538533

Sandia National Laboratories

Operated for the U.S. Department of Energy by
Sandia Corporation

Carlsbad, New Mexico 88220

Date: February 1, 2005

To: Dave Kessel, MS 1395 (Org. 6820)

L. H. Brush J W Garner

From: Larry Brush, MS 1395 (Org. 6822); and Jim Garner, MS 1395 (Org. 6821)

Subject: Additional Justification of the Insignificant Effect of Np on the Long-Term Performance of the WIPP

INTRODUCTION

This write-up provides additional justification for previous statements that the chemical behavior of Np will have an insignificant effect on the long-term performance of WIPP disposal system. For example, Brush and Xiong (2004) stated that - although organic ligands significantly increase the solubilities of any actinides that speciate in the +V oxidation state - "the ... effect of organic ligands on An(V) [i.e., Np] solubilities had essentially no impact on the long-term performance of the WIPP."

Brush and Xiong (2004) pointed out that "the significant effect of organic ligands on An(V) solubilities had essentially no impact on the long-term performance of the WIPP because: (1) Np is the only actinide expected to speciate in the +V oxidation state ..., (2) the probability that Np will speciate as Np(V) is 0.5, and (3) from the standpoint of its potential effects on long-term performance, Np is much less important than Pu, Am, U, or Th."

This write-up provides additional justification for the third point quoted above, that "from the standpoint of its potential effects on long-term performance, Np is much less important than Pu, Am, U, or Th."

DISCUSSION

The first approach used to demonstrate the insignificant impact of Np on the long-term performance of the WIPP is to compare the total quantity of ^{237}Np in the repository to the total quantity of all of the radionuclides in the inventory. Note that ^{237}Np is the only isotope of Np that was included in the analysis to determine the important radionuclides in transuranic waste from the standpoint of performance assessment (Fox, 2003). Therefore, for the purposes of this write-up, ^{237}Np is synonymous with "Np."

Neptunium-237 was included in the radionuclide inventory for the CRA-2004 PA. Furthermore, radioactive decay of ^{241}Am will produce ^{237}Np in the WIPP. The half-life of ^{241}Am is relatively short, 432.2 years; that of ^{237}Np is relatively long, 2.14×10^6 years. Nevertheless, the decay of ^{241}Am will not increase the total quantity of ^{237}Np enough to make this radionuclide important from the standpoint of the long-term performance of the repository. Figure 1, from Garner (2003, Figure 25), shows the total quantity of ^{237}Np (in EPA units) that will be present in the WIPP from 100 years to 10,000 years. In this figure, "SD" is the abbreviation for "sum of decayed" and the "E" following "SD" stands for "EPA units." This plot includes the ^{237}Np that will be introduced by emplacement of all TRU waste in the inventory, as well as that which will be produced by decay of ^{241}Am. Figure 1 shows that the total quantity of ^{237}Np present in the repository will initially be about 0.1 EPA unit, and that it will eventually increase to about 0.4 EPA unit.

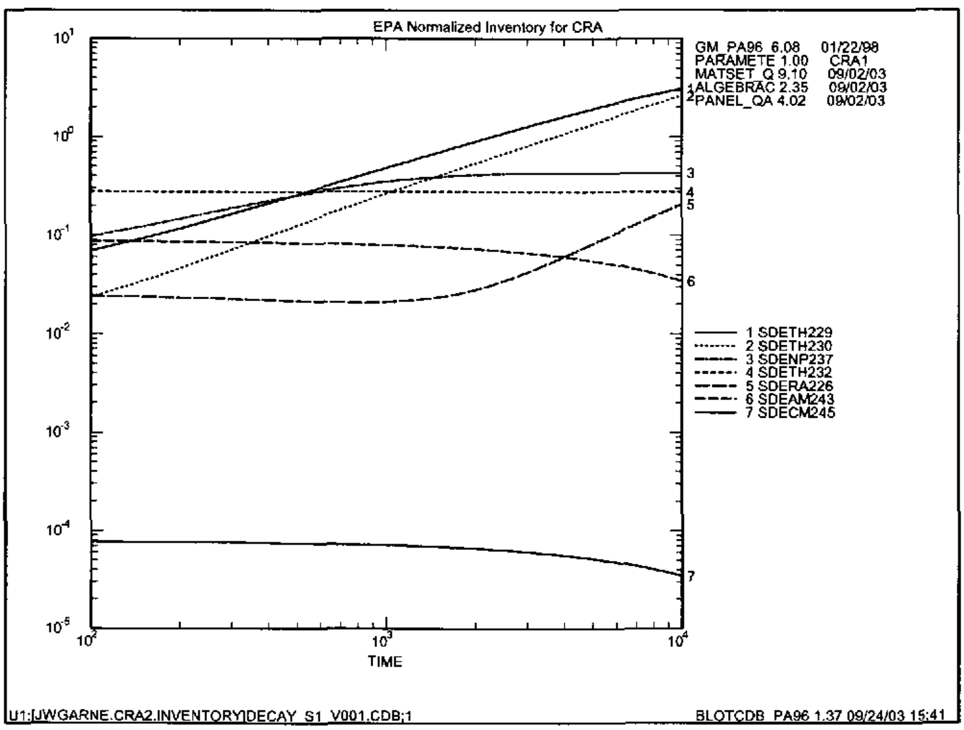

Figure 1. Time-dependent inventories of various isotopes. From Garner (2003, Figure 25).

Figure 2, (Garner, 2003, Figure 28), shows the total inventory (in EPA units) that will be present in the WIPP (see Line 1 or Line 2). In this figure, Line 1 represents the sum of all decayed radionuclides versus time; Line 2 is the sum of the "lumped" decayed radionuclides. (Garner (2003) explains the meaning of "lumped" radionuclides.) Figure 2 clearly demonstrates that the total quantity of ^{237}Np that will be present from 100 years to 10,000 years is miniscule relative to the total inventory, which will be about 7×10^3 EPA units at 100 years, but will decrease to about 2×10^3 EPA units by 10,000 years. Therefore, the *maximum* ratio of the quantity of ^{237}Np to that of the total inventory will be about 2×10^{-4} at 10,000 years. It was this result that originally led to the general conclusion that the potential effect of Np on the long-term performance of the repository is completely negligible, and to the decision to exclude Np from the Culebra transport calculations.

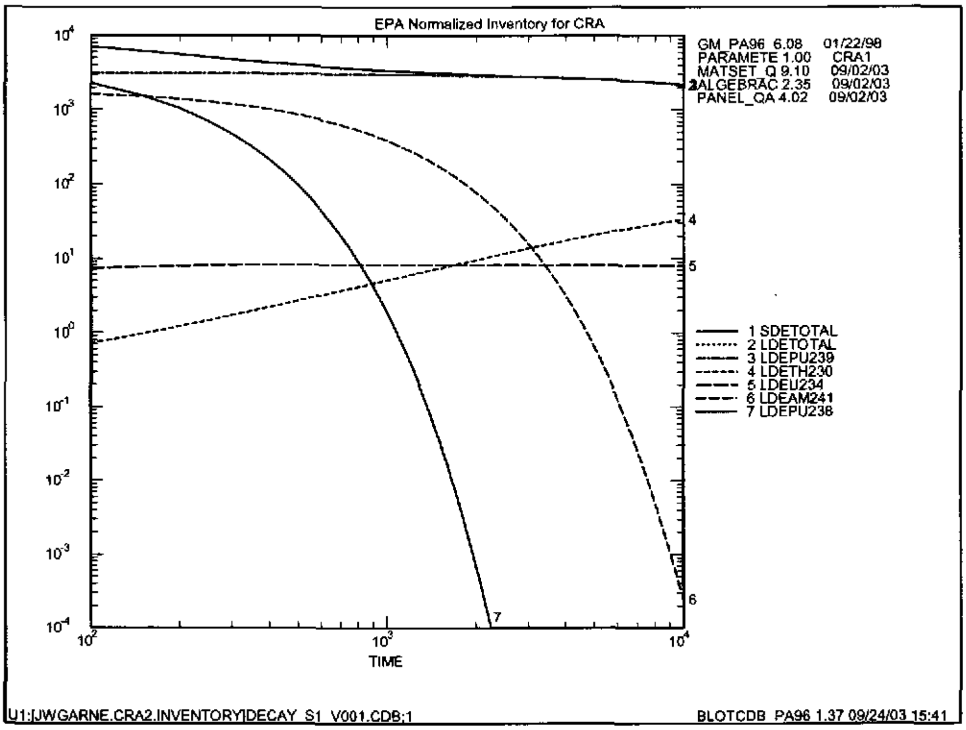

Figure 2. Time-dependent inventories of various lumped isotopes. From Garner (2003, Figure 28).

Another way to demonstrate the insignificance of ^{237}Np is to compare the total quantity of this radionuclide to the releases shown on the mean CCDF for Replicate 1 (Figure 3). At a probability of 0.1, the total release is approximately 0.1 EPA unit. If all of the ^{237}Np in the WIPP at 10,000 years were released (an *extremely* unlikely event), the total release would only increase by about 0.4 EPA unit (see above) to about 0.5 EPA unit, and the WIPP would still be in compliance. At a probability of 0.001, the release would increase from about 0.5 to 0.9 EPA unit, and - again - the WIPP would still be in compliance.

Neptunium-237 is one of the radionuclides included in the PANEL calculations and is thus included in the concentration curves that PANEL computes for inclusion in the CCDFGF calculations. Therefore, ^{237}Np is included in the direct brine releases (DBR) that CCDFGF calculates. However, the contribution ^{237}Np to DBR is insignificant. Note that all of the isotopes of Sr, Cs, Th, U, Np, Pu, Am, and Cm are also included in PANEL, even though most of these radionuclides do not contribute significantly to DBR. See Garner (2003) for more information on the concentration curves.

REFERENCES

Brush, L.H., and Y. Xiong, 2004. "Sensitivities of the Solubilities of +III, +IV, and +V Actinides to the Concentrations of Organic Ligands in WIPP Brines, Rev. 0." Analysis report, December 15, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 538203.

Fox, B. 2003b. "Radionuclides Expected to Dominate Potential Releases in the Compliance Recertification Application, Supersedes ERMS# 529245." Analysis report, August 28, 2003. Carlsbad, NM: Sandia National Laboratories. ERMS 531086.

Garner, J.W. 2003. "Analysis Package for PANEL: Compliance Recertification Application, Rev. 1." Analysis report. Carlsbad, NM: Sandia National Laboratories. ERMS 532349.

Vugrin, E. 2004. "Corrected CRA Figures." Memorandum to D.S. Kessel, December 20, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 538260.

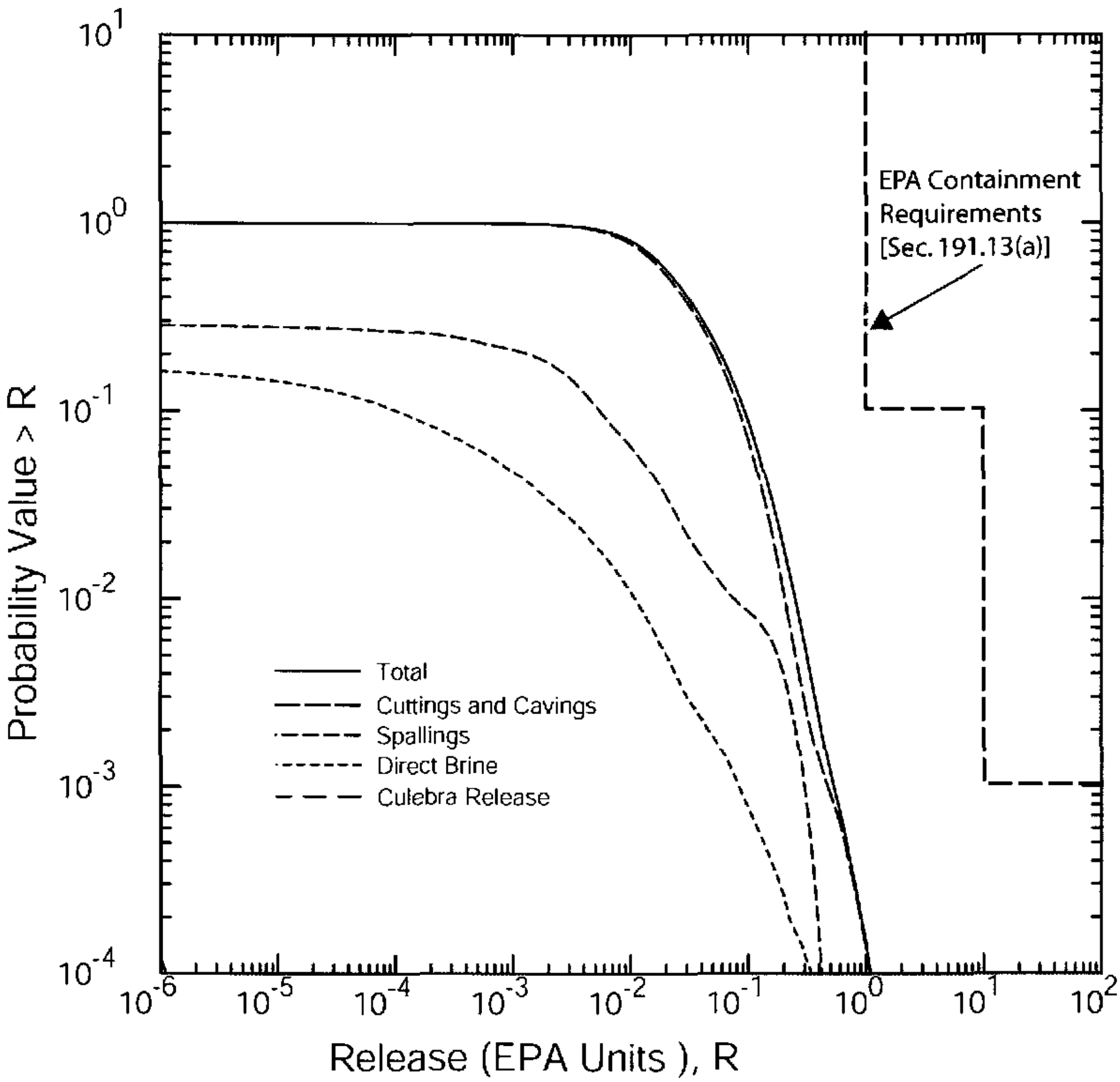

Figure 3. Current version of the CRA-2004 PA mean CCDF for Replicate 1 (Vugrin, 2003). Note that although the legend contains a symbol for the line representing Culebra releases, these releases are too small to plot in this figure.

Distribution:

MS 1395 M. J. Chavez (Org. 6820)
MS 1395 J. W. Garner (Org. 6821)
MS 1395 J. F. Kanney (Org. 6821)
MS 1395 T. Kirchner (Org. 6821)
MS 1395 G. R. Kirkes (Org. 6821)
MS 1395 C. D. Leigh (Org. 6821)
MS 1395 E. Vugrin (Org. 6821)
MS 1395 K. Vugrin (Org. 6821
MS 1395 S. Wagner (Org. 6821))
MS 1395 W. Zelinski (org. 6821)
MS 1395 M. J. Rigali (Org. 6822)
MS 1395 L. H. Brush (Org. 6822)
MS 1395 H. Deng (Org. 6822)
MS 1395 D. Wall (Org. 6822)
MS 1395 N. A. Wall (Org. 6822)
MS 1395 Y. Xiong (Org. 6822)
MS 1395 SWCF (Org. 6820), WIPP:1.3.1:PA:QA-L:DPRP1:Pkg533999 (2 copies)