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SUMMARY OF BNL STUDIES REGARDING COMMERCIAL MIXED WASTE*

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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, 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. They include regulatory or administrative actions as well as treatment or handling methods.

REGULATORY BACKGROUND

EPA regulations concerning the management and disposal of hazardous wastes are contained in 40 CFR Parts 260 to 270. The regulation 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 toxicity.

Testing must be conducted to determine whether wastes exhibit any of these hazardous characteristics. The toxicity characteristic was recently revised(4) and involves a leach procedure followed by leachate analysis for 8 metals and 44 organic constituents. In addition to these

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characteristics, wastes are hazardous if they correspond to one of the waste streams 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, and 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.

There are significant differences between the hazardous waste management system promulgated by EPA and the regulation of LLW disposal by NRC. These differences involve disposal site design and performance objectives, post-closure monitoring, waste package and container requirements, inspection of waste packages on arrival at the disposal site, and permitting requirements.

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's 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 ($\approx$780,000 ft^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. Oil-containing wastes would become potential mixed wastes under a proposed EPA rulemaking (see footnote C in Table 1). The classification of solvent-containing LLW as potential mixed wastes is applicable to the wastes as-generated. A further classification as toxic under the proposed toxicity characteristic leaching procedure (TCLP) may be pertinent as well.(4) 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 toxicity under the TCLP. The applicability of the TCLP for evaluating lead metal as hazardous in a LLW disposal site may be open to question.

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 subject to either NRC or EPA regulations, 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 components or separation of the radioactive from chemically hazardous components will result in a waste product that would be considered LLW, and not mixed waste. Substitution of a non-hazardous chemical in a specific process or application may limit the generation of a mixed waste. Alternatively, some mixed waste may become hazardous waste 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[d]	listed (F001 to F005) or ignitable (D001)	2.3	M,A,I,R
lead-containing wastes[e]	toxic (D008)	<0.1	M,A,I,R
chromium-containing wastes[f]	toxic (D007)	0.6[g]	R

[a]Calculated using as-shipped volumes, which, depending on the waste category, may include absorbents, solidification agents, compactible or non-compactible 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]Scintillation fluids, lab solvents, cleaning and degreasing solvents and sludges.
[e]Shielding or containers.
[f]LWR process wastes or system decontamination wastes.
[g]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. BNL's survey results indicated that in 1984 organic liquids in LLW were disposed of in absorbed or solidified form and that scintillation vials were packed in absorbent in order to meet the free liquid requirements of 10 CFR Part 61. These methods of packaging LLW organic liquids are similar to disposal of hazardous waste liquids by the EPA "lab pack" method described in 40 CFR Section 264.316, which involves placing small waste containers in an overpack container filled with absorbent. Immobilization through the use of solidification agents or absorbents may prove to be an acceptable treatment option for organic liquid wastes. It may be necessary to show that the final waste form is not toxic using the TCLP.

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 incineration at an EPA-permitted facility. Extension of the _de minimis_ classification 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 liquids. However, the ash residues may require additional treatment if they exhibit toxicity under the TCLP. 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.

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. The Barnwell, SC, LLW disposal site will accept packages containing only incidental or trace amounts of absorbed oil (<1% of the waste volume). The Richland, WA, LLW disposal site currently accepts LLW oil for disposal. As of May, 1986, the license for the Richland facility requires 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.(5) However, ash residues 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. *De minimis* waste oils could then be managed according to EPA regulations only.

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 lead 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 (HICs) 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 TCLP may not be generally representative of the environment of buried waste in a LLW disposal facility.(5) The EPA prescribed tests which were devised to assess the potential for the leaching of specific contaminants from 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 potential EP (or TCLP) toxic 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 radioactively-contaminated LWR process wastes to contain chromates is lower than assumed in the original survey analysis.(5)

Immobilization by solidification in binders such as cement, bitumen, or thermosetting polymers is one option available for the treatment of LLW which is toxic (as determined by the TCLP) due to chromates. It would have to be shown that the final waste form is not toxic under the TCLP. Solidification is a common management practice for ion-exchange resin wastes and evaporator concentrates. Chromate-containing ion-exchange resins packaged in HICs may also be an acceptable option. 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"(6) 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 the residues 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 liquid scintillation wastes can ship de minimis wastes to be burned at commercial facilities. Oil wastes may 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. While management options for handling potential mixed wastes are available, there is limited regulatory guidance for generators. 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.

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