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IDENTIFICATION OF RADIOACTIVE MIXED WASTES IN COMMERCIAL LOW-LEVEL WASTES*

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ABSTRACT

A literature review and survey were conducted on behalf of the U.S. NRC Division of Waste Management to determine whether any commercial low-level radioactive wastes(LLW) could be considered hazardous as defined by EPA under 40 CFR Part 261. The purpose of the study was to identify broad categories of LLW which may require special management as radioactive mixed waste, and to help address uncertainties regarding the regulation of such wastes.

Of 239 questionnaires sent out to reactor and non-reactor LLW generators, there were 91 responses representing 29% by volume of all low-level wastes disposed of at commercial disposal sites in 1984. The analysis of the survey results indicated that three waste streams generic to commercial LLW may be potential radioactive mixed wastes. These are as follows:

1. wastes containing organic liquids, disposed of by all types of generators and representing ≈2.3% by volume of all wastes reported,

2. wastes containing lead metal, i.e., discarded shielding and lead containers, representing <0.1% by volume of all wastes reported, and

3. wastes containing chromium, i.e., process wastes from nuclear power plants which use chromates as corrosion inhibitors; these represent 0.6% of the total volume reported in the survey.

Certain wastes, specific to particular generators, were identified as potential mixed wastes as well.

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INTRODUCTION

The disposal of low-level radioactive waste (LLW) is regulated by the U.S. Nuclear Regulatory Commission (NRC) under 10 CFR Part 61.[1] The U.S. Environmental Protection Agency (EPA) has promulgated regulations under authority of the Resource Conservation and Recovery Act (RCRA), governing the management and disposal of hazardous wastes.[2] Recently, questions have been raised regarding the applicability of EPA standards to LLW containing hazardous chemical constituents, or radioactive mixed wastes.

As part of its technical assistance program for the NRC, Brookhaven National Laboratory has been conducting several studies in order to provide NRC with the information needed to determine the applicability of EPA standards to radioactive mixed wastes. The studies which have been completed focused on the following:

- a review of EPA regulations, and
- a review of the literature and commercial disposal site records for the known chemical characteristics of LLW.

EPA regulations concerning the management and disposal of hazardous wastes are contained in 40 CFR Parts 260 to 270. The regulation of particular concern for determining whether LLW would be considered hazardous is 40 CFR Part 261, "Identification and Listing of Hazardous Waste." In 40 CFR Part 261, wastes are defined as hazardous if they exhibit one of four characteristics:

- ignitability,
- corrosivity,
- reactivity, and
- extraction procedure (EP) toxicity.

The characteristics are defined in Subpart C of 40 CFR Part 261. In addition to these characteristics, wastes are hazardous if they correspond to one of the wastes listed in Subpart D of 40 CFR Part 261. These lists are subdivided as follows:

- hazardous wastes from non-specific sources,
- hazardous wastes from specific sources,
- discarded commercial chemical products, off-specification species, container residues, and spill residues thereof.

The latter list of chemicals is subdivided into acutely hazardous and toxic lists.

The literature review and review of disposal site records identified two waste categories as potentially hazardous under the Subpart C characteristics. These were lead metal and organic solvents used in liquid

scintillation media. No LLW types were identified which directly corresponded to the wastes listed in Subpart D. Lead was considered potentially hazardous because of EP toxicity. Organic solvents were identified as potentially hazardous due to ignitability and the presence of toxic constituents listed in Appendix VIII of 40 CFR Part 261.

Survey of LLW Generators

The results of the early studies by BNL were extended by conducting a survey of generators of LLW. The survey questionnaire was designed to address information gaps identified in the earlier studies, e.g., the presence and concentrations of various hazardous constituents such as phenols, hydrazine, cyanide, and chromates. The survey was sent to 239 reactor and non-reactor generators of LLW. Of these, 97 responses were received, representing approximately 29% by volume of all LLW sent to commercial disposal sites in 1984.*

The distribution of waste volumes by generator type is shown in Table 1 as well as a comparison with the national volume of LLW disposed of in 1984. The response from each type of generator in terms of waste volumes was reasonably consistent with the overall response, with the exception of medical facilities.

TABLE 1. COMPARISON OF SURVEY RESPONSE WITH 1984 DATA
(cubic feet)

Generator Type	Totals for 1984[a]	Survey Response	Percent[b] Response
Reactor	1,682,149	511,759	30.4
Non-reactor			
academic	76,899	17,931	23.3
medical	60,290	10,865	18.0
industrial	799,286	242,739	30.4
Total	2,618,624	783,294	29.9

[a]Volumes for separate government category were distributed evenly over other non-reactor categories.
[b]Column 2 as a percentage of Column 1.

The analysis of the survey results revealed three broad categories of wastes which may be radioactive mixed wastes. These were as follows:

- wastes containing organic liquids, disposed of by all types of generators and accounting for 2.3% by volume of all wastes reported,

*Data for 1984 was obtained in a telephone contact with L. Carpenter of EG&G, Idaho National Engineering Laboratory on August 23, 1985.

- wastes containing lead metal, i.e., discarded shielding and lead containers, which represented <0.1% by volume of the LLW reported, and

- wastes containing chromium, e.g., process wastes from nuclear power plants which use chromates as corrosion inhibitors, which represented 0.6% by volume of the wastes reported.

Certain wastes, specific to particular generators, were identified as potential mixed wastes as well.

The sources of wastes containing organic liquids with respect to generator type and the distribution according to waste type are shown in Tables 2 and 3, respectively. These indicate that the largest amounts of waste in terms of disposal volume consist of scintillation vials, and that academic and industrial generators are the two largest sources of wastes containing organic liquids.

TABLE 2. SOURCES OF WASTES CONTAINING ORGANIC LIQUIDS

Generator Type	Volume (ft^3)	Percent Distribution	Percent of LLW Reported in Survey[a]
Reactor	2,451	14.7	0.5
Non-reactor			
academic	5,952	36.5	33.2
medical	3,727	15.0	34.3
industrial	5,604	33.8	2.3
Total	17,734	100.0	2.3

[a]Column 1 as a percentage of Column 2 in Table 1.

TABLE 3. WASTE TYPES CONTAINING ORGANIC LIQUIDS

Waste Type	Volume (ft^3)	Percent of Total
Scintillation liquids	3,222	18.2
Scintillation vials	9,178	51.7
Organic lab liquids	3,708	20.9
Miscellaneous solvents	1,626	9.2
Total	17,734	100.0

A comparison of the survey results listed in Tables 1 and 2 shows that, as a percentage of the total wastes reported for each generator type, wastes containing organic liquids represented 0.5% of all reactor wastes, 33.2% of academic totals, 34.3% of medical wastes, and 2.3% of industrial wastes. Because organic-containing wastes form a larger percentage of medical and academic facility wastes, and medical and academic facilities are under-represented in terms of volume compared to other generator types, the value of 2.3% mentioned earlier as the overall percentage of organic-containing wastes may underestimate the national figure. However, it was found during follow-up contacts that some respondents had included volume data for scintillation vials which were de minimis (de-regulated) and were sent to facilities other than commercial LLW disposal sites.

Wastes containing lead metal are present in less than one percent by volume of all LLW, according to the survey. These wastes are primarily in the form of discarded, contaminated shielding, e.g., lead bricks or blankets, and containers such as lead pigs for sealed sources. The lead metal wastes were generally mixed with non-compactible trash, and the quantities reported reflect the amounts as-shipped.

The amounts of lead-containing wastes reported in the survey are summarized in Table 4 according to generator type. These are reported as weight (lbs) since more than half the respondents for this category of wastes provided weight rather than volume data.

TABLE 4. SOURCES OF LEAD-CONTAINING WASTES

Generator Type	Weight (lbs)	Percent of Total
Reactor	77,400	64.3
Non-reactor		
academic	480	0.4
medical	820	0.7
industrial	41,660	34.6
Total	120,360	100.0

Chromium-containing wastes reported in the survey fell into three categories:

1. lab waste and trash contaminated with trace amounts of chromates used as carriers for Cr-51,

2. process wastes from LWRs which use chromates as corrosion inhibitors, and

3. process wastes from LWRs not using chromates, contaminated with chromium present in corrosion products.

The volumes associated with these categories are shown in Table 5. Approximately 95% of these wastes contain chromium in corrosion products, presumably as Cr_2O_3. The total volume of chromium-containing wastes corresponds to ≈13% of the total LLW reported in the survey.

TABLE 5. BREAKDOWN OF WASTES CONTAINING CHROMIUM

Source	Volume Shipped (ft^3)
Non-reactor	758.0
Reactor	
chromates used	5,350.0
corrosion products	95,450.0
Total	101,558.0

Conclusions and Discussion

The survey reported here was conducted with the intent of identifying categories of LLW which would be classified under EPA regulation 40 CFR Part 261 as hazardous due to the chemical properties of the waste. Three waste types are identified under these criteria as potential radioactive mixed wastes:

- wastes containing organic liquids,
- wastes containing lead metal, and
- wastes containing chromium.

The survey also indicated that certain wastes, specific to particular generators, may also be radioactive mixed wastes.

Ultimately, the responsibility for determining whether a facility's wastes are mixed wastes rests with the generator. The determination that certain types of LLW are mixed wastes may, in some cases, require further analysis. Of the three categories of LLW listed here as potential mixed wastes, two should be examined further. Wastes containing organic liquids, in particular, scintillation liquids and scintillation vials, do not need further evaluation because they can be considered listed hazardous wastes under a proposed rule defining all spent solvents previously listed and mixtures containing more than 10% of any of these solvents as hazardous wastes.[3] Wastes containing lead metal may have to be examined further. Lead bricks have been reported to exhibit EP toxicity[4] although the cited reference does not present numerical data. A testing program for wastes containing chromium, from LWRs which use chromates as corrosion

inhibitors, is being conducted under FIN A-3173. Of the three groups mentioned under chromium-containing wastes, this type is considered most likely to exhibit EP toxicity.

In addition to identifying mixed wastes, appropriate methods for the management of mixed wastes must be defined. In an ongoing study, BNL is evaluating options for the management of mixed wastes. These options will include segregation, substitution, and treatments to reduce or eliminate chemical hazards associated with the wastes listed above.

REFERENCES

1. Code of Federal Regulations, Title 10, Energy, Parts 0 to 99 revised as of January 1, 1985.

2. Code of Federal Regulations, Title 40, Protection of Environment, Parts 190 to 399, revised as of July 1, 1984.

3. Federal Register, FR 50 (83), pp. 18378-18381, April 30, 1985.

4. D. D. Nishimoto, K. L. Falconer, D. J. Wiggins, "Options for Treatment Storage and/or Disposal of Radioactive Mixed Waste at the Idaho National Engineering Laboratory," presented at Waste Management '85, Tucson, Arizona, March 1985.