WM'99 CONFERENCE, FEBRUARY 28 - MARCH 4, 1999

ORPHAN RADIOACTIVE WASTE: INDEFINITE STORAGE OR TRANSITION TO DISPOSAL?

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ABSTRACT

The Department of Energy (DOE) is responsible for the management and disposal of a category of waste that is not high-level waste or defense transuranic waste, and does not generally qualify for disposal in currently operating low-level waste disposal facilities. A strategy for the long-term management and disposal of this waste beyond indefinite storage and possible future emplacement in a geologic repository does not exist. This Aorphan@ waste consists of greater-than-Class C low-level waste generated by NRC or agreement State licensees and DOE-generated equivalent waste, excluding defense transuranic waste. The latter is included in the Department=s inventory of Special Case Waste (SCW).

This paper explores the issue of whether DOE can and should develop and implement a strategy for the long-term management/disposal of the orphan waste that could facilitate the near-term transition of this waste to disposal. The incentives for such a course of action are discussed, and specific candidate disposal options for selected orphan waste streams are presented.

INTRODUCTION

What is meant by the term Aorphan@ waste? For purposes of this paper, orphan waste refers to the body of radioactive waste that is not classified as high-level waste (HLW) or defense transuranic waste (TRUW), and will not generally qualify for disposal in currently operating low-level waste (LLW) disposal facilities. This category of waste would, therefore, include any greater-than-Class C low-level waste (GTCC LLW) DOE receives from licensees for disposal, and those DOE-generated non-HLWs with radiological characteristics generally comparable to those of GTCC LLW, excluding defense TRUW.

The DOE-generated orphan waste is currently stored across the Department=s complex of sites and is part of the inventory of waste nominally referred to as SCW. The GTCC LLW is currently stored at licensee sites, pending the establishment of a DOE program for accepting this waste for disposal, as required by the 1985 amendments to the Low-Level Radioactive Waste Policy Act. In nuclear programs abroad, waste streams comparable to the orphan waste are often classified as intermediate level waste.

A long-term management strategy for the orphan waste does not currently exist beyond indefinite storage. The issue to be explored in this paper is whether it would be in the best interests of the Department and the public to develop a strategy for the life-cycle management of the orphan waste with emphasis on transition of the waste from storage to disposal as promptly as safe and cost-effective capabilities permit. To date, the only disposal option being considered is the Yucca Mountain deep geologic repository proposed for the disposal of spent nuclear fuel and HLW. Even this option is only being examined by the Department in the context of the implications for the repository Environmental Impact Statement (EIS) if orphan waste were to be added to the source term inventory. The Office of Civilian Radioactive Waste Management (OCRWM), in agreeing to include the orphan waste in the EIS analysis, has made no commitment at this time to accept any orphan waste for disposal in the repository irrespective of the results of the EIS analysis.

BACKGROUND

Special Case Waste

A survey of DOE sites was conducted in 1989-90 in an attempt to define the inventory of waste in storage that had not been classified and consigned to one of the three systems for life-cycle management, i.e., the HLW, defense TRUW, and LLW management systems. The resulting reports identified the eight categories of SCW depicted in Table 1.

It was recognized at the time that a large percentage of the stored SCW had not been sufficiently characterized to determine its classification. Therefore, it was expected that ultimately, much of this inventory would be characterized, classified and consigned to one of the three waste management systems for which life-cycle management strategies existed. This is indeed happening.

The SPAR category of SCW consists of LLW that contains sufficient concentrations of radionuclides that the material does not comply with the acceptance criteria for disposal in DOE=s operating LLW disposal facilities. This category of material includes non-fuel bearing reactor components, ion exchange resins, sludges, filter media, and equipment contaminated with alpha and mixed fission products. The SPAR waste is generally comparable radiologically to the GTCC LLW under the Nuclear Regulatory Commission (NRC) classification system.

Table 1: Estimated SCW Inventory Summary (1990)[A]

Waste Category*	**Volume (x 10^3 m^3)**	**Curies (x 10^3)**
Non-Certifiable Defense TRUW	35.5	580.
Non-Defense TRUW	0.846	117.
SPAR**	34.2	122,000.
Fuel and Fuel Debris	8.30	21,600.
Uncharacterized	871.	201,000.
Excess Nuclear Materials	125.	796.
	1074.846	346,093.

* Two additional categories were included in the survey but were reflected in the data summary only as number of items. The additional categories were: ASealed Sources@ and ADOE-Title, held by others.@

** Specific performance assessment required (SPAR) waste.

Looking at the other categories of SCW in the 1990 survey, a reasonable and conservative assumption would be that 90% of the uncharacterized waste would, once characterized, be classified as LLW or TRUW, leaving about 87,000m^3 to add to the SPAR inventory. It was expected that the non-certifiable defense TRUW and the non-defense TRUW would be addressed under the TRUW management system as special categories of TRUW for which a long-term management strategy and plan were required.

The Aexcess nuclear materials@ have, since the referenced survey, been subjected to separate studies for the purpose of improving their management and ultimate disposition. Pursuant to this exercise, the materials were referred to as Amaterials in inventory.@ A recently concluded memorandum of agreement between DOE=s environmental management (EM) and defense programs (DP) provides for the transfer of specific excess nuclear materials from the DP program management responsibility to that of EM. Much of this material is SPAR-type waste requiring a long-term management plan.

Based on these considerations and the results of the 1990 survey, one could conservatively conclude that there was at least 121 thousand cubic meters (approximately 4 million cu. ft.) of stored orphan waste. This does not include the 36 thousand cubic meters of stored TRUW that was not expected to qualify for disposition in the Waste Isolation Pilot Plant or for transport in the TRUPACT-II shipping container and, therefore, requires a long-term management strategy and plan. It should be noted that the discussion so far has related only to waste generated prior to 1990.

<u>GTCC LLW</u>

In addition to the Department=s SCW, the other source of orphan waste is the licensee-generated GTCC LLW to be transferred to DOE for disposal. Since the legislative action of 1985 that charged DOE with responsibility for disposing of this waste, there have been no transfers of GTCC LLW to the Department pursuant to this mandate. This situation has prevailed for the past fourteen years due to the fact that DOE has not established terms and conditions under which such transfers could occur. The law requires that DOE be reasonably compensated for the services it provides to licensees under this program. Since DOE has not been able to decide the specific services it would provide in managing the licensees= GTCC LLW, it could not develop reasonable costs for such services; hence, terms and conditions do not exist for DOE acceptance of any categories of GTCC LLW.

An additional inhibitor to progress in establishing a GTCC LLW program has been the requirement that the GTCC LLW be disposed in an NRC-licensed facility. However, given the Department=s consideration in recent years of subjecting its nuclear programs to external regulatory authority, this constraint may no longer frustrate the program.

DISCUSSION

What are the incentives for DOE to develop at this time a definitive strategy and plan for the life-cycle management of the orphan waste that facilitates transition to disposal prior to access to a geologic repository? The principal drivers for such a course of action include:

- The reduction in annual costs associated with the indefinite on-site storage of waste that can be realized from transitioning the waste to disposal;
- The reduction in health and safety risks to current and future generations by minimizing indefinite storage of orphan waste;
- To facilitate the development and promulgation, pursuant to a rulemaking, of terms and conditions, including a schedule of reasonable charges, for DOE acceptance from licensees of GTCC LLW for management and disposal, thereby:
    1. Providing licensees with an alternative to indefinite on-site storage of GTCC LLW; and
    2. Reducing the likelihood that a Federal subsidy to many licensees would be necessary to cover the costs of GTCC LLW disposal in the geologic repository.
- To facilitate the elimination of stored waste as a barrier to the timely decommissioning and closure of facilities and sites and to the implementation of land use plans.
- To facilitate compliance with the regulatory principle of minimizing storage of radioactive waste.
- To provide an alternative to on-site indefinite storage of any orphan waste generated by "mission programs" once they are assigned responsibility for managing their waste.

These incentives are augmented by the following potential disadvantages resulting from the blanket consignment of GTCC LLW to emplacement in a geologic repository:

- It would establish a strong precedent for providing comparable long-term isolation for DOE's SCW with characteristics equivalent to the GTCC LLW.
- The unit disposal charges for the repository will be quite high. Equally important for DOE is the fact that repository disposal of waste that could be safely disposed

by other means may exhaust repository capacity that would be needed for other waste that requires Apermanent@ isolation in a repository.

$ Current DOE estimates about the volumes of GTCC LLW and DOE-equivalent SCW reflect very small quantities. There are uncertainties about these estimates that, once resolved, could result in significant increases in the volume of orphan waste to be managed and disposed. These uncertainties and their potential implications will be discussed later.

The guidance document accompanying the new DOE Order 435.1 concerning radioactive waste management has a requirement for identifying the generation of radioactive waste with no identified path to disposal and for reviewing and approving conditions under which such waste may be generated. The stated objectives of the requirement are to bring issues associated with the management of such waste to the attention of appropriate DOE managers to resolve the problems that will prevent it from being disposed before it is generated, to ensure the waste has appropriate long-term safe storage until it can be disposed, and to minimize the generation of waste with no path to dispose.

The document further notes that this requirement would ensure that senior management attention is directed to the potential long-term commitment made by the generation of such waste. The long-term commitment is associated with the prolonged storage of the waste and with the work necessary to resolve issues which prohibit the disposal of the wastes.

It is reasonable to assume that any waste generated in DOE programs in the future will have characteristics that fall within the range of those generated in the past and that have been disposed, or are legacy wastes currently in storage that may or may not have an identified path to disposal. It would appear, therefore, that to be consistent with the intent of this requirement in the Order, DOE should be addressing the issues that prevent the disposal of orphan waste currently in storage.

If it is agreed that these considerations represent sufficient justification to explore options for transitioning the orphan waste to disposal, what steps should be taken in pursuing this course of action? First of all, there needs to be a reversal of the tendency by DOE to ignore the wide variation in characteristics associated with orphan waste streams which has contributed to consideration of only a single disposal option - the deep geologic repository - for the inventory of orphan waste. This view is probably the result primarily of two considerations associated with GTCC LLW:

$ NRC, under pressure to identify a candidate disposal option for GTCC LLW, modified 10 CFR Part 61 in 1989 to state that this category of waste should be disposed of in a geologic repository licensed under 10 CFR Part 60 unless an alternative disposal option acceptable to NRC is proposed. This revision to the regulations was widely interpreted and reported as an NRC requirement that GTCC LLW be disposed of in a geologic repository. This erroneous interpretation had, and continues to have, a widespread influence on how this provision in the regulations is viewed.

$ The DOE-estimated volume of GTCC LLW in storage and projected for future generations has been sufficiently small that the DOE program concluded it would not be cost effective to provide a separate dedicated disposal facility for this material. The prevailing reaction to this conclusion for the past fourteen years, therefore, has been to view the geologic repository to be the obvious disposal for GTCC LLW. There was never any serious evaluation of disposal options tailored for specific categories of the GTCC LLW.

Clearly, the orphan waste streams consist of materials reflecting a wide variation in types and levels of radioactivity and half-lives, as well as chemical composition and physical states. The draft Yucca Mountain repository EIS notes that DOE-generated SPAR waste could include the following materials:

$ Production reactor operating wastes;
$ Production and research reactor decommissioning wastes;
$ Non-fuel-bearing components of naval reactors;
$ Sealed radioisotope sources exceeding Class C limits for waste classification;
$ DOE isotope production related wastes; and
$ Research reactor fuel assembly hardware.

Waste streams of similar radiological composition are generated in the private sector as GTCC LLW. However, their sources of generation involve civilian nuclear powerplants rather than production and naval reactors. The waste, as generated, can take a variety of forms, including:

structural materials containing activated products, ion exchange resins, sludges, filter media, and sealed sources.

Having established that the orphan waste consists of materials with a wide range of characteristics, what can we expect in terms of quantities to be managed and disposed?
The 1990 SCW survey, which included on-site visits, identified a large volume of stored SPAR waste, at least 34,000 cubic meters. However, a recent DOE Headquarters call for data from the Field concerning inventories of SPAR SCW resulted in a total of only 4,017 cubic meters. This total reflected contributions from only five DOE sites plus the Naval Reactors program. This is the volume of SCW that is being used for the repository EIS analysis. The GTCC LLW volume that EM provided to OCRWM for the EIS, as projected through 2055, was only 2,054 cubic meters.

There are a number of uncertainties and concerns associated with the use of the aforementioned volumes as a basis for developing a strategy for the long-term management of orphan waste or, for that matter, as a basis for determining the environmental impact of SCW and GTCC LLW on the geologic repository. These concerns include:

$ The credibility of a complex-wide inventory of only about 4,000 cubic meters of SCW that does not qualify for disposal in existing LLW disposal facilities is questionable and could result in an inappropriate management strategy. This total reflects no contribution from the Savannah River site and only 19.6 cubic meters from the Hanford Site. One would expect significant contributions of SPAR-type waste from both sites in view of the fact that they have served as the major defense production sites for the past half century.

$ The SPAR SCW inventory currently used for long-term planning does not include the waste generated in the decommissioning of DOE facilities. These activities will undoubtedly generate significant volumes of SPAR-type waste. The projected GTCC LLW inventory makes only a very modest provision for the future contributions from the decommissioning of the commercial nuclear power plants and other nuclear fuel cycle facilities.

$ The trend of recent years has been to impose more stringent acceptance criteria at DOE=s operating LLW disposal facilities. This has been due principally to the results of the assessments of long-term performance of these disposal systems. This trend could be enhanced as a result of the recently completed composite analyses of radiation dose contributions from all potential sources on DOE sites, not just from the waste disposal facilities. As a result, the inventory of SPAR SCW across the complex would be increased.

$ OCRWM has an obligation in its Standard Contract with nuclear utilities to accept for disposal non-fuel bearing components (NFC) removed from their reactors over their operating lifetime and stored in the fuel basins. Example components are cited in Appendix E of the contracts. OCRWM, however, has never classified what NFCs, beyond the examples cited, are to be accepted under the contracts. If subjected to NRC classification criteria, most of the components would be GTCC LLW; therefore, those components not on OCRWM=s acceptance list should be transferred to DOE as GTCC LLW. The current DOE projection for a GTCC LLW volume does not include a contribution from this source of generation.

Based on these uncertainties about the inventories of SPAR and GTCC LLW, it would seem reasonable to assume the total orphan waste inventory of about 6,000 cubic meters currently used by DOE for planning purposes is low by as much as an order of magnitude. In any case, the inventory should be large enough to remove any constraints on the list of candidate disposal options due to the limited volume of waste to be managed.

Are there reasonable disposal alternatives to emplacement in a deep geologic repository to be considered for the long-term management of the orphan waste? Options deserving consideration for specific categories of orphan waste include the following:

2. Sealed Sources:
   $ Co-disposed with LLW in a near-surface facility pursuant to the NRC-sanctioned concentration averaging concept;
   $ Commingled with HLW for vitrification and disposal (a course of action currently considered for disposal of stored cesium (Cs) and strontium (Sr) sealed sources at Hanford); and/or
   $ Disposed in an intermediate depth facility (e.g., lined or unlined augered borehole).
2. Irradiated non-fuel components which have been sized, compacted, and packaged for disposal:
   $ Co-disposal with LLW in a near-surface facility pursuant to the concentration averaging concept;
   $ Disposed in an intermediate-depth facility; and/or

- $ Emplaced in a geologic repository.

3. Design and establish a near-surface disposal facility with enhanced containment (e.g., below-grade concrete vaults with high-integrity emplacement containers) that could accept the higher risk LLW unacceptable at some operating DOE disposal facilities (e.g., the LLW contaminated with transuranics in concentrations greater than 10 nanocuries per gram) plus those categories of orphan waste determined appropriate pursuant to a performance assessment of the designed facility.

Evaluation of these disposal options, including associated costs, should require minimum effort in view of the extensive DOE and private sector experience available that is relevant to these options. The examination of the third option could draw heavily on the experience of recent years in the private sector resulting from the design and performance assessments for similar facilities proposed for regional disposal facilities in Illinois for the Midwest Compact, in Pennsylvania for the Appalachian Compact, and in North Carolina for the Southeast Compact.

CONCLUSIONS

Based on the foregoing discussion, one could reasonably conclude that:

- $ There are no regulatory constraints in considering disposal options for orphan waste in addition to emplacement of the waste in a geologic repository.
- $ There are meaningful incentives for exploring options that facilitate disposal of orphan waste prior to the accessibility of the repository - options that potentially provide more timely and cost-effective disposal than emplacement in the repository.
- $ The inventory of candidate disposal options need not be limited due to waste volume considerations, particularly if the SPAR SCW and GTCC LLW inventories are integrated for long-term management;
- $ The range of radiological characteristics associated with the orphan waste streams suggest the evaluation of multiple disposal options providing a range of waste isolation capabilities and unit disposal costs;
- $ There are indeed valid candidate options for the safe and cost-effective disposal of the various categories of orphan waste prior to the repository accessibility.

There would appear, therefore, to be ample justification for DOE to develop a strategy and implementing plan for the long-term management of orphan waste that are designed to facilitate the transition of the stored waste to disposal as promptly as resources permit.

References

1. ADepartment of Energy Special Case Radioactive Waste Inventory and Characterization Data Report,@ DOE/LLW-96 (Draft), May 1990.