Symposium and Celebration

In Honor of

Frank L. Parker

Distinguished Professor of Water Resources and
Environmental Engineering

Uncertainty in Long Term Planning-
Nuclear Waste Management, a Case Study

Monday, January 7 and
Tuesday, January 8, 2008

Jacobs Believed In Me Auditorium
Featheringill Hall
Vanderbilt University

Sponsored by

The Mason Foundation
The Garrick Foundation
The Consortium for Risk Evaluation with Stakeholder Participation

VANDERBILT School of Engineering

Symposium

Uncertainty in Long Term Planning- Nuclear Waste Management, A Case Study

The conditions of nuclear waste management today will be examined as a basis for exploring the potential paths forward over the mandated time period of 1 million years. Technical, programmatic, social, financial and natural risks over these time periods, as well as inter- and intra-generational responsibilities, will be considered. The possible changes, both positive and negative, in medical knowledge, technology, society and environmental conditions will be discussed. Speakers and additional participants with diverse technical, social, political, philosophical and national backgrounds will propose potentially societally acceptable paths forward and the advantages and disadvantages of each of the paths.

Organizing Committee

David S. Kosson, B. John Garrick,
Charles W. Powers, G. Steve Mason

Department of
Civil and Environmental Engineering
Vanderbilt University

Monday, January 7

8:00 a.m. Registration and Continental Breakfast

8:30 a.m. **Welcome**

Kenneth F. Galloway
Dean of the School of Engineering

Symposium Introduction

Frank L. Parker

9:00 a.m. **The Challenges of Nuclear Waste Management**

Stewardship and Nuclear Waste: What Is Our Responsibility to Future Generations?
E. William Colglazier

Abstract

Input from scientific and technical experts is an important factor, but not the only factor, in deciding on an acceptable path forward for safely managing nuclear waste. Value judgments expressed by the public and elected leaders are obviously critical in deciding "how safe is safe enough" and "how sure is sure enough" when dealing with substances that remain hazardous for periods exceeding recorded human history. People can differ on their value judgments, but being good stewards for future generations – bequeathing them the tools and wealth for improving their quality of life and protecting the planet – is nearly a universal value. This talk will focus on how one might think about our responsibility to future generations and how future generations might feel about the decisions that we make today.

Yucca Mountain:
The Real World Implementation Challenges
Edward F. Sproat III

Abstract

The program Director discusses his insights on the regulatory, legal and political challenges of licensing, funding and building the world's first deep geologic repository.

Assessing the Safety of Yucca Mountain
Tom Cochran

Abstract

Dr. Cochran will review the history of failed efforts to develop a geologic repository for nuclear high-level waste and spent fuel in the United States; the federal policies and the site selection process leading to the selection of Yucca Mountain as the sole proposed geologic repository, the failure of the Environmental Protection Agency to develop adequate criteria to be used in licensing of the proposed repository; and the inability of the Nuclear Regulatory Commission and outside experts to judge the adequacy of the Department of Energy's safety assessments of the proposed Yucca Mountain repository.

Spent Fuel Management at Exelon Nuclear
Adam H. Levin

Abstract

Exelon owns and operates the largest fleet of commercial nuclear power plants in the U.S., including 17 operating and four retired units in three states. Exelon also holds a minority interest in two other operating units. Given its

size, Exelon has a broad range of management challenges, including 11,000 MTU of spent fuel in onsite pools and dry cask storage. The challenges are global; affecting current plant operations, financial reporting, and plans for retirement and decommissioning. Exelon has experience and is prepared, to transport spent fuel off site, and supports the development of one or more federal locations for consolidated interim spent fuel storage until the Department of Energy completes the technology required to close the nuclear fuel cycle. This supports new plant development while programs for reprocessing, and permanent disposal of spent fuel and secondary waste products from reprocessing, are developed.

Facilitated Discussion
Bernard Goldstein

Noon **Lunch**
University Club

1:30 p.m. **The Current Situation in the United States and International Approaches**

Near Surface Disposal Facility Design, Operations and Closure
Joe Nemec

Abstract

Since the birth of the nuclear industry, waste has been a byproduct of both defense and commercial nuclear operations. Disposal approaches for some of these waste streams are still under development. In contrast, the disposal of low level waste has been accomplished for over 60 years with mixed results when viewed from a

human and environmental impact. This paper traces the evolution of low level waste disposal practices and provides a discussion of future issues.

WIPP and Yucca Mountain: A Success and a Failure. What are Lessons for the Future?

John Ahearne

Abstract

The US government has been trying for at least three decades to develop geological repositories for radioactive waste. The program for the Yucca Mountain repository continues to struggle while WIPP (Waste Isolation Pilot Plant) is running. Around the world government programs to develop geological repositories have had trouble. Only Finland seems to be successful although Sweden is making progress. In the 1990's, the National Research Council recommended processes for governments to address controversial public issues. The WIPP and Yucca Mountain programs will be compared with those recommendations to determine if there are lessons that can be learned.

The Legal Requirements for Yucca Mountain

Richard Meserve

Abstract

The presentation will survey the legal context for the establishment of a disposal facility at Yucca Mountain, including some of the lessons that should be learned. The difficulties that have been encountered suggest that a somewhat different approach might be pursued by other countries that seek to establish a disposal facility.

The Canadian Repository Program: Helping Society Make Up Its Mind

Tom Isaacs

Abstract

There are today still no operating repositories for the permanent disposal of high-level radioactive waste and spent fuel. Programs continue in many countries with significant nuclear power. Many countries have encountered substantial difficulties in implementing repository programs. Most have had serious schedule delay and several programs have been stopped mostly due to political and societal opposition. A small number continue to make timely progress. This talk will summarize repository program experiences to date and will describe in more detail the new approach taken in Canada after the passage of a law that re-established their program in 2002.

Progress in Implementation of a System for Deep Geological Disposal of Spent Nuclear Fuel in Sweden - Technical and Social Aspects

Claes Thegerstrom

Abstract

Final disposal of spent nuclear fuel and nuclear waste is a complex issue that has technical, scientific, social, ethical and political dimensions.

In Sweden the nuclear power industry is responsible for the management and disposal of all radioactive waste from its plants. The owners of the nuclear power plants have therefore jointly formed SKB. Over the past three decades a national system has been set up for management and disposal of radioactive waste in a safe manner.

The facilities required for final disposal of the spent nuclear fuel have however not yet been built. Since the 1970's SKB has been working with the development of the Swedish method for disposing of spent nuclear fuel, called the KBS-3 method. It entails encapsulating the spent nuclear fuel in copper canisters, which are embedded in bentonite clay at a depth of about 500 metres in the Swedish crystalline bedrock.

The development of the KBS-3 method has been carried out in parallel with the work to find a suitable site for the final repository. Full scale laboratories for encapsulation technology and disposal technology (Äspö Hard Rock Laboratory) are in operation since more than ten years. Site investigations have now been going on for five years at two sites. An environmental impact assessment is being made by SKB. Stakeholder involvement by concerned municipalities and the interested public is an essential part of the licensing and implementation process. The license application for an encapsulation plant was given to the safety authorities in 2006 and the licensing of the final repository is scheduled to start in 2010.

Facilitated Discussion
George M. Hornberger

5:30 p.m. **Recess (end of first day)**

Tuesday, January 8

8:30 a.m. Continental Breakfast

9:00 a.m. **Developing a New Paradigm – Approaches and Options**

Performance Assessment – Contributions from Natural and Engineered Barriers
Chris G. Whipple

Abstract

As the U.S. program to establish a high-level radioactive waste repository has progressed, the understanding of the relative contribution to waste isolation from the natural system and from engineered barriers has evolved. In the early days, the engineered barriers were not a high priority, but they have become so over the past decade. The reasons for this shift include the use of performance assessment as the basis for licensing, the relatively greater difficulty in specifying the details of the natural system, and the move to a million year dose limit.

What Have We Learned About Geological Disposal from the Yucca Mountain Experience?
B. John Garrick

Abstract

The U.S. Nuclear Waste Technical Review Board has been evaluating the science basis of the proposed Yucca Mountain high-level waste repository since 1987. In the course of the evaluations it has become apparent that quantifying the radiation safety performance of a deep underground repository is extremely challenging because of the very low radiation doses predicted and the extraordinarily long time periods associated with any

possible releases of radiation. Principal issues are obtaining a fundamental understanding of the chemical and physical environment of the waste packages, the mechanisms of their degradation, the form of the resulting mobilized radionuclides, and their retention, retardation and transport in the near and far fields. In spite of the complexities, much progress has been made and the application of the probabilistic thought process has enabled taking into account the uncertainties involved. The performance assessment results obtained by the U.S. Department of Energy, while exhibiting considerable uncertainty, indicate radiation doses to be very low at the accessible boundaries of the repository. The Board has identified many areas where a stronger science basis would lead to a substantial reduction in the performance uncertainties and greater transparency in the analyses. These include the corrosion of the waste packages, formulation of the radiation source term, and the impact of the thermal pulse. Even with these unresolved issues, this author does not believe the repository qualifies as a major safety issue. Indeed, it is a major compliance issue and a big time public confidence building challenge.

Regulation of Permanent Disposal Facilities – A Historical Perspective

Robert J. Budnitz

Abstract

This presentation discusses how one would set about developing a regulation for a deep geological repository for radioactive waste. A historical perspective is offered. Topics covered include the constraints on the regulator and the challenges faced in formulating a specific regulatory approach and specific technical regulations. The different approaches already in use in the U.S. for regulating the WIPP and Yucca Mountain repositories are

analyzed. A critique is offered about the regulatory time scale chosen (10,000 years? 1,000,000 years? a shorter period?), and about the dose level-of-protection chosen for Yucca Mtn. (15 mrem? 350?). Human intrusion, institutional control, retrievability requirements, and cost issues are also discussed.

Are Nuclear Facilities LULUs?
A Review of U.S. Data
Michael R. Greenberg

Abstract

The quality of published and gray literature surveys about public perception of nuclear power plants, waste management and scientific facilities is poor, especially given the importance of these facilities. A few acceptable surveys demonstrate increasing support for nuclear power. With regard to finding new facilities or expanding old ones, existing locations appear to be more support-able than proposed new ones, which is not a surprise. Our ability to explain these findings is entirely inadequate, and relying on intuition to explain the findings would be a serious error. The author calls for a federally led effort to systematically collect quantitative and qualitative data that includes perceptions, as well as underlying explanatory factors such as trust, personal efficacy, familiarity, financial interest, and other likely predictors of opposition to and support for new facilities. This data collection effort, however, implies a more basic serious effort by the federal government to establish two-way communication with potential host communities that includes efforts to establish mutually agreeable institutional processes for community involvement.

Engaging Publics in the Siting of Nuclear Waste Facilities
Roger E. Kasperson

Abstract

Two major strategic choices exist for siting nuclear waste facilities, whether in the United States or elsewhere. The reliance can be either coercion or consent. Coercion and preemption were the early choice historically. But it has become quite apparent in many societies that coercion brings with it high degrees on conflict with the people who bear the principal risks and who must host the facilities in or near their communities. Recent experience in many countries has been to shift to greater emphasis on consent, with public engagement and negotiation as principal mechanisms in the siting process. This has raised a host of issues regarding who the publics are, how they may be best engaged, what the principles of engagement ought to be, and what degree of success can be anticipated. This paper explores these issues in the context of a next generation of nuclear power development and the principal lessons emerging from past experience.

Noon **Lunch**
University Club

1:15 p.m. **Session Resumes**

What Characteristics of High Level Waste and Spent Nuclear Fuel Do or Should Shape Our Concepts of Intergenerational Ethical Responsibility for Their Disposition?

Charles W. Powers

Abstract

The original promises made by the US to implement the responsibilities to "resolve" all of the issues associated with the safe, permanent management of key nuclear wastes obviously have not yet been kept, and surely not within the time frames to which "we" committed ourselves. Many of the public officials who originally stipulated the responsibility and made the promises are "gone". By contrast, most of the institutions charged with the implementation of the promises are still extant. The ability of anyone (people or institutions) actually to "keep" the earlier promises made for them by the generation that is gone is, today, in serious doubt: perpetual siting opposition continues, and there is serious technical concern that the specific responsibility assumed or the promises made to "isolate" specified wastes "from the biosphere" can, in fact, ever be met. In this presentation we attempt to initiate a serious ethical re-exploration of the way in which the understanding of this aspect of nuclear waste management "responsibility" was first developed and to try to understand what it is about the specific materials (for example, their origin, their early use, their toxicity, their potential for dangerous proliferation, etc.) that caused "us" to accept responsibility and make promises that are categorically different than we make for other materials/situations/activities that create risk. Such a re-examination could help point towards a morally preferable path forward.

Health Perspectives and Approaches to Health Criteria for the Next 1000 years

Arthur Upton

Abstract

During the past century, the permissible limits for exposure to ionizing radiation have been lowered repeatedly, in accordance with advances in knowledge of the health effects of low-level irradiation. At present, the exposure limits are based on the hypothesis that there is no threshold in the dose-effect relationship for radiation carcinogenesis; however, this hypothesis is being challenged by growing evidence of adaptive and reparative processes that counteract the effects of radiation at low-to-intermediate dose levels. Further research incorporating and integrating approaches at the epidemiological, cellular, and molecular levels will be needed to resolve the matter. In the meantime, any risks to members of the general public that may result from exposure within the current dose limits appear to be undetectable by present methods.

Long and Long-Long Term Management: Goals and Decision Criteria

Milton Russell

Abstract

The potentially very long-lived hazards from some wastes and the irreversible nature of some ecological changes confront society and environmental decision makers with the issue of how to consider the benefits and costs of outcomes over time. This paper explores (ruminates upon) an approach that divides the future into "fuzzy" conceptual stages and suggests that different motives, criteria, and reasoning might be used for each when making environmental decisions. It also introduces the idea that space--i.e., sense of kinship distance--is

analogous to time in this regard, and that recognizing the similarity of the concepts may lead to a reshaping of some of our attitudes toward desirable social outcomes.

3:00 p.m. **Moving From Today to the Future**

Suggestions and Recommendations for a Path Forward – Integrating Our Collective Thoughts
David S. Kosson

Abstract

Management of nuclear waste in a manner that is credible to the public, technically sound and protective of human health and the environment is essential. Large quantities of nuclear materials exist today from past defense needs, civilian energy production and other sources. Current and likely future reliance on nuclear materials for defense, energy, and other uses, requires a forward looking sustainable approach. This presentation will provide a draft summary that integrates recommendations emerging from this symposium, other sources and the speaker's experience. Key considerations will be (i) social acceptability, (ii) engineered, natural and institutional systems, (iii) uncertainties, (iv) potential future advances in technical understanding, and (v) evolution of society.

Facilitated Discussion and Wrap Up
B. John Garrick

5:00 p.m. **Adjourn**