ACNW-0130A

MINUTES OF THE MEETING
ACRS/ACNW JOINT WORKING GROUP
MAY 11, 1999

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RS02

CERTIFIED

By
B. John Garrick - 7/15/99
and
Thomas S. Kress - 7/16/99

Issue Date: July 8, 1999

MINUTES OF THE MEETING OF THE
ACRS/ACNW JOINT WORKING GROUP
MAY 11, 1999
ROCKVILLE, MARYLAND

The U. S. Nuclear Regulatory Commission (NRC) Joint Working Group of the Advisory Committee on Reactor Safeguards (ACRS) and the Advisory Committee on Nuclear Waste (ACNW) held its first meeting on May 11, 1999, at Two White Flint North, Room T-2 B 3, 11545 Rockville Pike, Rockville, Maryland. The purpose of this meeting was to provide a forum for attendees to discuss and take appropriate action on the items listed in the agenda (Appendix II). The entire meeting was open to the public.

A transcript of the meeting is available in the NRC's Public Document Room at the Gelman Building, 2120 L Street, NW, Washington, DC 205550001. Copies of the transcript are available for purchase from Ann Riley & Associates, Ltd.,1025 Connecticut Avenue, NW, Suite 1014, Washington, DC 20036. Transcripts are also available for downloading from, or reviewing on, the Internet at http://www.nrc.gov/ACRSACNW.

ATTENDEES

Joint Working Group members who attended this meeting were Dr. B. John Garrick, ACNW, Joint Working Group Co-Chairman, Dr. Thomas S. Kress, ACRS, Joint Working Group Co-Chairman, Dr. George Apostolakis, ACRS and Dr. George Hornberger, ACNW. Dr. Charles Fairhurst, ACNW, and Dr. Raymond Wymer, ACNW, also attended. For a list of other attendees, see Appendix III.

1. Opening Remarks

(Richard Major was the Designated Federal Official for this meeting)

Dr. B. John Garrick convened the meeting at 8:31 a.m. on Mary 11, 1999, and explained that the purpose of the meeting was to discuss the NRC Staff's proposed framework for risk-informed regulation in the Office of Nuclear Material Safety and Safeguards.

2. **PRESENTATION BY THE OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS ON A FRAMEWORK FOR RISK-INFORMED REGULATION**

Dr. Carl Paperiello, Director of the Office of Nuclear Material Safety and Safeguards (NMSS), provided a status summary of risk-informed regulation in NMSS. He stated that, under the Atomic Energy Act, more than 40 different kinds of non-reactor activities, devices and systems are regulated through approximately 20,000 licensees. Most of the regulation of nuclear materials is done through the Agreement States Program, in which

the NRC relinquishes its regulatory authority to Agreement States who establish programs that are adequate and compatible. Exceptions to Agreement State regulation are the disposal of high level waste, greater than Class C wastes, spent fuel storage, transportation, and fuel-cycle facilities. Dr. Apostolakis asked how the adequacy of state regulatory programs was determined and maintained. Dr. Paperiello replied that state programs were reviewed and evaluated by the NRC every two to four years.

Dr. Paperiello noted that the characteristics of nuclear material applications differed significantly from one another. The complexity varies from simple devices using low activity sealed sources to large fuel cycle facilities or the geologic repository for high level waste. Material applications also differ significantly from reactors. Material applications tend to be less complex, have less sophisticated safety systems, and rely more heavily on human actions to assure safety. Dr. Kress asked if certain materials or activities were exempted from regulation. Dr. Paperiello responded there was a list of things exempted from regulation, such as smoke detectors and luminous dial watches.

There was a brief discussion among Drs. Paperiello, Apostolakis and Garrick on terminology. Dr. Paperiello suggested that there should be a distinction between the terms "risk assessment" and "PRA," with PRA being one technique for doing risk assessment. Dr. Apostolakis argued that the term PRA was more general, and referred to a conceptual approach that is applied differently in different circumstances, say

reactors and high level waste repositories. Drs. Garrick and Apostolakis agreed that clarifying the terminology should be one of the early issues for the Joint Working Group.

Dr. Paperiello stated that the Commission has directed NMSS to develop a framework for the use of risk analysis in decision making. He sees the next step in that process as establishing safety goals for material applications. An essential part of such safety goals is defining the population, or "target," to which they would apply. Dr. Paperiello indicated that he was in the process of establishing a group within NMSS to deal with risk assessment.

Dr. Kress suggested that establishing acceptance limits on regulatory objectives would be the first step in developing safety goals for materials applications. He noted that a common metric should be used for all the different applications, and suggested cost/benefit as a candidate. Dr. Apostolakis held that cost/benefit would be inappropriate in certain circumstances, and that acceptance values might be different for voluntary risks than for involuntary risks. He then asked Dr. Paperiello what was driving the move toward risk-informed regulation in the materials area. Dr. Paperiello replied that it was a combination of circumstances, including the direction toward risk-informed regulation taken on the reactor side, and the need for more quantitative risk information in areas such as high level waste disposal. He went on to question why, logically, different levels of risk were tolerated for different activities. Dr. Garrick suggested that there should be some logical relationship between reactor safety goals and safety goals for materials

applications. Dr. Apostolakis pointed out that numerical values are only one aspect of risk, and that risk is multidimensional. Different numerical values may be chosen because of other considerations, such as controllability or the voluntary/involuntary aspect of risk. Dr. Garrick cautioned that attention should be given to the experience with the reactor safety goals so as to avoid the same mistakes. He pointed out that the reactor safety goals themselves have not been implemented, and that instead core damage frequency has come into use. He further noted that a safety goal is a single attribute concept and may not capture all aspects of risk.

Following Dr. Paperiello's presentation, Mr. Seth Coplan presented the framework for risk-informed regulation in NMSS. He noted that his presentation was based on the Commission paper SECY-99-100, which in turn had its origins in the Commission's strategic planning process in 1996 and 1997. One result of the strategic plan development was a Staff Requirements Memorandum from the Commission that, in part, directed the NMSS staff to review materials regulations to identify areas that could be made amenable to risk-informed or performance-based approaches and to develop a framework for using risk technology in materials regulations. Historically, risk assessment applications have been developed within NMSS to address specific problem areas. Examples include performance assessment for high level waste repositories and integrated safety assessments for fuel cycle facilities.

Mr. Coplan explained that the activities regulated by NMSS can be divided into four categories:

- Activities that involve long term commitment of a site or facility to the presence of nuclear material at planned, acceptable levels (e.g., high level waste disposal)

- Activities that involve the use of engineered casks to isolate nuclear material (e.g., transportation and storage)

- Activities that involve chemical or physical processing (e.g., fuel fabrication)

- Activities that involve the use of sealed or unsealed byproduct material in a variety of industrial and medical applications.

He identified the risk assessment methods that have been developed or adapted to these four groups as performance assessment (high level waste disposal), probabilistic risk assessment and integrated safety analysis (transportation and storage), integrated safety analysis (nuclear material processing) and hazard/barrier analysis (use of byproduct material). Dr. Garrick pointed out that a profound difference between materials applications and reactors is that the major risks in materials applications derive from operations, while in reactors the major risks come from accident conditions.

Dr. Garrick questioned whether stakeholders, such as the Agreement States, should have been brought into the process of developing the framework earlier. Mr. Coplan replied that the Agreement States had been offered an opportunity to participate, but they elected to wait until the implementation phase.

Mr. Coplan described the framework for risk-informed regulation of materials applications as being similar to the reactor framework. There are four parts. The first is to identify all areas in NMSS where risk-informed regulation is a possibility. The second is to ensure that considerations underlying current regulations are thoroughly understood, and are only altered after careful consideration. The third is an evaluation of elements that risk considerations could improve. The fourth part is integration of existing deterministic considerations and new risk considerations. The implementation of this framework involves a five step process: (1) identify specific regulatory applications, (2) decide how to modify current regulations, (3) make appropriate changes to regulations and guidance documents, (4) staff training in new regulations and guidance, and (5) develop or adapt needed tools.

Dr. Apostolakis questioned whether the staff was involving other stakeholders, including the Joint Working Group, sufficiently early in the process. Mr. Coplan replied that the model the staff had in mind for its interaction with the Joint Working Group was the same process that was used recently in the development of risk-informed guidance by the reactor regulatory staff and the ACRS.

Dr. Hornberger asked if the staff was confidant that risk-informed considerations would not simply become another layer of regulation on top of existing requirements. Mr. Coplan answered that the guidance in the PRA policy statement included the issue of burden reduction, and that goal should be kept in mind throughout the process. Dr. Garrick suggested that it would be helpful to the Joint Working Group to know the staff's opinion as to what are the top 10 risk issues associated with materials handling.

3. DISCUSSION OF PROCEDURAL MATTERS AND FUTURE ACTIVITIES

Dr. Garrick asked the working group members for their thoughts on how the working group should proceed. Dr. Kress responded that the risk triplet needed to be addressed for all types of material regulation. He suggested that high level principles should be developed to guide review of proposed regulatory changes, and that such principles needed to include risk acceptance criteria and consideration of uncertainties. He further suggested that the common metric on risk acceptance criteria might be risk/benefit, and that uncertainties might be dealt with in some way by defense in depth. Dr. Apostolakis suggested that the staff take the lead in developing the high level principles. Dr. Hornberger noted that some thought needed to be given to how the licensees used risk considerations and how the NRC would relate risk assessments to particular regulations. Dr. Garrick observed that materials applications lacked a common risk focal point, such as core damage frequency in reactor applications. He restated his belief that the Joint

Working Group needed the benefit of the staff's identification of the significant risk issues.

Dr. Apostolakis recommended that the Joint Working Group write a letter to the Commission recommending that the staff develop a set of high level principles. Other recommendations could be to ensure that the language used in the NMSS effort is consistent with the white paper on risk-informed and performance-based regulation, and to identify aspects of risk, such as controllability, that should influence decisions. Dr. Garrick suggested that the letter could provide Joint Working Group comments on SECY-99-100.

The Joint Working Group next turned to discussion of how the group would conduct its business. Dr. Apostolakis explained that the Policies and Procedures Subcommittee of the ACRS had objected to the idea that the Joint Working Group should itself write letters to the Commission. The preferred approach was for the Joint Working Group to decide is a particular issue should be the responsibility of the ACRS, the ACNW or both. The Joint Working Group would then develop a report for consideration by the ACRS, ACNW or both, as appropriate. There was general agreement among working group members that situations requiring the NRC staff to brief the Joint Working Group and both full committees should be avoided. Dr. Apostolakis suggested that he and Dr. Kress report to the ACRS on the Joint Working Group's plan to draft a letter and outline the content so the full committee would be aware of what to expect at the July or September meeting.

At Dr. Garrick's suggestion, the discussion returned to the content of the proposed letter. Dr. Hornberger proposed that the first decision was whether to recommend principles or recommend that the staff think about what the principles should be. Dr. Garrick then summarized the points to be included in the letter as (1) a recommendation that the staff develop high level principles, including an example, (2) comments on SECY-99-100, and (3) some discussion of risk assessment methods with an illustration of the continuity of the methods from one category of risk to another. Dr. Apostolakis suggested adding a point on the need for quantitative objectives or safety goals.

Dr. Kress suggested that Dr. Garrick be designated to draft the letter, and Drs. Apostolakis and Hornberger agreed. Dr. Garrick acceded to this suggestion.

The meeting was then adjourned at 11:43 a.m.

MINUTES OF THE 110TH ACNW MEETING
JUNE 28–30, 1999

ACNW-0131

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APPENDICES

CERTIFIED
BY B. JOHN GARRICK
9/14/99

Issued: 9/08/99

MINUTES OF THE 110th MEETING OF THE ADVISORY COMMITTEE ON NUCLEAR WASTE JUNE 28–30, 1999 SAN ANTONIO, TEXAS

The U.S. Nuclear Regulatory Commission's (NRC's) Advisory Committee on Nuclear Waste (ACNW) held its 110th meeting on June 28–30, 1999, at the Center for Nuclear Waste Regulatory Analyses (CNWRA or Center), Southwest Research Institute (SwRI), 6220 Culebra Road, Building 189, San Antonio, Texas,. Notice of this meeting was published in the *Federal Register* on April 22, 1999, Volume 64, No. 77, pages 19832–19833 (Appendix I). The purpose of this meeting was to provide a forum for attendees to discuss and take appropriate action on the items listed in the agenda (Appendix II). The entire meeting was open to the public.

A transcript of selected portions of the meeting is available in the NRC's Public Document Room at the Gelman Building, 2120 L Street, NW., Washington, DC 20003-1527. Copies of the transcript are available for purchase from Ann Riley & Associates, Ltd., 1025 Connecticut Avenue, NW., Suite 1014, Washington, DC 20036. Transcripts are also available for downloading from, or reviewing on, the Internet <http://www.nrc.gov/ACRSACNW>.

ATTENDEES

ACNW members who attended this meeting include Dr. B. John Garrick, ACNW Chairman, Dr. Charles Fairhurst, Dr. Raymond G. Wymer, and Dr. George M. Hornberger. For a list of other attendees, see Appendix III.

I. CHAIRMAN'S REPORT (OPEN)

[Howard J. Larson was the Designated Federal Official for this part of the meeting.]

Dr. B. John Garrick, Committee Chairman, convened the meeting at 8:30 a.m. and briefly reviewed the schedule for the meeting. He stated that the meeting was being conducted in conformance with the Federal Advisory Committee Act. He asked members of the public who were present and had something to contribute to the meeting to inform the ACNW staff so that time could be allocated for them to make oral statements. He stated that the Committee had received one written statement from Dr. Donald L. Baker, Aquarius Engineering, Fayetteville, Arkansas. He noted the following items he believed were of interest:

- Ms. Cheryl Hawkins, a 1999 graduate in Chemical Engineering from the University of Maryland, Baltimore Campus, has joined the ACNW staff as a summer intern.

- Commissioner Greta Dicus will become "Interim" Chairman of NRC when Chairman Shirley Jackson's term expires on June 30, 1999. Chairman Jackson made the announcement at a periodic "all-hands" meeting with NRC staff on June 15, 1999. The White House confirmed Commissioner Dicus' appointment in a press release and is in the process of selecting a nominee to be Chairman, but has not identified that nominee.

- According to Mr. Virgil Autry of the South Carolina Department of Health and Environmental Control, regulators have recently determined that the potential remaining disposal capacity at the low-level radioactive waste (LLW) disposal facility in Barnwell, South Carolina, is only 3.2 million cubic feet—approximately half that of previous estimates. Mr. Autry also stated that the state reevaluated the unused acreage at the site and determined that approximately 17.4 acres are not suitable for disposal because of shallow ground water levels and other geohydrological conditions. That leaves about 16.6 acres of potentially suitable land, with an estimated disposal capacity of 3,172,010 cubic feet. Assuming an annual disposal rate of 300,000 cubic feet, this capacity will be sufficient for 10 years.

- The State of California will not appeal a court decision against transferring Ward Valley land for an LLW disposal site. Instead, California Governor Gray Davis has asked University of California President Richard Atkinson to chair an advisory group to find alternatives for LLW disposal. The group will have academic, scientific, environmental, and biotechnological experts, and representatives from utilities, State agencies, and the governor's office. In March 1999, a Federal judge refused to order the Department of the Interior to transfer Ward Valley land to the State of California.

- According to the General Accounting Office (GAO), the Department of Energy (DOE) spent 16 years and almost half a billion dollars on a separations technology before deciding the process produced too much benzene to be used safely. The in-tank precipitation process was designed to separate high-level nuclear waste from 34 million gallons of liquids stored in tanks at the Savannah River site in South Carolina. Initially, the facility was to begin operating in 1988. GAO said DOE now estimates an alternative process might not be available until 2007 and could cost $2.3 to $3.5 billion over its lifetime.

- U.S. Ecology's radwaste operations at Oak Ridge received an award for meeting and exceeding Federal water quality standards. The Kentucky-Tennessee Water Environment Association, a group of water quality experts, awarded its "Pretreatment Excellence Award" to the American Ecology subsidiary, which operates LLW processing and recycling centers at the Tennessee site.

- On June 10, 1999, South Carolina Governor Jim Hodges announced the creation of a task force "to examine the final disposition of South Carolina's low-level nuclear waste facilities." Among his comments in making that announcement were the following:

My stated goal would be to get South Carolina out of the business of taking nuclear waste from around the country. I think that that is a policy that is strongly supported across the State of South Carolina. And there's several options that are available.

One would be to go it alone. To tell the other States around the country that South Carolina would take care of its own low-level nuclear waste problem and that other States should do the same.

And another option would be to rejoin a compact—not necessarily the Southeastern Compact, but to rejoin or join a compact of States that we feel more comfortable with.

Now under either scenario, South Carolina would get out of the business of being the Nation's nuclear dumping ground.

II. DEVELOPING THE NRC/CNWRA REVIEW CAPABILITY (OPEN)

[Howard J. Larson was the Designated Federal Official for this part of the meeting.]

Dr. Wesley Patrick, President of the CNRWA, outlined the Center's organization and staffing, its capabilities, and its approach to problem-solving in the NRC program .

He stressed that the focus of the Center is explicitly on the NRC mission, complementing the technical capabilities of the NRC staff. The Center also provides assurance that a long-term continuity in technical assistance and research will exist as well as providing a central capability for integrating technical assistance (TA), research, and independent review activities through the use of state-of-the-art laboratories and the establishment of unique field/analog sites.

After discussing the sources of, as well as the areas of concentration of, expertise within the CNRWA, Dr. Patrick discussed several roles wherein external expertise has been, and will continue to be, obtained. Although there are many possible constraints on the use of external experts, it was stated that the principal constraints are in the area of conflict-of-interest considerations and the ability to adapt to the regulatory culture. Noting that the use of outside expertise was one of the areas commented upon by the ACNW, Dr. Patrick purposefully indicated that currently approximately one-fourth of the work performed by the CNWRA is performed by outside experts—which is double the former utilization percentage for outside experts.

Dr. Patrick discussed the four-pronged approach used by the Center as it progresses from the initial definition of a problem and determining the availability of data to the implementation of a solution. The following are elements of this approach:

1. Systems analysis—This involves the hierarchal decomposition of systems, the functional analysis of components , the relationship of functions to safety, and the analysis of pertinent regulations,

2. Use of laboratory facilities—Among the facilities noted were rock mechanics, geochemistry, hydrology, materials testing for both corrosion and strength and deformability, structural geology and tectonics, and an analog for volcanology. In addition, there are other laboratories at the SwRI that have been made available to the Center, including a hot cell.

3. Numerical computations —The Center has access to the usual suite of computers and workstations as well as some 40 scientific codes (10 of which were developed in house.) In addition, there are several programs (GIS, ARC/INFO, ARC/VIEW, and EarthVision) for geologic data manipulation and visualization. Parallel virtual machine computing software and software for managing data and documents are also available.

4. Field investigations and inspections—There have been geological/geophysical investigations of the basin and range, western United States, Yucca Mountain, Gulf of Mexico, Mekong Delta, Vietnam, and other places. Field-work has been conducted at six analog sites. Among these sites are Santorini in Greece, Paricutin volcano and Pena Blanca in Mexico, and the Tolbachik volcanic field in Siberia. These hands-on efforts have also been supplemented by field and laboratory technical evaluations, quality assurance inspections and audits, site evaluations involving uranium mining, *in situ* leaching, tank waste systems, and waste vitrification facilities.

Dr. Garrick thanked Dr. Patrick for his insights, but noted that he still had difficulty in understanding, from a scientific/technical perspective, the difference between TA activities and those classed as *research*. The answer given was that within the NRC, if the work was site-specific and short-term (1–3 years), it was considered technical assistance.

III. RISK INFORMING THE PLANNING AND PRIORITIZING PROCESS (OPEN)

[Howard J. Larson was the Designated Federal Official for this part of the meeting.]

Mr. C. William Reamer, Branch Chief, NMSS, noted three previous ACNW recommendations, stating that the following presentations would address these recommendations:

1. Performance assessment (PA) should be used in prioritizing key technical issues (KTIs).

2. The NRC research and TA program should adopt a risk-informed, performance- based approach.

3. A formal and transparent process should be developed for identifying the most important areas for research and TA.

Mr. Reamer discussed several factors influencing the establishment of work scope and priority. Among these factors are the apparent lack of relevant failure and risk statistics for an endeavor such as this; the recognition that the geosphere is an integral component of the system, not merely a passive host; and the unusual engineering challenges, namely, the exceptionally long period of performance, the exceptionally large spatial extent, and the high uncertainty in many of the features, events, and processes to be considered for the proposed Yucca Mountain repository. He outlined the general process used in determining priorities and allocating resources.

Mr. Reamer presented in some level of detail the following four-step prioritization process used by the staff:

1. The evaluation of the issues deemed most important to repository performance and the tools used to perform such an evaluation.

2. The prioritization of the 10 KTIs into three groups (high, medium, low) and the criteria considered in that prioritization.

3. Within each KTI, identifying, prioritizing, and revising activities in order to resolve that KTI.

4. The considerations in the assignment of resources.

Mr. Reamer used as an example of how the process works, how efforts related to the Repository Design and Thermal-Mechanical Effects (RDTME) KTI have evolved over

the period from FY1996 to FY2000 with regard to priority assigned, funding, and associated activities.

Mr. Reamer concluded by stating that although the prioritizing process is based on many factors, it must also be capable of responding to a multiplicity of potential changes. He defined his "path forward" as the implementation of a process that will result in finalization of 10 CFR Part 63, a risk- informed rule, the development and use of a risk-informed, performance-based Yucca Mountain Review Plan (YMRP), and the maintenance and use of PA tools.

The Committee questioned members of the staff about how they intended to handle the stated engineering challenges, noting that they were indeed significant. Dr. Timothy McCartin, NMSS, stated (via videoconference) that because the associated uncertainties, the staff's approach must be conservative, without being overly so.

Dr. Garrick commented that although it is true that there is a lack of overall failure/risk statistics, his experience shows that once the issues are decomposed, there are often data at the individual component level.

The YMRP, 10 CFR Part 63, and PA-related issues encompassed by Mr. Reamer's "path forward" have been designated by the ACNW as high priority issues, and as such, will be closely followed by the Committee.

IV. PROGRAM OVERVIEW—PROGRESS TOWARD KEY TECHNICAL ISSUE (KTI) RESOLUTION (OPEN)

[Howard J. Larson was the Designated Federal Official for this part of the meeting.]

Dr. Budhi Sagar, Technical Director, CNWRA, presented an overview of the high-level waste (HLW) program. This session, as well as all other presentations, were interactively tied in through video teleconferencing, with both NRC headquarters in Bethesda and a Department of Energy conference room in Las Vegas.

Dr. Sagar noted, that in addition to addressing the capabilities of the Center, presentations would also address some of the comments related to the Center made by the ACNW in various reports and letters. At the very least, it was intended that the concerns expressed by the Committee, and the Center's approach toward those concerns, be mutually understood.

Dr. Sagar's presentation addressed the following:

1. Key HLW program milestones—The most immediate milestones are the issuance by DOE of the Draft Environmental Impact Statement (DEIS), scheduled for August 1999; the issuance of the YMRP, scheduled for the end

of 1999 or early 2000; and the revised draft of 10 CFR Part 63, scheduled for December 1999.

2. The overall approach to achieving those milestones—The approach consists of five activities: (a) integration of all activities into a repository systems context; (b) maintaining a focus on issue resolution/document closure; (c) prioritization of work around the key technical issues; (d) assurance of consistency among the Yucca Mountain-specific 10 CFR Part 63, the YMRP and the issue resolution status reports (IRSRs); and (e) implementation of the total system PA methodology and total system performance assessment (TPA) code.

3. The strategy for resolving the KTIs—This effort consists of focusing and integrating CNWRA independent work; consideration of all relevant information; frequent interactions with DOE; documentation of issue resolution; and achieving ultimate resolution of issues using the YMRP to evaluate the DOE license application (LA) and preparation of the safety evaluation report.

4. The purpose/role, content, and status of the IRSRs and the status of staff-level resolution of the KTIs—Included in this topic was a discussion of some of the major difficulties in issue resolution.

In regard to this fourth topic, Dr. Garrick asked what the speaker considered to be the principal items of concern from his perspective. Dr. Sagar perceived the following as items of greatest concern:

1. Quality assurance-related issues — He stated that not only must the program plan be adequate, but the implementation of that approved plan in the proper manner is essential.

2. Data collection — The concern was whether DOE had sufficient resources and time to collect and evaluate the data necessary in order for the NRC to make a timely finding of adequate protection of public health and safety. (Although it is recognized that data collection is a continuing process, there is a minimum amount of data required to enable the NRC to make a safety determination.)

3. CNWRA resources — Although the Center is currently fully staffed, there is always a demand for high-caliber technical people. Loss of key staff is always a concern.

After discussing the VA review process, the status of the TPA, and auxiliary codes, and after presenting a draft outline of the Yucca Mountain Review Plan, Dr. Sagar outlined several future activities. These included a review of the DEIS, completion of TPA Version 4.0, development of the preclosure integrated safety analysis, future

work with DOE and other stakeholders on the YMRP, and the development of performance confirmation concepts.

The Committee was particularly interested in these activities and asked both staff and Center representatives about the approach that each intends to take with each of these activities. Among the questions raised were the possible relationship between the PA process and human intrusion, and multiple barriers and the possible impact of design changes upon the natural system.

General Observations — Although the Committee made general observations at the conclusion of the visit to the Center, the following observations were relevant to all presentations:

1. The visit to the Center was extremely productive from the perspective of a detailed, technical information exchange.

2. The face-to-face discussions with the knowledgeable Center technical specialists, coupled with the tour of applicable research facilities, was most beneficial.

3. ACNW members further noted that the interactions possible through the video conference system were indeed constructive. Furthermore, misconceptions on the part of any of the parties involved could be immediately noted and corrected.

The Committee looks forward to further technical interactions with both Center and NRC staff.

V. EVALUATING AND EXPLAINING CONTRIBUTIONS TO RISK (OPEN)

[Andrew C. Campbell was the Designated Federal Official for this part of the meeting.]

Dr. Budhi Sagar introduced the presentations on a variety of methods that the NRC and CNWRA employ in repository PAs to identify parameters and models that contribute the most to risk. He noted that the risk-triplet (What can go wrong? What are the consequences? and How likely is it?) is embedded in the approach. He said that the general methodology that they use to evaluate contributors to risk is sensitivity analysis. Dr. Sagar said that the Center includes uncertainty analyses within this methodology. He added that the post-closure performance measure used in 10 CFR Part 63 will be the expected annual dose over 10,000 years. This would include all credible disruptive scenarios and their associated probabilities. He said that Part 63 explicitly states that parameter uncertainty has to be factored into the estimation of risk. Dr. Sagar briefly discussed the different approaches for understanding the contributions to risk and the rationale for ranking parameters, events, processes, and components and/or subsystems.

Dr. Sagar discussed the analysis tools used to do sensitivity studies. These include an integrated, flexible systems model—the TPA 3.2 code—and detailed process level modeling codes. At the systems level, the Center conducts parameter uncertainty studies using Monte Carlo methods. In addition to evaluating the total system sensitivities, the Center also can obtain results for individual subsystem modules to 16 better understand how the performance of subsystems contributes to overall risk. The Center also conducts deterministic sensitivity studies at the process model level, which provides a basis for the approaches and abstractions used in individual modules of the total system model. He said that the Center uses several different methods to evaluate contributors to risk, including local and global sensitivities. Given the large variety of results, he said that synthesizing the results into an overall understanding of repository performance is an important issue. In the future the CNWRA will develop TPA 4.0 to refine and apply various sensitivity methods and to develop innovative approaches to present results in a clear and transparent manner. Dr. Sagar said that the next three presentations would discuss ranking parameters and integrated subissues, ranking of parameter sets, and ranking of system components.

Dr. Richard Codell, NMSS, discussed system-level sensitivity studies and alternative conceptual models evaluated using the NRC's TPA 3.2 code. He described the basic approach to sensitivity analysis and described different methods used. Dr. Codell presented the results of these studies and described how the different methods of evaluating sensitivities produce somewhat different rankings of variables. He noted that the appearance of a parameter in different rankings provides confidence that it is an important contributor to performance. Dr. Codell also discussed the analysis and results of evaluating alternative conceptual models. Alternative models included different time frames, different assumptions about the waste package (WP) and waste

form, and different assumptions about the geosphere. The results showed the importance of assumptions about waste form dissolution, WP and cladding performance, and wetting models for non-disruptive scenarios. For scenarios involving disruptive events (such as a volcanic intrusion into the repository) assumptions about the number and mode of WP disruptions, and the airborne transport of contaminated volcanic ash becomes important. He described a simple bounding model for evaluating the importance of colloidal transport. Mr. Codell concluded that colloids may not be that important to overall performance. In his summary and conclusions, he noted that none of the alternative models exceeded a 25 mrem dose standard. He also said that the results indicate the direction of future model development and show which integrated subissues require further study. Dr. Codell answered questions from the Committee about differences between the NRC model and the DOE model, assumptions about the number of early package failures due to defects, the timing and magnitude of peak doses, and the differences between sensitivity and importance measures.

Dr. Gordon Wittmeyer, CNWRA, discussed the CNWRA Parameter Tree Method that is being developed to help identify the most important combinations of parameters that affect performance. He discussed the objectives of the approach, including making the PA more transparent. He described approaches for simple analyses and more complicated analysis. The results show that the effect of the unsaturated zone on overall performance was "fairly minimal." He also discussed a similar approach for analyzing the TPA code subsystems. He said that such an analysis could be performed in terms of engineered barrier system release, unsaturated zone release, and saturated zone release. They are working on a computer code to perform any combinations of parameters and subsystem components. Dr. Wittmeyer then provided his summary and conclusions. In the ensuing question-and- answer session, the Committee discussed a variety of issues with Dr. Wittmeyer and other members of the CNWRA and NRC staffs. This included factors accounting for water diversions away from the waste, the significance of the very low doses observed for the 10,000-year analyses, and what they have identified as the most important issues. The staff replied that they have performed these analyses to better understand the model and repository system in order to prepare for review of the license application. The staff also said that longer time frame parameter tree analyses would be performed.

Dr. Norman Eisenberg, NMSS, discussed the importance analysis methodology that the staff has developed to identify the most important parameters to system performance. He discussed the concept and gave an example of the approach. He described objectives of importance analysis and how the analysis is performed. He said that multiple analyses are carried out with and without individual system or subsystem components in each analysis. The resulting performance ratios are ranked to provide an indication of a particular subsystem's importance to risk. He also described normalized importance measures and different statistical measures such as the mean, the 95th percentile, and the standard deviation that can be used. Dr.

Eisenberg said that some natural system components are the most important in their base-case analysis, which was based on an earlier DOE design. These results show that the pumping well volume, retardation in the saturated zone alluvium, and two of the rock units at Yucca Mountain are important to risk. He also discussed some of the conceptual difficulties with the approach and provided his conclusions. He added that NMSS would achieve more capability in a later version of the code. In the ensuing question-and-answer session, Dr. Eisenberg said that the importance of the natural system in NRC's analysis compared to DOE's analyses was due, in part, to different WP materials used in the NRC models. He also expressed concern about how DOE performed its importance analyses. He also said that importance analysis is a way of evaluating a component's role in minimizing risk. He said that it is a thought experiment to tell something about a model, though in the real system specific components, such as geologic features, would always be present. Dr. Sagar added that subsystem components could be analyzed for features like cladding, but that the Center had not performed these analyses.

VI. INVESTIGATING THE RISK CONTRIBUTION OF IGNEOUS ACTIVITY (OPEN)

[Lynn G. Deering was the Designated Federal Official for this part of the meeting.]

The CNWRA staff gave an overview on the status of the igneous activity KTI. Among the topics covered were risk insights from PA, technical bases and uncertainties, evaluation of conservatism in risk estimates, and remaining work.

The CNWRA staff reported that the expected annual dose from volcanism is around 1 mrem/yr, which is the largest contribution to overall dose. This estimate is supported by direct data, realistic interpretations, and conservative evaluations of complex processes. Work is underway to reduce large uncertainties that may impact the risk estimate by an order of magnitude. The number of WPs entrained is likely underestimated and the mass loading parameters through time are likely overestimated. The CNWRA staff believes that the continued level of effort during the next 2 years can reduce these uncertainties significantly.

Risk insights note that volcanism presents a quantifiable level of total system risk; current analysis show that Yucca Mountain does not exceed the dose standard; and the license application will need a clear and credible treatment of igneous activity. The CNWRA views an annual probability of 1×10^{-7} as reasonably conservative given the relatively few number of past volcanic events and uncertainties inherent in models and parameters. Work is taking place to evaluate the possible conservatisms in consequence calculations. The assumption that volcanic conduits are the same size as they have been observed at volcanoes and volcanic intrusions may underestimate the number of WPs affected; the assumption that the WP is breached when entrained into an erupting volcanic conduit appears reasonably conservative, but there are no

data on WP behavior under igneous conditions; the assumption that HLW grain size is reduced during eruption appears reasonably conservative given physical conditions of igneous events; the assumption of uniform entrainment of HLW during eruption appears reasonable given observed entrainment of wall-rock fragments; the assumption that tephra deposits eroded from the Yucca Mountain region are used to determine eruption characteristics appears realistic, given observed characteristics of basaltic eruptions; the assumption that the contaminant plume is directed toward the critical group is reasonably conservative and will not underestimate risk; the assumption that airborne particle concentration remains constant through time likely overestimates expected annual dose; but we need to develop a technical basis to assume change through time.

DOE appears to be addressing the staff's primary technical concerns noted in NRC's VA review. The staff notes that informal communication is greatly facilitating the issue-resolution process. After a lengthy question-and-answer period, this part of the meeting was brought to a close. The Committee plans to write a letter to the Commission next winter on the overall research program.

VII. REPOSITORY DESIGN AND THERMAL-MECHANICAL EFFECTS (OPEN)

[Howard J. Larson was the Designated Federal Official for this part of the meeting.]

Dr. Mysore Nataraja, NMSS, and Dr. Simon Hsuing, CNWRA, shared the presentation on this topic. The following items were discussed:

1. The principal subissues associated with the preclosure design of the repository. Specific subissues addressed were
   a. effectiveness of the design control process,
   b. design for seismic events and direct fault disruption,
   c. thermal-mechanical effects on repository design, and
   d. design required to meet 10 CFR Part 63 preclosure performance objectives, namely, dose limits under design-basis events, maintenance of retrievability, and accommodation of the performance confirmation program.

2. The use of an integrated safety analysis (ISA) for assessing preclosure performance compliance. (Note: The ISA is defined as "a systematic examination of the facilities, processes, equipment, structures, and personnel activities to ensure that all relevant hazards that could result in unacceptable consequences have been adequately evaluated and appropriate protective measures have been identified.")

3. The thermal-mechanical effects on postclosure performance and risk insights gained from PA (the dose contribution from rockfall and flow into drifts

possibly resulting in changes in geometry or permeability were discussed as examples).

4. The plans to evaluate the selected (of the five evaluated) DOE enhanced design alternatives. It was noted that DOE has not made the final design selection at this time, although the seemingly most-favored approach was called EDA II - 60 MTU/acre, 2 cm Ti drip shield, 2 cm Alloy-22 outer barrier, and 5 cm 316 inner barrier).

5. The status of progress to date. The following information was provided: the contribution of rockfall to dose is small using current assumptions, seals have been eliminated from further consideration based on the new 10 CFR Part 63, and the effects of ventilation for the new design are being evaluated.

6. The "path forward," as described, places greater focus on preclosure safety concerns. This focus includes the development of a preclosure review plan for both surface and subsurface facilities, the development of the capability to apply ISA in a regulatory framework (including its use as an evaluation tool), the need to discuss with DOE rock property data ,and the design analysis of the underground facility. However, although additional emphasis is being placed at this time on preclosure concerns, there are also postclosure performance-related concerns that have been identified as requiring further investigation.

The Committee asked several questions regarding the ISA. The staff stated that it was necessary to develop the capability to apply ISA in the regulatory framework and that it was the staff's intention to incorporate ISA in the YMRP. In light of its interest in the topic, the staff proposed, and the Committee agreed, to discuss the ISA early in calendar year 2000.

Mr. McCartin addressed a question concerning the likelihood of increased difficulty in monitoring the repository during preclosure because of the newest DOE design (storage in drifts in unshielded canisters) . He noted that the proposed 10 Part 63 requires pre- and postclosure monitoring of the repository.

VIII. THERMAL EFFECTS ON FLOW (OPEN)

[Lynn Deering was the Designated Federal Official for this part of the meeting.]

In its overview of ongoing modeling studies and experiments designed to evaluate the thermal effects on flow (TEF), members of the CNWRA staff covered the following topics: importance of TEF in repository performance; risk insights from PA; abstraction of TEF into the NRC TPA code; results of sensitivity analysis; objectives of tests and comparison of results with DOE; proposed DOE design modifications; progress to date; and path forward.

Members of the CNWRA staff presented risk insights on the fact that corrosion is dependent on temperature, relative humidity, and liquid water. Corrosion is highest in the range of 80° to 100°C, which can change depending on the amount of solutes in the water. DOE assumed in the viability assessment (VA) that water will not reach the drift until the temperature falls below boiling, that is, no penetration of the boiling isotherm down fractures and no water contacts WPs for 5,000 years. These assumption are of major concern to the CNWRA/NRC. The CNWRA will also examine DOE's new design closely, which reduces the heat load to offset dripping in the pillars between drifts due to condensate shedding.

The staff's major focus on the TEF KTI is to develop a technical basis for the arrival time of water on WPs, which is controlled by seepage, refluxing, and dripping. The staff is also focusing on understanding spatial distribution of flow and the chemistry of water contacting WPs.

The NRC is using the MULTIFLOW equivalent continuum code to conduct process-level modeling, and is determining the chloride content of water reaching the canister. The staff is also using MULTIFLOW to look at dual continuum modeling, that is, flow through fractures under partially unsaturated conditions. The code cannot be used to evaluate episodic fracture flow or focused fracture flow into the drift. The MULTIFLOW results are abstracted into REFLUX submodels, which are still under development.

The CNWRA has completed two experiments designed to test theories of reflux shedding, penetration of the boiling isotherm, and DOE instrumentation in the drift scale heater test (DST). The staff is beginning a third experiment using crushed tuff and infiltrating water to test the corrosion potential of the drift environment. Some results of the laboratory heater test indicate the following: reflux was not detected using thermocouples, which are being used by DOE in the DST; reflux into drift was observed using drip sensors; muddy residue was deposited in drift during heating; post-test saturation indicated dryout zones; and both the DOE's DST and CNWRA laboratory scale heater tests indicate highly concentrated water above the heater drift. In addition to the laboratory heater test results, additional progress to date includes that critical processes were observed, that is, penetration of boiling isotherm by flow down a fracture, which was not predicted in the process level or abstracted models; the analytical studies were supported by the experimental results for analysis of seepage, capillary diversion, and mechanics of dripping into a cavity; and accomplishment of a mechanistic model of fracture flow toward a heat source to evaluate importance of groove or film flow.

The future goals of the TEF KTI are to assess thermal effects for the new repository design; determine time and flux of water arrival at the WPs to scrutinize key assumptions in the DOE TSPA, continue sensitivity calculations to identify critical heat and mass transfer mechanisms important to repository performance, and continue to update the issue resolution status report.

After a question-and-answer period, this part of the meeting was brought to a close.

IX. EVOLUTION OF THE NEAR-FIELD ENVIRONMENT (OPEN)

[Andrew C. Campbell was the Designated Federal Official for this part of the meeting.]

Dr. William Murphy (CNWRA) briefed the Committee on work in the Evolution of the Near-Field Environment (ENFE) Key Technical Issue (KTI). He presented information on coupled thermal-hydro-chemical (THC) processes in the near field, the technical basis for NRC's review of DOE's work, risk insights gained from PA and sensitivity analyses, and the impacts of DOE design changes on staff efforts in this KTI. He also discussed the staff's achievements, including revisions to the ENFE Issue Resolution Status Report (IRSR), and planned work. Dr. Murphy discussed the impacts of THC processes on performance in several different integrated subissue areas including seepage and flow, the chemical environment for WPs and waste forms, radionuclide transport, and criticality in the near-field environment. Dr. Murphy summarized the current technical bases for the NRC's approach including the following: site data, laboratory tests, and the results of various completed and ongoing heated rock tests. He also compared results for

different THC models. He discussed the following: insights from natural analog studies, code development and modeling of THC processes, the abstraction of process model results into the PA and sensitivity studies. He presented peak dose results for different waste form dissolution models that have been incorporated into the NRC's TPA 3.2 code. These dissolution models include NRC's base case, a model based on natural analog studies, and a model based on the dissolution of Schoepite, a uranium oxide mineral phase.

Dr. Murphy described risk insights from the PA studies. These have shown that the quantity and chemistry of water contacting the WP and the source term release rate have a major influence on performance, whereas the near-field transport phenomena have relatively small effects. He noted that some of the risk uncertainties not currently evaluated in the NRC PA include near-field criticality, the effects on flow by near-field chemical reactions, and changes in near-field chemistry with time. Dr. Murphy also discussed the impact of recent DOE design changes for the repository (Enhanced Design Alternative - II). Some of the new features, such as lower temperature, absence of concrete, and wider drift separation probably decrease the importance of coupled THC processes. However some new features have been introduced that need to be studied, including the titanium drip shield, backfill, and material interactions. Dr. Murphy concluded by reviewing the NRC and CNWRA progress and accomplishments and discussing the path forward for a variety of activities that need to be completed.

The Committee discussed a variety of issues with Dr. Murphy and other members of the NRC and CNWRA staffs. These included the following: the abstraction process and the loss of detailed information, concerns about dissolution models and limited data sets for different models, near-field transport models, mountain scale effects on near-field chemistry, design changes by DOE and the complexity of modeling the system, corrosion processes affected by the near-field environment and impacts on WP welds, and the formation of uranium oxide phases and impacts on the radionuclide release rates.

X. CONTAINER LIFE AND SOURCE TERM (OPEN)

[Andrew C. Campbell was the Designated Federal Official for this part of the meeting.]

Members of the NRC and CNWRA staffs presented information to the Committee on work in the Container Life and Source Term (CLST) KTI. These presentations covered risk insights, the technical bases for the staff's positions, progress for ongoing studies, and planned activities. Dr. Gustavo Cragnolino, CNWRA, discussed WP performance, with particular emphasis on corrosion data and models for candidate WP materials. He also discussed the progress in issue resolution for the CLST KTI and the path forward.

Dr. Cragnolino discussed the integrated subissues for the CLST KTI. This included the following: WP corrosion, mechanical disruption, the quantity and chemistry of water contacting the WP, and radionuclide release rates and solubility limits. Some of the risk insights from conducting PAs include the importance of initial failures, the effects of design changes and fabrication processes, the importance of near-field chemistry and penetration location on release rates, and the effects of cladding and WP internal environment on release. He also discussed the need for a solid technical basis for estimating the number of initial WP failures. He said that although the percentage differences in the NRC and DOE approaches to juvenile failure of WPs are significant, the absolute values are in the micro-rem range for both the DOE and NRC analyses.

Dr. Cragnolino described the important parameters and methods for evaluating WP corrosion and the impact of different container alloys on WP lifetimes. He said that the comparison of container lifetime for three different materials shows significantly longer WP lifetimes for the revised WP design using alloy C-22. Dr. Cragnolino said that DOE's range of the general corrosion rate for WPs cannot be supported because of uncertainty. He then discussed the NRC's technical approach to evaluate WP design and materials. Some of the factors affecting performance of the corrosion resistant materials include the following: the critical temperature, chemistry—critical Cl concentration, redox potential, material micro-structure, passive dissolution rates (general corrosion), and active dissolution rates (localized corrosion). He discussed some of these issues in more detail such as the critical temperature, localized corrosion, limitations of expert elicitation, the uniform corrosion rate, and values used in DOE's TSPA.

In summary, Dr. Cragnolino said that the approach is flexible, the sensitivity studies allowed them to focus on detailed studies and the assumptions are not too conservative. Some of staff's progress in issue resolution includes closure of some issues because of design and/or material changes. He said that the full resolution of all subissues can only occur after DOE settles on a final design. The planned DOE experiments may not be performed in time for the review of the LA. Performance confirmation testing is thus important because of a lack of sufficient data. The NRC and CNWRA plan to evaluate fabrication effects and alternative designs, establish a better definition of near-field environment, continue discussion with DOE on methodology and data for corrosion and mechanical failures (in an Appendix 7 meeting), and develop plans for performance confirmation.

Dr. Cragnolino answered questions from the Committee. He discussed radiolysis effects, the lack of microbial degradation in Ni/Cr/Mo alloys, bounding assumptions in NRC's juvenile failure modeling and DOE's lack of a technical basis for its failure numbers. In answering a question on what NRC can do to assure that containers perform, Dr. Cragnolino discussed what needs to be done from his perspective. He answered questions about corrosion rate equations and activation energy. He was asked about progress in issue resolution and performance confirmation.

Dr. Cragnolino noted that although there is a limited period of time for experiments (four years) CNWRA extracted some good data so that DOE could produce data in a reasonable amount of time. It was noted by a member of the NRC staff that the performance confirmation period is specifically required in 10 CFR Part 63 and WPs are called out as an area of focus. There was a discussion about the pros and cons of a low- versus a high- temperature repository design.

Dr. Tae Ahn, NMSS, discussed waste form studies aimed at a better understanding of spent fuel degradation, cladding performance, and the degradation of high-leve waste (HLW) glass waste forms. He summarized some of the main results, including the sensitivity of dose to cladding performance and realistic waste form dissolution models. He discussed the technical basis for NRC's approach and compared different input data and sources for DOE and NRC models

In describing the chemistry inside WPs, he said that there would be high chloride ion concentrations and that oxidizing conditions would prevail. In reviewing the staff's progress and current studies he noted areas needing particular emphasis. These include sensitivity analyses, understanding local reducing conditions, the need to share data with DOE, parameters in the NRC's TPA 3.2 code, and getting a better understanding of chemistry inside the WP. He also described future work on uncertainties in this the CLST KTI, and planned tests of HLW glass and cladding performance. He added that they made progress in TPA sensitivity studies, evaluating local corrosion, and evaluating mechanical failure. He discussed HLW glass degradation, which inlcudes leaching, colloid formation, hydration effects and

microbial effects. The staff is making progress on scoping tests, and understanding uncertainties and sensitivity to different glass degradation modes.

In answer to questions raised by ACNW members, Dr. Ahn said that for plutonium (and other radionuclides) in HLW glass, solubility is the key factor determining release, not the total amount of inventory. When asked about realistic fuel dissolution analysis and cladding credit Dr. Ahn said that the dose history is very low for realistic models that account for both. He noted some of the continuing issues with respect to cladding performance, including a number of possible degradation modes. There was a discussion about taking credit for the chemical form of technetium in the spent fuel and dissolution.

A broad-range discussion session ensued in which the Committee members discussed with the staff a host of issues including the following: different performance time-frames, concern about information available in the literature, the need for a mechanistic approach that would allow the staff to focus on a few important chemistry details, concern that extrapolations of performance to long time frames need to be based on understanding mechanisms rather than extrapolating rates measured over short time frames in the laboratory. There was also discussion of different values for the dose calculated in the viability assessment and in the current models. It was noted that the CNWRA and NRC staffs were probing parameter effects in TSPA. An NMSS staff member thought that the issue of colloidal transport was blown out of proportion. But, he said that the presence of Pu colloids in the groundwater from the Benham bomb test at the Nevada Test Site raises it as an issue to the public, and that this issue should be resolved. A Committee member noted that the site shows the movement of Pu and other radionuclides as colloids below the water table, but he said that the real question is colloid mobility in the unsaturated zone, which he questioned. An NMSS staff member noted that they are concerned about a number of issues, although the doses associated with these issues are small, because in reviewing the LA they will have to understand what they mean.

XI. DRAFT ENVIRONMENTAL IMPACT STATEMENT GUIDANCE (INCLUDING TRANSPORTATION) (OPEN)

[Howard J. Larson was the Designated Federal Official for this part of the meeting.]

Mr. Michael Lee, NMSS, gave an overview of the documents directing DOE to prepare an environmental impact statement (EIS) for the proposed repository at Yucca Mountain and the NRC's role in that review. He indicated that since the NRC had not yet seen any sections of the DOE draft EIS (DEIS) his presentation would be somewhat limited.

He discussed the requirements of the Nuclear Waste Policy Act (NWPA) of 1982, as amended, and discussed related aspects of the National Environmental Policy Act (NEPA) and the guidelines of the Council of Environmental Quality (CEQ).

The NWPA requires that DOE issue a DEIS for comment and that the NRC's comments on the DEIS accompany any DOE site recommendation. NRC is classed as a "commenting agency" and is to provide comments with respect to environmental impacts falling within its jurisdiction or areas of special expertise. NRC's regulations also require that before giving DOE a license to construct and operate a geologic repository, in addition to other required documentation, an EIS must be provided.

It was noted that the EIS for the proposed repository at Yucca Mountain is different from most other EISs in that the NWPA does not require DOE to consider the need for a repository, alternatives to geological disposal, or alternatives to the Yucca Mountain site. However, the environmental impacts of design alternatives are to be considered.

DOE was scheduled to issue the DEIS for comment on July 30, 1999, with a 90-day comment period. (It is understood that the Governor of the State of Nevada has asked for an extension beyond 90 days and it is possible that other stakeholders will also request an extension.)

The staff intends to comment on radiological health and safety issues, spent nuclear fuel transportation safety issues, and any other issues that might be considered during a judicial review.

In light of the relatively compressed public comment period, the Committee intends to

1. Hear from DOE at the 111th meeting about its plans for the DEIS;

2. Attend (if schedules permit) one of the 14 DOE scheduled public briefing/comment sessions (currently to be held in various cities during August, September, and early October 1999);

3. Hear the NRC staff comments on the DEIS during the 112th meeting, September 14–15, 1999;

4. Receive a briefing from the DOE on public comments it has received; and

5. Develop its own comments in its areas of expertise (recognizing that the final DEIS, which the NRC is to "adopt," is still several years away from promulgation).

In response to a question from Dr. Garrick concerning the tools the NRC expects to use in evaluating the DEIS, Mr. Michael Lee noted that for post-closure issues the staff will use the TSPA. However, for the pre-closure evaluation, it is not certain whether the ISA will be "in-place" for use.

Drs. Hornberger and Fairhurst asked whether the CEQ had guidelines in place for EISs covering 10.000 or more years. The staff replied that there are no CEQ guidelines for a repository. There was also a discussion about what was meant by the NRC "adopting" DOE's EIS (recognizing that in 10 CFR 51.109 there is a legal discussion of the principle).

The Committee indicated that once it has seen the DEIS it would work with the staff in defining its participation in the DEIS review.

XII. DEFENSE IN DEPTH (THE MULTIPLE BARRIERS APPROACH) (OPEN)

[Lynn G. Deering was the Designated Federal Official for this part of the meeting.]

Mr. Keith McConnell, NMSS, indicated that the staff has developed a draft plan to clarify defense in depth (DID) in response to questions that were raised on what is meant by DID in 10 CFR Part 63 during a March Commission briefing and during public meetings on 10 CFR Part 63. The Commission issued a staff requirements memorandum asking the staff to clarify the DID requirement. Mr. McConnell indicated that the draft is still in progress and that the staff plans to address the ACNW on this subject later in the year.

Mr. McCartin described the DID philosophy in the proposed 10 CFR Part 63, including definition of the DID concept in the NRC's Risk-Informed, Performance-Based Regulation white paper, requirements in 10 CFR Part 63 including multiple barriers; and possible quantitative approaches for demonstrating DID. Mr. McCartin indicated that 10 CFR Part 63 requires multiple barriers, and not DID specifically.

However, the staff believes that DID is achieved through the multiple barrier requirement. 10 CFR Part 63 includes a 25 mrem annual dose limit, a demonstration of the capability of multiple barriers, and a stylized calculation of human intrusion. A barrier is defined as any material or structure that prevents or substantially delays movement of water or radioactive material. DOE is required to identify the barriers, describe their capability, and provide the technical basis for the capability of the barrier. It is in the context of the PA that the DID analysis will be done. The rigor needed to defend the barrier's capability should be proportional to its importance to performance. Laboratory and field measurements and analog studies can be used. Quantitative approaches include sensitivity analysis, importance analysis, and one-off analysis. The NRC is open to any approach that makes the PA and the capability of barriers more transparent and supports a more informed licensing decision.

Dr. Garrick emphasized that the ACNW is pushing for the quantification of the performance of barriers. Mr. McConnell indicated that the staff understands the Committee, and believes that the post-processor under development should assist in quantification of barriers and making the analysis more transparent. Mr. McCartin indicated that the staff needs to better explain what NRC wants to see as far as illuminating the understanding of how the barriers are functioning.

Mr. McConnell described the underlying bases for implementing DID, how the staff will clarify its expectations for demonstrating multiple barriers, when and how clarifications may be made available to stakeholders, and the schedule for planned activities. The underlying basis for implementing DID in 10 CFR Part 63 will be the philosophy in the NRC's white paper on risk-informed, performance-based regulation. The staff's overall goal is to avoid the reimposition of having subsystem performance objectives in the regulation. To clarify the staff's expectations for demonstrating DID through multiple barriers, the staff will refine the requirements as needed, and will use the YMRP and acceptance criteria and review methods as the vehicle. The staff will define how it will review DID and what it expects DOE to demonstrate for particular requirements. The staff will make stakeholders aware of the clarifications through technical exchanges with DOE, the ACNW, and the joint ACNW/Advisory Committee on Reactor Safeguards (ACRS) subcommittee, NRR, and other groups inside the NRC. The staff will also hold a public meeting in Nevada to discuss the YMRP in general and DID in particular. The staff is proposing to work with the ACNW and the joint subcommittee during the July/August 1999 time frame, and again in September 1999 following the public comment period on 10 CFR Part 63. The staff expects to complete its proposed approach to clarify DID by November 1999 and send it with the final rulemaking package to the Commission. During the question-and-answer period, the staff sought the Committee's opinion on how to simulate failure of a barrier in a reasonable way—other than assuming complete failure early in the analysis. Dr. Garrick noted that NMSS needs to work with NRR on the DID issue, but NMSS needs to be the leader rather than the follower with respect to how DID applies to materials,

and to avoid the idea of setting limits for DID that are at lower levels than the bottom-line safety objectives, that is, subsystem requirements.

XIII. ELECTION OF OFFICERS

[Howard J. Larson was the Designated Federal Official for this part of the meeting.]

The Committee re-elected Dr. B. John Garrick as Chairman and Dr. George M. Hornberger as Vice-Chairman. Their terms of office run from July 1, 1999, through June 30, 2000.

XIV. EXECUTIVE SESSION OPEN)

[Howard J. Larson was the Designated Federal Official for this part of the meeting.]

A. Future Meeting Agenda

Appendix IV summarizes the proposed items endorsed by the Committee for the 111th ACNW meeting on July 19–21, 1999, at the Center for Nuclear Waste Regulatory Analyses in Rockville, Maryland.

B. Future Committee Activities

The 112th ACNW meeting is scheduled for September 14–15, 1999.

APPENDIX III: MEETING ATTENDEES

110TH ACNW MEETING
JUNE 28–30, 1999

ACNW STAFF

Dr. Andrew Campbell
Ms. Michele Kelton
Dr. John Larkins
Mr. Howard Larson
Dr. Richard Savio

ATTENDEES FROM THE NUCLEAR REGULATORY COMMISSION (HEADQUARTERS VIA TELECONFERENCING)

JUNE 28, 1999

S. Wastler	NMSS
M. Nataraja	NMSS
B. Ibrahim	NMSS
R. Johnson	NMSS
M. Comar	NMSS
N. Eisenberg	NMSS
K. Stablein	NMSS
D. Brooks	NMSS
E. Wolfe	NMSS
B. Leslie	NMSS
J. Firth	NMSS
P. Reed	RES
L. Hamdan	NMSS
B. Dam	NMSS
R. Codell	NMSS
D. Esh	NMSS
V. Perin	NMSS

ATTENDEES FROM THE NUCLEAR REGULATORY COMMISSION (HEADQUARTERS VIA VIDEO TELECONFERENCING) **(CONT'D)**

JUNE 29, 1999

M. Nataraja	NMSS
B. Leslie	NMSS
S. Wastler	NMSS
B. Dam	NMSS
B. Ibrahim	NMSS
D. Esh	NMSS
N. Eisenberg	NMSS
K. Chang	NMSS
K. Stablein	NMSS
E. Wolfe	NMSS
C. McKenney	NMSS
D. Brooks	NMSS
M. Comar	NMSS
V. Perin	NMSS
P. Reed	RES
C. Greene	NMSS

JUNE 30, 1999 (Via telephone from NRC HQ - Rockville, MD)

D. Codell	NMSS
T. McCartin	NMSS
J. Firth	NMSS
N. Eisenberg	NMSS
R. Johnson	NMSS

ATTENDEES AT CNWRA, SAN ANTONIO, TEXAS

JUNE 28, 1999

D. Davidson	Nye County
M. Scott	CRWMS/M&O
A. Chowdhury	CNWRA
L. Bissell	Booz Allen/DOE
R. Irish	OIG
S. Zane	OIG
C. Lui	NMSS
T. Gunter	DOE
B. Reamer	NMSS
G. Witlmeyer	CNWRA
B. Ott	RES
W. Murphy	CNWRA
J. Weldy	CNWRA
A. Mohseni	NMSS

ATTENDEES AT CNWRA, SAN ANTONIO, TEXAS (CONT'D)

JUNE 28, 1999 (CONT'D)

S. Hsiung	CNWRA
S. Mohanty	CNWRA
L. Browning	CNWRA
B. Russell	CNWRA
W. Patrick	CNWRA
B. Sagar	CNWRA
R. McCullum	NEI
E. Pearcy	CNWRA

JUNE 29, 1999

A. Chowdhury	CNWRA
S. Hsiung	CNWRA
W. Patrick	CNWRA
M. Scott	CRWMS M&O
D. Davidson	Nye County, NV
A. Mohseni	NMSS
L. Bissell	Booz Allen/DOE
B. Sagar	CNWRA
S. Mohanty	CNWRA
B. Russell	CNWRA
R. Irish	CNWRA
S. Zane	OIG
M. Wisenburg	CRWMS M&O
D. Hughson	CNWRA
T. Ahn	NMSS
G. Wittmeyer	CNWRA
L. McKague	CNWRA
L. Browning	CNWRA

JUNE 30, 1999

W. Patrick	CNWRA
R. Green	CNWRA
A. Mohseni	NMSS
D. Davidson	Nye County, NV
A. Chowdhury	CNWRA
L. Bissell	Booz Allen
T. Gunter	DOE
S. Hsiung	CNWRA
M. Wisenburg	CRWMS M&O
M. Scott	CRWMS
S. Mohanty	CNWRA
J. Weldy	CNWRA
M. Smith	CNWRA

ATTENDEES AT CNWRA, SAN ANTONIO, TEXAS (CONT'D)

JUNE 30, 1999 (CONT'D)

G. Wittmeyer	CNWRA
S. Mohanty	CNWRA
R. McCullum	NEI
B. Sagar	CNWRA
J. Greeves	NMSS
B. Reamer	NMSS
C. Lui	NMSS
S. Kaplan	

ATTENDEES LAS VEGAS, NEVADA (VIA VIDEOCONFERENCING)

JUNE 28, 1999

J. Weaver	M&O
D. Bechtel	Clark County, NV
E. Tiesenhausen	CCCP
D. Franks	M&O Licensing
G. Shideler	SE&I, PCA
D. Sevougian	M&O/PAO
D. Wilder	LLNL

JUNE 29, 1999

J. Weaver	M&O
D. Franks	M&O licensing
D. Wilder	LLNL
J. Jesse	M&O
G. Shideler	M&O
R. Nolting	M&O
K. Mon	M&O/PAO
C. Hanlon	DOE
A. Haghi	M&O/Duke
D. Stahl	M&O

ATTENDEES FROM OTHER AGENCIES AND GENERAL PUBLIC

JUNE 28, 1999

I. Porpotage	ICF Kaiser

JUNE 29, 1999

I. Porpotage	ICF Kaiser
J. Russell	CNWRA

APPENDIX IV: FUTURE AGENDA

The Committee agreed to consider the following during the 111th ACNW Meeting, July 19–21, 1999:

- **ACNW Planning and Procedures** — The Committee will be briefed by its staff on issues to be covered during this meeting. The Committee will also consider topics proposed for future consideration by the full Committee and Working Groups. The Committee will discuss ACNW-related activities of individual members.

- **Risk Communications** — The Committee will continue to prepare for sessions with the local stakeholders to be held this fall in the Las Vegas, Nevada, area.

- **Revised Design for the Proposed Yucca Mountain Repository** —- Representatives from the DOE and its contractor will discuss the license application design selection process and describe the current final revised repository design.

- **Results of the Arthur Andersen Review of the Division of Waste Management Activities** — The Deputy Director of NMSS will discuss the results of recent strategic planning activities within the Division of Waste Management and their potential impact on ACNW activities.

- **DOE Presentation on the Draft Environmental Impact Statement (DEIS) for the Proposed Yucca Mountain Repository** — A DOE representative will discuss the scope of the DEIS and the review process, providing additional background information for the Committee's future comments once the document is made public.

- **Spent Fuel Project Office Briefing** — A representative of the Spent Fuel Project Office will present an update and overview of its activities. Also to be discussed is the relationship of current spent fuel transportation study initiatives to sites such as Yucca Mountain and the private fuel storage facility.

- **Meeting with the Director of the Division of Waste Management** — The Committee will meet informally with the Director of the Division of Waste Management to discuss items of mutual interest.

- **Preparation of ACNW Reports** — The Committee will discuss planned reports, including a white paper on Repository Design Issues at Yucca Mountain, a white paper on Near-Field Chemistry Issues, a joint ACRS/ACNW letter report on an NMSS approach to risk-informed, performance-based regulation in NMSS, and other topics discussed during this and previous meetings.

APPENDIX V
LIST OF DOCUMENTS PROVIDED TO THE COMMITTEE

[Note: Some documents listed below may have been provided or prepared for Committee use only. These documents must be reviewed prior to release to the public.]

MEETING HANDOUTS

AGENDA ITEM NO. **DOCUMENTS**

II **Developing the Nuclear Regulatory Commission/Center for Nuclear Waste Regulatory Analyses Review Capability**

1. Peer-Reviewed Publications **[Handout]**

2. Developing the NRC/CNWRA Review Capability, presented by Wes Patrick, CNWRA, dated June 28, 1999 **[Handout]**

III **Risk Informing the Planning and Prioritizing Process**

3. Risk Informing the Planning & Prioritizing Process to the Advisory Committee on Nuclear Waste, presented by Bill Reamer, NMSS, dated June 28, 1999 **[Handout]**

IV **Program Overview—Progress Toward KTI Resolution**

4. Program Overview Summary of Progress Toward Issue Resolution, presented by Budhi Sagar, CNWRA, undated **[Handout]**

V **Evaluating and Explaining Contributions to Risk**

5. System-Level Sensitivity and Alternative Conceptual Models in TPA 3.2, presented by Richard Codell, NMSS, undated **[Handout]**

6. Evaluating and Explaining Contributions to Risk, presented by Budhi Sagar, CNWRA, undated **[Handout]**

7. A Parameter-Tree Approach to Interpreting Results from the TPA Version 3.2 Code, presented by Gordon Wittmeyer, CNWRA, undated **[Handout]**

8. External Review Group **[Handout]**

9. Importance Analysis, presented by Norman Eisenberg, NMSS, undated **[Handout]**

Appendix V
109th ACNW Meeting
May 11-13, 1999

MEETING HANDOUTS (CONT'D)

AGENDA ITEM NO.	DOCUMENTS
VI	**Investigating the Risk Contribution of Igneous Activity**
	10. Investigating the Risk Contribution of Igneous Activity, presented by Brittain Hill, CNWRA, dated June 28, 1999 **[Handout]**
VII	**Repository Design and Thermal-Mechanical Effects**
	11. Repository Design and Thermal-Mechanical Effects, presented by M. Nataraja, NMSS, and S. Hsiung, CNWRA, undated **[Handout]**
VIII	**Thermal Effects on Flow**
	12. Thermal Effects on Flow Key Technical Issue, presented by Ronald Green, CNWRA, and Jeff Pohlen, NMSS, June 29, 1999 **[Handout]**
IX	**Evolution of the Near-Field Environment**
	13. Evolution of the Near-Field Environment, presented by William Murphy, CNWRA, undated **[Handout]**
XI	**Container Life and Source Term**
	14. Waste Form Studies, presented by Tae Ahn, NMSS, undated **[Handout]**
	15. Container Life and Source Term, presented by Gustavo Cragnolino, CNWRA, undated **[Handout]**
XII	**Draft Environmental Impact Statement Guidance (including transportation)**
	16. Staff Review of DOE's Draft Environmental Impact Statement: Proposed Approach, presented by Michael Lee, NMSS, **[Handout]**
XIII	**Defense in Depth (the Multiple Barriers Approach)**
	17. Defense-In-Depth Philosophy in Proposed Regulations for HLW Disposal at Yucca Mountain, presented by Timothy McCartin, NMSS, June 29, 1999 **[Handout]**
	18. DWM Staff's Proposed Approach for Clarifying Requirements for Defense In Depth as Applied to Geologic Disposal of High-Level Waste at Yucca Mountain, Nevada, presented by Keith McConnell, NMSS, June 30, 1999 **[Handout]**

MEETING NOTEBOOK CONTENTS

Appendix V
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TAB NUMBER	DOCUMENTS
	1. Schedule and Outline for Discussion, 109th ACNW Meeting, May 11–13, 1999, dated June 11, 1999
	2. Introductory Statement by the ACNW Chairman, undated
	3. Items of Interest, undated
	4. Introductory Statement by the ACNW Chairman, Second Day, undated
	5. Introductory Statement by the ACNW Chairman, Third Day, undated
	6. Letter dated June 5, 1999, from Donald L. Baker, Aquarius Engineering, to Dr. Richard P. Savio, Associate Director, ACRS/ACNW, re validity of the methods used to model unsaturated flow at the Yucca Mountain site
1-3/7-11	**CNWRA VISIT - BACKGROUND INFORMATION**
	7. Status Report
	8. Brochures from the Southwest Research Institute and the CNWRA
	a. "A Brief History of SwRI"
	b. "Facts About SwRI"
	c. "SwRI Business Advantages"
	d. "The Center," July 1998
	e. "Corrosion Evaluation and Migration Technologies," April 1999
	9. Viewgraphs by M. J. Bell and Wesley C. Patrick, "NRC High-Level Waste Repository Program: Highlights, Accomplishments, and Outlook," August 26, 1998
	10. Letter dated March 8, 1999, from William D. Travers, EDO, to Dana A. Powers, Chairman, ACRS, Subject: ACRS Report on the NRC Research Program - Review and Evaluation of the NRC Safety Research Program, NUREG-1635 (with attachments)
4/9/11	**Evaluating and Explaining Contributions to Risk** **Evolution of the Near-Field Environment** **Container Life and Source Term**
	11. Status Report Attachments:
	a. "System-Level Sensitivity Results and Alternative Conceptual Models in TPA 3.2," Viewgraphs presented at NRC/DOE Technical Exchange, March 25, 1999, by R. Codell
	b. "NRC Sensitivity and Uncertainty Analyses for a Proposed HLW Repository at Yucca Mountain, Nevada, Using TPA 3.1, Results and Conclusions," NUREG-1668, Volume 2, March 1999 **[provided under separate cover]**

c. "Importance Measures for Nuclear Waste Repositories," **Predecisional staff paper** by N. Eisenberg and B. Sagar, June 1998
d. "A Parameter Tree Approach to Estimating System Sensitivities to Parameter Sets," **preprint paper submitted to Risk Analysis**, by M. Jarzemba and B. Sagar
e. Consultant's Reports by J. Lin and S. Kaplan from January 12, 1999 meeting on Scenarios Analysis Methodology
f. Memorandum dated May 19, 1999, to Bill Reamer from Bret Leslie and Bill Dam, re "In-drift Geochemical Environment and Engineered Barrier System Transport Workshop Trip Report, April 12-15, 1999"
g. "Evolution of the Near-Field Environment in the Proposed HLW Repository at Yucca Mountain — A Review of Hypotheses," by W. Murphy (ed.), CNWRA Report dated June 1996
h. Executive Summary of Final Report on TSPA Peer Review Panel (February 11, 1999) and specific sections on Near-Field Geochemical Environment, Waste Package Degradation, Fuel Cladding, Waste Form Degradation, and Radionuclide Mobilization
i. "Scientific Bases for Cladding Credit as a Barrier to Radionuclide Release at the Proposed Yucca Mountain Repository," Materials Research Society Symposium on the Scientific Basis for Nuclear Waste Management, 1998 (in press)
j. "Waste Package Corrosion," viewgraphs presented by G. Cragnolino at NRC/DOE Technical Exchange, March 25, 1999
k. "Oxidative Release Models," viewgraphs presented by T. Ahn at NRC/DOE Technical Exchange, March 25, 1999
l. "Alternate Source Term Models for Yucca Mountain Performance Assessment Based on Natural Analog Data and Secondary Mineral Solubility," by W. Murphy and R. Codell
m. "Alternate Release Models," viewgraphs presented by W. Murphy and R. Codell at NRC/DOE Technical Exchange, March 25, 1999

[Provided separately in mailing.]

n. "Regulatory Perspectives on Model Validation in High-Level Radioactive Waste Management Programs: A Joint NRC/SKI White Paper," by N. Eisenberg, et al., NUREG-1636, March 1999

5 **Investigating the Risk Contribution of Igneous Activity**

13. Status Report
14. "Paths Forward on Igneous Activity Risk Assessments for Yucca Mountain," viewgraphs by B. Hill at NRC/DOE Technical Exchange on Total System Performance Assessments for Yucca Mountain, May 25-27, 1999

6 **Committee Activities/Future Agenda**

15. Set Agenda for the 111th ACNW Meeting, July 19-21, 1999

16. Agenda items for out months 1998
17. Reconciliation of EDO Responses to ACNW Reports
18. Discuss Attendance at Past Outside Meetings and Plans to Attend to Future Meetings (American Rock Mechanics Association-Fairhurst/Deering and Communications Training)
19. ACNW 1999 Meeting Calendar
20. OCRWM/M&O Meeting List
21. EDO's List of Future Meeting Topics
22. Election of Officers for 1999-2000
23. Consultant Selection for FY 2000

12 **Draft Environmental Impact Statement Review Guidance (including transportation)**

24. Status Report
Enclosures:

a. Timetable for the Staff Review and Comment on DOE Draft EIS: Proposed (June 3, 1999 E-mail from R. L. Johnson, NMSS)
b. "Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada," viewgraphs , dated February 17, 23 & 25, 1999
c. "Draft EIS Public Hearings," viewgraph dated May 4, 1999
d. Listing entitled "Draft EIS Public Hearings," E-mail from DOE to M. Lee, NMSS, May 20,1999
e. Letter dated March 2, 1999, from Wendy R. Dixon, DOE, to Tom Stephens, Director, Nevada Department of Transportation
f. Letter dated March 17, 1999 from Karen Cyr, General Counsel, NRC, to Commissioners
g. Summary Spring 1999 AGU meeting paper "Environmental Impact Statement Performance Assessment Analysis: Analyses and Results," by G. Saulnier, Duke Engineering, et al.
h. Nuclear Waste Policy Act of 1982 and Omnibus Budget Reconciliation Act of 1987, Public Law 100-203
i. NEPA Review Procedures for Geologic Repositories for High-Level Waste, U.S. Nuclear Regulatory Commission, *Federal Register*, Vol. 53, No. 87, May 5, 1988

13 **Defense in Depth (the Multiple Barriers Approach)**

25. Memorandum from Annette Vietti-Cook, Secretary, NRC, to William D. Travers, EDO, and Karen D. Cyr, General Counsel, Subject: Staff Requirements - Briefing on Status of DOE High Level Waste Viability Assessment (SECY-99-074)