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Testimony of Thomas B. Cochran

before the

Select Committee on Ontario Hydro Affairs

Hearings on

Management of Radioactive Wastes

Toronto, Ontario

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Introduction

My name is Thomas B. Cochran. I am a Senior Staff Scientist with the Natural Resources Defense Council (NRDC) in the Washington, D.C., office. NRDC is a private, non-profit, national environmental law organization with approximately 45,000 members. We have long been concerned with the radioactive waste management issue. We therefore welcome this opportunity to address the Select Committee on this issue.

I have a Ph.D. degree in physics from Vanderbilt University. I am a member of the U.S. Department of Energy's (USDOE) Energy Research Advisory Board. Recently I co-authored a report entitled "Radioactive Waste Management" prepared under a USDOE contract. I am providing the Select Committee with a copy of this report and will be referring to it later. I was a member of the International Panel of Experts convened last year by the Governor of Neidersachsen (Lower Saxony) to review the Gorleben Fuel Cycle Center, the Federal Republic of Germany's nuclear fuel reprocessing and waste disposal center.

With respect to specifics of the Canadian radioactive waste disposal program, I have reviewed two documents provided me, "Management of Radioactive Fuel Wastes: The Canadian Disposal Program," edited by Boulton (AECL-6314, October 1978), and the "First Annual Report of the Canadian

Nuclear Fuel Waste Management Program," edited by Boulton and Gibson (AECL-6443, December 1979).

In my prepared remarks I wish to focus on four areas where substantial improvements could be made in the Canadian program, namely (1) the development of waste disposal criteria and the timing of their development, (2) the choice of the regulatory process for defining and verifying these criteria, (3) the wisdom of focussing on hard rock (Precambrian granite shield) as the host geologic medium and glass as the waste form, and (4) public participation in the waste management process.

1. Radioactive Waste Disposal Criteria

Let us set aside all subsidiary considerations and simply address the question, what is the most rational way to attack the radioactive waste disposal problem? In answer to this, I would propose the following four-stage approach.

° Defining the problem

First, the waste problem must be carefully defined. The focus here would be on the quality and quantity of the wastes - the former to define the biological hazard of the wastes and the latter to define the present and future logistic problems.

° Establishment of criteria

Second, a definitive set of overall waste disposal criteria must be established. The overriding objective in establishing these criteria should be the protection of the present and future generations from the adverse effects of exposure to the ionizing radiation associated with the wastes. These should not be simply a set of motherhood

statements. Rather, extreme care should be taken to make them sufficiently restrictive to ensure that they are met only by adequate solutions. Defining these criteria or goals represents a societal decision which should be made with broadest public participation. The establishment should not be left up to the nuclear or geologic communities or even the scientific community.

The term "criteria" can take on different meanings. One can actually consider a hierarchy of criteria. Once the broad but definitive overall criteria or goals are established, the more technical detailed performance standards and regulatory guides would naturally follow. These might be site specific, such as site selection criteria, or they might be related to container design. If the overall criteria are sufficiently restrictive, the development of these secondary criteria logically could be left largely to the technical community.

The technical criteria must be capable of verification in the laboratory, or in the field at the repository site, so as to minimize the reliance on unverifiable mathematical modesl and "engineering judgment" as confirmation of the adequacy of any disposal approach. Commitments to any specific waste form, host geologic medium, or repository should be avoided until definitive criteria are developed.

° A comprehensive research and development program

The objectives of the third stage, the R&D program, are (a) to develop alternative disposal approaches, e.g., develop different waste forms and analyze a variety of geological media, (b) to develop laboratory and field verification

procedures, and (c) to identify through laboratory tests and field evaluations those disposal approaches that are likely to meet the predetermined disposal criteria. The R&D program must be directed by mature, technical competent leadership that will be widely respected by national and provincial officials and the public.

° A demonstration program

This program would involve the construction of a repository, emplacement of the waste, and implementation of verification procedures to demonstrate that the selected approach actually meets the criteria.

If the waste problem is to be solved properly, I would suggest that something along the lines of the approach outlined above must be followed. This is not the case for the approach taken by my own government. In fact, the U.S. appears to be proceeding backwards through the above stages, with site selection (i.e., the Waste Isolation Pilot Plant) having preceded a comprehensive R&D program and the development of criteria. Given the relatively smaller quantities of radioactive waste generated, the Canadian program will not face anything like the same logistics problems that will confront the U.S. program. Consequently, stage 1 is not a serious problem. The Canadian program, however, appears to have omitted the second stage, development of criteria.

The failure to develop definitive site selection and waste disposal criteria prior to the development of alternative disposal approaches, site selection, and construction of a demonstration repository, subjects the program to the criticism

that it will throw the dart and then locate the bull's-eye.

The only reference to an overall waste disposal criterion is the AECL-6314 statement (p. 1) that:

> The overall objective of the Canadian program is the safe management of radioactive wastes, ensuring that there will be no adverse effects on man or on the environment at any time.

While this is a laudable objective, it is unachievable.

Considerable attention has been devoted to the development of waste disposal criteria in the U.S. in the past two years, as can be seen from the list of references in Enclosure 1. The responsibility for the development of definitive waste disposal criteria in the U.S. lies with the U.S. Environmental Protection Agency (USEPA) and the U.S. Nuclear Regulatory Commission (USNRC). I am providing the Committee with a draft of proposed licensing criteria developed by the USNRC Staff. While there are still some problems with these criteria (e.g., the specificity of the siting criteria), the Staff deserves relatively high marks for the work they have done in this area during the past year. The USEPA, on the other hand, deserves low marks for their work to date, both because of the regulatory approach they are taking (discussed below) and the lack of specificity of their proposed guidance to date.

2. Choice of Regulatory Process

Before one adopts detailed licensing requirements, or criteria, for geologic disposal of radioactive wastes, it is

necessary to identify the regulatory approach by which a waste disposal plan will be judged against the fundamental criteria. There are two very different approaches that can be taken. One follows from the application of the defense-in-depth philosophy utilized in the licensing of nuclear power plants, and the second is based on a systems analysis through risk/consequence modeling. The USNRC has adopted the first approach while the USEPA and the Canadian program appear to be relying exclusively on the latter.*/ Of the two approaches the defense-in-depth approach is the preferred, and in fact the only workable, approach.

To judge whether a given waste disposal plan is acceptable under the second (Canadian and USEPA) approach, the entire plan, as a unit, from waste form to general site, is plugged into a mathematical model purported to function as an analog to the real world. The model yields what is taken to be an accurate or a conservative (in terms of safety) simulation of the behavior of the waste disposal plan over time. If the predicted behavior is within limits, the waste plan passes; if not, it fails.

This approach can lead to increased uncertainty: first, because failure of a single key component could jeopardize the entire plan, and, second, because, in addition to the probabilistic output of the model, one is faced with the very

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*/ See discussion under "Phase 1 - Concept Verification" in AECL-6314 (pp. 61-63), and "Post-Closure Assessment" in AECL-6443 (pp. 51-57).

real uncertainty of whether or not the model accurately represents all of the many things which might occur over hundreds of thousands of years - that is, whether the model represents the real world, or simply represents what its author thinks the real world is. This approach also represents an over-extension of our modelling capabilities and is essentially unverifiable. This is particularly true with regard to the Canadian program with its choice of hard crystalline rock as the disposal medium. The predicted rate of transport of radioactive isotopes from the repository will be highly dependent on the assumed values for retention factors in the pathway analyses (see AECL-6443, p. 54). These retention factors are poorly known and consequently have large associated uncertainties.

Under the defense-in-depth approach adopted by the USNRC, the waste component (the waste form, container and overpack), the engineered repository (i.e., the civil structure and the immediate surrounding geologic volume), and the more distant surrounding geologic strata (the site) will be each treated as independent components ("barriers") of the waste disposal system. These components are assigned specific verifiable criteria or performance standards that are independent of the other components. Defense in depth is built into the program by defining these performance standards so that the failure of one, or even two, of the components will not lead to failure of the overall plan. This multi-barrier approach is essential in order to compensate for uncertainties, gaps in our understanding of the chemical and mechanical processes

that will occur following disposal of high-level wastes deep underground.

For additional discussion of these two approaches, I refer you to "Managing Uncertainty: Establishing Design Criteria Through Defense in Depth." This is Part II of the NRDC Radioactive Waste Management Study which I referred to earlier.

3. The Host Rock and Waste Form

The Canadian program has focussed its R&D and site selection on Precambrian granite as the host rock and glass as the preferred waste form. As can be seen from Part II of NRDC's study, "Radioactive Waste Management," we agree that deep-lying, dry granite in the Precambrian Shield appears to be the most promising host rock, and therefore the focus on this medium by the Canadian program is appropriate. It should be noted, however, that there is a large body of opinion in the U.S. that believes the selection of the host medium should be made only after examining carefully four or five geological environments possessing a wide variety of emplacement media. President Carter has adopted this strategy and the U.S. program is being refocussed accordingly.

Borosilicate glass as a waste form has come under severe criticism in recent years, as evidenced by reports by the U.S. National Academy of Sciences (NAS) Panel on Waste Solidification, U.S. Interagency Review Group on Nuclear Waste

Management, USEPA, and others.*/ The NAS Panel's draft report, for example, stated:

> The worldwide enthusiasm for glass as a solid form for incorporating nuclear waste is puzzling, because the rationale for the preference is nowhere explicitly stated.

While borosilicate glass may be adequate under certain conditions (e.g., limitations on thermal loading), it is clear that other waste forms - some ceramics - are much preferred over glass. Rather than attempt to patch up a bad technology, the Canadian program should give a higher priority to alternative waste forms.

It is unlikely that glass will survive as a viable alternative in the U.S., both because the USNRC is forcing the USDOE to give far more attention to alternative waste forms and because the galss does not look favorable when judged against the draft USNRC criteria.

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*/ National Research Council, National Academy of Sciences, Solidification of High-Level Radioactive Wastes (pre-publication copy), Fall 1978; Interagency Review Group on Nuclear Waste Management, Subgroup Report on Alternative Technology Strategies for the Isolation of Nuclear Waste, TID-28818 (Final), Appendix A, "Isolation of Radioactive Wastes in Geologic Repositories: Status of Scientific and Technological Knowledge," October 19, 1978; U.S. Environmental Protection Agency, State of Geological Knowledge Regarding Potential Transport of High-Level Radioactive Waste From Deep Continental Repositories, Report of an Ad Hoc Panel of Earth Scientists, EPA/520/4-78-004; Ringwood, A.E., Safe Disposal of High Level Nuclear Reactor Wastes: A New Strategy, Australian National University Press, Canberra, Australia, and Norwalk, CT, 1978.

4. Public Participation

My remarks here will be brief. The description of the program in AECL-6314 and AECL-6443 appears to offer little in the way of public involvement. The program appears designed to feed the public official reports and bits and pieces of positive reassurance designed to head off criticism of decisions previously made. There is not much in the way of outreach programs designed to provide for public participation in the decisionmaking process.

Summary

In summary, the Canadian radioactive waste disposal program could be substantially improved by:

a. immediately establishing a major program to develop waste disposal criteria;

b. postponing commitments to any particular geologic host rock (e.g., granite), site or waste form until the criteria have been developed and approved;

c. utilizing defense-in-depth rather than risk/consequence modelling as the basis for the regulatory approach for verifying the adequacy of the disposal plan (i.e., verifying that the criteria are met);

d. shifting the focus of the waste form R&D from borosilicate glass to more promising ceramics; and

e. restructuring the program for public involvement to provide for substantially greater public participation in the decisionmaking process.

1. U.S. Nuclear Regulatory Commission, Proceedings of NRC Workshop on the Management of Radioactive Waste: Waste Partitioning as an Alternative, June 8-10, 1976.

2. U.S. Nuclear Regulatory Commission, Notes on Radioactive Waste Repository Siting, Summary of a Workshop entitled "Resource Potential and Environmental Stability of the Planet Earth for the Next Million Years," November 5-7 1976.

3. U.S. Nuclear Regulatory Commission, NRC Task Force Report on Review of the Federal/State Program for Regulation of Commercial Low-Level Radioactive Waste Burial Grounds, March 1977, NUREG-0217.

4. U.S. Nuclear Regulatory Commission, Determination of Performance Criteria for High-Level Solidified Nuclear Waste, July 1977, NUREG-0279.

5. U.S. Nuclear Regulatory Commission, Workshop Material for State Review of Site Suitability Criteria for High Level Radioactive Waste Repositories, September 1977, NUREG-0326.

6. U.S. Nuclear Regulatory Commission, Proposed Goals for Radioactive Waste Management, May 1978, NUREG-0300.

7. Report of Findings of the Peer Review of the Site Suitability Criteria for Geological Disposal of High Level Nuclear Waste, March 1, 1978, work performed by TRW Energy System Planning Division for U.S. Nuclear Regulatory Commission.

8. U.S. Nuclear Regulatory Commission, Workshops for State Review of Site Suitability Criteria for High-Level Radioactive Waste Repositories, Analysis and Recommendations, Prepared by Potomac Research Inc., February 1978, NUREG-0354.

9. U.S. Enviro-mental Protection Agency, State of Geological Knowledge Regarding Potential Transport of High-Level Radioactive Waste From Deep Continental Repositories, Report of an Ad Hoc Panel of Earth Scientists, EPA/520/4-78-004.

10. "Invitation for Comment: Environmental Protection Criteria for Radioactive Wastes," EPA DRAFT, October 1978.

11. U.S. Environmental Protection Agency, Proceedings of a Public Forum on Environmental Protection Criteria for Radioactive Wastes, March 30-April 1, 1978, ORP/CSD-78-2.

12. U.S. Environmental Protection Agency, Proceedings: A Workshop on Issues Pertinent to the Development of Environmental Protection Criteria for Radioactive Wastes, Feb. 3-5, 1977, ORP/CSD-77-1.

13. U.S. Environmental Protection Agency, Proceedings: A Workshop on Policy and Technical Issues Pertinent to the Development of Environmental Protection Criteria for Radioactive Wastes, April 12-14, 1977, ORP/CSD-77-2.

14. U.S. Environmental Protection Agency, Background Report, Consideration of Environmental Protection Criteria for Radioactive Waste, February 1978.

15. U.S. Environmental Protection Agency, Criteria for Radioactive Wastes, Recommendations for Federal Radiation Guidance, 43 Federal Register 53262-68 (November 15, 1978).

16. National Academy of Sciences, The Geological Criteria for Suitable Sites of High-Level Radioactive Waste Repositories, August 3, 1978.

17. National Academy of Sciences/National Research Council, Implementation of Long-Term Environmental Radiation Standards: The Issue of Verification, A Preliminary Report to the U.S. Environmental Protection Agency.

18. Proceedings of Conference on Public Policy Issues in Nuclear Waste Management, October 27-29, 1976, edited by Harrison Associates, Washington, D.C.

19. Selection Factor for Repository of Solid, High-Level and Alpha-Bearing Waste in Geological Formations (Rev. draft), October 1976, International Atomic Energy Agency.

20. A Bioethical Perspective on Acceptable-Risk Criteria For Nuclear Waste Management, Maxey, M.N., Lawrence Livermore Laboratory, prepared for U.S. Energy Research and Development Administration, July 15, 1977.

21. Interagency Review Group on Nuclear Waste Management, Report of the Subgroup on Federal Involvement (Licensing/Standards/Criteria), October 1977.

22. Holdsworth, T., et al., Site Suitability Criteria for Solidified High Level Waste Repositories - Draft, Lawrence Livermore Laboratories, September 30, 1977.

23. International Atomic Energy Agency, Selection Factors for Repositories of Solid, High-Level and Alpha-Bearing Wastes in Geological Formations, Revised Draft, December 1975.

24. U.S. Geological Survey, Geologic Disposal of High-Level Radioactive Wastes - Earth-Science Perspectives, Circular 779, 1978.

25. "Testimony of Peter Montague," July 18, 1978, before the Environment Subcommittee of the House Committee on Science and Technology, Hearings on Criteria for Radioactive Waste Management.

26. "Review of Issues Relevant to Acceptable Risk Criteria for Nuclear Waste Management," Jerry Cohen, Feb. 22, 1978, Lawrence Livermore Laboratory, Preprint, UCRL-80793.

27. Rochlin, Gene I., "Irreversibility and Multiplicity: Two Criteria for Disposal of Nuclear Waste," Institute of Governmental Studies, University of California, Berkeley, Working Paper #18, August 1976.

28. "Nuclear Waste Disposal: Two Social Criteria," G.I. Rochlin, Science (Jan. 7, 1977).

29. Radioactive Waste Management Criteria, Thomas B. Cochran and Dimitri Rotow, prepared for the U.S. Department of Energy, January 5, 1979.

30. NRDC Comments on Criteria for Radioactive Waste Proposed by Environmental Protection Agency, by Dimitri Rotow, Thomas B. Cochran and Arthur R. Tamplin.

31. Regulation of Geologic Repositories for the Disposal of High-Level Radioactive Wastes, Lawrence A. White, Michael J. Bell and David M. Rohrer, U.S. Nuclear Regulatory Commission, November 1979.

32. U.S. Nuclear Regulatory Commission, Disposal of High-Level Radioactive Wastes in Geologic Repositories; Proposed Licensing Procedures, 44 Federal Register 70408-21 (Dec. 6, 1979).

33. U.S. Nuclear Regulatory Commission, Regulations - Draft 9, 10 CFR Part 60, Disposal of High-Level Radioactive Wastes in Geologic Repositories.