

Packaging of AWE Plutonium and Uranium Contaminated Material

(Interim stage)

Summary of Assessment Report

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Background

The Atomic Weapons Establishment (AWE) has sought Interim stage endorsement of waste packages proposed for plutonium and uranium contaminated material (PUCM) currently stored at Aldermaston.

This document summarises the results of the assessment carried out by NDA Radioactive Waste Management Directorate (RWMD) in response to the submitted proposals. The assessment has been carried out as part of the Letter of Compliance process, whereby RWMD examines the disposability of the proposed waste packages by assessment against ILW packaging standards and specifications and the Phased Geological Repository Concept (PGRC). Further information on the Letter of Compliance process is available elsewhere¹.

Scope of the Proposals

The waste considered in this assessment comprises stocks of drummed legacy wastes generated as a result of operations at the AWE site, plus arisings from ongoing and future operations and decommissioning. The waste comprises a range of organic and inorganic materials with plutonium, uranium and tritium being the predominant radioactive contaminants. The majority of the waste is stored in 205 litre mild steel drums. Any waste that is not stored in 205 litre drums would be repackaged into 205 litre drums. The 205 litre drums are lined with materials such as steel, fibreboard, or high density polythene (HDPE). The existing storage drums and liners would also be treated and account for some 45 weight percent of the total inventory.

The AWE PUCM is defined in the 2004 UK Radioactive Waste Inventory as intermediate-level waste (ILW). This waste is therefore included in the generic assessments supporting the Phased Geological Repository Concept (PGRC). Compared with the disposal ILW inventory reported in the 2004 UK Radioactive Waste Inventory, AWE PUCM waste contains 0.8% of the tritium inventory, 0.7% of the U-235 inventory and 3.5% of the Pu-239 inventory.

The assessment has considered the compatibility of the proposed packages containing AWE PUCM with the requirements for safe long-term management, including storage, transport, emplacement and extended storage underground, and disposal, as currently expressed by the PGRC and standards and specifications for waste packaging as expressed in the Generic Waste Package Specification (GWPS).

This report also provides an assessment of disposability under the PGRC. This represents RWMD advice as to the disposability of the proposed waste packages based upon the standards and specifications developed from the geological disposal concept. It considers safety and environmental protection requirements for transport, handling and disposal of

¹ *Guide to the Nirex Letter of Compliance Process*, Nirex Document WPS/650, June 2006.

radioactive waste. It is expected that the assessment of disposability would contribute to the Radioactive Waste Management Case to be produced by the licensee as required by the regulators, and specifically to the reasoned judgement that the conditioned waste would meet anticipated requirements for acceptance from the potential disposal facility operator.

Packaging Proposals

The proposed packaging process includes retrieval and characterisation of drums of wastes and treatment by whole-drum high-force compaction (“supercompaction”) and placing the supercompacted drums into standard 500 litre Drums. The key features of the packaging proposal can be summarised as follows:

- Drums of waste would be retrieved from on-site stores.
- Corresponding record cards would be examined to identify drums of waste with incomplete or otherwise non-compliant records.
- Drums with incomplete or non-compliant records would be diverted to a monitoring suite comprising real-time radiography, high-resolution gamma spectroscopy and passive neutron coincidence counter, where they would be assayed to provide complete records.
- Identification and diversion of feed drums containing waste requiring additional treatment (WRATs) for separate treatment.
- Sea disposal drums and other oversize ‘packages’ would be opened and the waste repacked in 205 litre drums. The resultant 205 litre drums would be assayed in the monitoring suite.
- Drums found to be non-conforming after assay (for example, containing greater than the assessed safe fissile mass) would be diverted, and treated to render them consistent with packaging.
- Drummed wastes that are compatible with supercompaction, and have complete and compliant record cards would be treated by supercompaction. Many drums contain inner liners manufactured from polythene or fibreboard, which would remain in situ for compaction. It is anticipated that on average 8 pucks would be loaded into each 500 litre Drum.
- Liquids expressed from the pucks during compaction would be collected in a sump for separate treatment.
- Supercompacted drums (“pucks”) would be loaded into 500 litre Drums. The puck stack would be centralised within an inner stainless steel liner and constrained by engineering features. Pucks would be selected for loading on the basis of:
 - weight: mass of finished waste package not exceeding 2 tonnes;
 - height: puck stack height not exceeding 1 metre;
 - dose: dose rate from finished waste package consistent with RWMD limits;
 - criticality: loading of plutonium, uranium, beryllium and graphite controlled within established safe limits;
 - toxic materials: loading of toxic and hazardous materials not exceeding package limits.
- The 500 litre Drum would be infill grouted using a 3:1 pulverised fuel ash (PFA)/ordinary Portland cement (OPC) liquid grout with a water/cement ratio of 0.42.
- Added grout would fill both sides of the inner liner to effectively provide a ‘clean’ annulus all around the waste pucks.
- Once the infilling grout has been allowed to cure, the waste package would be completed by the addition of a separate capping grout layer and provision of a bolted lid. Equipment would be available for the removal of any bleed water from the surface of the wasteform and/or cap.

- The completed waste package would be subject to quality checks before transfer to an ILW interim store awaiting consignment to the planned national geological repository.

Wastes would be packaged in campaigns, controlled to different maximum fissile contents, to take account of the presence in some feeds of significant quantities of beryllium and graphite.

Any liquid produced during supercompaction ("squeeze") would be collected in a sump and exported from the plant for treatment in accordance with existing site procedures. Generation of squeeze is not expected to be a significant issue since wastes have essentially been generated from dry processes.

The 500 litre Drum has been designed to include internal furniture which would serve to centralise and constrain the pucks during packaging and grouting operations. In particular, a stainless steel inner liner of thickness 1.6mm serves to prevent any corrosive degradation products from the waste coming into contact with the containment boundary of the 500 litre Drum.

It is noted that supercompaction is used elsewhere in the UK for the treatment of similar wastes. The inclusion of the inner stainless steel liner represents a process improvement giving greater confidence in the ongoing integrity of the containment boundary.

Assessment of Disposability

The acceptability of the proposed packages has been assessed against criteria established within the PGRC and associated Generic Waste Package Specification.

The Assessment of Disposability is based upon a radionuclide inventory supplied by AWE as supplemented by RWMD. The data provided in the submission did not include estimates of daughter product radionuclides. Several radionuclides of relevance to transport and disposal will be generated by decay processes, for example actinium-227, thorium isotopes and radium isotopes. Accordingly, the uranium and plutonium specific activities have been back-decayed by 50 years (to 1954), then decayed to 2004 with radionuclide in-growth taken into account. Activation product and tritium inventories have also been assessed. The resultant radionuclide inventories have been further decayed to estimate inventories at the time of potential transport and disposal.

The wasteform consists primarily of supercompacted carbon steel drums containing compressible wastes. The proposed production of pucks by high-force compaction should produce a wasteform in which the activity is immobilised, and the general absence of water in the waste will limit gas production and slow its rate of evolution. Some drums have a high proportion of PVC wastes that have been identified as a potential risk in terms of chloride generation. In order to mitigate against this risk the inner stainless steel liner provides a secondary containment barrier between the chloride containing waste and the outer containment barrier provided by the 500 litre Drum. The resulting wasteform is a passive waste product that, under suitable storage conditions, should retain integrity during its service life.

The submission provided design requirements and an outline specification for the annular 500 litre stainless steel Drum. AWE has, however, been unable to supply the detailed design for the container at this stage. In order to enable assessments to proceed, key design features of the waste package were agreed between NDA RWMD and AWE. When the finalised drum design is available, it will be necessary to check this against the agreed design features to assure conformance with the assumptions underpinning the assessments reported in this Assessment Report.

The assessments of transport safety show that it would be possible for packages containing AWE PUCM to comply with all relevant criteria if transported in an IAEA Type B transport container with 70mm thick steel walls² such as the Standard Waste Transport Container (SWTC).

The assessments of repository operational safety show that it should be possible for 500 litre Drums containing AWE PUCM to be handled and stored safely within the geological repository.

The post-closure safety assessment has revealed no significant areas of concern that should prejudice disposal of packages containing AWE PUCM. The proposed inventory contains a large inventory of organic materials including polythene from the liners used in the 205 litre drums. Organic materials could form complexing agents in the long term, and these may act to increase the solubility and reduce the sorption of radionuclides in repository conditions. It has been established that degradation of polythene has no significant effect on radionuclide behaviour and that the other organic materials present will exhibit acceptable behaviour.

At this Interim stage assessment it was necessary to determine package limits for fissile content, principally uranium-235 and plutonium-239. The fissile mass content of the proposed AWE PUCM packages would not be consistent with any of the existing RWMD generic criticality cases and therefore package-specific criticality safety cases were developed for transport, repository operational and repository post-closure (this is in addition to AWE assessments for the packaging and storage phases).

Package-specific criticality cases for AWE PUCM have identified restrictions on fissile material and other material affecting criticality reactivity (e.g. beryllium and graphite). These restrictions are to be complied with during the packaging process through the application of the strategy for selection of pucks for loading into 500 litre Drums.

The proposed PUCM waste packages are expected to restrict the release of the tritium inventory and estimated rates of release have been determined to be acceptable.

In summary, the Assessment of Disposability has concluded that a Radioactive Waste Management Case ultimately could be made for packages containing AWE PUCM.

Requirements for further development work

In order to support progression of AWE PUCM proposals to the Final stage of endorsement, the following would need to be provided in future submissions. Some of the identified work needs to be completed prior to Final stage submission; these are identified as “pre-Final”:

- provide finalised design of the annular 500 litre Drum and its furniture for the packaging of AWE PUCM (pre-Final)
- ensure that the inner liner contains design features to restrain the grouted contents in the event of impact battering ram movement (pre-Final)
- confirm material contents of feed streams to the compaction process are compliant with the declared material composition envelope (Final)
- state how the acquired data using RTR will be linked to the corresponding waste packages and what procedures will be employed for minimising transcription errors for these records (Final)
- finalise and record the data recording methods including recording the uncertainty associated with fingerprints to establish the activity and minimise the uncertainty for identified significant radionuclides (Final)
- describe how it is intended to quantify the uncertainties in tritium inventory data for the final package record (pre-Final)

² A Type B transport container is defined by IAEA Transport Regulations and incorporated into UK transport legislation.

- produce a clear methodology statement on how radionuclide specific information will be obtained (Final)
- provide details of the Quality Management System that would control plant commissioning and operations (Final)
- extend the duration of the environmental monitoring programme to 3 to 5 years to give increased confidence that appropriate storage conditions are in place (Final)
- complete the Waste Product Specification covering the packaging of PUCM (Final)
- complete the Criticality Compliance Assurance Documentation, and demonstrate that packaging of fissile material would be controlled to ensure compliance with the package-specific criticality safety case (Final)

The above points have been raised as a series of Action Points within the Assessment Report.

Conclusions

The Interim stage proposals from AWE for the packaging of AWE PUCM have been assessed.

The assessment concluded that subject to the assurances provided regarding drum design, the proposed packages would be expected to be compliant with the Generic Waste Package Specification and consistent with disposal in the Phased Geological Repository Concept, and can therefore be endorsed at the Interim stage. The consistency of the proposed waste packages with the disposal concept has been demonstrated through the provision of an Assessment of Disposability.

It is suggested that the proposals potentially may need to be considered to be MEDIUM priority under the current regulatory prioritisation scheme³. The principal reason for this judgement is the significant fissile inventory of the proposed packages and the requirement for package-specific criticality assessment. AWE is therefore advised to seek the necessary interaction with regulators to confirm this position.

A number of Action Points have been raised which will require to be addressed as proposals for the waste packaging are taken forward.

³ *The Management of Radioactive Waste on Nuclear Licensed Sites – Part 1: The Regulatory Process*, Guidance from the Health and Safety Executive, the Environment Agency and the Scottish Environment Protection Agency to nuclear licensees, December 2007.