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Commission

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ABSTRACT

This compilation contains 11 reports issued by the Advisory Committee on Nuclear Waste (ACNW) during the ninth year of its operation. The reports were submitted to the Chairman and Commissioners of the U. S. Nuclear Regulatory Commission. All reports prepared by the Committee have been made available to the public through the NRC Public Document Room, the U. S. Library of Congress, and the internet at <http://www.nrc.gov/ACRSACNW>.

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PREFACE

The enclosed reports are the recommendations and comments of the U. S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste during the period between July 1, 1996 and June 30, 1997. NUREG-1423 is published annually. Volumes 1 through 6 contain the Committee's recommendations and comments from July 1, 1988 through June 30, 1996.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

July 10, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington DC 20555-0001

Dear Chairman Jackson:

SUBJECT: HEALTH EFFECTS OF LOW LEVELS OF IONIZING RADIATION

The health effects of ionizing radiation are central to many of the regulations that are promulgated by the Nuclear Regulatory Commission (NRC). The validity of the linear- no threshold (LNT) dose-response relationships in the area of low doses and low dose rates has been questioned. This letter supports the Commission's present course of action of a review and analysis by the National Council on Radiation Protection and Measurements (NCRP) leading to an evaluation of this important issue.

Our discussion and recommendations concerning this subject derive from the first meeting of the Joint Subcommittee of the Advisory Committee on Reactor Safeguards (ACRS) and the Advisory Committee on Nuclear Waste (ACNW) held on March 26, 1996. Presentations were made by members of the NRC staff, including the visiting medical fellow, and representatives from institutions and agencies such as the NCRP, the Health Physics Society, and the Massachusetts Emergency Management Agency. Written comments were also received from the public.

Most national and international scientific committees dealing with the subject take the view that the safest approach to regulation is one that relies on the LNT model of response to doses of ionizing radiation. This model holds that the ill health effects observed at high doses and high dose rates (mainly among atomic bomb survivors) can be extrapolated linearly to low doses and low dose rates, down to the smallest doses. The NRC staff prepares regulations on the basis of this model. One of the basic questions in this field is whether the LNT model is valid at the low doses and rates normally encountered in many of the regulatory domains. The increasing emphasis placed by the Commission on risk-informed regulation makes it imperative that the actual health risk of low levels of ionizing radiation be assessed accurately.

The NRC is currently funding a contract with the NCRP to make a critical evaluation of the LNT assumption. The ACNW has not reached conclusions on the validity of the LNT model, and will continue to study the matter. We see the NCRP study as an opportunity to obtain an independent review of the data and their quality.

The presence of unavoidable background radiation and the need for very large samples have made it difficult in the past to obtain definitive data on the validity of the LNT model. As with all small-effects phenomena, the quality of the data and the statistical interpretation of the results govern the ability of any study to contribute to the testing of the model. However, investigators in the field have recently been able to account for the effect of such confounding factors such as variation in background radiation. Some studies in the United States, as well as in China, Sweden, Poland, and Canada, have arrived at conclusions that do not support the LNT model. Other research concludes that it is likely that at least a threshold or perhaps a corresponding zero equivalent point with beneficial risk decrements (hormesis) exists at lower doses.

A notable example of the latter is a ten-year study by Johns Hopkins University of U.S. nuclear shipyard workers which, we were told, showed lower mortality, no increase in malignancies among workers exposed to radiation when compared to those who were not exposed, and no "healthy worker effect." This study may be particularly significant since the investigators were looking for evidence to support the LNT model. Another study, of Canadian women patients in tuberculosis sanitariums who underwent repeated fluoroscopy to monitor response to therapy, is used frequently to show the validity of the LNT model, but examination of data at lower doses shows significant beneficial effects. The 1994 report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) contains an extensive appendix detailing cellular repair mechanisms (called "adaptive response mechanisms") that could contribute to an explanation of a threshold, or, if such cellular responses were stimulated by low doses of radiation, to an explanation of beneficial effects.

In contrast, some of the public comments received by the Subcommittee suggested that the LNT model underestimates the harmful effects of low doses of radiation. Also NCRP Report No. 121, "Principles and Application of Collective Dose in Radiation Protection," issued November 1995 and discussed with the Joint Subcommittee at its March 26, 1996 meeting, finds that "from the point of view of the scientific bases of collective doses for radiation protection purposes, it is prudent to assume the effect per unit dose in the low-dose region following single acute exposures or low-dose fractions is a linear response."

In the face of conflicting views, the general belief of the national and international committees dealing with the matter has been that using the LNT model for regulatory purposes is a safe and conservative approach and, if there is error, it is on the side of enhanced protection. However, if there is a health benefit at low doses, this logic is incorrect. Even if there is no evident health benefit, there are significant societal costs associated with this conservatism that could be avoided or reduced if a threshold level could be established below which no harm occurs. A basic principle of risk-informed regulation is to prevent a situation in which scarce resources are misspent to avoid negligible risks, while significant risks remain unattended for want of resources to deal with them. Owing to the potentially significant costs of the present conservatism, we conclude that a reexamination of the regulatory model is appropriate.

It is obvious that agreement on an appropriate dose-response model is made more difficult by the differing voices on this subject within the scientific community and those outside of this community, including regulators, policy makers, and members of the public. The first task required to reach such an agreement is an impartial review of the data and their quality in the face of the extensive application of the LNT model in regulations and scientific opinion.

We recommend that the need for special attention be conveyed to the NCRP regarding its study. Such attention should include: (1) assurance that the study includes scientists other than those who are "recognized experts" with a reputation built on the LNT model, (2) an evaluation of the data by an entity with expertise in statistics or information science, but no prior position on LNT - such as the National Institute of Standards and Technology (NIST) as well as the NCRP study committee, and (3) consideration of essentially all studies that could relate to the LNT.

The Committee strongly believes in the NCRP goal of critically evaluating data related to low dose health effects. We will follow the program through interaction with NRC's Office of Research and will report to the Commission on the study and its implications.

Sincerely,

Paul W. Pomeroy
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

July 24, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington DC 20555-0001

Dear Chairman Jackson:

SUBJECT: ELEMENTS OF AN ADEQUATE NRC LOW-LEVEL RADIOACTIVE
WASTE PROGRAM

You have expressed interest in our view of what constitutes an adequate low-level radioactive waste (LLW) program. This topic was discussed by the Advisory Committee on Nuclear Waste (ACNW) in connection with its report to the Commission on SECY-95-201, "Alternatives to Terminating the Nuclear Regulatory Commission Low-Level Radioactive Waste Disposal Program," July 31, 1995. In addition, the Nuclear Regulatory Commission's (NRC's) LLW program has a direct link to decommissioning and the Site Decommissioning Management Plan (SDMP) program. This report relates the comments of the ACNW and its continued deliberations to a practical template.

Several fundamental assumptions emphasized in the introduction will help clarify the structure and priorities found in this description of a LLW program. This letter, as the subject implies, only addresses what the Committee believes are the "elements" of an adequate NRC low-level radioactive waste program. It is not intended to be a comprehensive program, the ideal program, or anything more than the subject of the letter implies. Neither have we attempted to specifically relate the elements to activities that are already a part of the current NRC program. We decided that the concept would be clearer if we stuck to the principle of describing the program elements without the interruption of frequent reference to current practices and activities. The Committee is aware that many of the elements noted are involved in the current program. In addition, the content and structure of an adequate program are outlined without the constraints of budget or politics. Further, this description is focused only on a NRC program. Programs under the jurisdiction of Agreement States will, of course, have a structure and scope determined by the individual State within the compatibility and adequacy criteria of the NRC. Such programs may differ from those identified here.

EXECUTIVE ABSTRACT

A program on LLW that is believed to be adequate to meet the responsibilities of the NRC is described. This description is based on selected fundamental principles and a view of the role of the NRC in its relation to the public, the states, and licensees. An adequate program must have elements that include staff capabilities; protocols related to standards, regulations, licensing; evaluation of technical and programmatic factors and documents; research; communication with the public; and interaction with other groups. This description presents a framework of a LLW program rather than simply reinstating activities that have been reduced by budget pressures.

1. INTRODUCTION

The NRC LLW program represents a most important interface between NRC and the public. The current absence of LLW facilities has forced the waste to be dispersed in thousands of interim storage location places that are generally much less secure than the storage areas for spent nuclear fuel. The LLW is generated and stored in a large variety of locations that are closer to the population and groundwater aquifers than any other major source of regulated radioactive materials. The nuclear waste issues, as conveyed to the public, have no closer general association with public health and safety than through LLW management. Therefore, the Commission should assign very high priority to the maintenance of a competent LLW program with a focused structure. In this context, the elements of an adequate LLW program are described, one that accomplishes the goals required by the mission of the NRC and responds to the impact on and importance to the public of this phase of nuclear activities.

The underlying assumptions on which a program is based define the scope and objectives of the program. This description of an adequate LLW program is based on the following assumptions including: (1) an Agreement States program has been established through revision of the Atomic Energy Act of 1954, as amended (AEA), (2) the goal of the NRC's LLW program is the protection of public health and safety and of the environment, and (3) the role of the Federal Government is to provide a centralized, demonstrably qualified, and highly responsive source of regulatory concepts, activities, and audits to which the public and governmental entities can turn for a satisfactory model and in case of questions, doubts, or concerns. The elements of an adequate LLW program are, by this definition, not limited by budgetary constraints or by political divisions. However, the "adequate" nature of the LLW program can be contrasted to an "ideal" program by budgetary constraints. The present description does not address specific budgetary issues for several reasons, not the least of which is our lack of experience with NRC budget processes.

In addition, the adequate program is not intended to interact with Agreement States programs except in a supportive manner or, as now practiced, when evaluations are required. Finally, elimination of parts of the described program can be expected to have a negative effect on the adequate nature of the remaining program.

2. BASES OF THE PROGRAM

(a) Objective

An adequate NRC LLW program ensures that the processing, storage, and disposal of LLW, as it is defined in 10 CFR Part 61, are carried out in accord with other NRC regulations (e.g., 10 CFR Part 20) and that the current and future impact of such activities will not represent an excessive risk to the affected population or the environment. This objective extends to all LLW-related activities within the jurisdictions of the NRC.

(b) Scope

For the purpose of this limited description, the primary scope of the LLW program includes all activities, regardless of agreements (e.g., Agreement State contracts) or coordination (e.g., compacts) among participants that involve the processing, temporary storage, transportation, and disposal of LLW. Also, it would be desirable to include in an adequate LLW program a modest amount of attention to "greater than class C" (GTCC) waste as defined in Part 61 and to "mixed waste." Under such an expanded scope, other wastes that would be included in an adequate LLW program are naturally occurring and accelerator produced radioactive material (NARM) and naturally occurring material (NORM), wastes from uranium recovery and processing, wastes that are formed by the inadvertent concentration of contaminants (e.g., sewage, bag house dust), and wastes derived from decontamination and decommissioning activities¹.

3. COMPONENTS OF AN ADEQUATE LLW PROGRAM

The components of an adequate LLW program include standards, regulations, licensing, enforcement, evaluation, communication, technical support and technical resources, research, and activities with other entities. The distinction between an "adequate" and an "ideal" LLW program is likely to be in the scope and completeness of execution of the LLW components. In order to be classed as adequate, the LLW program needs to contain those elements and

¹ Some of these wastes are precluded from NRC attention by various Acts of Congress. If there is a desire to frame a LLW program that is adequate but circumscribed under current laws, then such materials as defined in restricting legislation would be excluded from the scope. However, it is clear that the public draws no artificial distinctions such as made by Congress about the jurisdiction over the various kinds of relatively benign radioactive materials.

subelements that are critical (or believed to be critical by the public²) to the NRC'S public protection role. Program components at the "adequate" level are briefly described below.

(a) Standards

An adequate LLW program must have available to it generally applicable environmental standards, preferably expressed in terms of risk. The standards for groundwater protection should address the risk at the edge of any disposal facility in terms appropriate to this point of enforcement. In addition, the standards for exposure of the general population and occupational workers should be available in terms of risk that is in concert with risk standards found in other regulations. The present standards may be acceptable, except that Environmental Protection Agency (EPA) groundwater standards include resource protection that is not directly relevant to public health and safety³. The protocol for a working relationship between the NRC and the EPA needs to be developed, perhaps using the current interaction on the Yucca Mountain standard as a model.

(b) Regulations⁴

The regulations, specifically Parts 20 and 61, should be re-examined and revised so that their principal, obvious outcome is the protection of public health and safety when advanced concepts (e.g., above-grade vaults, advanced waste forms) of LLW disposal are utilized. The NRC should have in place regulations that identify minimum site characteristics for an acceptable LLW disposal facility location. There should be very few unequivocal disqualifying site attributes, and the site characteristics should be developed while mindful of the variety of disposal techniques likely to be submitted by prospective practitioners and the wide diversity in proposed facility terrains.

Regulations should identify the performance of a repository related to risk and be coupled to a time frame⁵ over which an applicant

²This is an important, albeit perhaps nontechnical, criterion not to be overlooked.

³The distinctions made by the USEPA should, in an ideal situation, be rectified.

⁴The provisions listed can be installed in revised regulations (Parts 61 and/or 20) or could be formulated in Regulatory Guides, technical position papers, or other documents. The selection of the avenue should be based on the extent to which the provisions are necessary to the protection of the health and safety and the environment and the extent to which alternative processes could accomplish the same goal.

⁵This would require revision to Part 61 since at present there is no time limit for showing compliance with the 25/75/25 mrem/y dose. The matter of time limits for demonstration of compliance with regulations is still being discussed by the ACNW.

must demonstrate compliance. To be considered adequate, a LLW program should include regulations so structured that anticipated LLW disposal licensees (now largely but not exclusively in Agreement States) would be able to use the regulations as guides for demonstrating their compliance. Further, the regulations should identify the "as low as reasonably achievable" (ALARA) process as part of the basis for performance of a LLW disposal facility and should ensure that the ALARA concept is employed, not as a numeric goal or quasistandard, but as a process⁶. In order to be a useful guide, the regulations should (1) state the limits of contamination of groundwater at the accessible environment⁷ (e.g., the EPA drinking water limit for appropriate aquifers), (2) state the limits on airborne contamination as measured at the site boundary, (3) refer to 10 CFR Part 20 for occupational exposure limits, and (4) set the limits to the contamination of the soil at the site. The regulations should be carefully crafted to allow applicants flexibility in reaching the desired goals. Agreement State regulations should be compatible. The NRC LLW staff should, however, be prepared to evaluate the proposals of applicants that elect to follow paths other than regulatory guides or position papers while claiming to arrive at the required level of protection of public health and safety. In order to maintain the LLW program in the adequate range, the NRC staff should be prepared to examine and modify the regulations as experience dictates. In addition, the NRC staff should exercise the capability to examine and evaluate the regulations of other entities, such as Agreement States⁸. Also, the internal organization structure of the NRC that deals with Agreement States should ensure that the technical experts from the Office of Nuclear Material Safety and Safeguards (NMSS) are directly available to help the Agreement States. Small teams of experts in technical and licensing matters could be drawn from various divisions and groups by matrix management. The role of the Office of State Programs should be defined to ensure such NMSS participation.

⁶The ALARA concept poses some difficulties when the process of defining compliance with regulations is described to the public. Nevertheless, the ALARA concept as a process can be used as a powerful tool in the regulatory arena and should be retained in LLW regulations.

⁷Risk levels in regulations should take into account the irreversible nature of contamination in certain situations, e.g., groundwater supplies from major aquifers. The exact means for taking this into account is not clear but the EPA ground water report gives some indication of what could be used as a starting point.

⁸The potential conflict of this recommendation with the apparent NRC position on its Agreement State relationships (i.e. NRC has relinquished authority) is recognized. However, if the NRC is to be viewed as the competent entity that assures public protection, the NRC must be prepared to intervene in a deficient operation, regardless of the agreement status. This is believed to be a requirement for an adequate program.

(c) Licensing

The NRC staff should be capable of managing, with internal expertise, all important aspects of licensing a LLW facility. Similar capability must exist for the approval (e.g., review of topical reports) of concepts, equipment, and processes. Procedures for licensing, i.e., requirements for documentation and associated information, should be defined in available documents. These should detail the considerations to be used by the NRC staff in the review process. The details of compliance determination strategies and methodologies should be defined in guides except in those rare instances where rulemaking is required when focused (e.g., singular) protocols are deemed to be optimal (should be rare) or to avoid excessive and unproductive legal arguments at the time of processing the license application.

This implies that the LLW staff in an adequate program largely has technical capability no less than any applicant or intervenor⁹. Such competence can be obtained by employing qualified personnel maintained by, for example, continuing scientific and technical activities. The latter is a necessary part of maintaining a capable staff for an adequate LLW program.

(d) Enforcement

An adequate LLW program should contain NRC inspection and enforcement activities to ensure that public health and safety is unequivocally protected. The public must be able to see the enforcement of the NRC regulations. Further, the evaluation of the compatibility and adequacy of Agreement State programs must contain provisions measuring the quality of the enforcement process as well as the use of evaluation criteria that are directly related to public health and safety, e.g., number of incidents, number of overexposures, and violations of technical specifications leading to excessive risks.

(e) Evaluation

Evaluations can be divided into several parts. The NRC staff must have sufficient technical skill (see (c) above and footnote 9) and sufficient working knowledge to evaluate the submissions of potential licensees. This includes information about site characteristics, as well as disposal and operating systems. Further, the NRC staff must be able to support Agreement State activities by providing requested technical evaluations. Such support will likely involve negotiation about the extent, timing, and costs. The NRC LLW staff must remain cognizant of activities

⁹This may be perceived as too stringent, especially in times of budgetary stress. On the other hand, the public view of the necessary technical quality of those charged with protecting its health and safety may well demand such a level of competence.

in Agreement States and should provide requested comments and advice, especially when recognized deficiencies could lead to an unsatisfactory outcome.

The NRC LLW program staff should have the capability to evaluate all aspects of the performance of LLW facility licensees. In addition, incidents that result in serious violation of the technical specifications of a LLW facility, provide indications of important deficiencies in the control of wastes, result in excessive exposures of personnel, or result in offsite contamination in excess of predetermined levels should be investigated and evaluated by the NRC LLW staff. In this role, the NRC LLW staff as the technically competent and vigilant Federal oversight agency should seek to ensure the protection of public health and safety.

(f) Communication With the Public

The adequate LLW program must be able to communicate, in terms clear to the public, the actions and their consequences of evaluating applications, granting licenses, evaluating Agreement State programs, rectifying deficiencies in licensee and Agreement State activities, etc. The NRC staff needs to communicate regularly with Agreement States and licensees. The interactions should be designed to address technical issues and to ensure that misconceptions and misunderstanding of LLW regulations or the NRC role in their application are corrected in a timely manner. In order to ensure this process is effective, staff size and capabilities must match the needs and the results of evaluation of the outcome of the interaction processes. The use of small interdisciplinary teams (see (b) above) may be an effective paradigm. Public perception of NRC activities should reflect the basic mission of the NRC, i.e., protection of public health and safety and the environment. Regular reporting to the public on all facets of LLW disposal and management should be part of an adequate LLW program.

(g) Technical Support

The NRC must be able to provide technical support to licensees and Agreement State programs when requested and also when such support appears to be required. As already noted, technical evaluations and support in the prelicensing stage should include evaluation of applications, identification of deficiencies in analyses and data acquisition, etc. The NRC staff should be able to formulate peer review process protocols for LLW technical issues that would aid the potential licensee or Agreement States in developing a sound and defensible technical basis for license applications. Technical support from an adequate program must also be functioning during the operational and closure phase of LLW facilities. An adequate LLW program should evidence coordination between the LLW staff and operating materials licensees.

(h) Research

An adequate NRC LLW program may encompass research activities. However, the LLW program need not involve a research component, except that the maintenance of technical skills of the staff could be implemented in part by research programs, and except in instances where important research broadly related to LLW is not being done by other groups. Research activities must specifically address problems noted in evaluation of LLW disposal facility sites or that have been identified through internal and external performance evaluation of the LLW systems. Research on site- or facility-specific problems need not be part of an adequate LLW program. In the absence of a suitable research program, the NRC LLW technical staff needs to be provided with scientific and technical growth through other avenues.

(i) Interfaces

An adequate LLW program should have identified points of contact with other agencies and organizations, as well as within the NRC. The former include the EPA regarding standards and mixed wastes, the Department of Energy (DOE) regarding GTCC disposal and Agreement States. Sound agency management will define the extent and distribution of such contacts.

4. OTHER ACTIVITIES IN AN ADEQUATE LLW PROGRAM

In SECY-95-201, the NRC staff presents in Table 1 the options considered in the SECY paper and the activities for a number of elements. We comment here on their relevance to an adequate LLW program.

- (a) Rulemaking will be needed both initially to develop functional bases for the adequate LLW program and occasionally thereafter to correct and expand regulations as the need arises. The LLW staff¹⁰ should have sufficient technical capability to evaluate the work of RES and others in the rulemaking process.
- (b) The NRC LLW staff will need to be able to respond to petitions in concert with other offices (e.g., the Office of the General Counsel).
- (c) The Commission should be able to obtain policy guidance and advice from the LLW staff. That staff can, in the course of normal duties, develop various technical documents that provide guidance to potential applicants, to Agreement State programs, and to others.

¹⁰The assignment of RES personnel to the rulemaking role may be an unnecessary artifact of previous agency operations. If the LLW staff is competent, interaction with OGC advisors may be all that is necessary.

- (d) International activities should be part of an adequate LLW program, owing to the importance of such activities to the U.S. and to the safe use of nuclear technology. The extent to which such activities are pursued needs to be carefully defined, largely because of budget constraints.
- (e) Import/export authorization need not be part of an adequate LLW program. This topic can be managed by other Federal agencies in consultation with NRC and DOE.
- (f) Emergency access to LLW facilities is not a necessary part of an adequate LLW program and could be managed by another Federal agency.
- (g) Assistance to other Federal agencies should be part of an adequate LLW program if the topics so warrant. NRC management should determine the extent of involvement on a case-by-case basis.

We trust these comments are responsive to your request.

Sincerely,

A handwritten signature in cursive script, reading "Paul W. Pomeroy". The signature is fluid and stylized, with a large loop at the end.

Paul W. Pomeroy
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

August 30, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

SUBJECT: COMMENTS ON THE FINAL DRAFT BRANCH TECHNICAL POSITION ON
THE USE OF EXPERT ELICITATION IN THE HIGH-LEVEL
RADIOACTIVE WASTE PROGRAM

The purpose of this letter is for the Advisory Committee on Nuclear Waste (ACNW) to make recommendations on the subject Branch Technical Position (BTP) and to identify residual concerns of the Committee relating to the formal use of expert elicitation. During the 85th meeting of the ACNW on August 22, 1996, the NRC staff discussed the final draft BTP with the Committee, emphasizing the responses to public comments on the draft BTP. The Committee has had a long-standing interest in the use of formally elicited expert judgment in nuclear waste programs and we recommended development of guidance such as this in our memorandum of July 31, 1991, to Robert Bernero titled "The Role of Formal Elicitation of Expert Judgment in the Performance Assessment of a Geologic High-Level Waste Repository." The use of formal elicitation of expert judgment in the facility licensing process remains one of the priority issues of the Committee.

Recommendation

The BTP provides important guidance to the applicant, the affected units of Government, and interested parties on the use of formally elicited expert judgment. The ACNW anticipates that the BTP will be immediately useful to the NRC staff, for example, in its evaluations of (or comments on) the Department of Energy's (DOE's) Probabilistic Volcanic Hazard Assessment and later comments on DOE's Probabilistic Seismic Hazard Assessment. In the long term, the BTP will provide valuable guidance to the DOE in the preparation of its license application and to other parties carrying out expert elicitations in connection with the facility licensing process.

We wish to commend the NRC staff for completing the final draft BTP, which is desirably brief and nonprescriptive. The applicant

is left to its own creativeness on how to handle such important issues as probabilities, methods of aggregating uncertainties, data updating, and the final form of the results. The Committee strongly recommends the prompt completion and publication of the final draft BTP.

Residual Concerns

Although the ACNW welcomes and supports the subject draft BTP, we have several residual concerns regarding the use of formally elicited expert judgment in the decision-making process. The Committee does not intend that these concerns delay publication of the draft BTP. We realize that these concerns could be addressed by a variety of means outside the BTP, including workshops, letters, NUREGs, technical exchanges, and so on. These concerns include the following:

1. Subject Matter Experts

The Committee believes that the nomination process for selecting subject matter experts should include organizations such as the National Academies of Sciences and Engineering, private industry, State development and regulating bodies, and representative public interest groups.

We also believe that the process of formulating the problem to be solved, the issues to be addressed, and the detailed questions to be answered should take place, primarily, before and during the process of selecting experts. The Committee's suggested approach is that before deciding on the final panel of experts, a much larger number of experts be contacted and their input be elicited on refining the general problem that has been formulated by the generalists and the normative experts. In this way, a much larger knowledge base is available to fine tune the issues, and the opportunity exists for a very effective group of experts to evolve that will eventually make up the panel. Further refinement of the issues and questions should be performed by the selected panel of subject matter experts.

2. Aggregation of Results

The Committee believes that the results from expert elicitation should clearly display the uncertainties in the chosen performance measures for a particular issue. Therefore, the aggregation of the results of the expert panel should also be clear in terms of the uncertainties in the individual judgments of the panel members and the method of aggregation and integration of bottom-line results that include the quantification of uncertainties. This property of the elicitation process becomes especially important to the

regulators in the consideration of multiple elicitations covering similar or identical issues. The scientific process considers a full range of alternatives on the basis of the technical knowledge base of each and the associated reasoning processes, all of which should be exposed in the decision-making process. This documentation will facilitate the regulator's ability to discriminate between different alternatives on the basis of the evidence presented.

In this regard, major guidance would come from an illustration of the aggregation process that embraces the notion of combining and integrating probability distributions. The idea would not be to prescribe a process but rather to illustrate in graphical and analytical terms an example of what is meant by the aggregation process. It is believed that such an aid would greatly facilitate and add meaning to the use of probability methods in the licensing process in general, and in expert elicitation in particular.

3. Interpretation of the Results

The Committee wishes to emphasize that as a result of the flexibility of the process, the applicant should not conclude that following the guidance implies automatic acceptance of the results. The results, and the detailed bases thereof, are the desired outcome of the elicitation process. The credibility of the results has to be principally based on the individual's reasoning process, the method of aggregation, and the supporting knowledge base, including the use of specific data wherever possible.

4. Application of Expert Elicitation

Although the Committee was pleased that the BTP was not overly prescriptive on the matter of how to conduct expert elicitations, there is a need for additional guidance on candidate issues for application. A discussion of appropriate applications would illustrate the limitations and the general intent of the process.

Additionally, the Committee believes that the Commission, consistent with its Policy Statement on probabilistic risk assessment may wish to examine the decision-making process to take greater advantage of results developed through state-of-the-art expert elicitations. For example, there may be an impact on the admissibility for testimony of a valid elicitation resulting from the unavailability of one or more subject matter experts. Although there are legal arguments for the need for a "sponsoring witness," such an individual may not be able to represent, as his or her own, the full range of the technical arguments contained in the original elicitation.

The Committee believes that these residual concerns should not delay the prompt publication of the BTP. The ACNW looks forward to working with the staff to address these concerns through other avenues.

We hope that these comments will be useful to you.

Sincerely,

A handwritten signature in cursive script, reading "Paul W. Pomeroy". The signature is fluid and stylized, with a large initial "P" and a long, sweeping underline.

Paul W. Pomeroy
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

November 8, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

Subject: COMMENTS ON COUPLED PROCESSES IN THE NRC HIGH-LEVEL WASTE
PRELICENSING PROGRAM

SUMMARY

The Advisory Committee on Nuclear Waste (ACNW) is impressed by the progress that the NRC staff and the Center for Nuclear Waste Regulatory Analyses (CNWRA) have made in developing a strong program to study potential coupled processes at the site of the proposed repository at Yucca Mountain, Nevada. Furthermore, we are pleased with the plans for integrating coupled processes among the vertical slice investigations of key technical issues (KTIs). The Committee has provided observations and suggestions to strengthen NRC's approach to coupled processes.

We want to emphasize the following recommendations:

- (1) Performance assessment needs to have a more prominent role in guiding the prioritization of coupled processes studies.
- (2) The NRC should revise its decision to not participate in DECOVALEX, a multidisciplinary international program dedicated to the Development of Coupled Models and their Validation against Experiments.
- (3) The coupled processes studies are "data starved." Changes are needed in the program to rectify this situation.
- (4) The modeling studies in thermal-hydrological (TH) processes need to be expanded.
- (5) Greater attention is needed on near-field chemistry, with particular emphasis on thermal-hydrological-chemical (T-H-C) processes that affect contaminant release and transport.

INTRODUCTION

In February 1996, we communicated our recommendations and suggestions on the "Revised Prelicensing Program Strategy for the U.S. Nuclear Regulatory Commission High-Level Waste Repository Program ('Vertical Slice Approach')" and the NRC staff's plans for resolving KTIs dealing with the proposed high-level waste (HLW) geologic repository at Yucca Mountain, Nevada. In that letter, we made suggestions for improving the strategy and investigation of the KTIs, but we were, and continue to be, supportive of the work of the NRC staff in this regard. We see this program as an excellent response to maintaining a prelicensing program focused on critical issues in the face of limited resources. In our February 1996 letter we expressed our concern that within the specified strategy and program, it was unclear if the issue of in situ thermal-mechanical-hydrological-chemical (T-M-H-C) coupled processes was moving toward resolution. This letter provides further comments on that concern.

Construction of the proposed repository will perturb the stress pattern in Yucca Mountain, thus resulting in mechanical deformation of the surrounding rock and the emplaced HLW will cause a significant heat pulse to the rock. The resulting thermal and mechanical effects are interrelated and may significantly affect the movement of water and the nature of related hydrologic properties, as well as the chemical processes acting on the waste, canisters, and surrounding engineered and natural materials of the repository. These coupled processes may have an important impact on the performance of the repository over the course of its history. The algorithms used in modeling the performance of the repository system are influenced strongly by the analytical descriptions of the various coupled relationships among physical and chemical phenomena. The Committee is concerned that the "vertical slice" approach to the KTIs could lead to neglect of interaction of phenomena and their resulting modifications of parameters and processes. To evaluate the current validity of this concern, the ACNW reviewed the status of the investigation of coupled processes by the NRC staff and the integration of these activities among and within KTIs through a working group on T-M-H-C coupled processes at the 85th meeting of the Committee. Comments were made by representatives of the NRC staff, the CNWRA, Lawrence Berkeley Laboratory, the U.S. Geological Survey, the Department of Energy (DOE), academia, and private industry.

The Committee learned of the significant progress in the T-M-H-C coupled processes investigations and was impressed by studies being performed by the NRC and CNWRA. Effort has been put into the related KTI investigations and the integration of elements of the coupled processes among the KTIs. Below are our observations and suggestions regarding coupled processes, which should focus future activities on the potentially most critical elements.

TECHNICAL OBSERVATIONS AND SUGGESTIONSI. General

- (1) The NRC staff, with the support of the CNWRA, has developed a strong program for studying the impact of selected coupled processes on the performance of the potential repository at Yucca Mountain. This is especially true in T-H coupled processes, which have been ranked consistently as high priority in reviews of both the NRC's and the DOE's programs.
- (2) A key to coupled processes studies and the development of supporting data is understanding their overall importance to repository performance. The Committee is pleased to see the increasing role of performance assessment (PA) in this regard. It is critical that the PA activity be used to provide the necessary insights and understanding of physical processes to maximize the return on investment of investigative resources. The Committee looks forward to the increased use of PA to guide the scope of analysis and research activities.
- (3) We understand the continued need to reassess the allocation of HLW funding in the face of shrinking resources. However, the Committee is concerned about NRC's withdrawal from Phase II of the multidisciplinary international program DECOVALEX. The Committee sees the results of the DECOVALEX project to date as meaningful to the NRC HLW program. The testing of mathematical models and computer codes for predicting the effects of coupled processes, which is the aim of the project, is a most critical aspect of the study of coupled processes. In the tasks outlined for the continuing project, a variety of models and codes, developed largely independently by investigators in several countries, will be tested against each other and against experimental results from international nuclear waste test facilities. Although these test sites will not duplicate exactly the proposed unsaturated-tuff geologic repository at Yucca Mountain, the results should be useful in the NRC scoping studies and testing of models and codes. For these reasons, the Committee urges the staff to reverse its decision to withdraw from the DECOVALEX project.
- (4) The coupled processes studies of the NRC and the CNWRA appear to be "data starved." The primary emphasis of the studies has been on developing models and related codes. This is an important element of the program but is only one of the necessary ingredients to bringing the program to fruition. The termination of the HLW research program in this topic apparently has reduced access to experimental and geologic analog information useful in validating the models and codes and in providing bounding data. This is true over a range of processes but is especially important to thermal processes and their effect on properties and other processes. In the face

of this problem, both the NRC and the CNWRA should make specific efforts to obtain all relevant data from the DOE and its contractors. Further, the Committee believes that there is important information to be gained from studies of current and ancient geologic regions, with thermal anomalies for which data are available. For example, existing data from the Nevada Test Site operations may be useful. Also, the Committee has learned of recent studies on the properties, chemistry (mineralogy), and mechanical characteristics of rocks similar to those at Yucca Mountain surrounding an igneous intrusion in the Nevada Test Site. This and similar analogs are potentially a valuable source of T-H-M-C information.

Limitations on data from thermal testing are exacerbated by the current timing of the thermal tests being conducted and organized by the DOE at Yucca Mountain. The high thermal inertia of the rock precludes significant acceleration of the studies. Currently, the single heater test in the Exploration Study Facility and the large block test will provide thermal input before the DOE's Viability Assessment (VA), but these tests will not give the bulk properties of Yucca Mountain. The plan is to obtain these properties from the drift scale thermal tests, but data from this test will not be available in time for the VA decisions. Furthermore, it is unclear how the results of these tests will be used to evaluate alternative models for describing thermally induced phenomena in highly fractured rock. The NRC should consider how these data limitations will affect their response to the DOE's VA.

II. Specific

- (1) The Committee concurs with the emphasis placed by the NRC staff on the T-H coupled processes, but we note that in the CNWRA's assessment of the importance of post-closure processes, the combination of T-H processes on chemical processes is deemed most important. We agree with this conclusion because of the potential effect on release, transport, and retardation of radionuclides. However, we note only limited, albeit important, attention directed to the chemical portion of the coupled processes equation. Studies are largely limited to model and code development using simplified matrix mineralogy (chemistry). We believe greater attention is warranted on near-field, contaminant-related chemistry, for example, the effect of temperature on the chemistry of glasses, of sorption of radionuclides by zeolites and other minerals, of redox changes, and so on. We encourage scoping studies to determine the potential impact of temperature and hydrology on chemistry as this will affect NRC decisions that have to be made in the near term related to the VA. For example, mineral precipitation and dissolution may

profoundly alter the rock permeability in the near-field region. The required thermodynamic data at elevated temperatures currently are inadequately known and the effects of such attributes as grain size and fracture filling on chemical reactions need clarification.

- (2) The NRC and the CNWRA note potential shortcomings in the Equivalent Continuum Model (ECM), which is the current focus of T-H studies. Of critical concern is the effectiveness of the ECM in predicting flow through fractured rock and the possible development of the "heat pipe" associated with the thermal pulse caused by the decaying HLW. The DOE Peer Review Team on Thermohydrologic Testing and Modeling also identifies potential shortcomings. The Executive Summary of the DOE report states that the ECM quantitative predictions, particularly where they impact design of the underground structures, should be accepted with a great deal of caution. The Executive Summary also states the following:

The main computational codes. . . have undergone extensive development and verification. The next step in their use, however, should involve investigations, primarily in underground tests, where the efficacy of ECM can be carefully examined. Given the apparent limitations of the ECM, further application of these models would appear to be inappropriate without such confirmation.

We encourage the CNWRA to expand its studies of T-H to include testing the ECM models and codes through studies of current and ancient geothermal regions. These geologic analogs, at a minimum, should identify the effects and relative importance of the principal processes.

- (3) We encourage studies of T-H-C processes between the repository and the location of the critical group. We understand that a study has been initiated at the CNWRA to study hydrological chemical (H-C) effects in the Calico Hills formation, which is rich in cation exchange minerals. We believe this and related studies are warranted. The staff needs to be aware of nonreversible processes in the near field, such as thermal effects on permeability, and their impact upon far-field processes.
- (4) The program to study the effect of natural disruptive processes, for example, igneous activity, was not the subject of our current review. Nonetheless, we were pleased to learn that the study of the effect of natural disruption of the repository is included in future plans for coupled processes investigations by the NRC.
- (5) We believe it is important to conduct scoping studies to aid in the assessment of the potential effects from coupled

processes that are not deemed important on the basis of literature review. Specifically, we suggest that scoping calculations be performed to address the concerns regarding "indirect flow" processes or "Onsager processes."

- (6) We believe the mechanical aspects of the T-H-M-C processes are less problematic than the other components, and, thus, at this time, related studies can be minimized or eliminated.

III. Related Issues

- (1) Our original concerns about the investigation of coupled processes in the "vertical-slice" approach to key issues during the prelicensing studies by NRC were focused on the integration among the various processes. We are pleased that the NRC management has proceeded beyond the KTI dealing with Total Systems Performance Assessment and Integration by developing a management integration task force. We congratulate the staff on this action, which goes a long way toward alleviating our concern. This "top-down" approach has many advantages. Nonetheless, we encourage the staff at all levels to be sensitive to the need to communicate across discipline and KTI boundaries and thus to implement integration meaningfully and in a timely manner. In addition, we encourage management to continue support of the Integration Task Force in the important studies leading to decisions at the time DOE completes its VA process and in the years beyond the VA in the prelicensing and licensing periods.
- (2) We have referred to many of the coupled processes investigations as "data starved." Resource limitations mandate limited opportunity for experimentation and field studies, and, thus, this lack of data is likely to remain unremedied, without special efforts on the part of management. We believe joint programs with other nations that have parallel interests are a worthwhile investment. In addition, every effort must be made to apply the considerable data collected by DOE and its contractors to the NRC programs. Furthermore, we suggest that important data on critical coupled processes problems exist in peer-reviewed journals and industrial and government literature. Management should work toward developing a climate that fosters using these low-cost data in the NRC program.
- (3) The Staff is encouraged to be sensitive to the developing DOE strategy for waste emplacement in the repository so that the potential effects on thermal loading are included in scoping and sensitivity studies as part of the coupled processes program. Because of limited thermal testing at the time of the VA, the NRC should evaluate the impact of these studies at that time and develop strategies for minimizing their impact. Limitations imposed by an incomplete understanding of thermal

properties and processes because of restricted in situ testing even in the post-VA period remains a possibility that needs to be considered by the NRC.

We believe the NRC staff has a strong program to examine the importance of coupled processes and trust that these suggestions will be helpful in further focusing the program.

Sincerely,

A handwritten signature in cursive script, reading "Paul W. Pomeroy". The signature is fluid and stylized, with a large loop at the end of the last name.

Paul W. Pomeroy
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

November 14, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

**SUBJECT: A "ROAD MAP" TO THE ACNW'S RECOMMENDATION FOR TIME
SPAN FOR COMPLIANCE OF THE PROPOSED HIGH-LEVEL
WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA**

Introduction

On June 7, 1996, the ACNW sent a letter to Chairman Jackson laying out a procedure for establishing a time of compliance (TOC) for the proposed high-level waste (HLW) repository at Yucca Mountain, Nevada. This letter outlined a general two-part approach in defining a compliance period for nuclear waste facilities and recommended a site-specific approach to the Yucca Mountain Repository compliance period that is based upon scientific and technical insights gained from site studies. The recommended approach deviates from the generic TOC established in 10 CFR Part 60, which the Committee found to be without strong scientific basis, and also deviates from the peak dose compliance period suggested in the report of the National Research Council, "Technical Basis for Yucca Mountain Standards." As a result, several questions have arisen regarding the ACNW's recommendations, especially as related to implementing a TOC. To answer these questions and improve understanding of the advantages and limitations of the recommendations, the Committee has prepared this brief explanatory memo, which provides a "road map" to its proposal.

Time of Compliance - Definition and Problem

The TOC is the period of time over which the risk of adverse consequences from a repository must comply with a specified standard. Over this stipulated time span, the integrity of the whole repository system must be maintained. In itself, the TOC is not a measure of safety; rather dose (or risk) is the appropriate indicator of safety for a repository. The TOC specifies the minimum time span over which the repository system must meet the dose limits.

The dilemma in developing a TOC is that the time span must be sufficiently long to permit evaluation of potential processes and events leading to the loss of integrity of the repository and transport of radionuclides to the critical population. Yet the period must be short enough that inherent uncertainties in processes and events and in the biosphere and critical population group, which will increase with time, will not invalidate the results of the evaluation. Reasonable confidence must exist that the uncertainties in the reference calculation for the time span can be identified and quantified in a probabilistic format.

The ACNW Recommendation

The Committee recommends a generic two-part approach for determining the TOC. The first part involves determining the TOC on a repository-specific basis, that is, on the basis of an analysis using modeling, analogs, and experiments to specify the time for release and transport of radionuclides to the critical population group. This analysis considers site and waste characteristics, site design, and engineered barriers. The TOC must confirm the ability of the total repository system, including the geosphere, to prevent radionuclides from reaching the biosphere for a minimum of several thousand years.

The second part of the recommendation requires a point estimate calculation of the time for the potential release of radionuclides to reach peak dose. Performance assessment is used to determine the magnitude of the dose at this time. Comparison of the calculated peak dose with the standard will indicate whether the repository performance complies and will identify deficient performance factors that may require redesign or reconsideration of the repository. This part does not require a definitive measure of compliance in the sense of a numeric evaluation between the standard and the calculated dose because of the limitations in the calculations imposed by the breadth of the uncertainties in processes and events.

Implementation of the Recommendation

The enclosed flow chart provides a road map for implementing the Committee's recommendation on TOC for the proposed HLW repository at Yucca Mountain. Implementation flows from the top of the chart downward. The process is based on input provided by the site characterization, the engineering design of the repository, the waste characteristics, and the design of the waste containment. Part #1 involves determination of the TOC and evaluation of the repository in terms of the specified standard. Part #2 also is a requirement but does not involve a numerical evaluation. It is an advisory component, not a de facto regulation.

The implementation process should be defined in the regulation, but the actual TOC need not be specified. The time span only can be determined when the site characterization and repository design are completed.

The steps in the implementation of the TOC are indicated on the flow chart:

Input

1) Site characterization, the engineering design of the repository, the waste characteristics, and the waste containment design provide input to the first part of the TOC. The engineering, waste characteristics, and waste containment are subject to redesign, depending on the results of the performance evaluation for the TOC. In addition, it may be necessary to further investigate specific components of the natural setting as a result of the assessment of the performance and the range of uncertainties in the performance of the repository.

Part #1

2) Analysis of the input characteristics using empirical and theoretical modeling, analog studies, and results from laboratory and in situ experiments will determine the anticipated time for release and transport of radionuclides to the critical population group on the basis of the defined reference biosphere. The critical population group and the reference biosphere should be delineated in the regulation. Note that this time is not the ground water travel time, but, tying it to the dose standard, it is the time for transport of radionuclides from the repository to the critical population group. This time should be based for example on the peak dose or the beginning of the decrease from the peak dose of the most mobile (i.e., high-solubility, low-retardation) radionuclides such as ^{129}I and ^{99}Tc that are anticipated from possible leakage of the repository.

3) A base-level TOC is required to eliminate the consideration of a low-integrity repository system. If the anticipated TOC is less than a few thousand years (e.g., $\sim 3 \times 10^3$ years) the repository is rejected or the engineered system and waste containment are redesigned to increase time for release and transport of radionuclides to the critical population.

4) If the calculated time is greater than a few thousand years, total systems performance assessment is used to compare repository performance with the anticipated Yucca Mountain standard (40 CFR Part 197).

5) If comparison of the calculated performance with the standard shows that the repository performance is deficient, the repository should be rejected or redesigned. However, if the repository performance complies with the standard at the TOC the repository evaluation process should continue with Part #2.

Part #2

6) The performance assessment analysis used in Part #1 to establish the TOC should be continued until peak dose is obtained and repository performance should be evaluated at that time. The uncertainties in the system should be identified and quantified in a

probabilistic format on the basis of the best available information, and their effect should be determined through bounding calculations.

7) If the comparison of the calculated performance shows that at the time of peak dose the repository is significantly deficient, for example, an order of magnitude or more, compared to the anticipated standard, the major sources of the deficiency should be identified and possible remedial actions designed and carried out. If these actions are not possible or ineffective the repository may be rejected. However, if the bounding calculations indicate that the repository complies with in an order of magnitude of the standard, the proposed repository performance is deemed acceptable.

Sincerely,

A handwritten signature in cursive script, reading "Paul W. Pomeroy". The signature is fluid and stylized, with a large initial "P" and a long, sweeping underline.

Paul W. Pomeroy
Chairman

Enclosure: as stated

Flow Chart for Implementing a Two-Part Approach to the Time Span For Compliance of a Specific HLW Repository

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

November 20, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: SCREENING METHODOLOGY FOR ASSESSING PRIOR LAND BURIALS OF
RADIOACTIVE WASTE AUTHORIZED UNDER FORMER 10 CFR 20.304
AND 20.302

During its 87th meeting, October 22-23, 1996, the Advisory Committee on Nuclear Waste (ACNW) reviewed staff plans relevant to the decommissioning of sites in which radioactive waste had been buried as authorized under former 10 CFR 20.304 and 20.302. In addition to receiving information on the history and background leading to the development of the screening criteria to be promulgated in a branch technical position (BTP), the ACNW was briefed on related agency rules and information notices. The BTP, which was not available for ACNW review during its 87th meeting, will be finalized when more directly related field experience is obtained and public and licensee comments are evaluated.

These screening criteria are directed at potentially hundreds of onsite, non-reactor burial locations that will require an evaluation or screening process to determine if further remediation is required. The NRC staff has prepared a simple, conservative three-step method to evaluate the risk from these burial sites:

1. review burial records,
2. estimate the dose from ingestion of the total inventory in groundwater (a conservative approach), or
3. estimate the dose to a resident farmer from all pathways.

If the estimated dose from Step 2 or Step 3 is less than 100 mrem/yr, no further site work is required, and the site can be released for unrestricted use. The ACNW agrees with the NRC staff approach.

The ACNW offers the following comments and recommendations:

1. The NRC staff does have a responsibility to assure itself through independent audits and reviews that the risks are

reasonably assessed. These reviews are especially important where, for example, the burials may include greater than anticipated inventories of uranium; disposed wastes that contain isotopes, such as chlorine-36, which at the time of disposal were not perceived to be a significant problem; the location and distribution of wastes are imprecisely recorded (or, in some instances, unrecorded).

2. In those situations requiring review and approval of the NRC staff prior to final site decommissioning, the staff must be certain that the risks and contributors to the risks are understood, and should not rely only on an assessment of how the input parameters were either measured or calculated.
3. We concur with the staff's position that licensees not be allowed to use Step 3 of the BTP screening process for isotopes with atomic numbers of 88 or higher due to the lack of confidence in the dose equivalent factors in the current version of NUREG-1500, "Working Draft Regulatory Guide on Release Criteria for Decommissioning: NRC Staff's Draft for Comment," August 1994.

The ACNW recognizes the benefit in providing a simple, relatively straightforward approach to resolving the problems extant from these past burials. We note that this issue might provide the Commission with an opportunity to advance its risk-informed, performance-based decision-making process. The ACNW anticipates further discussions on this specific issue with the NRC staff as the staff completes its evaluation of public comments and gains applicable field experience. Further, the ACNW intends to explore the compatibility of various screening criteria and methodology currently used by the NRC in the decommissioning process.

Sincerely

Paul W. Pomeroy
Chairman

Reference:

Draft Branch Technical Position, "Screening Methodology for Assessing Prior Land Burials of Radioactive Waste Authorized Under Former 10 CFR 20.304 and 20.302," October 1996.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

November 20, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: 1997 PRIORITY ISSUES FOR THE ADVISORY COMMITTEE ON
NUCLEAR WASTE

CRITERIA FOR PRIORITIZATION

The Advisory Committee on Nuclear Waste (ACNW) has adopted and implemented criteria for assigning priorities to issues it will consider. Priorities are assigned and updated annually on the basis of the criteria presented below. Of course, priorities are subject to change at any time on the basis of the needs of the Commission and developing events.

The overarching criterion for assigning priorities to issues is the protection of the public, workers, and the environment from any adverse effects of the management of nuclear waste, especially in regard to disposal facilities.

Other criteria applied in the prioritization process are listed below:

- **NRC's strategic plan, including trends and directions in regulatory practice, such as the adoption of a risk-informed, performance-based method of regulation and decision-making**

This criterion for establishing priorities includes the consideration of the Commission's own thinking and judgment concerning nuclear waste issues. In particular, it includes a clear understanding of the Commission's view of what the priorities are. However, the ACNW does not restrict the issues to only those of immediate concern to the Commission.

- **The strategy and activities of licensees and applicants**

Special emphasis should be placed on the Department of Energy's (DOE's) licensing strategy and activities, including the program plan, the site characterization

program, and the performance assessment for the proposed Yucca Mountain repository. The idea is that priorities are dependent not only on the regulatory process but also on the intentions of the licensee and applicant.

- **The scientific and technical basis of information supporting the safety and performance assessments of nuclear waste disposal facilities, including the quality and level of technical expertise involved**

The importance of an issue is clearly dependent on the quality of the supporting information, such as basic data, and the analyses performed.

- **The timeliness of the advice provided by the ACNW with respect to effective decision-making in the regulatory process**

The licensing process involves the systematic and incremental development of information. Timely regulatory decision-making depends strongly on an effective match of information development and regulatory involvement.

The application of these criteria has resulted in the following priority issues, not listed in order of importance. It should be pointed out that not all of these issues will be considered. In the final analysis, current events will determine the course of our reviews.

PRIORITY ISSUES

1. Regulatory Framework

The ACNW will continue to focus on the framework for high-level waste disposal. Environmental Protection Agency (EPA) standards (40 CFR Part 197) and NRC's conforming regulations are scheduled for development. The ACNW will monitor the interaction between the EPA staff and the NRC staff as they consider these standards and regulations. In 1997 DOE will provide for agency and public comment, their HLW siting regulation (10 CFR Part 960). The ACNW will review and comment on the DOE document. Subissues under this topic are the following: regulatory time of compliance, consideration of the critical group and reference biosphere, and whether consideration should be given to risk discounting as an element of a standard. We will consider the defense-in-depth philosophy, the use of subsystem requirements, and the treatment of uncertainty.

2. Waste Isolation Strategy

The ACNW will monitor and comment on DOE's final Waste Isolation Strategy and the NRC staff's response to this document, once these become available. The Waste Isolation Strategy document is expected toward the end of 1996 from the DOE. This issue will focus on the source term and will consider container design. As part of this review, we will examine the NRC staff's Key Technical Issues (KTI) effort and its interface with the DOE's Waste Isolation Strategy.

3. Viability Assessment and Site Characterization

The DOE is scheduled to complete the viability assessment (VA) of the Yucca Mountain repository site in 1998. The principal objective of the VA is to address the major unresolved technical questions and the technical and economic feasibility of constructing and operating a geologic repository at the Yucca Mountain site. The ACNW will review DOE's conclusions and the NRC staff's review of the VA. The ACNW will also be able to determine if the KTI process (the basis of the staff's review effort) will produce sound regulatory decisions. The ACNW will provide advice to the Commission and guidance to the staff on site characterization and analysis activities related to DOE's studies and NRC's KTIs.

4. Repository Design

The ACNW will continue to focus its attention on the repository design, including thermal loading issues. Additional details of the design will be developed as part of the viability assessment determination, but will not be finalized. The ACNW has unresolved concerns on coupled thermal-hydrological-mechanical-chemical processes and will continue to evaluate progress in this area. Other design elements that could affect the overall behavior of the repository, due to their effects on overall system chemistry, are concrete tunnel liners and iron from steel sets and fuel canisters. The ACNW will evaluate the adequacy of models that have been developed to predict repository behavior. Issues such as retrievability and canister design would be considered under this topic. The ACNW will examine the proposed location of the repository within Yucca Mountain and the impact that the repository "foot print" will have on the facility design.

5. Low-Level Radioactive Waste (LLW) Disposal

In December 1995, the ACNW commented on SECY-95-201 in which the NRC staff listed three options for NRC's LLW program (eliminate, reduce, or keep the status quo). In July 1996,

the ACNW produced a report titled "Elements of an Adequate LLW Program," which suggested that, as a minimum, the current program be retained. Our advice is consistent with the Commission's preliminary preferred option in Direction Setting Issue Paper 5. Agreement State programs and the progress of compacts and individual States in developing new disposal facilities remain an issue with ACNW. We remain concerned about the final disposal strategy for mixed wastes and will continue to monitor developments. The ACNW will continue its review of an NRC staff Branch Technical Position on Low-Level Waste (LLW) Performance Assessment and the related time of regulatory compliance associated with LLW disposal.

6. Decommissioning

The ACNW continues to have a strong interest in waste disposal issues related to decommissioning. In the past, the ACNW has advised the Commission on streamlining the Site Decommissioning Management Plan (SDMP) and on the lessons learned from decommissioning the Pathfinder power plant. The ACNW anticipates commenting further on the use of performance assessment in determining priorities for cleanup in SDMP sites. We have several concerns in this area, including residual levels of contamination, mixed waste, greater-than-Class C waste, and consistency of screening criteria and methodology.

7. Expert Judgment in Regulatory Decision Making

The ACNW issued a report in August 1996 on the NRC's Branch Technical Position (BTP) on Expert Elicitation in the High-Level Radioactive Waste Program. In its advice on the BTP, the ACNW identified four areas of concern: (1) the selection of subject matter experts and participation of the experts in refining the problem definition, (2) aggregation of the results, (3) interpretation of the results, and (4) application of expert elicitation. The ACNW will continue to monitor the application of the BTP to specific expert elicitations being conducted by DOE and on the generic applications of the BTP guidance.

8. Risk-Informed and Performance-Based Regulation

The ACNW expects to support an effort designed to help move the agency from deterministic regulations toward risk-informed and performance-based regulation. The goal is to link adequate assurance of safety more closely with the regulations. Our effort will consider practices in other nations that are implementing risk-informed and performance-based regulations. Efforts toward risk harmonization with the EPA will be considered.

9. Performance Assessment (PA)

The ACNW will continue to monitor DOE's total system performance assessment (TSPA) and review the staff's Iterative Performance Assessment Program including NRC's audit review of TSPA. We will continue to consider whether PA is being used to its full advantage in prioritizing issues. The ACNW will investigate the treatment of uncertainty in the use of bounding analyses. Uncertainty analyses are important in determining the adequacy of site characterization and abstracting geologic information for PA models. The ACNW will continue to monitor progress in these areas, and will comment on the advisability of the NRC staff producing a separate guidance document on the treatment of uncertainty.

10. Uranium Mill Tailings

The ACNW will review NRC regulations pertaining to uranium mill tailings. Considerations will include a determination of the risk and practical remediation methods such as the stabilization of tailings piles and groundwater protection monitoring in the vicinity of the tailings pile, as well as radon emissions control. We are interested in the impact on NRC regulations of (1) the current Congressional requirement for perpetual government custody of tailings sites and (2) the EPA standards for the cleanup of uranium and thorium mill sites after permanent closure.

11. Interim Surface Storage Facilities for Spent Fuel

The ACNW will address NRC concerns with a central interim HLW storage facility. We will identify issues that need consideration in surface HLW facilities, including handling operations, cask requirements, comparative risk of various options, and alternatives to dry storage.

We look forward to discussing this 1997 list of priority issues with you and the other Commissioners in the near future. We would welcome any comments and suggestions regarding additions, deletions, or changes in emphasis that you might wish to make.

Sincerely,

A handwritten signature in dark ink, appearing to read "Paul W. Pomeroy", with a stylized, flowing script.

Paul W. Pomeroy
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

January 30, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

**SUBJECT: COMMENTS ON SELECTED DIRECTION-SETTING ISSUES IDENTIFIED
IN NRC'S STRATEGIC ASSESSMENT OF REGULATORY ACTIVITIES**

The Advisory Committee on Nuclear Waste (ACNW) is pleased to provide its comments on several selected direction-setting issues (DSIs) that were identified in the U.S. Nuclear Regulatory Commission's (NRC) Strategic Planning Framework Document released on September 16, 1996. These issues are an important part of Phase II, "Rebaselining and Development of Decision Papers of the Agency's strategic assessment of its regulatory activities." Our conclusions were reached through deliberative discussions within the ACNW based on the Phase II document and a briefing on October 22, 1996, on those DSIs of most interest to the ACNW. The presentations by Mr. James L. Milhoan, Deputy Executive Director for Operations and co-chair of the rebaselining subcommittee, and several members of the rebaselining subcommittee were useful to the ACNW in focusing its deliberations on critical topics.

In the following discussion, our comments on seven of the DSIs pertain to topics that are within the scope of our activities as specified by the Commission. Where appropriate, our review comments on the nature and completeness of the background discussion and decision options are provided for the seven DSIs. In the interest of limiting the length of this letter while considering numerous issues, we have purposefully minimized the depth of the backup discussion. We will be pleased to expand on topics at your request.

Before discussing specific DSIs, we have the following general comments regarding the Phase II document:

- (1) Rebaselining Nuclear Waste Activities and Related DSIs - We see the rebaselining effort of the NRC as it relates to nuclear waste activities to be extremely important and timely. Regulating the handling, storage, and disposal of nuclear waste to protect the health and safety of the public and its environment is a critical role of the NRC, which permits the use of radioactive materials for a broad range of uses beneficial to our society. Implementation of nuclear waste activities and associated regulations,

especially as they relate to storage and disposal, has been contentious and slow. Rebaselining involving the review of NRC's role and procedures is timely because (a) new standards and regulations are being prepared for the high-level waste program, (b) there is a need to smooth the interface between standards of the Environmental Protection Agency (EPA) and NRC regulations, and (c) the decline in resources for all parties, including potential licensees, demands a sharper focus on what is demonstrably and significantly important to public health and safety. Identification of the DSIs and the introspective view of the NRC that led to their definition, the broad internal and external discussion of the DSIs, and the ultimate Commission decisions on them offer opportunities to establish improved nuclear waste regulations.

- (2) Broadened Role of the NRC in Regulation of Nuclear Material - The current regulatory environment for radioactive materials has been developed over a long period and is administered by a variety of agencies with different philosophies and concerns. The result is a patchwork of regulatory legislation that fails to be as consistent, coherent, effective, and efficient, as possible. The public generally is confused about radioactive waste regulations and unaware of the agencies involved and their specific responsibilities and competence in the regulation of radioactive materials to protect public health and safety. Rebaselining by the Commission should have as an ultimate goal the reorganization of radioactive material regulations into a coherent and internally consistent assemblage. The achievement of this goal will be fostered by minimization of the number of agencies involved. Thus, within the constraints of a regulatory agency, we encourage the NRC to think boldly about taking on increased responsibilities for the regulation of radioactive materials.
- (3) Omissions in the DSIs - In our review of the DSI papers, we have identified a few issues that we believe are especially important to the effective and efficient implementation of nuclear waste regulations, but are not identified as DSIs. We realize that these issues were considered in the mix of nuclear waste issues facing the Commission, but were deemed insufficiently compelling to warrant individual identification and discussion as a DSI. Nonetheless, we wish to bring them to your attention.
 - (a) Information Management - We are pleased to see "managing information" identified in NRC's Strategic Plan as a Core Resource Strategy Arena (Figure 2 of the Strategic Planning Framework Document). We understand that this important area has been factored into rebaselining by implementation of the Information Technology Management Reform Act and the appointment in the near future of a chief information officer for the NRC. This is encouraging because we believe that internal management of information which includes the efficient and effective handling, transfer, repositing, and accessing of both technical and administrative information is to a significant degree one key to the success of the NRC in today's data and information-rich society. The pivotal role of data and information management in the knowledge-driven

Commission may be cause for the Commission to place greater emphasis on this issue and its integration into all units and activities of the NRC.

- (b) Cross-Cutting Issues - In reviewing the DSI papers, we noted that some concerns to the NRC are relevant to several of the DSIs. Examples of these cross-cutting issues are mixed waste and greater-than-Class-C (GTCC) waste. We draw your attention to these because in our view they are important issues, but may be neglected because they cross DSI boundaries. They are important because multiple agencies or divisions within NRC have overlapping responsibilities that may impede actions by agencies involved, as well as by licensees. The resulting confusion may be potentially detrimental to the public health and safety and lead to inefficiencies. The NRC should be proactive to minimize occurrence of such administratively generated hurdles involving other agencies and should examine its own structure to ensure that such impediments to coherent regulatory activities do not exist within the NRC.

The safe storage and disposal of wastes that have the attributes of hazardous waste regulated by the Environmental Protection Agency (EPA) and low-level waste (LLW) regulated by the NRC or one of its Agreement States remains a perplexing problem. The ACNW has been concerned with mixed wastes for several years (e.g., letter to the Commission dated May 3, 1989) and continues to monitor the ongoing activities and progress of discussions between EPA and the NRC leading to reconciliation of the conflicting requirements for storage and disposal of wastes that fall under the purview of both agencies. We suggest that these activities be given greater attention in the strategic planning of the NRC with emphasis on resolving regulatory overlap with the EPA.

GTCC waste is classified as LLW, but is generally unacceptable for disposal in the surface or near-surface structures being designed for LLW. Thus, storage and disposal of this waste is a problem that transcends several DSIs. We note that this issue is discussed in a memorandum from D. L. Morrison, Director, Office of Nuclear Regulatory Research, January 14, 1997, "Rulemaking Plan - Interim Storage for Greater-Than-Class-C Waste, Changes to 10CFR Part 72." Clearly, this problem along with concerns about mixed waste deserves significant attention in strategic planning, and thus, the Commission may wish to identify it as such.

DSI-2: Oversight of the Department of Energy

Actions in the near term by either the Department of Energy (DOE) or Congress could lead to an expansion of NRC regulatory authority and responsibilities to include DOE nuclear facilities. The DSI-2 paper deals with the question of whether the NRC should seek this authority and responsibility. Further, it provides the background of how this issue arose, a description and discussion of the issue, and the relevant options open to the Commission.

We believe this issue should be decided primarily on the basis of the benefits to the health and safety of the public, but other considerations include minimizing regulations and overlap among them, improving regulatory consistency, maximizing overall regulatory efficiency, and assuring independent oversight and regulatory surveillance. Our review indicates that the DSI paper discussion does not fully address the positive aspects of this issue as they relate to these criteria. Clearly, numerous problems and concerns are associated with regulating DOE facilities as developed in the DSI paper, but these are problems that any agency will face in carrying out the regulatory duties, and the NRC by virtue of its broad nuclear regulatory experience is best suited to addressing them. As stated in the discussion of Option 1A, "The Commission's support for assuming broad authority over DOE facilities would be based on recognition of the need for external regulation and on the recognition that NRC's expertise places it in the strongest position of any existing agency to assume these responsibilities."

Acceptance of Option 1, "Support broad responsibility for NRC regulation of DOE," has many potential positive attributes. It could simplify the desirable goal of reorganizing the national regulatory framework for radioactive materials into a consistent, integrated entity. These new regulatory responsibilities likely will result in the need for additional technical expertise within the Commission, which will then be available to other more traditional activities of the NRC. Finally, the expansion of NRC to regulatory functions into DOE nuclear facilities will be less burdensome to an evolving NRC if the traditional mission and scope of the Agency is reduced in the future. This reduction may result from a declining nuclear power generation industry and a reduction in materials and other licensing perhaps because of a rising role of Agreement State activities. Despite these very positive aspects to the NRC broadening its oversight role to include DOE nuclear facilities, we are aware of the need to identify clearly the methods, timing, staffing, and funding of the implementation of this responsibility within the NRC, including the preparation of pertinent regulations. In addition, care must be exercised to ensure that current NRC programs and regulatory responsibilities are not adversely affected by these new responsibilities.

In conclusion, we suggest that the Commission explore various derivatives of Option 1, that is, support NRC regulation of DOE, but we believe that co-regulation should be emphatically avoided because of the potential for conflicts and confusion in regulations. Enhancement of public health and safety is neither evident nor can it be envisioned from multi-party regulation of the same general activity, materials, or devices. Finally, only by participating in discussions and decisions regarding the regulation of DOE facilities will the NRC be poised to see that its view of needs for public health and safety is implemented.

DSI-4: Relationship with Agreement States

Current rebaselining efforts of the Commission present an opportunity to review the relationship of the NRC with Agreement States. The direction of the DSI-4 paper is to consider NRC's strategy regarding states becoming and remaining Agreement States. The

paper makes a strong case for maintaining a core licensing and review program and a cadre of competent technical staff to conduct the program within the NRC. We believe this is essential to fulfill the requirements of the Atomic Energy Act (AEA) and is consistent with NRC's mission. Furthermore, any action regarding funding with respect to relationships with Agreement States must be anchored in maintaining the health and safety of the public as well as in the Omnibus Budget Reconciliation Act of 1990. Although we agree with the discussion regarding the need for maintaining a critical mass of talent within the agency, the level of licensing activity required for this as stated in the DSI paper appears to have little basis in fact and fails to consider an expertise resident in the agency as a result of related activities.

The conclusion we reach is that some form of Option 3, "Continue the current Agreement States Program, including adopting current initiatives," is preferable. We believe the agency should maintain the authority and responsibilities it has in this area through the AEA. Further, the hazards of dual regulation as well indicated by experience in nuclear waste regulation and elsewhere strongly argue against Option 4, which would lead to co-regulation.

We believe it is unfortunate that in the discussion of the Agreement State Program in the DSI paper, the staff did not take the opportunity to emphasize additional aspects of this program. Broadening of this topic could lead to consideration of criteria used to evaluate the adequacy and compatibility of an Agreement State's program. We believe that a direct relationship has not been proven between the evaluation criteria and assurance of the competency of the States programs and benefits to protection of public health and safety. One measure of the benefits could be the number and severity of incidents reported (e.g., overexposure, misadministration of radiopharmaceutical and treatments, loss of control sources). Another measure could be the cost to potential licensees. Still another concern associated with the Agreement State Program is the situation in which State regulations are significantly more stringent than those of the NRC. This situation is legal, but the lack of consistency in regulations leads to the public's confusion regarding the hazards of radioactivity and the validity of related regulations. In addition, the impact of removal of this inconsistency on interstate commerce affairs, such as transportation, would eliminate vagaries caused by local, current special interests.

We also wish to comment on two of the related issues discussed in Section VI of this DSI paper. To ensure the compatibility and adequacy of the Agreement State Program, we believe that it is essential to incorporate all aspects of the LLW programs of the States (Section VI.A.). The site review of an LLW disposal facility is a critical component in the evaluation of the technical capability of an Agreement State's program. The quality of results and the technical intensity of the Agreement State review process should be one measure of the adequacy of the program. In addition, we support NRC's Independent Radiation Monitoring Program (IRMP) implemented at NRC-licensed facilities, which is discussed in Section VI.B of the DSI paper. The IRMP provides important verification of results reported by licensees and thus serves to assure public health and safety from potential radioactive releases to the environment.

DSI-5: Low-Level Waste

In a recent letter to the Commission (December 29, 1995), the ACNW concluded that "... in the radioactive waste field, the management of LLW poses broader, more direct and ubiquitous potential risks to the health and safety than any other activity...." As a result, we believe the rebaselining efforts of the Commission with regard to this DSI are especially important. Further, this conclusion was critical to our recommendation in the letter of December 29, 1995, that the NRC adopt a strong regulatory role in LLW disposal. This recommendation is supported by an extensive discussion in the letter of the needs for a Federal presence in this radioactive waste area and the strengths that the NRC brings to the solution of the problems of LLW. Thus, we highly recommend Option 2, "Assume a strong regulatory role in national LLW program," of the DSI paper. However, the DSI paper implies that a national LLW disposal program exists. Our view of the current situation is that, other than in the words of the LLW policy act and its amendments, a functional coherent national policy is absent. The volatility of the current LLW activities as associated with the current and past conflicts in policy, special interests, and variable practices provides ample evidence for this conclusion.

We are concerned about several items in this DSI paper. We note the following:

- (1) A number of waste types are missing from the discussion. In our general introductory comments, we noted our concern about the omission of DSI cross-cutting issues such as mixed wastes and greater-than-Class-C wastes. As stated previously, we believe these issues need to be adequately addressed in the strategic planning of the agency.
- (2) NRC's acceptance of long-term storage of LLW, although attractive as a practical solution to a current problem, may not be acceptable to the Nation. The current national policy is to provide final disposal by the present generation in a manner that does not jeopardize public health and safety now and in the future. The DSI paper does not adequately address the requirements for implementing long-term storage of LLW. We also are concerned about the rather favorable light placed on interim storage in the DSI paper presumably because to date no incident has been reported as a result of storage on the originating site. However, no evidence exists that onsite storage can be effective over the expected life of the waste and the proliferation of storage sites enhances the risk.
- (3) We suggest that caution be exercised in using "rules of thumb" to define waste types in terms of the length of time over which they may be hazardous. In view of the absence of a *de minimis* position regarding radioactivity and the broad application of the no threshold-linear view of the health effects of radiation, we suggest rules of thumb are a significant oversimplification.
- (4) Finally, we question the acceptance of DOE waste sites as potential disposal sites for civilian wastes. The DOE sites were not selected on the basis of criteria used in siting

and licensing civilian disposal facilities, and evidence is lacking that these sites could meet the standards and regulations in effect.

In conclusion, we recommend Option 2 of this DSI paper but encourage additions to (1) develop a more comprehensive definition of LLW and (2) evaluate the potential implementation and impact of assured storage with adequate protection and termination procedures.

DSI-6: High-Level Waste and Spent Fuel

Rebaselining of the NRC comes at a propitious time for the high-level waste (HLW) program considering the implementation of new standards by EPA and siting regulations by DOE for the proposed Yucca Mountain repository and related modifications in the Yucca Mountain regulations by the NRC. In addition, the viability assessment of the proposed Yucca Mountain deep-geologic-burial repository will soon be completed and Congress is considering to legislate significant changes in the national HLW program.

Before we recommend an option for this DSI, we have several observations regarding NRC's HLW program and related comments in this DSI.

- (1) The DSI paper lists key specific barriers to the program's success as identified by the DOE's Office of Civilian Radioactive Waste Management. Although we agree that some of these represent significant hurdles for the program, we believe that a critical barrier pertains to the final one of the list provided, that is, "General program and budgetary constraints." Within the scope of this barrier, we find that changes in the laws and funding levels have led to instability in planning and conducting the characterization of the site and design of the repository. This is exacerbated by the lack of implementation of multiyear funding plans. These problems are of special concern now that an achievable program plan, the Viability Assessment, has been instituted by DOE to achieve the will of Congress in a reasonable time with a modest budget. The advantages of a stable program and budget for the successful licensing by the NRC of a HLW repository need to be conveyed to Congress.
- (2) The barriers to DOE's HLW program are important to understand, but the NRC must recognize that these are not necessarily the critical hurdles for the NRC to overcome in the licensing process. The NRC needs to sharpen the focus of its HLW program beyond the key technical issues and identify significant problems facing it in regard to the program.
- (3) A related topic is the implied direct connection between changes in the HLW program of DOE and the NRC. No evidence exists that a change in the DOE program should lead to a direct proportional modification in NRC's program. NRC's role in the HLW program is much different than DOE's. In fact, a case can be made that some

cutbacks in the DOE program may necessitate increases in the NRC program, for example, to ensure sufficient data and analysis for the licensing processes. The effects of reductions in the DOE program on the NRC licensing plans need clarification.

- (4) DOE has made it clear that the viability assessment of the Yucca Mountain repository is not a technical site suitability (TSS) evaluation. This evaluation will come later, but it is unclear what new DOE data gathering and analyses will be available considering the marked reduction in operating budget and the likely decrease in key scientific/technical personnel and related infrastructure. Thus, we believe prudence requires that the NRC define as much as possible critical data and analyses it requires to conduct a comprehensive license review. If some are missing at the time of the completion of the Viability Assessment, DOE should be notified of these deficiencies while data and analyses personnel and programs are intact.

We support Option 3, "Maintaining NRC's existing high-level waste repository program," in the DSI-6 paper. As we have stated previously (e.g., in our letter to the Commission, "Comments on High-Level Waste Prelicensing Program Strategy and Key Technical Issues," February 16, 1996), we believe in general that the NRC, through its identification of key technical issues and the vertical slice approach to the prelicensing program, has taken appropriate action. Further, we support flexibility in the program so as to adapt to potential actions that Congress may take in the near future. In addition to supporting Option 3 we suggest that serious considerations be given to incorporating the following suggestions raised in other options:

- (1) The use of rulemaking as discussed in Option 2 is a potentially efficient procedure to deal with contentious issues. Rulemaking may be useful in stabilizing the repository approval process and reducing NRC-related uncertainties.
- (2) As discussed in Option 2, we encourage the NRC to prepare a new part of *Title 10 of the Code of Federal Regulations (10CFR)* covering the regulations for Yucca Mountain. These new regulations could avoid the burden of some aspects of 10CFR Part 60 that: (a) are not really pertinent to an unsaturated repository, (b) have proven to be points of weakness as they have been reviewed in the prelicensing period, and warrant modification, such as the subsystem criteria. The ACNW has developed suggestions regarding time of compliance (letter to the Commission, "Time Span for Compliance of the Proposed High-Level Waste Repository at Yucca Mountain, Nevada," June 7, 1996) that should be considered in the new regulations together with suggestions regarding the reference biosphere and critical group, which are currently under final development by us.
- (3) The interim storage of spent fuel appears to be an action that is increasingly needed. However, Option 5, seems unnecessarily complex for the purpose of providing storage facilities until the repository can accept fuel. Such facilities (dry, onsite storage) exist now and seem to be quite satisfactory. The need to involve Congress is unjustified

and should be avoided. The polemics that may arise from a desire to use a centralized facility are likely to be divisive to the HLW program. Several regional centralized facilities may be more likely to be acceptable. Some form of centralized facility for spent fuel will likely be a requirement if the rate of progress on the underground repository does not increase. The legislation likely to be considered by Congress and the possibility of a Presidential veto suggest that the Yucca Mountain repository program may be terminated regardless of the results of the technical site suitability evaluation. Such events would require identification of an alternate repository site requiring several years, perhaps a decade or more. The Commission should consider inclusion in Option 3 the task of ensuring that centralized, dry, spent-fuel storage facilities can be readily licensed by a process that is simple and adequate for the protection of the public and the environment (e.g., ground water) for sufficiently long periods. Public involvement should be ensured, but sufficiently prescribed to avoid crippling legal maneuvering. The safe license period for interim storage is an unknown. This is a subject for study and further deliberation by the Commission.

Concerning the broader issue of managing the nation's HLW, the Committee found the ideas of DSI-6 on a quasi-government agency and a joint committee oversight function as stimulating and thought provoking. While we have no position on this issue at this time, the Committee encourages the Commission to examine such creative ideas for considering future directions for the management of the nation's radioactive waste.

In conclusion, rebaselining offers an excellent opportunity to revamp and streamline the HLW program of the NRC. We offer several general suggestions and recommend an option for the DSI that incorporates the present program, and also several supplementary actions that will speed the licensing process without weakening it.

DSI-9: Decommissioning - Non-Reactor Facilities

The regulation of and progress in decommissioning of non-reactor facilities by the NRC are problems requiring significant Commission efforts and are attracting increasing public scrutiny. Thus, rebaselining of the Commission's strategic plans in this area is especially important. In our view the problem that needs consideration is placement of the scope and system of decommissioning regulations into a comprehensive strategy for all "low-level" waste leading to consolidation of regulatory controls and consistent regulatory criteria on all radioactive materials (uranium mill tailings, NORM, NARM, decommissioning waste, etc.) within a single agency, the NRC. Rather than simply addressing the rather limited focus of the question considered in the DSI-9 paper, we suggest that the Commission would be better served by first developing a document that specifies the elements of an adequate decommissioning program for non-reactor facilities in the manner of our letter to the Commission of July 24, 1996, in which we developed the elements of an adequate NRC low-level radioactive waste program.

Elements of an adequate NRC program for decommissioning non-reactor facilities should include:

- (1) protection of the safety of the public and preservation of the environment,
- (2) timeliness of actions,
- (3) reasonable waste disposal processes and economics,
- (4) demonstration to the public of acceptable residual risk, and
- (5) fiscal and technical capability of the licensee to accomplish decommissioning. The ACNW also has indicated in previous reports that there are several issues key to the success of the Site Decommissioning Management Plan as described in SECY-90-121 and subsequent revisions. One of the key items is the quality of the final survey, especially when levels of residual contamination are close to background. Other issues include: (1) prioritization of scheduling of a site for decommissioning based on risk posed by the site and (2) assurance that wastes generated can be disposed of in a reasonable fashion (e.g., they are not mixed wastes). Finally, high priority must be placed on ensuring consistency of the residual risk criterion (e.g., equivalent to 15 mrem/yr for unrestricted access) with a generally accepted standard that includes the risk of groundwater contamination.

In view of the preceding discussion, we find none of the options presented to the Commission totally acceptable. Nonetheless, elements of some of these options offer useful suggestions. Option 2, "Change the decommission review process," is worthy of consideration and testing as specified in the Commission's preliminary conclusions. However, we are reminded that the review process is only a tool to ensure that the decommissioning product will be satisfactory. The product is the important point. We strongly disagree with Option 6, "Focus on decommissioning cases in which progress can be made: Transfer stalled sites to the Environmental Protection Agency's Superfund Program." The Commission needs to identify those sites posing the greatest risk to the public and the environment and direct its resources to those cases. The second part of this option to transfer stalled sites to EPA is ill-advised. The Commission should make any decisions to transfer its responsibilities to other agencies on the basis of furthering the protection of public health and safety, not simply on cost saving consideration.

In conclusion, we believe strategic planning with regard to decommissioning should start with developing a coherent view of an adequate decommissioning program and the issues inherent in it. Further, this program should be consistent with regulations for other low-level waste and should be based on well defined risk-based protocols. Emphasis should be placed on remediating sites that pose the greatest risk to public safety and the environment. Within the regulations flexibility should be encouraged in remediation to husband resources as long as

the public safety is protected as determined by high-quality, final radiation surveys of the residual contamination.

DSI-12: Risk-Informed, Performance-Based Regulation

The Commission's policy to incorporate risk insights into all nuclear regulatory activities is most heartening. We believe that risk-informed, performance-based (RIPB) regulations based upon probabilistic risk assessment (PRA) are necessary for efficient protection of the public's health and safety and the Nation's environment from nuclear waste materials. Unfortunately, the discussion of RIPB regulation in the DSI-12 paper is too superficial in the nuclear waste area to be useful in detailing courses of action to be considered. One of our members, B. John Garrick, sent you a letter, dated January 17, 1997, stating his personal views on this DSI. Our views parallel those of Dr. Garrick.

The RIPB approach has not been translated into a generic concept useful in waste management in this DSI paper. Clearly, there is no adequate definition of RIPB regulation in the waste area that will be helpful in setting related regulatory protocols. The basic concepts and tenets necessary for application to the waste field need to be identified. Critical among these is the need to understand the processes that result in significant risks and procedures for specifying these risks and their attendant uncertainties. This requires a minimum level of information and/or knowledge of the processes and related phenomena for the application of the RIPB methodology. Criteria for recognizing this minimum level need to be developed through sensitivity studies and other PRA procedures.

We believe that the development of RIPB regulations at the NRC is especially timely in the waste management area because of, for example, impending decisions regarding new standards and regulations for the proposed HLW repository at Yucca Mountain and the possible regulation of DOE nuclear waste facilities. The extensive experience of the NRC in performance assessment in regard to both low- and high-level waste management should be especially useful in this regard. In terms of options, we encourage an aggressive move toward RIPB regulation, that is, Option 3. However, we note that critical regulatory decisions are needed in the near term in the waste field, so a truly proactive stance is needed to capitalize on the opportunities of RIPB. In addition, we support Option 2; that is, we believe it is necessary to justify the application of RIPB protocols in terms of benefits to public health and safety.

DSI-22: Research

Throughout its history the ACNW has maintained a strong interest in the research of the NRC and has continued to monitor both the low- and high-level waste programs of the agency. Although we have provided critical reviews of the programs, generally we have been supportive of this research as it contributes to the effectiveness of NRC's regulatory

responsibilities. Thus, we are pleased to support the research program in the strategic planning of the Commission. In the waste management area, we see cause for a more aggressive approach to research, but planning should be focused on specific topics. We support our colleagues from the Advisory Committee on Reactor Safeguards in their letter to you of November 19, 1996, in regard to the need for research to support NRC's transition to risk-informed, performance-based regulation.

NRC is a knowledge-driven organization requiring new and confirmatory information to carry out its mission. Thus, confirmatory research is critical to its role. We see no need for NRC to maintain a basic research program that acquires new fundamental information, for example research supported by the National Science Foundation. Thus, we question the role of exploratory research in general, rather we would encourage the use of anticipatory research wherein topics are identified for potential future use by the NRC that require a somewhat longer time to research and evaluate than the shorter term applied or confirmatory research. In addition to these general statements and concerns, we raise the following points and observations regarding the DSI:

- (1) The DSI does not resolve the issue of who should perform NRC research. There are three possibilities: staff at NRC headquarters, contractors at the Center for Nuclear Waste Regulatory Analysis (CNWRA); and researchers at Universities and research centers. We believe that a strong research program at NRC headquarters is inappropriate. However, a relatively small cadre of staff with special expertise in selected core technical areas should be maintained to serve as technical consultants, mentors, and tutors to the staff. These staff will likely have strong research experience in their background, but not necessarily currently involved directly in anticipatory or confirmatory research. The research performed at the CNWRA has been responsive to the needs of NRC's HLW program and has been done efficiently. We think that the NRC should continue to support the work at CNWRA. Finally, we encourage university-based research as an integral component of the NRC research program. The Educational Grant Program, with an increase in maximum funding level to \$100,000/yr, will not only make available to the Commission expertise and facilities that are unavailable internally, but will aid in the support and encouragement of students who form the future cadre for the protection of public health and safety from nuclear waste.
- (2) The implication of the DSI is that there is a direct linkage between current NRC licensing activities and the quantity of research that is needed. The lack of current LLW licensing within the NRC is cited as an example. This view requires reconsideration. Although it may be defensible from a short-term budget standpoint, such a policy is based on the erroneous assumption that research can be easily started up. Further, in the case of LLW, although the NRC has no licensing actions on the immediate horizon, the Agreement States do face near-term licensing. Agreement States have neither the broad role of the NRC nor the resources to conduct research and thus depend on the NRC for LLW research.

- (3) The ACNW generally has continued to support participation in international research programs related to nuclear waste. The potential benefits far outweigh the cost.

Thus, we support Option 7, that is, continuing to actively participate in international safety programs.

- (4) There is a need for greater discipline within the NRC regarding the selection of research topics in nuclear waste. A principal goal of research should be to provide the understanding of the phenomena and processes that lead to risk to public health and safety and the Nation's environment, quantification of this risk under applicable source and site conditions, and definition of attendant uncertainties. Topics should be selected for research programs accordingly. There are two general classes of research topics at the NRC: (1) research pertinent to licensing considerations of a particular facility (e.g., site characterization, inventory and its chemistry, corrosion of engineered barriers, and waste containers) and (2) research topics pertinent to the development of regulations, including generic topics such as health effects of low levels of radiation, biotransport of radioactive elements, food chain studies, and role of colloids. We believe there are many current research needs at the NRC that can readily be identified. Considerable confirmatory research is needed to ensure that license applicant's results are viable and sound. Emphasis should be placed on research in potentially risk-sensitive and controversial areas. The Commission in its strategic planning should provide guidelines for the selection of research topics based on the above discussion.

In conclusion, we believe an aggressive research program is needed to fulfill the responsibilities of the NRC to the nation. However, it is not clear that a basic research program is a requirement. Rather, a focused approach to research is needed, within guidelines established by the Commission that involves both short- and long-term programs and deals both with immediate licensing agendas and generic problems that contribute to the NRC's transition to risk-informed, performance-based regulation.

Conclusion

In conclusion, we have presented general comments on the Phase II NRC document, "Strategic Assessment and Rebaselining Initiative - Stakeholder Involvement Process Papers," of September 16, 1996, and specific comments on seven DSIs detailed in the Phase II document. These seven DSIs are related to regulating the handling, storage, and disposal of nuclear waste and as such fall within the purview of the ACNW.

We present numerous positive comments related to the rebaselining efforts and options submitted to the Commission in regard to nuclear waste issues. We find that discussions of several of the DSIs and the identified in the DSI papers do not provide, in our view, a comprehensive range of opinions or options. Our discussions attempt to fill these voids and suggest courses of action for the Commission to take in its rebaselining efforts. Clearly, our

discussions covering this broad range of topics do not comprehensively treat all the issues or arguments. We will be pleased to provide more exhaustive discussions of any of the topics upon your direction.

Thank you for the opportunity to contribute to this important process in the strategic planning for the future role of the NRC.

Sincerely,

A handwritten signature in cursive script, reading "Paul W. Pomeroy". The signature is fluid and stylized, with a large loop at the end of the last name.

Paul W. Pomeroy
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

February 11, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

**SUBJECT: TIME OF COMPLIANCE FOR LOW-LEVEL NUCLEAR WASTE
DISPOSAL FACILITIES**

In this letter, we communicate the observations and recommendations of the Advisory Committee on Nuclear Waste (ACNW) on the time span for compliance of low-level waste (LLW) disposal sites. This letter complements our letter of June 7, 1996, on "Time Span for Compliance of the Proposed High-Level Waste Repository at Yucca Mountain, Nevada," in which we proposed a set of general principles for establishing the time span for compliance of nuclear waste facilities. Building on these principles, we recommend a two-part approach to establishing the time frame for LLW compliance. The first part utilizes a site-specific time span based on an analysis to determine the time at which release and transport of the more mobile radionuclides produce a peak dose to the critical population group. The second part is a qualitative evaluation, not requiring a specific measure of compliance, which is used to identify any significant deficiencies in the performance of the disposal system.

Our observations and recommendations are derived from a working group meeting on "Regulatory Time of Compliance for Radioactive Waste Disposal" held during the 82nd meeting of the ACNW on March 27, 1996, at which the time of compliance for both high- and low-level waste facilities was discussed; a presentation by the Office of Environmental Policy and Assistance in the Office of the Environment, Safety, and Health of the U.S. Department of Energy (DOE) at the 84th meeting of the ACNW on June 27, 1996; and remarks made at both the 84th and 85th meetings of the ACNW on June 27 and August 22, 1996, respectively, by officials of several States involved in developing LLW facilities.

The Problem

Performance assessment provides useful information on how an LLW facility may perform over a period of time. Thus, performance assessment is an important tool for demonstrating LLW regulatory compliance as specified in Part 61 of Title 10 of the Code of Federal Regulations (10 CFR Part 61) and related guidance of the U.S. Nuclear Regulatory

Commission (NRC). A critical element of a performance assessment is the length of time over which the calculated dose should be compared to the specified standard or regulation. This is the time span of compliance. The current NRC regulation for LLW disposal facilities (10 CFR Part 61) does not specify this time span. The rule is concerned with minimum times of analyses. For example, 10 CFR 61.7(a)(2) states, "In choosing a disposal site, characteristics should be considered in terms of the indefinite future and evaluated for at least a 500-year time frame." This statement is, in part, the origin of the misconception that 10 CFR Part 61 is a "500-year rule," which only requires a demonstration of compliance for this time period. A time specification of 10,000 years is included in the draft Branch Technical Position (BTP) on Low-Level Waste Performance Assessment and was included in the Draft Environmental Impact Statement (DEIS) for 10 CFR Part 61 (NUREG-0782). However, the Final Environmental Impact Statement (FEIS) for 10 CFR Part 61 (NUREG-0945) does not include a compliance period.

The DOE is preparing radiation protection requirements for the public from its near-surface disposal of LLW and residual radioactivity in soil. DOE officials have informed us that they intend to promulgate regulations (10 CFR Part 834) in the near future. The DOE Format and Content Guide and Standard Review Plan for DOE Low-Level Waste Disposal Facility Performance Assessments specifies a time of compliance of 1,000 years. This decision is not based on a scientific or technical rationale but rather is believed to be consistent with the intergenerational equity principle. This principle states that no generation should needlessly deprive its successors of the opportunity to enjoy a quality of life equivalent to its own and is an often-cited benchmark in establishing policy on time of compliance. In developing guidance on time of compliance, DOE points out that dose analyses beyond 1,000 years could be used in evaluation of facility alternatives, but that these results should be used with caution because of the potential uncertainties. This two-part approach to time of compliance using a shorter, quantitative evaluation followed by a longer, qualitative consideration is widely employed in other national and international regulations and guidance.

The ACNW has a long-standing interest in the development of guidance by the NRC for LLW performance assessment, as evidenced in numerous discussions with the Division of Waste Management, Office of Nuclear Material Safety and Safeguards, and several letters over the past half decade to the Chairman of the Commission. The time frame for performance assessment has been of special concern. In our letter of June 3, 1994 (Appendix A), we pointed out the need for a specified time of compliance in the LLW regulations. Later, in a letter to the Chairman of the Commission on regulatory policy issues in LLW performance assessment dated June 28, 1995 (Appendix B), the Committee again suggested the need for a maximum time frame for analyzing the safety of an LLW disposal site. The Committee pointed out that much larger quantities of long-lived radionuclides are being disposed of as LLW than was anticipated in the DEIS/FEIS, resulting in the potential for peak dose times in excess of 10,000 years. A letter received by the Committee from James M. Taylor, Executive Director for Operations, dated May 17, 1996 (Appendix C), confirms the staff's continuing interest in this topic. Subsequently, a

working group on regulatory time of compliance and deliberations and discussions led to our letter of June 7, 1996, in which we outlined a set of principles for establishing a regulatory time of compliance for the proposed high-level waste repository at Yucca Mountain.

Considerations Regarding LLW Disposal Time of Compliance

We seek to devise a rational basis for selecting a time of compliance that relates the characteristics of a disposal site and its impact on public health and safety. The principles stated in our letter of June 7, 1996 (Appendix D) provide a rational approach for establishing a time span of compliance. The period of time must be short enough so that meaningful evaluations can be made without excessive uncertainty, but long enough to permit the evaluation of processes that may lead to the loss of integrity of the facility and transport of the radionuclides to the critical group. These principles need to be sufficiently generic so that they can be applied to a variety of LLW disposal facilities.

The regulatory principles involve a two-part approach. In the first part, the time of compliance should be established by the estimated time at which transport of the more mobile radionuclides produce a peak dose to the critical group. This time estimate is based on a systems analysis using data from site characterization, modeling, analogs, and experimental studies. The specified time of compliance is not a direct measure of the facility's performance, but defines the span of time over which the performance of the facility is assessed by comparing the calculated dose with the standard. This definition leads to an apparent paradox in that a disposal facility with superior containment qualities has a longer time of compliance than a site of lesser quality. However, in the proposed methodology, the time of compliance is not a measure of safety, but is the time at which the calculated dose from the facility must meet the standard. The goal is not to set a specific time that would be enforced like the dose standard. On the contrary, the objective is to allow the regulator to evaluate the dose versus time relationship from the site-specific performance assessment calculations that will serve as a benchmark of facility performance and an indicator of long-term safety. The specified time of compliance may be of such a long duration that the procedure could lead to the calculated doses having unacceptably large uncertainties. In this case, a time of compliance shorter than that calculated on the basis of transport should be specified using the time history of the source term hazard as a criterion.

The second part of our proposed regulatory approach generally pertains to facilities for which the highest dose occurs as a result of less mobile radionuclides. These instances require calculation of a point estimate of the dose to the critical group at the time of overall peak dose, which is compared with the standard. The latter comparison should be only qualitative because of the anticipated long periods required to reach the peak dose and the attendant uncertainties in both the time period and dose. This calculation permits the identification of important performance factors that define risk to the critical group. Ameliorating actions such as modification of the source term or waste form may be needed to minimize the difference between the calculated dose and the standard. We believe, as

stated in our letter of June 7, 1996, that this latter comparison should not become a *de facto* regulation because of the potential for large uncertainties in the assessment of performance and risk. In addition, as stated in our previous communication on time of compliance, the specified time is strongly influenced by assumptions about the reference biosphere and the critical group. As such, the procedures for identifying and documenting the assumptions for a specific facility are an integral part of the regulations and guidance.

Several significant features that are unique to the LLW program should be recognized.

- Surface and near-surface LLW facilities are subject to deleterious surficial processes such as erosion and flooding. Rates of surficial processes may be altered by climatic change. Such considerations should be factored into the performance assessment.
- In many areas of the Nation, LLW facility sites could be located within a few tens of meters of the saturated zone, resulting in relatively short periods for water to move from the surface through the facility and through the unsaturated zone to the water table. This situation, coupled with the possibility of a limited distance to the critical group from the disposal site in many regions of the United States, may lead to relatively short times of compliance when the waste containers and engineered barriers of the facility fail.
- The concrete vault disposal system proposed in some LLW facilities may delay releases for long periods, but the time period over which the concrete is able to withstand degradation is not well established.
- The potential for significant quantities of certain long-lived radionuclides, such as uranium in near-surface LLW sites, is greater than was anticipated in the DEIS for 10 CFR Part 61. The result is that peak doses may not occur until a long period of time has passed, perhaps tens or hundreds of thousands of years. In addition, the risk from some decay products may be higher than that of the parent. If the calculated doses at very long periods exceed the standard by significant factors, the LLW disposal system may require modification.

Recommendations for an LLW Disposal Time of Compliance

On the basis of the regulatory principles and observations discussed above, the ACNW recommends that the LLW disposal regulations or guidance include a generic, two-part approach to the time of compliance used in assessing the capability of an LLW site to protect the public health and safety. This approach will lead to different compliance times, depending on the waste, the facility, the associated geosphere, the specified reference biosphere, and the critical group.

- The first part of the approach requires compliance with the numerical standard over a specified period of time. This time span should be no shorter than an estimate of

the anticipated time it takes for the more mobile radionuclides to produce a peak dose to the critical group and no longer than a time period over which scientific extrapolations can be convincingly made. This time period should be determined on the basis of site-specific characteristics of the entire disposal system using modeling, analog studies, and results from laboratory and *in situ* experiments. If the disposal system fails to meet the standard during the specified time period, ameliorating actions should be required or the site should be rejected.

- The time period of compliance must be defined in concert with the reference biosphere and the critical group. Thus, the regulations also must include requirements and guidance for defining the latter on a facility-specific basis using known site characteristics and effects of long-term processes that are technically supported.
- In certain cases, the calculated time of compliance should be replaced with a maximum time of compliance such that uncertainties in performance assessment can be reasonably bounded.
- The second part of the compliance regulation is designed to be used in evaluation of the robustness of the facility over the range of external processes and events that may affect the performance of the facility over long time periods. This evaluation also will ensure that no significant changes in the dose from the disposal site will occur in the near term after the calculated time of compliance. Estimates of the peak dose from the facility beyond the time of compliance are qualitatively compared with the dose standard. This part should not become a *de facto* regulation.

Summary

The ACNW recommends implementation of regulations that will establish procedures and guidelines for setting the regulatory time of compliance for LLW disposal facilities. The recommendation proposes a two-part approach that is based on generic regulatory principles modified for LLW. This approach is supportive of the two-part program being discussed by the NRC staff and views held by a variety of national and international regulatory agencies.

We believe that our recommendations can be used to shape a robust and defensible regulation.

Sincerely,

A handwritten signature in dark ink, appearing to read "Paul W. Pomeroy", with a stylized, flowing script.

Paul W. Pomeroy
Chairman

Appendix A

Excerpt from ACNW letter to Chairman Selin, dated June 3, 1994, entitled "Review of the Low-Level Radioactive Waste Performance Assessment Program," Item B.6 concerning time of compliance.

B. Branch Technical Position

6. The Committee believes that there is significant uncertainty about the required time frame for PA. The presently used arbitrary numerical values (e.g., 10,000y) lack bases in either standards or regulations. The Committee recommends that, as a minimum, the time frame for site-specific PA should be guided by the dose-time profile as depicted in the draft BTP and used in conjunction with an explicit upper time limit. The NRC staff is urged to develop a position on the appropriate time frame and submit it to the Commission for discussion, review, and approval.

Appendix B

Excerpt from ACNW letter to Chairman Selin, dated June 28, 1995, entitled "Regulatory Issues in Low-Level Radioactive Waste Performance Assessment."

TIME FRAME FOR PERFORMANCE ASSESSMENT

The Committee believes there is merit in choosing a generic maximum time frame for analyzing the safety of an LLW facility. We do caution the staff against letting time-frame limits detract from focus on the actual performance of a site-specific LLW facility.

One important attribute of the LLW field is the variability in the radionuclide content of LLW. For example, much larger quantities of long-lived radionuclides are being disposed of as low-level waste than was previously anticipated. The result is that at some sites, peak doses will occur at times longer than 10,000 years. We believe the application of peak dose calculations to be an important issue and plan to report to you on this subject after a timely review of this topic. Again, the Committee urges the principle of completeness by assessing first the safety of a specific facility and then being satisfied that it is in compliance with the regulations. Nevertheless, the BTP should identify a time period such as 10,000 years for which performance

assessment of an LLW site should be completed and beyond which such analyses should not be required.

Appendix C

Excerpt from enclosure to letter of May 17, 1996, entitled "Regulatory Issues in Low-Level Waste Disposal Performance Assessment," from James M. Taylor, Executive Director for Operations, to the ACNW.

Regulatory Issue 3. - Timeframe for PA

The staff appreciates ACNW's support on the selection of a 10,000-year generic maximum timeframe for analyzing the safety of an LLW facility. The staff shares ACNW's concern that a generic timeframe should not distract from assessing actual facility performance in cases where large amounts of long-lived radionuclides are being disposed of. In particular, the staff is concerned about the appropriateness of disposing of very large quantities of uranium at near-surface LLW disposal facilities and believes that further discussions on uranium disposal are needed with U.S. Department of Energy and U.S. Environmental Protection Agency staff.

Appendix D

Excerpt from ACNW letter to Chairman Jackson, dated June 7, 1996, entitled "Time Span For Compliance of the Proposed High-Level Waste Repository at Yucca Mountain, Nevada."

Regulatory Principles for Establishing the Time Span for Compliance

On the basis of the preceding considerations, the ACNW recommends that a two-part approach to definition of the compliance period be established for nuclear waste facilities. The first part involves the following three elements:

- (1) The time period for compliance should be based on the estimated time for release and transport of the radionuclide contaminants to reach the critical group. This time estimate should be based on geologic, geochemical, and hydrologic characterization of the site and its environs, as well as regional study of geologic processes and their potential effects on the site, and total systems performance assessment. This estimate must confirm the ability of the repository system to retain radionuclides for a minimum of several thousand years. The selection of the time of compliance must be evaluated along with the specification of the reference biosphere and critical group.

- (2) The reference biosphere and the lifestyles of the critical group should be defined on the premise that no major changes will occur in society that will significantly affect their lifestyles as they relate to risk from the repository and that the climate can be reasonably bounded. The minimum distance from the boundary of the repository to the critical group will be a major decision.
- (3) The compliance time should be sufficiently short such that extrapolations of significant processes and their rates can be made robustly with reasonably modest uncertainties.

The second part of the compliance period regulations should be based on assessments extending from the specific compliance period to the calculated time of the peak risk to the critical group. There is no definitive measure of compliance in the sense of a numeric match between a standard and the calculated peak risk, and this second part should not be allowed to become a de facto regulation. A comparison between the standard used in the first part and the calculated peak risk should lead to identification of important performance factors that define risk to the critical group. Depending upon the extent to which the peak risk exceeds the standard, ameliorating actions to reduce this difference should be initiated, such as increasing the integrity of the engineered barriers, improving site characterization to more closely bound uncertainties, or, in the extreme, abandoning the candidate site.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

February 13, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

**SUBJECT: COMMENTS ON FLOW AND RADIONUCLIDE TRANSPORT AT
YUCCA MOUNTAIN**

Evaluation of the strategy for dealing with disposal of high-level radioactive wastes will require a license applicant to demonstrate convincingly that a site has hydrogeological characteristics that are appropriate for mitigating releases of radionuclides to the biosphere. Consequently, the Advisory Committee on Nuclear Waste (ACNW) continues to hold as a high priority the evaluation of NRC Key Technical Issues that relate to flow of water and the transport of radionuclides at Yucca Mountain. The ACNW held a working group on flow and radionuclide transport on September 26, 1996. The Committee heard from representatives of the Los Alamos National Laboratory, the Lawrence Livermore National Laboratory, the Lawrence Berkeley Laboratory, the Electric Power Research Institute, the Department of Energy (DOE) Yucca Mountain Project Office, and the University of Arizona.

Following the presentations at the working group, and on the basis of other experience as well, the ACNW has several recommendations that reflect our continuing interest in the important issue of transport of radionuclides at the site.

- Because of the importance of radionuclide transport and the effects of sorptive processes on radionuclide concentrations in groundwater, as recognized in the DOE Waste Containment and Isolation Strategy, the NRC should maintain a critical level of expertise within its staff and at the Center for Nuclear Waste Regulatory Analyses (CNWRA) related to flow and radionuclide transport.
- The NRC staff should examine available information from DOE to ensure that the abstraction from detailed models to the total system performance assessment (TSPA) models are valid and transparent and that the details of individual models are clear. As part of this examination, the NRC should

follow closely the appropriate DOE expert elicitations and TSPA abstraction workshops.

- It is not clear that DOE is developing a comprehensive chemistry model for the site for analyzing transport processes. Accordingly, the staff should ensure that the CNWRA continues to develop coupled chemical and hydrologic transport models to determine whether these coupled processes are important to demonstrating compliance with a risk- (or dose-) based standard. As part of this model development, the staff should continue to support the work at the CNWRA to determine the potential importance of "foreign" materials (such as concrete and steel) in the performance of the repository.
- The Apache Leap Research Site (ALRS) could be used as a location to collect important data on colloid migration through a fractured unsaturated tuff. The NRC should consider supporting work to observe naturally occurring colloids and possibly to introduce colloidal "tracers" at the ALRS to generate data useful for bounding calculations at Yucca Mountain.

DETAILED COMMENTS

Total System Performance Assessment Issues

Radionuclide transport by subsurface water at the Yucca Mountain site is thought to be the most significant pathway in terms of risk to the critical group. The evaluation of risk will be accomplished through TSPA. It is necessary to establish the important processes and mechanisms for retaining and retarding the release and transport of radionuclides from the repository. These processes attenuate radionuclide concentrations in the ground water and thus reduce the calculated dose to a member of the critical group. To be effective in evaluating of the expected license application for Yucca Mountain, the NRC staff will have to be able to understand and critically evaluate the work of DOE and its contractors on transport phenomena. The ACNW is concerned that the NRC staff had to eliminate radionuclide transport work at the CNWRA. The issue remains critical to assessment of the repository, and we encourage reinstatement of CNWRA activities in this area.

An evaluation of the Yucca Mountain site with respect to standards will require the framework of a risk assessment. The ACNW is not convinced that the DOE program is strongly integrated. We are concerned that the transition from models developed in somewhat isolated "science" programs of DOE contractors to those required for practical, "engineering" system-level performance assessment may be opaque. It is essential that the NRC staff fully understand the abstraction process. Currently, DOE is planning and conducting a series of expert elicitations related to the performance assessment resource

base. The NRC staff needs to continue evaluating these activities, as well as the DOE abstraction workshops.

Flow and Transport in the Vadose Zone and the Saturated Zone

Samples recovered from the Yucca Mountain Exploratory Studies Facility (ESF) show apparent "bomb-pulse" ^{36}Cl on or near some faults that are mapped at the surface¹. The isotopic data, which provide important insights into transport processes, reinforce the notion that an interconnected set of fractures forms a transport pathway for radionuclides at Yucca Mountain. DOE models for flow and transport in the vadose zone must employ flow along faults and fractures and diffusion from the fractures into the matrix as important processes. There appears to be a paucity of critical information on hydrological characteristics of fractures and faults and their impact on the transport of radionuclides.

Models for the vadose zone employed by DOE necessarily rely on integrated average values of percolation fluxes of water through the repository horizon. The generally accepted average flux values have crept upward over the past years, covering a range between 1 and 20 mm/yr. In the saturated zone, models use "dual continuum" methods to approximate flow in fractures and diffusion into the surrounding rock matrix. The available data related to hydrological characteristics of rocks in the saturated zone may not be adequate to constrain models in a credible way. The NRC and CNWRA staffs need to maintain their efforts in flow and transport modeling in the vadose zone and the saturated zone, and on the use of data to determine parameters in the models, to ensure that they will have the capability to conduct an assessment at the time of license application.

The Role of Chemistry in Evaluating Risk

In February 1995, a group of DOE and contractor scientists prepared a "white paper" outlining the needs for quantifying chemical reactions at Yucca Mountain.² The report notes that "the key performance issue for the Yucca Mountain site is radionuclide transport. Transport, in turn, consists of the coupling of flow (hydrology) and retardation (geochemistry)." This report describes how chemical studies involving concrete, waste canisters, and other "foreign" materials in the near field are essential ingredients of a program. In such a program, solubility, speciation, and sorption must all be adequately quantified in the near and far fields. We could not determine from material presented to us at the working group the extent to which DOE is taking into account the effect that these "foreign" materials have on reactions and speciation of important nuclides (e.g., Np, Tc, U, Pu, I, and perhaps Se). The chemical state of the repository needs to be evaluated to

¹ Fabryka-Martin, J.T., Dixon, P.R., Levy, S., Liu, B., Turin, H.J., and A.V. Wolfsberg. 1996. Systematic sampling for chlorine-36 in the Exploratory Studies Facility. Draft material presented to the ACNW.

² Simmons, A.M., Nelson, S.T., Cloke, P.L., Crump, T.R., Duffy, C.J., Glassley, W.E., Peterman, Z.E., Siegel, M.D., Stahl, D., Steinkampf, W.C., and B.E. Viani. 1995. The Critical Role of Geochemistry in the Program Approach. Unpublished paper.

determine whether these materials exercise a significant buffering effect on the chemical environment in terms of the calculated consequences.

The role of geochemistry in radionuclide transport has become crucial to demonstrating compliance. The understanding of the hydrologic system at Yucca Mountain has evolved from a model based primarily upon fluid flow through the rock matrix, with very slow transport pathways, to a model that includes, and may be dominated by, fluid flow through an interconnected network of fractures, with relatively fast pathways. What is needed is a comprehensive chemical model for the site. The NRC staff should evaluate DOE's efforts in this area and determine the advisability of DOE's developing a site chemistry model. We are concerned that DOE may be relying too much on laboratory-scale experiments. We urge the NRC staff to investigate the appropriate use of data from intermediate-scale field tests and from natural analogs to build confidence in modeling results.

Colloids and Radionuclide Transport

The transport of colloids through unsaturated rocks is a poorly understood phenomenon. We received no information at our working group to counter the 1995 conclusion of Manaktala, et al³: "Based on reports in the available literature, it may be possible for colloids to form in the Yucca Mountain environment, but the extent to which they could contribute to overall radionuclide transport remains unclear." We do not know whether colloid migration could be an important consideration in either enhancing or inhibiting radionuclide transport at Yucca Mountain. We believe that it is important to deal with the colloid issue in a direct fashion. The importance of colloid transport may be negligible, but an initiative must be taken to assess whether this is true.

The ALRS is in a fractured tuff but has an annual rainfall of more than twice that at Yucca Mountain. In a sense, the ALRS is an "analog" for Yucca Mountain under pluvial conditions, which are anticipated to occur within the time frame of a few tens of thousands of years. Because the ALRS is wetter than Yucca Mountain, it should be possible to collect water samples of flow through fractures in the vadose zone and determine colloid concentrations. Because there is a known connection along a fracture to a surface expression in a stream channel, it should also be possible to introduce colloidal "tracers" at the surface and monitor samples at depth to quantify transport. Data from the ALRS should prove to be very valuable in performing bounding calculations for Yucca Mountain that may resolve the colloid issue.

³ Manaktala, H., Turner, D., Ahn, T., Colten-Bradley, V., and E. Bonano. 1995. Potential Implications of Colloids on the Long-Term Performance of a High-Level Radioactive Waste Repository, CNWRA 95-015.

We trust that our comments and suggestions will be helpful in assessing the potential risks associated with the proposed high-level waste repository at Yucca Mountain.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul W. Pomeroy". The signature is fluid and cursive, with a large initial "P" and a long, sweeping underline.

Paul W. Pomeroy,
Chairman

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

April 3, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

SUBJECT: REFERENCE BIOSPHERE AND CRITICAL GROUP ISSUES AND THEIR
APPLICATION TO THE PROPOSED HIGH-LEVEL WASTE REPOSITORY AT
YUCCA MOUNTAIN, NEVADA

The purpose of this letter is to convey the observations and recommendations of the Advisory Committee on Nuclear Waste (ACNW) regarding the issues associated with defining the reference biosphere and the critical group in site-specific regulations for the proposed high-level waste (HLW) repository at Yucca Mountain. This letter supplements the ACNW letter dated June 7, 1996, subject, "Time Span for Compliance of the Proposed High-Level Waste Repository at Yucca Mountain, Nevada," in which we indicated the dependence of the time of compliance on the specification of the reference biosphere and critical population group. In that letter, the Committee indicated that it would provide additional comments on these topics after review and discussion. We believe this letter is appropriate and timely in view of the Commission's need to respond to the Environmental Protection Agency's (EPA's) efforts to develop a Yucca Mountain specific standard (40 CFR Part 197) and make appropriate modifications to the Nuclear Regulatory Commission's (NRC's) HLW regulations.

Our observations and conclusions are based on discussions during a working group meeting on "Specification of the Critical Group and Reference Biosphere" held during the 84th meeting of the ACNW on June 25, 1996, and presentations on biosphere modeling at the 90th meeting of the ACNW on March 21, 1997. During the working group sessions, both oral and written presentations were made by members of the National Academy of Sciences/National Research Council Panel that authored the report, "Technical Bases for Yucca Mountain Standards," and by representatives of the NRC staff, the EPA, the Department of Energy (DOE), the Electric Power Research Institute, and the State of Nevada.

In this letter we provide definitions and assumptions that generally apply to the issues of the biosphere and critical group, and offer suggestions on how these general considerations and definitions can be applied to the Yucca Mountain site. In the course of providing advice on the treatment of biosphere and critical group issues, as well as all other issues, the Committee has been supportive of the agency's desire to move in the direction of risk-informed, performance-

based regulations and standards. Important attributes of adopting a risk-informed approach are the focus on the health and safety of the public and the quantification of uncertainties.

THE PROBLEM

It is necessary to establish a rational basis for determining the radionuclide exposure scenario(s) for the proposed Yucca Mountain repository. Key to solving this problem is specification of a reference biosphere and a critical group. Specification of a reference biosphere sets the conditions for all pathways by which radionuclides from the repository may reach humans, including movement through the food chain as well as direct ingestion of ground water. Specification of a critical group is required because regulations will likely be based on acceptable doses to this group, a surrogate for the public. This approach is in contrast to the traditional NRC dose-based regulatory approach that considers the maximally exposed individual at a prescribed distance from the facility for determining compliance. Also, because of the long time periods involved and the desire to simplify the performance assessment wherever possible, an appropriate definition of the time of compliance is an important consideration.

The definitions for time of compliance, critical group, and reference biosphere should enable a license applicant to identify clearly the assumptions and calculations used in performance assessment. The specification of these elements should be based as much as possible on scientific and technical evidence. In the absence of such evidence, a decision based on policy will have to be made by the appropriate Government unit on the basis of current conditions and reasonably bounded uncertainties. For example, the specification of the critical group, as well as certain factors of the reference biosphere, will require decisions about appropriate estimates of future human demographics and behavior. The overall objective in defining these terms for Yucca Mountain should be protection of the public health and safety and the environment for future generations, using policies and procedures rooted in available science.

GENERAL DEFINITIONS AND ASSUMPTIONS

The following definitions and assumptions form a basis for providing guidance on the important, interconnected issues of the reference biosphere and the critical group necessary for the performance assessment of a geologic repository for radioactive waste.

1. The reference biosphere is the environment (biologic, geologic, hydrologic, and atmospheric) in the vicinity of the repository in which the biota and the critical group may come in contact with radionuclides. The biosphere defines the portion of the environment in which radionuclides can reach human populations. Exposure pathways in the biosphere include ground water, surface water, soils, plants, animals, and air.
2. The critical group is a relatively homogeneous group of people whose location in the general vicinity of the repository and whose habits are such that they include individuals expected to receive the highest doses from radionuclides discharged from the repository. Estimates of exposures to the critical group may be extended to risk through the appropriate dose-response relationship.

3. The biosphere and the critical group should be based on known site characteristics. Site characteristics include the geologic and climatic setting, engineered safety features, and demographics. The policy set forth in the standard and regulations must allow site-specific characteristics to be considered; that is, they must not be overly prescriptive in a generic sense.
4. The societal state of the region around the repository cannot be predicted with confidence for thousands of years into the future. Large uncertainties exist in the description of the societal states. Decisions regarding demographics, human behavior, and land use thousands of years into the future should be a matter of policy derived from available science. A reasonable policy is that the current societal state in the vicinity of a site will be the basis for analyzing the expected safety of the public unless there is scientific evidence to indicate that other climatic, demographic, or biological conditions are more appropriate.

These four definitions and assumptions are believed to be a reasonable foundation for addressing the issues of biospheres and critical groups for any nuclear waste repository. We now apply these definitions and assumptions to the proposed Yucca Mountain repository and the surrounding area with respect to the specific issues of the biosphere and the critical group.

APPLICATION OF THE REFERENCE BIOSPHERE AND THE CRITICAL GROUP TO THE PROPOSED YUCCA MOUNTAIN REPOSITORY

Reference Biosphere

The description of the biosphere is an important element of defining repository exposure scenarios for calculating public health risk. The primary source of risk is likely to be the ingestion of food and water. Site-specific attributes are critical to the description of transport pathways that lead to calculated exposures of the critical group. Thus, site characterization is a key source of information for describing the reference biosphere.

Future changes in the biosphere that can be reasonably characterized should be considered in this definition. For example, climatic components of the reference biosphere will change with time. Paleoclimatic and paleohydrologic studies of the Quaternary Period, and especially the Holocene, indicate (and can provide bounds on) climate change to a cooler, wetter regime associated with the onset of the next glacial cycle. The anticipated changes in climate over time can be used to refine the reference biosphere when supported by scientific evidence. For example, a potential rise in the water table as a result of a cooler, wetter climate could make ground water more accessible in the currently arid regions in the vicinity of Yucca Mountain. Should evidence to the contrary arise as a result of site characterization studies, that too should be part of the input to the definition of the reference biosphere.

Critical Group

As indicated in definition 2 above, the critical group is a relatively homogeneous group of people whose location and habits are such that they are representative of those individuals expected to receive the highest doses as a result of the discharge of radionuclides. The suggested policy

assumption of item 4 above leads to the definition of the critical group. For example, the density, distribution, and habits of the population in the Amargosa Valley could be the basis for defining the critical group. Although the definition of a Yucca Mountain specific critical group will likely be decided on the basis of policy, the need remains to develop a repository performance assessment model that is convincing, clear, and justifiable.

The purpose of this letter is not to prescribe a calculation procedure but to identify some principles that the Committee believes should guide the critical group risk calculations for the proposed Yucca Mountain site. These principles are as follows:

1. The principle of consistency should be applied in the use of probabilistic methods. The "principle of consistency" as used here is the consistent application of probabilistic methods to different aspects of the Yucca Mountain repository performance assessment, including waste container degradation, radionuclide transport, and the human exposure scenario.
2. The critical group should include those individuals who are at greatest risk.
3. The group should be relatively homogeneous in terms of the exposure of its individuals to radiation.
4. Even if the regulation prescribes a maximum acceptable dose to only the critical group, risk-based calculations should be performed that clearly display the probability and health effects to the public in the vicinity of the repository.

Calculations of the type specified in item 4 above are consistent with the adoption of a risk-informed approach to regulation. In particular, it is important to understand how the risk is distributed. Thus, calculations that indicate the likelihood that "N" or more people will receive "D" or more dose will provide a meaningful indication of the risk to the entire population being studied. Such calculations can be especially constructive in revealing site peculiarities that may result in highly localized doses. Furthermore, the results may reveal interdiction options that could turn an otherwise questionable site into an acceptable one at a fraction of the resources that might be required to consider an alternate site.

The Committee believes that the definitions, assumptions, and principles outlined herein provide a basis for the NRC staff to develop guidance on the licensing of the proposed Yucca Mountain HLW repository. We wish to emphasize an important message in this letter. Even though a policy solution is required for some of the issues associated with the Yucca Mountain site, the Committee believes that scientific evidence should prevail when it exists. For example, both the regulations and the staff should encourage the DOE to consider temporal changes, such as climate, and to utilize those changes that can be scientifically supported.

SUMMARY

Specification of the reference biosphere and the critical group is an important element in the regulation of nuclear waste disposal facilities. The ACNW proposes a set of definitions and assumptions to guide the specification of the biosphere and the critical group. For the proposed

Yucca Mountain repository, we recommend using the results of the site characterization program as the principal basis for defining the reference biosphere, the environment through which the critical group may be exposed to radionuclides. The Committee believes that specification of the critical group, a small relatively homogeneous assembly of the most highly exposed people that serve as a surrogate for the public, requires the establishment of policy. The policy suggested is that the reference biosphere and the critical group could be based on present conditions in the Amargosa Valley unless a scientific basis can be given for using other assumptions.

We believe that our proposed approach can result in a robust and defensible set of regulations.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul W. Pomeroy", with a stylized, sweeping flourish at the end.

Paul W. Pomeroy
Chairman

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