Radioactive Waste Management

Magnox Swarf Storage Silo Wastes at the Silos Direct encapsulation Plant (SDP) (Interim stage)

Summary of Assessment Report

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Introduction

Sellafield Ltd (SL) has sought Interim stage endorsement of proposals for the packaging of Magnox Swarf Storage Silo (MSSS) waste at the Silos Direct encapsulation Plant (SDP). The wastes consist of intermediate level solid and sludge waste representing some of the highest hazards in the UK nuclear estate.

This Assessment Report provides the basis and findings of the Interim stage disposability assessment by NDA Radioactive Waste Management Directorate (RWMD) for the proposals to package MSSS waste at SDP. The assessment has been carried out through the Disposability Assessment process, where RWMD examine the compatibility of the proposed packages with the requirements for safe long-term management, including transport, emplacement and extended storage underground, and disposal, as currently expressed for the Illustrative Geological Disposal Concepts for Intermediate Level Waste and Low Level Waste (ILW/LLW). This concept has been developed as part of the programme to implement geological disposal for the UK's higher activity wastes. Further information on the RWMD disposability assessment (Letter of Compliance) process is available elsewhere[1].

Background

A Conceptual stage Letter of Compliance (LoC) was provided in 2008, supported by a formal assessment. SL had sought Interim stage endorsement along with the Conceptual stage submission, but it was concluded that the project was not yet sufficiently advanced and had not met all the requirements to allow Interim stage endorsement. In response, a disposability assessment and advice on recommended activities, denoted as Action Points, to achieve later stages of endorsement was provided. It was recognised that SL would need to progress the project at risk before an Interim stage LoC could be issued. Therefore, a formalised process was established and agreed for managing closure of Action Points prior to an Interim stage LoC assessment, to build confidence and minimise the risk of a subsequent failure to endorse the proposals. In 2010, proposals for SDP were revised, with the introduction of the new $3m^3$ Box with inner liner concept. The Action Points were updated to reflect these changes in 2011, and it was confirmed that these changes did not impact the Conceptual stage LoC.

[1] NDA, Guide to the Letter of Compliance Process, NDA Document WPS/650, March 2008

SL has now sought Interim stage endorsement based on responses to the remaining issues derived from recent research and development to address the outstanding Interim stage Action Points. This Assessment Report provides the basis and findings of the Interim stage disposability assessment by RWMD for packages of MSSS waste to be produced at the SDP.

Scope of Assessment

The objectives of this Interim stage assessment are to assess the status of outstanding Interim stage Action Points, review those previously assessed and closed, assess four Final stage LoC Action Points brought forward to Interim stage by SL for programme reasons, and review and update the list of Final stage Action Points. RWMD aims to conclude whether sufficient evidence has been provided against the Action Points, or whether further information is required. The assessment provides an updated Interim stage Disposability Assessment of the proposals for packaging MSSS waste at SDP.

The proposal covers the MSSS waste contained in 22 silos (compartments), all of which is included in the 2010 UK Radioactive Waste Inventory. The composition, condition, and age of the wastes in each compartment are variable and consist of: corroded fuel cladding and swarf, irradiated or contaminated Miscellaneous Beta-Gamma Waste (MBGW) located primarily in Compartment 15, and a mixture of swarf and MBGW due to seeping of corrosion products into the underlying MBGW layers. There is a layer of limestone pebbles in the bottom of each compartment that will be retrieved with the swarf. Process wastes will also be generated from retrieval and SDP operations.

Waste from Compartment 11 (primarily stainless steel waste from uranium oxide fuel), waste stored in the building void, residual waste left in each compartment after completion of bulk removals, and product boxes made from effluents from the SDP process are currently excluded from assessment.

Waste Packaging Proposal

The waste would be retrieved through the use of heavily shielded Silo Emptying Plant (SEP) machines to be installed on the upper loading face of the silos. A mechanical grab would recover waste from the silo and deposit it into a skip. The weight and level of liquid in each skip would be recorded and monitored by the SEP. The SEP machine operator would segregate waste items that are potentially challenging or problematic to the SDP process, record the type of waste being handled, and collect still photographs. Filled Skips would be designated as either Undersize destined for tumble mixing in the Undersize Mixing Vessel (UMV) or Oversize destined for flood grouting. The SDP process concept would convert each skip of waste into a product package, which should enable waste tracking directly from the silo through SDP, into a product box, and storage.

The $3m^3$ Box to be used at SDP would be a double-skinned stainless steel waste container. The thick inner liner would be manufactured from stainless steel to handle impacts of heavy loads. The liner would be fitted with feet, but the feet would not be used to support the liner within the box. There will be a gap (annulus) between the box and the liner which would be left empty initially for on-site storage. This concept allows the wasteform to expand resulting in no change to external package geometry.

About 85% of the product boxes are expected to consist of Undersize waste consisting of swarf, sludge, small items of MBGW, and similar maintenance items arising from retrieval and processing. At SDP, undersize waste skips would be tipped with associated washings into an Undersize Mixing Vessel (UMV). Excess liquor would be decanted and a fixed volume of secondary effluent would be added to the mixing vessel. At the mixing station, the required mass of grout powders (a blend of Ground, Granulated Blast furnace Slag (GGBS) and European Standard Portland Cement (CEM 1)) would be added. The mixing vessel would then be inclined to a fixed mixing angle and rotated at a fixed speed for a fixed mixing time in order to disrupt containerised waste. The mixing vessel would then be discharged into a liner and the mixing vessel washed internally with water up to three times. Wash water from the first two washings would be added to the liner. If a third wash is needed, the wash water would be left in the UMV for the next batch. An anti-flotation plate (AFP) would be installed on the liner only if judged to be required.

About 15% of the product boxes are expected to consist of Oversize waste, including problematic and large items. Oversize skips could also contain sludge that happens to be present in the grab. Although the silos were nominally filled in campaigns, resulting in layers of waste types, there would be some physical mixing at the interface of the swarf and MBGW layers and a significant seeping of corrosion products into underlying MBGW layers, creating a mixture of both waste types. At the silos, items classified as oversize feed would be placed in a skip and imported to the oversize treatment line at SDP. The oversize items would then be removed using an in-cell crane and placed inside a liner where they would be covered with water and an AFP installed. All oversize liners would be fitted with an AFP. The filled liner would then have the cover water removed and a pre-mixed GGBS/CEM I grout added to encapsulate the waste. This process is called flood grouting. Wash water from the grout line would then be added to the product box liner.

Effluents from SDP operations would arise and include wasteform bleed water, UMV decant, and oversize decant. These effluents would be acidified and the volumes reduced using an evaporator. Where possible, concentrate and settled solids from the liquid effluent treatment evaporator would be returned to the undersize route. During periods when retrievals are being conducted from silos consisting of large quantities of MBGW, the addition of the effluents to an undersize box may not be possible, resulting in the accumulation of secondary effluent stock. In these cases it is proposed that product boxes containing only secondary waste (Effluent Only boxes) would be produced. These product boxes have been excluded from the current assessment because a suitable formulation has not yet been developed and tested.

Recovery station(s) would be equipped to deal with any damaged or non-compliant products. A product inspection and condition monitoring regime would identify any products potentially requiring such rework. A Wet Rework Station would be used to provide operators the opportunity to correctly position MBGW waste within filled undersize liners. A Dry Rework Station would be used to provide operators the opportunity to rework any liners that fall outside the acceptance criteria. Also, a range of organic components, primarily derived from MBGW, may be retrieved and cause foaming by the surface tension being lowered. This could affect product set and produce bleed. Foaming is expected to be infrequent, but mitigation efforts would take place in the Dry Rework Station if necessary.

All liners would be allowed to set for 24 hours before any bleed water is removed. Residual bleed water would be removed and evaporated as previously discussed. All liners would then be monitored for hydrogen release rate followed by capping. The capping grout would be a pre-mixed GGBS/CEM I grout. Once the cap had set the liner would be exported through a gamma gate into the Box Handling and Monitoring

Cave, where the liner would be placed into a clean corner-lifting $3m^3$ box and lidded to form the double skinned product package. The external surfaces of the box would be swab monitored to confirm the absence of contamination and once deemed suitable for export the boxes would be transferred to the SDP Box Transfer Facility via the export tunnel where gamma monitoring would occur. Product packages would be stored with the annulus unfilled until a GDF becomes available, at which time a decision would be taken on filling the annulus.

The total volume of stored waste in MSSS is estimated to be 9,000 m^3. The total number of packages to be produced using the packaging process described above is currently predicted to be 12,000, including maintenance arisings.

Wasteform

The properties and performance of the wasteform underpin the expected behaviour of the proposed waste packages and the basis for assessment. A wasteform production method that removes liquids and solidifies the wastes to restrict radionuclide releases under normal and fault conditions would have the potential to produce a disposable waste package. SL has provided evidence of the properties and performance of the proposed wasteforms to demonstrate that these expectations would be fulfilled. The submitted evidence has been examined specifically against product quality, wasteform sensitivity, and product evolution:

- Product quality: the as-made products are expected to contain a mix of solid and sludge waste and be immobilised in a cement grout. The resulting wasteforms are expected to be variable in composition according to the relative mix of sludge and residual Magnox cladding, uranium, and types of MBGW items present. RWMD are proceeding with the assumption that this generally represents the product quality expected from SDP waste products. As noted above, Effluent Only boxes have been excluded from assessment.
- Wasteform sensitivity: in order to understand the potential for the wasteform to be disposable, the sensitivity of the wasteform properties to variations in waste composition and/or process variations needs to be understood. Sellafield Ltd has proposed wasteform production and capping using GGBS/CEM I grout formulations, which have been developed and tested for both the undersize and oversize processes. The proposal suggests that it would be possible to manufacture acceptable wasteforms using these formulations, and RWMD has assessed the available evidence supporting these arguments. Evidence shows that the mixing process is improved by the presence of solid items that can act as mixing agitators and these can help to produce well mixed products. However, RWMD has concluded that clear evidence to support the arguments in the proposal has not been provided and that evidence is required to demonstrate that the proposed formulations and process can accommodate realistic variations in the feed to produce a product with appropriate strength with reproducible results.
- Product evolution: in order to understand the potential for the wasteform to be disposable, evolution of the waste/wasteform needs to be understood in order to determine whether product ageing affects the ability of the waste package to deliver necessary properties/performance. Corrosion of reactive metals such as Magnox, uranium and aluminium will result in expansion of the wasteform which is the overriding factor in limiting the package lifetime. The $3m^3$ Box with inner liner concept allows the wasteform to expand. As mentioned previously, the gap between the box and the liner would be left empty initially for on-site storage to allow this expansion to occur. Sellafield Ltd has investigated wasteform expansion of a completed $3m^3$ box with filled annulus and determined that if stored at 20°C it would take over 600 years to

achieve 4% expansion resulting in lid bolt failure, and over 1000 years to achieve 10% expansion resulting in box splitting. RWMD concludes that under the current proposal, evolved SDP packages meet the package integrity requirements, which requires it to be maintained for 150 years.

Based on the submitted evidence, RWMD has concluded that adequate products could be made subject to Sellafield Ltd demonstrating that the proposed formulations and process can accommodate realistic variations in the feed to produce a product with appropriate strength with reproducible results.

Data Recording

Considerable work has been undertaken to develop data recording proposals, taking account of the challenges associated with characterising the waste. An achievable data recording process, which is simple to operate at MSSS and SDP is proposed, based on analysis of historic records and other data to provide best estimate inventories constructed from knowledge of swarf and MBGW. Two limiting case package inventories would be calculated (for swarf and MBGW/mixed waste). RWMD is satisfied that these two limiting case package inventories are bounding and believes these scenarios to be an extreme and unlikely event in reality.

For undersize wastes, the weight, volume, compartment of origin and still photographs would be recorded. Every skip arriving at SDP would have a declared waste volume, mass, and compartment of origin, and would give rise to only one waste package. Small items of maintenance arisings would also be sent to SDP and the presence of such items would be recorded to note that a given skip (hence a given package) includes waste of this type. The basis of the physical/chemical inventory data recording proposal is to use a generic characterisation to produce a best estimate. An estimated inventory would be generated for each finished waste package based on analysis of historical tipping records. This would cover both the physical/chemical contents and the radionuclide inventory. A spreadsheet calculation would be used to derive a characterisation for each waste type in each compartment. When a compartment has been emptied, a reconciliation factor would be applied, based on the difference between the assumed volume and the actual volume of waste retrieved. As UMV washout would be returned to the same box liner as the waste that was tipped, it does not need any additional calculation. Evaporator concentrate would be combined within the mixer, in which case the associated inventory would already have been incorporated. The required mass of grout powders would be recorded. The proposed characterisation and a provisional radionuclide inventory would also be calculated for each skip of waste. A reconciliation factor would be applied to the provisional radionuclide inventory, except for the measured activities of Co-60 and Cs-137, which would be established for all finished waste packages using a gamma measurement system in the Box Transfer Facility. A dedicated process would be used to account for the presence of Magnox and uranium by calculations to determine individual isotope activities originating from both the uranium and Magnox cladding.

Oversize wastes, including large maintenance arisings and large items including MBGW which could challenge the undersize mixing route, would be segregated from the compartments, placed in a skip, and sent to SDP. Records that do not contribute to the radionuclide inventory of MBGW, would be identified and removed. The physical/chemical inventory for each box would contain the weight of irradiated steel and irradiated graphite present. Calculations would be completed to determine the individual isotope activities. The final MBGW inventory would be the sum of the irradiated steel and irradiated graphite contributions. Various other items in MBGW such as enriched fissile materials, sources, and isotope cartridges would also make contributions to the radionuclide inventory of the waste, although it is not proposed to account for these items in the inventory. The methodology for the radionuclide inventory is based on a characterisation scaled by weight.

Fingerprints for both swarf and MBGW have not yet been provided for review by RWMD. It will be important for these implementation and procedural details to be completed at Final stage. Overall, RWMD has assessed the data recording proposals for undersize and oversize waste and concludes that it suitably describes the methodology and data to be recorded for the defined SDP waste packaging process. Any future revision of the SDP process might require updating of the data recording proposals.

Outcome of assessment

The broad range of wastes proposed to be packaged at SDP results in a wide range of waste package inventories, with differences in the dominant radionuclides present in the wastes. The bounds for assessment were defined as an Average package for all compartments excluding 11 and 15 (Compartment 11 is excluded from assessment and Compartment 15 consists of MBGW), one Maximum MBGW package (Compartment 15), and one Maximum Swarf package (Compartments 16-22). RWMD are satisfied that these inventories capture the waste to be expected from MSSS, although waste products reflecting the Maximum inventory cases would be an unlikely occurrence in reality.

<u>Compliance with Waste Package Specification</u>

The Generic Waste Package Specification and more detailed Level 3 Waste Package Specification (WPS) for the corner lifting variant of the $3m^3$ Box detail a number of features of waste packages and quantitative limits necessary for the packages to be compatible with transport to and disposal in a GDF[2,3]. These features and limits have been derived from the geological disposal concept as it is currently envisaged. The proposed SDP waste packages have been confirmed as compliant, with the exception of lifting feature dimensions which are not compliant with the specifications. Furthermore, additional information is required in order to confirm overall compliance with the properties of wasteform specification.

<u>Compliance with the transport system design and safety case</u>

The design of the SDP waste packages, including mass, size, and handling features allows transport in the Standard Waste Transport Container – 285 (SWTC-285). RWMD considers that waste package evolution would not change this conclusion and therefore that the proposed waste packages would be compliant with the transport system design. In reaching this conclusion, the waste owner is reminded that SDP waste packages must meet the dose rate limit when using the SWTC-285.

The heat output for the Maximum Swarf package scenario at 2040 is close to the transport limit of 400W, but is not exceeded. Although there is a possibility of in-growth from Am-241, the net heat output is still expected to decrease from these packages if transport is delayed.

The bulk gas generation limit for a corner-lifting $3m^3$ Box within an SWTC-285 is 66 litres per day, based on a maximum transport period of 28 days. Although these limits were estimated to be exceeded by the Maximum Swarf package, the acute corrosion rates used to calculate these outputs assume that that the metal has not been corroded prior to packaging. This is highly unlikely for MSSS wastes as there is

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[2] Nuclear Decommissioning Authority, *Geological Disposal: Generic specification for waste packages containing low heat generating waste,* NDA Report NDA/RWMD/068, 2012

[3] Nuclear Decommissioning Authority, *Geological Disposal: Waste Package Specification for corner-lifting variants of 3 cubic metre box waste package*, WPSGD No. WPS/315/03, 2013

evidence that metals will have already started to corrode in the compartments. In addition, the assumption in the gas modelling input data is that these un-corroded metals will corrode under worst case conditions. Therefore, the results presented are highly conservative and it can be argued that the values are adequate as they could be much lower in reality. SL has ongoing work to demonstrate safe rates of hydrogen evolution during retrieval, transport and processing of MSSS waste as a result of the presence of reactive materials.

The SDP wastes will contain inventories of a number of gaseous radionuclides, such as Rn-222, C-14, H-3, and Kr-85. It was assumed that all potentially gaseous radionuclides are in gaseous form and that the entire inventory of gaseous radionuclides escape over 28 days, the maximum period allocated for transport. Under these conditions, the Maximum Swarf package exceeds the transport limits due to Kr-85. In reality, the packages would be stored prior to being transported. If it is assumed that gases would be released during storage, more than about four years would be sufficient to produce acceptable gas release rates in subsequent transport. Therefore the release of active gases is likely to meet requirements, even for the maximum inventory packages.

The packaging proposal does not result in a significant increase in annual operator dose under normal operating conditions. No release of particulate activity is expected under normal conditions of transport, because the transport container seal and package filtered vent would be present and effective in providing containment for particulates. Under accident conditions, the Transport Regulations require radioactive releases to be less than 1 A_2 in the week following an accident. The Maximum MBGW package gives the highest releases for impact and fire, representing 56% of the activity limit both for fire and impact. Therefore the waste packaging proposal does not have any implications on the Transport System Safety Assessment.

Transport criticality safety has been demonstrated for SDP packages containing a limiting case of 2.9 tonnes of uranium oxide (corroded fuel), which equates to 2.6 tonnes of original uranium metal. This is based on the assumption that fissile wastes are well distributed within the wasteform by mixing, or for oversize wastes that the inventory is based on irradiated natural uranium and low carryover of sludge or fuel. For oversize items, which would include the MBGW wastes, a criticality case can be made using the above limit. The amount of uranium present in packages containing MBGW would be limited by sludge adherence and the larger quantities of steel present.

The risk of future non-acceptance of SDP packages on criticality safety grounds for transportation was recognised in a previous assessment. In an effort to develop the criticality safety assessment and to liaise with regulators to minimise the risk of future non-acceptance, SL has now developed an outline transport criticality safety case, which considers the new transport regulations[4] with regard to criticality safety, and argues that it would be possible to demonstrate criticality safety on the grounds that fissile material would be excepted by the authorities and that the packages meet criticality safety requirements based on a standard Criticality Safety Assessment. There may be a risk that the Radioactive Materials Transport team of the Office for Nuclear Regulation does not accept the arguments, and it will be important for SL to provide RWMD with the outcome of these future interactions for analysis at Final stage.

Overall, RWMD considers the SDP waste packages to be compliant with the transport system design and safety case as currently foreseen.

[4] IAEA, *Regulations for the Safe Transport of Radioactive Material*, SSR-6, 2012.

Compliance with engineering design and the Operational Safety Case

The SDP waste package mass, dimensions, activity content, and heat production are consistent with the planned storage and disposal system. However, the lifting and handling features in the form of pocket twistlocks are not currently consistent with the WPS, which are aligned with the British and International Standards. RWMD considers it unlikely that waste package evolution would have any significant effect on these conclusions.

The wide range of package contents results in a broad range of assessed doses from normal operations and from operational accident scenarios. The highest worker doses are assessed from a multiple package fault involving MBGW packages. Due to the expected infrequent occurrence of high inventory packages, it would be more appropriate to consider the average inventory in this fault, in which case the doses would be reduced.

For faults involving single packages of undersize or oversize waste, the highest worker doses are lower. Most fault scenarios give doses consistent with the most stringent Basic Safety Level (BSL) or the Basic Safety Objective (BSO). The public doses from faults are generally several orders of magnitude lower than the worker doses.

For the Maximum MBGW package, the inventory is approximately two orders of magnitude greater than the Average package inventory, even though less than 500 packages are expected to be produced. This is due to a combination of the extreme heterogeneity of the waste, due to the assumed presence of unique wastes such as intact irradiated neptunium isotope cartridges, and the conservative assumption that the most radioactive materials could arise in a single box. For the Maximum Swarf package, high doses are also calculated. In this case the maximum inventory is considered to be reasonable and may consistently apply to a number of waste packages. Therefore, Maximum Swarf packages are of greatest safety significance in the Design Basis Analysis. The safety impacts are sensitive to the assumed release fractions. Adequate protection of the wasteform by the container and annulus, and evolution of the wasteform due to any residual metal corrosion, are likely to be important factors affecting these release fractions.

There is also a range of potential conservatisms arising from a variety of sources integrated into these determinations. These conservative parameters are used at this stage of the design process and RMWD are reviewing their applicability. Therefore, the few waste packages and faults assessed to give the largest doses and contain potential sources of conservatisms could be reviewed against more realistic operational safety scenarios.

Releases from packages are expected only in the event of the most severe accidents involving breach of package containment. Most accidents would result in negligible on and off-site doses. None of the design basis fault sequences involving individual waste packages, or small groups of packages could result in the final safety barrier, the filters on the ventilation system, being rendered ineffective.

Under all normal conditions of operation at the GDF, workers are not exposed to direct doses for these package types. The Average package inventory dose rate is low and would make a minimal contribution to annual worker dose. If a worker were to be in close contact with such a package in its transport container for 1000 hours per year, the cumulative dose would only just exceed the effective dose limit for employees 18 years of age and above who work with ionising radiation, although a much higher dose would result from a Maximum package over this exposure period. It would be a rare occurrence that a package with inventory approaching the Maximum MBGW package is created.

Operational criticality safety has been demonstrated for SDP packages containing the limiting case of 2.9 tonnes of uranium oxide (corroded fuel), which equates to 2.6 tonnes of original uranium metal. This is based on realistic fuel burnup, enrichment and cooling time, and limited beryllium, and on the fissile material being uniformly distributed in the 3m^3 box.

It is concluded that it should be possible for SDP wastes to be handled and stored safely within a GDF. The variability in dose correlates to a broad range of wastes assessed including a broad range of conservatisms. Therefore, focus should be on the packages and faults that are assessed to give the largest doses and the possible sources of conservatism in those cases. The public doses from faults are generally several orders of magnitude lower than the worker doses.

RWMD will be undertaking a programme of work to look at the potential conservatisms in the operational safety assessment, and Interim stage endorsement will depend on the outcome of this work.

Compliance with the Environmental Safety Case

Since the MSSS wastes have been assessed through the Disposal System Safety Case (DSSC) and its associated inventory, the assessment of post-closure safety is based on a simple screening assessment to check whether the expectations for the waste steam used in the generic DSSC are still appropriate. In doing so, consideration has been given to the potential significance of organic materials.

Overall, the values for a ground level release of radioactive gases from a 15m stack comply with the design target, except for C-14 and H-3. For a stack release at a height of 15m, the doses are reduced, and are compliant. The potential dose from C-14 due to migration of methane is of greater concern but is recognised as a generic issue for the GDF and is the subject of further research. It has been estimated that the Magnox will be fully corroded within 140 years, and therefore C-14 must also have all been released on the same timescale. The total generation rate of C-14 as methane for the packages is above the rate of radioactive gas generation for C-14 bearing methane, which is potentially significant but not a new finding, since this result has been identified previously and highlighted with other wastes containing irradiated materials. RWMD is undergoing a programme of research to improve the understanding of these issues.

The SDP wastes will potentially contribute a significant proportion of the total calculated risks from both the groundwater and gas pathways for a GDF, but it is concluded that this waste stream does not present any new issues from the point of view of post-closure risk from the groundwater pathway. A limit of 300W is placed on the heat output of packages within the back-filled GDF (the date of backfilling is assumed to be around 2090). At 2040, the Average package and Maximum MBGW packages are below this specified limit. However, the Maximum swarf package is greater than 300W at 2040. This scenario is based on an extreme and unlikely fuel loading and if any such packages actually arose, they would represent a very small portion of the total number of packages to be disposed in the GDF. Consequently, during emplacement, it would be very unlikely that such high heat packages would accumulate in one location and therefore any adverse effects on the backfill would be localised. It can be concluded that the potential risks arising from the worst case thermal output for the Maximum swarf packages can be tolerated.

Post-closure criticality safety has been demonstrated for SDP packages containing a limiting case of 2.9 tonnes of uranium oxide (corroded fuel), which equates to 2.6 tonnes of original uranium metal. As before this is based on realistic fuel burnup, enrichment and cooling time, with limited beryllium, and on the assumption that the fissile material is uniformly distributed in a 3m^3 box. The potential for dissolution of uranium and its separation from plutonium under disposal conditions before significant decay of Pu-239 to U-235 is a key factor with regard to post-closure criticality safety. RWMD supports the view that the dissolution and removal of uranium and grout from a $3m^3$ box before most Pu-239 has decayed to U-235 is unlikely in the absence of large quantities of organic materials. Therefore, it is reasonable to exclude scenarios involving separation of uranium from plutonium from the criticality evaluations for the SDP packaging concept.

Overall, RWMD considers the SDP waste packages to be compliant with the environmental safety case as currently foreseen. Although the generation rate of C-14 as methane is above the specified limit, the issue has been highlighted with other wastes containing irradiated materials and RWMD is undertaking a programme of research to improve the understanding of the related issues.

Statement of disposability

The assessments of transport safety, operational safety and post-closure safety show that packages produced at SDP should be disposable in a GDF. This Assessment Report provides a draft Assessment of Disposability, intended to demonstrate that the waste packages produced would comply with safety and environmental protection requirements for transport, handling and disposal of radioactive waste as foreseen by RWMD.

The assessment has identified two issues that would preclude issue of an Interim stage LoC for SDP waste packages. Where compliance gaps have been identified, Action Points have been assigned.

Wastes from MSSS Compartment 11, the MSSS building void, residual waste left in each compartment after completion of bulk removals, and product boxes made from SDP process effluents, are currently excluded from assessment.

Conclusions

SL has sought Interim stage endorsement of proposals for packaging wastes from MSSS at the SDP. It has been concluded that the GDF can accommodate SDP waste packages, although potential areas for improvement to the GDF operational safety assessment may be required. Such improvements would reduce the conservatisms while demonstrating safe doses.

Interim stage endorsement cannot be granted at this time. Although the majority of Interim stage Action Points and related development work has progressed significantly, two Interim stage Action Points remain involving the following issues:

- Further evidence is required to demonstrate that the proposed formulations and process can accommodate realistic variations in the feed to produce a product with appropriate strength with reproducible results.
- The proposed design of the twistlock lifting features incorporates an aperture that is larger than that specified by RWMD, which was developed for consistency with British and International Standards.

It is also important to note that RWMD will be undertaking a programme of work to look at the potential conservatisms in the operational safety assessment, and Interim stage endorsement will depend on the outcome of this work.

SL will need to work closely with RWMD and maintain the good practices already established. Prior to Interim stage endorsement, all Interim stage Action Points identified in this disposability assessment should be addressed and RWMD will need to present these conclusions to the RWMD Nuclear Safety and Environment Committee (NSEC) for advice.