MIXED WASTE MANAGEMENT OPTIONS*

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ABSTRACT

Currently, limited storage and treatment capacity exists for commercial mixed waste streams. No commercial mixed waste disposal is available, and it has been estimated that if and when commercial mixed waste disposal becomes available, the costs will be high. If high disposal fees are imposed, generators may be willing to apply extraordinary treatment or regulatory approaches to properly dispose of their mixed waste. This paper explores the feasibility of several waste management scenarios and management options.

Existing data on commercially generated mixed waste streams are used to identify the realm of mixed waste known to be generated. Each waste stream is evaluated from both a regulatory and technical perspective in order to convert the waste into a strictly low-level radioactive or a hazardous waste. Alternative regulatory approaches evaluated in this paper include a delisting petition, no migration petition, and a treatability variance. For each waste stream, potentially available treatment options are identified that could lead to these variances. Waste minimization methodology and storage for decay are also considered. Economic feasibility of each option is discussed broadly.

Another option for mixed waste management that is being explored is the feasibility of Department of Energy (DOE) accepting commercial mixed waste for treatment, storage, and disposal. A study has been completed that analyzes DOE treatment capacity in comparison with commercial mixed waste streams.

INTRODUCTION

There currently are no mixed waste disposal and treatment facilities existing to manage much of the nation's mixed waste in accordance with 40 CFR 268 requirements. Because of the low volume projections for this special type of low-level waste, one State has reported that the potential disposal cost of a single cubic foot of Class A mixed waste could be on the order of $15,000, exclusive of treatment. This estimated cost is approximately 100 times higher than the cost of disposing of nonhazardous, Class A low-level radioactive waste at a similar location. This discrepancy has prompted at least one State to question whether generators of mixed waste will likely find less expensive ways to manage their mixed waste, thereby avoiding land disposal of the waste entirely. By evaluating regulatory constraints, mixed waste inventory, mixed waste minimization options, and potential treatment options and their costs, this paper helps identify what mixed wastes cannot be managed out of existence.

REGULATORY CONSTRAINTS

Classification of low-level radioactive waste is described in 10 CFR 61. Low-level radioactive waste contains source, special nuclear, or by-product material that is not classified as high-level radioactive waste, spent nuclear fuel, or by-product material as defined in Section 11e(2) of the Atomic Energy Act (AEA). Regulations given in 40 CFR 260 and 261 provide guidance to the regulated community and authorized State representatives on the definitions of solid and hazardous waste. The regulatory definition of hazardous waste is derived from Congress' definition in Resource Conservation and Recovery Act (RCRA), Section 1004(5). Mixed waste is low-level radioactive waste regulated under the AEA that also contains a hazardous waste component regulated under the RCRA.

Disposal of this waste must satisfy both sets of requirements unless the waste can be treated or justified to fall under one or the other set of requirements. For example, if mixed waste can be treated to remove the radioactive portion of the waste, the waste is no longer classified as a mixed waste and can be disposed of in a hazardous waste facility.

The Environmental Protection Agency (EPA) developed and published criteria to identify characteristics of hazardous waste and to list wastes to be regulated. In developing these criteria, EPA had to consider the toxicity, persistence, biodegradability, and potential for bioaccumulation of waste material. Waste listed under 40 CFR 261 (3) can be "delisted" under certain requirements and be disposed of as low-level radioactive waste.

METHODOLOGY

Three studies will be outlined in this paper. The purpose of study number 1--Mixed Waste Management Options was to evaluate the feasibility of managing all mixed waste as either hazardous waste or radioactive waste. Regulatory options such as delisting, no migration petition, and treatability variances were considered. Technical options such as treatment and waste avoidance were also considered.

For this study, it was assumed that no land disposal facility was available for the management of commercial mixed waste. Therefore, if the waste were to be disposed of, all types and classes of mixed waste would need to be converted to either solely low-level radioactive waste or solely hazardous waste.

Two compact regions having relatively recent and complete information on mixed waste generation were selected to

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provide a representative cross-section of the types of mixed waste requiring disposal. The National Institutes of Health mixed waste streams were also used to provide more comprehensive data on medical research waste.

Each waste stream was categorized by EPA waste code and radioactive waste class. Additional information, such as waste form or radionuclide concentration, was also used to categorize the existing waste types. The evaluation generally followed the steps outlined in Fig. 1, Mixed waste management schematic.

FEASIBILITY OF REGULATORY OPTIONS

The hazardous component of the characteristic mixed waste can be removed through treatment of the characteristic of the waste by complying with the mandatory requirements imposed through RCRA's land disposal restrictions. This waste can be disposed of in a low-level radioactive waste disposal facility because the characteristic portion of the mixed waste has been eliminated. Listed waste, however, remains listed even after mandated treatment under RCRA's land disposal restrictions. This listed waste must still be disposed of as listed waste under RCRA, regardless of the effectiveness of such treatment. For listed waste to be disposed of as solely radioactive waste, it must first be "delisted," as prescribed in 40 CFR 260.20 and 40 CFR 260.22.

EPA has recognized that a listed waste from a particular facility may not actually be hazardous. This situation may occur if

- The waste does not contain the components or exhibit the characteristics for which it was originally listed.
- The waste contains the components at relatively low levels.
- The listed components are present in an immobile form.

The regulations pertaining to delisting require demonstrations that the treated waste is no longer hazardous and, therefore, is not required to be managed in a land-based unit meeting RCRA standards. Requirements for delisting include the following:

- Detailed description of the manufacturing process or other operations that produced the listed waste
- A description of the waste and an estimate of the average and maximum monthly and annual quantities of waste covered by the demonstration
- Test results on representative samples
- A list of all materials used in the manufacturing or other operating processes that produce the waste (examples include raw materials, intermediate products, by-products, products, oils and hydraulic fluids, and surface preparation materials)
- Groundwater monitoring data.

The cost of delisting averages $100,000 to $350,000 per petition. The time to process a delisting petition is approximately two years. At the present time, there have been no mixed waste delisting petitions submitted, and the success rate of delisting petitions overall is 12%. In addition to the cost and time involved in developing a delisting petition, the petition must be site and waste specific. Extensive waste analysis must be performed. If a waste stream changes in any way, the existing petition cannot be used.

One waste treatment facility has expressed the interest in developing a delisting petition for certain representative mixed waste streams. This will decrease the cost of individual mixed waste generators delisting their waste streams.

The regulations provide other options for waste management. A no migration variance is a formal decision that can be rendered by EPA to allow land disposal at a particular facility of specific, prohibited wastes (including mixed wastes) that do not meet the treatment standards established by EPA under 40 CFR 268. For example, if a disposal facility could qualify for a "no migration" variance [40 CFR 264.301 (d)], the disposal facility would not be required to have a dual liner, leachate collection system. These minimum technical facility requirements cause much of the additional cost of mixed waste disposal. Similarly, if the untreated waste could be demonstrated not to migrate from the disposal facility, it may be exempted from treatment requirements (40 CFR 268.6). Additionally, a treatability variance may be used to provide treatment better suited to a unique or hard-to-treat waste.

Information requirements for obtaining a successful no migration variance will vary considerably depending on the type of facility and the approach chosen to demonstrate that migration will not occur. The critical components that should be included in the application are

- Waste description
- Facility description
- Site Characterization
- Monitoring plans
- Waste mobility monitoring
- Assessment of environmental impacts
- Prediction of infrequent events
- Quality assurance and quality control plans.

To qualify for a no migration petition, it is estimated that the cost will range from $100,000 to $500,000 and will take a minimum of two years to gain approval. One no migration petition that has been approved for mixed waste is at the Waste Isolation Pilot Plant in Carlsbad, NM.

The third type of regulatory option is a treatability variance under 40 CFR 268. It allows alternative or customized methods of treatment for certain types of mixed waste streams. For example, wastes with a complex matrix, such as mixed waste, may be difficult to treat either to the acceptable level or by the required treatment method, because the waste is significantly different from the wastes considered when EPA established the standards.

The regulations allow a generator or owner/operator of a treatment, storage, or disposal facility to submit a petition requesting a variance that will establish an alternative treatment standard. Variance submittal requirements include the following:

- Description of the processes and feed materials involved in the generation of the waste and an evaluation of whether they may produce a waste that is not covered by the demonstration
- A waste description, including the same characteristics that EPA used to develop the best demonstrated available technology
- A description of the system used to treat the waste

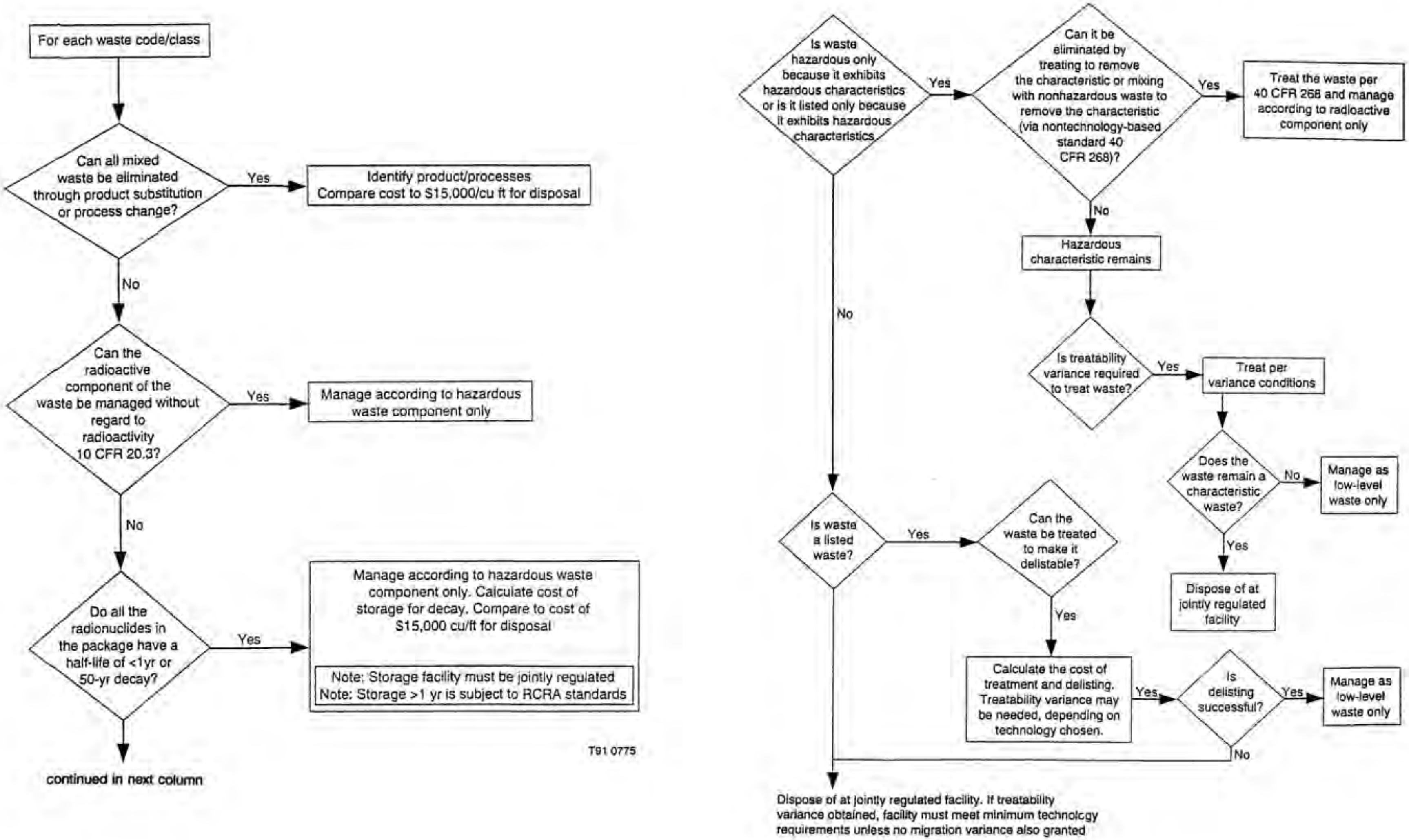

Fig. 1. Mixed waste management schematic.

- A description of any other treatment systems investigated by the petitioner, the treatment system believed by the petitioner to be appropriate for the waste, and the concentrations in the treatment residue that can be achieved by using the preferred treatment techniques
- Descriptions of all sample handling preparation and test methods used to obtain data indicating that the treatment standards are not achievable
- A certification that all of the information submitted in the petition is accurate.

The cost for a treatability variance is about $40,000 and takes four months to one year for approval.

In addition to treating the hazardous waste component to 40 CFR 268 requirements, it is also possible to deregulate the radioactive waste component. The most common method of "treatment" for radioactive waste is storage for decay. This treatment has been used for materials with relatively short half-lives (half lives of up to two months); however, the projected cost of mixed waste disposal could make this treatment concept economical for much longer lived radionuclides (half lives on the order of five years). Alternatively, a waste may qualify for the exemption under 10 CFR 20.306.

ANALYSIS OF MIXED WASTE STREAMS

A summary table of preferred management options for mixed wasted is found in Table I.

The comparison of waste management options is built on several assumptions, which may change as more information on cost of treatment becomes available. First, incineration and stabilization were preferred mixed waste treatment strategies. Biological treatment was not used in any of these treatment strategies because it appeared that the wastes were in highly concentrated form, more suitable to incineration. Where dilution of the waste is possible, then the less expensive biological treatments may show promise. Second, the cost of incinerating mixed waste quoted by a single company formed the basis for all calculations involving incineration. It was assumed that some treatment services will include delisting as part of the treatment service and that delisting would at least double the normal cost of incineration. Although treatment technologies are listed in the matrix and mixed waste may be eliminated because of the treatment, some of those treatment technologies are not presently available.

(Place Table I at end of document.)

MINIMIZATION OPTIONS

The purpose of study number 2--Guidelines for Mixed Waste Minimization is to determine potential commercially generated mixed waste streams that may benefit from minimization techniques.

This study is divided into two phases. Number one is a document for State policymakers so that mixed waste minimization programs can be encouraged for generators. Phase two informs generators how to identify mixed waste streams and how to identify processes that can be implemented to eliminate mixed waste on a waste stream basis.

Mixed waste minimization methodology is shown in Fig. 2.

Several features determine the success of a mixed waste minimization program. Management commitment at all levels involves considering changes in the way a business operates. It also involves committing financial and personnel resources.

Employee training and awareness programs help employees recognize waste minimization opportunities. Once employees have made a commitment, a program of awards and recognition can be implemented to reinforce the commitment.

Once management has provided directives and resources for the waste minimization program, a method for tracking waste generation should be developed. The most effective systems measure and report quantities of waste by its chemical and physical characteristics, radiological isotope, and activity, as well as by generator.

Wastes cannot be minimized until the problems associated with the generation of the waste are defined, and the solutions to these problems are defined, developed, and implemented. Techniques for minimizing wastes must be evaluated. Innovative solutions depend on properly defining the source of the waste and effectively evaluating options that address the source of the waste.

Options for the minimization of mixed waste fall into the following seven technology categories:

1. Substitution of nonhazardous or nonradioactive inputs
2. Reformulation or redesign of end products
3. Modification or redesign of production process
4. Change in material usage, handling, and storage practices
5. Use of closed loop reclamation, reuse, or recycling
6. Use of onsite or offsite recycling processes
7. Modification or redesign or processes, technologies, equipment, or maintenance practices.

Once technologies are identified and assessed, implementing the appropriate technologies should follow. Analyses of results, documentation, and lessons learned will help to evaluate the waste minimization program. Then successful results should be communicated to industries with similar problems.

Mixed waste minimization should only be considered when there is reduced risk to employees, the public, and the environment. Another consideration is that the ethical problem of the impact of the waste minimization effort may be worse than if no waste minimization were done at all. For example, if an effort to reduce mixed waste required a reduction in medical diagnostic tests, would there be an unacceptable increase in deaths as a result?

Long-term cost savings associated with incorporating an option include some easily measured savings on the following: raw material costs, disposal costs, permitting costs, storage cots, shipping costs, and any utilities or labor costs.

DOE CAPABILITY FOR TREATING COMMERCIAL MIXED WASTE

The third study involves an alternative under consideration for managing commercial mixed waste. Currently, DOE is exploring the feasibility of accepting commercial mixed waste for treatment, storage, and disposal.

DOE has recently completed an assessment of its mixed waste streams and the facilities capable of managing those waste streams. This data has been compared to commercial mixed waste streams analyzing treatment capacity.

TABLE I

Preferred Options for Mixed Wastes

Waste Description/Form	Waste Code/Class	Appropriate Treatment Approach	Residue Management
Organic Solvents—Liquid ignitable wastes	D001/A	Treat for characteristic (INCIN), dispose of in Atomic Energy Act (AEA) (NRC-regulated) facility	LLW
Organic Solvents—Absorbed liquid, ignitable wastes	D001/A	Deactivate to remove characteristic, stabilize, dispose of in AEA facility	LLW
Acid	D002	Neutralize acid	LLW
Lead acid battery	D002/D008/A	Internally contaminated: deactivate to remove characteristics, decontaminate lead plates, submit treatability variance for radioactive lead core, dispose of in AEA/RCRA facility	Mixed Waste
		Not internally contaminated: deactivate to remove characteristic, decontaminate lead plates, thermal recovery in lead smelter, dispose of in AEA facility	LLW
Magnesium, thorium chips	D003/A	Deactivate to remove characteristic, stabilize, dispose of in AEA facility	LLW
Liquid chromium—corrosion-inhibiting chromates, incidental corrosion products, Cr-51 carrier, other chromium	D007/A	Precipitation/filtration to remove characteristic, dispose of filtrate in sewer, stabilize filter	LLW
Aqueous lead wastes	D008/A	Same as above	LLW

TABLE I
(Cont.)

Waste Description/Form	Waste Code/Class	Appropriate Treatment Approach	Residue Management
Absorbed liquid chromium or resins—corrosion-inhibiting chromates, incidental corrosion products, Cr-51 carrier, other chromium	D007/A	Reduction and precipitation to remove characteristic, stabilize, dispose of in AEA facility	LLW
Radioactive lead solids, activated lead, contaminated lead containers	D008/A,B,C	Treat to remove lead characteristic, decontaminate radioactive lead solids, stabilize, dispose of in AEA facility	LLW
Aqueous mercury	D009/A	Precipitation/filtration to remove characteristic, dispose of filtrate in sewer, stabilize filter	LLW
Elemental mercury	D009/A	Treat by amalgamation, dispose of in AEA/RCRA facility	Mixed waste
Unknown mercury	D009/A	Chemical precipitation to remove characteristic, stabilize and dispose of in AEA facility	LLW
Solvents using freon, distillation bottoms and filters	F001/A	Incinerate, delist residue, dispose of in AEA facility	LLW
Absorbed solvent liquids, spent solvents using freon	F001/A	Incinerate, delist residue, dispose of in AEA facility	LLW

TABLE I
(Cont.)

Waste Description/Form	Waste Code/Class	Appropriate Treatment Approach	Residue Management
Liquid solvents, scintillation fluids, other organic fluids			
- Spent solvents	F002/A	Incinerate, delist residue, dispose of in AEA facility	LLW
- Methylene chloride	F002/A	Same as above	LLW
- Toluene	F005/A	Same as above	LLW
- Benzene	F005/A	Same as above	LLW
- Paint solvents	F005/A	Same as above	LLW
- Semi-volatiles	F005/C	Same as above	LLW
- Toluene	F005/B,C	Same as above	LLW
- Acetonitrile	U003/A	Same as above	LLW
- Chloroform	U044/A	Same as above	LLW
- DDT	U061/A	Same as above	LLW
- Methylene chloride	U080/A	Same as above	LLW
- 1,4-Dioxane	U108/A	Same as above	LLW
- Phenol	U188/A	Same as above	LLW
- Dioxin	F027	Same as above	LLW

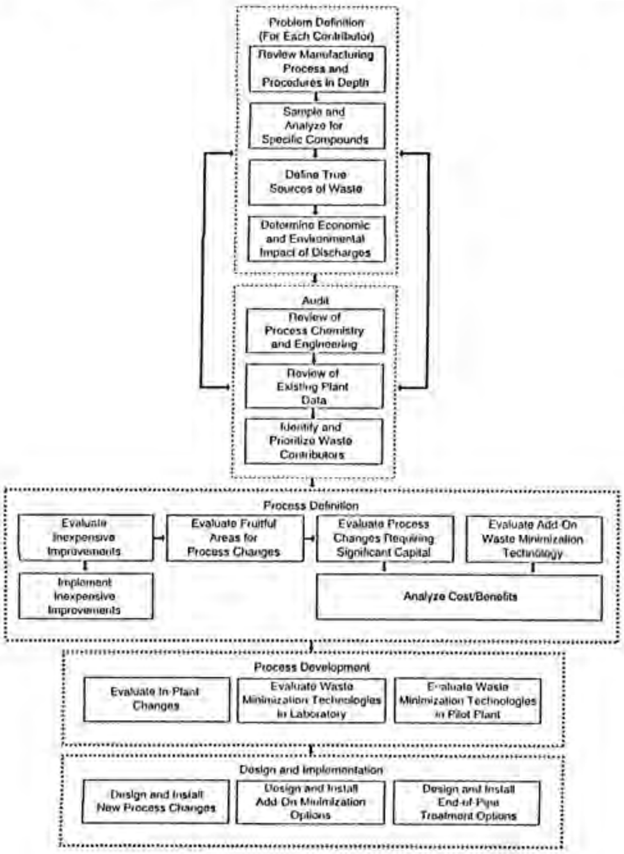

Fig. 2. Mixed waste minimization methodology.

The evaluation included:

- DOE treatment capability
- Listing of the treatability groups assigned to the commercial mixed waste streams for each treatment capability
- The total volume of commercial mixed waste for the treatability groups requiring management under each treatment capability
- The listing of DOE facilities capable of providing that treatment capability that includes the annual operating capacity and first available date for receiving any waste
- Comments on availability, compatibility, issues, opportunities.

CONCLUSIONS

Most, but not all, mixed waste can be managed to avoid disposal in jointly regulated disposal facilities. Wastes that will require jointly regulated disposal fall into two categories: (a) characteristic waste having a technology-based treatment standard other than contaminated elemental mercury and lead solids that cannot be decontaminated and (b) treatment facility equipment and process wastes that were derived from treating listed mixed wastes requiring jointly regulated disposal.

The volumes of these wastes are expected to be very small. However, they still will require mixed waste disposal. High-efficiency particulate air filters from incinerator facilities may also require disposal in jointly regulated facilities. The incinerator facilities treat listed and other bulky wastes from secondary waste streams. These secondary wastes are extremely difficult to predict because their production will vary with the number of treatment facilities, and with types and volumes of waste treated.

Some mixed waste streams in certain processes can be successfully minimized. The up-front elimination of these wastes through waste minimization, process change, and product substitution programs also provides alternatives to disposal. However, there are certain mixed waste streams that are either necessary for university and hospital research, the hazardous component cannot be substituted, or the process cannot be modified to eliminate the waste.

BIBLIOGRAPHY

Code Of Federal Regulations, 10 CFR 20, "Standards for Protection Against Radiation" (January 1991).

Code Of Federal Regulations, 10 CFR 20, Section 303, "Disposal by Release into Sanitary Sewerage Systems" (January 1991).

Code Of Federal Regulations, 10 CFR 20, Section 306, "Disposal of Specific Wastes" (January 1991).

Code Of Federal Regulations, 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste" (January 1991).

Code Of Federal Regulations, 40 CFR 260, Section 20, "General" and Section 22,"Petitions of Amend Part 261 to Exclude a Waste Produced at a Particular Facility" (July 1991).

Code Of Federal Regulations, 40 CFR 261, "Identification and Listing of Hazardous Waste" (July 1991).

Code Of Federal Regulations, 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities -Subpart O, Incinerators" (July 1991).

Code Of Federal Regulations, 40 CFR 264, Section 301, Subsection (d), "Design and Operating Requirements" (July 1991).

Code Of Federal Regulations, 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities - Subpart O, Incinerators" (July 1991).

Code Of Federal Regulations, 40 CFR 266, "Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities" (July 1991).

Code Of Federal Regulations, 40 CFR 268, "Land Disposal Restrictions" (July 1991).

Code Of Federal Regulations, 40 CFR 268, Section 6, "Petitions to Allow Land Disposal of a Waste Prohibited under Subpart C of Part 268" (July 1991).

Code Of Federal Regulations, 40 CFR 268, Section 42, Table 3, "Technology-based Standards for Specific Radioactive Hazardous Mixed Waste"(July 1991).

EG&G IDAHO, INC., "Waste Minimization Plan Municipal Sanitary Wastes," (May 23, 1991).

U.S. Department of Energy, "U.S. Department of Energy Idaho Operations Office Waste Minimization and Pollution Prevention Awareness Plan," DOE/ID-10333(91), Idaho National Engineering Laboratory (May 1991).