DETERMINING HOW MUCH MIXED WASTE WILL REQUIRE DISPOSAL

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INTRODUCTION

Estimating needed mixed-waste disposal capacity to 1995 and beyond is an essential element in the safe management of low-level radioactive waste disposal capacity. Information on the types and quantities of mixed waste generated is needed by industry to allow development of treatment facilities and by states and others responsible for disposal and storage of this type of low-level radioactive waste. The design of a mixed waste disposal facility hinges on a detailed assessment of the types and quantities of mixed waste that will ultimately require land disposal.

Although traditional liquid scintillation counting fluids using toluene and xylene are clearly recognized as mixed waste, characterization of other types of mixed waste has, however, been difficult. Liquid scintillation counting fluids comprise most of the mixed waste generated and this type of mixed waste is generally incinerated under the supplemental fuel provisions of the Resource Conservation and Recovery Act (RCRA)[1]. Because there are no currently operating mixed waste land disposal facilities, it is impossible to make projections of waste requiring land disposal based on a continuation of current waste disposal practices. Evidence indicates the volume of mixed waste requiring land disposal is not large, since generators are apparently storing these wastes. Surveys conducted to date confirm that relatively small volumes of commercially generated mixed waste volume have relied heavily on generators' knowledge of their wastes. However, many generators of radioactive waste are unfamiliar with hazardous waste designations and regulations. Additionally, many generators fear self-incrimination since long-term storage of several types of untreated mixed waste is prohibited under RCRA. Evidence exists that many generators are confused by the differences between the Atomic Energy Act and the Resource Conservation and Recovery Act (RCRA) on the issue of when a material becomes a waste. Other survey techniques may more consistently apply regulatory definitions and waste designations, yet these other techniques tend to be significantly more expensive and lack the generators' in-depth understanding of the waste.

Even in those states understanding how much mixed waste is generated, most lack an understanding of how much of that waste will ultimately require land-based disposal as mixed waste. Complicating projections of mixed waste disposal are recent regulations prescribing treatment levels for hazardous waste. Because of uncertainty on the amount and types of mixed waste currently being generated, few commercial facilities have committed the necessary resources to develop treatment to comply with the requirements of 40 CFR 268. Since the radioactive waste management industry has been slow to develop treatment facilities for what is generally perceived as a small quantity of waste, little data are available on actual volume reductions/increases as a result of treating mixed waste to meet standards of the Resource Conservation and Recovery Act (RCRA).

In spite of these uncertainties, estimates of waste volumes requiring disposal can be made. This paper proposes an eight-step process for such estimates.

STEP ONE: CLASSIFY WASTE

In order to determine how much waste will require land disposal, the types and amounts generated must be determined. Waste classification systems exist for both commercial low-level and hazardous waste. Under RCRA, the generator is required to determine if the waste is hazardous. This is done by determining if the waste is excluded under 40 CFR 261.4, is listed under 40 CFR 261, Subpart D, or if the waste is characteristically hazardous as defined in 40 CFR 261, Subpart C. The Environmental Protection Agency (EPA) has assigned waste codes for each type of hazardous waste.

Similarly, the Nuclear Regulatory Commission (NRC) has established criteria for classifying radioactive waste as either Class A, B, or C, stable and unstable, per 10 CFR 61.55 and interpretive branch technical positions on the subject of waste classification and stability.

For example, a researcher discarded a tritium labeled pesticide, endrin, in a liquid scintillation cocktail with an initial tritium concentration of 0.1 microcurie per ml. In this hypothetical case, the researcher recognized he was generating a mixed waste for which there was no readily available treatment or disposal method. Consequently, the researcher absorbed the liquid onto a diatomaceous earth absorbent for safe storage pending development of treatment or disposal capacity. The annual generation rate of this waste is one gallon of liquid, which results in the generation of 3 gallons of absorbed liquid.

In this example, the waste would consist of xylene and toluene, organic solvents listed in 40 CFR 261.31 as F003 and F005, respectively. Wastes designated as F003, are listed due to the characteristic of ignitability, and wastes designated as F005 are listed due to toxicity. The pesticide endrin is known from process knowledge to be present in the waste in concentrations greater than 0.02 mg/l. Thus, this waste is classified under RCRA as both a listed waste and a characteristic waste (for toxicity and ignitability). The radioactive classification for this waste is Class A, unstable. The concentration of tritium in the waste does not automatically qualify for exemption under the NRC's rule governing liquid scintillation counting, 10 CFR 20.306.

STEP TWO: AMOUNT IN STORAGE

Because no land disposal facilities have accepted mixed waste since 1985, it is possible that a significant volume of mixed waste is in storage. Because waste treatment levels have only recently been specified (55 FR 22520), wastes generated prior to summer, 1990 may not be in a form that is compatible with EPA's recommended or required treatment. Consequently, it is important to determine the volume of waste in storage and the form of that waste.

Using the example above, there are 12 gallons of absorbed waste in storage. The absorbent used was an inorganic diatomaceous earth granular product. There are also two-one gallon containers of liquid scintillation vials, each with 15 ml of liquid scintillation fluid, layered in the same absorbent, with twice the absorbent necessary to contain the liquid.

STEP THREE: CURRENT GENERATION RATE

Because past practices cannot be assumed to be representative of current waste generation practices, knowledge of current waste management practices is needed to provide valid estimates of the types and quantities of waste generated.

The researcher in the above example has become knowledgeable about EPA's land disposal restrictions and has decided not to mix his waste with absorbent anymore. This year the researcher will empty (or crush) his liquid scintillation vials and triple rinse the vials. The researcher generates one gallon of liquid scintillation fluid and one gallon of rinsate.

STEP FOUR: FUTURE GENERATION RATES

Because past practices cannot be assumed to continue, future waste generation must be closely evaluated. When evaluating future waste practices, not only must the technical nature of the waste be evaluated, but also the likely behavior of the waste generator. Past predictions of low-level waste generation have largely been inaccurate because the behavioral aspects of the waste manager were largely neglected. For example, many states overestimated the volume of waste expected for disposal in 1986, neglecting the powerful impact that a $10 per cubic foot surcharge would have on the total volume of waste needing disposal. Since one state is projecting mixed waste disposal will cost on the order of $15,000 per cubic foot[2], a similar overestimate of mixed waste volume could be anticipated if a behavioral reaction to the economics of mixed waste disposal are neglected. While the effect of behavioral factors may be impossible to estimate numerically, they must be considered in evaluating estimates of future waste generation.

In the example cited previously, the field of research involving tritium and endrin is likely to continue for five more years. It could therefore be assumed that the researcher will continue to generate the same waste at the same rate of one gallon per year of liquid for each of the next five years. However, behavioral factors should also be considered. In response to projected disposal costs, is the researcher likely to change waste management practices. For example, the rinsate could be disposed of under the Clean Water Act by discharge to a publicly owned treatment works (POTW), in full conformance with EPA and NRC requirements. The research protocol may be change to reduce the concentration of tritium in the waste. Alternatively, it may be possible to aggregate this liquid scintillation counting waste with other liquid scintillation counting wastes (note: aggregation is not dilution) reducing the concentration of tritium to the point where the waste may be exempted from disposal as radioactive waste. This waste aggregation may also reduce the concentration of eldrin below characteristic levels. If these or other waste management techniques are employed, it is possible that no mixed waste will require land disposal.

STEP SIX: REQUIRED TREATMENT

EPA has prescribed treatment levels that all hazardous waste must meet (40 CFR 268) prior to land disposal. These treatment levels are either specified concentrations of hazardous contaminants in the waste itself, in an extract of the waste, or a prescribed treatment method. All waste must meet these treatment levels (or receive an exemption from EPA) in order to be land disposed. NRC has also prescribed waste form requirements that all low-level radioactive wastes must meet in order to be disposed in a shallow-land burial facility (10 CFR 61.56). Since mixed waste is regulated under RCRA and the AEA, it must meet the requirements of both 40 CFR 268 and 10 CFR 61.56 prior to land disposal.

Using the same example waste, the ignitable characteristics of the waste must be deactivated (DEACT) so that the waste is no longer ignitable, and the toxic characteristics must be treated either by biodegradation (BIODEG) or incineration (INCIN). In order to meet the treatment standards for the organic constituents, however, the concentrations of xylene (F003) and toluene (F005) in an extract of the waste residue must not exceed 0.15 mg/l of xylene or 0.33 mg/l of toluene. Additionally, the waste residue may not contain more than 0.13 mg/l of endrin. The treatment requirements under 10 CFR 61.56 are less technically demanding in that the waste must not contain any free-standing liquid. If the waste cannot meet the RCRA treatment requirements, a treatability variance may be sought from EPA.

STEP SEVEN: EFFECT OF TREATMENT ON VOLUME

Knowing the required treatment provides some insight into how the waste must be treated, but provides little firm evidence on the nature of the waste after treatment. With no operating treatment facilities for this waste, it is difficult to predict how the waste will actually perform during treatment. For example, the literature suggests that volume reduction factors on the order of 100 to 1,000 can be expected for incineration of some organic wastes[3]. Incineration of the waste would comply with the required treatment for the toxic and ignitable characteristics and is the recommended treatment for the xylene and toluene. However, it is not known whether these performance-based concentrations will be met by incineration. If additional stabilization of the waste were required, volume reduction factors could be considerably less.

Considering the example waste and based on considerable experience with non-radioactive hazardous waste, it could be conservatively assumed that incineration of the example waste will be the method of choice. Volume reduction factors of from 1:1,000 to 1:100 could be expected for the liquid waste. However, due to difficulties involved with incinerating the waste in storage that was already absorbed onto diatomaceous earth, no net volume reduction can be realized during treatment for this stored waste. In fact, there may need to be additional stabilization of this waste, thereby increasing the volume.

STEP 8: PROFESSIONAL JUDGEMENT

Until facilities are developed for treatment of mixed waste and operational history has been demonstrated, professional judgement must be interjected into estimates of future waste generated. Estimates of expected volumes must be tempered by considering the behavior of the generator with regards to product substitution, continued need to generate the waste, the effect of small quantity generator allowances and other regulatory relief, and any alternative waste management efforts that might be employed for each source of waste. Estimates must also be tempered by considering regulatory uncertainties with regards to granting treatability variances, delisting petitions, no migration petitions, and other types of regulatory relief. Sensitivity analyses should be performed to test the effect of changes to the assumptions used in the estimation process.

Continuing with the same example waste, a comparison of the total waste generated with the total waste requiring disposal under both favorable and unfavorable assumptions is presented in Table 1. The favorable assumptions were chosen to minimize the waste requiring land disposal as mixed waste; the unfavorable assumptions were chosen to maximize the waste needing disposal as mixed waste. Depending on the assumptions used, the volume of waste requiring land disposal as mixed waste could range from none to approximately 50% of the original volume. The greatest factor affecting the final volume requiring disposal for this example waste is not future generation of the waste, but past waste management practices affecting stored mixed waste.

SUMMARY

Many uncertainties exist that affect the accuracy of mixed waste projections. The uncertainties can be classified as technical, regulatory, and behavioral. Included among the technical uncertainties is the lack of demonstrated and operating mixed waste treatment technologies compatible with 40 CFR 268 treatment standards. Regulatory uncertainties also exist including the potential effect of treatment variances and petitions for delisting of certain wastes which may or may not be granted. Behavioral uncertainties include the continued likelihood of generation of mixed waste in the same quantities and forms that were generated in the past.

In spite of these uncertainties, estimates of the volumes and types of mixed waste requiring disposal can be made. These estimates should be tempered, however, with a combination of uncertainty analyses and professional judgement.

TABLE 1
COMPARISON OF WASTE GENERATED AND
WASTE REQUIRING DISPOSAL
(Volume in Gallons)

Type ot Waste Generated	Total Volume Generated	Total Volume Disposed-Minimizing Assumptions	Total Volume Disposed-aximizing Assumptions
Waste in Storage	12 gallons absorbed	0 [a]	12[b] (12)[c]
	2 gallons vials in absorbent	0[a] (0.002)[e]	2.0[d]
Currently Generated Waste	1 gallon LSC	0[a] (0.001)[e]	0.01[f]
	1 gallon rinsate	0[a] (0.001)[e]	0.01[f]
Future Waste Generated	Maximum of 5 gallons LSC	0[a] (0.005)[e]	0.05[f]
	5 gallons rinsate	0[a] (0.005)[e]	0.05[f]
TOTAL	26	0 (12.012)	14.11

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[a] The treated waste is delisted.

[b] The treated waste showed no volume reduction because of the absorbent used

[c] The waste was treated but not delisted. No volume reduction could be realized because of the absorbent used.

[d] The vials in storage were not all intact, therefore no volume reduction following treatment.

[e] Treatment provided a volume reduction factor of 1,000.

[f] Treatment provided a volume reduction factor of 100.

REFERENCES

1. U.S. Congress, Office of Technology Assessment, Partnerships Under Pressure: Managing Commercial Low-Level Radioactive Waste, OTA-O-426, 1989.

2. Jay Ringenberger, presentation at Host-States Meeting, May 16-17, 1990, conference held in Washington, D.C.

3. U.S. Department of Energy, Low-Level Radioactive Waste Volume Reduction and Stabilization Technologies Resource Manual, DOE/LLW-76T, December