

Packaging of AWE Plutonium and Uranium Contaminated Material

(Conceptual stage)

Summary of Assessment Report

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Introduction

This is a summary of an assessment carried out by Nirex in response to a proposal from Atomic Weapons Establishment (AWE) for the packaging of Plutonium and Uranium Contaminated Material at the Aldermaston site. The proposed packaging process comprises retrieval and sorting of stored drums and treatment by whole-drum high-force compaction ("supercompaction") and placing the supercompacted drums into Nirex standard 500 litre Drums and storage for an indefinite period in an unconditioned form. The final conditioning step would be completed at some time in the future by the addition of fluid cementitious grout.

Background

The Nirex mission is, in support of Government policy, to develop and advise on safe, environmentally sound and publicly acceptable options for the long-term management of radioactive materials in the UK. This includes all intermediate-level radioactive waste and some low-level radioactive waste (ILW and LLW).

As part of this role, Nirex sets specifications and standards for the packaging of ILW and some LLW, based on its Phased Geological Repository Concept (PGRC)¹. Nirex issues Letters of Compliance when the proposed packaging methods are judged to be capable of producing waste packages that would be consistent with Nirex requirements for long-term management and protection of the environment. This process is intended to minimise the risk of inappropriate treatment, the need for future repackaging and the creation of a new legacy of wastes to be dealt with by future generations, with all the attendant safety, environmental and cost implications. The process of obtaining a Letter of Compliance is embedded in the regulators' arrangements for the conditioning and packaging of ILW, as described in the guidance issued by the regulators^{2,3}.

In line with regulatory guidance, Nirex carries out independent assessment of the specific waste packaging proposals in particular to assess disposability of the proposed waste packages by consideration of requirements for future storage, transport and disposal as embodied in the Nirex standards and specifications for waste packaging and underpinning Phased Geological Repository Concept.

¹ *The Nirex Phased Disposal Concept*, Nirex Report N/074, July 2003.

² *Improved Regulatory Arrangements for the Conditioning of Intermediate Level Radioactive Waste on Nuclear Licensed Sites: Provision of Advice to the Health and Safety Executive by the Environment Agency and the Scottish Environment Protection Agency*, Regulators' Position Statement, December 2003.

³ *Conditioning of Intermediate Level Radioactive Waste on Nuclear Licensed Sites: Provision of Advice by the Health and Safety Executive, the Environment Agency and the Scottish Environment Protection Agency*, Guidance to Industry, March 2005.

AWE Proposals for the Packaging of Plutonium and Uranium Contaminated Material

For more than 50 years, Atomic Weapons Establishment (AWE) has been involved in the design, development, manufacture and maintenance of the UK's nuclear warheads. A range of intermediate level wastes have been generated as a result of operations involving uranium, plutonium and tritium. Operational wastes are currently estimated to continue to arise until about 2030, and decommissioning wastes until about 2039. The wastes are currently stored in a variety of different containers in purpose-built stores on the Aldermaston site.

The wastes predominantly have arisen and continue to arise from glove box operations involving the handling of plutonium and uranium and from refurbishment and decommissioning of redundant production facilities. Most, but not all of the radioactivity in waste containers is in the form of particulate surface contamination. Plutonium and uranium residues within the waste are principally in oxide and metallic forms.

AWE have made Conceptual stage proposals for the packaging of the plutonium and uranium contaminated material (PUCM) in a form that will allow for acceptance at a future waste disposal facility. Initial proposals from AWE described four different options for the packaging of the wastes. Subsequently, AWE requested that only one option, supercompaction, be considered. Supercompaction is a treatment technique whereby waste drums (typically of 200 litre capacity) containing waste materials are subject to high-force compaction which compresses the drum down to a small fraction of its original size. The resultant compact is often referred to as a "puck". The key features of the supercompaction option can be described as follows:

- Historic stocks of stored 200 litre waste drums with good records of the waste contents, will be subject to high-force compaction. The resultant pucks loaded into a stainless steel single-skinned 500 litre Drum.
- Stocks of drums with poor records will be characterised to enable identification and removal of wastes that require further treatment, or for items that are compatible with free release or disposal to the LLW repository at Drigg, for alternative disposal routes. The residual ILW characterised and confirmed as suitable for treatment would be supercompacted and loaded into 500 litre Drums as before.
- Large waste items not suitable for supercompaction will be loaded directly to 500 litre Drum waste containers.
- Loose powders and mobile wastes such as sludges will be solidified in smaller containers, and these loaded into the 500 litre Drum waste containers.

All 500 litre Drums containing supercompacted and other wastes would be transferred to the on-site storage facility (or facilities). In Nirex experience and in line with regulatory guidance, it would be normal practice to condition the wastes by the addition of an encapsulation matrix to surround the pucks or waste items, to immobilise any radioactivity and to provide a passive safe wasteform that is resistant to accidents and compliant with future disposability requirements. The AWE strategy would not undertake this conditioning step before the wastes go into store but would propose to defer this step until some time into the future.

The proposed packaging process would lead to around 7,000 off 500 litre Drums with an average package radionuclide inventory at 2040 of 77.7 A₂ multiples⁴. The maximum inventory of a waste package is calculated to be 770 A₂ multiples. When compared to the reference assessment inventory considered by Nirex, the AWE plutonium and uranium contaminated material waste packages would constitute some 2.3% of the unshielded ILW waste volume considered in the 2003 generic safety and environmental performance assessments.

⁴ A₂ multiples provide a measure of the activity content of transport packages, where each radionuclide is weighted according to its damage potential.

Disposability Assessment

The disposability assessment conducted by Nirex considers the proposed waste packages for compliance with packaging standards and the safety, environmental and security assessments that underpin the Phased Geological Repository Concept (PGRC). This is achieved by assessing the proposed waste packages against the published Generic Waste Package Specification and safety assessments that address transport of waste packages to the facility, safety of operations at the facility and performance of the repository concept following backfilling, sealing and closure.

A key aspect of the disposability assessment has been consideration of the likely evolution of the containerised but unconditioned waste during storage and how this may impact on proposals to rework the containerised waste to produce Nirex compliant disposal packages at some stage in the future. The plutonium and uranium wastes contain a considerable amount of organic bearing plastics and PVC wrapping materials. Under alpha irradiation PVC will degrade and if combined with moisture will form hydrochloric acid. Because the wastes will be stored in a containerised form without the benefit of a conditioning matrix, it is possible that acidic degradation products could collect in the base of the single-skinned stainless steel 500 litre Drum and jeopardise the integrity of containment barrier. Should this strategy be pursued it will be necessary to improve the design of 500 litre Drum to reduce the risk of early failure of the containment barrier. It will also be necessary to maintain the packages under a storage regime whereby packages can be monitored and inspected such that any untoward degradation can be detected and corrective actions undertaken.

The submission has not specified an upper limit for the containerised storage period which has been left open-ended. AWE propose that the conditioning step will be achieved by the introduction of fluid cementitious grout into the 500 litre Drum thereby encapsulating the compacted and other wastes contained therein. The strategy will only work if this approach can be demonstrated to be credible. Without a realistic timescale to consider the evolution of the wastes and waste package Nirex has not been able to demonstrate to its satisfaction that the described process is credible.

Notwithstanding the concern above, in conducting assessments of transport, operations and post-closure safety Nirex has had to assume that it will be possible to rework packages and bring them into compliance with packaging standards. Assessments have been undertaken on the basis of this assumption. Assessments have also flagged a general need for improved data to substantiate the radionuclide inventory of waste packages, particularly for the large items and solidified wastes for which scant details were provided.

The assessment of transport safety has concluded that further work is required to demonstrate that 500 litre Drum waste packages containing AWE plutonium and uranium contaminated materials will be transportable in compliance with the fissile safety case developed by Nirex for the proposed IAEA Type B standard transport container⁵. Based on existing studies it is thought that the requisite criticality safety case could be produced and that transport should be possible in the 70 mm shielded container concept although this would need to be confirmed.

In the case of the repository operational safety assessment, the final waste package is expected to be compatible with Nirex design and safety criteria. A case for the fissile content will have to be produced but based on previous work for analogous wastes this should be achievable.

The post-closure assessment has determined that further work is required to demonstrate compliance with fissile material groupings used to generate waste package fissile screening levels. Existing generic work has been based on plutonium waste systems or enriched

⁵ A Type B transport container is defined by IAEA Transport Regulations and incorporated into UK transport legislation.

uranium systems. In the case of AWE mixed plutonium and uranium, further evaluation will be required to determine appropriate waste package fissile screening levels for post-closure considerations. No other significant areas of concern for post-closure safety have been identified.

The assessment has concluded that the initial containerised waste packages will not be compliant with Nirex packaging standards and that further work will be required in the future to add a conditioning matrix and to make the packages compatible with disposability requirements. The duration of the containerised storage period has not been defined and as a consequence Nirex has not been able to comment on the credibility of this as an exit route.

It is not clear what benefit is seen in the containerised storage strategy. The containerised wastes will arguably have improved containment provided by virtue of the stainless steel 500 litre Drum, but the wastes themselves could not be claimed to be conditioned and would not appear to be consistent with regulatory guidance on passive safe storage⁶. Deferral of the conditioning step might keep open options for alternative treatment routes but advice from Government's Radioactive Waste Policy Group has argued that wastes should be conditioned for disposal⁷ and that the review by the Committee on Radioactive Waste Management should not prevent nuclear sites from working to Nirex standards.

Furthermore, degradation of the waste materials during containerised storage may lead to aggressive species which could collect in the base of the container and threaten the integrity of the containment barrier. Deferral of the conditioning step introduces uncertainty in the final condition of the waste and may put at risk the eventual production of a disposable waste product.

The Assessment Report identifies a number of detailed information and/or research requirements that AWE will need to address at this Conceptual stage and in future stages if the project is taken forward.

Conclusions

The Conceptual stage submission from AWE for the packaging of plutonium and uranium contaminated material in 500 litre Drums has been assessed.

The assessment report has concluded:

- The strategy of containerised storage and deferral of the conditioning step will lead to non-compliant waste packages when judged against the Nirex packaging standards and specifications and would require additional work in the future to make them disposable.
- The duration of the containerised storage period has not been defined and as a consequence Nirex has not been able to comment on the credibility of grout encapsulation as an exit route.
- Degradation of the supercompacted wastes may lead to the generation of aggressive degradation products which may threaten the integrity of the stainless steel containment. AWE should address the risk of early package failure by redesign of the 500 litre Drum and by proposing an inspection and monitoring regime for the containerised storage period.
- Further work is required to reconcile potential waste package fissile content with safe fissile levels generated under transport, repository operations and post-closure scenarios.
- Further information is required to substantiate the radionuclide inventory of waste packages and of physical and chemical characteristics, particularly encapsulated sludges and large items.

⁶ HSE, *Guidance for Inspectors. Management of Radioactive Materials and Radioactive Waste on Nuclear Licensed Sites*, March 2001.

⁷ Defra, *Report on RWPG Sponsored Compatibility Workshop*, DEFRA/RAS/04.007, 2004.

- Justification for the strategy which defers manufacture of the final waste packages to the future has not been provided and is not warranted from technical considerations as similar wastes on other sites are being conditioned to meet disposability requirements. The strategy also appears from the Nirex perspective to run counter to Government policy and regulatory guidance.

Consistency of the proposed waste package with the Phased Geological Repository Concept has been assessed and a Conceptual stage Disposability Assessment produced. In assessing the Conceptual stage proposal, Nirex has identified a number of issues that would need to be followed up if the approach is taken forward.

Technical issues have been identified which require further work to be undertaken now and which would prevent the issue of a Conceptual stage Letter of Compliance.

The proposal has the potential to raise significant disposability and policy issues and deferral of grouting increases the risk that the packages will in the future be found to be non-compliant. The proposal has been categorised as Category 1 under Nirex assessment procedures and will require to be considered by the Nirex Waste Management Advisory Committee and Nirex Directorate.