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

B. S. Bowerman, C. R. Kempf, D. R. MacKenzie, B. Siskind, and P. L. Piciulo
Department of Nuclear Energy
Brookhaven National Laboratory
Upton, New York 11973

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 the following waste types generic to commercial LLW may be potential radioactive mixed wastes:

- Wastes containing oil, disposed of by reactors and industrial facilities, and representing 4.2% of the total LLW volume reported in the survey.
- Wastes containing organic liquids, disposed of by all types of generators, and representing 2.3% by volume of all wastes reported.
- Wastes containing lead metal, i.e., discarded shielding and lead containers, representing <0.1% by volume of all wastes reported.
- 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.

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 and permitting requirements 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.

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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.* (A complete description and details of the survey and responses are contained in Ref. 3.)

The distribution of waste volumes by generator type is shown in Table I 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 I

Comparison of Survey Response with 1984 Data (cubic meters)

Generator Type	Totals for 1984[a]	Survey Response	Percent[b] Response
Reactor	47,633.3	14,491.4	30.4
Non-reactor			
academic	2,177.5	507.7	23.3
medical	1,707.2	307.7	18.0
industrial	22,633.2	6,873.6	30.4
Total	74,151.2	22,180.4	29.9

[a]Volumes for separate government category were distributed evenly over other non-reactor categories.
[b]Survey volume as a percentage of 1984 total volumes.

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

- wastes containing oil, disposed of by reactors and industrial facilities, and representing 4.2% of the total LLW volume reported in the survey,
- wastes containing organic liquids, disposed of by all types of generators and accounting for 2.3% by volume of all wastes reported,
- 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, i.e., 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.

Waste oil will become a listed hazardous waste under a proposed EPA rule.[4] A total of 925.3 m^3 of LLW containing waste oil was reported in the survey. Table II provides a breakdown by generator type of the sources of oil-containing LLW. The volumes shown are for the as-shipped wastes, including absorbents and/or solidification media. Most of the generators who reported disposing of oil wastes stated that these are stored for times ranging from several weeks to as much as several years before shipment for disposal. According to the survey results, BWRs ship the largest volume of oil-containing wastes.

TABLE II

Sources of Wastes Containing Oil

Generator Type	Volume (m^3)	Percent
Industrial	35.4	3.8
Reactor		
BWR	761.9	82.3
PWR	128.0	13.8
Total	925.3	100.0

Wastes containing organic liquid may be hazardous because they contain EPA-listed spent solvents or spent solvent mixtures,[5] or because they exhibit ignitability. The sources of wastes containing organic liquids with respect to generator type and the distribution according to waste type are shown in Tables III and IV, 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. The volumes shown are as-shipped quantities which include absorbents (or solidification medium) used in packaging the wastes.

A comparison of the survey results listed in Tables I and III 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

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

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.

TABLE III

Sources of Wastes Containing Organic Liquids

Generator Type	Volume (m^3)	Percent Distribution	Percent of LLW Reported in Survey[a]
Reactor	69.4	14.7	0.5
Non-reactor			
academic	168.6	36.5	33.2
medical	105.6	15.0	34.3
industrial	158.7	33.8	2.3
Total	502.3	100.0	2.3

[a]Organic-containing waste volumes as a percentage of total survey waste volumes from Table I.

TABLE IV

Waste Types Containing Organic Liquids

Waste Type	Volume (m^3)	Percent of Total
Scintillation liquids	91.4	18.2
Scintillation vials	259.9	51.7
Organic lab liquids	105.0	20.9
Miscellaneous solvents	46.0	9.2
Total	502.3	100.0

The last two categories were considered potential mixed wastes because they may exhibit EP toxicity. 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 V according to generator type. These are reported as weight (kg) since more than half the respondents for this category of wastes provided weight rather than volume data.

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.

TABLE V

Sources of Lead-Containing Wastes

Generator Type	Weight (kg)	Percent of Total
Reactor	35,108	64.3
Non-reactor		
academic	218	0.4
medical	372	0.7
industrial	18,897	34.6
Total	54,595	100.0

The volumes associated with these categories are shown in Table VI. 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. Because of the low solubility of Cr_2O_3 (category 3) and the low chromate concentrations reported for wastes in category 2, only the second category is likely to exhibit EP toxicity.

TABLE VI

Breakdown of Wastes Containing Chromium

Source	Volume Shipped (m^3)
Non-reactor	21.5
Reactor	
chromates used	151.5
corrosion products	2,702.8
Total	2,875.8

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. Four waste types are identified under these criteria as potential radioactive mixed wastes:

- wastes containing oil,
- 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. Oil wastes and wastes containing organic liquids do not need further evaluation, since these may be considered listed wastes. In addition, lead metal may not need further evaluation for EP toxicity. Results are to be presented at Waste Management '86 (Tucson, March 3-6, 1986) on testing of lead metal for EP toxicity.[6] A BNL study of LWRs which use chromate as corrosion inhibitors is in progress. The results of this study are expected to show whether this category of wastes is a generic concern or specific to a small set of generators.

In addition to identifying mixed wastes, appropriate methods for the management of mixed wastes must be defined. BNL recently completed a draft study[7] 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. The draft report will soon be released for public comment.

REFERENCES

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