UNDERSTANDING THE PROBLEMS ASSOCIATED WITH MANAGING COMMERCIAL MIXED LOW-LEVEL RADIOACTIVE WASTE

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ABSTRACT

Commercial mixed low-level radioactive waste (LLW) is difficult and in some cases impossible to manage. No disposal capacity is available for the waste and commercial treatment capacity is generally also unavailable. Without available treatment and disposal capacity, mixed LLW generators cannot receive a storage permit in most cases. This catch-22 applies to mixed LLW containing an organic solvent, a dioxin, or a hazardous constituent on the California List. Other hazardous constituents in mixed LLW will face the same dilemma after May 1992. The Environmental Protection Agency and the Nuclear Regulatory Commission need to take immediate action to address this dilemma.

INTRODUCTION

A small portion of LLW contains constituents classified as hazardous under the Resource Conservation and Recovery Act (RCRA) of 1976. Until 1985, most of this waste was disposed of in commercial LLW disposal facilities. After 1985, none of the three operating LLW disposal sites have accepted mixed LLW, although it continues to be generated. Mixed LLW disposal facilities in the future will be licensed jointly by the Nuclear Regulatory Commission (NRC) and the Environmental Protection Agency (EPA) or by states with NRC/EPA licensing/permitting authority. Some of these agencies' regulations covering mixed LLW are inconsistent or duplicative. Moreover, some regulations are unattainable.

Since disposal capacity does not exist for mixed LLW, most generators are using all available management techniques to alter their practices so that they generate either exclusively radioactive waste or exclusively hazardous waste. By doing so, disposal of the waste is possible. Some practices that generate mixed LLW, however, cannot be so altered and a mixed LLW remains. Under EPA regulations, treatment of the waste is then required, but generally is unavailable commercially. An ad hoc survey indicates that the cumulative volume of stored mixed LLW at generating facilities is not rising, even though disposal capacity has not been available since 1985(1). It is unclear where the waste is going.

To understand the problems concerning mixed LLW management, four questions are addressed: 1) Who generates what types of mixed LLW?; 2) How are generators managing mixed LLW?; 3) For which types of mixed LLW are management options unavailable and, therefore, regulations unattainable?; and 4) How can these regulatory problems be resolved?

WHO GENERATES WHAT TYPES OF MIXED LOW-LEVEL WASTE?

The full range of LLW generators (e.g., nuclear power plants, medical and academic institutions, and various industries such as pharmaceutical and biotechnology firms) and LLW processors produce mixed LLW. Several studies performed in the mid-1980s indicate that about 3 to 10 percent of all commercial LLW is mixed LLW.

The hazardous constituents in mixed LLW typically include: organic chemicals, lead, waste oil, aqueous corrosive liquids, chromates, and cadmium. Practices responsible for generating these waste types are listed in Table I.

HOW IS MIXED LOW-LEVEL WASTE MANAGED?

The absence of disposal capacity has pressured mixed LLW generators in looking for waste minimization techniques that avoid waste generation. As mentioned, these generators try to treat the waste so that it is either solely radioactive or solely hazardous when its initial generation cannot be avoided. The generator can then ship the waste to either a LLW disposal site or a hazardous waste landfill. Furthermore, EPA requires that a mixed LLW generator treat the hazardous constituent in the waste, following a specified treatment standard, before disposing it. However, the facility necessary to meet these standards is often inaccessible or nonexistent. Once EPA has fully developed and begins to enforce these standards, it will pressure industry to build the necessary facilities to meet the standards, and the use of waste minimization and treatment techniques will likely increase further.

With respect to waste minimization, substitution techniques can eliminate or drastically reduce the amount of radioactive material used, and in-plant processes can be modified to reduce the quantity of waste generated. For example, toluene and xylene are often replaced with non-hazardous fluids in scintillation cocktails. A radioactive, but non-hazardous, waste is in turn generated, which can be shipped to a LLW disposal site.

After waste minimization techniques are used to the extent practicable, generators treat their mixed LLW to reduce the volume and to reduce handling, shipping, storage, and disposal costs. For example, liquid mixed LLW is concentrated through evaporation, ion-exchange, filtration,

precipitation and centrifuging, and distillation. Solid waste is sorted to ensure that the mixed LLW is both hazardous and radioactive. Solid mixed LLW is also decontaminated using several techniques.

TABLE I
MIXED LLW GENERATION PRACTICES

Organic chemicals are produced by the full range of LLW generators. Scintillation fluids, which are used in diagnostic tests and general laboratory counting procedures for environmental and facility monitoring, comprise the largest volume of mixed LLW. These fluids typically contain toluene and xylene. Organic chemicals are also generated by industries during the manufacture of sealed sources, pharmaceuticals, radiopharmaceuticals, and diagnostic tests. Industries and nuclear power plants use organic chemicals, such as acetone and chlorofluorocarbons (CFCs), commonly referred to as freon, for cleaning protective clothing, tools, equipment, and instrumentation. Trash can also be contaminated with organic chemicals.

Lead becomes radioactively contaminated when it is used to store radioactive materials in a shielded container or to shield workers from radiation exposure during product manufacturing and laboratory research. This lead may be in the form of foil, sheets, bricks, or containers for storage or shipping. If lead is decontaminated, the cleaning solutions containing dissolved lead and radioactive material will also be classified as a mixed LLW.

Cadmium waste can be radioactively contaminated at a nuclear power plant when welding rods containing cadmium are used. Equipment with such welds and the liquids and solid materials used to clean such equipment may also be contaminated with cadmium. This waste may not be found to be a mixed LLW if it passes the EPA leachability test.

Chromates are used by some nuclear power plants to inhibit corrosion in water circulation systems. When the water purification resins are periodically changed, they will be considered mixed LLW if they fail the EPA leachability test.

Waste oil from pumps and other equipment that are located in radioactive areas is generally contaminated. Such waste oil and oily trash, principally from radioactively contaminated machine shops, are considered hazardous under some state regulations. EPA is currently making a determination on whether waste oil will be listed as a hazardous waste.

Source: Adapted from *Partnerships under Pressure: Managing Commercial Low-Level Radioactive Waste – A Special Report*, U.S. Congress, Office of Technology Assessment, OTA-O-427, (Washington, DC: U.S. Government Printing Office, November 1989).

Table II lists all waste minimization and treatment techniques currently in use for all known types of mixed LLW. Results from an ad hoc survey of mixed LLW generators indicate that technology transfer is not occurring between different types of generators to the degree possible(1). Such transfer of information could greatly reduce the current generation of mixed LLW. Where the term "long-term storage" appears on Table II, either a minimization and/or treatment technique used at another facility needs to be transferred or such a technique is currently unavailable. For example, several treatment techniques are available for non-mixed LLW, but not for mixed LLW. Most notable is that a commercial incinerator is not available for mixed LLW.

FOR WHICH TYPES OF MIXED LOW-LEVEL WASTE ARE MANAGEMENT OPTIONS UNAVAILABLE AND, THEREFORE, REGULATIONS UNATTAINABLE?

No commercial treatment facility is generally available for mixed LLW, yet treatment standards are in effect for mixed LLW containing organic solvents, dioxins, and any hazardous constituent on the California List. The California List includes free cyanides, corrosives, hazardous waste mixed with polychlorinated biphenyls, and certain metals (i.e., arsenic, cadmium, chromium, lead, mercury, nickel, thallium, and selenium). An EPA treatment standard may be expressed as a specified technology (e.g., incineration), as a total concentration in the waste, or as a concentration in the waste extract by using an EPA leaching test. In all cases, these treatment standards are based on the performance of the best demonstrated available technology (BDAT).

There are two types of mixed LLW identified for which treatment is necessary or may be necessary, but a treatment facility is unavailable. First, organic chemicals, in some cases, can be distilled and the nonradioactively contaminated chemical can be concentrated for reuse. Nonetheless, the residue is still a mixed LLW. Examples of such chemicals are toluene and xylene used in manufacturing pharmaceuticals and chlorofluorocarbons (CFCs) used in dry cleaning clothing and cleaning tools and equipment. For the most part, organic chemical mixed LLW falls into the solvent category, and the BDAT for solvents is incineration. No commercial incinerator, however, is available to treat organic chemical mixed LLW. Furthermore, EPA did not consider possible radioactive constituents in developing hazardous waste standards. Some organic chemicals contain high concentrations of radionuclides (e.g., tritium and carbon-14) that would escape through a conventional off-

TABLE II
Summary of Mixed LLW Generation Practices

	GENERATOR COMMUNITY							
	Industrial facilities					**Medical/academic institutions**		**Nuclear power plants**
TYPE OF MIXED LLW	Pharmaceutical manufacturing	Biotechnology manufacturing	Other manufacturing	Spent fuel storage	Waste processor	Medical/clinical & research	University nonmedical research	
Liquid scintillation cocktails or fluids	Substitute environmentally benign fluids Store for decay Declare BRC Revise procedures Long-term storage	Store for decay Declare BRC	Substitute environmentally benign fluids Store for decay Declare BRC	NA	Liquid released as nonradioactive waste	Substitute environmentally benign fluids Store for decay Declare BRC	Substitute environmentally benign fluids Store for decay Declare BRC Revise procedures Long-term storage	Reclaim solvent and incinerate Substitute environmentally benign fluids Manage as radioactive waste Long-term storage
Organic chemicals	Substitute nonhazardous materials Revise procedures Store for decay Long-term storage	Justify use Store for decay	Substitute environmentally benign fluids Store for decay Improve inventory practices Long-term storage	NA	NA	NA	Education Notification prior to use Justify use Long-term storage	Recycle Substitute other materials Manage as radioactive waste Long-term storage
Trash with organic chemicals	NA	Store for decay	NA	NA	NA	NA	NA	NA
Lead	Use nonlead containers Long-term storage	Decontaminate	Long-term storage	NA	Decontaminate Use coated lead	Use nonlead containers Minimize use of containers Long-term storage	Use nonlead containers Minimize use of containers Long-term storage	Decontaminate (onsite or at waste processor) Long-term storage
Lead decontamination solutions	NA	NA	NA	NA	Solidify	NA	NA	NA
Waste oil	NA	NA	Solidification	NA	Filtration Solidification Incineration	NA	Long-term storage	Filtration Solidification Incineration
Trash with oil	NA	NA	NA	NA	NA	NA	NA	Manage as radioactive waste
Chlorofluorocarbon (CFC) solvent	NA	NA	NA	NA	NA	NA	NA	Manage as radioactive waste Recycle solvent Long-term storage
CFC concentrates	NA	NA	NA	NA	Long-term storage	NA	NA	Manage as radioactive waste Delist Long-term storage
Aqueous corrosive liquids	NA	NA	NA	Long-term storage	NA	NA	NA	NA
Chromate waste	NA	NA	NA	NA	NA	NA	NA	Manage as radioactive waste
Cadmium waste	NA	NA	NA	NA	NA	NA	NA	Delist by solidification Manage as radioactive waste

NA = Not applicable

SOURCE: Rogers & Associates Engineering Corp., "Management Practices and Disposal Concepts For Low-Level Radioactive Mixed Waste," RAE-8830-1, contractor report prepared for the Office of Technology Assessment, March 1989, p. 2-17.

gas filtering system used in incinerators. Newly designed incinerators or completely new techniques (e.g., some water-based thermal oxidation process, like supercritical water oxidation, or some new stabilization technique) may be needed to treat these wastes.

Second, waste oil may be a problem with respect to treatment. If EPA decides that waste oil is a RCRA-listed hazardous waste, the overall volume of mixed LLW will dramatically increase. All generators of mixed LLW oil will have to meet the established treatment standard, and the BDAT to meet this standard will likely be incineration. Based on comments from some generators, it appears unlikely that filtration will successfully work in all cases for separating radioactive particulates from oil. Therefore, incineration will be required. As with organic chemicals, no commercial mixed LLW incinerator is available.

If treatment capacity is to be developed commercially for these wastes, generators of "like" wastes will have to group together and pressure the waste treatment industry to develop the necessary treatment facilities. However, for six reasons, the industry is reluctant to develop mixed LLW facilities. First is lack of data. Without a national survey on mixed LLW volumes and types, industry will have difficulty meeting market needs. Second is the possibility that state compacts could attempt to restrict the import and export of waste for treatment, thereby limiting waste volumes and making the development of a treatment facility economically unviable. Third is the long licensing period expected for receiving a permit to operate such a facility. Fourth is the reluctance of facility operators to contaminate the internal mechanisms of their machinery with radioactivity. Fifth, is the opposition of some public interest groups to siting such facilities. Sixth, is the problem that no generator has found a technology in the research and development phase, much less available commercially, that can handle certain types of mixed LLW (e.g., organic solvents with high concentrations of tritium and carbon-14).

A generator of mixed LLW for which no treatment capacity is available has two other potential options for treating its waste. First, it can submit a "no migration" petition, for which a generator must demonstrate that disposal of this waste, without being treated first, will result in no migration. However, no such variance for mixed LLW has been granted to date. Second, a generator can apply for a case-by-case extension for 1 year, renewable for 1 year. To receive this extension, the generator must be able to demonstrate that a good-faith effort has been made to locate and contract with facilities nationwide to manage its waste. In addition, the contractor must have a binding contract with a treatment facility operator/developer that will construct or otherwise provide alternative treatment, recovery, or disposal capacity for the waste. The contract must ensure that this capacity will be available at the end of the extension period. Since no such treatment facility is operational or, to date, is even planned, this second option appears unfeasible. If storage of such wastes extends significantly, excessive radiation exposures to workers could result if adequate storage conditions are not maintained and waste packages degrade.

The result of considering these "options" forces generators into ceasing the practice that produces the mixed LLW or into simply storing their waste. Storage, however, is prohibited for any period longer than that needed to accumulate enough volume to "facilitate proper recovery, treatment, and disposal" (40 CFR Part 268). Since no commercial treatment facility or disposal facility is available for certain problem mixed LLW, storage in all likelihood would not be allowed. It should be noted that storage prohibitions do not apply in states that have base RCRA authorization but have not yet received mixed waste authorization. Mixed waste is a provision under RCRA, and EPA is not responsible for regulating a particular provision during the period while the state is waiting to receive authorization for it. Therefore, during this interim period before a state is granted mixed waste authorization, the storage prohibition does not apply unless a state law establishes the prohibition. As of January 1990, Guam and eleven states had mixed waste authorization: South Carolina, Washington, Tennessee, Colorado, Georgia, Kentucky, Utah, Minnesota, Ohio, North Carolina, and Michigan.

In states where storage is not allowed, generators of mixed LLW are left with no options but to stop generating the waste or to ignore the storage prohibition. Without a solution to this problem, states or EPA could prohibit generators from producing mixed LLW or to cease operation. Services provided by nuclear utilities, pharmaceutical manufacturers, and research and medical institutions could be crippled.

Another problem with mixed LLW management is that EPA has not established all treatment standards for hazardous waste. EPA's land disposal restrictions will not apply to hazardous constituents other than organic solvents, dioxins, and the constituents that are on the California List until May 1992. EPA proposed a 2-year national capacity variance in November 1989 for these wastes. This proposed rule is scheduled to be final in May 1990.

Even without the mixed LLW problems that may occur after May 1992, mixed LLW generators are still faced today with one major waste problem -- the management of organic chemicals. Treatment standards are in effect for waste containing these constituents, and yet often the standards cannot be met. Since a comprehensive national survey has

not been conducted to determine all the possible types of mixed LLW, it is unclear what other types of mixed LLW are not treatable or will not be treatable after May 1992.

WHAT POLICY OPTIONS ARE AVAILABLE FOR REGULATING MIXED WASTE?

As a remedy to this catch-22 concerning no viable option for managing mixed LLW containing organic solvents, dioxins, or constituents on the California List, EPA could consider allowing generators to store this waste until treatment and disposal facilities are developed(2). EPA could require that generators demonstrate their diligence to ensure that these facilities are developed as a condition for permitting such storage. EPA would have authority to stop waste storage if a generator fails to demonstrate progress. An advantage to this approach is that, as generators apply for a storage permit, EPA would learn what types and volumes of mixed LLW are being generated. EPA could use the data to better ensure that wastes are not being illegally disposed; the waste treatment industry could use the data as a marketing tool to develop necessary waste treatment facilities.

In an EPA proposed rule (Land Disposal Restrictions for Third Scheduled Wastes, 54 Federal Register 48372, Nov. 22, 1989), EPA requests comments on an alternative approach for prohibiting storage; the storage prohibition would only apply if storage is surrogate disposal. This more relaxed interpretation of storage prohibition could help resolve the current catch-22 situation that mixed LLW generators are facing.

The NRC, EPA, and DOE may wish to consider providing some funding to support the research and development of treatment options for these problem wastes. In particular, monies within DOE's technical assistance program for states could be redirected to support this research. Special attention could be given to treatment technologies for organic chemicals containing high concentrations of carbon-14 and tritium(2).

The EPA and NRC could develop an active interagency task force under Congressional oversight to regulate mixed LLW management. The current NRC-EPA Interface Council, which was formed to address mutual concerns, could be expanded, or a new task force could be formed with members from both agencies. Congress, in its agency oversight capacity, could request such a task force to develop joint rulemaking or joint guidance on mixed LLW issues where compromises between the two agencies are needed.

Congress could forward a tight agenda to the task force. The agenda could contain milestones that address regulations that are not attainable and resolve possible inconsistencies and duplication among agency regulations. Regulatory issues listed in Table III could be addressed through joint rulemaking or joint guidance.

TABLE III
MIXED LLW REGULATORY ISSUES REQUIRING ATTENTION

Regulations that are Currently Unattainable

* certain treatment standards
* storage prohibition

Possible Regulatory Conflicts and Inconsistencies

* waste sampling and testing
* facility inspection and enforcement
* timing conflict between EPA location standards and LLW disposal siting efforts
* timing conflict between states being granted mixed waste authorization and states' schedules in developing LLW disposal facilities

Regulatory Overlap and Duplication

* procedures for determining inconsistencies between Atomic Energy Act and RCRA
* below regulatory concern limits for specific wastes
* facility design variance procedures
* waste package manifest requirements
* licensing and permitting procedures
* recordkeeping
* financial assurance requirements
* facility monitoring requirements
* emergency preparedness and prevention requirements
* post-closure failure scenarios
* remediation

Source: Adapted from Partnerships under Pressure: Managing Commercial Low-Level Radioactive Waste -- A Special Report, U.S. Congress, Office of Technology Assessment, OTA-O-427, (Washington, DC: U.S. Government Printing Office, November 1989).

Congress could also request that the task force report on additional areas where rulemaking or guidance is needed. This task force could decide that all the issues are resolvable through joint rulemaking or joint guidance, or it could decide that legislation is needed. If legislation is

needed, Congress will be better informed after the task force makes its recommendations than it is now to determine which issues need to be resolved by law.

REFERENCES

1. Rogers and Associates Engineering Corporation, "Management Practices and Disposal Concepts for Low-Level Radioactive Mixed Waste -- A Background Report," contractor report prepared for the U.S. Congress, Office of Technology Assessment (May 1989).
2. Office of Technology Assessment, "Partnerships under Pressure: Managing Commercial Low-Level Radioactive Waste -- A Special Report," U.S. Congress, OTA-O-427, (Washington, DC: U.S. Government Printing Office, Nov. 1989).