LBL-23638

Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA

EARTH SCIENCES DIVISION

To be presented at the American Nuclear Society
Winter Meeting, Los Angeles, CA, November 15–19, 1987

RELEASE RATES FROM WASTE PACKAGES IN A SALT REPOSITORY

P.L. Chambré, Y. Hwang, W.W.-L. Lee, and T.H. Pigford

June 1987

Prepared for the U.S. Department of Energy under Contract DE-AC03-76SF00098

DISCLAIMER

LBL--23638

DE87 014082

UCB-NE-4102
LBL-23638
June 1987

Release Rates from Waste Packages in a Salt Repository*

P. L. Chambré, Y. Hwang, W. W.-L. Lee and T. H. Pigford
Department of Nuclear Engineering & Lawrence Berkeley Laboratory
University of California, Berkeley, CA 94720

In a companion paper[1], we predicted very low thermally-induced brine migration in a salt repository after the salt has consolidated against the waste package, so low that radionuclide release into the consolidated salt is expected to occur largely by molecular diffusion. Here we present estimates of radionuclide release rates from waste packages into salt. This conservative and bounding analysis shows that release rates from waste packages in salt are well below the U. S. Nuclear Regulatory Commission's (USNRC) performance objectives for the engineered barrier system.[2]

We assume a spherical-equivalent spent-fuel waste package placed in a salt bed of infinite extent, and consolidation of the borehole annulus has taken place. At $t = 0$ the container in the waste package is assumed to disappear, and is replaced by a film of stagnant brine. This brine film may result from brine migration due to thermal and pressure gradients. We assumed conservatively that saturation concentrations of the low-solubility species exist at the waste surface. Radionuclides released from the waste form into brine diffuse *through brine in grain boundaries in the rock salt. We calculate the time-dependent radionuclide release* rate into the salt and compare with the USNRC release-rate criteron.

Time-dependent release rates were calculated from Chambré's analytic solution for diffusional mass transfer. The governing equation considers only diffusion, without advection. Retardation by equilibrium sorption and radioactive decay are both included. The numerical results for ^{234}U and ^{237}Np are shown in Figures 1 and 2, expressed as the mass release rate of a species normalized to its inventory. The spherical-equivalent spent-fuel waste package is 0.72 m in radius. In both cases a diffusion coefficient of 10^{-7} cm^2/s and porosity of 0.001 are used. Assumed retardation coefficients are 50 for neptunium and 20 for uranium. The assumed solubility for uranium is 0.001 g/m^3 and neptunium is assumed to be released congruently. Because both species are of low solubility, solubility-limited dissolution should apply. The figures show that the fractional release rates are below the USNRC limit of 10^{-5}/yr for all times on the graphs. For the shorter half-life

*Work supported in part by U. S. Department of Energy via Contract DE-AC03-76SF00098

^{234}U decay further reduces the release rate at large times.

Using methods discussed in the companion paper[1], time-dependent brine migration velocities resulting from pressure gradients can be obtained and the resultant radionuclide transport compared with diffusional transport. Such a comparison is being published elsewhere.

References

1. Y. Hwang, P. L. Chambré, W. W.-L. Lee and T. H. Pigford, "Pressure-Induced Brine Migration in Consolidated Salt in a Repository," UCB-NE-4101, LBL-23637, Paper submitted for the 1987 Winter Meeting, American Nuclear Society

2. 10 *Code of Federal Regulations* 60.113(a)(1)(ii)(B).

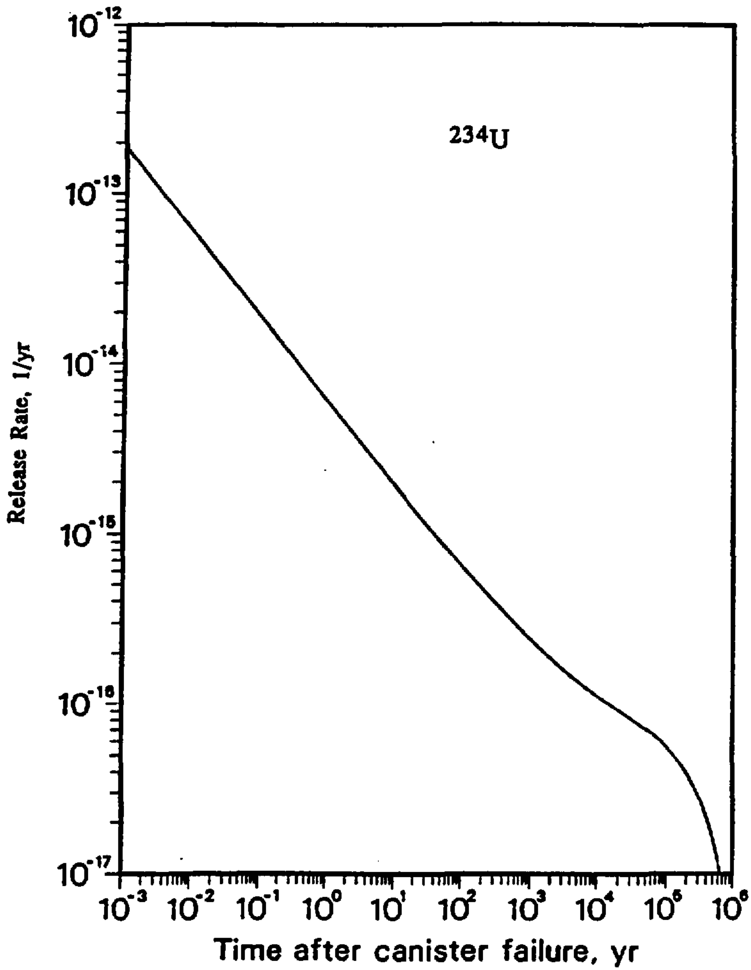

Figure 1. Release Rate of ^{234}U by Diffusion

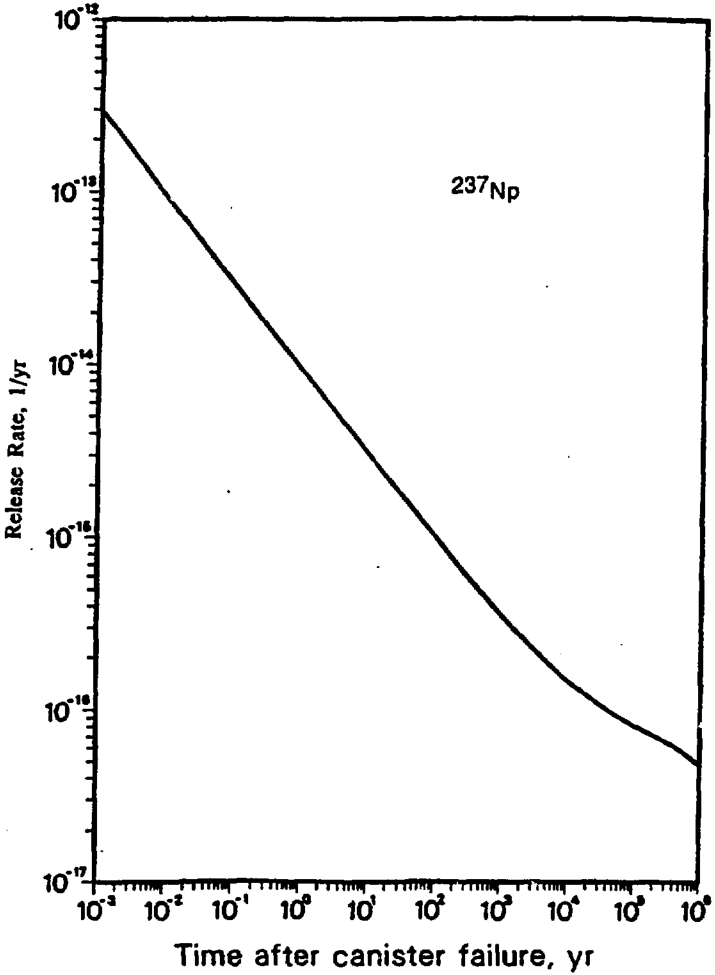

Figure 2. Release Rate of ^{237}Np by Diffusion