UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Subject: Science Advisory Board Review of the Release of Carbon-14 in Gaseous Form from High-Level Waste Disposal

Dear Ms. Browner:

At the request of the Office of Radiation Programs, the High-Level Waste/Carbon-14 Subcommittee of the Science Advisory Board's Radiation Advisory Committee reviewed the issues document, *Issues Associated with Gaseous Releases of Radionuclides for a Repository in the Unsaturated Zone.* Although the framework for the model used in the issues document to calculate carbon-14 release is conceptually valid, the technical basis for a number of the critical assumptions, parameters and parameter ranges adopted in the application of the model is not clear and leads to results that are biased in the direction of higher releases to the environment as well as to underestimates of the uncertainties. The Subcommittee considers the following to be its most significant findings and recommendations.

a) Releases of carbon-14 from a repository may produce an appreciable global population dose over 10,000 years, but the average individual dose would be very low. For a reasonable upper bound release of half the carbon-14 initially contained in a repository, the global population dose over 10,000 years is estimated to be 14 million person rem, and the corresponding average individual lifetime dose would be about 0.01 mrem. Based on the EPA's preliminary risk factor for carbon-14, these doses correspond to calculated lifetime individual risks of 3×10^{-9}, and population risks of less than one fatality every two years on average, or 4,000 cancer fatalities world wide over 10,000 years. Whether or not these doses constitute a public health concern is a fundamental issue of principle. The Subcommittee did not try to resolve this issue, but EPA must address it when considering carbon-14 releases. Consistent with the report Reducing Risk, the Subcommittee recommends the predicted individual and population doses be considered in comparison with doses from other sources, with dose limits in other standards, and with other environmental and radiation risks.

b) The uncertainty analysis performed in the issues document is in a preliminary state and can be improved substantially. When the broader uncertainty bands for various parameters are considered, the overall uncertainty regarding the potential magnitude of carbon-14 releases is quite broad. Consequently it is not possible on the basis of presently available information to predict with reasonable confidence whether releases from an unsaturated repository would be less than or greater than the Table 1 (40 CFR 191) release limits. (The Table 1 release limit is one-tenth of the inventory.)

c) The issues document does not accurately characterize the potential for gaseous carbon-14 releases from the repository to the environment, although the Subcommittee notes it may not be possible to do so based on currently available information. The EPA document's assumptions about release mechanisms and rates of release from the wastes and containers, and about transport mechanisms and rates, do not appear to be supported by sound technical justifications.

d) The description of the effectiveness of engineered barriers designed to reduce or impede releases is not adequate because there has been little research and development of engineered barriers specifically designed to contain carbon-14 in an unsaturated repository. The issues document assumed that such devices contributed little to the containment of carbon-14. Delaying the release of carbon-14 from the waste containers or containment area would allow time for radioactive decay, which would reduce the ultimate release to the environment. (The significance of the reduction in the release would depend on the containment time relative to the 5,730 year half-life of carbon-14.) Therefore, the Subcommittee encourages investigation of the use of multiple barriers to retard the migration of carbon-14 to the accessible environment. In a presentation to the Subcommittee by its contractor, DOE indicated that it is possible that a multilayer waste container could contain the carbon-14 long enough to meet the EPA limit, but that it would not be possible to verify that the container would be gas tight for 10,000 years. The Subcommittee agrees with the issues document that the potential costs and benefits of an upgraded waste container or additional engineered barriers have not been firmly established, and the Subcommittee was unable to agree on the technical feasibility and effectiveness of improved barriers.

e) EPA needs to revise the description in the document of the physical and chemical retardation and transport of carbon-14 from the waste repository to the surface, because the hypothesis that the principal transport mechanism in flat terrain would be diffusion is incorrect. This hypothesis leads to the erroneous conclusion that carbon-14 transport could be greatly reduced by locating an unsaturated

repository in flat terrain. Temperature effects from a heated repository likely would cause the advective component to be dominant under almost any reasonable scenario.

f) Although the document's estimate of the amount of carbon-14 in unreprocessed spent nuclear fuel of 1 curie/metric tonne of heavy metal (Ci/MTHM) appears reasonable, the estimate of the total inventory of carbon-14 in the repository (100,000 curies) should be changed to 70,000 curies because the Congress has limited the first repository's capacity to 70,000 MTHM. Such a change, however, would have no effect on the calculation of the ratio of carbon-14 releases to the release limit in 40 CFR 191.

In responding to the broader issue of risk reduction, the Subcommittee notes that optimizing site selection on the basis of a single criterion may cause a change in optimal conditions for other criteria. For example, carbon-14 releases to the accessible environment would probably be less from a saturated site than from an unsaturated site, but risks from other radionuclides may be greater or smaller depending on a number of factors.

We appreciate having been given the opportunity to conduct this particular review. We request that you provide us with a formal response to our advice, particularly with respect to the issues of engineered barriers, quantitative uncertainty analysis and risk reduction we have raised.

Sincerely,

Raymond C. Loehr

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