

concentrations in the waste on a worker exposure analysis ensures that people at or near the site while waste is being handled are not exposed to unacceptable levels of radiation (*see* section II.D.3.d). Also, we expect that exposures to people who might be at the site after the facility is closed would be well within acceptable public dose limits. The radionuclide concentrations in the mixed waste will be based on levels that are bounded by the risk management approach for radiation exposure to members of the public that EPA uses in its regulatory programs and NRC uses at licensed low-level waste disposal facilities. There are a range of possible exposure levels that could be considered to be consistent with EPA risk management policies. We believe setting dose or risk limits within these values will be appropriate for the disposal of mixed waste under the approach. We, in cooperation with the NRC, intend to select exposures that should result in concentration limits that will be protective for all RCRA-C facilities, should minimize the need for additional NRC requirements, and will help generators to dispose of a considerable portion of their mixed waste.

Numerous factors will play a role in deciding what reference exposure levels should be used. Many of these factors reflect prior Federal and non-Federal risk management decisions related to radioactive waste management and disposal, supporting technical information, and risk levels applied under different statutory and regulatory actions. The regulatory approach selected by NRC may be an important factor.

When we use the term "risk" in general, we are talking about correlating exposures to contaminants with health effects resulting from those exposures. Risk is often expressed as the likelihood of an exposure resulting in a given health effect within a population. A risk of 10^{-4} for example, means that a level of exposure will cause (on average) a health effect in one person out of a population of 10,000. Where radiation is concerned, there are two basic ways to

express this correlation (radiation risk focuses on cancer, either incidence or fatality). Radiation protection standards (including those issued by EPA) have traditionally been written in terms of dose (*e.g.*, in millirem), which is an expression of the physical effect on body tissue of the energies transmitted by radiation. Dose can be translated to risk; however, there have been a number of different ways to calculate dose (*see* Table 1), and the correlations with risk are affected by the dose system used. Our current estimates are that an annual committed effective dose equivalent of 15 millirem (mrem), incurred each year for a period of 30 years, carries a lifetime risk of fatal cancer of approximately 3×10^{-4} (3 in 10,000). This is an "average" dose, and the correlation will differ for individual radionuclides (*i.e.*, taking each radionuclide separately, the lifetime risk associated with an annual exposure of 15 mrem may be somewhat higher or lower than $\times 10^{-4}$). It is generally estimated that the average person in the United States can expect to receive an annual dose of about 300 mrem from natural sources, such as cosmic radiation, radon, and naturally occurring radionuclides in soil, rocks, and building materials.

The other way to express this correlation is to calculate risk directly. This is the approach used by our Superfund program in determining cleanup levels, and applies methods developed more recently than the dose-to-risk correlations. The differences in risk estimates using the two methods can be significant for some radionuclides; however, in some cases the direct risk calculation is higher, in other cases the conversion from dose gives the higher risk. The dose-to-risk method is more familiar to the radiation community and consistent with radiation protection standards, while the direct calculation of risk is more consistent with the way non-radiation hazards (such as RCRA hazardous waste) are evaluated. We request comment on which method should underlie the calculation of radionuclide concentration limits in LAMW.

To provide perspective, we examined risk management decisions we made in areas other than radiation risk. Though the RCRA corrective action standards do not specify radionuclides (61 FR 19432, May 1, 1996), cleanup levels are to be determined on a site-by-site basis, using other promulgated standards where appropriate. Generally, EPA considers 10^{-4} to 10^{-6} to be the acceptable lifetime risk range for all contaminants. However, the preference is for remedies at the lower (more protective) end of the risk range; 10^{-6} is considered a point of departure, and applying situation-specific factors may result in risk within the target range but above 10^{-6} . The RCRA corrective action standards also are designed to be consistent with Superfund.

In order to provide context for the reference exposure levels that will be used to derive the limiting radionuclide waste concentrations, we list current EPA and NRC radiation limits in Table 1, which are given in terms of dose. It is important to understand that some of these limits are in the "whole body" format, while other, more recent limits are in the "effective dose" format. Further, the "committed" effective dose (CED) explicitly accounts for internal radiation contributions from radionuclides remaining in the body from earlier intakes (the "total" effective dose equivalent, or TEDE, has a similar purpose). The dose under the "old" format translates into different doses for different radionuclides under the "new" format. The translation depends on how a particular radionuclide distributes itself throughout the body. Iodine, for example, preferentially deposits in the thyroid, which is a very small organ. Iodine's effective dose at the 4 mrem/year whole body or any organ Maximum Contaminant Level (MCL) for drinking water is less than 1 mrem/year. However, in an evaluation completed in December 2000, we reaffirmed that the radionuclide MCLs derived from a 4 mrem/yr whole body dose generally fall within our target lifetime risk range of 10^{-4} to 10^{-6} when more recent risk assessment methods are applied (65 FR 76716, December 7, 2000).

TABLE 1.—CURRENT EPA AND NRC RADIATION DOSE LIMITS

Uranium Fuel Cycle (40 CFR 190.10(a))	25 mrem/year whole body, 75 mrem/year thyroid, mrem/year any other organ.
Generally Applicable Standard for Management and Storage of Spent Nuclear Fuel (SNF) and High Level Waste (HLW) (40 CFR 191.03).	25 mrem/year whole body, 75 mrem/year thyroid, mrem/year any other critical organ.
Land Disposal of Low-Level Radioactive Waste (10 CFR 61.41)	25 mrem/yr whole body, 75 mrem/yr thyroid, 25 mrem/yr any other organ.
Decommissioning Nuclear Facilities (10 CFR 20.1402)	25 mrem/yr TEDE, all pathways (unrestricted use, although use of alternative criteria may allow up to 100 mrem/yr TEDE)).
Generally Applicable Individual-Dose Standard for Disposal of SNF and HLW (40 CFR 191.15).	15 mrem CED/year.