

also expect to examine performance over longer times (e.g., up to 10,000 years) to see how well a 1,000 year modeling period captures the behavior of most radionuclides. There is no consensus on the most appropriate time for performance assessments. Periods from 100 years to 10,000 years have been used in assessments for various waste disposal methods. While NRC regulations do not specify a time period in 10 CFR part 61, NRC guidance in "A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities," NUREG-1573 (2000), endorses a 10,000-year modeling period for licensed LLRW sites. However, NRC generally uses a 1,000-year period for assessing the dose consequence of residual radioactive material at the time of license termination. NRC has its radiological criteria for license termination in 10 CFR part 20, subpart E. The 1,000-year period is typical for evaluations of low-level waste disposal (as opposed to high-level waste or spent fuel disposal, which generally focus on much longer time periods), and is specified by DOE for performance assessments at its disposal facilities (DOE Manual 435.1-1, "Radioactive Waste Management Manual"). However, some believe that modeling for low-level radioactive waste must also look at periods well beyond 1,000 years (to 10,000 years or longer) to fully address the possibility of significant change to the site from erosion or other long-term or cyclic processes. Others believe that a modeling period of 1,000 years or longer stretches the credibility of what modeling can reasonably project, and that at most it is possible to examine with confidence only a few hundred years (particularly with near-surface facilities, which are more easily affected by climatic or geologic changes than are deep subsurface facilities). We believe that 1,000 years may be appropriate because it is likely that the rule will involve such low radionuclide concentrations that the value of modeling over longer periods becomes more questionable in the light of expected changes in surface conditions over longer periods. It may also be appropriate to consider periods on the order of 100 years as more consistent with the RCRA approach to post-closure site care. We request comment on the appropriate timeframe for modeling.

*c. "Off-Normal" Events.* In assessing the long-term performance of the disposal cell, we typically use fairly well defined climatic conditions (e.g., precipitation rates) and incorporate assumptions about the behavior of the

engineered cap and liner. However, we must also consider what happens when the system departs from "normal" behavior. Situations to be examined would include heavier than normal precipitation over a period of years (or possibly the indefinite future), alternative cap and liner degradation scenarios, and the possibility that the rate of water entering into the disposal cell would exceed the rate exiting the cell, causing water levels to rise inside the cell. In such a situation (also known as the "bathtub effect"), waste remains in contact with water and radionuclide concentrations can build up in the water collected in the disposal cell, so that when releases to the subsurface occur, radionuclide concentrations are higher than they would be if the water spent less time in contact with the waste. Alternatively, continued heavy precipitation could cause the water level to overflow the disposal cell, providing a surface pathway for radionuclide transport.

*d. Disposal Facility Worker.* For radionuclides that remain immobile under the off-site exposure modeling described above (i.e., those that do not reach the receptor well within the modeling period, even with conservative transport assumptions), there must be another means of developing waste concentration limits. One approach that might be considered is the possible exposure that workers at the RCRA disposal facility might receive because of radiation from the waste material. In this case, exposures to the RCRA-C worker would also serve as a benchmark for public exposures, both during the facility's operational life and after final closure. Assessing worker dose will allow estimations of exposures to the public without relying on excessively speculative exposure scenarios; as discussed below, we believe that anyone who is not directly handling the waste will receive much lower exposures than would be expected of a worker.

The worker exposure analysis being considered would serve two functions. First, it would limit potential exposures to the general public in a manner that is generally consistent with the risk management approach for radiation exposure to members of the general public that EPA uses in its regulatory programs and NRC uses at fully-licensed low-level waste disposal facilities. We would expect exposures to people not directly handling waste to be much less than the exposures considered as a reference level for modeling. We believe that this will ensure that actual exposures to true members of the general public, such as visitors during

the operating life of the facility, will be minimal. We believe such an approach is appropriate for the disposal of low-activity mixed waste under this proposal. Second, it should provide a reasonable basis for NRC, and Agreement States, to determine whether significant additional worker protection requirements beyond those of RCRA are necessary. Specifically, whether NRC should consider requiring inclusion of training, personal dosimetry, record keeping and reporting, in its regulatory approach. The goal is to identify radionuclide concentrations that are low enough for the NRC to conclude that it is unnecessary to consider RCRA workers as occupational workers under NRC regulations. We also note that workers handling AEA material are subject to NRC's occupational radiation standards, rather than Occupational Safety and Health Administration (OSHA) standards. Workers handling non-AEA material are subject to the ionizing radiation standards issued by OSHA, which are found in 29 CFR 1910.1096. We anticipate that NRC's consideration of worker protection requirements would be likely to address the necessary elements of the OSHA requirements.

We emphasize that we do not intend to set a standard for worker exposure. However, we are considering modeling several worker exposure scenarios to assist in setting the radionuclide concentration limits for LAMW. Some scenarios might assume that the waste already has been treated and stabilized in a cement/concrete mixture, or in a less dense medium such as polyethylene. This would mean that the radionuclides most likely to be limited by a worker scenario are those that emit strong gamma radiation. Alpha, beta, and weak gamma emissions are not as likely to be able to escape the stabilized waste form to expose the worker. However, we are also considering scenarios involving bulk waste that is neither solidified nor containerized. These scenarios would present a greater risk of waste becoming airborne, leading to exposure by inhalation or ingestion. In such cases, the alpha, beta, and weak gamma emissions would be of more importance than for stabilized waste forms. We seek comment on the proportion of bulk waste that might be disposed under this rulemaking.

*e. 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 through pathways similar to a disposal facility worker who handles waste containers within the facility. In