temperate climate conditions are described in terms of annual rainfall and the average monthly maximum and minimum temperatures. ESC 2010 notes that the area is extremely windy which could lead to the erosion of exposed soils.

Hydrogeology

The surface water balance, groundwater flow and hydraulic conductivities at the site are described in detail in ESC 2010. Groundwater flow has been identified in DSRL's PA as a key pathway for radionuclides leaching from the facility to reach the biosphere and this aspect of site characterisation has been a key area of interest to SEPA.

The present day surface water balance is affected by engineered drains under the Dounreay site and runway and a complex network of semi natural drains to the north-west. The engineered drains are assumed to fail over the longer term. DSRL report surface water observed discharging from the ditches over the cliffs whilst further inland, around the runway area, the water table is believed to be below the land surface and it is assumed precipitation infiltrates through the surface to recharge the groundwater.

The subsurface hydrogeology is characterised by water flow along fractures in the unaltered, low permeability bedrock probably through the entire mass of the more permeable overlying, near surface weathered bedrock. Hydraulic conductivities are reported for the overlying soil, till, weathered bedrock and unaltered bedrock and relatively consistent with depth.

ESC 2010 suggests that the near surface groundwater flow is towards the sea (36 and 37) with groundwater level contours roughly parallel to the coast. Similarly, DSRL discuss the flow of deeper groundwater towards the sea.

Geochemistry

The analysis of groundwater sampled from DSRL's boreholes is reported in terms of major, minor and trace element composition and levels of background radiation to provide a baseline dataset. The geochemistry is discussed in terms of its consistency with DSRL's hydrogeological models for the site and the results of the local scale hydrogeological model. The data also provides insight into conditions that influence the retardation and sorption of radionuclides and their treatment in the PA models for the site. These data are supported by experimental sorption studies that are discussed in ESC 2010.

Resource potential

The review of the resource potential of the site considers the exploitation of underlying rocks for flagstones stating that the resource is plentiful in the Caithness area and there is no particular reason why the site would be chosen for its excavation. There are no other significant resources identified at the site. Given the volumes of rainwater and standing water in the area DSRL see no reason for groundwater to be abstracted. This has however been considered under Requirement 7.

Potential for Future Disruption of the Site

ESC 2010 discusses a number of potential causes of disruption of the site identified from the scenario development process for the PA. These are changes in sea level, coastal erosion, seismic activity and glacial erosion.

DSRL have reviewed the effects of climate driven sea level rise as part of their siting studies and the PA. DSRL consider a best upper estimate of a 12 metres rise at Dounreay over several thousands of years. The location of the facilities at 24-29 metres significantly reduces the risk that the facilities might be inundated by sea level rise of tsunami.

DSRL consider estimates of coastal erosion as uncertain, especially given the influence of sea level rises. An upper estimate of 10mm per year has been based on the maximum rate of geo extension in the area (38) together with a review of world wide cliff erosion rates. The facilities will be sited over 100m inland from the 20m AOD contour so the erosion of the facilities whilst the waste within is above background levels of radioactivity is considered by DSRL to be unlikely. As it can not be ruled out the potential consequences have been assessed in the PA.

DSRL do not believe that the facility will be affected by seismic activity in the next 100, 000 years as the area has been seismically stable for the last 200 million years (39). Ground rupture has however been considered in the PA. The generation of a tsunami by an offshore earthquake has also considered. Whilst a tsunami of up to

20m above sea level could reach the facilities following erosion of the cliff or sea level rise DSRL do not believed that the erosive damage to the top of the engineered cap would disturb the emplaced waste.

Cooling of the global climate in the very far future and the on set of glacial conditions is considered unlikely to occur in the next 100,000 years. The disruption of the facilities due to glaciation is considered in the PA.

Ongoing Work

The third phase of DSRL's site characterisation work relates to the excavation and construction of the vaults and in particular to support the detailed design and construction. DSRL have produced an updated SCP to co-ordinate this work and ensure that the characterisation is reflected in the development of DSRL's further iterations of their ESC. This constitutes a key aspect of DSRL's Forward programme as discussed in ESC 2010.

Conclusion

SEPA believes that DSRL have approached their site investigation in a structured manner proportionate to the hazard presented by the waste. Site investigation has been a key topic in technical meetings between SEPA and DSRL. DSRL's iterative SCP has considered the geology, hydrogeology and geochemistry of the area and supports the development of the PA models. The resource potential for the site and potential future disruption scenarios have been discussed with potential future disruptions addressed in the PA.

This work is ongoing and future characterisation will be reflected in the further iterations of the ESC and the PA. The SCP has been developed in conjunction with the Monitoring Plan so as to ensure activities needed to establish the monitoring baseline are included. SEPA considers that DSRL have addressed Requirement 11 of the GRA in an adequate manner at this time.

4.3.12 Requirement 12 - Use of site and facility design, construction, operation and closure

The GRA states:

The developer/operator of a disposal facility for solid radioactive waste should make sure that the site is used and the facility is designed, constructed, operated and capable of closure so as to avoid unacceptable effects on the performance of the disposal system.

The GRA requires that DSRL's approach to the use of the site and to facility design, construction, operation and closure should be proportionate to the hazard presented by the waste that the facility is intended to receive. This includes demonstrating that the location of the facility within the characterised site is large enough to accommodate the quantities of waste to be disposed whilst being far away enough from geological media of less suitable characteristics. Further, DSRL is required to demonstrate that their methods of facility construction are consistent with the claims of their safety case and that the containment properties of the geological environment are not affected adversely.

SEPA and DSRL have discussed the proposed design of the facility and its construction, operation and closure in the context of the characterised site at a

number of technical meetings which have fed into the iterations of the ESC leading to ESC 2010.

DSRL is at the stage of finalising their detailed design of the facility and preparing the associated excavations. It is accepted that the design may change, for example to reflect the site geology revealed during the excavation stages. Recognising the nature of the work needed to meet this requirement, DSRL's Forward Programme identifies a number of ongoing issues in ESC 2010 (FPs 3, 4, 5, 6, 7 and 8).

The grouting of wastes and the use of concrete vaults is consistent with LLW disposal practice elsewhere, including at the UK national LLWR, and disposal facilities in France and Spain. DSRL continued to develop their design in more detail, supported by more refined and detailed safety assessments. The key features and components of the facility and how their functions support DSRL's safety case are summarised in the table below as presented in ESC 2010. ESC 2010 discusses each of these features and components to a degree of detail to be expected for this stage of the facility design.

Design components of the proposed New LLW Facility and their associated functions

Feature / Component	Description	Function
Location	Adjacent to the eastern boundary of the existing Dounreay nuclear licensed site.	Optimised balance between short-term environmental impacts and long-term sea inundation and erosion potential.
Depth	Top of waste form located below near-surface high groundwater flow layer, i.e., around 4 m below ground surface. Eight-high container stacking increases depth and reduces footprint compared to four-high stacking.	Optimum balance between cost, short-term environmental impact, likelihood of intrusion, and potential releases to the surface environment.
Waste Conditioning	Cement grout (LLW vaults)	Shielding. Low permeability. Chemical conditioning – alkaline environment and retarding medium.
Waste Package	LLW - Mild steel ISO containers or equivalent Demolition LLW – nylon bags	Allows waste handling using forklifts and stacking of containers – LLW vaults Sufficiently robust for local transportation. Corrosion promotes reducing chemical conditions in the vaults after closure.
Backfill	Cement grout (LLW vaults only). Sand (Demolition LLW vaults)	LLW vaults - low-permeability, alkaline environment to provide a retarding medium. Demolition LLW vaults – eases emplacement and enhances long-term stability
Base and Walls	Low-permeability durable concrete.	Reduce water ingress into the facility. Operational stability.

Feature / Component	Description	Function
Drainage	Void between the walls of the vaults and the host rock. Upper zone with most groundwater flow drained by gravity system. Deeper zone with lower groundwater flow drained by pump system. Filled with rock on closure.	Keep the interior of the facility dry during operations. Manage water flow to allow monitoring and control of water during operations. Provides hydraulic cage around vaults on closure
Lid and Cap	Mixture of layered materials, including low-permeability lid, anti-intrusion layer of slabs of rock, low-permeability layer, and soil	Minimise upward migration of water from the facility to the surface. Deter inadvertent and deliberate intrusion. Accommodate settlement and small volume of gas generation from the waste form.

ESC 2010 also outlines assumptions made regarding the facility design and the generation of gas. It is anticipated that gas generation will be slight and spread over a prolonged timescale with minimal disruption. DSRL have identified the evaluation of the lid and cap design in terms of waste settlement, human intrusion, gas generation and the reduction or prevention of upward water flows as part of their Forward Programme.

The design of the facility and hazard containment is also considered. This is discussed in some detail under Requirement 10. Hazardous contaminants will be immobilised by waste conditioning and the engineering of the vaults will provide a level of protection no less stringent than that required of a hazardous landfill under the Landfill (Scotland) Regulations 2003.

ESC 2010 states that no specific design considerations have been made with regard to criticality. Rather, the waste acceptance criteria (WAC) as discussed under Requirement 13 require a load management plan to ensure that fissile materials are spread evenly through the vaults to be consistent with DSRL's criticality safety case. Similarly, the effects of heat generation have not been explicitly accounted for in the design of the facility as DSRL's review (40) concludes that temperatures in the vaults are not likely to rise significantly above the ambient.

ESC 2010 states that construction will be phased to enable the development and sizing of future vaults to be tailored to actual waste arisings. A preliminary programme of construction has been declared as follows, although dates are dependent on the progress of decommissioning of the Dounreay nuclear licensed site and may alter as the programme evolves:

- Phase 1 will be constructed from 2012 to 2015.
- Phase 2 may be constructed between 2015 and 2018.
- Phase 3 may be constructed between 2019 and 2021.

Site characterisation will continue to be undertaken to show that the characteristics of each part of the site meet any pre-defined requirements in the safety case. These might include geotechnical specifications, such as minimum acceptable rock strength and maximum acceptable water flows, location with respect to faulting, and consistency with PA assumptions. The procedures to undertake characterisation during construction, evaluate data against PA assumptions, and identify corrective

actions as necessary will be developed on the basis of design, PA, and site characterisation needs prior to construction.

The operations at the facility will primarily involve the checking and acceptance of packaged and conditioned waste from the Dounreay site and its emplacement in the vaults. Operations and associated design requirements for the scheme design are described in the Design Justification Report (41), and DSRL have developed an initial operational plan for the facility (42). DSRL will develop an operational management plan during the detailed design, construction and operation stages of the project. Operational procedures will be developed further during Stage 3 of the project and will be submitted to SEPA prior to first waste emplacement.

ESC 2010 states that operations will be conducted in a manner that does not impact on the long-term performance requirements of the engineering. Concrete, reinforcement and steelworks will be designed to be highly durable, inherently robust and stable and DSRL claim that the engineering will require little maintenance during operations.

Closure of the vaults will involve sealing of all voids in and backfilling around the external walls, sealing of the operational drains, construction of lids over the vaults, removal of the steel roof and cladding and the installation of the engineered cap. DSRL intend grouting around the containers within the LLW vaults. DSRL have deferred their design of the closure works until nearer the time of implementation, although they state that it will be specified during the design and build work to the detail necessary to ensure that its implementation is not impacted adversely by the construction work. Currently, DSRL envisage that as much of the excavated material as possible will be used in backfilling around the vaults and forming the engineered cap over the vaults.

No specific provision is made for setting aside funding to complete the closure of the facility. The facility is funded by the UK Government through the NDA. The current UK Government approach for existing nuclear liabilities is to fund decommissioning activities, including waste disposal, from budgets in the year in which the activities are undertaken.

Conclusion

SEPA has engaged with DSRL throughout their initial facility design and their site characterisation. SEPA have discussed the Forward Programme with DSRL and are satisfied that DSRLs intends to address the Requirement in terms of the construction, operation and closure of the facility. SEPA has set conditions in the draft Authorisation to ensure that the facility is designed, constructed and operated in accordance with the assumptions of DSRL's ESC. SEPA is satisfied that, at this point in the development of the facility, DSRL have addressed adequately Requirement 12 of the GRA.

4.3.13 Requirement 13 – Waste acceptance criteria

The GRA states:

The developer/operator of a disposal facility for solid radioactive waste should establish waste acceptance criteria consistent with the assumptions made in the environmental safety case and with the requirements for transport and handling, and demonstrate that these can be applied during operations at the facility.

The GRA describes waste characterisation, treatment and packaging as being the responsibility of the consignor of the radioactive waste to the disposal facility, but it is the responsibility of the operator of the facility to make sure that the waste accepted for disposal is consistent with the environmental safety case and the requirements at the facility for transport and handling.

In this instance both the consignor and the disposer of the waste are the same organisation, DSRL, and it is SEPA's view that robust waste acceptance criteria (WAC) need to be established to manage the disposal of the waste to the facilities and demonstrate consistency with the environmental safety case. Further, DSRL should demonstrate that there are procedures in place to make sure that these criteria are met before waste is emplaced in the facility.

Factors that can affect the performance of the waste after disposal include the radionuclide content, the chemical and physical form, and durability, the susceptibility to microbial action, the thermal and radiation stability and mechanical stability.

With this in mind the GRA states that the WAC should include requirements to ensure as far as practicable that all wastes are passively safe. The chemical and physical form of the waste should limit detrimental chemical and microbial interactions, and should restrict the release of radionuclides into the disposal environment in accordance with the assumptions of the environmental safety case. The radiation and heat resistance of the waste should also be consistent with the safety case. Packaging should have sufficient mechanical stability to withstand the conditions of transport and handling and to meet any assumptions regarding structural integrity made in the safety case. It should also be demonstrated that the accumulation of fissile material, such as to produce a neutron chain reaction will not arise. The WAC will also be used to manage the hazardous content of the waste as discussed in Requirement 10.

ESC 2010 describes DSRL's WAC (see ESC Appendix 1) and their derivation. An initial set of WAC was developed in 2009 taking account of relevant assumptions in the ESC and the design of the facility. These were discussed with SEPA and subsequently revised. It is recognised that the WAC will be developed further before waste is emplaced in the facilities and this is reflected in DSRL's Forward Programme.

In reviewing ESC 2010 SEPA noted that DSRL were proposing the use of high level WAC developed from an assessed radiological capacity for waste to be disposed in the facilities. This capacity was based on a ten-fold increase in the radioactivity of the radionuclides modelled in Run 3PA with the exception of the isotopes of uranium, plutonium and americium, the activities of which were doubled. A supporting PA calculation using the increased inventory results in a peak annual dose to the crofter PEG which just complies with the regulatory risk guidance level.

It is SEPA's view that it is the radioactive waste inventory used in Run 3PA, based on the Dounreay Radioactive Waste Inventory 2009 as shown in table 4.1 of ESC 2010, that forms the basis of DSRL's environmental safety case and underpins their application for an Authorisation under RSA 93. As such the WAC should be developed from this inventory and not the higher inventory.

SEPA has specified WAC as part of the draft Authorisation. These criteria specifically limit the activities of radionuclides in the waste that can be disposed of to those presented in Appendix 3 of the draft Authorisation. The limits in Appendix 3

are based on the Dounreay Radioactive Waste Inventory 2009 as shown in table 4.1 of ESC 2010. These limits could only be increased through a variation to the Authorisation which would need to be supported by an appropriate environmental safety case.

DSRL have produced a post-closure criticality safety case (43) which has been used to inform the development of their WAC. SEPA commissioned a review of the safety case by specialist contractors and are satisfied that it is adequate.

Conclusion

SEPA expects future iterations of DSRL's ESC will accord with the WAC in SEPA's draft Authorisation. SEPA considers that, at this time, Requirement 13 has been met adequately.

4.3.14 Requirement 14 - Monitoring

The GRA states:

In support of the environmental safety case, the developer/operator of a disposal facility for solid radioactive waste should carry out a programme to monitor for changes caused by construction, operation and closure of the facility.

A reasoned and proportionate approach to establishing a programme for monitoring the site and facility should be developed. This is intended to show that the facility is operating within the parameters set out in the environmental safety case. The monitoring should not, however, compromise the environmental safety of the facility.

Monitoring and sampling during the investigative, pre-construction and construction site investigation phases (see Requirement 11) should be used to provide a baseline against which the results of the monitoring programme can be compared. These should include measurements of pre-existing radioactivity in environmental media together with geological, physical and chemical parameters relevant to environmental safety and which may change as a result of facility construction and waste emplacement.

During the period of authorisation, radiological monitoring and assessment will be required to provide assurance of radiological protection of the public and environment. Non-radiological parameters will also need to be monitored to confirm understanding of the effects of construction, operation and closure of the facility on the site. The programme will also need to set out levels of specific contaminants that will trigger action.

DSRL developed a high-level Monitoring Plan in 2007 which was updated in 2010 (44). DSRL developed their SCP in conjunction with this plan so as to ensure activities needed to establish the monitoring baseline are included.

The Plan has been developed in a reasoned and transparent fashion from a scope that is based on the consideration of four monitoring objectives:

- Long-term safety case,
- Operational safety case,
- Environmental impact assessment, and

- Other objectives.

DSRL considers monitoring control of the facilities, waste management developments and public reassurance as other objectives of their monitoring plan.

For the RSA 93 Authorisation, SEPA is concerned primarily with the monitoring in support of the long-term safety case objective.

The Plan is comprised of a number of programmes each of which consists of groups of related parameters identified by their objective (e.g. groundwater monitoring covers hydrogeological and groundwater chemistry parameters). The duration of each programme is defined in terms of the stages of development of the facilities; pre-construction, construction, operations, closure and post-closure.

The Plan is then derived by considering overlaps between the programmes, the associated parameters, and their durations. Outlines of the procedures and techniques for collecting and assessing monitoring data for each parameter are provided in the Monitoring Plan 2010.

DSRL propose that the monitoring programmes will be documented as required by the Management System currently in operation on the Dounreay licensed site. This will include specified measurement and evaluation details and schedules, performance measures, potential responsive actions, and reporting requirements. As these documents are developed, they will be referenced from the over-arching Monitoring Plan. DSRL state that the Monitoring Plan and detailed implementation plans together address the desired features of a monitoring and surveillance programme for near-surface disposal facilities identified by IAEA (45).

DSRL recognise that the detailed design of the facilities and their construction may result in the identification of further information requirements and associated monitoring parameters for the construction activities. The revision of the Monitoring Plan is therefore anticipated once the design and build contract is in place.

ESC 2010 describes briefly DSRL's general procedure for undertaking monitoring and evaluating the data against defined performance measures. This includes an outline of how DSRL will apply risk management options where monitoring data present concerns with regard to compliance.

The Forward Programme in ESC 2010 includes the continued development and implementation of the Monitoring Plan for the facilities and its periodic review and update.

Conclusion

SEPA is satisfied that, whilst the development of DSRL's Monitoring Plan is ongoing, their approach is reasoned and proportionate, includes consideration of the site investigation and baseline and is not likely to disturb the performance of the disposal system.

SEPA's draft Authorisation includes a condition that DSRL prepare, maintain and implement a management plan that includes environmental monitoring. DSRL will be required to use Best Practicable Means in the preparation, maintenance and implementation of the programme of monitoring the site and the facility to demonstrate compliance with the Authorisation and assumptions of the ESC. This

programme will be agreed in writing with SEPA. SEPA considers that Requirement 14 has been met at this stage.

4.4 Summary of determination by assessment of compliance with GRA

SEPA has determined DSRL's application for an Authorisation, under RSA 93, for disposal of solid low level radioactive waste. DSRL's application is supported by the latest iteration of their Environmental Safety Case (ESC 2010) which provides and substantiates a set of claims concerning the environmental safety of their planned disposal. SEPA has reviewed ESC 2010 and supporting documentation against the requirements and guidance in the GRA.

SEPA is satisfied that ESC 2010 meets the requirements, and therefore the principles, set out in the GRA to the extent possible at this stage of the facility development. It is accepted that as DSRL move on from the detailed design and construction stages of the facility, future iterations of their Environmental Safety Case will be produced. It is SEPA's expectation that these future iterations will reflect DSRL's enhanced characterisation of the site, the optimisation of their facility design and waste inventory and the further development of their operational procedures.

5. Other Determination Considerations

SEPA is required to carry out its regulatory duties in accordance with legislation, taking account of Government policy. Policy is set out in a variety of documents and a number of these are summarised below to outline the framework within which SEPA operates when considering applications for Authorisation under RSA93. In addition, SEPA operates within its own set of principles for open, fair and consistent regulation.

5.1 Policy and Legal Considerations

5.1.1 Sustainable Development

The UK Government and devolved administrations are committed to sustainable development. In 2005, the Government published 'Securing the Future – The UK Government Sustainable Development Strategy' and the Sustainable Development Framework: ' One Future: Different Paths'

Section 31 of the Environment Act 1995 gives the Scottish Ministers power to issue guidance to SEPA on the role they consider it appropriate for SEPA to make towards the goal of sustainable development. In December 2004, Scottish Ministers issued "Statutory Guidance to SEPA made under Section 31 of the Environment Act 2005 (Paper 2004/21)".

SEPA must have regard to that guidance in performing its functions, including the issue of authorisations for the disposal of radioactive waste under RSA. In the case of the LLWF the facility is being constructed to deal with waste from the Dounreay Nuclear Facility, the principle of which is supported by the Explanatory Note given by the Scottish Ministers in the Direction issued to SEPA in May 2005.

These provide the strategy and framework in which SEPA must operate. SEPA contributes to sustainable development, largely by enforcing legislation aimed at protecting the environment. Authorisations issued under RSA 93 and environmental permits for non-radioactive discharges provide some of the ways in which we carry out this role.

5.1.2 Review of Radioactive Waste Management Policy

Low Level Waste Policy

The Low Level Radioactive Waste Policy 2007 (LLW Policy) provides a statement of UK Government and devolved administrations' policy for the long term management of the UK's solid low level radioactive waste. This policy statement amends or replaces relevant parts of the 'Review of Radioactive Waste Policy: Final Conclusions (Cm2919)'

The policy says:

"*Preparation of plans for the management of LLW must be based on an assessment of all practicable options for its long term management. Any implementation of options under this policy will be subject to a satisfactory risk assessment and optimisation study, as required by relevant regulatory bodies. Government believes that disposal to an appropriately engineered facility, either below or above ground, with no intent to retrieve should be the end point for LLW that remains following the*

application of the waste hierarchy. This position is held on the basis that new disposal facilities will be of sufficiently robust design such that risks to the public in the future will be within the post-closure risk target, and therefore that postponing final disposal to future generations is unjustified. With regard to LLW and VLLW disposal to landfill, Government sees no reason to preclude controlled burial of radioactive waste from nuclear sites from the list of options to be considered in any options' assessment, provided the necessary safety assessments can be carried out to the satisfaction of the environmental regulators This supersedes paragraph 117 of Cm2919".

UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry

In 2010 the Government published (46) the UK strategy for the management of solid low level radioactive waste from the nuclear industry. The aim is to provide a high level framework within which low level radioactive waste (LLW) management decisions can be taken flexibly to ensure safe, environmentally acceptable and cost-effective management solutions that reflect the nature of the LLW concerned.

"*To deliver this aim, three strategic themes have guided the development of this strategy:*

I. the waste hierarchy;
II. the best use of existing LLW management assets;
III. and the need for new fit-for-purpose waste management routes.

The strategy is to apply the waste hierarchy more effectively to the management of LLW. We have set out the preference for managing LLW at higher levels of the hierarchy, which will mean a move away from the past focus on disposal. In turn, this will make the best use of the Low Level Waste Repository (LLWR) and ensure the UK's capacity for the management of LLW. Being able to manage the UK's LLW is vital for the nuclear industry, plant operation, decommissioning, power generation (existing and new) and also for other LLW producers, such as hospitals and universities.

Where the preference for higher levels of the waste hierarchy cannot be met and disposal is necessary, it must be optimised to minimise the overall impact of LLW management on people and the environment. We believe that:

- *Waste prevention is a fundamental principle for the operation and decommissioning of nuclear facilities*
- *There are resource and cost benefits in minimising the amount of LLW we have to manage*
- *Reuse defers waste production and extends the life of resources*
- *Recycling is the preferred way forward for the treatment of metallic LLW*
- *Volume reduction ensures best use of disposal capacity*
- *Disposal capacity is a precious resource and it must be used sparingly and as a last resort*

The LLW Strategy requires that managing LLW should not be separated from managing other radioactive wastes and non-radioactive wastes (Controlled wastes) and implementation will require an integrated waste management approach. LLW producers and managers should develop plans for the management of LLW that are informed by the waste hierarchy, the proximity principle and the need for early solutions. Affordability will be a key consideration in the implementation of the

strategy. It will be crucial that lifecycle environmental and social benefits of managing waste at higher levels of the waste hierarchy are compared with direct disposal. Decision making should be supported by sound business cases to identify the most advantageous option and should be completed in an open and transparent manner. To make suitable arrangements in the determination of treatment and disposal routes, robust decision making and early dialogue with communities affected by waste management activities are needed and should consider all viable options. This may include in-situ disposal; development of new facilities on or adjacent to sites to manage waste from that site; or extended to manage waste from a number of sites; or the development of facilities away from nuclear sites. There is considered to be sufficient capability in the nuclear estate (including the supply chain) for the provision of waste management, treatment and disposal services and the strategy proposes continued utilisation of this capability rather than investment in centralised facilities in the near term.

However, the strategy does report the need for robust information to underpin these assessments (i.e. volume and radioactivity content and forecast arisings). The strategy presents the drivers for continual improvement in quality of information, principally the need to continually assess the availability of capacity for managing the waste.

The amounts of waste we think will arise in the future mean that we need to change the way we manage it. The consultation on this strategy told us that people want to reduce the environmental impact of LLW management, which means closer alignment with the way other industry manages its wastes and moving away from relying on disposal. The strategy sets out how we will ensure the UK's continued capability and capacity through avoiding generating waste, reusing materials and recycling LLW based on robust information and transparent decision making processes. The LLW Repository, where the majority of UK LLW waste is disposed, is central to the strategy and it is important that we preserve the capacity at the site and use it wisely. All disposal capacity is a precious resource; it should be used sparingly and as a last resort".

Disposal represents the final option in waste management, and as such SEPA has required through its Authorisation that a demonstration be made that the waste hierarchy has been applied to any waste packages accepted for disposal in the facility. Scottish Ministers supported the intent that LLW produced at Dounreay be dealt with by a facility onsite in its Explanatory Note when issuing a Direction in 2005, to SEPA, not to grant authorisation for solid LLW from Dounreay to be disposed to British Nuclear Fuel plc's facilities at Drigg and Sellafield.

Review of Radioactive Waste Management Policy cm2919

Large parts of the Review of Radioactive Waste Management Policy (cm2919) have been superseded by subsequent policy documents, particularly the LLW Policy 2007 and the Higher Activity Waste Policy 2011.

In addition to these two document the government has also published revisions to the Cm2919 policy statements dealing with decommissioning in their document entitled "The decommissioning of the UK nuclear industry's facilities, 2004"

Cm2919 still provide the policy basis for the use of risk and dose criteria although The Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000 to SEPA provides further details.

Risk and dose criteria are applied in the context of this application through the assessment of compliance with the requirements set out in the GRA. SEPA's assessment of this is explained in detail in Chapter 5 of this document.

5.1.3 Landfill Regulations

The Landfill (Scotland) Regulations 2003 enact the requirements of the Landfill Directive (1999/31/EC; EC 1999). The vehicle for implementing the technical requirements of the Landfill (Scotland) Regulations 2003 is the PPC Regulations. "Waste" is defined in regulation 2 of the PPC Regulations as meaning, unless the context otherwise requires, anything that is waste for the purposes of the Waste Framework Directive and which is not excluded from the scope of that Directive.

Radioactive waste is specifically excluded from the scope of the Waste Framework Directive (now codified as Directive 2006/12/EC; EC 2006b), where already covered by other legislation. In Scotland, radioactive waste is covered by other legislation, namely RSA93 and for this reason excluded from the scope of the Waste Framework Directive.

The Requirements of the LF Regulations are still applied to the facility to ensure equivalent levels of protection, through Requirement 10 of the GRA and key aspects such as permeability of the base, sides and final cap of the facility are reflected in the Authorisation.

5.1.4 Protection of the Water Environment

The Water Environment and Water Services (Scotland) Act 2003 implements the requirements of the Water Framework Directive 2000/60/EC and gave the Scottish Ministers powers to introduce regulatory controls in order to protect and improve Scotland's water environment. Regulatory controls to achieve this aim are applied through the Water Environment (Controlled Activities) (Scotland) Regulations 2011. With respect to the LLWF the RSA93 Authorisation is deemed to be a relevant Authorisation under CAR, as detailed in Section 1.4, provided it is consistent with the requirements of CAR. DSRL undertook a quantitative assessment of the potential impacts from the facility on surface waters and the marine environment in 2008 which concluded that minimal changes to the quality of the water environment are expected as a result of long-term radionuclide releases from the disposal facility. On the basis of this assessment SEPA has determined that the RSA93 Authorisation to be compliant with the requirements of CAR.

5.1.5 Waste Strategy

Best Practicable Environmental Options and Best Practicable Means

Within the context of radioactive waste management, there is a close relationship between implementation of Best Practicable Environmental Option (BPEO) and Best Practicable Means (BPM). In essence BPEO can be used at a strategic level for identifying the best option for managing and treating radioactive waste and BPM requires an optimum level of protection to be chosen and then utilised to its best advantage in minimising the generation and release of radioactive waste.

Best Practicable Environmental Option (BPEO)

BPEO is defined in Cm 2919 as:

'*A concept developed by the Royal Commission on Environmental Pollution, it implies that decisions on waste management have been based on an assessment of alternative options evaluated on the basis of factors such as the occupational; and environmental risks, the environmental impacts, the costs and the social implications'*

The application of the concept of Best Practicable Environmental Option (BPEO) forms one aspect of the regulatory response of SEPA to the optimisation principle formulated by the International Commission on Radiological Protection (ICRP). This principle seeks radiation doses to people that are "as low as reasonably achievable" (ALARA), economic and social factors being taken into account.

The Royal Commission on Environmental Pollution (RCEP). RCEP provided the following definition of BPEO in its Twelfth Report (RCEP, 1988):

"… the outcome of a systematic and consultative decision-making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, at acceptable cost, in the long term as well as in the short term."

As the BPEO concept has been developed in the UK, it has generally been applied to decisions where a strategic choice between different approaches to managing environmental impact is required. An element of stakeholder input to the process, coupled with transparency regarding data and assumptions, are also generally considered integral to the BPEO concept, which is particularly suited to exploring the impact of different perspectives on the eventual decision.

The key characteristics of BPEO assessments identified and advocated by RCEP are generally regarded as definitive, and include the following:

- The process is essentially strategic – it is geared towards identifying a preferred overall strategy from the perspective of the environment as a whole, as opposed to detailed optimisation of the selected scheme.
- A structured and systematic process is used to identify and compare strategic options. The presumption is that a BPEO assessment will generally be an open and transparent process, documented to make explicit the reasoning, data and assumptions.
- Alternatives should be evaluated in terms of their projected implications for environmental quality. Consideration also needs to be given to questions of practicability (including financial costs and/or benefits, as well as wider social and economic considerations), as well as the overall strategic objectives, in order to reflect the wider context in which the decision is being taken.
- The process should involve consideration of environmental effects in both the short term and the long term, requiring consideration to be given to the relative importance of different indicators of environmental performance (e.g. short-lived versus persistent pollutants).
- Effects on the environment are not necessarily restricted to direct emissions of pollutants to land, air and water from the process (or activity) itself; life cycle considerations (such as energy demand) may also have a part to play in the decision process.

- There is an accent on consultation as an integral part of the assessment process – an informed assessment of alternatives necessarily involves taking into account the values and perspectives of a range of stakeholders.

The BPEO process was undertaken by UKAEA to provide an objective review of LLW management options and identified the construction of new LLW disposal facilities on UKAEA (now NDA) owned land to accept LLW from Dounreay and the nearby Vulcan site only as the preferred option.

Best Practicable Means BPM

BPM is defined in Cm 2919 as:

'Within a particular waste management option, the BPM is that level of management and engineering control that minimises, as far as practicable, the release of radioactivity to the environment whilst taking account of a wider range of factors, including cost-effectiveness, technological status, operational safety, and social and environmental factors. In determining whether a particular aspect of the proposal represents the BPM, the Inspectorates will not require the applicant to incur expenditure, whether in money, time or trouble, which is disproportionate to the benefits likely to be derived'.

SEPA has a duty to ensure that all exposures to radiation are kept as low as reasonably achievable, taking into account economic and social factors. SEPA has set out how the concept of BPM is used to satisfy the ALARA principle (47). This is achieved by placing three key requirements into Authorisations for the disposal of radioactive waste which require:

- The use of BPM to minimise the radioactivity of and volume of radioactive waste generated;
- The use of BPM to minimise the total radioactivity in radioactive waste that is discharged to the environment; and
- The use of BPM to minimise the radiological effects of any radioactive waste discharges on the environment and members of the public.

Additionally the concept of BPM is used to ensure that all operations carried out at the Authorised Premises are conducted within this framework, for instance in carrying out radiochemical analysis or taking measurements and samples or in the operation and maintenance of equipment.

The requirement to keep all radiation exposures as low as reasonably achievable, taking into account social and economic factors applies over and above the requirement to control doses to individuals in accordance with the specified dose limits. The qualification that economic and social factors should be taken into account in any assessment of what is reasonably achievable means that all practices that give rise to exposure to radiation must be examined carefully to see what might be done to reduce exposure, but that in deciding whether any particular measures should be used a correct balance must be achieved between the benefit to be derived from those measures and their cost (not only in monetary terms). This does not mean that the decision on what level of protection should be achieved should be taken on the basis of readily quantifiable factors only. The international standards include the requirement to take social factors into account and this recognises the importance of considerations, which cannot be quantified in the process of establishing the appropriate level of protection. When applied to waste disposal, such considerations might include general policies for environmental protection as well as public perceptions of the importance of such matters. However it is fundamental to

the control procedure that measures should not be required which involve costs grossly disproportionate to any benefits likely to be achieved.

As a condition of the Authorisation SEPA has placed a requirement on DSRL to ensure radioactive waste is disposed of at a time, in a form, and in a manner so as to minimise radiological effects on the environment and members of the public.

BPM is given the following meaning within SEPA's Authorisation (consistent with the various definitions of Best Available Techniques) as follows:

In determining whether particular means are the "best practicable" for the purposes of this Authorisation, the Authorisation Holder shall not be required to incur expenditure whether in money, time or trouble which is, or is likely to be, grossly disproportionate to the benefits to be derived from, or likely to be derived from, or the efficacy of, or likely efficacy of, employing them, the benefits or results produced being, or likely to be, insignificant in relation to the expenditure.

(b) Where reference is made to the use of "best practicable means" in this Authorisation, the terms "best", "practicable" and "means" have the following meaning:

"Best" – means the most effective techniques for achieving a particular objective, having due regard to technological advances (state of the art) and changes in scientific knowledge; and understanding.

"Practicable" – indicates that the "means" under consideration should only be selected following an optimisation process that includes consideration of the technical viability including comparable processes, facilities or methods of operation which have recently been successfully tried out and takes into account social and economic costs and benefits.

"Means" – includes: technology, disposal options, the design, build, maintenance, operation and decommissioning of facilities, and wider management arrangements.

(c) The social and economic costs and benefits that should be taken into account in the optimisation process used to decide what is practicable includes (where relevant);

- economic costs
- social benefits
- radiological exposures to the public
- occupational radiological exposures
- radiological impact on the environment
- conventional safety
- consistency with the waste hierarchy
- impact of the non-radioactive properties of radioactive waste
- the generation and associated impact of non-radioactive wastes, including climate change emissions
- the proximity principle
- applicable government policy

5.1.6 Conservation

The Conservation (Natural Habitats & Conservation) Regulations 1994 (Habitats Regulations) implement Council Directive 92/34/EC on the conservation of natural habitats and wild flora and fauna (the Habitats Directive), and pick up and strengthen the requirements of Council Directive 79/409/EEC on the Conservation of Wild Birds (the Birds Directive). The Directive aims to establish a network of the most important sites for wildlife and maintain them at favourable conservation status. The network consists of Special Protection areas (SPAs) for birds and Special Areas of Conservation (SACs) for other species and habitats. The Habitats Regulations require SEPA to be satisfied that the integrity of designated European sites (SACs and SPAs) will not be adversely affected by relevant permissions issued by SEPA.

In addition, the Nature Conservation (Scotland) Act 2004 sets out a series of measures which are designed to conserve biodiversity and to protect and enhance the biological and geological natural heritage of Scotland. In doing so, the Act provides the principal legislative components of a new, integrated, system for nature conservation within Scotland. The Act also locates the conservation of biodiversity and of Scotland's natural environment within a wider British, European and global context. In relation to biodiversity in particular, it requires public bodies and office-holders to consider the effect of their actions at a local, regional, national and international level. Measures relating to the protection of species and habitats also recognise the importance of the wider international context.

As a public body under Section 1 of the 2004 Act, SEPA is required to further the conservation of biodiversity when exercising its regulatory functions. As part of the consultation process, SEPA will identify any significant biodiversity interests that might be affected, and will take these into account in its decision-making. The 2004 Act also introduced tighter controls for the protection of Sites of Special Scientific Interest (SSSIs). These include stronger requirements for SEPA and other regulatory bodies to protect SSSIs through the implementation of regulatory regimes. As part of that process SEPA is required to consult with, and take account of advice from Scottish Natural Heritage before permitting any activity which may harm a SSSI.

SEPA identified three designated sites with 5km of the LLWF. A short summary of each is given below:

- North Caithness Cliffs Special Protection Area

North Caithness Cliffs SPA is approximately 2km from the LLWF of special nature conservation and scientific importance within Britain and the European Community for supporting very large populations of breeding seabirds. The site overlaps either partly or wholly with Duncansby Head SSSI, Stroma SSSI, Dunnet Head SSSI, Holborn Head SSSI, and Red Point Coast SSSI. The seaward extension extends approximately 2km into the marine environment to include the seabed, water column and surface.

Full details are available at:

http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8554

- Sandside Bay Site of Special Scientific Interest

Sandside Bay Site of Special Scientific Interest (SSSI) lies approximately 2.5km from the LLWF, just north of Reay. The site is in two parts. The main part of the site includes the foreshore, dunes, dune slacks and the banks of the Burn of Isauld. The second part of the site is an area of herb-rich grassland within the golf course.

Sandside Bay SSSI is one of two coastal sites designated to represent dune and links habitats in Caithness.

The dunes are dominated by marram grass *Ammophila arenaria,* with flowering plants such as Alpine meadow-rue *Thalictrum alpinim*, yellow rattle Rhinanthus minor, bird's foot trefoil *Lotus corniculatus*, and lady's bedstraw *Galium verum* on the stabilised back slopes. The links have species-rich short turf with uncommon species including

Full details are available at:

http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=1405

- Ushat Head Site of Special Scientific Interest

Ushat Head Site of Special Scientific Interest (SSSI) is a low exposed headland, approximately 4.5km from the LLWF and 9km northwest of Thurso. It is of particular botanical importance for its maritime heath, which is a northern, species-rich type of heathland that is found only in Caithness, Sutherland and Orkney. There is a good representation of species-rich maritime heath communities in a mosaic with maritime grassland. Heathers and creeping willow Salix repens are the main dwarf shrubs. The rare Scottish primrose Primula Scotica and small-fruited yellow sedge Carex viridula are found at Ushat Head SSSI. Roseroot Sedum rosea and kidney vetch Anthyllis vulneraria are abundant, along with the maritime species, spring squill Scilla verna, sea campion Silene uniflora and sea plantain Plantago maritima.

Full details are available at:

http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=1585

DSRL undertook an assessment of potential impacts on non-human biota using the ERICA integrated approach. This assessment concluded impacts on the terrestrial ecosystem from the LLWF are negligible or present no significant harm. SEPA accepted this as a demonstration the facility did not present a risk to the above designated sites. Further detail is available in Chapter 5.3.9 – Environmental Radioactivity.

5.1.7 Article 37

As a Member State of the European Union, UK activities involving radioactive substances are governed by legislation set down under the Euratom Treaty (Council Directive 80/836/EURATOM).

Article 37 of the Euratom treaty states:

"Each Member State shall provide the European Commission with such general data relating to any plan for the disposal of radioactive waste in whatever form as will make it possible to determine whether the implementation of such a plan is liable to result in the radioactive contamination of the water, soil or airspace of another Member State".

It is not for SEPA to decide when submissions are required; it is for the UK Government. SEPA provides technical advice to Government and co-ordinates submissions in Scotland on behalf of the Scottish Government. Thus SEPA's role in the preparation of an Article 37 submission is as an intermediary between the facility

operator and the Scottish Government, and includes advising the facility operator on the contents of the submission, reviewing the submission and advising the Scottish Government that the submission is complete.

The Commission provided the following opinion on the Article 37 submission on 21 December 2011.

"In conclusion, the Commission is of the opinion that the implementation of the plan for the disposal of radioactive waste in whatever form arising from the New Low-level Waste Facilities located adjacent to the Dounreay nuclear licensed site in Scotland, United Kingdom, during its normal operational life and after its final closure, as well as in the event of accidents of the type and magnitude considered in the General Data, is not liable to result in a radioactive contamination of the water, soil or airspace of another Member State."

5.1.8 Human Rights

The Human Rights Act 1998 (HRA 98) came into force on 2 October 2000, and incorporates the provisions of the European Convention on Human Rights (Council of Europe 1950) into domestic law. It requires public bodies, such as the environment agencies, to act in a way, which is compatible with the 'Convention Rights', which are those Articles of the European Convention on Human Rights that are specified in HRA 98 (section 1, and Schedule 1).

The main Convention rights that might be affected by SEPA's radioactive substances regulation decisions are the right to life (Article 2), the right to a fair trial (Article 6), the right to respect for private and family life (Article 8) and the right to protection of property (Article 1, First Protocol).

Certain Convention rights are absolute. Some Convention rights are limited in explicit and finite circumstances. Other Convention rights are qualified. Interference with a qualified right may be justified if it is in accordance with the law, serves one of the aims set out in the qualification to the relevant Article and is 'necessary' in a democratic society. Interference may be considered 'necessary' if there is a pressing social need and any interference with individual rights is proportionate to the aim pursued. It is recognised that public authorities, such as the environment agencies, often have to strike a balance between the general social and economic needs of the community and the specific interests of individuals.

Under HRA 98, SEPA must consider whether its decisions in respect of authorisations under RSA 93 will result in or fail to prevent any potential or actual breach of a Convention right. If we identify such a breach, we must then consider whether we have the discretion under national law to act otherwise. A public authority will not be acting unlawfully under HRA 98, if it is required to act in a particular way by some provision of primary legislation. SEPA has identified no such breach under HRA98.

5.1.9 Transport

SEPA's remit in determining applications made under RSA93 does not extend to regulating the transport of radioactive material or waste. SEPA is aware that radioactive waste is routinely transported by road, rail and sea and is subject to exacting standards laid regulated by ONR's Radioactive Materials Transport Team (formally part of the Department of Transport till October 2011).

5.2 SEPA's Principles for Regulation

In order to encompass the changes currently driven by the EU, UK and Scottish policy and legislation, to reflect community expectations and to progress the requirements of SEPA's Management Statement, SEPA has developed a set of principles which are expected to be reflected in both the application determination process and the Authorisation itself.

The over-arching principle is that of Sustainable Development which is enshrined in SEPA's Main Aim (see Section 1.3) and has been described as:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Within this umbrella principle of Sustainable Development are contained five higher-level principles and five lower-level, or process, principles. The higher-level principles are:

1. Integrated Environmental Protection;

2. Efficiency and Effectiveness;

3. Polluter Pays;

4. Sound Science and Information; and

5. Precautionary Principle

Together with the higher-level principles, the process principles are designed to produce outcomes in licensing, enforcement and routine matters that are both reasonable and achievable. These lower-level principles are:

1. Environmental Protection and Improvement;

2. Proportionality;

3. Fairness, Consistency and Legal Correctness;

4. Transparency and Accountability; and

5. Awareness Raising and Good Practice

SEPA has incorporated all of the above principles into its procedures for determination of applications under RSA93.

5.3 Radiological Protection Principles

When considering any application to dispose of radioactive waste, SEPA is guided by the radiological protection principles recommended by the International Commission on Radiological Protection in ICRP60 and given effect within the European Community by the 13 May 1996 Council Directive 96/29/Euratom, referred to as the Basic Safety Standards Directive (BSS Directive). In May 2000 the Scottish Executive issued a Direction, the Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000, to SEPA specifying the duty of the Agency to observe the requirements of the Directive. For radioactive substances,

the system of protection is based on three principles; (i) justification of a practice, (ii) optimisation of protection and (iii) the application of individual dose limits.

5.3.1 Justification

Justification is one of the principles of radiological protection established by the ICRP and is a requirement of the BSS Directive. 'Justification' means that 'any decision that alters the radiation exposure situation should do more good than harm' (ICRP 2007).

The Justification of Practices Involving Ionising Radiation Regulations 2004 implements this aspect of the BSS Directive. Under these Regulations, the UK Government and devolved administrations make all justification decisions. These policy decisions are required before any regulatory action can proceed.

Defra's guidance (in conjunction with the devolved administrations) on application and administration of the Regulations makes clear that ICRP emphasises that radioactive waste management and disposal operations are an integral part of the practice generating the waste and that it is wrong to regard them as a free-standing practice that requires its own justification (Defra 2007).

5.3.2 Optimisation

The principle of optimisation of dose or risk is derived in Council Directive 96/29/EURATOM from the recommendations of the ICRP and has been enshrined in European Directives, (EC Directive 80/836, 84/467 and 96/29/Euratom). ICRP 60 states the principle as:

"In relation to any particular source within a practice, the magnitude of individual doses, the number of people exposed, and the likelihood of incurring exposures where these are not certain to be received should be kept as low as reasonably achievable, economic and social factors being taken into account."

Principle 2 and Requirement 8 of the GRA consider Optimisation in the context of near surface disposal of LLW. Further detail is available in Chapter 5.3.8 Requirement 8 – Optimisation.

5.3.2 Dose Limits and Constraints

Exposure to ionising radiation can cause cancer and hereditary defects. The higher the radiation dose, the greater the likelihood or risk that a cancer or hereditary defect will develop. But, apart from very high levels of radiation dose, there is no certainty that an individual exposed to radiation will suffer a health effect. The dose/risk relationships have been determined by studies on various groups that have been exposed to radiation, predominantly survivors of the atomic bombs in Japan and certain medical patients.

There is little evidence that very low doses of radiation can cause harm. However, the approach taken in radiation protection errs on the side of caution by assuming that there is no dose so low that it cannot potentially cause harm and there is no absolutely safe threshold of radiation dose below which the risk may approach zero. In the present state of knowledge it is appropriate to assume an increasing risk with increasing dose. This approach is accepted by the ICRP and by national bodies like Health Protection Agency (formerly National Radiological Protection Board) in the UK.

The Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000 requires SEPA when discharging its functions in relation to the disposal of radioactive waste under RSA93 to ensure that the dose limits for members of the public set out in Article 13 of Council Directive 96/29/EURATOM are not exceeded. The dose limit is set at 1 milliSievert in a year (excluding medical irradiation) which is estimated to equate to a risk of death from fatal cancer of 1 in 20,000. The Direction to SEPA also requires that the contribution to public dose arising from the authorised radioactive discharges of any one new nuclear installation should be constrained to a maximum of 0.3 milliSieverts in a year which equates to a risk of approximately 1 in 66,000. In addition where a number of nuclear facilities are adjacent, possibly owned by different organisations, an overall site constraint of 0.5 milliSieverts (a risk of 1 in 40,000) will be applied. Additionally SEPA is required to ensure that reasonable steps are taken such that the contribution to the exposure of the population as a whole from practices is kept as low as reasonably achievable, economic and social factors being taken into account.

Dose Limits and Constraints are applied in the context of the LLWF through the requirements set out in the GRA.

5.4 Scottish Ministers

SEPA has undertaken to inform Scottish Ministers of its decision on any application to grant or vary RSA93 authorisations, prior to granting or refusing the application, in order to provide Scottish Ministers the opportunity to exercise their powers of call-in or direction. Accordingly, this document, recording SEPA's decision, has been forwarded to Scottish Ministers

6. Authorisation and explanation of Conditions

6.1 Authorisation and explanation of Conditions

A copy of the Authorisation Schedule of Conditions *(formatted in italics)*, along with an explanation of the reasoning behind, or the purpose of, SEPA applying the Condition is given below.

It should be noted that the Schedule of Conditions will evolve to reflect the controls SEPA consider necessary to fulfil its duties under RSA93 through the construction, operational and closure stages of the facility. This Authorisation is being granted during the construction of phase 1 of the facility and will be subject to variation as SEPA considers necessary, or following a valid application by DSRL.

6.2 Schedule 1

1. LIMITATIONS AND CONDITIONS RELATING TO THE AUTHORISED PREMISES AND THE UNDERTAKING

1.1 Description of Undertaking

1.1.1 The Undertaking is the disposal of low level radioactive waste.

1.2 The Authorised Premises

1.2.1 The Authorised Premises are located adjacent to the Dounreay site as shown in the Location Guide forming Appendix 1 and as delineated in red on the Site Plan forming Appendix 2 of this Authorisation

These conditions define clearly the authorised activity and the boundary of the area covered by the Authorisation, inside which the authorised activities may be undertaken.

6.3 Schedule 2

2. GENERAL LIMITATIONS AND CONDITIONS

2.1 Environmental Safety Case

The Authorisation Holder shall maintain an Environmental Safety Case.

2.1.2 The Authorisation Holder shall update and provide to SEPA the Environmental Safety Case at a frequency agreed in writing with SEPA.

The Environmental Safety Case is the key document which supports DSRL's application for the disposal of radioactive waste at this facility. The facility is currently at the construction stage for Phase 1 of the 3 Phases for which planning consent has been granted. Phase 1 consists of a single vault for conditioned LLW (and bulk items) and a separate vault for Demolition Waste, which is DSRL's classification for unconditioned LLW, also defined in the Authorisation Interpretation of Terms.

Condition 2.1 requires DSRL to update and provide to SEPA the ESC at appropriate intervals, agreed with SEPA through the life of the facility. The next iteration of the

ESC is expected to be submitted to SEPA in 2013/ 14 and will reflect the additional information gathered during excavation and construction of the two Phase 1 vaults.

2.2 *Optimisation*

2.2.1 The Authorisation Holder shall use best practicable means to ensure that no unnecessary radioactive waste is generated on these Authorised Premises.

2.2.2 The Authorisation Holder shall use best practicable means to ensure that radioactive waste is disposed of at times, in a form, and in a manner so as to minimise the radiological effects on the environment and members of the public at the time of disposal and in the future.

Optimisation, which encompasses BPM, is a regulatory expectation on all authorised facilities and therefore this condition is applied in all Authorisations. SEPA requires Authorisation holders to use best practicable means in order to minimise radiological effects on the environment and members of the public.

For the avoidance of doubt this condition applies to waste generated on the disposal facility and not to waste intended for disposal to the facility.

2.3 Design and Construct

2.3.1 The Authorisation Holder shall ensure the Authorised Premises are designed and constructed in accordance with in the assumptions in the Environmental Safety Case 2010.

2.3.2 The base, sides and final cap of the disposal vaults at the Authorised Premises shall consist of an artificially established, engineered barrier constructed to ensure as a minimum the following standards:

2.3.2.1 permeability of less than or equal to 1.0 x 10-9 metres/second; and

2.3.2.2 an artificial barrier with a thickness of not less than 0.5 metres, giving equivalent or greater protection than a 5 metres thick mineral layer; and

2.3.2.3 the artificial barrier shall provide sufficient attenuation capacity to prevent an unacceptable risk to groundwater.

2.3.3 The Authorisation Holder shall, prior to waste disposal, provide to SEPA documentary evidence, including a certificate of completion, that each phase of the Authorised Premises are designed and constructed in accordance with the detailed design provided to SEPA in accordance with paragraph 2.3.2.

2.3.4 The Authorisation Holder shall, prior to construction of each phase, provide to SEPA a detailed programme of Construction Quality Assurance monitoring and reporting, including the demonstration of compliance with the standards required in paragraph 2.3.5.

2.3.5 The Authorisation Holder shall provide a copy of any completion certificate(s) issued by the local authority to SEPA as soon as practicable.

SEPA has applied Conditions in 2.3 to ensure that key assumptions relating to the design and construction made by DSRL in their ESC are reflected in the facility construction.

Specific requirements relating to the permeability of the base, sides and final cap of the vaults have been applied along with the requirement to provide an artificial barrier at least 0.5m thick and the need for Construction Quality Assurance monitoring and reporting. These conditions are in place to ensure that DSRL meets Requirement 10 of the GRA and demonstrates that an equivalent standard of environmental protection has been applied to the facility as would be applied to a non-radioactive hazardous waste disposal facility.

2.4 Disposal of Radioactive Waste

2.4.1 The accumulation and disposal of radioactive waste at the Authorised Premises shall not commence without written agreement from SEPA.

2.4.2 The Authorisation Holder shall inform SEPA in writing, at least 28 days before the first disposal of radioactive waste is made under the terms of this Authorisation, of the programme being undertaken to satisfy paragraph 2.9.2.

The authorisation process being followed is unusual in that the application for Authorisation is being determined by SEPA ahead of the detailed design and construction process being completed. It should be noted that this is in line with the GRA for near surface disposal facilities. Condition 2.4 therefore ensures that no waste can be disposed of or accumulated at the facility until such time as SEPA is fully satisfied DSRL is in a position to safely manage the waste and has appropriate monitoring in place to demonstrate this.

2.5 Accumulation of Radioactive Waste

2.5.1 The Authorisation Holder shall only accumulate radioactive waste in order that it may be disposed of in accordance with the conditions and limitations in this Authorisation.

2.5.2 The Authorisation Holder shall dispose of accumulated radioactive waste as soon as it is practicable to do so and in any event within 24 hours of receipt.

2.5.3 The Authorisation Holder shall ensure that radioactive waste which is being accumulated shall be segregated from waste which is not radioactive waste and shall be accumulated separately.

2.5.4 The Authorisation Holder shall ensure that only suitably qualified and experienced persons shall have access to the accumulated radioactive waste.

2.5.5 The ionising radiation symbol and the word ''Radioactive" shall be displayed at all times at the immediate location where any radioactive waste is being accumulated.

2.5.6 All radioactive waste being accumulated shall be clearly and legibly marked to permit its identification.

2.5.7 All radioactive waste being accumulated shall be stored in such a manner as to prevent, as far as is reasonably practicable, the contamination of other articles or substances.

2.5.8 The accumulated radioactive waste shall be stored in such a manner so as to prevent, as far as reasonably practicable, the dispersal of any radionuclide

contained in any of the radioactive waste as a consequence of fire, corrosion, explosion, flood or any other hazard.

DSRL did not apply for an Authorisation to accumulate radioactive waste. In determining the application SEPA formed the view that the need to accumulate radioactive waste for short periods of time was a reasonably foreseeable requirement due to operational.

Following discussion with DSRL, SEPA has applied Conditions to the Authorisation allowing the accumulation of radioactive waste, with appropriate controls. A Condition has also been applied limiting the time waste can be accumulated to 24 hours from the time of receipt, reinforcing that such accumulation is permitted only for short periods of time where driven through operational necessity. Long term storage of waste at the facility is not authorised.

2.6 Operation

2.6.1 Notwithstanding paragraph 2.2.1 the Authorisation Holder shall operate the Authorised Premises in accordance with the assumptions of the Environmental Safety Case. However, in the event of any conflict between the assumptions of the Environmental Safety Case and the conditions of this Authorisation, the conditions of this Authorisation shall take priority.

2.6.2 The Authorisation Holder shall prepare, maintain and implement a Management Plan which includes, but is not limited to:

I. Load management
II. Leachate management
III. Water management
IV. Packaging
V. Criticality Safety Case
VI. Authorised Waste Acceptance Criteria implementation
VII. Capping
VIII. Environmental Monitoring
IX. Records management
X. Training of staff

2.6.3 The Authorisation Holder shall, prior to the disposal of waste, produce and maintain a contingency intervention strategy for the retrieval of disposed waste.

2.6.4 The Authorisation Holder shall produce, maintain and implement contingency arrangements and emergency plans for reasonably foreseeable events including, but not restricted to, corrosion , explosion, flooding, fire and loss of containment of the waste.

2.6.5 All operations on the Authorised Premises shall be carried out in accordance with the Management Plan. Where any limit or condition of this Authorisation conflicts with the Management Plan, the Authorisation condition shall take precedence over the Management Plan.

2.6.6 Unless otherwise specified in this Authorisation any proposed change(s) by the Authorisation Holder to the Management Plan shall be submitted in writing to SEPA at least 28 days before the implementation of the proposed change(s). The Management Plan shall only be amended in accordance with the proposed change(s) if, and to the extent that, either (a) SEPA gives

written approval of the proposed change(s) or (b) SEPA has not indicated to the Authorisation Holder in writing within 28 days of receiving the proposed change that the proposed change(s) are rejected.

2.6.7 *The Authorisation Holder shall take all practicable measures to prevent access to the radioactive waste by any person not authorised by the Authorisation Holder.*

2.6.8 *Whenever the Authorisation Holder knows or has reasonable grounds for believing or suspecting that any radionuclide contained in the radioactive waste has been or may be dispersed in a manner not permitted by this Authorisation the Authorisation Holder shall take all practicable measures forthwith to restrict any further dispersal of any such radionuclide and notify SEPA without delay.*

2.6.9 *The Authorisation Holder shall take all practicable measures to prevent the loss or theft of any radioactive waste.*

2.6.10 *Whenever the Authorisation Holder knows or has reasonable grounds for believing or suspecting that any of the radioactive waste has been lost or stolen the Authorisation Holder shall take all practicable measures forthwith to recover the radioactive waste and notify SEPA without delay .*

Condition 2.6 borrows heavily from the proven approach SEPA has developed for the regulation of non-radioactive waste disposal facilities (i.e. landfills). DSRL is required to prepare, implement and maintain a number of documented processes, procedures and contingencies ahead of the facility becoming operational and to maintain these through the life of the Authorisation.

A number of key areas of operation that DSRL is required to address through the Management Plan have been highlighted in the Authorisation, namely:

- Load management
- Leachate management
- Water management
- Packaging
- Criticality Safety Case
- Authorised Waste Acceptance Criteria implementation
- Capping
- Environmental Monitoring
- Records management
- Training of staff

The operator can amend the plan in agreement with SEPA without the necessity to undertaken a formal variation to the authorisation, but SEPA's agreement is required prior to any amendments taking effect.

SEPA has prescribed the need for DSRL to produce and maintain an intervention strategy for the retrieval of disposed waste, should it prove necessary in future.

A contingency plan is required to be produced, maintained and implemented covering reasonably foreseeable events. SEPA have prescribed a number of events to be considered, namely:

- Corrosion
- Explosion
- Flooding
- Fire
- Loss of containment of waste

The Authorisation does not restrict the plan to what SEPA prescribes, and through routine site regulation, DSRL will be challenged by SEPA on its consideration of any other factors that may be relevant.

It is considered that addressing these aspects through a management plan provides an appropriate balance between SEPA having regulatory control to ensure protection of people and the environment, while providing the operator the necessary flexibility to operate the facility.

Standard conditions requiring the operator to take all practicable steps to prevent unauthorised access to, loss or theft of waste and to take measures to restrict the extent of any release of waste to the environment (including recovery of the waste) have been included. SEPA must be notified of any such incident without delay.

2.7 Closure

2.7.1 The Authorisation Holder shall produce, maintain and implement a plan for the closure of the vaults, consistent with the Environmental Safety Case, which must be agreed in writing by SEPA prior to commencement of closure of the vaults.

2.7.2 The Authorisation Holder shall, prior to the cessation of waste disposal, produce a plan for the maintenance of active institutional control following the closure of the facility which must be agreed in writing by SEPA prior to its implementation, and thereafter maintained and implemented.

At the time of drafting this Authorisation the facility is at the first phase of construction, but it has been recognised that consideration must be given to the future closure, maintenance and long term monitoring of the facility and surrounding environment.

Condition 2.7 therefore requires DSRL to produce, maintain and implement a plan for closure of the vaults which is consistent with the ESC. This closure plan is to be supported by a plan for the maintenance of active institutional control, which must be agreed with SEPA prior to implementation.

In the long term, following cessation of waste emplacement, the facility will enter what is known as a period of active institutional control, nominally considered to be up to 300 years. During this period the facility will be actively monitored and managed. The Authorisation requires plans for this period to be agreed with SEPA prior to their implementation and to be maintained and implemented thereafter.

2.8 Management

2.8.1 The Authorisation Holder shall have a management system and resources which are sufficient to achieve compliance with the limitations and conditions of this Authorisation and which include, without restricting the generality of the requirement under this paragraph:

2.8.1.1 written arrangements specifying how the Authorisation Holder shall achieve compliance with each limitation and condition of this Authorisation, to include arrangements for control of the design and operation of systems and equipment provided for such compliance with this Authorisation, and any modifications made to these systems and equipment;

2.8.1.2 written Environmental Operating Rules and operating instructions;

2.8.1.3 a written maintenance schedule and instructions;

2.8.1.4 adequate supervision of the disposal of radioactive waste by suitably qualified and experienced persons, whose names shall be clearly displayed with each copy of this Authorisation that is posted on the Authorised Premises as required by Section 19 of the Act;

2.8.1.5 adequate supervision by suitably qualified and experienced persons of the operation and maintenance of the systems and equipment provided to meet the requirements of paragraph 2.2.1 and for the disposal of radioactive waste;

2.8.1.6 internal audit and review of the Authorisation Holder's management system and its efficacy.

2.8.2 The Authorisation Holder shall inform SEPA, at least 28 days in advance or, where this is not possible, without delay, of any change in the management system, or resources which might have, or might reasonably be seen to have, a significant impact on how compliance with the limitations and conditions of this Authorisation is achieved.

2.8.3 The Authorisation Holder shall appoint each Radioactive Waste Adviser in writing and include in the appointment the scope of advice which the Radioactive Waste Adviser is required to give.

The Authorisation recognises the importance of appropriate management controls being in place to ensure the optimal level of protection of people and the environment.

This requirement is common across Authorisations and therefore SEPA's standard Authorisation conditions relating to management have been determined as appropriate and applied through Condition 2.8. In essence the Authorisation Holder is required to put in place and be able to demonstrate a suitably resourced management system that enables them to comply with the conditions of the Authorisation.

Written arrangements are required detailing how each limitation and conditions of the Authorisations will be met, including:

- Environmental Operating Rules and operating instructions.
- Written maintenance schedule and instructions.
- Supervision by suitably qualified and experienced personnel to oversee the disposal of waste, operation and maintenance of systems and equipment and the application of BPM
- Internal reviews to be undertaken of the suitability and effectiveness of the management system.
- Provision of Radioactive Waste Adviser(s).

These management conditions are considered to provide an appropriate level of regulatory control to ensure sufficient management of the facility.

2.9 Sampling, measurements, tests, surveys and calculations

2.9.1 The Authorisation Holder shall take samples and conduct measurements, tests, surveys, analyses and calculations to determine its compliance with the limitations and conditions of this Authorisation.

2.9.2 The Authorisation Holder shall use best practicable means to prepare, maintain and implement a programme of monitoring the site and the facility, which must be agreed in writing with SEPA prior to its implementation, so as to demonstrate compliance with the conditions of the Authorisation and to confirm the assumptions of the Environmental Safety Case. Any proposed change(s) by the Authorisation Holder to the programme of monitoring shall be submitted in writing to SEPA at least 28 days before the implementation of the proposed change(s) and not implemented without written agreement from SEPA.

2.9.3 The Authorisation Holder shall undertake a programme to monitor the levels of radioactivity and ionising radiation in the environment and food caused by the disposal of radioactive waste on or from the Authorised Premises by taking such samples, conducting such measurements, tests, surveys, analyses and calculations, including environmental measurements and assessments, as are necessary to continuously assess the effectiveness of the measures taken by the Authorisation Holder to comply with paragraphs 2.4.1, 3.1.3 and 3.1.4.

2.9.4 The Authorisation Holder shall carry out reviews at an appropriate frequency of the adequacy of the programme undertaken to satisfy paragraph 2.9.2 and 2.9.3.

2.9.5 The Authorisation Holder shall use the best practicable means when taking samples and conducting measurements, tests, surveys, analyses and calculations to determine its compliance with the limitations and conditions of this Authorisation, unless particular means are specified in this Authorisation.

2.9.6 The Authorisation Holder shall keep any sample or a sub sample taken as a requirement of paragraphs 2.9.2 and 2.9.3 for a minimum period of six months from the date of sampling and in sufficient quantity that the analysis carried out by the Authorisation Holder can be repeated, and shall provide any of the samples or sub samples, on request, to an Authorised Person or to such other person as an Authorised Person specifies; and if required by SEPA dispatch samples for tests at a laboratory and ensure that the samples or residues thereof are collected from the laboratory within three months of receiving written notification that testing and repackaging in accordance with the appropriate transport regulations are complete.

2.9.7 The Authorisation Holder may dispatch samples of radioactive waste for testing to a Waste Permitted Person.

2.9.8 The Authorisation Holder shall evaluate all groundwater monitoring data against the baseline agreed in writing with SEPA.

2.9.9 Where the evaluation of the monitoring data shows any parameter exceeding baseline levels, the Authorisation Holder shall report this to SEPA, in writing, within 28 days.

2.9.10 The Authorisation Holder shall report to SEPA, on the basis of aggregated data once a year, the results of monitoring carried out in compliance with this Authorisation. The report shall give an explanation and interpretation of any trends or exceedances of control levels agreed in writing with SEPA in the monitoring data submitted. This report shall be submitted to SEPA, in writing, by 31 March each year.

2.9.11 All monitoring boreholes and access to them, shall be maintained to enable samples to be taken. Any borehole that is damaged or destroyed to the extent that sampling or monitoring in accordance with the requirements of this Authorisation is not possible shall be replaced where necessary as soon as possible. Damage to boreholes shall be recorded.

2.9.12 All sample points shall be constructed, maintained and appropriately identified as sample points so that representative samples may be safely obtained.

2.9.13 Borehole logs and construction details surveyed to ordnance datum shall be retained by the Authorisation Holder.

2.9.14 The Authorisation Holder shall provide and at all times maintain in good repair systems and equipment for:

2.9.14.1 carrying out any sampling, monitoring and measurements necessary to determine compliance with the limitations and conditions of this Authorisation; and

2.9.14.2 measuring and assessing exposure of members of the public and radioactive contamination of the environment.

2.9.15 The Authorisation Holder shall have and comply with appropriate criteria for the acceptance into service of systems, equipment and procedures for:

2.9.15.1 carrying out any sampling, monitoring and measurements necessary to demonstrate compliance with the limitations and conditions of this Authorisation; and

2.9.15.2 measuring and assessing exposure of members of the public and radioactive contamination of the environment.

2.9.16 The Authorisation Holder shall carry out regular calibration, at an appropriate frequency, of systems and equipment provided for:

2.9.16.1 carrying out any sampling, monitoring and measurements necessary to determine compliance with the limitations and conditions of this Authorisation; and

2.9.16.2 measuring and assessing exposure of members of the public and radioactive contamination of the environment;

2.9.16.3 regular checking, at an appropriate frequency, that such systems and equipment are serviceable, accurate and effective and correctly used at all times.

SEPA expects DSRL to undertake whatever sampling, measurements, testing, surveys and calculations are appropriate and necessary to demonstrate compliance with the Authorisation. Condition 2.9 requires the preparation, maintenance and implementation of a programme of monitoring that will achieve this aim. That programme must be agreed in writing with SEPA, reviewed at appropriate frequency, and requires SEPA's agreement before any proposed amendments can be implemented.

Groundwater sampling is considered a key part of the monitoring programme (as the facility is near-surface), therefore SEPA have applied monitoring conditions specifically relating to groundwater requiring DSRL to evaluate results against agreed baseline levels. Appropriate baseline levels must be agreed with SEPA prior to first emplacement of waste and an annual report prepared providing the basis of the aggregated data and an explanation and interpretation of any trends or exceedances of baseline levels.

Requirements have been included within the condition for DSRL to construct, maintain and appropriately identify all sample points, and to retain borehole logs and constructions details surveyed to ordnance datum. These requirements have been included to ensure the appropriate construction and maintenance of boreholes and the long term retention of borehole logs and construction details which may be required to information future assessment work.

General requirements on DSRL to provide, maintain and calibrate, as appropriate, the necessary equipment to demonstrate compliance with the Authorisation and for measuring and assessing exposure to members of the public and radioactive contamination of the surrounding environment have been included. These conditions are in place to provide confidence that data has been gathered by DSRL using appropriate and well maintained equipment.

2.10 Waste Compliance Testing

2.10.1 The Authorisation Holder shall prepare, implement and maintain a programme of waste compliance testing agreed in writing with SEPA prior to the commencement of disposal of waste.

2.10.2 Waste compliance testing shall consist of non-destructive tests which demonstrate that the waste complies with the Authorised Waste Acceptance Criteria.

2.10.3 The Authorisation Holder shall select, with a frequency agreed in writing with SEPA, waste consignments, held by the waste consignor, which shall be destructively tested to confirm their content and characterisation against the consignor's waste records.

Conditions on waste compliance testing are necessary in order for DSRL to demonstrate that waste accepted for disposal in the facility has been appropriately characterised and consigned in line with the Authorised Waste Acceptance Criteria (WAC). A combination of destructive and non-destructive testing has been prescribed by SEPA.

SEPA formed the view through its determination of DSRL's application that destructive testing of waste packages was necessary and appropriate to demonstrate compliance with the Authorised WAC. SEPA requires that all samples sent for testing are returned to the facility on completion of testing. DSRL must prepare,

implement and maintain a programme of waste compliance testing which has to be agreed with SEPA.

2.11.1 Records

2.11.1 The Authorisation Holder shall:

2.11.1.1 make, as soon as is reasonably practicable, and retain true, accurate and legible records sufficient to demonstrate whether the limitations and conditions of this Authorisation are and have been complied with; and

2.11.1.2 retain all records made in accordance with all previous Authorisations issued to the Authorisation Holder and related to the Authorised Premises covered by this Authorisation.

2.11.2 The Authorisation Holder shall implement and maintain a comprehensive system of recording information on all aspects of the Authorised Premises including:

I. All decisions and reasoning underpinning the Environmental Safety Case;
II. Site investigation and characterisation details;
III. Design and build documents and drawings;
IV. Waste form and characterisation data;
V. Detailed information demonstrating that disposed wastes are Authorised Waste Acceptance Criteria compliant ;
VI. Waste emplacement locations;
VII. Other operational information as required;
VIII. Details of facility closure;
IX. Details of, and data from, monitoring programmes.

2.11.3 Duplicates of the records referred to in 2.11.1.1 and 2.11.1.2 shall be kept at diverse locations, agreed in writing with SEPA, in durable form and, prior to revocation of the Authorisation, shall be included in the public archive.

2.11.4 If the Authorisation Holder amends any record made in accordance with this Authorisation the Authorisation Holder shall ensure that the original entry remains clear and legible.

SEPA expects Authorisation Holders at nuclear sites to make and retain true and accurate records relating to the demonstration of compliance with the limitations and conditions of the Authorisation and to retain the records (in duplicate at diverse locations) until the end of the period of Authorisation and ultimately to include these in the public archive.

Although this facility is not on a nuclear licensed site, the sole consignor of waste to the facility is the Dounreay Nuclear Establishment. It is therefore considered appropriate by SEPA that equivalent standards are applied for the recording and keeping of records as would be applied to a nuclear licensed site.

2.12 Provision of information

2.12.1 The Authorisation Holder shall supply on request and without delay, to any Authorised Person any record made as a requirement of this Authorisation.

2.12.2 The Authorisation Holder shall supply to SEPA any such information in such format and within such time as SEPA may periodically specify in writing.

2.12.3 The Authorisation Holder shall inform SEPA without delay if the Authorisation Holder has reason to believe that disposal of radioactive waste is occurring, has occurred or might occur which does not comply with the limitations and conditions of this Authorisation, and shall report the circumstances in writing to SEPA as soon as practicable thereafter.

2.12.4 The Authorisation Holder shall inform SEPA in writing, within 90 days of the effective date of this Authorisation, of the organisational structure and resources, together with the whole management system or such parts of the management system as SEPA specifies in writing, provided to achieve compliance with the limitations and conditions of this Authorisation.

Condition 2.12 relating to the provision of information states that DSRL must supply on request and without delay any information made as a requirement of the Authorisation to any Authorised Person. The condition also prescribes that SEPA shall be supplied with any information, in a format and within timescales it specifies in writing. DSRL have been required to inform SEPA without delay, and subsequently in writing should any disposal occur, or potentially occur which does not meet the limitations and conditions of the Authorisation.

It has been recognised that at the time of applying for this authorisation DSRL did not require, nor could reasonable be expected to have in place a management system necessary to achieve compliance with the limits and conditions of the LLW Facility authorisation. SEPA has therefore specified this information shall inform SEPA within 90days of the date of the authorisation how the requirement for a management system shall be met.

These conditions allow SEPA access to any information that it considers relevant in discharging its duties in relation to the facility, and requires the Authorisation Holder to inform SEPA if disposal takes place, or could potentially have taken place which would be out with the limits and conditions of the Authorisation.

6.4 Schedule 3

3. LIMITATIONS AND CONDITIONS RELATING TO TYPES OF WASTE THAT CAN BE DISPOSED OF UNDER THIS AUTHORISATION AND THE DISPOSAL ROUTES AUTHORISED

3.1 Disposal of radioactive waste

3.1.1 The Authorisation Holder is authorised to dispose only of the radioactive waste arising from the Dounreay Nuclear Establishment and from the Undertaking at the Authorised Premises, only of the types of radioactive waste identified in Table 3.1, only by the relevant disposal routes specified in Table 3.1.

3.1.2 The maximum radionuclide specific activities that are to be disposed of at the Authorised Premises are specified in Appendix 3 and are subject to any further limitations and conditions contained within Schedules ***Error! Reference source not found.*** *to 7.*

Table 3.1

Radioactive Waste Type	*Disposal Route*	*Permission to Accumulate*
Low Level Waste	*Emplacement in Vaults LLW-1, LLW-2, LLW-3-1, LLW-3-2*	*YES*
Demolition Waste	*Emplacement in Vaults DLLW – 1 and DLLW-2*	*YES*
Radioactive Waste	*Return to Dounreay Nuclear Establishment*	*YES*
Samples of Waste	*Transfer to a Waste Permitted Person*	*YES*

3.1.3 The Authorisation Holder is authorised to accumulate and dispose of radioactive waste arising from the Undertaking at the Authorised Premises by return to the Dounreay Nuclear Establishment for conditioning and subsequent disposal

3.1.4 The Authorisation Holder shall maintain in good repair the systems and equipment provided:

3.1.4.1 to meet the requirements of paragraphs 2.4.1 and 3.1.2; and

3.1.4.2 for the disposal of radioactive waste under this Authorisation.

3.1.5 The Authorisation Holder shall check, at an appropriate frequency, the effectiveness of systems, equipment and procedures provided:

3.1.5.1 to meet the requirements of paragraphs 2.4.1 and 3.1.2; and

3.1.5.2 for the disposal of radioactive waste under this Authorisation.

Schedule 3 prescribes that only waste arising from the Dounreay Nuclear Establishment and from undertakings at the Authorised Premises may be disposed at the facility. This is in line with the current planning consent and the RSA93 application received by SEPA from DSRL.

Conditions have been applied prescribing which vault Low Level Waste and Demolition waste can be disposed to, in line with DSRL's plans and the ESC. Low Level Waste is defined in the Authorisation as meaning solid low level radioactive waste having a radioactive content not exceeding four gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity. Demolition waste is a DSRL concept and for the purposes of this Authorisation is defined as LLW streams made up of unconditioned material including, but not restricted to, concrete, bricks, metals, stone, sand and soil which have radioactivity levels not exceeding 0.01 GBq/ tonne alpha or 0.4 GBq/ tonne beta/ gamma.

In practical terms LLW waste will be disposed of in a grouted form which ultimately results in a grouted monolith being created at vault closure and Demolition waste will be disposed of in bags and backed filled with low permeability material. It is recognised that bulk items are expected to be disposed of to the LLW vault and SEPA expect DSRL to address how the emplacement of these will be undertaken, and BPM demonstrated for this, in the management plan required by Condition 2.6.

It has been determined by SEPA as appropriate to prescribe separate vaults for each of the waste categories given how DSRL have stated they intend to operate the facility.

Provision is made in Schedule 3 for the return of waste to the Dounreay Nuclear Establishment and for the transfer of samples of waste to a person permitted to receive that waste sample. Both these routes are considered necessary and appropriate for DSRL to return waste to the consigner if necessary and to meet the requirements of this authorisation.

3.2 Authorised Waste Acceptance Criteria

3.2.1 The following Authorised Waste Acceptance Criteria shall apply to radioactive waste accepted at the Authorised Premises;

I. No waste package will be accepted for disposal at the Authorised Premises unless it has been demonstrated by the consignor that Best Practicable Means and the waste hierarchy have been applied;
II. The physical characteristic of the waste package shall be such that safety is not compromised during any stage of management;
III. Best Practicable Means shall be applied to the disposal of each bulk item at the Authorised Premises;
IV. Waste in its untreated form shall contain < 0.1%wt very toxic substances and < 3 %wt for toxic substances;
V. Only waste meeting the definition of Demolition Waste shall be disposed of to the Demolition waste vault;
VI. Biodegradable waste must be excluded as far as is practicable and must not exceed 1%wt of the untreated waste package;
VII. Only the radionuclides up to the activity specified in Appendix 3 shall be disposed of at the Authorised Premises;
VIII. Compacted waste packaged in HHISO containers shall contain no greater than 600g Uranium-235;
IX. Mixed compacted and non-compacted waste packaged in HHISO containers shall contain no greater than 600g Uranium-235;
X. Non-compacted waste packaged in HHISO containers shall contain no greater than 60g Uranium-235;
XI. Non-containerised Low Level Waste must have a mass content of no greater than 60g Uranium-235 per item;
XII. Packages of Demolition Low Level Waste must have a mass content of no greater than 6g Uranium-235.

3.2.2 In the event that radioactive waste or its packaging does not meet any of the Authorised Waste Acceptance Criteria set out in paragraph 3.2.1 it shall be rejected by the Authorisation Holder. Rejected radioactive waste shall be returned to the Dounreay Nuclear Establishment forthwith and SEPA informed in writing without delay.

DSRL prepared and submitted to SEPA, as part of the ESC, a selection of Waste Acceptance Criteria (WAC). SEPA reviewed DSRL's submission and has applied what it considered to be the key WAC requirements through the Authorisation to ensure protection of the environment and members of the public and reflect the claims and assumptions made by DSRL in their.

Through these requirements waste volumes consigned to the facility for disposal should have been minimised, the toxicity of each waste packaged kept within

prescribed limits and the volume of biodegradable waste within each package kept at a level which will not compromise the long term stability of the facility.

The radionuclide activities prescribed in Appendix 3 of the Authorisation are those reported in ESC 2010 and used in the Performance Assessment submitted by DSRL in support of their application. It is therefore appropriate to limit the inventory to these levels to ensure the facility performs according to the assumptions of the ESC.

Package limits set for Uranium-235 mirror those used by DSRL in preparation of the Criticality Safety Case prepared and submitted in support of their application. These same limits have been applied to ensure the operation of the disposal facility is not contrary to the assumptions made when preparing the safety case.

Should any waste package fail to satisfy any part of the WAC then it must be returned to the Dounreay Nuclear Establishment without delay and SEPA informed in writing.

3.3 Waste Characterisation

3.3.1 In respect of all radioactive waste accepted for disposal at the Authorised Premises, the Authorisation Holder shall ensure, by appropriate auditing, that the radioactive waste has been characterised by the consigner such that all information necessary for the safe disposal of the radioactive waste in the long term is correct, available and recorded.

SEPA expect all waste to be characterised appropriately by the consignor in order that it can be demonstrated that the WAC has been complied with and that the waste can be safely disposed of at the facility. The GRA states that it is the responsibility of the developer or operator of the facility to make sure that the waste accepted for disposal is consistent with the assumptions of the ESC and the requirements at the facility for transport and handling. SEPA has applied this Condition to require that the disposal facility undertakes appropriate auditing of the consigning facility to ensure waste intended for disposal at the authorised facility has been appropriately characterised.

6.5 Schedule 4

4. FURTHER LIMITATIONS AND CONDITIONS RELATING TO THE HAZARDOUS PROPERTIES OF THE RADIOACTIVE WASTE TO BE DISPOSED

4.1 Excluded hazardous materials

4.1.1 Radioactive waste containing any of the following hazardous properties are excluded from disposal at the Authorised Premises:

I. Combustible metals, such as uranium, lithium, magnesium, zinc, zirconium, sodium, potassium, calcium and other metals, in finely divided form;
II. Other pyrophoric materials;
III. Phosphorus;
IV. Fixed liquids (e.g. immobilised in cement) with flash points less than 21°C;
V. Chemical compounds representing a high fire hazard;
VI. Materials that react with water to evolve heat and flammable gases (e.g. hydrides, nitrides and carbides);
VII. Strongly acidic or alkaline compounds.

4.1.2 Notwithstanding paragraph 3.2.1, the Authorisation Holder shall ensure that radioactive waste to be disposed of at the Authorised Premises shall comply with the following conditions:

I. Waste containing loose powders or asbestos must be in sealed containers;
II. Waste must not contain strong complexing agents, unless treated and stabilised;
III. All waste containing ion exchange material must be intimately stabilised to ensure retention of its radioactivity content;
IV. No readily leachable/soluble solid wastes are to be disposed of without conditioning. Readily leachable/soluble solid waste must be fixed in a solid matrix (e.g., cement) that will not readily release that component when contacted with water;
V. Waste must not contain, or be capable of spontaneously generating, quantities of toxic gases, vapours or fumes harmful to persons transporting, handling or disposing of the waste;
VI. Waste must not contain material capable of detonation or explosive decomposition or reaction at normal pressures, nor of explosive reaction with water;
VII. Waste must not contain corrosive material that might prejudice the integrity of the container, including bags, used for disposal;
VIII. Waste must not contain metals or other materials, unless treated and stabilised, that might react readily with grout;
IX. Pressurised gases, including redundant cylinders and aerosols, must be excluded until made safe;
X. Strong oxidising agents (e.g., peroxides, chlorates, nitrates) are to be eliminated wherever practicable. In any event, these materials are not to be in close contact with easily oxidised materials;
XI. *Waste containing pathogens or biologically hazardous material shall be excluded from waste packages accepted for disposal unless demonstrated to have been made safe.*

This Condition requires that waste materials which posses certain risks or associated categories of danger as defined by the Chemical (Hazard Information and Packaging for Supply) Regulations are excluded from waste packages unless made safe through conditioning or mixing with other materials prior to disposal. This is derived from Environment Agencies Technical Guidance WM2 – Hazardous Waste, Interpretation of the definition and classification of hazardous waste.

It should be noted that uranium in finely divided form is excluded as a combustible metal by this condition. This does not exclude uranium in its entirety from the facility. Specific controls have been applied to volumes of uranium in each waste package by the Authorised WAC to ensure its disposal is in accordance with the assumptions in the ESC and Criticality Safety Case.

These controls apply an equivalent level of control on the hazardous properties of the waste consigned for disposal to the facility as SEPA would apply to non-radioactive hazardous waste facility to ensure protection of people and the surrounding environment.

6.6 Schedule 5

5 FURTHER LIMITATIONS AND CONDITIONS RELATING TO DISPOSAL OF RADIOACTIVE GASEOUS WASTE BY DISCHARGE TO THE ENVIRONMENT

5.1 Discharge of radioactive gaseous waste

5.1.1 Disposal of radioactive gaseous wastes is not authorised by this Authorisation.

DSRL have not identified any discharges of gaseous waste from the facility in the ESC nor applied for any gaseous discharges from the facility. SEPA has therefore not permitted any gaseous waste discharges to the environment through this Authorisation.

SEPA have required DSRL to prepare and maintain a contingency plan covering the possibility explosion, fire or loss of containment in Condition 2.6 which will be expected to consider the possibility of gaseous discharges.

6.7 Schedule 6

6 FURTHER LIMITATIONS AND CONDITIONS RELATING TO DISPOSAL OF RADIOACTIVE AQUEOUS WASTE BY DISCHARGE TO THE ENVIRONMENT

6.1 Discharge of radioactive aqueous waste

6.1.1 Disposal of radioactive aqueous wastes is not authorised by this Authorisation.

DSRL have not identified any discharges of aqueous waste from the facility in their ESC nor applied for any aqueous discharges from the facility. SEPA has therefore not permitted any aqueous waste discharges to the environment through this Authorisation.

SEPA have required DSRL to produce a Water Management Plan and to prepare and maintain a contingency plan covering the possibility of a flood event in Condition 2.6 which will be expected to consider the possibility of aqueous discharges.

6.8 Schedule 7

7 INFORMATION REQUIREMENTS

7.1 Information requirements

7.1.1 The Authorisation Holder shall provide the information specified in Table 8.1 by the relevant completion date and, shall notify SEPA, in writing, within 14 days of the completion of each of those specifications.

Table 7.1

Specified information	*Completion Date*
1. For each calendar year a summary of the disposal records required by paragraph 2.11.1.1.	*Within 8 weeks from the end of that calendar year.*
2. A report on the review of the environmental	*3 years from the date of this*

safety case including any actions needed and timescales for completion.	*Authorisation and at the same intervals thereafter unless SEPA otherwise specifies in writing.*
3. For each calendar year a summary of the results required by paragraph 2.9.2 in relation to the environmental monitoring programme	*By 31 March the following year.*

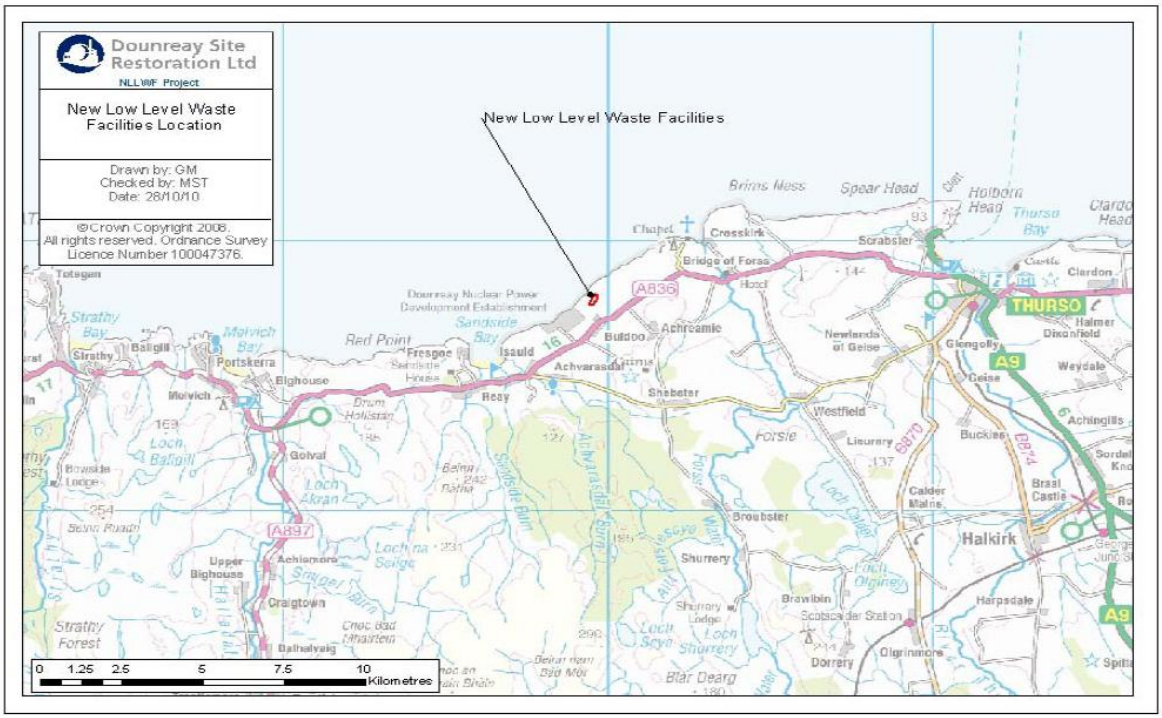
In order to provide clarity and ease of reference SEPA determined to include a Table within the authorisation detailing all information requirements and the completion date for each of these contained within the authorisation.

6.9 Schedule 8

8 APPENDICES

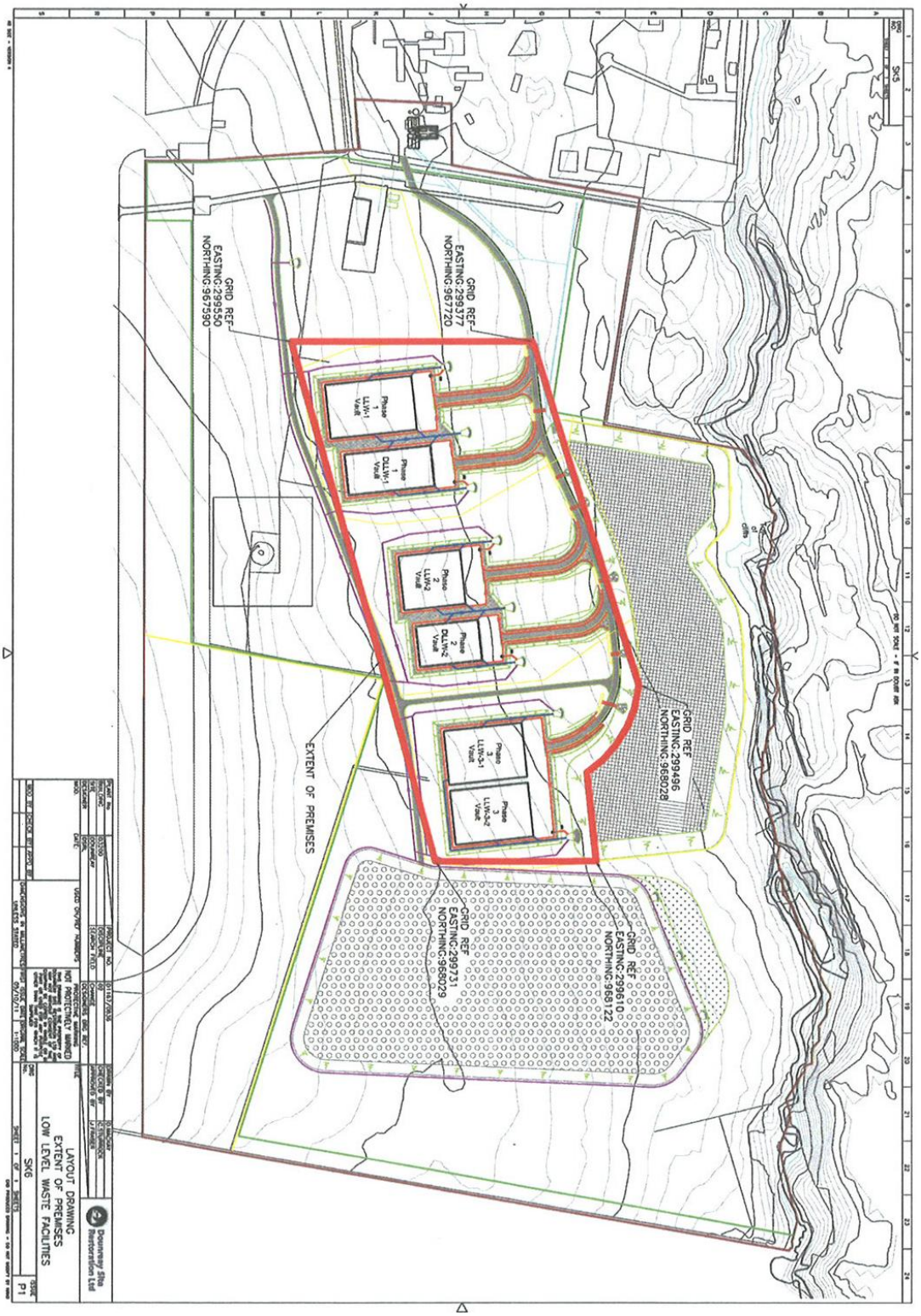
8.1 Appendix 1 – Location Guide

For clarity the location of the facility has been included as Appendix 1



8.2 Appendix 2 - Site Plan

Appendix 2 contains the Site Plan delineating in red the boundary of the Authorised Premises which the conditions of this Authorisation apply, as referred to in Condition 1.2 of the authorisation.



8.3 Appendix 3 – Radionuclide Inventory

Appendix 3 – Radionuclide Inventory

Only the radionuclides up to the 2009 activity level as specified in the Table below shall be disposed of at the Authorised Premises

Nuclide	Demolition LLW (Bq)	LLW (Bq)
H-3	3.56E+08	2.67E+12
C-14	2.16E+05	5.48E+09
Co-60	7.63E+09	2.83E+11
Ni-63	8.77E+08	6.12E+10
Se-79	2.05E+07	5.40E+07
Sr-90	2.97E+11	2.71E+12
Nb-94	4.69E+07	2.94E+08
Mo-93	+	+
Tc-99	2.05E+08	9.90E+08
Cs-137	5.92E+11	4.01E+12
Sm-151	6.01E+09	1.06E+11
Eu-152	3.76E+04	2.71E+11
Pb-210	*	1.33E+09
Po-210	**	1.19E+09
Ra-226	**	9.00E+09
Ra-228	4.92E+07	6.28E+08
Ac-227	4.59E+03	5.86E+04
Th-228	7.47E+07	7.10E+08
Th-229	**	6.59E+04
Th-230	8.28E+04	4.54E+06
Th-232	9.79E+07	9.29E+07
Pa-231	6.43E+04	4.64E+05
U-232	1.40E+08	5.75E+07
U-233	**	3.56E+07
U-234	2.15E+09	1.33E+11
U-235	7.83E+08	4.42E+09
U-236	2.24E+08	1.14E+10
U-238	6.24E+07	1.20E+09
Np-237	3.63E+05	1.26E+06
Pu-238	1.31E+10	5.57E+10
Pu-239	1.40E+10	3.18E+11
Pu-240	1.73E+10	1.28E+11
Pu-241	3.84E+11	2.11E+12
Pu-242	5.97E+06	5.59E+07
Am-241	1.99E+10	3.36E+11
Am-242m	2.23E+08	1.75E+09
Am-243	1.79E+07	3.19E+07
Cm-243	7.72E+07	7.78E+07
Cm-244	9.46E+08	3.53E+09
Other Alpha	1.84E+08	1.44E+09
Other Beta/Gamma	1.76E+10	9.89E+10
Total Alpha	**6.92E+10**	**1.01E+12**
Total Beta/Gamma	**1.31E+12**	**1.24E+13**

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