BNL-NUREG--34896

TI84 014387

SOURCE TERM DEVELOPMENT FOR TRITIUM AT THE SHEFFIELD DISPOSAL SITE.

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The Sheffield low-level radioactive waste disposal site, which ceased operation in 1978, has been the focus of modeling efforts by the NRC for the purpose of predicting long-term site behavior. To provide the NRC with the information required for its modeling effort, a study to define the source term for tritium in eight trenches at the Sheffield site has been undertaken. Tritium is of special interest since significant concentrations of the isotope have been found in groundwater samples taken at the site and at locations outside the site boundary. Previous estimates of tritium site inventory at Sheffield are in wide disagreement. In this study, the tritium inventory in the eight trenches was estimated by reviewing the radioactive shipping records (RSRs) for waste buried in these trenches. It has been found that the tritium shipped for burial at the site was probably higher than previously estimated. In the eight trenches surveyed, which amount to roughly one half the total volume and activity buried at Sheffield, approximately 2350 Ci of tritium from non-fuel cycle sources were identified.

The review of RSRs also formed the basis for obtaining waste package descriptions and for contacting large waste generators to obtain more detailed information regarding these waste packages. As a result of this review and the selected generator contacts, the non-fuel cycle tritium waste was categorized. The tritium releases from each of these waste categories were modeled. The results of this modeling effort are presented for each of the eight trenches selected.

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*Work carried out under the auspices of the U.S. Nuclear Regulatory Commission.

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The Sheffield low-level radioactive waste disposal site, which ceased operation in 1978, has been the focus of modeling efforts by the NRC for the purpose of predicting long-term site behavior. In order to develop realistic predictive models, a detailed knowledge of the amounts and isotopic distribution of the waste, as well as waste form and waste packaging is required. As input to radionuclide groundwater transport models, it is necessary to define release from the buried waste packages to the trench environment, i.e., the source term. In order to provide the NRC with the information required for its modeling effort, a study to define the source term for eight trenches at the Sheffield site has been undertaken.[1] The isotopes of interest in this study were H-3, C-14, Cs-137, Sr-90, Co-60, I-129, and actinides (specifically isotopes of Pu and Am). Details of the source term development study as a whole are given in Reference 1. This paper will focus on the source term development with respect to a single isotope, tritium. Tritium is of special interest since concentrations of the isotope have been found in groundwater samples taken at the site and at locations outside the site boundary.

The tritium inventory at the Sheffield site has been estimated previously in two studies.[2,3] However, the estimates arrived at in these studies are in wide disagreement. The Interagency Task Force study estimated a site inventory of 1980 Ci of tritium,[2] while that performed by the NUS Corporation[3] estimated 675 Ci. We have estimated the tritium inventory in eight trenches at Sheffield by reviewing the radioactive shipping records (RSRs) for waste buried in these trenches. It has been found that the amount of tritium shipped for burial at the site was higher than previously estimated. In the eight trenches surveyed, which amounts to roughly one-half the total volume and activity buried at Sheffield, approximately 2350 Ci of tritium was identified from non-fuel cycle sources alone. Tritium from fuel cycle sources probably contributes very little to the site inventory (<100 Ci). It is concluded that the difficulty in estimating the site inventory of tritium was most probably due to the fact that the contribution to the inventory of any given trench due to non-fuel cycle sources is highly variable.

The review of RSRs also formed the basis for obtaining waste package descriptions and for selecting large waste generators for contact to obtain more detailed waste package descriptions. As a result of this review and the selected generator contacts, the non-fuel cycle tritium waste was categorized into eight classes:

1. Solid wastes in packages with activities <1 Ci.

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2. All liquid wastes and miscellaneous solids in packages with activities <1 Ci.

3. Tritiated target material.

4. Effluent gas scrubbers.

5. Tritiated organics, including tritiated luminous paints.

6. Tritium-containing concrete.

7. Tritium-contaminated wastes in BNL concrete vaults.

8. Waste in packages which cannot be relied upon to provide any tritium containment, i.e., packages from which total release of the package inventory to the trench is likely to occur within the first year after burial.

The tritium releases for each of these cases was modeled. Both gaseous release and release through contact with water were considered as release modes. It was found that, given the waste forms and packages, gaseous release of tritium may be the dominant release mode.

After modeling the release expected from each case, activity in a given trench was proportioned among the eight cases using information obtained from the review of the RSRs. The annual release to each trench was then calculated. These releases, decay corrected and plotted as a function of time, are shown in Figures 1 and 2. Two things are evident from these figures. First, the release of tritium to the trench environment is dominated by releases during the first year. Second, the release after the first year is of the form e^{-at}, where a is a constant and t is the time in years. The data in these figures were fitted with a least-squares straight line using annual releases from the second through the sixtieth years. It was found that the value of the constant was 0.11 ± 0.03 years^{-1}. This means that tritium release from the tritium-contaminated waste buried in the eight trenches considered has an effective "half-life" of 6.3 years.

The results of this source term modeling have not been verified as comparison with site monitoring data is not straightforward. This is one area where additional work needs to be done. These results do indicate several things however. First, given the type of waste buried at Sheffield, the consequences of gaseous release from waste packages should be considered in site modeling and site monitoring efforts. Secondly, it may be possible to represent the release of tritium to the trench environment at Sheffield with a simple analytic function after the first year; however, it should be noted that these first year releases will predominate. Finally, the modeling efforts, as well as the review of the RSRs do not indicate that, subsequent to the first year after burial, any large failure of containment, which will result in large tritium releases to the trench environment, can be expected.

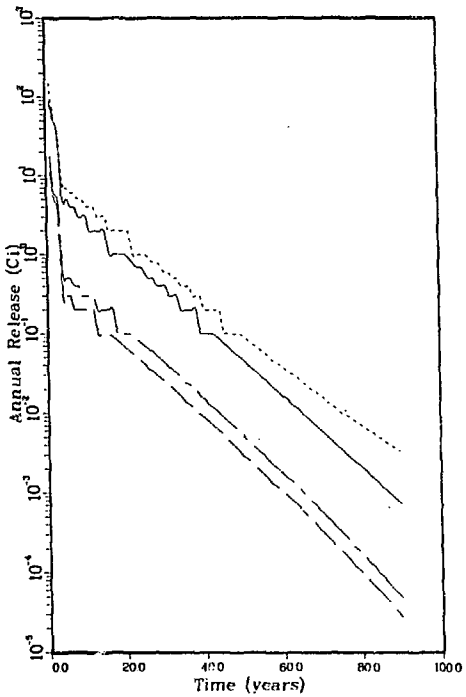

Figure 1. Annual releases from four trenches vs time after burial. ____ Trench 1; --- Trench 2; ___.___ Trench 7; ____ - ____ Trench 11.

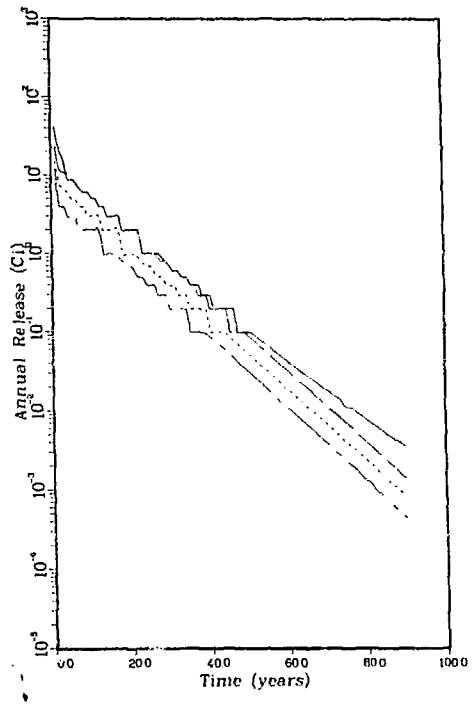

Figure 2. Annual releases from four trenches vs time after burial. ____ Trench 14A; --- Trench 23; ___ . ___ Trench 24; ____ - ____ Trench 25C.

References

1. D. R. MacKenzie et al., "Evaluation of the Radioactive Inventory in, and Estimation of Isotopic Release From the Waste in Eight Trenches at the Sheffield Low-Level Waste Burial Site," Draft Report, BNL-NUREG-34022, January 1984.

2. K. Dragonette et al., "Interagency Task Force Report on the Proposed Decommissioning of the Sheffield Nuclear Waste Disposal Site," SHEF 79-9, September 1979.

3. NUS Corporation, "Draft Environmental Assessment of the Sheffield Low-Level Waste Disposal Site," Vol. II, Appendix C, October 31, 1979 (Draft).