LBL-13097
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July 1981

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Prepared for the U.S. Department of Energy under Contract W-7405-ENG-48

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Submitted to Transactions of the
American Nuclear Society

LBL-13097
UCB-NE-4007

# WATER DILUTION VOLUMES FOR HIGH-LEVEL WASTES

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This work was supported by the Assistant Secretary for Nuclear Energy, Office of Waste Isolation of the U. S. Department of Energy under contract W-7405-ENG-48. Funding for this project is administered by the Office of Nuclear Waste Isolation at Battelle Memorial Institute.

This manuscript was printed from originals provided by the author.

The potential toxicity of high-level wastes is frequently expressed as the amount of water that would be required to dilute dissolved radionuclides to drinking-water concentrations[1,2]. New data from the International Committee on Radiation Protection[3] on the biological uptake and risks from ingested radionuclides suggest appreciable changes in the water-dilution volumes of high-level wastes. Our estimates of the new water-dilution volumes are presented here.

The water-dilution volume for a radionuclide in the waste is defined as the decay rate of that radionuclide divided by its concentration limit in water. We estimate new concentration limits from the new ICRP[3] data for the annual limits for intake (ALI) of radionuclides by workers. The ALI is divided by the annual water intake of 0.8 $m^3$ for an adult and by ten to obtain a concentration that will limit the annual ingested dose to 0.5 rem. This concentration limit is not on the same basis as the MPC[4] or the RCG[5]. Both MPC and RCG consider only the dose to the critical organ, whereas the ALI and our estimated concentration limit include accumulated dose from radionuclides distributed to several organs and tissues.

Dividing the radionuclide quantities (bq/GWe yr) for the fuel cycle of pressurized-water reactor[2] by these estimated concentration limits, we obtain the calculated water-dilution volumes of high-level reprocessing wastes, spent fuel, uranium ore, and mill tailings shown in Figures 1, 2, and 3. The ratios of these new values of water-dilution volume to those from our previous calculations[1,2] are 0.089 for $^{90}Sr$, 24 for $^{241,243}Am$, 7.4 for $^{239,240}Pu$, 300 for $^{237}Np$, 7.7 for $^{226}Ra$, and 1.5 for $^{137}Cs$ and $^{210}Pb$. Each of these factors is the ratio of the present RCG[5] to our estimated new concentration limit.

Cohen[6] has reassessed the potential hazard of high-level wastes in terms of the potential health effects per unit of fuel discharged from a reactor, using the ICRP[3] data on rads per unit of ingested activity and data from the 1980 BEIR report[7] on risk per rad. He calculated that the risk per unit ingested activity of $^{237}Np$ increases by a factor of 230 over that determined from previous ICRP and BEIR data[4,8]. We find a numerical error in his calculations and estimate that, on this same basis, the risk per unit ingested activity of $^{237}Np$ increases by a factor of 440. Cohen correctly estimates a 57-fold reduction in the risk per unit ingested activity of $^{226}Ra$, but his estimate of the total risk for uranium ore is too low because he neglected the contribution from $^{210}Pb$. We have not used the BEIR data in our present calculations of water-dilution volume because the ICRP data on ALI's already include a risk estimate.

ACKNOWLEDGEMENT

This work was supported by the Assistant Secretary for Nuclear Energy, Office of Waste Isolation of the U. S. Department of Energy under contract W-7405-ENG-48. Funding for this project is administered by the Office of Nuclear Waste Isolation at Battelle Memorial Institute.

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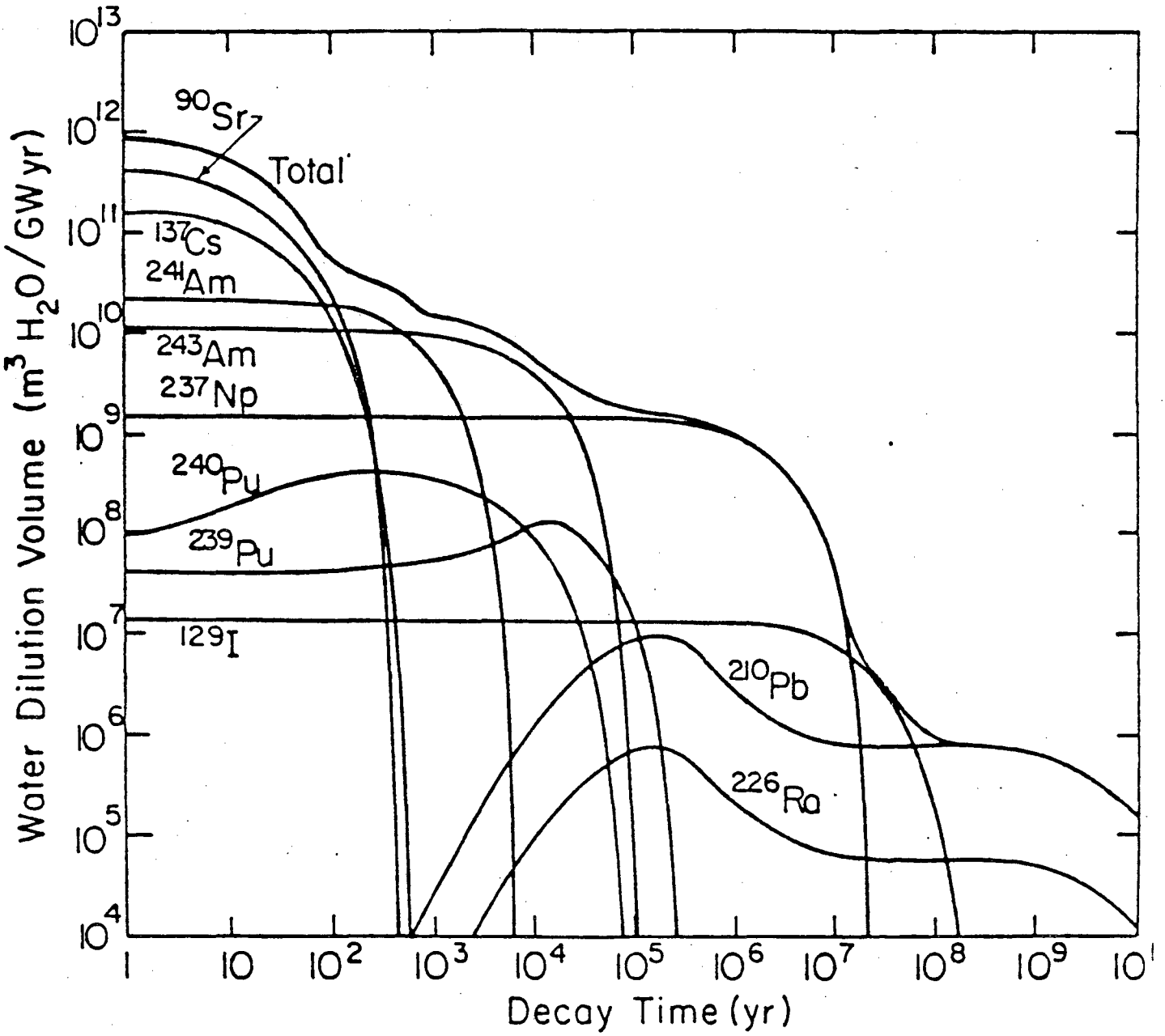


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Figure 1. Water-dilution volume for radionuclides in high-level reprocessing wastes formed by operating a 1 GWe PWR for one year, 150-day preprocessing cooling.

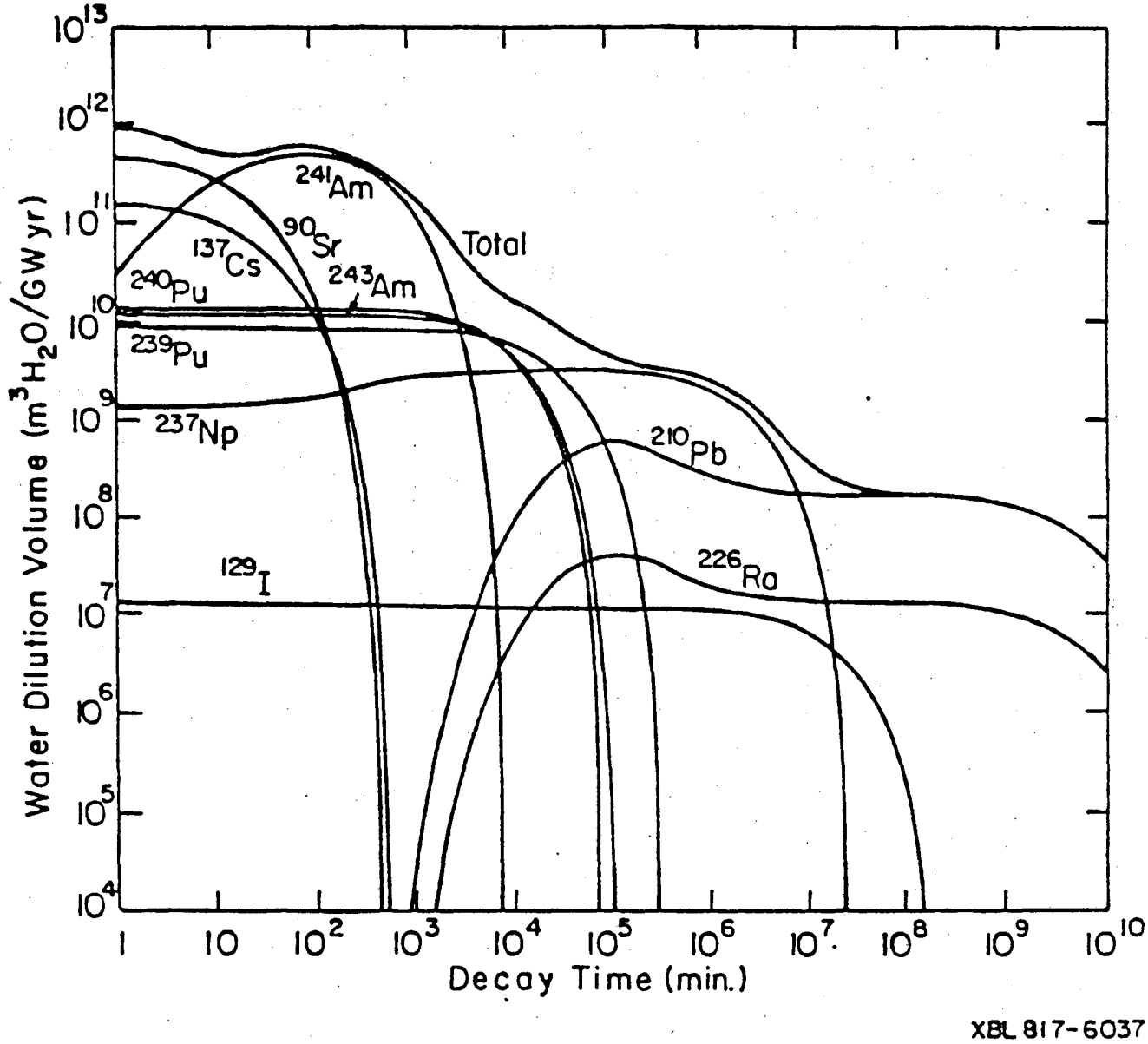


Figure 2. Water-dilution volume for radionuclides in spent fuel discharged yearly from a 1 GWe PWR.

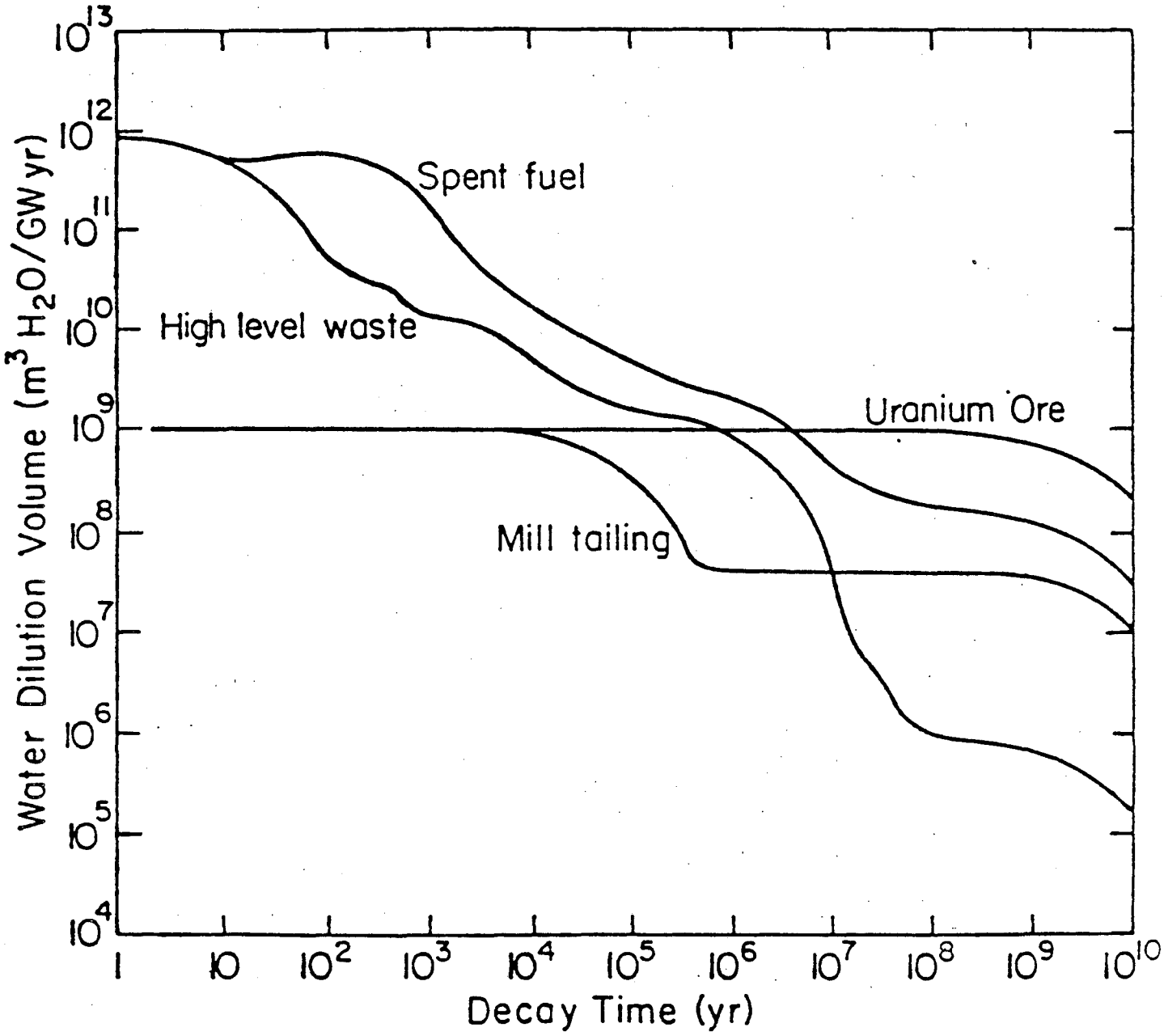


Figure 3. Water-dilution volume for high-level reprocessing waste, spent fuel, uranium ore, and mill tailings, all on the basis of 1 GWe-yr of electrical produced.

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

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