# Recertification CARD No. 55
## Results of Compliance Assessments

BACKGROUND

The individual and groundwater protection requirements place limitations on both the potential radiation exposure of individuals and the possible levels of radioactive contamination of groundwater due to disposal of waste in the Waste Isolation Pilot Plant (WIPP).  The individual protection requirement focuses on the annual radiation dose of a maximally exposed hypothetical person living on the surface just outside the boundary to the accessible environment.  In particular, Section 194.55 requires that WIPP be constructed in such a manner as to provide a reasonable expectation that, for 10,000 years after disposal, undisturbed performance of the disposal system will not cause the annual committed effective dose equivalent (hereafter simply called "dose") to exceed 15 millirems (150 microsieverts) to any member of the public in the accessible environment.  Section 194.55 also requires that underground sources of drinking water be protected at least to the extent prescribed by the Safe Drinking Water Act regulations at 40 CFR Part 141.

REQUIREMENTS

(a) "Compliance assessment shall consider and document uncertainty in the performance of the disposal system."

(b) "Probability distributions for uncertain disposal system parameter values used in compliance assessments shall be developed and documented in any compliance application."

(c) "Computational techniques which draw random samples from across the entire range of values of each probability distribution developed pursuant to paragraph (b) of this section shall be used to generate a range of:

> (1) Estimated committed effective doses received from all pathways pursuant to §194.51 and §194.52;
>
> (2) Estimated radionuclide concentrations in USDWs pursuant to §194.53; and
>
> (3) Estimated dose equivalent received from USDWs pursuant to §194.52 and § 194.5."

(d) "The number of estimates generated pursuant to paragraph (c) of this section shall be large enough such that the maximum estimates of doses and concentrations generated exceed the 99th percentile of the population of estimates with at least 0.95 probability."

(e) "Any compliance application shall display:

(1) The full range of estimated radiation doses; and

(2) The full range of estimated radionuclide concentrations."

(f) "Any compliance application shall document that there is at least a 95 percent level of statistical confidence that the mean and the median of the range of estimated radiation doses and the range of estimated radionuclide concentrations meet the requirements of § 191.15 and Part 191, Subpart C of this chapter, respectively."

## 1998 CERTIFICATION DECISION

### 194.55(a)

In the Compliance Certification Application (CCA), the U.S. Environmental Protection Agency (EPA or Agency) found that the U.S. Department of Energy (DOE) considered uncertainty in two ways:  1) by assigning probability distributions to 57 of the key parameters that describe the repository, and sampling from them in carrying out the PA (CCA Chapter 6, pp. 6-21 to 6-23 and 6-173 to 6-199, and CCA Appendix PAR);  and 2) by translating from ground water contaminant level to doses by means of the bounding analysis (CCA, Chapter 8 and Docket A-93-02, Item II-I-10).

DOE's method of evaluation of uncertainty in the amounts of contaminants transported underground was essentially the same as that for the 300 scenarios involving human intrusion in the PA, as presented in CCA, Chapter 6.1.2, except that those uncertainties introduced by the borehole drilling process can be ignored.  EPA found this aspect of the treatment of uncertainties to be satisfactory.

EPA reviewed the bounding calculation as presented in CCA, Chapter 8 and supplementary information (Docket A-93-02, Item II-I-10) and reported the results of that evaluation in 2004 Compliance Recertification Application (2004 CRA) CARD 51/52—Consideration of Protected Individual and Exposure Pathways. EPA determined that DOE's conceptual model and the use of the GENII-A computer code to calculate radiation doses were appropriate.  EPA found this bounding calculation to be acceptable in lieu of further uncertainty analysis.

### 194.55(b)

The probability distributions for uncertain disposal system parameter values used for demonstrating compliance with the individual dose and ground water requirements of Section 194.55 are identical to those used for the containment requirements in §191.15.  EPA concluded that DOE in the CCA provided general information on probability distributions, data sources for parameter distribution, forms of distributions, bounds, and importance of parameters to releases.
EPA initially raised concerns about the completeness of the list of CCA PA parameters, the description and justification that support the development of some code input parameters,

and the traceability of data reduction and analysis of parameter records. DOE improved the documentation in the Sandia National Laboratories (SNL) Record Center in Albuquerque, New Mexico, of the basis of parameters, and also developed better "roadmaps" that link parameter documentation and parameter development. Upon subsequent review of records in the SNL Record Center, EPA determined that DOE adequately provided the required information for probability distributions of code input parameters.

**194.55(c)**

EPA examined DOE's use of the Latin Hypercube Sampling (LHS) procedure, EPA found that the LHS technique draws samples from the entire range of each sampled parameter, is appropriate for use in assessing the concentrations of radionuclides in ground water, and was implemented correctly by DOE.

DOE's evaluation of individual doses and ground water radionuclide contamination and assessment of underground sources of drinking water were described in Chapter 8 of the CCA. EPA evaluated the conceptual model that DOE used to estimate a maximum individual exposure in its bounding calculation. EPA determined that DOE's conceptual model and the use of the GENII-A computer code to calculate the radiation doses were appropriate.

**194.55(d)**

The number of estimates generated must be large enough so that the probability is at least 0.95 that at least the maximum estimate exceeds the 99th percentile of the population of estimates. If the 300 realizations were statistically independent, then the probability that the maximum estimate exceeds the 99th percentile of the population of estimates would equal $1 - (0.99)300 = 0.951$, and the Section 194.55(d) criterion would be satisfied. The LHS method is designed to cover the wide range of possible parameter values better than simple random sampling. On that basis, the probability that the maximum LHS estimate exceeds the 99th percentile of the population of estimates exceeded 0.95, and the Section 194.55(d) criterion were satisfied.

The determination of the groundwater concentration and individual dose is based on the performance assessment (PA) analysis of releases to the Salado interbeds. Therefore, the number of estimates of concentrations and doses due to releases to the interbeds is the same as the number in the PA and is dependent on the same calculations.

**194.55(e)**

Section 194.55(e) requires DOE to display the full ranges of estimated doses and concentrations. EPA found that:

-The estimated doses caused by ingesting water from the USDW were reported in CCA Table 8-2. The maximum estimated dose rate from the other relevant pathways (0.46

mrem/year) was reported in a DOE response document (Docket A-93-02, Item II-I-10, Enclosure 2h). The all-pathway individual doses were obtained by adding 0.46 mrem/year to those values. The maximum annual dose obtained in this fashion was less than 1 mrem/year (0.93 mrem/year).

-The CCA, Section 8.2.3, p. 8-15, states that the maximum estimated radium concentration across the nine, non-zero, realizations is 2.0 pCi/L.

-Table 8-1 of the CCA contains the 300 estimated concentrations for the five radionuclides 241Am, 239Pu, 238Pu, 234U, and 230Th, of which only nine were above the selection criteria. The nine 226Ra concentrations were not separately recorded, but the maximum gross alpha particle concentration, including radium and excluding radon and uranium, was reported as 7.81 pCi/L. The confidence interval analysis described below under Section 194.55(f) used a more conservative approach that added the total radium concentration bound (2.0 pCi/L) to the total of the five radionuclide concentrations, including uranium.

-The 300 USDW dose estimates were reported in CCA Table 8-2.

EPA found DOE's calculations to be conservative.

**194.55(f)**

EPA required DOE to perform a Performance Assessment Verification Test (PAVT) using modifications to the parameters and codes used in PA. DOE performed additional compliance assessment calculations of individual dose and radioactivity concentration as part of the PAVT. The mean dose calculated in the PAVT from all pathways was an order of magnitude below the limit of Section 191.15. Because all radionuclides contributing to the dose were alpha-emitting, the PAVT also indicated compliance with the annual dose equivalent to the total body or any internal organ from beta particle and photon radioactivity in USDWs. The mean radionuclide concentrations calculated in the PAVT for alpha-emitting radionuclides (including radium 226 but excluding radon and uranium) and for radium 226 and radium 228 were below the limits of Subpart C of Part 191.

DOE was required to demonstrate that there is at least a 95 percent level of statistical confidence that the mean and the median of the range of estimated radiation doses are less than 15 millirem per year, and that the range of estimated radionuclide concentrations are compatible (after dilution, as discussed above) with the regulations developed under the Safe Drinking Water Act. DOE's bounding analysis indirectly verified these requirements by showing that the maximum estimated dose or concentration was always lower than the maximum allowable value.
As with the CCA, the PAVT involved groundwater modeling simulations for the undisturbed repository. The results of this modeling projected non-zero groundwater concentrations for only 13 of the 300 modeling simulations (as opposed to 9 in the CCA PA). The projected groundwater concentrations from the PAVT are found in "Summary of EPA-

Mandated Performance Assessment Verification Test (Replicate 1) and Comparison with the Compliance Certification Application Calculations, July 25, 1997" (Docket A-93-02, Item II-G-26) and "Supplemental Summary of EPA-Mandated Performance Assessment Verification Test (All Replicates) and Comparison with the Compliance Certification Application Calculations" (Docket A-93-02, Item II-G-28).  EPA found that the mean and median radionuclide concentrations in ground water calculated in the PAVT complied with the requirements of Subpart C, Part 191, both for gross alpha particle radioactivity (including radium-226 but excluding radon and uranium) and for radioactivity concentration for radium-226 and radium-228 (Docket A-93-02, Item V-B-26).

Drinking water and all-pathways doses corresponding to projected ground water concentrations in the PAVT were estimated using the modeling methodology established for the CCA.  DOE initially submitted results for the drinking water pathway only, where the largest dose value was $3.2 \times 10^2$ mrem/y (Docket A-93-02, Item II-G-39, Table 3).  Later, in its "Summary of the EPA-Mandated PAVT Results for Individual Protection Requirements," DOE calculated $3.1 \times 10^2$ mrem/y for all other pathways combined (Docket A-93-02, Item II-G-40, Table 5).  This calculation again resulted in value orders of magnitude less than the 15 mrem/y requirement.  EPA's calculation of the total body dose from DOE's concentrations for the 13 non-zero realizations yielded a maximum value of $3.1 \times 10^1$ mrem/y (Docket A-93-02 Item V-B-25).

DOE's PAVT analysis of beta, electron, and photon doses to the whole body and to individual internal organs is shown in its "Summary of the EPA Mandated PAVT Results for Individual Protection Requirements" (Docket A-93-02 Item II-G-40, Table 3).   DOE demonstrated that the largest organ dose is $2.9 \times 10^4$ mrem/y on the bone surface.  The analysis also showed that the maximum effective dose from beta, electron, and photon emissions is $1.5 \times 10^5$ mrem/y.

Results of the PAVT thus showed that the mean dose contributions from both alpha-emitting radionuclides and from photon and beta-emitting radionuclides are below the limits in 40 CFR 191.15 and Subpart C.

DOE was required to demonstrate that there is at least a 95 percent level of statistical confidence that the mean and the median of the range of estimated radiation doses are less than 15 millirem per year, and that the range of estimated radionuclide concentrations are compatible (after dilution, as discussed above) with the regulations developed under the Safe Drinking Water Act.  DOE's bounding analysis indirectly verified these requirements by showing that the maximum estimated dose or concentration was always lower than the maximum allowable value

A complete description of EPA's 1998 Certification Decision for Section 194.55 can be obtained from Docket, A-93-02, Items V-A-1 and V-B-2.

**CHANGES IN THE CRA**

DOE's approach to compliance with Section 194.55 has not changed since the CCA.  The 2004 Compliance Recertification Application (2004 CRA) Chapter 8, describes DOE's compliance with the individual and groundwater protection requirements.  DOE captures uncertainty, §194.55(a), in 2004 CRA Chapter 6 Section 6.1.2 as noted on page 8-3 of 2004 CRA Chapter 8.  As noted in 2004 CRA Chapter 8.1.5 parameter uncertainty is discussed in 2004 CRA, Appendix PA, Attachment PAR to verify compliance with §194.55(b).  The 2004 CRA, Chapter 8 describes how DOE calculated the effective dose and dose equivalent as required by §194.55(c).  Section 8.1.4 of 2004 CRA Chapter 8 also notes that DOE's selection of more than 298 sampled vectors fulfills the requirements of §194.55(d).  DOE also notes in Section 8.1.4 that their bounding analysis adequately fulfills the requirements of Section 194.55(f).  Section 8.1 of 2004 CRA Chapter, 8 shows how DOE considers the full range of estimated radiation doses and radionuclide concentrations as required by §194.55(e).

**EVALUATION OF COMPLIANCE FOR RECERTIFICATION**

EPA reviewed DOE's 2004 CRA documents, in particular 2004 CRA, Chapter 8.  EPA found that little has change since the original certification decision.  DOE's approach to compliance with Section 194.55 requirements has not changed.

EPA did not receive any public comments on DOE's continued compliance with the results of compliance assessments requirements of Section 194.55.

**RECERTIFICATION DECISION**

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.55.