

Lawrence Berkeley National Laboratory

Recent Work

Title

WATER DILUTION VOLUMES FOR HIGH-LEVEL WASTES

Permalink

<https://escholarship.org/uc/item/9027m76j>

Authors

Choi, J-s.
Pigford, T.H.

Publication Date

1981-07-01



Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA

EARTH SCIENCES DIVISION

Submitted to the Transactions of the American Nuclear Society

WATER DILUTION VOLUMES FOR HIGH-LEVEL WASTES

Jor-shan Choi and T.H. Pigford

July 1981

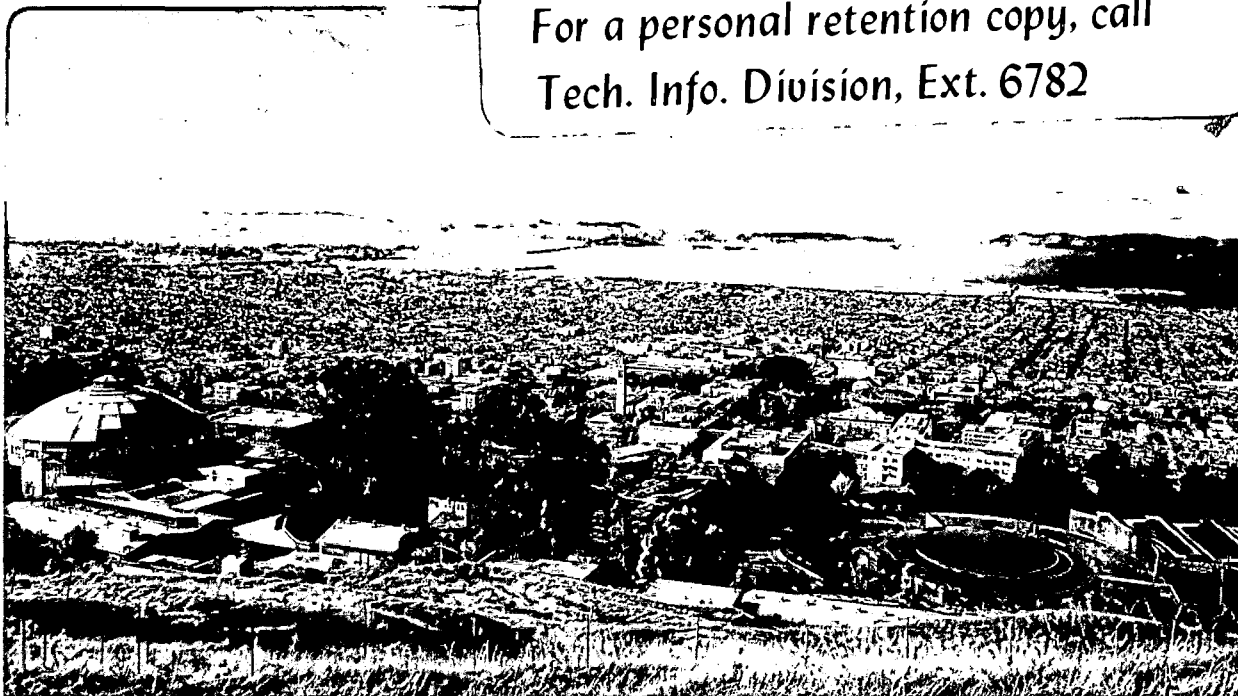
RECEIVED
LAWRENCE
BERKELEY LABORATORY

AUG 31 1981

LIBRARY AND
DOCUMENTS SECTION

TWO-WEEK LOAN COPY

This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 6782



e-2
LBL-13097

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

WATER DILUTION VOLUMES FOR HIGH-LEVEL WASTES

Jor-shan Choi and T. H. Pigford

Earth Sciences Division
Lawrence Berkeley Laboratory

Department of Nuclear Engineering
University of California

Berkeley, California 94720

July 1981

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 Protection³ 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 ICRP³ 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 MPC⁴ or the RCG⁵. 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 reactor² 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 ⁹⁰Sr, 24 for ^{241,243}Am, 7.4 for ^{239,240}Pu, 300 for ²³⁷Np, 7.7 for ²²⁶Ra, and 1.5 for ¹³⁷Cs and ²¹⁰Pb. Each of these factors is the ratio of the present RCG⁵ to our estimated new concentration limit.

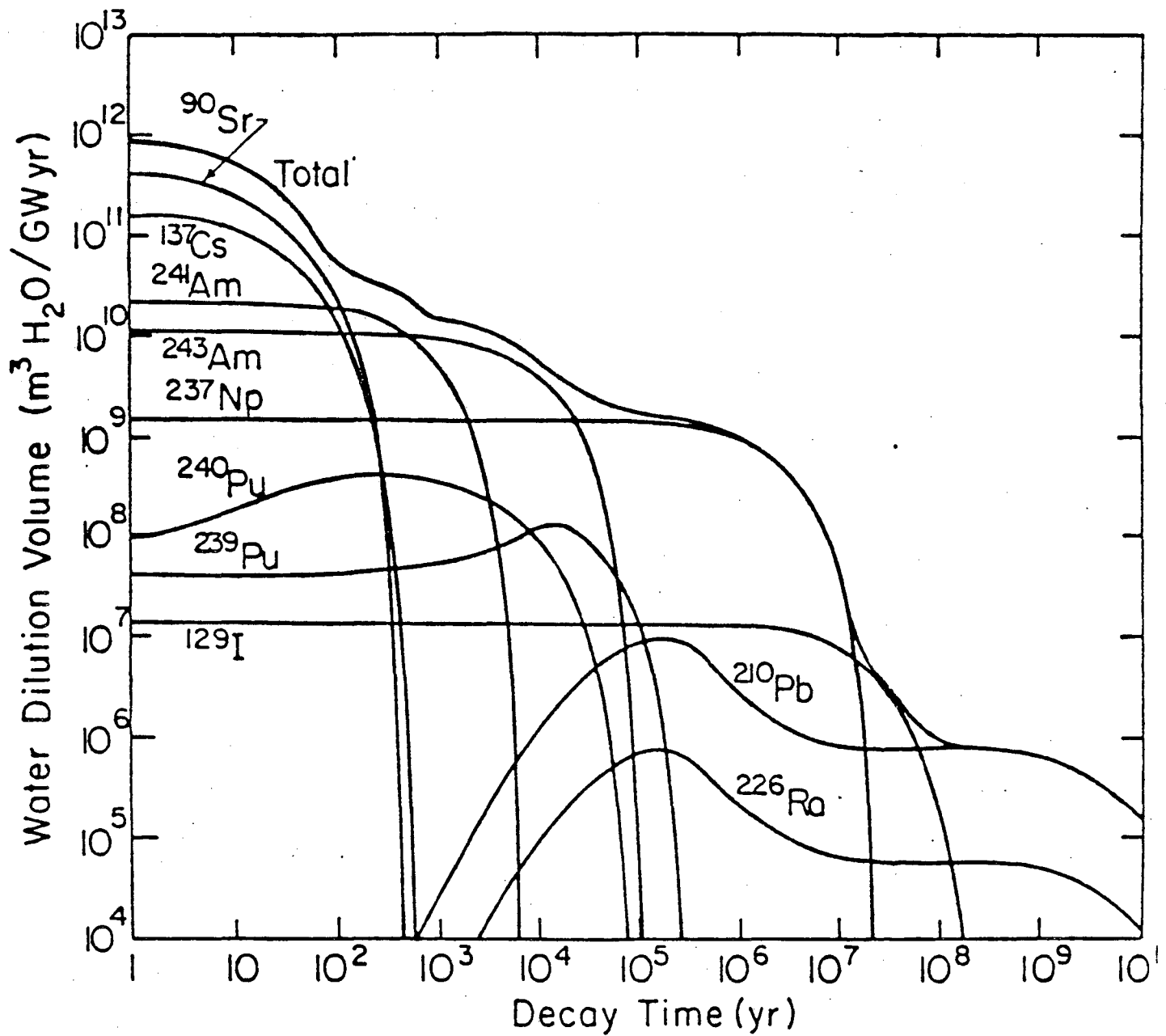
Cohen⁶ has reassessed the potential hazard of high-level wastes in terms of the potential health effects per unit of fuel discharged from a reactor, using the ICRP³ data on rads per unit of ingested activity and data from the 1980 BEIR report⁷ on risk per rad. He calculated that the risk per unit ingested activity of ²³⁷Np 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 ²³⁷Np increases by a factor of 440. Cohen correctly estimates a 57-fold reduction in the risk per unit ingested activity of ²²⁶Ra, but his estimate of the total risk for uranium ore is too low because he neglected the contribution from ²¹⁰Pb. 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.

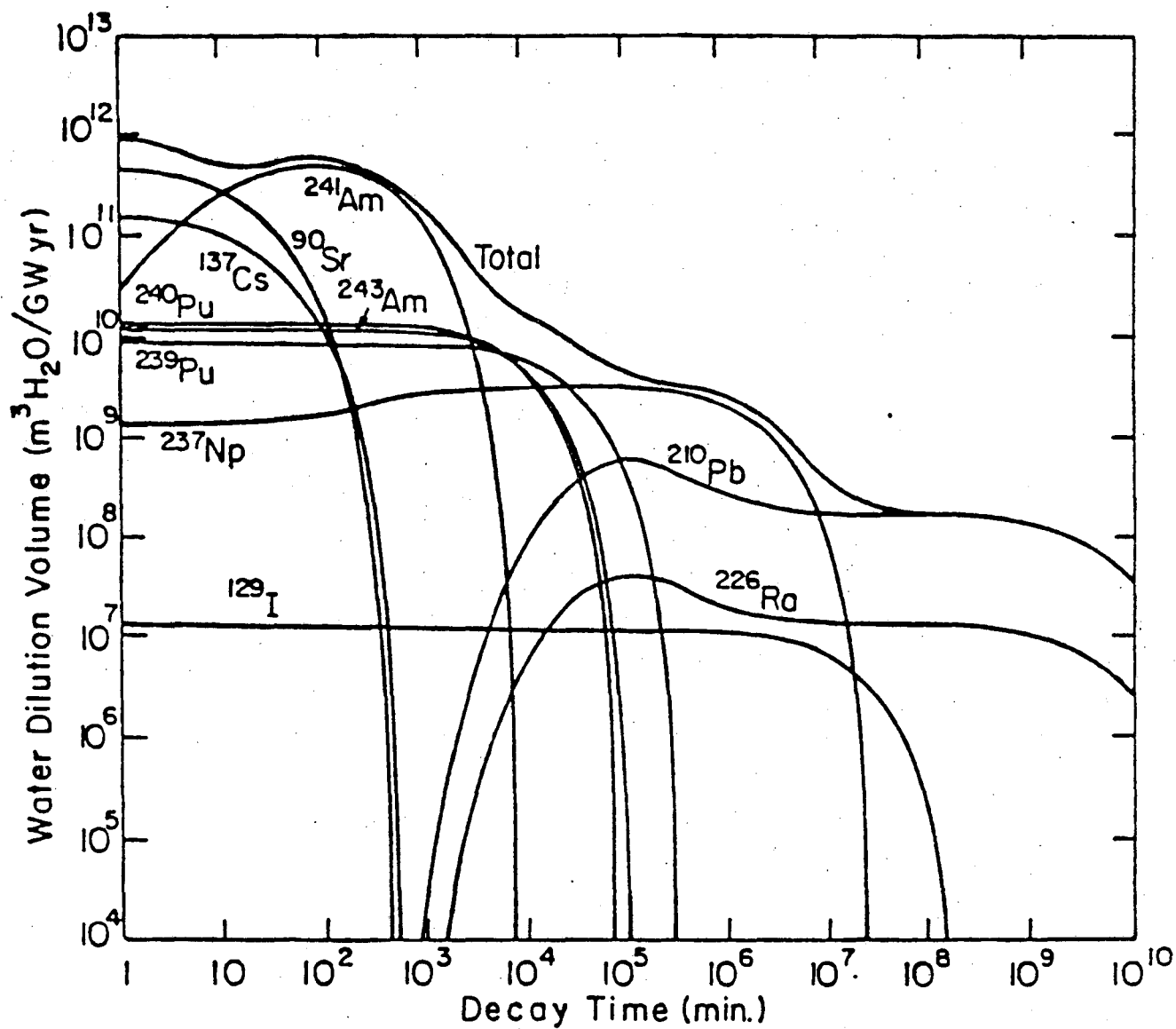
References

1. T. H. Pigford and J. S. Choi, "Effect of Fuel Cycle Alternatives on Nuclear Waste Management", Proc. Symp. Waste Management, CONF-761020 (1976).
2. M. Benedict, T. H. Pigford, H. Levi, "Nuclear Chemical Engineering", 2nd ed., Chap. 8, pp. 354-376, McGraw-Hill Book Co., New York (1981).
3. International Committee on Radiation Protection, "Limits for Intakes of Radionuclides by Workers", Publication No. 30, Annals of ICRP 3, No. 1-4 (1980).
4. International Committee on Radiation Protection, "Permissible Dose for Internal Radiation", ICRP Publication No. 2, Pergamon Press (1959).
5. U. S. Nuclear Regulatory Commission, Rules and Regulations IOCFR20, Appendix B, Table II, Federal Register, Dec. 1, 1979.
6. B. L. Cohen, "Effects of ICRP Publication 30 and the 1980 BEIR Report on Hazard Assessment of High Level Wastes", Trans. Amer. Nuc. Soc. 38, 84-85 (1981).
7. National Academy of Science, Committee on Biological Effects of Ionizing Radiation, "The Effect on Populations of Exposure to Low Levels of Ionizing Radiation" (1980).
8. National Academy of Science, Committee on Biological Effects of Ionizing Radiation, "The Effect on Populations of Exposure to Low Levels of Ionizing Radiation" (1972).



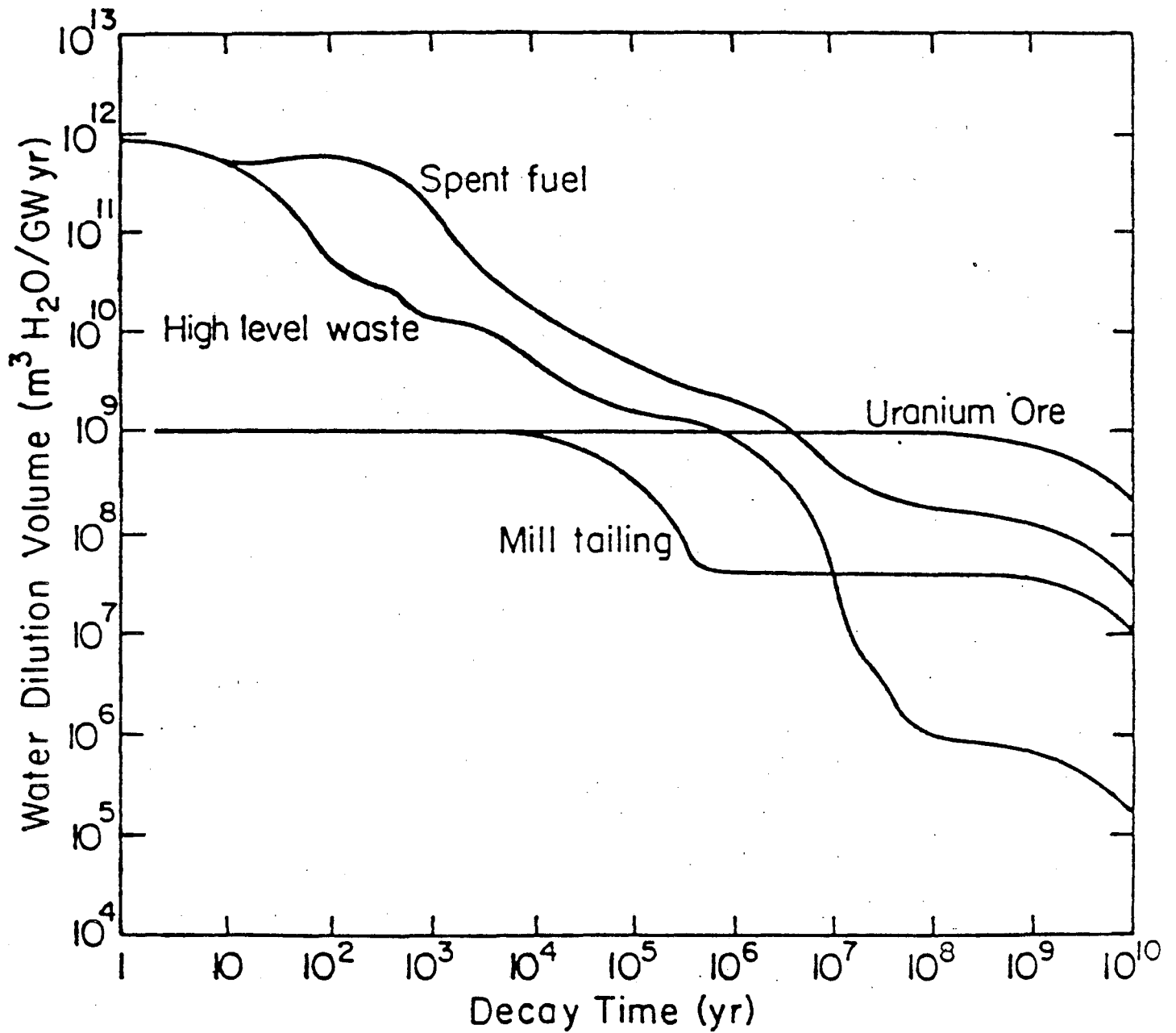
XBL 817-603

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.



XBL 817-6037

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



XBL 817-6036

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.

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720