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# OVERVIEW OF MIXED WASTE ISSUES*

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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. Concerns have emerged regarding the applicability of U.S. Environmental Protection Agency (EPA) regulations and permit requirements, under the Resource Conservation and Recovery Act (RCRA), to the potentially hazardous chemical content of some LLW, and the appropriate methods for managing such wastes. In order to establish a data base on their quantities and characteristics, Brookhaven National Laboratory (BNL) reviewed the literature(1) and conducted a limited survey of reactor and non-reactor waste generators.(2) Based on these studies, low-level wastes which are potentially hazardous under EPA regulations have been identified. A subsequent study(3) included a technical evaluation of treatment options for managing these potential mixed wastes. Management options have been evaluated for their potential to address both NRC and EPA concerns and they include regulatory or administrative actions as well as treatment or handling methods.

## REGULATORY BACKGROUND

BNL's study necessarily included a review of EPA regulations concerning the management and disposal of hazardous wastes which 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." Wastes are defined as hazardous if they exhibit one of four characteristics defined in Subpart C of 40 CFR Part 261:

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

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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 regulatory differences between NRC and EPA pertaining to LLW and hazardous waste disposal, respectively, begin with the waste designation point. For the NRC, the source, quantity, and presence of certain radionuclides in the waste can make it LLW. NRC has thus promulgated regulations directed toward disposal site and as-shipped waste package performance. For EPA, waste identification procedures must be applied to the material as generated at the time the decision to discard has been made. EPA regulates both treatment or processing, and disposal of waste once it has been identified as hazardous.

The time frame after disposal for NRC Class B and C package designs is 300 to 500 years. EPA specifies a double-lined trench design which must be monitored for 30 years; subsequent efforts to limit water infiltration are required but the projected fate of these wastes beyond the monitored period is not clear. LLW liquids must be solidified or absorbed in twice the necessary absorbent while EPA allows disposal of hazardous liquids (most are disposed of by deep-well injection). EPA will accept disposal of liquids in a landfill if packaged using the "lab pack" absorbed liquid method. Related to this, EPA does not require containerization, while NRC container requirements range from minimum (Class A) to rather extensive for HICs (Class B and C). Storage for decay (and subsequent unregulated disposal) to reduce the radiological hazard is allowed by NRC (the effectiveness of this is, of course, a function of the particular radionuclides involved). Storage of EPA hazardous wastes for longer than three months may only occur at permitted facilities and disposal is regulated. At-disposal-site inspections for waste package correspondence with the manifest is required by NRC but waste content inspection and, if necessary, analysis, is mandated by EPA. In the former case, there is concern about worker exposure to radiation hazard. In 10 CFR Part 61 NRC presents minimum requirements that non-radiological hazards of LLW be reduced to the maximum extent possible. Until recently, EPA has not specifically been concerned with LLW, while the NRC agreement states with operating LLW disposal sites have required a determination that the radiological hazard in waste exceeds the non-radiological hazard. No guidance has been given on how to quantitatively evaluate the different hazards.

Mechanisms by which regulatory authority is removed for wastes include the de minimis designation by NRC, and at present, delisting or exclusion by EPA (the establishment by EPA of the "below regulatory concern" designation is expected in the near future).

## IDENTIFICATION OF POTENTIAL MIXED WASTES

For the purpose of BNL study, mixed wastes have been defined as those wastes which are classified as LLW according to 10 CFR Part 61 and which may contain chemically hazardous materials as defined under 40 CFR Part 261. The identification of potential mixed wastes was, in general, based on an evaluation of the final waste product to be shipped for disposal, including any treatment, e.g., stabilization needed to meet 10 CFR Part 61 requirements.

BNL's literature and document review(1) and survey of LLW generators(2) focused on establishing the types and volumes of potential mixed wastes shipped to commercial LLW sites for disposal. The literature review showed a lack of consistent quantitative data on the chemical components of LLW, and a survey was conducted in order to fill this gap. The survey was directed at those LLW generators identified in the early phases of BNL's studies, as well as at larger generators whose names were provided by NRC. The survey questionnaire was designed to obtain information on any potential mixed wastes and, based on findings of earlier work, also on the presence and concentrations of various hazardous constituents such as phenols, hydrazine, cyanide, and chromates. Questionnaires were sent to 239 reactor and non-reactor generators of LLW. Of these, 97 responses were received, representing 22,000 $m^3$, or approximately 30% by volume of all LLW sent to commercial disposal sites in 1984.(2)

Table 1 summarizes the categories of potential mixed wastes identified from the survey results. The classification of oil- and solvent-containing LLW as potential mixed wastes is applicable to the wastes as-generated. A further classification as EP toxic under new EPA toxicity characteristics leaching procedure (TCLP) guidance may be pertinent as well. The solvent-containing wastes include scintillation counting fluids, lab solvents, and cleaning and degreasing solvents and sludges. The two categories of lead and chromium wastes are considered potential mixed wastes because they may exhibit EP toxicity. The applicability of the EP toxicity test for evaluating lead metal as hazardous in a LLW disposal site may be open to question.

Inclusion of annual generation total values for LLW and for EPA-hazardous wastes will aid in putting the quantity of potential mixed waste in perspective. The radioactive organic liquid category of LLW is the largest potential mixed waste category (2.3% by volume of total LLW) identified in the BNL survey.(2) Total annual commercial LLW generation represents ≈0.04% (by weight) of the annual EPA-hazardous waste total.(4) This means that the potential mixed wastes comprise a few parts in a million of total EPA-hazardous waste.

## MANAGEMENT OPTIONS FOR POTENTIAL MIXED WASTES

A number of management options may be applicable to mixed wastes. They involve either processing the waste to a form which is of concern to either NRC or EPA, but not both, or processing the waste so that both the radiological and chemical hazards will have an acceptably low probability of causing harm to man or the environment. Destruction of the chemically hazardous component or separation of the radioactive from chemically hazardous components will result in a waste product that would be of concern only to NRC. Substitution of a non-hazardous chemical in a specific process or application may limit the generation of a mixed waste. Delisting or exemption by EPA of the chemically hazardous component is another way of making a waste a concern to only NRC. Alternatively, mixed waste may become a concern exclusively to EPA if it is found that the radioactive content is at a level or concentration low enough to allow NRC regulatory action defining it as de minimis, or below regulatory concern.

Table 1

LLW Identified as Potential Mixed Wastes

| Waste Category | Tentative Hazard Classification | Percentage of Survey Total Volume[a] | Source[b] |
|---|---|---|---|
| oil-containing wastes | listed (F030)[c] | 4.2 | R,I |
| solvent-containing wastes (scintillation fluids, lab solvents, cleaning and degreasing solvents and sludges) | listed (F001 to F005) or ignitable (D001) | 2.3 | M,A,I,R |
| lead-containing wastes (shielding, containers) | EP toxic (D008) | <0.1 | M,A,I,R |
| chromium-containing wastes (LWR process wastes, system decontamination wastes) | EP toxic (D007) | 0.6[d] | R |

[a]Calculated using as-shipped volumes, which, depending on the waste category, may include absorbents, solidification agents, compactible or noncompactible trash or other packaging materials.
[b]By facility type, I = industrial, R = reactor, M = medical, A = academic.
[c]Proposed rule. Federal Register FR 50 (230) pp. 49258-70.
[d]Volume refers to light water reactor process wastes only.

## Organic Liquid Wastes

At present, none of the operating commercial low-level waste disposal sites are accepting wastes containing organic liquids. However, prior to November 1985, wastes containing organic liquids could be disposed of at the Richland, WA, site, if they had been solidified or absorbed on approved absorbents. Based on BNL's survey results organic liquids in LLW were disposed of in absorbed or solidified form. In the case of scintillation vials, liquids in small vials were packed in absorbent in order to meet the free liquid requirements of 10 CFR Part 61. The use of absorbents of LLW generators in packaging organic liquids was similar to disposal of hazardous waste in liquid form by the EPA "lab pack" method which is described in 40 CFR Section 264.316. This method involves placing small waste containers in an overpack container filled with absorbent. Currently, some organic liquid wastes are being burned as fuel.

Scintillation fluid wastes containing sufficiently low levels of C-14 and/or H-3 are classified by NRC as de minimis and are, therefore, not LLW. They can be handled by such methods as incineration at an EPA-permitted treatment, storage, and disposal facility. Extension of the de minimis classification of scintillation fluids to other wastes containing similarly low levels of isotopes would permit their management in a like manner.

Incineration is the most widely applicable destruction method for organic liquid waste. It may yield residues which can be secondary wastes and may require another treatment step. In the case of liquid organic wastes for which destructive methods eliminate the chemical hazard, the residue will not be a mixed waste, but simply LLW.

Immobilization methods for the treatment of organic liquid wastes can include sorption or solidification. Sorption of liquid by diatomaceous earth, vermiculite, clay products, and natural or artificial fiber products is considered solidification by members of the chemically hazardous waste-handling community. Solidification, according to the meaning of 10 CFR Part 61, refers to fixation or immobilization of either liquids or dispersible solids in a solid monolithic waste form. The solidification agents or binders most commonly used for LLW are Portland cement and other inorganic cements.

## Oil Wastes

EPA published a proposed rule listing used oil as a hazardous waste on November 29, 1985. When this rule becomes final, radioactively-contaminated oil wastes would be potential mixed wastes. Absorbents and solidification agents are currently used to process LLW oil for disposal. Some waste generators mix LLW oil with other wastes, such as organic lab liquids, degreasing solvents and aqueous wastes, before or during packaging for disposal. Specific disposal site license conditions, however, restrict the acceptance of wastes containing oil for disposal. For example, the Barnwell, SC, LLW disposal site will accept packages containing only incidental or trace amounts of absorbed oil not exceeding 1% of the waste volume. The Richland, WA, LLW disposal site currently accepts LLW oil for disposal. It is likely that as of May, 1986, the license for the Richland facility will require stabilization of all wastes containing >10 volume percent oil. Sorption will be acceptable for disposal of LLW containing <10 volume percent oil.

Of the options for treatment of waste oil, incineration appears to be an applicable destructive method. However, the residue may contain inorganic hazardous constituents in addition to radionuclides which may render the residue a mixed waste. Sorption and solidification are, in principle, applicable to LLW oil. Another alternative for the management of LLW oil would be the development of de minimis levels of radionuclide concentrations below which the waste oil is no longer a LLW. In such an event, waste oils may be suitable for burning as a used oil, fuels in boilers and industrial furnances according to EPA regulations.

### Lead Wastes

Lead wastes are of concern for their potential EP toxicity. They may be divided into two groups: those in which the lead is an integral part of a waste package and serves as shielding to minimize the radiation from contained wastes (usually discarded sources), and those in which the land is itself contaminated. Destruction of lead is not an option; decontamination and immobilization appear to be the principal viable management options for these wastes. High integrity containers may be used for the immobilization of lead-containing wastes. Such a disposal option may be consistent with EPA objectives, given a period of performance for lined trenches of 30 years, whereas the design lifetime of a HIC is at least 300 years.

For the purpose of assessing the potential mixed waste hazard posed by metallic lead, the EP toxicity test and the TCLP test may not be generally representative of the environment of buried waste in a LLW disposal facility. The EPA prescribed tests were devised to assess the potential for the leaching of certain specified contaminants from potentially hazardous waste disposed of in an actively decomposing municipal landfill. The leachants for the EP toxicity test and the TCLP have pH values between 3 and 5, whereas LLW disposal site trench waters are generally neutral or slightly alkaline, usually having pH values greater than 5. An assessment of the hazard posed by metallic lead may have to be done on a site-specific basis for each LLW disposal facility.

### Chromium-Containing Wastes

Process wastes from light water reactors which use chromates as corrosion inhibitors were considered likely potential mixed wastes. These process wastes can be in the form of organic ion-exchange resins or evaporator bottoms. A follow-up telephone survey indicated that chromate use was more widespread than reported in the initial survey results. However, in all cases, chromates were used in normally nonradioactive systems. Plant management practices are directed at keeping these systems isolated and preventing the release of chromate-containing liquids to radwaste cleanup systems. Thus, the potential for LWR process wastes to contain chromates is lower than originally assumed in the survey analysis.

Solidification is a common management practice for ion-exchange resin wastes and evaporator concentrates. Cement is a typical solidification agent but bitumen and thermosetting polymers can also be used. Ion-exchange resins are also being disposed of in high integrity containers. Substitution of a non-hazardous corrosion inhibitor for chromate is a management option that is being considered by some plant operators.

Miscellaneous Wastes

On the basis of the BNL survey, it must be assumed that many generators will produce small amounts of waste which may contain some hazardous constituents (i.e., compounds listed in 40 CFR Part 261, Appendix VIII). Responses to the survey indicated that the listed constituents are likely to be present in trace amounts or relatively low concentrations, and to be in either the organic liquid waste or in general LSA trash (paper, contaminated rubber gloves, lab clothing, glassware, etc.).

Generators of these wastes will have the same options as apply to liquid organic wastes. For generators that produce small amounts of hazardous or acutely hazardous constituents, a useful option could be chemical destruction on a laboratory scale. It has been pointed out in "Prudent Practices for Disposal of Chemicals from Laboratories"[5] that laboratory destruction of the hazardous characteristic of a chemical compound, including destruction of Appendix VIII constituents, is part of an experiment, not treatment in the regulatory sense. Thus, if applied as a management option, it can minimize the generation of mixed wastes (although it may still be low-level radioactive waste). The options available for lead (immobilization and recovery or reclamation) will in general be applicable to other inorganic wastes.

## CONCLUSIONS

Based on BNL's study it was concluded that there are LLWs which contain chemically hazardous components. Scintillation liquids may be considered an EPA listed hazardous waste and are, therefore, potential mixed wastes. Since November, 1985 no operating LLW disposal site will accept these wastes for disposal. Unless such wastes contain *de minimis* quantities of radionuclides, they cannot be disposed of at an EPA permitted site. Currently generators of LSC wastes can ship *de minimis* wastes to be burned at commercial facilities. Oil wastes will also eventually be an EPA listed waste and thus will have to be considered a potential radioactive mixed waste unless NRC establishes *de minimis* levels of radionuclides below which oils can be managed as hazardous wastes. Regarding wastes containing lead metal there is some question as to the extent of the hazard posed by lead disposed in a LLW burial trench. Chromium-containing wastes would have to be tested to determine whether they are potential mixed wastes.

There may be other wastes that are mixed wastes; the responsibility for determining this rests with the waste generator. It is believed that there are management options for handling potential mixed wastes but there is no regulatory guidance. BNL has identified and evaluated a variety of treatment options for the management of potential radioactive mixed wastes. The findings of that study showed that application of a management option with the purpose of addressing EPA concerns can, at the same time, address stabilization and volume reduction concerns of NRC.

## REFERENCES


1. B. S. Bowerman, R. E. Davis, and B. Siskind, "Document Review Regarding Hazardous Chemical Characteristics of Low-Level Waste," NUREG/CR-4433, BNL-NUREG-51936, January 1986.

2. B. S. Bowerman et al., "An Analysis of Low-Level Wastes: Review of Hazardous Waste Regulations and Identification of Radioactive Mixed Wastes," NUREG/CR-4406, BNL-NUREG-51933, November 1985.

3. C. R. Kempf et al., "Management of Radioactive Mixed Wastes in Commercial Low-Level Wastes," NUREG/CR-4450, BNL-NUREG-51944, published for public comment, January 1986.

4. J. P. Lehman, "Scientific Basis for Hazardous Waste Disposal," paper presented at the Annual Meeting of the National Council on Radiation Protection and Measurements, Washington, D.C., April 3-4, 1985.

5. Committee on Hazardous Substances in the Laboratory, Robert A. Alberty, Chairman, Commission on Physical Sciences, Mathematics and Resources, National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, D.C., 1983.