

must satisfy the licensing authority that they can meet these limits through long-term performance assessments. The performance assessment evaluates the projected inventory of radionuclides in the disposal cell at closure and models the movement of those radionuclides in the environment using site-specific conditions.

RCRA considers risk when deciding which wastes should be defined as hazardous. RCRA evaluates how individual constituents, when land disposed, will behave in the environment over long periods of time. Listed wastes (those designated by F, K, P, or U waste codes) automatically include substances that have a lifetime cancer risk of  $10^{-4}$  or higher to a nearby receptor (*i.e.*, exposures to the contaminant would cause a fatal cancer to one person or more in a population of 10,000). RCRA lists substances with a lifetime cancer risk between  $10^{-4}$  and  $10^{-6}$  on a case-by-case basis. It does not list those substances with a lifetime cancer risk less than  $10^{-6}$  (*i.e.*, fewer than one in 1,000,000). For non-cancer toxic effects, if the concentration of the constituent in leachate exceeds the drinking water treatment standard for that constituent (*i.e.*, the "Hazard Quotient" is greater than or equal to 1), the waste is listed as hazardous. Toxicity characteristic wastes (designated by the D waste code) are defined at the concentration that corresponds to a  $10^{-5}$  lifetime fatal cancer risk. In determining whether to list a waste as hazardous, RCRA does not focus on individual site characteristics, but conducts generalized assessments that consider climatological and hydrogeological variations around the country along with how much of a particular waste is generated and how many sites across the country might accept such waste, and does not credit the engineered features required in the regulations (as we would expect to do for LAMW).

Since 1998, hazardous waste must meet the Universal Treatment Standards (UTS) in 40 CFR part 268 before being land disposed. The UTS are constituent-specific concentration or treatment technology standards that effectively reduce the toxicity, although the waste must still be disposed of as hazardous. Our recent Hazardous Waste Identification Rule (HWIR) effort is intended to establish risk-based constituent concentrations at which listed hazardous wastes could "exit" regulation under Subtitle C. They could then be disposed of as "solid waste" under Subtitle D.

In sum, both the NRC and RCRA approaches serve to limit the risk to the

public from waste disposal. Although we plan to conduct modeling of the disposal cell (that may combine aspects of the site-specific and generalized approaches), we will also examine the NRC and RCRA disposal regulations to support the modeling efforts.

### 3. Modeling Scenarios

The modeling effort would have two aims. The first aim would be simply to assess the performance of the generic RCRA-C design in terms of long-term radionuclide containment. The second aim would be to derive limits for radionuclide concentrations in the wastes to be disposed of in such a facility. Both NRC and EPA will have to be satisfied with the modeling to successfully implement this approach. EPA's modeling approach is detailed below and will be coordinated with the NRC.

*a. Situations to be Addressed.* The initial step in a risk or dose assessment is to determine how a person might be exposed to the material in question. If there is no exposure, as for the period when waste is contained and isolated within an intact disposal cell, the risk or dose will be zero. There are four situations that could result in human exposures to the radionuclides in low-activity mixed waste:

- The gradual degradation of the disposal cell through expected natural processes, which results in radionuclide releases over long periods of time (100 years or more);
- Releases caused by "off-normal" events, such as unusually high precipitation over a period of years;
- Exposures to RCRA disposal facility workers handling LAMW; and
- Exposures caused by human activity that disrupts the disposal site.

These scenarios are discussed in more detail in the following sections. We request comment on the adequacy of these scenarios and whether there are others we should consider. We recognize that similar scenarios could be used to describe potential exposures to the hazardous constituents already handled at the facilities under consideration, and that such exposures may be of equal or greater risk than would be presented by radionuclides; however, our purpose in this discussion is to determine the best way to demonstrate that the RCRA technology is adequately protective for radionuclides.

#### *b. Long-term Disposal Cell*

*Performance.* i. General Discussion. To model the long-term performance of the RCRA hazardous waste disposal cell, assumptions must be made about the initiation of failure of the cap and liner

system to allow water to enter the cell, interact with the wastes, and exit the disposal cell to the surrounding area. Once released from the disposal cell, contaminated water would percolate downward through the unsaturated zone above the local water table, eventually reaching the water table 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 pathways of exposure would include the surface transport of waste accidentally spilled during operation of the disposal facility.

With this simple conceptual model, potential releases from the disposal cell 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 from the contaminated well and amounts of contaminated food consumed;
- Ground-water flow rates;
- Effectiveness of the cap in controlling water infiltration and the liner in retarding contaminant movement;
- Radionuclide retardation effects (primarily sorption into the geologic media and solubility constraints); and
- Radioactive decay along the flow paths.

To test the performance of the disposal cells, we would model a wide range of site-specific conditions in arid and humid climatic settings as well as variations in hydrogeologic conditions, such as variations in the thickness of the unsaturated zone below the disposal facility and ground-water flow rates in the saturated zone. Variations in all these parameters will affect the exposures incurred by the receptor for the scenarios analyzed. We would expect to base our modeling on data available for actual sites in order to capture the variation in various site parameters. We could use the data for DOE sites, because they represent a wide range of climatic and hydrogeologic conditions across the nation, and because they are relatively well-characterized and a good data base of site-specific conditions is available for them. We also could use site data