



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

May 14, 1993

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- Kay Whitfield
- Evelyn Williams
- Jeanne Mullikin
- Connie Shum

FROM: James L. Blaha, AO/OEDO

SUBJECT: 5/5/93 LETTER FROM NAS TO NRC STAFF INFORMING NRC OF UPCOMING MEETING OF NAS COMMITTEE ON TECHNICAL BASES FOR YUCCA MOUNTAIN STANDARDS

As requested by Commissioner Curtiss' office, the subject document is provided for your information.

  
James L. Blaha, AO/OEDO

Enclosure:  
As stated

- cc: (w/o encl.)
- J. Taylor, EDO
  - J. Sniezek, DEDR
  - H. Thompson, DEDS
  - J. Blaha, AO/OEDO
  - K. Stablein, OEDO
  - M. Federline, NMSS
  - SECY
  - OGC
  - OCA
  - OPA

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# NATIONAL RESEARCH COUNCIL

2101 CONSTITUTION AVENUE WASHINGTON, D.C. 20418

EXECUTIVE OFFICE

May 5, 1993

Ms. Margaret Federline  
U.S. Nuclear Regulatory Commission  
High Level Waste Management Division  
1 White Flint N Bldg, 11555 Rockville Pike  
Rockville, MD 20852

In keeping with the Energy Policy Act of 1992, the National Academy of Sciences (NAS) has embarked on a process aimed at providing findings and recommendations to the U.S. Environmental Protection Agency on the technical bases of public health and safety standards for a high-level nuclear waste repository at Yucca Mountain, Nevada.

The NAS project will be conducted by the Committee on Technical Bases for Yucca Mountain Standards. The chairman of the committee is Robert W. Fri, President of Resources for the Future. The list of current members of the committee is enclosed.

A statement of the committee's charge, drawn from the Act and its legislative history, is also enclosed. The committee's report is due by the end of calendar year 1994.

The committee's first meeting will be held on May 27-29, 1993, in Las Vegas at the Alexis Park Resort Hotel, 375 East Harmon Avenue, beginning at 2:00 p.m. on the 27th. The meeting will be open to the public. While a detailed agenda is not yet available, most of the sessions on the 27th and 28th will be devoted to discussions of the committee's task with federal and state officials and representatives of industrial and environmental groups. Time will also be reserved on the afternoon of the 28th for observers in the general audience to present their views to the committee. The central objective of this meeting is to obtain a broad spectrum of views on interpreting the committee's charge, factors to take into account, and issues to address.

If you plan to attend the meeting and particularly if you want to make an oral presentation to the committee, please let us know in advance so that we can provide sufficient space for everyone who wishes to attend. Write to Ms. Lisa Clendening; Board on Radioactive Waste Management; National Academy of Sciences; 2101 Constitution Avenue, NW; Washington, DC 20418. The telephone number for facsimile transmissions is (202) 334-3077. Persons who indicate that they plan to attend will receive copies of the detailed agenda as soon as it is made final.

Sincerely,

Myron F. Uman  
Assistant Executive Officer  
Special Projects

Enclosures

~~94-11054-56~~

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**NATIONAL RESEARCH COUNCIL**  
**COMMISSION ON GEOSCIENCES, ENVIRONMENT, AND RESOURCES**

2101 Constitution Avenue Washington, D.C. 20418

**BOARD ON**  
**RADIOACTIVE WASTE MANAGEMENT**

Office Location:  
Milton Harris Building  
Room 456  
2001 Wisconsin Avenue, N.W. 20007

**Committee on Technical Bases for  
Yucca Mountain Standards**

**Chairman**

**Robert W. Fri, Resources for the Future**

**Engineering**

**Sol Burstein (NAE), Wisconsin Electric Power (ret.)**  
**Charles Fairhurst, University of Minnesota**

**Environmental Sciences**

**Robert J. Budnitz, Future Resources Associates**  
**Thomas H. Pigford, University of California, Berkeley**  
**Gilbert F. White (NAS), Institute for Behavioral Sciences (emer.)**

**Geology**

**Jean M. Bahr, University of Wisconsin, Madison**  
**Fred M. Phillips, New Mexico Institute of Mining and Technology**

**Health**

**Melvin W. Carter, Georgia Institute of Technology**  
**Arthur C. Upton (NAS, IOM), New York University (ret.)**

**Risk Assessment**

**Chris G. Whipple, ICF Kaiser Engineers**  
**Susan D. Wiltshire, JK Research Associates**

**Risk Management**

**John F. Ahearn, Society of the Sigma Xi**  
**R. Darryl Banks, World Resources Institute**  
**Charles McCombie, (Swiss) National Cooperative for the Disposal of Radioactive Waste**

**Staff**

**Myron F. Uman, Project Leader**  
**Raymond Wassel, Project Officer**  
**Lisa Clendening, Project Administrator**

April 28, 1993

**NATIONAL RESEARCH COUNCIL**  
**COMMISSION ON GEOSCIENCES, ENVIRONMENT, AND RESOURCES**

2101 Constitution Avenue Washington, D.C. 20418

**BOARD ON**  
**RADIOACTIVE WASTE MANAGEMENT**

Office Location:  
Milton Harris Building  
Room 456  
2001 Wisconsin Avenue, N.W. 20007

**Charge to the Committee on Technical Bases for Yucca Mountain Standards**

The Energy Policy Act of 1992 (P.L. 102-486) requires the U.S. Environmental Protection Agency (EPA) to promulgate standards for protection of the public from releases of radioactive materials at a proposed repository at Yucca Mountain in Nevada. The Act also requests the National Academy of Sciences to provide findings and recommendations to EPA in this regard. In accordance with Section 801(a)(2) of the Act, the committee shall conduct a study to provide findings and recommendations on the technical bases for "reasonable standards for protection of the public health and safety, including--

(A) whether a health-based standard based upon doses to individual members of the public from releases to the accessible environment ... will provide a reasonable standard for protection of the health and safety of the general public:

(B) whether it is reasonable to assume that a system for post-closure oversight of the repository can be developed, based upon active institutional controls, that will prevent an unreasonable risk of breaching the repository's engineered or geologic barriers or increasing the exposure of individual members of the public to radiation beyond allowable limits; and

(C) whether it is possible to make scientifically supportable predictions of the probability that the repository's engineered or geologic barriers will be breached as a result of human intrusion over a period of 10,000 years."

The legislative history of this provision indicates that the listing of these specific questions is not intended to preclude the committee from addressing additional questions or issues related to appropriate standards for radiation protection at Yucca Mountain. On the question of human intrusion, for example, the committee might also address issues related to predictions of the probability of natural events that could compromise a repository. On the question of a health standard based on dose to individual members of the public, the committee might also address the collective dose to the general population that could result from the adoption of such an approach.

In making its findings and recommendations, the committee shall provide expert scientific guidance on the issues involved in establishing standards, but the authority and responsibility to establish the standards remains with the EPA Administrator in accordance with law.

4/29/93

# Reports & EVENTS

National Academy of Sciences  
National Academy of Engineering  
Institute of Medicine  
National Research Council

2101 Constitution Avenue, NW  
Washington, DC 20418

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## A GUIDE FOR THE NEWS MEDIA

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Date: May 4, 1993  
Contacts: Craig Hicks, Media Relations Associate  
Richard Julian, Media Relations Assistant  
(202) 334-2138

### MEDIA ADVISORY

#### COMMITTEE TO EXAMINE TECHNICAL BASES OF EPA STANDARDS FOR PROPOSED RADIOACTIVE WASTE SITE

In the Energy Policy Act of 1992, Congress asked the National Academy of Sciences to evaluate the technical bases of EPA's public health and safety standards for the proposed high-level radioactive waste repository at Yucca Mountain, Nev. The Academy's National Research Council will launch an 18-month study of these issues at a news conference on Thursday, May 27, from 10 a.m. - 11 a.m. PDT in the Monte Carlo 3 room of the St. Tropez hotel, 4503 Paradise Road, Las Vegas.

On hand to discuss the background, purpose and procedures of the study will be committee chair Robert W. Fri, president and senior fellow, Resources for the Future; and staff project leader Myron F. Uman of the National Research Council. Both will be available for interviews following the presentation.

The committee's first meeting will be held following the news conference. The meeting is open to the public. It will begin at 2 p.m. PDT Thursday, May 27, and end on Saturday, May 29, in the Marketplace room of the Alexis Park hotel, 375 East Harmon Avenue, Las Vegas. Most of this meeting will be devoted to discussions of the committee's task with federal and state government officials and representatives of environmental and industry groups. Time will be reserved for observers in the audience to present their views to the committee.

Reporters can obtain copies of the meeting's agenda at the Las Vegas news conference or from the Office of News and Public Information, (202) 334-2138.

The study is funded by the U.S. Environmental Protection Agency. A committee roster is overleaf.

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This listing is prepared by the Office of News and Public Information. It may not include some activities planned on short notice. Details are subject to change and should be checked directly with the contact person for each event.

# NATIONAL RESEARCH COUNCIL

2101 CONSTITUTION AVENUE WASHINGTON, D.C. 20418

EXECUTIVE OFFICE

April 30, 1993

Mr. Robert M. Bernero, Director  
Office of Nuclear Material Safety and Safeguards  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555

Dear Mr. Bernero

The committee of the National Research Council that is charged with providing the Environmental Protection Agency with findings and recommendations on the technical bases of standards at Yucca Mountain wishes to establish and maintain strong technical liaison with the Nuclear Regulatory Commission.

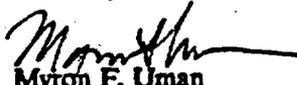
To this end, I am writing to request that you assign a member of your staff the formal responsibilities of liaison representative to our newly formed Committee on Technical Bases for Yucca Mountain Standards. Under the Council's policies, a liaison representative attends and participates in committee meetings, except executive sessions, to assure that the committee has access to all of the pertinent technical information that the agency possesses. In addition, the liaison representative helps to assure that the agency has access to the technical information available to the committee from other sources.

At your suggestion, I have discussed our interest in having a designated liaison representative from the U.S. NRC with Margaret Federline of your staff. Based on that conversation and her previous experience with National Research Council committees, I am confident that she is fully aware of the responsibilities and obligations of liaison representation.

I hope that you will agree that the sustained participation of a designated technical liaison representative of the U.S. NRC will substantially aid the committee in this challenging endeavor. We are also asking the Environmental Protection Agency, the Department of Energy, and the Nevada State Nuclear Waste Projects Office each to designate an appropriate technical liaison representative.

If you have any questions about this request or any other aspect of the study, please do not hesitate to call me at (202) 334-1659.

Sincerely,

  
Myron F. Uman  
Assistant Executive Officer  
Special Projects

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NRC



UNITED STATES  
**NUCLEAR REGULATORY COMMISSION**  
 WASHINGTON, D.C. 20555-0001

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Enclosure has been  
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June 10, 1993

**MEMORANDUM FOR:** The Chairman  
 Commissioner Rogers  
 Commissioner Curtiss ✓  
 Commissioner Remick  
 Commissioner de Planque

**FROM:** James M. Taylor  
 Executive Director for Operations

**SUBJECT:** NATIONAL ACADEMY OF SCIENCES COMMITTEE ON TECHNICAL BASES  
 FOR YUCCA MOUNTAIN STANDARD, MAY 27-29, 1993, LAS VEGAS,  
 NEVADA

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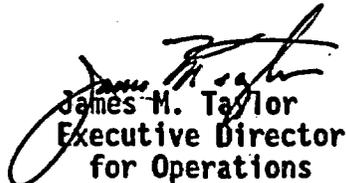
On May 27-29, 1993, the National Academy of Sciences (NAS) Committee on Technical Bases for Yucca Mountain Standard held its first meeting in Las Vegas, Nevada. The NRC was represented at this meeting by the NRC liaison to the Committee, other staff of the Division of High-Level Waste Management, a staff member from the Office of the General Counsel, and a member of Commissioner Curtiss' staff. The 15 member Committee indicated its intent to complete the study, requested in the Energy Policy Act of 1992, within 18 months. The Committee emphasized the importance of public involvement in the study and noted that Committee meetings will be open to the public with a large number of meetings to be held in Nevada to facilitate public participation.

This first meeting focused on defining the scope of the project and developing a workplan for conducting the study. The Committee emphasized that it does not consider it within the Committee's mandate to (1) make recommendations on the suitability of the Yucca Mountain site, (2) determine "how safe is safe enough," or (3) develop a standard; instead its mandate is to provide expert scientific guidance and recommendations regarding the technical basis of the Environmental Protection Agency (EPA) high-level waste disposal standards for Yucca Mountain. With these exceptions, the Committee emphasized that it is not to question all assumptions underlying the regulatory framework for high-level waste disposal. The Committee heard from EPA on the history of radiation waste disposal standards and from over 20 representatives of federal, state, and county governments, the Nuclear Waste Technical Review Board, the nuclear electric industry, environmental and public interest organizations, Indian tribal representatives, the American Nuclear Society, and members of the general public regarding issues to be considered in the development of recommendations. The NRC staff presentation is included as an enclosure. Presentations made by other contributors are available from the Executive Director for Operations' office. Individual Committee members and numerous speakers stressed the need to consider the standard in the licensing framework within which it will ultimately be implemented. Of particular interest to the NRC, a question was raised by one Committee member and several presenters as to whether NRC subsystem requirements (10 CFR 60.113) represent dual regulation. NRC staff responded by explaining the regulatory history of the development of subsystem requirements and the role these requirements play

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in enhancing the Commission's confidence in making a licensing decision with reasonable assurance. It is unclear whether the Committee will pursue this issue in the future.

The Committee created working groups from within its membership to focus on key issues raised in the Energy Policy Act. The priority that the Committee will give to issues beyond those discussed in the Energy Policy Act will be decided at future meetings. In addition, the Committee is arranging for consultants to conduct literature reviews in the areas of (1) international approaches to health-based high-level waste disposal standards, (2) human intrusion, (3) effectiveness of active and passive institutional controls, and (4) long-term prediction of disruptive natural events as a basis for input to Committee discussions. All Committee findings and recommendations will be subjected to peer review. The Committee asked the NRC staff and others to provide information on identified subjects and to participate in future meetings. The next meeting is planned in late August or early September focusing on the adequacy of health-based standards. The NRC staff plans to provide such information to the Committee consistent with the Commission's previous positions on these issues and will raise to the Commission's attention any new matters of policy.

  
James M. Taylor  
Executive Director  
for Operations

Enclosure:  
NRC Presentation to the NAS

cc: SECY  
OGC  
OCA  
OPA

**NATIONAL ACADEMY OF SCIENCES COMMITTEE ON TECHNICAL BASES  
FOR YUCCA MOUNTAIN STANDARDS  
MAY 27, 1993**

**U.S. NUCLEAR REGULATORY COMMISSION STAFF VIEWS  
ON ENVIRONMENTAL STANDARDS  
FOR DISPOSAL OF HIGH-LEVEL WASTES**

**Margaret V. Federline, Chief  
Hydrology and Systems Performance Branch  
Division of High-Level Waste Management  
U.S. Nuclear Regulatory Commission**

**I. INTRODUCTION**

Thank you for the opportunity to present the U.S. Nuclear Regulatory Commission (NRC) staff's views on the major issues involved in developing standards for disposal of high-level wastes (HLW). Under the provisions of the Nuclear Waste Policy Act (as well as earlier legislation), the NRC is one of three Federal agencies with a role to play in disposal of HLW. The Department of Energy has the responsibility for actual disposal of HLW -- developing a repository and operating it. The U.S. Environmental Protection Agency (EPA) has been charged with developing the environmental standards that will be used to evaluate the safety of the repository developed by DOE. NRC is the implementor -- the regulatory agency that will determine whether DOE's proposal does, in fact, comply with the requirements of EPA's standards.

The NRC's regulatory role causes the NRC to have a strong interest in both the form and the content of HLW standards. Of course, the NRC's first interest is protection of public health and safety. We look to EPA's standards to define an adequate level of public health protection. When implementing EPA's standards, the NRC staff's major concern is with the clarity of the standards and the practicality of evaluating compliance with them during licensing. However, the NRC staff also recognizes a strong national interest in proceeding with HLW

disposal in a manner that is adequately safe. The NRC staff therefore is concerned that the standards should provide a level of safety that is sufficient to adequately protect future generations, but is not so stringent that demonstrating compliance with the standards becomes needlessly costly or time consuming. With those basic concerns in mind, let me now turn to the basic safety goal for HLW disposal, and then discuss the major issues the NRC staff believes will be important in formulating standards to achieve that basic goal.

## II. THE BASIC SAFETY GOAL

More than a decade ago, the Nuclear Waste Policy Act set up a national program for development of deep geologic repositories for disposal of high-level radioactive wastes (HLW). This decision was not reached lightly. A wide range of alternative disposal technologies, ranging from subseabed disposal to disposal in space, had earlier been evaluated by the U.S. Department of Energy (DOE). After selection of repository disposal as the preferred technology, the safety of deep geologic disposal of HLW was reviewed twice by the U.S. Nuclear Regulatory Commission (NRC). First, the Waste Confidence Decision of 1984 found reasonable assurance that safe disposal of HLW in a repository is technically feasible. Then, in 1990, the NRC reviewed and reaffirmed its earlier views on the technical feasibility of safe repository disposal. And, the U.S. has not been alone in its pursuit of repository disposal. Other nations with substantial nuclear power programs have also endorsed the concept of disposal of HLW in deep geologic repositories.

One might reasonably ask the question "On what basis has this generation, today, selected repository disposal and evaluated its safety?" The answer lies, I

think, in what can be called the "Societal Pledge to Future Generations." The Pledge is really very simple. First, it assumes that future societies will be just as concerned as we are today about the potential health hazards of radiation exposure. No more and no less. The Pledge then promises to provide future societies with the same protection from radiation we would expect for ourselves. No more and no less. The Pledge further promises to provide that protection in a way that does not impose burdens on future societies. In other words, future societies will not need to take special precautions to protect themselves from the radioactive materials we generate today. Instead, we will do today whatever is necessary to ensure an adequate level of radiation protection. This Pledge is, I believe, what decision-makers in the U.S. and other nations had in mind when deep geologic disposal was selected as the preferred technology and was declared to be safe.

Of course, the Pledge I just described is rather general and lacks many important details. Development of those details, in the form of recommendations for environmental standards, is the charter of this panel of the National Academy of Sciences. Many difficult issues must be addressed by the panel, including several that I will discuss in a moment. I think, however, that the difficulty of some issues can be reduced by accepting the Societal Pledge I described. When considering environmental standards, we should not try to forecast possible cures for cancer, capabilities to detect and correct genetic abnormalities, long-term changes in societal lifestyles and preferences, and so on. It will be difficult enough to predict the geologic evolution of a repository site. Trying to also predict human and societal evolution over thousands of years, and to litigate those predictions during licensing, seems to me to be both unproductive and

unnecessary. Instead, we should assume that human beings and their social institutions will remain much as they are today and, based on that assumption, we should provide for the future the same protection from radiation we would demand for ourselves. Trying to speculate about the ways in which humans or societies might change over thousands of years in the future, and to tailor standards to those changes, seems a very difficult undertaking with little chance of success.

### III. THE ISSUES

As I see it, there are at least seven major issues that need to be addressed by this panel. Let me discuss each of these issues.

(1) Health-based versus technology-based standards. Any environmental standard should have as its underlying basis a safety goal for the allowable health risk to an individual or a population. Perhaps the most fundamental issue facing this panel is the way in which the safety goal should be determined. When EPA developed its 1985 standards, the underlying safety goal was largely based on EPA's analyses of the waste isolation capabilities of several hypothetical HLW repositories. EPA estimated the health effects that might be caused by those repositories, compared that level of health effects to the estimated impacts of unmined uranium ore, natural background radiation and similar reference points, and then required that any real repository perform at least as well as EPA's hypothetical repositories. Thus, the safety goal underlying EPA's 1985 standards can be termed "technology-based" because it was derived from EPA's analyses of the waste isolation capabilities of repositories.

The advantage of a technology-based safety standard is that it largely eliminates questions about whether the projected impacts of a repository will be "as low as reasonably achievable" (ALARA). After all, the whole purpose of a technology-based standard is to require the best level of performance that a particular technology is thought to be able to provide. Thus, a technology-based standard can largely eliminate any need for a time-consuming and controversial ALARA analysis during the licensing review for a specific repository. The disadvantage of a technology-based standard is the potential for such a standard to be overly stringent if EPA misjudges the waste isolation capability of repositories or the costs of achieving compliance. Failure to recognize the potential for gaseous release of carbon-14 from an unsaturated zone repository illustrates the vulnerability of technology-based standards when applied to a new or evolving technology like HLW disposal. There also is no guarantee that a purely technology-based standard would be adequately protective.

In contrast to EPA's technology-based safety goal, the International Commission on Radiological Protection (ICRP) has recommended a "health-based" safety goal. The ICRP examined other risks accepted by society and, on that basis, developed recommended dose and risk limits for individuals who might be exposed to releases from a repository in the future. The ICRP's recommendations can be characterized as "health-based" because they represent the judgment of the ICRP as to the highest level of health risk that any person should ever be subjected to, regardless of the costs or technical difficulties of achieving compliance.

The Energy Policy Act asks this panel to consider whether a "health-based standard" would be reasonable. In my view, use of the term "health-based" refers

to the type of safety goal recommended by the ICRP, in contrast to the technology-based health goal previously adopted by EPA. As I stated earlier, one of the most fundamental issues facing this panel is whether a health-based safety goal, like that recommended by the ICRP, would provide a reasonable basis for EPA's HLW standards and whether such a basis would be preferable to the technology-based approach previously used by EPA.

In the NRC staff's view, EPA should reduce the emphasis placed on technical achievability when deriving its standards. The "carbon-14 issue" illustrates the vulnerability of technology-based standards to new information. For a new undertaking, like a HLW repository, there is a real potential for technology-based standards to be unreasonably stringent if all significant releases cannot be identified and included in the derivation of those standards. On the other hand, there is no guarantee that technology-based standards will be adequately protective. For these reasons, the NRC staff has recommended to EPA that much more emphasis be placed on health-based reasoning when deriving EPA's HLW standards.

(2) Individual versus population protection. The second major issue facing this panel involves the type of radiation protection to be emphasized by EPA's standards -- protection for individuals or protection for the population as a whole. EPA's 1985 standards emphasized protection of populations by imposing "containment requirements" that limited the cumulative amount of radioactive material released over 10,000 years. In contrast, the Energy Policy Act now asks whether a standard, "based upon doses to individual members of the public," would be reasonable.

EPA's decision to base its 1985 standards on population impacts rather than on protection of individuals was EPA's most significant departure from the traditional concepts of radiation protection, from the recommendations of advisory groups like the ICRP, and from the practices of other nations. EPA's defense of its decision was two-fold -- practicality and a desire to emphasize waste containment rather than dilution.

EPA's practicality concern deserves close attention by this panel. Ten years ago, the Waste Isolation Systems Panel of the National Academy of Sciences warned that large individual doses can occur if humans consume contaminated groundwater in the vicinity of a HLW repository. The reason is simple -- groundwater flow rates are too low to provide significant dilution of potential releases. When trivial doses were estimated for a repository at Hanford, it was assumed that releases would be diluted in the Columbia River. There is no Columbia River near Yucca Mountain. In fact, at Yucca Mountain, consumption of groundwater may be the most likely pathway for repository releases to reach humans. Since groundwater flow provides little dilution of releases, unacceptably large doses may be predicted to occur unless a Yucca Mountain repository performs much better than would have been required by EPA's 1985 standards.

There are strong arguments in favor of an individual protection standard, either as a supplement to EPA's cumulative release limits, or as a replacement for those release limits. One of the first principles of radiation protection has always been to provide an adequate level of protection for each individual potentially exposed to radiation. Questions have been raised about EPA's 1985 standards because those standards depart from that tradition. When this panel considers

whether to recommend adoption of an individual dose standard, the panel will also need to face the challenge of finding a practical way to make such a standard workable for a repository where no large river is available to dilute potential releases, but which has clear advantages for containment of wastes.

The NRC staff considers that radiation protection for individuals should be a part of EPA's standards. However, it will be very important to ensure that an individual protection standard is applied in a reasonable manner. An individual protection standard should not attempt to protect all individuals, under all conceivable circumstances, at all times in the future. For example, it does not seem reasonable to try to protect a hypothetical farm family located at the boundary of a Yucca Mountain repository, when it is unlikely that such a farm family will ever exist. Instead, a more realistic scenario would involve exploitation of groundwater near Yucca Mountain as a supplement to the municipal water supply for regional populations. Water consumers in the region would then form the critical group whose doses would be limited by an individual protection standard.

(3) Fundamental versus derived standard. Development of environmental standards usually begins with establishment of an underlying basic safety goal, expressed in terms of an allowable dose or health risk to an individual or a population. However, it is not necessary to express the standard directly in terms of that fundamental goal. Instead, the standard can be expressed in terms of a derived quantity, such as quantity or concentration of radioactive material released to the environment. The advantage of a derived, release limit standard is simplicity. Evaluations of compliance need not predict who will live where, or

how they will live, for thousands of years into the future. The disadvantage of a derived standard is the possibility that conditions near a repository will be different from those assumed when deriving the standard from the basic safety goal. If so, the actual health risk caused by releases from a repository might be significantly different from the basic safety goal.

As we all know, EPA's 1985 standards were expressed in terms of release limits derived from EPA's analyses of the expected performance of hypothetical repositories. Those release limits were controversial, at least in part, because the release limits were derived using a "world-average" biosphere that bore little resemblance to the biosphere likely to exist near Yucca Mountain. Thus, the actual number of health effects that might be caused by releases from Yucca Mountain might also bear little resemblance to EPA's health effects goal. Now, the Energy Policy Act asks this panel to consider whether a standard "based upon doses" to individual members of the public is reasonable. I interpret the phrase "based upon doses" to allow this panel to consider derived standards, such as limits on concentrations of radionuclides released to the environment, as well as standards that directly limit doses. The issue before this panel is whether the simplicity of derived standards, and the relative ease of evaluating compliance with them during licensing, outweighs the potential for derived standards to depart from the underlying basic safety goal.

The NRC staff has supported a derived standard (e.g., a limit on radionuclide releases) because such a standard would be easier to implement during licensing than a fundamental standard expressed in terms of doses or health risks. Of course, if a derived standard is to be used, it would be necessary to avoid

unrealistic assumptions in the derivation of the standard. A fundamental (dose or health risk) standard would also be acceptable, provided that such a standard could be implemented using some type of "static" or "reference" biosphere. The NRC staff would object to any fundamental standard that permitted unlimited speculation about future human locations, lifestyles and societal conditions.

(4) Active institutional control. EPA's 1985 standards assumed that active institutional controls (guarding or monitoring a site and remedial activities) will not be relied upon for more than 100 years after repository closure as the means to achieve acceptable waste isolation. The Energy Policy Act now asks this panel to advise EPA on the potential for post-closure oversight to prevent an unreasonable risk of breaching the repository's barriers or of causing unacceptable radiation doses to the public.

The advantage of relying on active institutional controls is the potential to reduce the near-term cost of achieving and demonstrating compliance with the environmental standards for Yucca Mountain. Some probabilistic projections, especially those involving human intrusion, will likely be contentious during a licensing review and substantial efforts may be needed to demonstrate acceptable repository performance. Societal practices such as monitoring drinking water quality could provide effective protection of populations near a repository, and credit for such practices could be beneficial in demonstrating repository safety.

The disadvantage of reliance on active controls is the history of loss of such controls which raises questions about the wisdom of relying on institutions to ensure repository safety. Historical examples of durable institutions generally

involve functions that societies find useful (e.g., maintaining records), and it is difficult to project the willingness of future societies to perpetually monitor a repository site.

The NRC's regulations for geologic repositories have not assumed that active institutional controls would be effective in preventing human intrusion for more than 100 years after facility closure. This assumption appeared to be prudent for a HLW repository, since no practical method has ever been identified to guarantee that such active institutional controls will persist or will continue to be effective. "Passive" institutional controls, however, such as monuments, markers and land-use records, are likely to persist and be effective in deterring future human intrusion into a repository.

(5) Probabilistic standards. The cumulative release limits of EPA's 1985 standards applied to virtually all causes of releases, including human intrusion. Concerns about the scientific predictability of intrusion is reflected in the Energy Policy Act's identification of post-closure oversight and human intrusion as subjects for this panel's review. Predicting the probabilities of some rare geologic events, such as volcanic activity at Yucca Mountain, could prove nearly as troublesome as predictions of human intrusion. Therefore, I encourage this panel to include rare geologic events, along with human intrusion, when considering whether it is possible to make scientifically supportable predictions of potential repository disruptions.

In probabilistic risk assessments, the probability that an event will occur cannot always be determined from the historical frequency of occurrence of

similar events. For rare events, the estimated probabilities are often values that represent an individual's degree of belief (grounded on some theoretical or empirical foundation) that the events will occur. Although such probability estimates might not be scientifically verifiable in the most rigorous sense, they have provided an adequate basis for past regulatory decisions (e.g., regarding seismic potential in the eastern United States). Thus, it is reasonable to expect that a probabilistic standard will prove workable during licensing. Nevertheless, some of the events of concern for predicting the performance of a repository may be even more speculative than events dealt with in the past, and could be difficult to evaluate during licensing. In the NRC staff's view, implementing probabilistic standards during repository licensing will be challenging, but should ultimately prove to be feasible.

(6) As low as reasonably achievable (ALARA). EPA's 1985 standards did not contain a specific requirement that projected releases be ALARA. EPA's containment requirements, which were derived from analyses of the waste isolation capabilities of hypothetical HLW repositories, were effectively "generic" ALARA levels. In contrast, an explicit ALARA requirement is a prominent feature of the recommendations of international advisory organizations.

The principal advantage of an explicit ALARA requirement would be consistency with other radiation protection standards. The disadvantage would be significant difficulties in evaluating compliance with such a criterion. The large uncertainties in projected repository performance would make any case-specific ALARA analysis highly speculative, especially if the performance of real or hypothetical alternative sites were to be considered.

The NRC staff would object to any broad-based requirement that repository releases be demonstrated to be ALARA, especially if such a requirement were applied to site selection. The NRC's regulations now contain a requirement for consideration of alternatives to the major design features of a repository. Any more extensive ALARA analysis is likely to prove speculative and unworkable.

(7) 10,000-year period of concern. The containment requirements of EPA's 1985 standards applied only for the first 10,000 years after repository closure. In contrast, the recommendations of some international advisory groups and the regulations of some other nations are open-ended, restricting individual doses and risks in perpetuity. While not specifically addressed by the Energy Policy Act, questions have been raised about the time period for which environmental standards should be applied at Yucca Mountain.

The advantage of a 10,000-year cut-off can be stated very simply -- practicality. With a 10,000-year cut-off, the licensing process does not need to consider very speculative long-term geologic and climatic changes that might disrupt repository performance. On the other hand, some of the hazardous constituents of high-level waste have half-lives exceeding 10,000 years, and releases of those materials could pose a significant human health hazard well beyond 10,000 years. Previously, EPA reasoned that a repository that is able to meet its standards for the first 10,000 years after disposal would be likely to perform well for longer times, as well. It should be noted that, when EPA's standards were challenged in a Federal court, the court did find that EPA's explanation of its 10,000-year limit was adequate.

The NRC staff prefers that any numerical HLW standard be applied only for a limited time after disposal (e.g., 10,000 years). The farther into the future one tries to predict repository performance, the more uncertain those predictions will be. In the NRC staff's view, the very large uncertainties inherent in estimating releases over very long times makes it impractical to make a scientifically rigorous demonstration of compliance with numerical regulatory limits. Instead, potential releases that might occur after the regulatory period should be estimated by DOE and disclosed in a suitable format, such as an Environmental Impact Statement.

#### IV. CONCLUDING REMARKS

In conclusion, let me return to my earlier remarks about the basic Societal Pledge we are making to future generations. We are not promising to predict every nuance of future society's attitudes toward, or concerns about, radiological hazards. Nor are we trying to forecast the full range of potential changes in societal lifestyles and potential modes of exposure to releases from a repository. We are simply promising to provide future humans with the same type of radiological protection, and the same level of safety, that we would demand for ourselves. If this panel can focus its deliberations on determining the safety standards we would find acceptable today, I think reasonable and workable recommendations for HLW disposal standards can be developed. I wish you great success in your deliberations, and I offer you any support from the staff of the NRC that you might find helpful in your efforts.

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**NATIONAL ACADEMY OF SCIENCES COMMITTEE ON TECHNICAL BASES  
FOR YUCCA MOUNTAIN STANDARDS  
MAY 27, 1993**

**U.S. NUCLEAR REGULATORY COMMISSION STAFF VIEWS  
ON ENVIRONMENTAL STANDARDS  
FOR DISPOSAL OF HIGH-LEVEL WASTES**

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**I. INTRODUCTION**

Thank you for the opportunity to present the U.S. Nuclear Regulatory Commission (NRC) staff's views on the major issues involved in developing standards for disposal of high-level wastes (HLW). Under the provisions of the Nuclear Waste Policy Act (as well as earlier legislation), the NRC is one of three Federal agencies with a role to play in disposal of HLW. The Department of Energy has the responsibility for actual disposal of HLW -- developing a repository and operating it. The U.S. Environmental Protection Agency (EPA) has been charged with developing the environmental standards that will be used to evaluate the safety of the repository developed by DOE. NRC is the implementor -- the regulatory agency that will determine whether DOE's proposal does, in fact, comply with the requirements of EPA's standards.

The NRC's regulatory role causes the NRC to have a strong interest in both the form and the content of HLW standards. Of course, the NRC's first interest is protection of public health and safety. We look to EPA's standards to define an adequate level of public health protection. When implementing EPA's standards, the NRC staff's major concern is with the clarity of the standards and the practicality of evaluating compliance with them during licensing. However, the NRC staff also recognizes a strong national interest in proceeding with HLW

disposal in a manner that is adequately safe. The NRC staff therefore is concerned that the standards should provide a level of safety that is sufficient to adequately protect future generations, but is not so stringent that demonstrating compliance with the standards becomes needlessly costly or time consuming. With those basic concerns in mind, let me now turn to the basic safety goal for HLW disposal, and then discuss the major issues the NRC staff believes will be important in formulating standards to achieve that basic goal.

## II. THE BASIC SAFETY GOAL

More than a decade ago, the Nuclear Waste Policy Act set up a national program for development of deep geologic repositories for disposal of high-level radioactive wastes (HLW). This decision was not reached lightly. A wide range of alternative disposal technologies, ranging from subseabed disposal to disposal in space, had earlier been evaluated by the U.S. Department of Energy (DOE). After selection of repository disposal as the preferred technology, the safety of deep geologic disposal of HLW was reviewed twice by the U.S. Nuclear Regulatory Commission (NRC). First, the Waste Confidence Decision of 1984 found reasonable assurance that safe disposal of HLW in a repository is technically feasible. Then, in 1990, the NRC reviewed and reaffirmed its earlier views on the technical feasibility of safe repository disposal. And, the U.S. has not been alone in its pursuit of repository disposal. Other nations with substantial nuclear power programs have also endorsed the concept of disposal of HLW in deep geologic repositories.

One might reasonably ask the question "On what basis has this generation, today, selected repository disposal and evaluated its safety?" The answer lies, I

think, in what can be called the "Societal Pledge to Future Generations." The Pledge is really very simple. First, it assumes that future societies will be just as concerned as we are today about the potential health hazards of radiation exposure. No more and no less. The Pledge then promises to provide future societies with the same protection from radiation we would expect for ourselves. No more and no less. The Pledge further promises to provide that protection in a way that does not impose burdens on future societies. In other words, future societies will not need to take special precautions to protect themselves from the radioactive materials we generate today. Instead, we will do today whatever is necessary to ensure an adequate level of radiation protection. This Pledge is, I believe, what decision-makers in the U.S. and other nations had in mind when deep geologic disposal was selected as the preferred technology and was declared to be safe.

Of course, the Pledge I just described is rather general and lacks many important details. Development of those details, in the form of recommendations for environmental standards, is the charter of this panel of the National Academy of Sciences. Many difficult issues must be addressed by the panel, including several that I will discuss in a moment. I think, however, that the difficulty of some issues can be reduced by accepting the Societal Pledge I described. When considering environmental standards, we should not try to forecast possible cures for cancer, capabilities to detect and correct genetic abnormalities, long-term changes in societal lifestyles and preferences, and so on. It will be difficult enough to predict the geologic evolution of a repository site. Trying to also predict human and societal evolution over thousands of years, and to litigate those predictions during licensing, seems to me to be both unproductive and

unnecessary. Instead, we should assume that human beings and their social institutions will remain much as they are today and, based on that assumption, we should provide for the future the same protection from radiation we would demand for ourselves. Trying to speculate about the ways in which humans or societies might change over thousands of years in the future, and to tailor standards to those changes, seems a very difficult undertaking with little chance of success.

### III. THE ISSUES

As I see it, there are at least seven major issues that need to be addressed by this panel. Let me discuss each of these issues.

(1) Health-based versus technology-based standards. Any environmental standard should have as its underlying basis a safety goal for the allowable health risk to an individual or a population. Perhaps the most fundamental issue facing this panel is the way in which the safety goal should be determined. When EPA developed its 1985 standards, the underlying safety goal was largely based on EPA's analyses of the waste isolation capabilities of several hypothetical HLW repositories. EPA estimated the health effects that might be caused by those repositories, compared that level of health effects to the estimated impacts of unmined uranium ore, natural background radiation and similar reference points, and then required that any real repository perform at least as well as EPA's hypothetical repositories. Thus, the safety goal underlying EPA's 1985 standards can be termed "technology-based" because it was derived from EPA's analyses of the waste isolation capabilities of repositories.

The advantage of a technology-based safety standard is that it largely eliminates questions about whether the projected impacts of a repository will be "as low as reasonably achievable" (ALARA). After all, the whole purpose of a technology-based standard is to require the best level of performance that a particular technology is thought to be able to provide. Thus, a technology-based standard can largely eliminate any need for a time-consuming and controversial ALARA analysis during the licensing review for a specific repository. The disadvantage of a technology-based standard is the potential for such a standard to be overly stringent if EPA misjudges the waste isolation capability of repositories or the costs of achieving compliance. Failure to recognize the potential for gaseous release of carbon-14 from an unsaturated zone repository illustrates the vulnerability of technology-based standards when applied to a new or evolving technology like HLW disposal. There also is no guarantee that a purely technology-based standard would be adequately protective.

In contrast to EPA's technology-based safety goal, the International Commission on Radiological Protection (ICRP) has recommended a "health-based" safety goal. The ICRP examined other risks accepted by society and, on that basis, developed recommended dose and risk limits for individuals who might be exposed to releases from a repository in the future. The ICRP's recommendations can be characterized as "health-based" because they represent the judgment of the ICRP as to the highest level of health risk that any person should ever be subjected to, regardless of the costs or technical difficulties of achieving compliance.

The Energy Policy Act asks this panel to consider whether a "health-based standard" would be reasonable. In my view, use of the term "health-based" refers

to the type of safety goal recommended by the ICRP, in contrast to the technology-based health goal previously adopted by EPA. As I stated earlier, one of the most fundamental issues facing this panel is whether a health-based safety goal, like that recommended by the ICRP, would provide a reasonable basis for EPA's HLW standards and whether such a basis would be preferable to the technology-based approach previously used by EPA.

In the NRC staff's view, EPA should reduce the emphasis placed on technical achievability when deriving its standards. The "carbon-14 issue" illustrates the vulnerability of technology-based standards to new information. For a new undertaking, like a HLW repository, there is a real potential for technology-based standards to be unreasonably stringent if all significant releases cannot be identified and included in the derivation of those standards. On the other hand, there is no guarantee that technology-based standards will be adequately protective. For these reasons, the NRC staff has recommended to EPA that much more emphasis be placed on health-based reasoning when deriving EPA's HLW standards.

(2) Individual versus population protection. The second major issue facing this panel involves the type of radiation protection to be emphasized by EPA's standards -- protection for individuals or protection for the population as a whole. EPA's 1985 standards emphasized protection of populations by imposing "containment requirements" that limited the cumulative amount of radioactive material released over 10,000 years. In contrast, the Energy Policy Act now asks whether a standard, "based upon doses to individual members of the public," would be reasonable.

EPA's decision to base its 1985 standards on population impacts rather than on protection of individuals was EPA's most significant departure from the traditional concepts of radiation protection, from the recommendations of advisory groups like the ICRP, and from the practices of other nations. EPA's defense of its decision was two-fold -- practicality and a desire to emphasize waste containment rather than dilution.

EPA's practicality concern deserves close attention by this panel. Ten years ago, the Waste Isolation Systems Panel of the National Academy of Sciences warned that large individual doses can occur if humans consume contaminated groundwater in the vicinity of a HLW repository. The reason is simple -- groundwater flow rates are too low to provide significant dilution of potential releases. When trivial doses were estimated for a repository at Hanford, it was assumed that releases would be diluted in the Columbia River. There is no Columbia River near Yucca Mountain. In fact, at Yucca Mountain, consumption of groundwater may be the most likely pathway for repository releases to reach humans. Since groundwater flow provides little dilution of releases, unacceptably large doses may be predicted to occur unless a Yucca Mountain repository performs much better than would have been required by EPA's 1985 standards.

There are strong arguments in favor of an individual protection standard, either as a supplement to EPA's cumulative release limits, or as a replacement for those release limits. One of the first principles of radiation protection has always been to provide an adequate level of protection for each individual potentially exposed to radiation. Questions have been raised about EPA's 1985 standards because those standards depart from that tradition. When this panel considers

whether to recommend adoption of an individual dose standard, the panel will also need to face the challenge of finding a practical way to make such a standard workable for a repository where no large river is available to dilute potential releases, but which has clear advantages for containment of wastes.

The NRC staff considers that radiation protection for individuals should be a part of EPA's standards. However, it will be very important to ensure that an individual protection standard is applied in a reasonable manner. An individual protection standard should not attempt to protect all individuals, under all conceivable circumstances, at all times in the future. For example, it does not seem reasonable to try to protect a hypothetical farm family located at the boundary of a Yucca Mountain repository, when it is unlikely that such a farm family will ever exist. Instead, a more realistic scenario would involve exploitation of groundwater near Yucca Mountain as a supplement to the municipal water supply for regional populations. Water consumers in the region would then form the critical group whose doses would be limited by an individual protection standard.

(3) Fundamental versus derived standard. Development of environmental standards usually begins with establishment of an underlying basic safety goal, expressed in terms of an allowable dose or health risk to an individual or a population. However, it is not necessary to express the standard directly in terms of that fundamental goal. Instead, the standard can be expressed in terms of a derived quantity, such as quantity or concentration of radioactive material released to the environment. The advantage of a derived, release limit standard is simplicity. Evaluations of compliance need not predict who will live where, or

how they will live, for thousands of years into the future. The disadvantage of a derived standard is the possibility that conditions near a repository will be different from those assumed when deriving the standard from the basic safety goal. If so, the actual health risk caused by releases from a repository might be significantly different from the basic safety goal.

As we all know, EPA's 1985 standards were expressed in terms of release limits derived from EPA's analyses of the expected performance of hypothetical repositories. Those release limits were controversial, at least in part, because the release limits were derived using a "world-average" biosphere that bore little resemblance to the biosphere likely to exist near Yucca Mountain. Thus, the actual number of health effects that might be caused by releases from Yucca Mountain might also bear little resemblance to EPA's health effects goal. Now, the Energy Policy Act asks this panel to consider whether a standard "based upon doses" to individual members of the public is reasonable. I interpret the phrase "based upon doses" to allow this panel to consider derived standards, such as limits on concentrations of radionuclides released to the environment, as well as standards that directly limit doses. The issue before this panel is whether the simplicity of derived standards, and the relative ease of evaluating compliance with them during licensing, outweighs the potential for derived standards to depart from the underlying basic safety goal.

The NRC staff has supported a derived standard (e.g., a limit on radionuclide releases) because such a standard would be easier to implement during licensing than a fundamental standard expressed in terms of doses or health risks. Of course, if a derived standard is to be used, it would be necessary to avoid

unrealistic assumptions in the derivation of the standard. A fundamental (dose or health risk) standard would also be acceptable, provided that such a standard could be implemented using some type of "static" or "reference" biosphere. The NRC staff would object to any fundamental standard that permitted unlimited speculation about future human locations, lifestyles and societal conditions.

(4) Active institutional control. EPA's 1985 standards assumed that active institutional controls (guarding or monitoring a site and remedial activities) will not be relied upon for more than 100 years after repository closure as the means to achieve acceptable waste isolation. The Energy Policy Act now asks this panel to advise EPA on the potential for post-closure oversight to prevent an unreasonable risk of breaching the repository's barriers or of causing unacceptable radiation doses to the public.

The advantage of relying on active institutional controls is the potential to reduce the near-term cost of achieving and demonstrating compliance with the environmental standards for Yucca Mountain. Some probabilistic projections, especially those involving human intrusion, will likely be contentious during a licensing review and substantial efforts may be needed to demonstrate acceptable repository performance. Societal practices such as monitoring drinking water quality could provide effective protection of populations near a repository, and credit for such practices could be beneficial in demonstrating repository safety.

The disadvantage of reliance on active controls is the history of loss of such controls which raises questions about the wisdom of relying on institutions to ensure repository safety. Historical examples of durable institutions generally

involve functions that societies find useful (e.g., maintaining records), and it is difficult to project the willingness of future societies to perpetually monitor a repository site.

The NRC's regulations for geologic repositories have not assumed that active institutional controls would be effective in preventing human intrusion for more than 100 years after facility closure. This assumption appeared to be prudent for a HLW repository, since no practical method has ever been identified to guarantee that such active institutional controls will persist or will continue to be effective. "Passive" institutional controls, however, such as monuments, markers and land-use records, are likely to persist and be effective in deterring future human intrusion into a repository.

(5) Probabilistic standards. The cumulative release limits of EPA's 1985 standards applied to virtually all causes of releases, including human intrusion. Concerns about the scientific predictability of intrusion is reflected in the Energy Policy Act's identification of post-closure oversight and human intrusion as subjects for this panel's review. Predicting the probabilities of some rare geologic events, such as volcanic activity at Yucca Mountain, could prove nearly as troublesome as predictions of human intrusion. Therefore, I encourage this panel to include rare geologic events, along with human intrusion, when considering whether it is possible to make scientifically supportable predictions of potential repository disruptions.

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