RESOLVING MIXED WASTE ISSUES

Dominick A. Orlando and Michael F. Weber
Division of Low-Level Waste Management and Decommissioning
U.S. Nuclear Regulatory Commission, Washington, D.C.

ABSTRACT

NRC and the Environmental Protection Agency (EPA) have been cooperating on resolving the issues associated with the management of mixed waste since the mid-1980s. The agencies have published several joint guidance documents designed to assist mixed waste managers in complying with the regulatory requirements of both agencies. In 1992 the agencies completed several joint projects including the publication of a draft guidance document on the testing of mixed waste and the results of the National Profile on Commercially Generated Low-Level Radioactive Mixed Waste. This paper discusses in detail the contents of the NRC/EPA joint guidance document on testing, the results of the National Profile and the status of on-going NRC and EPA efforts to assist mixed waste managers to resolve the issues associated with the management of mixed waste.

BACKGROUND

Since the mid-1980's, NRC and EPA have been cooperating to resolve the issues associated with the management, treatment, and disposal of low-level radioactive and hazardous waste (mixed waste). Low-level mixed waste is waste that satisfies the definition of low-level radioactive waste in the Low-Level Radioactive Waste Policy Amendments Act of 1985 (1) (LLRWPAA) and contains hazardous waste that is either: 1) listed as a hazardous waste in 40 CFR Part 261, Subpart D, or 2) causes the waste to exhibit any of the characteristics of hazardous waste identified in 40 CFR Part 261, Subpart C (2,3). In October 1992, Congress enacted the Federal Facility Compliance Act (FFCA), which also contains a definition of mixed waste. As defined in the Act, mixed waste is waste that contains both hazardous waste and source, special nuclear or byproduct material subject to the Atomic Energy Act of 1954 (4) (AEA). Because mixed waste contains radioactive and hazardous waste, mixed waste generated by licensed nuclear facilities is subject to both NRC's requirements under the AEA (5) and EPA's requirements under the Resource Conservation and Recovery Act of 1976 (6) (RCRA) or comparable State requirements.

Uncertainties in the volume and characteristics of low-level radioactive mixed waste have been one of the principal barriers to commercial development of treatment and disposal facilities for mixed waste. To address this uncertainty, NRC and EPA have jointly developed the National Profile on Commercially Generated Low-Level Radioactive Mixed Waste (the National Profile). The agencies developed the National Profile in response to a May 1990 request from the Host State Technical Coordinating Committee, which stated that better characterization of commercial mixed waste was needed by States, compact officials, private developers, and Federal agencies to plan and develop treatment and disposal facilities for mixed waste (7) The National Profile was developed for NRC and EPA by the Oak Ridge National Laboratory (ORNL) and is based on a 1991-1992 survey of nuclear facilities licensed by NRC and the Agreement States.

NRC and EPA have jointly developed and issued guidance documents on the definition of mixed waste, siting guidelines for low-level mixed waste disposal facilities (8), a conceptual design for a mixed waste disposal facility (9) and guidance on mixed waste testing (10). By developing these joint guidance documents, the agencies attempted to provide assistance to mixed waste managers faced with the complicated task of understanding and complying with the regulations and requirements of the two agencies. The objective of both agencies was, and continues to be, to improve the level of human and environmental protection by facilitating regulatory compliance.

CURRENT EFFORTS

The interagency cooperation that produced the four joint guidance documents is currently continuing with a range of activities, including finalization of the joint guidance on mixed waste testing and the development of additional joint guidance to address mixed waste storage.

Mixed Waste Testing

On March 26, 1992, the agencies announced, in the Federal Register, the availability of a draft guidance document on the testing of mixed waste (10). The agencies began development of this guidance document in late 1987 and a draft was ready in early 1989. EPA's adoption of the Toxicity Characteristic Leaching Procedure (TCLP), in mid-1990, required that the agencies extensively revise the guidance document. The TCLP poses special concerns from a radiation protection standpoint because it requires samples of at least 100 grams and disaggregation of solid samples, by grinding, to particle sizes of less than 9.5 mm diameter prior to testing. Both of these requirements could significantly increase worker radiation exposure, unless appropriate precautions are implemented in accordance with the licensee's ALARA program, such as preparation of the samples in a hot cell or glove box. However, for high-activity wastes these precautionary measures could exceed the reasonable range and require extraordinary efforts to comply with the TCLP protocol verbatim, while keeping worker exposures ALARA.

The joint guidance on mixed waste testing emphasizes the use of process knowledge whenever possible to determine if a waste is hazardous and offers two strategies for maintaining radiation exposures ALARA when testing is required. The first strategy involves using a sample size of less than 100 grams to perform the TCLP. In order to use a waste sample smaller than that prescribed in the TCLP, a generator must ensure that the resulting test is sufficiently sensitive to measure the constituents of interest, at the regulatory levels prescribed in the TCLP. The second strategy involves using surrogate materials in testing. These surrogates must faithfully represent

the hazardous constituents and characteristics, except radioactivity, of the waste mixture. The joint guidance also discusses other allowable sampling and testing procedures such as representative drum sampling or only sampling drums with the lowest external radiation exposure, as long as the contents are representative of drums with high external exposure rates. To date, the agencies have received over 700 requests for copies of the draft guidance document and approximately 100 comments from 20 different commentors.

The agencies are analyzing the comments and incorporating those comments felt to be valid into the final guidance document. The agencies intend to issue a final version of the document by mid-1993. The agencies will also prepare a comment summary document as an adjunct to the final joint guidance document.

Mixed Waste Storage

The agencies are currently developing joint guidance that addresses important issues associated with safe storage of mixed waste. Given the current lack of treatment and disposal capacity for much mixed waste, most generators are being forced to store their mixed waste until adequate capacity is developed. Temporary storage of mixed waste for brief periods of time can be routinely accommodated by most licensees as part of their radiation protection programs under existing NRC and Agreement State licenses.

However, as storage time increases, potential problems increase. This is particularly true when the waste is stored on-site for greater than 90 days, at which time EPA generally requires that the generator obtain a storage permit. In contrast to NRC's general performance requirements for generators in 10 CFR Parts 20, 30, 40, 50, and 70, EPA has developed specific requirements for the acceptable storage of hazardous waste. Compliance with these requirements could complicate compliance with NRC requirements and license conditions, as well as licensee programs for maintaining radiation exposures ALARA.

In addition, because most mixed wastes are currently covered by the Land Disposal Restrictions (LDRs), extended storage of such wastes may be prohibited. The Hazardous and Solid Waste Amendments of 1984 amended RCRA by, among other things, prohibiting the storage of hazardous waste subject to the LDRs "unless such storage is solely for the purpose of accumulating necessary quantities of waste to facilitate proper recovery, treatment or disposal" (RCRA Section 3004(j) and 40 CFR 268.50(a)(1)). Thus, in the absence of mixed waste treatment and disposal facilities, mixed wastes cannot be treated, stored, or disposed. This "Catch 22" that mixed waste generators face was described in detail in a 1989 assessment of low-level waste management prepared by the Office of Technology Assessment (11).

On August 29, 1991, EPA announced in the Federal Register an enforcement policy for the storage prohibition at Section 3004(j) of RCRA for facilities that generate mixed waste (12). In accordance with the policy EPA, will ascribe low enforcement priority to violations involving the storage of mixed wastes subject to the LDRs under certain conditions.

Although EPA's enforcement policy assigns a low priority against violations related to storage for most mixed waste generators, technical guidance is still needed to identify acceptable approaches to resolve specific issues in a manner that complies with both agencies' requirements. These issues include the inspection and surveillance of stored waste, waste compatibility and segregation, storage container requirements, and time limitations on waste storage without a RCRA permit. For each issue, the agencies are attempting to identify acceptable procedures and practices that comply with both agencies requirements and maintain radiation exposures ALARA. The agencies plan to publish a draft guidance document for public comment in early 1993.

National Mixed Waste Profile (13)

Based on the results of the National Profile, approximately 140,000 ft^3 of mixed waste were generated in the United States in 1990. Of this, approximately *100,000 ft^3 or 71* percent was liquid scintillation fluid (LSF). Organic solvents such as chlorofluorocarbons (CFCs), corrosive organics, and waste oil made up 18 percent, toxic metals made up 3 percent, and the "other" category made up approximately 8 percent. The "other" category consists of complex waste streams comprised of more than one component, that did not lend itself to delineation as a single waste stream. Figure 1 summarizes the results of the National Profile.

The Industrial category generated the most mixed waste in 1990, approximately 50,000 ft^3. The predominant waste stream reported by this generator category was LSF (68 percent) followed by the "other" waste stream (14 percent). The Industrial category included facilities such as radiopharmaceutical, chemical, nuclear fuel, and sealed source manufacturers; industrial research and development companies; and consulting firms and analytical laboratories.

The Nuclear Utility category produced the least amount of mixed waste, approximately 14,000 ft^3. The predominant waste streams in this generator category were waste oil (35 percent) followed by CFCs (27 percent) and the "other" category (17 percent). Based on the results of the National Profile, the nuclear utilities produced only 11 ft^3 of LSF in 1990.

The Academic category produced approximately 29,000 ft^3 (92 percent LSF, 4 percent "other"). The Government category produced approximately 27,000 ft^3 (77 percent LSF, 13 percent "other organics" i.e., those organic compounds not included in the CFC or chlorinated organics category). The Medical category produced approximately 20,000 ft^3 (94 percent LSF, 3 percent other organics).

The predominant radionuclides reported by the respondents to the survey, although not necessarily in their order of predominance, were: ^{14}C, ^{3}H, ^{32}P, ^{35}S, ^{60}Co, ^{125}I, ^{137}Cs, ^{134}Cs, ^{238}U, and ^{51}Cr.

The Appalachian Compact appears to have produced the most mixed waste in 1990, approximately 23 percent of the total. The Rocky Mountain Compact appears to have produced the least, about 0.5 percent of the total. It should be stressed that the Profile was developed to illustrate mixed waste at the national level. The objective of the Profile was to develop projections of mixed waste generation at the national level, within a factor of 2 *and within 95 percent* confidence limits, at the national level. As such, some facility categories were not surveyed in all States or compacts. For example, no medical facilities in the Rocky Mountain compact were sent survey questionnaires. While this may impact on Compact or State projections of mixed waste generation, exclusion of these facilities would not be expected to impact on the accuracy of the survey or the validity of the profile conclusions on a national basis.

Mixed Waste in Storage at the End of 1990

The profile indicated that about 75,000 ft^3 of mixed waste were in storage as of December 31, 1990. Mixed waste contaminated with cadmium made up the largest portion of the mixed waste in storage (35 percent) followed by LSF at 17 percent. The Industrial generator category reported the largest portion of mixed waste in storage (57 percent, comprised primarily of approximately 26,300 ft^3 of sewer sludges contaminated with cadmium). This waste stream, however, was reported by only one facility; the volume of waste was estimated at the national level using the weighting factors for that facility group. Therefore, the national volume of this waste may be considerably overestimated and may be limited to the actual volume reported by the one facility.

Nuclear utilities reported approximately 29 percent of the total volume of mixed waste in storage, primarily mixed waste contaminated with CFCs, waste oil, and lead. The Academic category reported approximately 7 percent of the mixed waste in storage, the Government category reported approximately 4 percent, and the Medical category reported approximately 3 percent. For the latter three generator categories, the predominant waste stream in storage was LSF waste.

It is important to note that the total amount of mixed waste at the end of 1990 cannot be derived from the sum of the amount of waste in storage and the amount of waste generated in 1990 because some of the waste generated in that year may have been treated or destroyed prior to the end of 1990. The amount of waste generated in 1990 does not reflect the reduction in volume from volume reduction, treatment, and destruction that may occur because of treatment (i.e., incineration of LSF waste).

Comparisons with Previous Estimates

The National Profile confirmed earlier estimates that the mixed waste generation rate is a small fraction of the overall generation rate of low-level radioactive waste (LLW) generated and disposed of in the United States. Comparing the generation rate of LLW estimated in the National Profile to the estimated generation rate of mixed waste in 1990, indicates that mixed waste comprised about 9 percent of the LLW generated in 1990. This is within the previously estimated mixed waste generation rate of 3-10 percent of LLW (14). As an alternative, the estimated generation rate of mixed waste can be compared against the total volume of waste transferred to commercial disposal facilities in 1990. In 1990, approximately 1,143,000 ft^3 of LLW were disposed of at the three commercial disposal facilities (15). Assuming that all the LSF mixed waste was or could be destroyed or suitably treated by incineration, the amount of mixed waste generated in 1990 is less than 4 percent of the total volume of LLW disposed of in 1990. Of course, this mixed waste was not disposed of at the commercial disposal facilities because they did not accept mixed waste for disposal since the 1980s.

The National Profile also confirmed previous estimates that the amount of mixed waste generated in the commercial sector is a small fraction of the amount generated by DOE. A recent *Federal Register* notice (16) indicated that DOE annually generates approximately 800,000 ft^3 of LDR mixed waste. This total represents a subset of DOE's mixed waste because it omits mixed waste that is not currently subject to the Land Disposal Restrictions (LDRs) under the Resource Conservation and Recovery Act (RCRA) or that may be generated by environmental restoration and decommissioning activities. If LSF waste is excluded from the total amount of mixed waste generated by licensed nuclear facilities in 1990 (assuming that most LSF can be incinerated using currently available capacity), the estimated mixed waste generation rate for the licensed facilities is approximately 5 percent of the DOE annual LDR waste generation rate. If LSF is not excluded from this comparison, commercial mixed waste would represent approximately 18 percent of the DOE's LDR mixed waste. The volume of DOE mixed waste is expected to increase significantly in the future as a result of DOE's environmental restoration and decommissioning program.

Uncertainties in Estimates

The National Profile represents a "snapshot" of mixed waste generated or in storage in 1990. As such, some waste streams may not have been included in the survey population if facilities included in the survey were not generating these wastes during 1990. For example, unless a facility undergoing decommissioning was included in the survey population, any mixed waste generated by this activity would not be represented in the total waste estimates. However, at least two facilities that were generating mixed waste from decommissioning and decontamination activities completed survey questionnaires. In one case, the facility produced approximately 2 million cubic feet of liquid mixed waste, as a result of a one-time contamination event. This information was not included in the National Profile because the facility is petitioning a State regulatory agency to delist the waste as a non-hazardous waste (i.e., not a mixed waste) and because inclusion of this information would significantly bias the National Profile results and prevent their use as a predictive tool for the Nation. In the second case, approximately 8,000 ft^3 of sewer cleaning sludges containing cadmium and uranium resulting from clean-up operations was included in the National Profile.

The types and volumes of mixed wastes that could result from facility decommissioning or remedial actions are extremely variable. Accurate projections of these mixed wastes will be difficult. Factors that impact on projections of possible decommissioning or remedial action mixed wastes would include past facility operations and practices, as well as the methods used to decontaminate the facility during the decommissioning and the method chosen to perform the remedial action. For these reasons, mixed wastes from decommissioning and site remediation were not specifically included in the survey. As additional information becomes available from reactor and materials facilities decommissioning, this variability in projecting mixed waste from these activities should be reduced.

Treatment Demand vs. Capacity

The treatability assessment in the National Profile concludes that adequate treatment capacity exists for most mixed waste. ORNL contacted commercial vendors to determine the extent of currently available treatment capacity for mixed waste and then compared this capacity with the mixed waste types and volumes identified in the National Profile.

The following four companies currently offer commercial treatment services for some mixed wastes:

1. NSSI/Recovery Services Inc. (Houston, TX);
2. RAMP Industries (Denver, CO);

3. Diversified Scientific Services Incorporated (Kingston, TN); and
4. Quadrex Corporation (Gainesville, FL).

In addition, two other companies are presently planning to develop or are considering development of new treatment facilities for mixed waste: Scientific Ecology Group (Oak Ridge, TN), and Envirocare of Utah (Salt Lake City, UT). These facilities may provide additional treatment capacity within the next several years.

Based on a comparison of the treatment services offered by these existing companies and the types and volumes of waste in the National Profile, it appears that more than 95 percent of the mixed waste generated during 1990 can currently be treated using existing commercial treatment capacity. However, insufficient capacity currently exists for mixed wastes contaminated with CFCs, some LSF wastes, lead shielding and other waste contaminated with lead solids, and equipment and debris contaminated with mercury. The National Profile estimates that at least 12,000 ft^3 additional treatment capacity for mixed waste is presently required, primarily for macroencapsulation. The estimate of necessary additional capacity includes mixed wastes both generated and in storage in 1990.

Uncertainties in Treatability Assessment

ORNL relied on information obtained from the facilities offering the treatment services. As such, the treatment capacity reported by these facilities may, in some cases, be overly optimistic. As discussed in the National Profile, the actual capacities of the treatment facilities have not been tested at the design capacities reported. In addition, various other factors could affect the ability of these facilities to treat the amount of mixed waste for which capacity is claimed. These factors may include limited capacities for necessary pretreatment of or preparation of the mixed waste; the timing of treatment campaigns and downtime between campaigns; and the limited capacity to simultaneously process multiple mixed wastes streams of diverse or similar characteristics.

The report also does not consider the impact that treatment of the Department of Energy's (DOE's) mixed wastes may have on the ability of the treatment facilities to treat commercial mixed waste. As described in the draft *Implementation Plan for DOE's Programmatic Environmental Impact Statement for Environmental Restoration and Waste Management,* DOE is considering use of commercial vendors to treat mixed waste and hazardous waste generated by the cleanup and management of the nuclear weapons complex. Given the large volumes and generation rates of DOE mixed waste, commercial treatment of DOE mixed waste could result in competition and a shortfall in capacity for commercial mixed wastes as treatment facilities commit treatment capacity to treating DOE mixed waste streams.

ORNL also informally queried several mixed waste generators about why so much mixed waste was presently being stored when a large treatment capacity exists for most mixed waste. The reasons given by the generators and other factors developed by ORNL based on their observations and discussions with generators are outlined below. A discussion of these factors will appear in the NUREG on the National Profile.

- *Small* mixed waste generators may not be aware of the existing mixed waste treatment facilities or their capabilities.
- Mixed waste generators may not have sufficient information about their waste or pretreatment capabilities to satisfy the waste acceptance criteria of the treatment facility.
- Mixed waste generators believe they will be liable for their waste "from cradle to grave" and do not want to send the waste to a treatment facility without adequate assurances that their waste will be managed in accordance with all applicable regulations. These assurances may be difficult or impossible to obtain.
- Because of the various regulatory authorities involved in mixed waste management and the interpretation of the regulations by these authorities, generators may be confused about acceptable methods to treat and dispose of their waste. As such, they are uncomfortable sending their waste to any treatment facility and prefer to keep their waste on-site.

The results of the profile should be helpful to States and compacts in planning the management of mixed waste. The results should also assist the Department of Energy (DOE) in considering acceptance of mixed waste for treatment and disposal at DOE facilities. NRC has encouraged DOE to consider accepting mixed waste for treatment and disposal and has stated that it is ready to support any effort to resolve the mixed waste issue that is consistent with NRC's responsibility to protect the public health and safety and the environment (18). DOE initiated consideration of this option in late 1990 and has since been working with the States in exploring the merits and viability of this option. Based on the National Profile, the volume of commercially generated mixed waste, not currently being treated or disposed of by commercial facilities is minuscule compared to the mixed waste generation rate for DOE facilities. In a May 26, 1992 Federal Register notice (57 FR 22024) proposing that EPA grant a case-by-case extension for DOE's LDR mixed wastes, EPA reported the generation rate of DOE LDR mixed waste was approximately 800,000 cubic feet per year (16). This would indicate that the amount of commercially generated mixed waste that would need to be treated or disposed of by DOE is between 0.6 and 2.3 percent of DOE's LDR mixed waste generation rate (assuming that all LSF waste generated by licensed nuclear facilities can be treated and disposed of using existing commercial facilities). However, DOE acknowledges that it currently lacks sufficient capacity to manage its own mixed waste and that concentrated efforts over the next several years will be required to bring the Department's current operations into compliance with RCRA.

CONCLUSION

NRC and EPA will continue to cooperate in responding to these and other issues associated with the management of commercial mixed waste. The agencies hope that these cooperative efforts will result in reduced regulatory burden on generators while maintaining and enhancing the protection of the public health and the environment from the hazards associated with commercial mixed waste. In order to help identify the issues that need resolution, the agencies require assistance from the regulated community, States, and the public. The agencies especially welcome comments and suggestions from the regulated community, trade organizations, professional and technical societies, State and local governments, Federal agencies, and public interest groups.

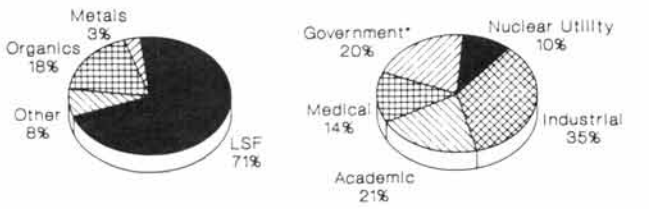

Fig. 1. Results of the National Profile-mixed waste by waste stream and facility.

REFERENCES

1. LLRWPAA, 1986, Low-Level Radioactive Waste Policy Amendments Act of 1985, Public Law 99-240, 42 U.S.C. 2021, January 15, 1986.
2. U.S ENVIRONMENTAL PROTECTION AGENCY, 40 CFR Part 261, Identification and Listing of Hazardous Waste, Title 40 Code of Federal Regulations Part 261, U.S. Government Printing Office, 1991.
3. U.S. ENVIRONMENTAL PROTECTION AGENCY and U.S. NUCLEAR REGULATORY COMMISSION, 1989, Guidance on the Definition and Identification of Commercial Mixed Low-Level Radioactive and Hazardous Waste and answers to Anticipated Questions, October 4, 1989.
4. FFCA, 1992, Federal Facility Compliance Act of 1992, Public Law 102-386, 42 U.S.C. 6901 note.
5. AEA, 1954 (as amended), Atomic Energy Act of 1954, as Amended, Public Law 83-703, 42 U.S.C. 2011-2286.
6. RCRA, 1976 (as amended), Solid Waste Disposal Act (Resource Conservation and Recovery Act), Public Law 89-272 (as amended by Public Law 94-580, et. seq.), 42 U.S.C. 6901-6991i.
7. ALVARADO, R.A. Convenor, Host State Technical Coordinating Committee, Letter to W. K. Reilly, Administrator, U.S. Environmental Protection Agency and K. M. Carr, Chairman, U.S. Nuclear Regulatory Commission, May 14, 1990 [available upon request from the authors].
8. U.S. ENVIRONMENTAL PROTECTION AGENCY and U.S. NUCLEAR REGULATORY COMMISSION, 1987, Combined NRC-EPA Siting Guidelines for Disposal of Commercial Mixed Low-Level Radioactive and Hazardous Waste, EPA Office of Solid Waste and Emergency Response Directive 9480.00-14, June 29, 1987.
9. U.S. ENVIRONMENTAL PROTECTION AGENCY and U.S. NUCLEAR REGULATORY COMMISSION, 1987, Joint NRC-EPA Guidance on a Conceptual Design Approach for Commercial Mixed Low-Level Radioactive and Hazardous Waste Disposal Facilities, EPA Office of Solid Waste and Emergency Response Directive 9487.00-8, August 3, 1987.
10. U.S. NUCLEAR REGULATORY COMMISSION, Clarification of RCRA Hazardous Waste Testing Requirements for Mixed Waste, Draft Guidance, Federal Register v. 57 10508, March 26, 1992,.
11. OFFICE OF TECHNOLOGY ASSESSMENT, Partnerships Under Pressure: Managing Commercial Low-Level Radioactive Waste, U.S. Government Printing Office, OTA-O-426.
12. U.S. ENVIRONMENTAL PROTECTION AGENCY, Enforcement Policy on Mixed Waste Storage, Federal Register, v. 56, 42730-42732, August 29, 1992.
13. U.S. NUCLEAR REGULATORY COMMISSION, National Profile on Commercially Generated Low-Level Radioactive Mixed Waste, NUREG CR/5938, December 1992.
14. National Profile on Commercially Generated Low-Level Radioactive Mixed Waste, Technical Letter Report for Task 1, FIN 1647, ORNL, November 16, 1990.
15. 1990 Annual Report on Low-Level Radioactive Waste Management Progress, U.S. DOE, DOE/EM-0059P.
16. Federal Register Vol. 57, pp 22024-22094, Tuesday May 26, 1992.
17. Draft Implementation Plan for the Programmatic Environmental Impact Statement for the Department of Energy Environmental Restoration and Waste Management Program, U.S. DOE, January 1992
18. SELIN, IVAN, Chairman, U.S. Nuclear Regulatory Commission, Letter to James A. Watkins, Secretary, U.S. Department of Energy regarding DOE's acceptance of commercial mixed waste for treatment and disposal, August 2, 1991.