APPROACHES TO DEVELOPING ALTERNATIVE DISPOSAL OPTIONS FOR LOW-ACTIVITY RADIOACTIVE WASTE

D. J. Schultheisz, K. S. Czyscinski, R. M. Ferguson, C. E. Foutes,
J. M. Gruhlke, R. D. Joglekar, A. D. Klinger
U.S. Environmental Protection Agency

ABSTRACT

The Environmental Protection Agency (EPA) recently issued an Advance Notice of Proposed Rulemaking (ANPR) titled "Approaches to an Integrated Framework for Management and Disposal of Low-Activity Radioactive Waste" (68 FR 65120-65151, November 18, 2003) to request public comment on options to promote a more consistent framework for the disposal of radioactive waste with low concentrations of radioactivity ("low-activity"). This paper will summarize the prominent points of the ANPR. EPA collaborated with the Nuclear Regulatory Commission (NRC) in developing the ANPR. Portions of the ANPR address potential regulatory mechanisms for NRC to allow alternative disposal of waste from its (or Agreement State) licensees.

INTRODUCTION

Radioactive waste in the United States has traditionally been regulated based on its statutory definition or origin, rather than its radiological properties, encouraging the misconception that some waste types are inherently "worse" than others. In fact, some wastes, inconsistently regulated, if regulated at all for their radiological properties, can sometimes present higher risks to the public than those more tightly regulated. In addition to inconsistent regulation and risk perception, the current system discourages efficient use of resources and has resulted in limited disposal options.

EPA's ANPR suggests that a consistent risk-management framework can be applied to the disposal of "low-activity" radioactive waste, regardless of its origin. It is important to understand that "low-activity" is at present only a concept. The ANPR discusses methods and considerations that could be applied to define "low-activity". However, the benefits of identifying additional disposal options based on a consistent consideration of risks could include:

- reater and more certain public health protection;
- more efficient use of resources in risk reduction;
- more efficient site cleanups; and
- more consistent disposal decision-making by States (as opposed to case by case decisions).

The disposal technology of particular interest is the hazardous waste landfill permitted under Subtitle C of the Resource Conservation and Recovery Act (RCRA). These landfills have detailed engineering and technology requirements, and are permitted to contain chemically hazardous waste that presents a risk to public health and the environment. This disposal technology has the potential to address several "low-activity" waste streams, as described below.

POTENTIAL “LOW-ACTIVITY” WASTE STREAMS

Low-activity radioactive waste (LARW) includes a wide variety of different waste types all having “low” concentrations of radionuclides. The ANPR focuses on:

- mixed waste, including waste from Department of Energy operations and cleanup;
- waste containing Technologically Enhanced Naturally Occurring Radioactive Material;
- certain wastes from processing uranium or thorium ore (e.g., FUSRAP);
- AEA source material presently exempted from regulation (“unimportant quantities”);
- low-level radioactive waste (LLRW).

As noted above, one positive outcome of the approach under discussion would be a consistent risk basis for evaluating “low-activity” waste, regardless of its origin or place in the current regulatory system. However, for purposes of this discussion, the types of waste listed above are kept distinct because the current requirements for disposal are affected by the origin of the waste.

Mixed Waste

Mixed waste is both chemically hazardous according to RCRA and contains source, special nuclear, or byproduct material as defined in the Atomic Energy Act of 1954 (AEA). The ANPR focuses on mixed low-level radioactive waste. Such waste is regulated and managed under both authorities but under certain conditions, one authority, or set of regulatory requirements, may be sufficient to provide public health and environmental protection. EPA recently took this rulemaking approach in offering a conditional exemption from RCRA requirements if the waste is managed in accordance with NRC or Agreement State requirements (66 FR 27218, May 16, 2001).

EPA is now exploring whether consistent standards can be developed that would allow RCRA hazardous waste landfills to accept “low-activity” mixed waste (LAMW). Mixed waste is the logical starting point for testing this concept, as it is already subject to the RCRA disposal requirements. Additionally, the RCRA-AEA “dual regulation” framework has limited disposal options for mixed waste.

Mixed waste is generated in relatively small volumes in the private sector - utilities, hospitals, pharmaceutical manufacturers, universities, other research and industrial applications. However, the number of small generators (3,000 or more) and the expense associated with waste management and disposal create a disproportionately large regulatory and economic burden. There have been reports that some more scientifically advanced practices are not used because they might generate mixed waste. There is also concern that the limited availability of disposal may lead to inappropriate storage and/or disposal.

The Department of Energy (DOE) generates mixed waste in larger volumes, and also has a significant backlog of waste stored at its sites, some of it for a number of years. There are indications that DOE mixed waste may differ in some fundamental ways from “commercial” mixed waste, because of differences in the generating processes and the predominant radionuclides.

Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)

TENORM wastes take a variety of physical forms, including soil, pipe scale, sludges from water treatment, and residues from the processing of mineral ores. Essentially, any process that involves extracting material from the earth (soil, rock, mineral, and water) brings along the natural radioactivity in that material and has the potential to concentrate it in residues or make it more accessible to human contact and exposure. Common processes that generate TENORM waste (some in far larger volumes than low-level radioactive waste) include:

- mining and mineral processing (ore residues from uranium, copper, zircon, aluminum, titanium, rare earths);
- phosphate mining and processing (phosphogypsum);
- oil and gas production (pipe scale from produced waters);
- pulp and paper production (pipe scale);
- drinking water and wastewater treatment (filter and treatment media, sludges);
- geothermal energy production (pipe scale); and
- coal combustion (ash and clinker).

If the radionuclide content is low enough, TENORM wastes may be appropriate candidates for alternative disposal. Unlike low-level waste, TENORM wastes contain a relatively narrow range of radionuclides, and a number of RCRA-C disposal facilities already accept certain TENORM wastes. However, unlike mixed waste, most TENORM wastes are not regulated at the Federal level. Disposal decisions are made by the States, which may have a variety of authorities (or no explicit authority) to apply. The inconsistency of regulation across States suggests that a consistent approach to evaluating disposal could streamline evaluations of these waste streams and improve their management. Only wastes that meet the specifications derived for the RCRA-C disposal option under consideration would be candidates for disposal under this broader approach. However, this would probably not foreclose States from continuing to use other available mechanisms (such as case-by-case evaluations) to address disposal of higher-concentration TENORM wastes.

Residuals from Uranium or Thorium Processing

Processing ore to remove uranium or thorium (“milling”) leaves a waste material that generally resembles a fine sand. These “mill tailings” were unregulated until 1978, and large tailings piles were subject to misuse and dispersion into the environment. The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) defined mill tailings as “byproduct material” subject to regulation. However, certain tailings generated prior to UMTRCA have been determined to fall outside the jurisdiction of current regulations, though they are for all practical purposes identical to regulated mill tailings. This “pre-UMTRCA” byproduct material has been remediated and disposed in recent years by the Formerly Utilized Sites Remedial Action Program (FUSRAP), although such waste has also been found at Superfund sites. It has generally been disposed of in bulk, shipped in rail cars or trucks, and sometimes used as cover material at landfills. Most tailings are relatively low-activity after extraction of uranium or thorium from the ore material. If the “pre-UMTRCA” tailings in fact fall outside Federal regulations, State authorities would make disposal decisions, similar to TENORM. In certain cases, such wastes have been disposed of at RCRA Subtitle C disposal facilities with the approval of State authorities.

“Unimportant Quantities”

Some wastes under the AEA are exempted from regulation. In particular, the Nuclear Regulatory Commission (NRC) deferred unimportant quantities of source material containing less than 0.05 % by weight uranium or thorium, from its regulation. Certain consumer products and some mining wastes may contain uranium or thorium originating from ores not meeting the 0.05% criterion. For example, zircon contains minute quantities of uranium and thorium and is used in metal molds in foundries and as a glaze for ceramics. Thorium is used to make a more dense glass for prescription glasses. Uranium or thorium may be side products of certain phosphate extraction operations or rare earth mining.

Low-Level Radioactive Waste (LLRW)

LLRW is defined in various federal laws as any AEA radioactive waste that is NOT spent nuclear fuel, high-level waste, transuranic waste, or uranium/thorium mill tailings. Volumes of LLRW have decreased significantly over the past decade or so, and the vast majority of LLRW is in the lowest waste class defined by NRC (Class A), suggesting that a significant percentage might be considered “low-activity” (however, “low-activity” should not be considered synonymous with “Class A”, as some of the Class A limits are quite high).

Low-level waste that is not mixed waste currently has a limited set of disposal options. One disposal site in Richland, Washington is limited to members of the Northwest Low-Level Radioactive Waste Compact (and, by agreement, the Rocky Mountain Compact). The Barnwell, South Carolina disposal facility serves member states of the Atlantic Compact and, for a limited time, other states as well (except North Carolina). (Note that Barnwell recently announced that it has only about 9,100 cubic feet of disposal capacity unreserved through 2008.) Another disposal facility in Utah, the Envirocare site, accepts certain forms of LLRW with limited radionuclide concentrations, subject to oversight by the Northwest Compact. It might be reasonable to consider additional disposal options for low-activity LLRW that do not require the extensive radiation controls of the 10 CFR part 61 licensed sites in Washington and South Carolina or do not meet the physical requirements to be eligible for disposal at Envirocare.

RCRA HAZARDOUS WASTE REQUIREMENTS

In considering the potential use of RCRA hazardous waste landfills for disposal of “low-activity” radioactive waste, a contrast has been drawn between RCRA’s “technology based” approach and the “performance based” approach applied by NRC and DOE to radioactive waste disposal. It would seem, therefore, that a key to assessing the applicability of RCRA to radioactive waste is to understand what is incorporated into RCRA’s “technology based” approach.

RCRA regulations for hazardous waste are in 40 CFR parts 261 to 268. Parts 264 and 268 address requirements for disposal facilities and for treating waste prior to disposal, respectively.

Disposal Facility Construction

The description of RCRA as “technology based” primarily applies to the requirements in 40 CFR part 264 for construction and operation of hazardous waste treatment, storage, and disposal facilities. Subpart N provides specific requirements for hazardous waste landfills. Requirements intended to ensure that RCRA-C facilities limit contact of waste with water (and subsequent leachate generation), include:

Disposal Cell Cap: at closure, a final cover must be installed that minimizes infiltration of liquids, promotes drainage, minimizes erosion, accommodates settling and subsidence, and has permeability no greater than that of the disposal cell liner system or natural subsoils.

Liner System Beneath the Disposal Cell: the liner must be constructed of materials of sufficient strength and thickness to withstand pressure gradients, contact with waste constituents, climatic conditions, and other stresses. The liner system consists of two layers. The top layer must be a geomembrane constructed to prevent the migration of hazardous constituents into the liner. The bottom liner is a composite constructed of at least two layers: the upper layer is a geomembrane, while the lower consists of at least 3 feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec.

Leachate Collection and Removal System: the leachate collection system is located above the top liner. It must be: capable of limiting leachate depth above the liner to 30 cm; chemically resistant to waste constituents; capable of withstanding pressures exerted by overlying materials; and able to function without clogging.

Leak Detection System: the leak detection system is also a second leachate collection system. It is located between the liners (i.e., above the lower, composite liner) and constructed with a bottom slope of 1% or more, using granular drainage materials 12 inches or more in thickness and with a hydraulic conductivity of 1×10^{-2} cm/sec or more. It may also be constructed with synthetic or geonet drainage materials with a transmissivity of 3×10^{-5} m^2/sec or more. It also must be chemically and physically resistant to waste and pressures.

Operational Functions

RCRA is also explicit about how the facility must approach operational functions, both while the facility is operating and during the closure and post-closure phases. In particular, facility operators must follow specific procedures regarding (see 40 CFR part 264):

Inspections: the facility operator must inspect equipment and procedures in accordance with a written schedule (including inspecting the installation of the liner and leachate collection system), must inspect the operation of the landfill after storms, and must inspect the leachate collection system regularly during operation and post-closure.

Recordkeeping: the facility operator must maintain inspection records for at least three years and maintain records detailing the location, dimensions, and contents of disposal cells.

Monitoring/Corrective Action: RCRA regulations have specific requirements for ground-water monitoring of hazardous constituents (40 CFR 264.92-96). Constituents to be monitored, maximum concentrations in ground water, the point of compliance for monitoring, and the compliance period for monitoring are specified in the facility permit. The facility operator must conduct a ground-water monitoring program in accordance with the permit and implement corrective action when a hazardous constituent is detected in ground water at concentrations that exceed those listed in the facility's permit.

Closure/Post-Closure: the facility owner/operator must have an approved closure plan describing how final closure will be done (including decontamination and removal of equipment or waste residues), and minimizing further maintenance needs. In addition, the owner/operator must file a survey plat with the local land-use authorities and the EPA Regional Administrator that shows the location of all hazardous waste units. The survey plat must note that the future land use is restricted in accordance with applicable regulations. The property deed must also state that the site has been used to manage hazardous waste and cite the appropriate future use restrictions. At a minimum, uses that would disturb the integrity of the final cover, the liner, or other parts of the containment system are not permitted unless necessary to protect human health and the environment, or if such uses will not increase the potential hazard to human health and the environment. The facility's owner or operator must also construct the final closure cap to minimize infiltration and erosion and accommodate settling or subsidence with little maintenance (40 CFR 264.310), and must perform maintenance that becomes necessary throughout the post-closure period.

Waste Treatment

The RCRA Universal Treatment Standards (UTS) are located in 40 CFR part 268. Most are in the form of concentration limits of the respective hazardous constituents, but some are in the form of specified treatment technology (particularly in the case of hard-to-treat wastes). The UTS are based on the level of reduction that can be achieved by available technology, not on risk reduction. However, by reducing the concentration of toxic constituents, the practical effect is some reduction in risk.

Waste generators must certify that the waste meets the UTS and has undergone the necessary treatment.

Post-Closure Care Period

RCRA establishes a minimum period of 30 years for facility maintenance and monitoring after closure of the disposal cell (with extensions as necessary to protect human health and the environment). (40 CFR part 264, subpart G) This is significantly shorter than the periods typically discussed in relation to radioactive waste disposal. However, no RCRA disposal facility has gone through the post-closure care period, and there are suggestions from State regulators that it would be unlikely to allow a facility to be released from care after only 30 years. As an example, a commercial RCRA-C landfill undergoing closure in South Carolina has a 100-year period for active monitoring and maintenance in its State-issued permit.

Land Ownership

RCRA allows private ownership of disposal sites, with the possibility of future sale and (limited) reuse. (40 CFR part 264, Subpart G) Restrictions on use and information on the location of hazardous waste are to be in the public record. Reuse is restricted to activities that will not disturb the final cover. NRC licensing under 10 CFR part 61 is contingent on eventual ownership of the site by a Federal or State government entity.

TECHNICAL ANALYSES (MODELING AND MODELING SCENARIOS)

Long-term performance modeling has traditionally been used to assess the safety of radioactive waste disposal sites, and it is reasonable to apply such an approach to examine the capability of the RCRA-C disposal technology to provide long-term containment of low-activity radioactive wastes. Regulations applicable to low-level radioactive waste disposal facilities (10 CFR part 61) do not specify an overall design for a disposal cell; rather, the regulations specify a performance (dose) standard. This means that there are a number of different "designs" proposed or used for low-level waste (ranging from a simple unlined trench to concrete vaults or bunkers, either below-grade or above ground). Any particular design is validated by how well projected doses many years into the future compare with the overall performance standard. Thus, modeling is particularly significant in evaluating a potential radioactive waste disposal facility. By contrast, RCRA disposal relies on technology standards for permitting, and post-closure performance of RCRA facilities as demonstrated through active care (monitoring, maintenance).

Post-closure modeling of low-activity waste in RCRA-C landfills would have two aims. The first is to assess the long-term radionuclide containment ability of the generic RCRA-C design (a basic assessment of safety), using the same validation process as for low-level radioactive waste sites. The second is to derive acceptable radionuclide concentration limits in the wastes for disposal in such a facility.

Exposure Scenarios to be Modeled

To assess potential exposure to the radionuclides in LARW, four basic situations can be identified:

- the gradual degradation of the disposal cell through expected natural processes, which results in radionuclide releases over long periods of time (many hundreds to thousands of years), referred to as the "expected case" (#1a below);
- releases caused by "off-normal" situations, such as unusually high precipitation for a period of years (#1b below);
- exposures caused by human activity that disrupts the disposal site (#2 below); and
- exposures to workers involved in handling LARW (#3 and #4 below).

Long-term Disposal Cell Performance

Long-term performance modeling of the RCRA hazardous waste disposal cell must invoke basic assumptions about the eventual failure of the cap and liner system - to allow water to enter the cell, interact with the wastes, and exit into the surrounding area. Once released, contaminated water would percolate downward through the unsaturated zone above the local water table, eventually reaching it and migrating laterally in the direction of ground-water flow toward a receptor at some distance from the disposal facility. For this conceptual model, the receptor is a person living close to the facility who receives doses from the use of contaminated ground water. Other release and transport pathways would include the surface transport of waste accidentally spilled during operation of the disposal facility. Exposures in scenarios of this type are typically dominated by various uses of ground or surface water, including direct ingestion, irrigation, and consumption of food grown with contaminated water.

With this simple conceptual model, potential releases can be calculated for assumed waste concentrations by specifying the other parameters involved in contaminant transport calculations. Important factors for consideration in the modeling calculations include:

- rainfall rates;
- thickness of the unsaturated zone under the disposal cell;
- distance from the disposal cell to the well supplying water to the receptor;
- drinking water consumption rate and amounts of contaminated food consumed;
- ground-water flow rates;
- ability of the disposal cell cap to control water infiltration;
- ability of the disposal cell liner to retard contaminant movement;

- radionuclide retardation effects (e.g., sorption and solubility constraints); and
- radioactive decay along the flow paths.

These factors are most prominent in modeling the expected case, and “off-normal” situations. Modeling should address a wide range of conditions in arid and humid climatic settings as well as variations in the hydrogeologic conditions listed above. Variations in all these parameters will affect the exposures for the scenarios analyzed. Databases of conditions at actual disposal sites would be used to capture the nationwide variation in various site parameters. Additional sensitivity studies of the modeled scenarios would identify the variables most important to disposal cell performance and hypothetical exposures, and are essential for interpreting the results of disposal cell performance modeling.

- Expected performance case: The disposal cell degrades over time with releases into the underlying unsaturated and saturated zones, and subsequent contaminant migration laterally to a well supplying the water needs of a nearby person. Exposures are calculated from direct ingestion of drinking water and food produced using contaminated ground water. Radionuclide concentration limits in the wastes would be calculated by scaling those exposures against the selected level of protection (a defined exposure limit).
- Off-Normal” Events: Modeling must consider what happens when the system departs from “normal” behavior such as through heavier than normal precipitation over a period of years, alternative cap and liner degradation scenarios, and the possibility that water levels could rise inside the cell. This “bathtub effect” may allow radionuclide concentrations to build up in the accumulated water and releases could contain higher radionuclide concentrations than otherwise expected. In addition, water overflowing the disposal cell could provide a surface pathway for radionuclide transport.

Post-Closure Site Use

Because existing regulations allow RCRA sites to remain privately owned, it is possible that a site could be accessed after closure, particularly if institutional control is lost. People who casually traverse the site, or even spend hours at a time there, would not be expected to receive doses that exceed those calculated for the disposal facility worker (#3 below). However, more extensive use involving a disturbance of the disposal cell must be considered, such as:

- house construction - excavation of some portion of the disposal cell, disturbing the waste layer and scattering contaminated material on the surface. The foundation and basement could be constructed at some depth in the disposal cell, and the resident could engage in small-scale crop production or raise some livestock on the contaminated site. NRC used such a scenario to develop 10 CFR part 61; or
- drilling a well through the disposal cell - some exposure to the driller(s) as contaminated material is brought to the surface, penetrating the waste layer and cell liner and essentially creating a pathway for radionuclides to move through the unsaturated zone to the aquifer.

In its rulemaking for 10 CFR part 61, NRC concluded that extensive inadvertent intrusion was not credible for waste in a structurally stable waste form (as long as the waste remained in a form recognizably man-made, intruders would avoid disturbing it). Intrusion after any solidified waste has broken down or containers have degraded would likely be hundreds of years after closure, suggesting that shorter-lived radionuclides will have decayed. Hazardous constituents that do not degrade over time, such as heavy metals, will still be present and may pose risks comparable to or greater than those from radionuclides.

Unlike long-term evaluations, intrusion exposures are driven by direct contact with the waste and a higher probability of external exposure and inhalation or ingestion of degraded waste material or contaminated soil. Disposal standards typically do not address exposures to a person who intentionally disrupts the waste site.

Disposal Facility Worker

Concentration limits should also consider radiation exposures to workers at a RCRA disposal facility. In this case, exposures to the RCRA-C worker could also be used to gauge public exposures, both during the facility's operational life and after final closure. Assessing worker dose will not rely on excessively speculative exposure scenarios. It is likely that people not directly handling the waste will receive much lower exposures than a worker. Exposure scenarios could include:

- external exposures from handling containers - involving assumptions about how long a worker is exposed, distance from the container(s), number and configuration of containers, and use of a solidification medium (e.g, concrete or polyethylene); and

- internal exposures from inhalation or ingestion - from routine handling of bulk waste (e.g., soil or construction debris) or from an accident involving scattering of previously containerized waste.

Transportation Worker

It might be necessary to consider exposures to a worker involved in transporting waste to the RCRA disposal facility. The transportation worker would most likely be exposed in similar ways to a disposal facility worker who handles waste containers within the facility. Department of Transportation requirements for transportation of radioactive material would be relevant.

Modeling Considerations

Conservatism

The modeling should be appropriately conservative i.e., parameter values should be selected to over-estimate, rather than under-estimate, releases. This helps to account for uncertainty by incorporating an additional margin of safety. However, it would not be appropriate to be overly conservative. Focusing on "worst case" conditions leads to unrealistic modeling results.

"Wet" and "Dry" Sites: some sites have characteristics that lead to "better" performance, such as low precipitation rates and deep ground water tables. The expected better performance of such sites could lead to two options for specifying waste radionuclide concentrations:

- Option 1: Derive a single set of concentration limits for all sites:

- Option 2: Derive a method to distinguish "better" sites:

EPA has provided guidance on a method that allows small and remote solid waste landfills to take site characteristics into account when applying for a no-migration variance. See "Preparing No-Migration Demonstrations for Municipal Solid Waste Disposal Facilities: A Screening Tool," EPA530-R-99-008, February 1999 (available at http://www.epa.gov/osw).

Modeling Timeframe

There is no consensus on the most appropriate timeframe for performance assessments. Periods from 100 years to 10,000 years have been used for various waste disposal methods. One thousand years may be appropriate for LARW since radionuclide concentrations are likely to be so low that modeling longer periods becomes more questionable in the light of expected changes in surface conditions over longer periods. However, the presence of long-lived isotopes in LARW may prompt consideration of longer timeframes.

POLICY AND IMPLEMENTATION

In evaluating alternatives for disposal of "low-activity" waste, a sound technical basis is necessary but not sufficient. Technical analyses (e.g., modeling) answer the question, "How well will (or should) this disposal alternative perform?" but cannot answer fundamental policy questions, such as:

- should the disposal alternative be pursued?
- what must be done to build confidence in the disposal alternative?
- what must be done to make the disposal alternative work in the real world?

Answering these questions requires both a practical approach to implementing a process that ensures protective disposal (what are the rules for disposal?) and a sensitivity to public perception and political climate.

Policy Issues

1. Allowing Alternative Disposal: Several factors will play a role in determining whether to allow a particular disposal alternative, such as whether it is:
    - needed - would it provide a service not now effectively utilized or available? Would it improve management and disposal practices?
    - protective - can it provide the same level of public health and environmental protection as current disposal practices?
    - voluntary - is it another option, or will generators/disposers be required to implement it?
    - restricted - under what conditions will it be allowed? In special cases? More routinely?

Once a decision is made to pursue a disposal alternative, any restrictions or conditions would be translated into specific actions that a generator or disposal facility would carry out (see discussion of implementation issues). However, other considerations may dominate the decision-making process. Some States have restrictions (by statute, regulation, policy, or executive order) on radioactive material disposal, such as prohibiting disposal in unlicensed facilities or in proximity to chemically hazardous waste. In other cases, public opinion may be strongly against any consideration of disposal alternatives, or it might support restrictions that severely limit the value of the approach.

2. Reference Level of Protection: Exposure evaluations typically involve modeling projected radionuclide releases against maximum allowable exposures to individuals (the reference level of protection). The characteristics and lifestyle of the hypothetical exposed individuals are conservatively defined so they receive among the highest projected exposures. For the RCRA-C disposal option, this approach is being used to assess the overall safety of the RCRA-C disposal technology and develop the actual radionuclide concentrations in waste that would define it as low-activity waste. In this way, the safety assessment approach used in the radioactive waste management regulatory framework would be applied to the RCRA-C disposal technology.

These maximum exposure limits (the performance measure used in developing the standards governing the operation of the disposal facility) should reflect the exposure scenario considered, the nature of the waste, other radiation protection standards, and the level of confidence in the disposal approach (i.e., how likely the desired level of protection would be achieved in real life). The reference level need not be the same for each exposure scenario.

Implementation Issues

There are a number of practical considerations in making an alternative disposal approach work at the generator or disposal facility level. For “low-activity” waste disposal at RCRA facilities, these considerations primarily involve reconciling the different approaches embodied in the RCRA and AEA requirements. The discussion below touches on regulatory mechanisms that could be used and some specific actions that could be taken to implement the approach and build confidence that it can be successful.

1. Regulatory Oversight Mechanisms

    - Use of the RCRA Permit: RCRA facilities already have permits that describe acceptable waste, as well as monitoring, maintenance, and other administrative requirements. Some RCRA facilities already have radiation-related provisions in their permits, such as those that accept certain TENORM wastes. In other cases, implementing this approach could involve a permit modification.
    - NRC Regulation for AEA Materials: NRC has several options available for addressing RCRA disposal of AEA material. These include regulating the disposal facility through a license (general or specific) or exemption to possess AEA material, and/or regulating the waste generator to ensure meeting appropriate waste acceptance criteria for disposal.
    - State Controls: States may have authorities other than the AEA and RCRA authorities delegated to them to apply to low-activity wastes.

2. Specific Implementation Actions: additional conditions could be placed, either on the waste acceptance criteria (and considered in modeling and deriving radionuclide concentration limits) or on the facility operation (and long-term acceptability of the disposal option), as listed below.

    - Waste Acceptance Considerations: there are a number of ways to ensure that waste is truly “low-activity” and to increase confidence that the modeling will adequately project facility performance, including:

    - limit “low-activity” to Class A concentrations as an upper limit (only if limits determined by the other conservative modeling methods described earlier exceed these levels, which is not expected);

    - waste form/packaging requirements;

    - impose facility activity or volume caps;

    - impose the unity rule (i.e., “sum of the fractions”);

    - generator analyses/certification; and

    - disposal facility sampling.

3. Facility Assurance Measures: conditions to help ensure a facility operates and is maintained appropriately could include:

    - extended post-closure care requirements;
    - government site ownership;
    - explicit ground-water monitoring;
    - notification and record-keeping; and
    - segregation of radioactive and hazardous wastes.

NON-REGULATORY APPROACHES TO LOW-ACTIVITY RADIOACTIVE WASTE

The conceptual approach under consideration relies on regulatory actions, which would grant new flexibility (that is, it would allow actions not possible under the existing regulatory structure). Regulations would also provide assurance to the public that disposal is conducted in a safe manner, as well as provide a measure of protection for generators and disposal facility operators. LARW generators or disposal facilities could choose not to take advantage of the additional disposal options. However, perhaps not all of the candidate low-activity waste streams could be addressed through a single regulatory action or authority. Therefore, actions that do not involve rulemakings or other regulatory methods may be effective in addressing issues related to LARW disposal.

Advantages and Disadvantages of Non-Regulatory Approaches

A regulatory approach has the advantage of providing assurance to the public that a protective practice is executed, through imposed requirements on those managing the waste, and potential enforcement mechanisms if the requirements are not followed. In addition, regulatory requirements provide waste managers a measure of assurance that their operations are less liable to legal challenges later, as long as they followed the regulatory requirements.

However, a prime complaint about regulatory programs is that they are too prescriptive and limit the flexibility of the regulated parties in meeting goals. Regulations can also limit the flexibility of regulatory agencies in improving the effectiveness of the program, because modifying a regulatory program takes significant time and resources unless flexibility is initially built into the regulatory framework. In addition, enforcement actions, while necessary to maintain the integrity of the program, by their very nature often result in adversarial relationships with limited trust. In short, the burden of regulatory programs to all parties can sometimes outweigh the positive benefits.

These concerns can sometimes be offset by offering a “non-regulatory” alternative to achieve the same overall goals. Non-regulatory approaches typically take one of two forms. The first offers the regulated community an opportunity to show that it can perform at least as well, and preferably better, with some flexibility in current regulations. For example, an individual regulated entity will work with the regulatory agency to identify specific regulatory requirements that it believes are preventing it from implementing an innovative waste treatment or new production method, or are simply hampering its full potential in achieving environmental results. Program participants must justify continued regulatory flexibility by demonstrating those results. EPA’s Project XL is a program of this type that is aimed at “superior” environmental performers.

The other common non-regulatory approach is more focused on encouraging desirable outcomes through recognition or other incentives. EPA’s Energy Star program, for example, involves manufacturers of computers and other appliances in a voluntary partnership to encourage energy efficiency and conservation. If their products meet the standards for the program, participating companies may advertise their status as “Energy Star” companies and label their products accordingly. The companies benefit from their image as environmentally responsible and consumers benefit from having a clear choice of products that use less energy. In a broader sense, certification under the ISO 14000 standards for environmental management serves the same purpose.

While these types of programs can clearly be successful, it is not clear that these approaches could be effectively applied to waste disposal in general, or to LARW disposal in particular. The first approach relies on a well-developed regulatory infrastructure and is typically applied on a case-by-case basis. If such a regulatory infrastructure already existed that could provide a common basis for identifying additional options for LARW disposal without regard for the origin of the waste, EPA would not have issued its ANPR. Similarly, case-by-case evaluations are now being done (e.g., to allow a specific radioactive waste to be disposed at a RCRA-C facility), but they are costly and time-consuming. The necessary resources could be used more effectively if these wastes were evaluated more consistently.

The second approach described above is most effective when incentives can be used (possibly in place of regulation) to encourage program participants to provide more environmentally responsible goods and services, or to operate their programs in a more responsible way. However, if it is to be protective, waste disposal must be a regulated practice to establish benchmarks against which alternative practices can be judged as demonstrably equivalent or “superior”, and the feasibility of a voluntary incentive program targeted to LARW without the underlying regulatory framework is not obvious. Once a regulatory framework is in place, however, it may be easier to identify incentives that will influence the use of a LARW disposal option, as suggested below.

Potential Non-Regulatory Approaches

Develop Guidance

While establishing Federal regulations for pre-1978 mill tailings and TENORM wastes faces certain hurdles, establishing guidance may achieve many of the same goals but without a complex regulatory framework. While guidance does not have the enforcement “teeth” of a regulation, guidance does provide a common reference point for acceptable waste management. With a guidance in place, generators, disposal facilities, and regulatory authorities may find it easier to identify appropriate disposal options; at the same time, regulatory agencies sometimes come to view guidance as a de facto regulation (i.e., “the only way to do it” rather than “one acceptable (or suggested) way to do it”). Another question is what kind of guidance would be most appropriate, and who should issue that guidance. It may be possible to establish Federal guidance for both pre-1978 mill tailings and TENORM wastes, but Federal guidance has traditionally been used to guide Federal agencies in matters related to radiation protection. Given that not all of this material falls under Federal agency purview, the usefulness of Federal guidance for pre-1978 mill tailings and TENORM may be limited, although there certainly are examples of Federal guidance being applied more broadly. While not Federal guidance, strictly speaking, EPA has published suggested guidance for dealing with the radioactive residues from treating drinking water. (See 56 FR 33091, July 18, 1991.) Whether a unified guidance applicable to both pre-1978 mill tailings and TENORM wastes is possible and practical is open to question. Perhaps joint State-Federal guidance would be appropriate to cover both pre-1978 mill tailings and TENORM wastes: however, developing such guidance may not be possible in the face of widely differing State regulations on these wastes.

Partner with Selected Stakeholders to Develop Waste-Specific "Best Practices"

An alternative approach to guidance might be a partnership between Federal, State, and industry representatives to establish "best practices" targeted to specific industries or waste types. Again, lacking the "teeth" of a formal regulation, a code of "best practice" creates a common reference point of accepted practice that brings additional attention to those entities failing to abide by such a code. Establishing such best practice that is endorsed and used by the industries in question may also lessen the need for formal regulation and result in cooperation rather than confrontation. It is possible that industry could establish an in-house panel of recognized experts and affected stakeholders that would develop, monitor, and facilitate the implementation of best practices by companies within a given industry, even allowing the use of the panel's code of "best practices" logo to companies abiding by this code. This might work in a manner similar to EPA's Energy Star program, as noted above. However, the wide range of sources for these wastes may well pose insurmountable difficulties in developing consensus on truly protective treatment and disposal practices. Further, although "best practices" may be agreed upon, there is no assurance that they would be applied in all cases.

An Example?

In an action that combines aspects of the guidance and "best practices" approaches, EPA recently issued a "Guide for Industrial Waste Management" (EPA530R-03-001). EPA joined with members of State governments, tribes, industry, and environmental groups to develop this guidance on how best to manage non-hazardous industrial solid wastes, which are generated in much larger volumes than municipal solid wastes. The Guide is intended to be a practical resource, covering engineering and scientific principles applicable to developing and operating waste management units, effective communication, risk assessment, and other topics. Computer models and other tools are included in the Guide, which is also available on CD-ROM (EPA530-C-03-002).

CONCLUSION

Identifying additional disposal options for "low-activity" radioactive waste has the potential to improve radioactive waste disposal. Applying consistent risk analysis methods to waste, regardless of its origin, should improve efficiency and provide greater and more certain public health and environmental protection. The technical challenge of demonstrating the ability of disposal facilities, such as RCRA-C hazardous waste landfills, to contain low concentrations of radioactive material is significant. However, the challenge of building public confidence that such disposal is appropriate and protective may be greater still.

FOOTNOTES

See http://www.epa.gov/epaoswer/non-hw/industd/index.htm for more information.