The Department of Energy's National Disposition Strategy for the Treatment and Disposal of Low Level and Mixed Low Level Waste

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ABSTRACT

The U. S. Department of Energy's (DOE) Environmental Management (EM) program is committed to the environmental remediation of DOE sites. This cleanup mission will continue to produce large amounts of Low Level Waste (LLW) and Mixed Low-Level Waste (MLLW). This paper reports on the development of the DOE LLW/MLLW National Disposition Strategy that maps the Department's long-range strategy to manage LLW and MLLW. Existing corporate LLW and MLLW data proved insufficient to develop this strategy. Therefore, new data requirements were developed in conjunction with waste managers. The paper will report on the results of this data collection effort, which will result in development of DOE LLW/MLLW disposition maps.

INTRODUCTION

The Department of Energy is currently developing a LLW/MLLW National Disposition Strategy to establish a long-range corporate plan to manage LLW/MLLW. Currently, each DOE site determines the disposal options for its own LLW and MLLW. However, to a large degree, site specific waste management plans have not been integrated within a complex-wide baseline.

Although, the present decentralized system to manage LLW/MLLW disposal has been effective, the Department is developing a corporate strategy to manage LLW/MLLW disposition for a number of reasons. There is increasing Congressional interest in how DOE manages its LLW/MLLW, specifically regarding the life-cycle cost of waste disposal. Congress recently requested the U.S. Government Accountability Office (GAO) to determine whether DOE sites use life-cycle cost analysis to evaluate LLW treatment and disposal options. The GAO was also requested to determine if the Department has a corporate strategy for cost effectively managing LLW disposal. Consequently, the GAO published a report criticizing the Department for not conducting life-cycle cost analyses for LLW/MLLW treatment and disposal [1]. Furthermore, The DOE will include waste and material disposition maps within the Five-Year Plans supporting the FY 2007 President's Budget Request. In addition to the Congressional impetus, recently stakeholder organizations, such as the National Governor's Association, have called for a "national forum" and "formal integration" of DOE waste management plans.

In addition, a corporate waste disposition strategy will assist the Department to dispose of problematic MLLW streams with no current disposal path as well as to integrate site waste disposition plans to find cost efficiencies. A key element of this strategy is an assessment of

DOE and commercial LLW/MLLW disposal options and identification of any bottlenecks and/or gaps in LLW/MLLW treatment or disposal.

Early in the development of the strategy, a need was identified for new corporate LLW and MLLW information. Existing corporate LLW and MLLW data was inadequate. This paper will discuss the Department's effort to develop a new DOE LLW/MLLW database and the consequent development of DOE LLW/MLLW disposition maps.

Environmental Management projects require flexibility. Therefore, the waste management system must be agile and able to respond to sudden changes and dynamic circumstances.

DEVELOPMENT OF THE NATIONAL DISPOSITION STRATEGY

The LLW/MLLW National Disposition Strategy is being developed in two phases. Phase I examines selected DOE sites with a significant quantity of EM LLW/MLLW. Phase II will examine those sites not included in Phase I, so as to encompass the entire Department. The Phase I sites are:

- Oak Ridge, Tennessee
- Savannah River Site, South Carolina
- Idaho National Lab, Idaho
- Hanford (to include the Office of River Protection), Washington
- Portsmouth Project, Ohio
- Paducah Gaseous Diffusion Plant, Kentucky

Development of the LLW/MLLW National Disposition Strategy began in 2004. The preliminary draft was distributed to various stakeholder organizations for review in the spring and summer of 2005. For example, selected attendees at the Joint Department of Defense (DOD)/DOE Low-Level Radiological Waste and Mixed Waste Generators Conference, in May 2005, were requested to review the preliminary draft. Based on comments received, the Draft Phase I LLW/MLLW National Disposition Strategy was extensively revised.

DEVELOPMENT OF A DOE CENTRALIZED LLW/MLLW DATABASE

Concurrent with formulating the National Strategy, EM began to collect new information on LLW/MLLW volumes in 2005. To accomplish this, EM used the existing corporate information system known as the Integrated Planning, Analysis and Budgeting System (IPABS). In August 2005, waste managers from DOE sites met and agreed upon LLW/MLLW data requirements. A minimal data set was agreed upon which supports EM's strategic efforts, with a minimal data collection effort required from the field. A new IPABS module, the Baseline LLW/MLLW Disposition Data (BLDD) was developed for data entry purposes into the corporate database. The BLDD was activated on October 17, 2005, and data entry proceeded after that. EM's data collection covered all EM sites generating LLW/MLLW in fiscal year 2006 and beyond. This data will support development of the disposition strategy for Phase I sites. The sites responded with the required information in November and December 2005. After a period of quality

control reviews and analysis, the information was made available for EM staff use in drafting documents in January 2006.

In order to map the LLW/MLLW streams, the Department has adopted the Waste Information Management System (WIMS) developed, under DOE sponsorship, by the Hemispheric Center for Environmental Technology (now the Applied Research Center) of Florida International University (FIU). The WIMS is an internet-based platform capable of manipulating the LLW/MLLW data and generating waste disposition maps. The corporate database will feed the Central Internet Database, a publicly available website maintained by the Department, and the FIU WIMS in a read-only capacity. WIMS will produce simplified "waste disposition maps" for each DOE site by waste type that will help to identify any impediments to disposition. The LLW/MLLW waste disposition maps are part of the EM Five Year Plan and will be publicly available when the EM Five Year Plan is sent to Congress.

LIFE-CYCLE COST ANALYSIS OF LLW/MLLW DISPOSITION OPTIONS

Ultimately, EM's goal is to provide strategic direction to assist in the reduction of treatment and disposal costs. However, the Department lacks a consistent complex-wide basis to quantify these costs. The LLW/MLLW National Disposition Strategy qualitatively discusses the life-cycle cost analysis of LLW/MLLW disposition and provides the framework to begin the development of a consistent Department-wide methodology for conducting life-cycle cost analyses of waste treatment and disposal options.

The life-cycle cost analysis issue was highlighted in 2002, when the House Committee on Appropriations directed the Department to prepare a study analyzing the life-cycle costs of LLW treatment and disposal. Congress was concerned that the Department may be relying too heavily on DOE disposal facilities and not fully considering commercial options. The resulting DOE study [2], submitted to Congress in July 2002, analyzed the Department's LLW life-cycle disposal cost. Although the study recommended LLW life-cycle costs be evaluated and considered in selecting the appropriate treatment or disposal, the study cautioned that the Department's cost collection and reporting processes need to be improved to ensure valid costs comparisons.

Congress recently requested the GAO to determine whether DOE sites appropriately use life-cycle cost analysis to evaluate LLW treatment and disposal options. The GAO report [1], *Department of Energy, Improved Guidance, Oversight, and Planning are Needed to Better Identify Cost-Saving Alternatives for Managing Low-level Radioactive Waste,* published last October, is critical of the Department's implementation of cost guidance. The GAO found that the DOE sites are not consistently using life cycle cost analyses to assist waste disposal decisions. The GAO believes that without complete, well-documented life cycle cost analyses, EM may be overlooking cost-saving opportunities.

The Department agrees with the GAO that updated life cycle cost guidance is necessary to improve LLW/MLLW management. As reflected in the DOE LLW/MLLW National Disposition Strategy, the Department is re-evaluating its current policies and guidance on waste management activities including life cycle cost analysis. The Department has provided guidance

on life cycle cost analysis in DOE Order 430.1B, *Real Property Asset Management*, [3], with a supplemental guide DOE Guide 430.1-1, *Cost Estimating Guide*, [4]. EM plans to provide specific guidance in 2006 on conducting life cycle cost analysis as applied to LLW/MLLW treatment and disposal.

Developing life-cycle cost analysis guidance for LLW/MLLW treatment/disposal will be challenging because comparing DOE disposal costs with the pricing at commercial Treatment Storage and Disposal Facilities (TSDF's) is not straightforward. The difficulty in comparing DOE costs with commercial pricing is largely tied to the differences in federal and commercial accounting practices and funding protocols and the aggregate way in which DOE captures and reports costs. Some DOE disposal facilities are funded through a combination of direct funding through annual appropriations and disposal fees charged to the waste generators. Fixed costs, such as the construction of a disposal facility, as well as costs for disposal facility closure and long-term stewardship, are typically direct-funded through annual appropriations. Disposal fees charged by DOE disposal facilities typically relate to the facility's variable cost. Furthermore, DOE facilities typically do not budget for future costs tied to site closure and long-term stewardship because such funds will be requested from Congress when required.

In addition, DOE facilities dispose of some waste that would be eligible for commercial disposal and other waste that falls outside the waste acceptance criteria for commercial TSDF's. However, DOE facilities typically do not collect the costs associated with these wastes separately. By aggregating the costs, it is difficult to determine the costs associated with those wastes that could be disposed of in commercial facilities. Furthermore, different types of costs related to waste disposal may be budgeted separately (e.g., regulatory, security, utilities, etc.). A consistent life cycle cost analysis must include all costs associated with waste disposal at DOE facilities, regardless of account.

When considering the disposal cost of a given waste stream, the actual fee paid to a disposal facility may be only a fraction of the total cost. A significant portion of the total LLW/MLLW treatment/disposal cost may be the expense incurred in preparing and shipping the waste, referred to as pre-disposal generator costs. The primary components of pre-disposal generator costs are waste characterization, treatment, packaging, and transportation. These costs are often budgeted for separately and, as such, are not readily apparent.

The DOE study estimated that pre-disposal costs may represent as much as 90% of the total waste disposal cost [2]. Unit pre-disposal costs are strongly influenced by the radioactive constituents in the waste, the physical form, and the origin of the waste, transportation distances and the waste volume. Because the Department disposes of a wide variety of LLW/MLLW, the amount of pre-disposal costs also varies extensively depending on the waste stream. Pre-disposal costs for an on-site Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) disposal cells are much lower than for other TSDF's because of the low costs associated with bulk landfill disposal as well as the large waste volumes. On the other hand, low volume waste streams requiring treatment, extensive characterization and special packaging could require pre-disposal costs exceeding $\$5{,}000/m^3$. For example, the pre-disposal cost for the disposal of equipment removed from the Hanford Site tank farms includes the

removal of equipment, survey and characterization, dismantling/size reduction and packaging in standard boxes.

The authors of this DOE study [2] conclude that it is difficult to accurately assess pre-disposal costs because the pre-disposal cost elements (characterization, treatment, packaging and transportation) are not customary DOE project accounting categories. There is no uniform DOE Complex-wide protocol for collecting and reporting such costs. If the Department is to use life-cycle cost metrics to guide treatment or disposal site decisions, standardized protocols would improve the bases for such decisions as well as any subsequent analysis. Because pre-disposal costs may represent such a significant fraction of the total life-cycle waste disposal costs, they also may represent a significant life cycle cost savings opportunity.

Recent DOE/EM Paducah-Envirocare Analysis of Complex-Wide Cost Impacts in Integrating Large-Scale Waste Disposition Regimes

Disposing a large quantity waste stream at a commercial TSDF may impact the costs at a DOE disposal site. In 2005, the Portsmouth and Paducah Project Office (PPPO) performed a cost analysis for the disposal of the Paducah Gaseous Diffusion Plant's (PGDP) remaining 20,000 tons (37,000 m^3) of contaminated scrap metal from the Paducah Northwest Scrap Yards. The disposition was originally part of the baseline plan for Fiscal Years 2006 through 2007 with disposal being earmarked for the Nevada Test Site (NTS). The options under consideration were disposal at Envirocare of Utah or at NTS. Given the large volume of waste material, PPPO also examined how the Paducah scrap metal waste volumes could impact NTS disposal unit rates charged to other DOE generators. If the Paducah scrap metal were to be disposed of at Envirocare, the NTS operating costs would have to be spread among the remaining, smaller, disposal volumes. A life cycle cost analysis was performed to place the estimates on a common basis and to fully account for the NTS disposal site impacts.

Based on this analysis, PPPO determined that the Envirocare disposal option provided both cost and schedule savings. Cost savings associated with the PGDP project disposing at Envirocare was estimated to be about $15M with several months of schedule acceleration also envisioned.

The PPPO analysis also revealed that the increase in cost to DOE waste generators/shippers to NTS as a result of the large-volume diversion to Envirocare would be about $1.6M over two years. This would be principally based on tipping fee considerations. About 40% of the cost would be borne by Paducah and/or PPPO. NTS tipping fee charges are calculated as a composite of fixed and variable costs based on a working crew size as a function of volume. For fiscal year 2006, the NTS tipping fees are estimated to be about $293.00 per m^3 and $254.00 per m^3 based on disposition volumes of 28,000 m^3, and 65,000 m^3, respectively.

Thus, based on the PPPO analysis, large-scale waste disposition regimes diverted to the commercial sector may very well adversely impact costs at DOE waste disposition sites. This fact should definitely be considered in the examination of future life-cycle costs for waste disposition at DOE sites.

RADIOLOGICAL RELEASE OF WASTE FOR DISPOSAL IN A LANDFILL

The LLW/MLLW National Disposition Strategy highlights the use of authorized limits to release waste with very low quantities of residual radioactive material because this process has the potential to significantly reduce waste disposal costs and minimize LLW quantities, while protecting human health and the environment. Under the Department's radiation protection requirements, it is possible to radiologically release materials for restricted or unrestricted use. For waste disposal, this can result in more appropriate and economical disposal as well as minimizing the amount of LLW requiring disposal. A restricted radiological release of waste materials, for example, could result in a hazardous waste containing small quantities of residual radioactive material being disposed of in a RCRA Subtitle C hazardous landfill or a non-hazardous waste with an acceptably low radiological component being disposed at a Subtitle D landfill.

DOE radiological release requirements are contained in DOE Order 5400.5, *Radiation Protection of the Public and the Environment* [5], and the companion DOE Guide 441.1-xx, *Implementation Guide, Control and Release of Property with Residual Radioactive Material* [6]. The DOE Order governs radiation protection related to released property through the use of "authorized limits" which are the radiological release criteria. The Order provides authorized limits for radioactivity on surfaces, using the release criteria in Figure IV-1 of DOE Order 5400.5. The release criteria in this Order only apply to materials with surface contamination. Authorized limits for materials containing residual radioactive material in mass or volume must be derived consistent with the requirements and processes in DOE G 441.1-xx, and approved by the Assistant Secretary for Environment, Safety and Health, EH. Similarly, authorized limits for radioactivity on surfaces different than those in DOE Order 5400.5 may be approved by the DOE on a case-by-case basis. This authority has been delegated to Field Office Managers under certain circumstances. Consequently these managers may approve authorized limits under conditions discussed in DOE G 441.1-xx. Potential doses must be maintained as far below dose constraints as is reasonably achievable through an ALARA process, i.e. As Low as Reasonably Achievable (ALARA). It must be demonstrated that the potential dose will be below the individual dose constraint of ~1 mrem/year to any individual and 10 person-rem/year, collective dose. DOE G 441.1-xx also clarifies the authority to approve alternate ALARA/dose-based derived authorized limits for surfaces or activity in mass or volume where potential doses are less than the 25 mrem dose constraint but in excess of 1 mrem/year individual dose or 10 person-rem/year collective dose.

Great care should be taken that authorized limits intended for release of materials into landfills are not misused in any way. For example, incinerators greatly reduce the volume of flammable wastes, and trace amounts of residual radioactivity in a flammable waste could become concentrated if the waste were incinerated rather than disposed in a landfill.

Benefits in using authorized limits are not confined to cost savings only. The use of the authorized limits process preserves valuable disposal capacity at radioactive waste disposal sites as well as minimizing the amount of LLW requiring disposal.

IMPLEMENTATION OF THE LLW/MLLW NATIONAL DISPOSITION STRATEGY

The LLW/MLLW National Disposition Strategy is the framework under which the Department will corporately manage LLW/MLLW treatment and disposal. Phase I of the Strategy is scheduled to be completed in draft in March 2006. Phase II will then examine those DOE sites with LLW/MLLW streams not included in Phase I. The following activities are necessary to fully implement the strategy; with some of these planned in parallel with Phase II of the National Disposition Strategy:

- Complete a policy analysis. This will include a review of the existing guidance and modification, as necessary, of DOE Order 435.1-1, *Radioactive Waste Management* [7].

- Complete a Project Management Plan to describe how the Department will corporately manage LLW/MLLW disposition.

- Continue the Joint Department of Defense (DOD)/DOE Low-Level Radiological Waste and Mixed Waste Generators Conference (FEDRAD). In May 2005 EM-12, the Office of Commercial Disposition Options, co-sponsored this FEDRAD conference. During this conference, DOE personnel dialogued with commercial vendors and resolved several problematic MLLW issues. These conferences are now planned to be held annually to assist communication between the Department and the commercial LLW/MLLW treatment and disposal industry.

- Conduct a programmatic risk assessment of problematic MLLW streams and develop disposition contingency plans.

- Develop and implement guidance regarding life-cycle cost analyses for LLW/MLLW treatment and disposal. This may include recommending a systematic and consistent method to establish a common basis and analyze all cost elements.

- Conduct a complex-wide conference for presentations and lessons learned on the establishment and use of authorized limits for the radiological release of waste.

- Consider additional methods to encourage waste minimization; for example, perhaps through additional analyses or possibly through contract incentives.

REFERENCES

1. U.S. Government Accountability Office, *Department of Energy, Improved Guidance, Oversight, and Planning are Needed to Better Identify Cost-Saving Alternatives for Managing Low-level Radioactive Waste,* Report number GAO 06-94, Washington DC, Oct. 2005.
2. Department of Energy, *Report to Congress, The Cost of Waste Disposal: Life-Cycle Cost Analysis of Disposal of Department of Energy Low-Level Radioactive Waste at Federal and Commercial Facilities*, Washington DC, July 2002.
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6. Department of Energy Guide G 441.1-xx, *Implementation Guide, Control and Release of Property with Residual Radioactive Material*.
7. DOE Manual 435.1-1, Change 1, *Radioactive Waste Management Manual*, dated June 2001.