

EPA'S PROPOSED STANDARDS FOR THE DISPOSAL OF COMMERCIAL LOW-ACTIVITY MIXED WASTE

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ABSTRACT

The U.S. EPA will soon be proposing an environmental standard for the disposal of commercial low-activity mixed waste. This proposed standard would not relax current disposal practices but instead expedites disposal through the use of alternative disposal facilities. It is expected to offer many benefits to the commercial sector while at the same time being fully protective of the public health. As it creates a new and >optional= pathway for the disposal of these wastes, it is viewed as a >voluntary= standard in terms of its impact on generators and disposal site operators.

INTRODUCTION

The Environmental Protection Agency (EPA) will be proposing, sometime in 1999, a generally applicable environmental standard for land disposal of low activity mixed waste (LAMW) generated in the commercial sector. The proposed standard will apply only to mixed waste with radionuclide levels below the concentration limits of Class A low-level radioactive waste (LLW), as defined by the NRC in 10 CFR Part 61 (1). This proposed regulatory action will address the protection of the general public and ground water by proposing waste radionuclide concentration limits for the land disposal of LAMW. The disposal technology to be used is based upon the RCRA Subtitle C (RCRA-C) hazardous waste disposal requirements (2). RCRA-C disposal has been demonstrated to be protective of the public health for the types of wastes considered here. It will fall to the NRC and Agreement States, as the implementing bodies, to actually license such sites for LAMW disposal.

LAMW AND THE NATURE OF THE PROBLEM

LAMW is characterized by the presence of both hazardous chemicals and radioactive materials regulated under the Atomic energy Act (AEA), and excludes high-level waste, transuranic waste, spent nuclear fuel, or byproduct material defined as uranium or thorium tailings. Typically, however, LAMW contains radioactive materials similar to those found in Class A low-level waste, regulated under 10 CFR Part 61, but at lower concentrations. Commercial LAMW otherwise is analogous to other wastes classified as Resource Conservation and Recovery Act (RCRA) hazardous waste (3). Most of these wastes are and will be generated in small amounts well into the future by many categories of waste generators, including medical, educational, industrial, and nuclear power plants. Activities that generate LAMW include

research and development (R&D), laboratory analyses, facility maintenance, nuclear power plant operation and maintenance activities, and decontamination in support of routine facility or plant

Table 1. Categorization of Commercial Mixed Wastes

Waste Category	Hazardous Component	Radionuclide Component	Origin
Liquid Scintillation	toluene, xylene	H-3, C-14, P-32, S-35, Ca-45, Ni-63, I-125	laboratory measurements
Waste Oils	oils	H-3, Mn-54, Zn-65, Co-60, Cs-134, Cs-137	equipment operation and maintenance
Halogenated Organics	freon, chloroform, trichloroethane, chlorinated solvents and organics	H-3, C-14, P-32, S-35, Mn-54, Co-58, Co-60, I-125, U	dry cleaning, refrigeration, degreasing and decontamination
Lead Wastes	lead bearing ash, oils, batteries, penetration sealants	P-32, Sr-90, I-125, Co-60, Cs-137, Ra-226, Th-232, U	research and industrial activities
Mercury Wastes	mercury bearing equipment and debris	H-3, C-14, Mn-54, Co-60, I-125, Cs-137	laboratory activities
Chromate Wastes	chromium bearing solutions	Cr-51, Co-60	research, maintenance and waste treatment
Cadmium Wastes	cadmium	Co-60, Cs-134, Cs-137	decontamination of reactor internals
Aqueous Corrosive Wastes	organic/inorganic acids and bases	H-3, C-14, P-32, S-35, Cr-51, Mn-54, Co-60, Ni-63, I-125, Cs-134, U	decontamination activities
Miscellaneous Organics	solvents, reagents, organics,	H-3, C-14, P-32, S-35, Ca-45, I-125, U	manufacturing, laboratory operations and cleaning
Other Hazardous Materials	organic sludges, trash, ash, alloys, biological wastes, etc.	H-3, C-14, P-32, S-35, Cr-51, Mn-54, Co-60, Ni-63, I-125, Cs-134, U	industrial, research and medical activities

operations. In general, such activities do not create new hazardous substances; rather, low activity mixed wastes are generated when chemicals are used as cleaning agents or solvents, or are part of a process and thus become commingled with radioactive materials. Table 1 provides more detailed information on these wastes, the nuclides they typically contain, and their sources (4).

A national profile of mixed waste volumes and characteristics developed by the Nuclear Regulatory Commission indicated that, based on 1990 practices, commercial facilities generated

about 3,950 cubic meters of mixed waste and held another 2,120 cubic meters in storage(5). The profile divides mixed waste properties and generation into five sectors including medical facilities, academic institutions, government institutions, industrial facilities, and nuclear power plants. Projected volumes of these wastes are expected to decrease, reflecting an emphasis on volume reduction at the source.

These mixed wastes are being stored on site by approximately 3000 small volume generators, in part, because treatment and disposal options are extremely limited due to the dual regulatory requirements of RCRA and AEA. These dual requirements create relatively high costs for the disposal of small volumes of mixed waste. Estimates of the number of individual sites where mixed waste is stored have been as high as 10,000 (6). The lack of disposal options for these generators poses operational and safety problems, increased management costs, and prolonged storage of the wastes. Some of the wastes have been stored for over a decade. The Agency is concerned that there may be increased risks from continued storage of these wastes at a very large number of generator sites which may not be equipped to manage them for extended periods of time. EPA has already taken enforcement actions under RCRA against some generators because of improper storage, but also recognizes the lack of management options available for some mixed wastes. The Agency recently extended its policy giving a low priority to enforcement of storage of mixed waste with no available treatment or disposal options (7).

There is also a concern that the high costs and difficulty of waste disposal will cause doctors, hospitals, and diagnostic laboratories to suspend certain procedures, which could result in less than optimum health care. In addition, there are reports that problems with storage and disposal of radioactive wastes have caused researchers to avoid scientific procedures known to be effective and to develop less effective alternatives (8). There is also concern that such problems may hamper medical research.

Congress recognized the problem of lack of facilities to treat and dispose of mixed waste and encouraged EPA and NRC to devote resources to develop a strategy to address the issues (9). Also, Congress expressed concern to the Council of Environmental Quality (CEQ) about this problem which has persisted for over 11 years and still no resolution in sight.® Congress asked the Council what action is being taken to help resolve the problem (10).

THE LAMW STANDARD

EPA will propose a standard under which LAMW could be disposed of in RCRA-C disposal cells. These disposal cells would be required to meet both RCRA requirements and NRC and Agreement State requirements for radioactive waste disposal. NRC and Agreement State requirements might be patterned after criteria established for low-level radioactive waste. The proposed standard would ensure that low activity mixed waste will be disposed of in a manner protective of the public and the environment. The proposed standard would consist of one or more tables of maximum allowable radionuclide concentrations in wastes, which provide long-term public health protection corresponding to specific dose limits to a member of the Critical Population Group (CPG) and to workers. The waste radionuclide concentration limits proposed in the rule will be derived from performance assessment modeling of reference wastes

in a generic RCRA-C disposal cell. The analyses consider all significant exposure pathways and exposure scenarios, including off-site exposures through the use of ground water and worker exposure during operation of the disposal facility. With these analyses, concentration limits are derived reflecting the behavior of individual radionuclides, under the range of environmental conditions possible over the regulatory time frame.

The concentration limits would provide long-term public health protection in conformity with a reference dose level used for modeling as described below. Waste with multiple radionuclides would be further restricted under the sum-of-the-ratios rule, i.e., the sum of the ratios of all radionuclide concentrations present in the mixture and contributing to doses for worker or off-site receptors cannot exceed unity. As an additional protective measure, concentration limits will not be allowed to exceed the maximum values established for Class A waste, the least restricted class of low-level waste. The requirements of this proposed standard will be commensurate with the relatively low radiological hazard presented by LAMW, while recognizing that the design of RCRA disposal cells and permitting process do not address the presence of radioactivity. EPA is also considering whether it would be appropriate to allow RCRA-C owners or operators to use site-specific information to calculate alternative allowable concentration levels so long as it can be demonstrated to the licensing authority, i.e., NRC, that the maximum radiation doses will be consistent with the reference dose levels used in the EPA proposed rule now under development.

EPA believes that, under certain conditions, RCRA Subtitle C disposal facilities can serve as appropriate disposal sites for mixed waste with limited radioactivity. The RCRA regulatory framework incorporates an array of requirements whose purpose is to assure containment of chemically hazardous wastes in near surface disposal cells. In the case of mixed wastes, chemically hazardous constituents containing radionuclides would likewise be isolated from the environment by such RCRA requirements. RCRA regulations control the siting, design, and operation of hazardous waste disposal facilities(11). Siting requirements include the prohibitions on sites located in flood plains or seismically active areas. Design requirements specify liners and leachate collection systems for disposal cells. New disposal cells are required to have two liners with a leachate collection system above and between the two liners. In addition, there are requirements to divert the flow of surface waters resulting from at least a 25-year storm from the active portion of disposal units and to provide a system to collect run-off from a 24-hour, 25-year storm. Operating requirements include a ground water monitoring program and corrective action program. Compliance monitoring around the facility must be performed to assure that the concentrations of hazardous constituents in the ground water do not exceed specified limits at the point of compliance listed in the facility permit. Should the concentrations of hazardous constituents exceed these concentration levels, the facility must begin a corrective action program to reduce measured concentrations to acceptable levels. Closure requirements include addition of a final cover to minimize long-term migration of liquids through the disposal cell. This final cover must have a permeability less than or equal to that of any bottom liner system.

Maximum allowable radionuclide concentration limits will be developed using conservative modeling assumptions for a range of geohydrological settings, and under arid and humid environmental conditions. EPA is currently considering whether it should vary these limits based on the impact of site characteristics on dose. Given the novel nature of the proposed standard, it was deemed important to establish radionuclide concentration limits and corresponding dose limits below levels typically associated with NRC waste disposal regulations. Finally, application of such a lower dose limit was deemed prudent and necessary in recognition of (1) the inherent uncertainties in projecting the performance of RCRA-C disposal technologies and (2) the possibility that for a region, multiple disposal sites might be used if the volumes of LAMW were large enough.

DISPOSAL SITE MODELING

To assess the long-term protection offered by the RCRA-C hazardous waste disposal technology, performance modeling under a range of climatic and hydrogeologic conditions is being performed using the EPA PRESTO-CPG code (12). Commercial mixed wastes are modeled in a disposal cell with design features consistent with the RCRA-C design. The intent of this modeling is to determine maximum allowable radionuclide concentrations in wastes to assure that potential exposures from a variety of possible scenarios are below a reference dose level considered acceptable for the generic scenarios. Bounding and sensitivity studies for the systems modeled are also being performed so that results can be generalized to assure that the waste concentration limits derived, and which will be used to derive waste acceptance criteria in the proposed rule, are conservative and consistent with the possible range of disposal site characteristics nationwide. From this combination of site modeling, sensitivity and bounding analyses, it should be possible to derive waste concentration limits that can be generalized to any prospective disposal site and which address the range of site conditions important for radionuclide containment and isolation. This modeling should also point to the need for any waste treatment and packaging requirements that must be imposed to assure acceptable performance for the disposal system.

The PRESTO code was developed by the EPA and has the advantage of being easy to run for a wide range of parameter variations, making it a suitable vehicle for the type of regulatory development efforts described here. The PRESTO code has a number of features that facilitate the kind of sensitivity and bounding analyses needed for regulatory development applications. Infiltration of ground waters into the disposal cell is modeled in a dynamic fashion that requires only estimates of annual precipitation and hydraulic properties of the disposal cell. The conversion of annual precipitation data to actual water infiltration rates is performed internally in the code based on geographic data on rainfall patterns and infiltration characteristics. Options for calculating waste radionuclide releases allow modeling of soil-like wastes as well as containerized and solidified wastes. Transport of contaminants outside the disposal cell is modeled using a one-dimensional transport path to simplify calculations without an unacceptable loss in accuracy for short travel paths on the order of tens to about 300 meters distance from the disposal cell border. PRESTO includes calculation of up to four major daughter products in the decay chain of radionuclides included in the analyses and evaluation of doses through ingestion, inhalation and external exposure pathways. These features allow sensitivity and bounding

analyses for a large number of site parameters to be conducted easily and relatively quickly.

Based on information in published sources, a listing of 70-80 radionuclides found in all types of mixed wastes was developed for use in modeling calculations (**13, 14, 15**). A generic RCRA-C disposal cell design was simulated containing 3500 m³ of wastes with cap (2 m thickness) and liner thickness and hydraulic conductivities as required by RCRA regulations (**16**). For a conservative analysis, the off-site receptor's water well is located 50 m from the edge of the disposal cell and exposures are calculated for pathways using ground water as the source of radionuclides. At the end of the 30 year facility monitoring period required by RCRA regulations, the disposal cell cap is allowed to fail so that ground water infiltration can begin to mobilize radionuclides from the wastes. The cell liner is also allowed to fail beginning at thirty years and continuing to degrade totally at 300 years when its hydraulic conductivity becomes equal to the underlying soil zone. The liner is failed to a greater extent than the cap so that infiltrating water can migrate into the unsaturated zone below the cell, enter the saturated zone and move down gradient to the receptor's well. For our initial modeling effort, ten DOE operation sites were modeled because a well documented data base of site climatic and hydrogeologic information is available for these sites, which would allow bounding analyses to test the effects of variations in important site parameters. These ten sites ranged from arid to humid areas, with variations in rainfall and other important parameters such as depth to the saturated zone and ground water flow velocities. The wastes modeled in these assessments were treated as contaminated soils, i.e., the K_d waste release option in PRESTO was used under the assumption that this release mechanism would result in higher releases from the disposal cell than from the other options in PRESTO. From initial modeling it was found that a small number of radionuclides are mobilized from the wastes and result in doses to the receptor. Over a period of hundreds of years, doses to the off-site receptor resulted from the transport of H-3, C-14, I-129, Tc-99, Np-237 and isotopes of uranium. The remainder of the radionuclides did not contribute to doses significantly during the 1,000 year modeling period. As expected, arid sites provided better waste containment than humid sites, reflecting the lower infiltration of precipitation into the arid sites and the deeper unsaturated zones typically present at these sites.

The results of the preliminary modeling of ten disposal sites indicated three poor performing sites should be selected for more intensive modeling of the performance of cement stabilized wastes in the RCRA-C disposal cell. The two poorest performing humid environment sites were used. One poor-performing arid site was used as well for comparative purposes.

All LAMW is assumed to be stabilized as part of the waste treatment process. Hazardous waste must be treated to comply with the RCRA land disposal restrictions before it can be land disposed (**17**). Stabilization is a common waste management practice, though it is not required for all waste types. The modeling assumed that Portland cement would be used for stabilization, as it is widely used, readily available, relatively inexpensive, and has been extensively studied. Two approaches are being considered for calculating releases from stabilized wastes. As an upper bound, a source term for untreated contaminated soil is used (this essentially recreates the initial modeling using ten sites, as described above). In this approach, radionuclides are released to infiltrating waters via radionuclide-specific K_d factors for soil materials. This establishes the

recognized upper bound because no stabilizing medium would be expected to contain radionuclides less effectively than soil. A conservative approach is being taken in selecting K_d values so that lower values of this parameter are selected from available information on the range of values reported in the literature.

The other approach for stabilized wastes involves simulating the leaching of cement waste forms, the most commonly used immobilizing technique for mixed wastes. Two methods of simulating leaching were used, one incorporated in the PRESTO code and one based on the DUST code, which was developed by Brookhaven National Laboratory for the NRC for the purpose of assessing leaching from cement (18). The PRESTO code uses a phenomenological approach to modeling the leaching of solidified waste forms by mathematically simulating diffusion behavior. The DUST code takes a more mechanistic approach to describing radionuclide releases from cement by direct calculation from diffusion coefficients. This method is more scientifically rigorous, but makes scoping analyses more difficult and time consuming since the code does not consider transport from a disposal facility and consequent exposure scenarios. Parameters describing the radionuclide release from cement/concrete waste forms were obtained from the literature and used in both models for comparative purposes.

To calculate maximum waste concentration levels, a common concentration is assumed for each of the waste radionuclides and the dose to the off-site receptor is calculated using the EPA PRESTO-CPG code. This dose level is compared to a reference dose level and the limiting waste radionuclide concentration calculated from the ratio of the calculated dose to the reference dose. For our calculations a 1 mrem/yr reference dose was selected for the total all-pathways dose to the off-site receptor, and is consistent with the exposure level used for the disposal of Cesium contaminated bag-house dust in RCRA-C facilities (19). This level is also sufficiently below the ground water protection requirement of 4 mrem/yr for beta/photon emitters allowing more than one facility to be located up gradient of the receptor. The reference dose level for the purpose of this rulemaking has not been finalized as yet.

Since only a small number of radionuclides are mobilized to contribute to the off-site dose, another approach is necessary for calculating limiting radionuclide waste concentrations for those radionuclides that remain relatively immobile. For those radionuclide species that do not contribute to doses from ground water use, a worker exposure scenario is being evaluated. To perform the worker exposure scenario a stabilized waste is assumed, the wastes being immobilized in either cement or polyethylene and placed within a metal drum in the case of the cement waste form and in wooden boxes as an additional alternative for the polyethylene waste form. For the initial worker exposure assessments a reference dose of 1 mrem/yr is being assumed, equivalent to the off-site resident exposure. This low reference dose for the worker assumes that no requirements for occupational exposures similar to those applied to radiation workers will be applied to workers at the RCRA-C disposal sites. These workers are effectively protected to the same level as the general public. Results from the worker exposure analyses are not available as yet, but these results will be examined to determine if usable waste concentration limits can be derived from this approach or if additional waste treatment/stabilization and packaging requirements are necessary to provide an adequate level of

protection. Concentrations of short half-life radionuclides and immobile radionuclides with strong gamma emissions (e.g., Cesium and Cobalt isotopes) are anticipated to be limited by the worker exposure reference dose limit. In deriving waste concentration limits from worker exposure calculations, concentration limits are not anticipated to be allowed above the Class A levels for low-level radioactive wastes given in 10 CFR Part 61, since the waste stream of interest is low-activity mixed wastes intended as a subset of low-level wastes. Even if the results of modeling suggest that waste limits for specific radionuclides disposed of in a RCRA-C cell could be higher than the Class A limits, these limits would cap the waste concentration proposed for this rule so that the waste stream addressed clearly remains categorized as low-activity waste.

From sensitivity and bounding studies based on variations in site parameter values, the performance of the RCRA-C disposal cell relative to the radionuclides mobilized by ground water is most strongly affected by parameters that control the amount and timing of ground water infiltration through the wastes (cap failure rates largely), parameters that affect releases from the waste (release K_d and associated with the wastes) and transport through the ground water beyond the disposal cell (aquifer thickness, K_d values along the transport pathway, ground water velocity and distance to the receptor-s well). The importance of each of these parameters varies for specific radionuclides and is somewhat site dependent also. A consistent correlation in the bounding and sensitivity studies for all radionuclides that contribute to off-site doses is observed between the dose and the assumed extent of cap failure, suggesting that this is an important design parameter for the disposal system in general.

Performance modeling of the RCRA-C disposal cell technology is still ongoing. Additional modeling using probabilistic sampling is planned along with confirmatory modeling using a code other than PRESTO. Our initial modeling incorporates some conservative assumptions, such as a short travel path to the off-site receptor (50 meters) and relatively rapid failure of the disposal cell cap and the onset of radionuclide releases to the infiltrating ground waters. Additional modeling to examine variations in waste release rates, cap failure and infiltration assumptions, is indicated based on the results of our performance evaluations.

INVOLVEMENT ON THE PART OF THE STATES, NRC, AND COMPACTS

EPA is proposing the regulation and developing the general conditions for its application. However, EPA will have to rely on the NRC and States to implement the regulation. RCRA-C disposal facilities that want to accept LAMW will have to obtain a license under the AEA. The NRC would be responsible for developing the specific requirements for licensing. Low-level waste disposal is currently regulated by the NRC under 10 CFR Part 61. EPA envisions that LAMW disposal could be conducted under simplified licensing requirements, possibly based on a modified version of 10 CFR Part 61. Of course, being the implementing agency, it goes without saying that the NRC will have the final say here.

The full 10 CFR Part 61 licensing process is lengthy and complex, and normally requires extensive site characterization. One reason a simplified procedure might be acceptable is that EPA is defining LAMW so that radionuclide concentrations will not exceed the maximum values

for Class A waste. Class A is the least radiologically hazardous class of low-level waste, and does not require extensive treatment or packaging. Packaging and isolation (depth of burial) requirements for Class B and C waste are progressively more extensive.

The similarities between the RCRA and AEA disposal approaches provide another reason to seek simplified licensing. 10 CFR Part 61 addresses many aspects of facility licensing, including:

- \$ facility siting criteria;
- \$ facility design;
- \$ facility performance (dose to public);
- \$ worker protection;
- \$ financial assurance;
- \$ land ownership;
- \$ waste classification and packaging;
- \$ environmental monitoring; and
- \$ facility closure and long-term care.

RCRA regulations for hazardous waste land disposal facilities cover much of the same ground. While there are some differences that result from how the regulations are written (i.e., RCRA regulations focus more on technical requirements, AEA regulations on performance requirements), EPA believes that the overall goals and methods employed are compatible and provide a sound basis for a simplified licensing process. As an example, information contained in the facility's RCRA permit, and available data from operations, could be used to satisfy portions of 10 CFR Part 61.

Regardless of the NRC approach to licensing, such licensing can not proceed until implementing regulations are issued. In selecting a licensing approach, it is important for the NRC to be able to accept EPA's analyses as providing assurance that RCRA-C facilities can safely dispose of low concentrations of radionuclides. It is also important that EPA's analyses give the NRC maximum flexibility in developing its licensing requirements.

While the regulations facilitating LAMW disposal will be issued at the Federal level, it is likely that actual implementation and oversight will be carried out by States. Both EPA and NRC delegate authority to administer their programs to States that have demonstrated compatibility with Federal requirements. Most States have authority to regulate both hazardous and radioactive waste. This means that individual States will be able to exercise discretion in facility permitting and licensing. Authorized States are permitted to go beyond Federal requirements to some extent. It is possible that States could add provisions that would make LAMW disposal financially unattractive or effectively impossible. EPA has and will continue to work with State regulators to address their concerns.

The impact of the proposed regulation on current low-level waste management efforts, as managed by low-level waste Compacts and unaffiliated States, might need to be assessed at the regional or State level since the radioactive component of the waste might fall under the

jurisdiction of such entities, depending upon charters and statutes enacted in response to the Low Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240). In light of the small amounts of LAMW addressed by the proposed rule, this action is not expected to impact current efforts for developing regional low-level waste disposal facilities. It is believed that most Compacts will not have provisions for accepting mixed wastes.

OTHER ASPECTS OF THE RULEMAKING

The proposed standard will not relieve the operators of commercial facilities from having to comply with all applicable regulatory requirements for characterizing and treating hazardous materials prior to disposal. Nor will the proposed standard relax existing RCRA waste acceptance criteria for disposal facilities regulated by the EPA and State and local agencies.

The proposed LAMW disposal rule will permit an additional disposal option, not currently available, for certain types of mixed wastes. It is important to note that the proposed rule does not impose new requirements that would act to increase the cost of doing business. It does not require a change in current disposal practices for those who do not wish to take advantage of this option.

This approach is believed to provide commercial RCRA-C operators and waste generators a more flexible and cost-effective method to dispose of specific types of wastes, given the current status of Federal and State regulations. In the absence of this action, waste disposal costs for small volume generators are expected to remain high, since they would be required to dispose of low activity waste in facilities designed to receive more hazardous waste or store waste for indefinite time periods at the point of generation. This approach is also believed to free up disposal capacity at facilities specifically designed to receive more hazardous low-level and mixed waste, while allowing the disposal of LAMW in alternate, but equally protective facilities. Accordingly, the proposed standard is expected to provide an effective disposal method commensurate with the radiological and hazardous properties of LAMW. In turn, these considerations should encourage waste generators to dispose of such wastes, rather than storing them. In the long term, this approach is believed to be generally safer for workers and the public, as it appropriately places such wastes into a small number of facilities designed for disposal, as opposed to storage in numerous facilities not necessarily designed to offer long-term containment and protection.

Potential savings in disposal costs are directly dependent upon on the actions of waste generators, as well as on legal constraints arising from other Federal and State regulations and how the Nuclear Regulatory Commission chooses to implement the approach within the commercial sector. It is expected that waste generators and treatment facilities would utilize this new disposal option to reduce the costs associated with storage and treatment of mixed waste. The cost savings are expected to result from:

- The reduced need for interim waste storage
- The development and availability of new waste treatment techniques
- The development and application of new waste segregation techniques

- Reduced waste transportation costs
- The availability of lower-priced LAMW disposal in RCRA-licensed disposal cells

Indirect returns are also expected from the increased use of testing and research methods that are currently being curtailed due to limited mixed waste disposal options.

Although the risks associated with disposal are essentially unchanged, the reduced need for interim storage is expected to reduce storage risks in the long-term. Transportation risks are expected to be reduced as well once local LAMW disposal capacity becomes available.

CONCLUSIONS FROM THE ANALYSIS

This analysis suggests there are benefits from the proposed standard, both in terms of greater public health protection and in terms of savings to be realized by the use of alternative disposal technologies for commercial mixed waste. While it is not possible to quantify the enhanced public safety afforded by a reduction in storage periods for LAMW, increasing public safety does exist as a solid rationale for this action. And while the absolute amount of savings realized by generators is likely to be small given the relatively small volumes of commercial waste, they are nonetheless significant, particularly to small generators. Expedited and inexpensive access to approved disposal facilities should provide an inducement to the many generators currently storing such waste to proceed with disposal and to improve public health protection.

REFERENCES

1. Code of Federal Regulations, Title 10, Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."
2. Code of Federal Regulations, Title 40, Part 264, "Land Disposal Restrictions."
3. Code of Federal Regulations, Title 40, Part 261, "Identification and Listing of Hazardous Waste".
4. NUREG CR-5938, USNRC, 1996, Washington, DC.
5. U.S. Nuclear Regulatory Commission, National Profile on Commercially Generated Low Level Radioactive Mixed Waste, NUREG/CR-5938, December 1992, Washington, DC.
6. Kaye, Gordon J., "The Crisis in LLRW Disposal Short and Long-term Effects on the Biomedical Community," Newsletter for Appalachian Compact Users of Radioactive Isotopes, June 1991
7. Environmental Protection Agency, "Extension of the Policy on Enforcement of RCRA Section 3004(j) Storage Prohibition at Facilities Generating Mixed Radioactive/Hazardous Waste", Federal Register, 63:59989-59992, November 6, 1998.

8. Isaac, Peter G., et al., A Nonradioactive Probes, @ Molecular Biology, p. 259-160, vol. 3, June 1995.
9. Hearings before the Subcommittee on Energy and Power of the Committee on Commerce, House of Representatives, 104 Congress, Second Session, September 5, 1996, Serial Number 104-114.
10. Questions for the Record for Ms. McGinty from Senator Johnston, Congressional Record, June 1996.
11. Code of Federal Regulations, Title 40, Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities."
12. Hung, C-Y, 1998, Overview of the PRESTO Model, in: Proceedings of the Workshop on Review of Dose Modeling Methods for Demonstration of Compliance with the Radiological Criteria for License Termination, NUREG/CP-0163, pg.93-109, USNRC, Washington, D.C.
13. U.S. Department of Energy, 1997, Integrated Data Base for 1996: Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, DOE/RW-0006, Rev.13.
14. U.S. Nuclear Regulatory Commission, 1992, National Profile on Commercially Generated Low-Level Radioactive Mixed Wastes, NUREG/CR-5938, Washington, D.C.
15. U.S. Department of Energy, 1997, 1996 State-by-State Assessment of Low-Level Radioactive Waste Received at Commercial Disposal Sites, DOE/LLW-243, Lockheed Martin Idaho Technologies Company.
16. Code of Federal Regulations, Title 40, Part 264, "Land Disposal Restrictions."
17. Code of Federal Regulations, Title 40, Part 268, "Land Disposal Restrictions."
18. Sullivan, T., 1991, Disposal Unit Source Term (DUST) Data Input Guide, Brookhaven National Laboratory, NUREG/CR-6041, BNL-NUREG-52375.
19. U.S. Nuclear Regulatory Commission, 1997, A Disposition of Cesium-137 Contaminated Emission Control Dust and other Incident Related Material, Final Staff Technical Position, @ Federal Register, 62:13176-13198.