

UNITED STATES NUCLEAR REGULATORY COMMISSION Nuclear Safety Research Review Committee

Washington, D.C. 20555

January 21, 1994

Dr. David Morrison, Chairman Nuclear Safety Research Review Committee The MITRE Corporation 7525 Colshire Drive McLean, VA 22102-5481

SUBJECT: Final Report dated January 21, 1994, of Advanced Reactor Subcommittee Meeting of October 15, 1993

Dear Dave,

A final version of the report was approved at the full NSRRC meeting of January 13, 1994. The text of the subject final report is attached for submission of the NRC as a full NSRRCendorsed subcommittee report.

Sincerely,

Indias'

Neil E. Todreas Chairman, Advanced Reactor Subcommittee

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UNITED STATES NUCLEAR REGULATORY COMMISSION Nuclear Safety Research Review Committee Washington, D.C. 20555

January 21, 1994

Dr. David Morrison, Chairman Nuclear Safety Research Review Committee The MITRE Corporation 7525 Colshire Drive McLean, VA 22102-3481

Dear Dr. Morrison:

This letter reports on the Advanced Reactor Subcommittee meeting of October 15, 1993, held in Cambridge, Massachusetts. The Agenda for this meeting which covered thermal hydraulic, engineering materials and components, passive system reliability and severe accident issues for advanced reactors is attached. The NSRRC and USNRC meeting attendees were:

Advanced Reactor Subcommittee

Dr. Neil Todreas, Chairman Dr. E. Thomas Boulette Mr. Sol Burstein Dr. Spencer Bush Dr. Robert Uhrig NSRRC Member Dr. Herbert Isbin NRC Staff Mr. Eric S. Beckjord, Director, RES Mr. Ralph Caruso, NRR Mr. Andrzej Drozd, NRR Dr. Farouk Eltawila, RES Mr. G. Norman Lauben, RES Dr. Donald McPherson, NRR Dr. Charles Serpan, RES Dr. Brian Sheron, RES Dr. Louis Shotkin, RES

The Subcommittee acknowledges the detailed review provided at this meeting by Drs. Shotkin and Sheron of comments expressed in its letter report of January 14, 1993, which reported on the Subcommittee's December 2-3, 1992, meeting. (All comments were satisfactorily addressed except that involving modular construction which is covered later in this report.) These exchanges between the Subcommittee and RES provided a firm technical background for the discussions at this October 1993 meeting. The Subcommittee comments regarding this meeting are grouped under topical headings which follow: Overall Perspective Regarding Completeness of the Research Activities for Advanced Reactors

Throughout the Subcommittee meeting, members sought to have the RES staff define which features of the AP600 and SBWR were sufficiently different from current designs that justified the current research programs. In general, the Subcommittee was satisfied with the answers provided. For the present, no additional topics for research applicable to advanced reactors in the areas of thermal hydraulics engineering, materials and components, and severe accidends were identified by the Subcommittee, and no additional research had been identified by NRR or by RES. However, in several cases cited within this report, particularly within the engineering materials and component area e.g., check valves, forged SA508 Class 3 steel, fatigue, aging and reactor internals, an NRC position and its technical basis needs to be prepared and subsequently examined by the Committee to confirm its tentative agreement with RES that no RES activity in these areas is necessary.

Thermal-Hydraulic Analysis Capability for Advanced Passive Reactor Accident Response

The RELAP 5 code has been designated as the code which the NRC will develop and assess against experimental data sufficiently for it to be used as the principal analysis tool for NRC evaluation of AP600 and SBWR accident response. Consequently, the Subcommittee is very interested in the technical quality of the develop and activity underway on RELAP 5, the timeliness and completeness of the code documentation, the technical capabilities and interactions among the PWR and BWR oriented code development teams at INEL, ORNL, and BNL, and the technical capabilities of the project management group within the Division of Systems Research, RES which is directing this demanding technical task.

To date, the Subcommittee is concerned with code development and documentation results and the adequacy of technical capabilities being applied to this activity at INEL and within RES. The Subcommittee recognizes that RES receives advice, suggestions, and criticisms from a variety of sources regarding the high priority research being devoted to the phenomena involved in models used in RELAP 5. The Subcommittee discussed in detail how RES has responded in the past to such inputs, and what RES is currently doing to be responsive to criticisms. The availability of scrutable documentation has not kept pace with the improvements reported as being

made in RELAP 5 and this contributes to misunderstandings. The Subcommittee knows that RES has a PROCESS in place for evolving responses, but suggests that this PROCESS needs to be improved. The Subcommittee is concerned that the overall net effect of outside input be a constructive PROCESS and not an open loop for recycling criticisms and enhancing polarization. Further, the Subcommittee believes that improved communications between advisory committees already in place may prove to be more effective than generating new ad hoc consultants and additional research.

Specifically, it is suggested that RES work to achieve a proper balance in how experts at National Laboratories are used for code developments and code assessments to ensure that codes are developed, assessed, and maintained in environments that generate technical staff growth and competence in cost-effective ways. While RES inhouse technical expertise has been advanced through the recent addition of a senior T/H expert, additional augmentation may be required to ensure that the appropriate technical skills are available to oversee specific areas in code development and assessment that may need improvements. Further, while the NSRRC has endorsed the use of peer reviews, the Subcommittee cautions that complete reliance on peers to achieve resolution of technical issues is not appropriate. In-house technical expertise, leadership, and effective communications are vital aspects of the PROCESS to achieve resolutions.

In the Subcommittee discussion of this activity with the NRC attendees, it became apparent that a specific mission statement for each NRC ALWR thermal-hydraulic code application (i.e., each code applied to each reactor design to be certified) would be useful in assessing the adequacy of the RES development program. RES agreed to provide the appropriate statements. This should include containment analysis codes as well as reactor systems codes. RES stated that these mission statements might be formulated into Phase I and Phase II portions. RES noted that a Phase II approach might include use of the codes to explore hypothetical conditions beyond the design bases. Even in the Phase I investigations, just what specific scenarios would be included apparently has not yet been fully defined by RES.

Finally, the Subcommittee would like to be informed as soon as practical of the PROCESS that RES plans to utilize to generate effective responses to the range of sources commenting on this overall research activity.

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Engineering Materials and Component Issues

The status of NRC criteria for advanced reactors with regard to a number of engineering issues was discussed. While the Subcommittee concurs with RES that there appears to be no need at this time to initiate research activities in these areas with the possible exception of check valve reliability at the low differential pressures expected in passive reactor applications, the Subcommittee would like to be informed of the relevant regulatory criteria and the RES basis that data in these areas is sufficient for current licensing needs. These areas include:

- The reliability of check valves under their intended service conditions particularly operation at low pressure differential.
- The validation of forged SA508 Class 3 steel for reactor pressure vessels and steam generator tube sheets. (The letter of Dr. Shao to Dr. Bush of November 3, 1993, subsequent to the meeting provides a response which should be made the basis of the formal RES response to this Subcommittee request.)
- A uniform position on fatigue for all ALWR designs.
- Criteria for aging for 60 year life for both passive and active components. RES
 stated it had not identified unique aging requirements for the AP600 and SBWR.
- Criteria should be developed for reactor internals.

Reliability of Passive Safety Systems and Modular Construction

The Subcommittee states its continuing interest in these areas and acknowledges that in response to its previous questions of RES activities underway, the SNL study comparing passive and active ECCS has been terminated. We further note that the identification of practical approaches for evaluating passive systems and areas for methods improvement is to be assessed at a forthcoming workshop prior to reinstituting research activity. The Subcommittee would like to be promptly informed of the schedule and program for this workshop. The Subcommittee was not informed of the resolution of its comments from the December 2-3, 1992, meeting on the research underway in the modular construction area.

Severe Accident Issues for Advanced Reactors

A thorough briefing on design features and issues associated with advanced reactor performance under severe accident conditions was presented. It was followed by a presentation of the elements of the severe accident program applicable to the advanced LWRs.

The ongoing research program is adequate for the ALWRs. We note that the magnitude of effort to develop and qualify codes for degraded core behavior-SCDAP/RELAP 5 and MELCOR is extensive. Further, the adequacy of CONTAIN for containment assessments will be assessed against data and the COMMIX code. This plan is proper but should emphasize evaluating how the lumped parameter representation of CONTAIN will suffice in the presence of strong buoyant effects. Two phenomena will be investigated which are specific to advanced water reactors.

- The performance and adequacy of submerging the bottom head of the reactor vessel in water. Specifically, the intensity and distribution of the downward facing heat flux will be investigated.
- The hydrogen combustion behavior in steam condensing environments. The condensation of steam can return an environment from the inerted to the compustible regime. Experiments will be performed with igniters and volumetric condensation rates typical of those in the ALWRs.

Overall, the severe accident program is well designed to cover conditions and phenomena applicable to ALWRs.

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AGENDA

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NSRRC ADVANCED REACTOR SUBCOMMITTEE

Friday, October 15, 1993

1.	Introduction	N. Todreas	8:00 am						
2.	Update on AP600 and SBWR Testing	L. Shotkin	8:15-10:15						
	 Vendor Test Programs Overview of AP600/SBWR test program/schedule NRC monitoring/review 								
	 AP600 Starus of ROSA V modifications Planned testing matrix and comparison to SPES and OSU tes Planned NRC testing in OSU 	ting matrices							
	 SBWR Contractor selection for small SBWR loop General description of SBWR loop Analysis plans/testing schedules 								
	BREAK		10:15-10:30						
3.	Advanced Reactor T/H Code Development and Assessment Plans	N. Lauben	10:30-11:30						
	 RELAFS (includes CONTAIN coupling) 								
	• TRAC								
	· RAMONA								
4.	Summary/Discussion of T/H Program	N. Todreas/ B. Sheron	11:30-12:00						
	LUNCH		12:00-1:00						
5.	Engineering Issues for Advanced Reactors	C. Serpan	1:00-2:00						
	Minimizing/preventing Generic Failure Mechanisms								
	 Positions Regarding Fatigue Design Criteria 								
	· Reliability of Active Components as a Function of Age								
6.	Passive System Reliability Program Update	B. Sheron	2:00-2:10						
7.	Severe Accident Issues for Advanced Reactors								
	 A. Discussion of design differences that could lead to different phenomena/EPRI design criteria Passive containment cooling Debris coolability In-vessel debris retention 	B. Sheron	2:10-2:50						
	BREAK		2:50-3:10						
	 B. Possible impacts of experimental work on advanced reactor performance MACE RASPLAV SURTSEY FARO 	F. Eltawila	3:10-4:10						
	C. Committee/staff discussion of on-going/future research on severe accident features in advanced reactors	N. Todreas/ B. Sheron	4:10-6:00						
	Adjourn		6:00 pm						

NSRRC WASTE SUBCOMMITTEE MEETING REPORT December 16 & 17, 1993 Center for Nuclear Waste Regulatory Analysis San Antonio, Texas

INTRODUCTION

The NSRRC Waste Subcommittee met at the Center for Nuclear Waste Regulatory Analysis (CNWRA) on December 16 & 17, 1993, in San Amonio, Texas. The focus of the meeting was on High Level Waste research and the agenda for the meeting is given in Appendix A. Committee members present were Professor F. Molz, Chairman, Drs. R. Vogel, H. Isbin, and D. Morrison (for December 16). Documents made available to the Subcommittee are noted in Appendix B. In addition, during the meeting, many recent Center preprints and reports were displayed for individual selections. The Subcommittee members also visited the Hydraulics Characterization Laboratory Facilities, and laboratories associated with corrosion research, sorption studies, and thermohydrology research. A representative from the State of Nevada was present at the meeting and laboratory visits.

DOE OVERVIEW & UPDATE

The CNWRA presented a brief overview and update on DOE's activities. Current planning is for DOE to submit its license application for the proposed high level waste repository at Yucca Mountain in the year 2001.

Planning for monitored retrievable storage (MRS) facilities is underway, and DOE is required to accept spent fuel starting in 1998. Staff members representing RES and NMSS agree that no research needs have been identified for licensing MRS facilities.

The concept of a high-temperature, extended dry repository is under active study by DOE. The feasibility of maintaining a dry repository for several additional centuries by raising the temperature is the study objective. Limited laboratory and field testing is planned in the near future.

NRC/DOE INTERACTION

The Subcommittee was introduced to the SYSTEMATIC REGULATORY ANALYSES (SRA) approach which has been used to develop 96 regulatory requirements based on the provisions of 10CFR60. The format and contents to be submitted by the Licensee (DOE) are prescribed in Format and Content Regulatory Guide (FCRG). The review process is then to be carried out in accordance with the License Application Review Plan (LARP). Research needs have been identified by NMSS, and NMSS and RES have identified basic information requirements, which have been called Key Technical Uncertainties (KTU's). Compliance with each regulatory requirement will be determined by resolving the KTU's. Discussions of KTU's spanned topics that need no further RES efforts to topics that will rely on DOE programs. The interactions with DOE were outlined including procedures for formal NMSS-DOE interfacing, and a diagram representing the process is shown in Figure 1. RES and NMSS are committed to periodic review of the KTU's. The Subcommittee wishes to be kept informed on the progress being made by RES in establishing consistency checks for KTU's, on developments which may lead to new KTU's, and the process for judging when a KTU has been resolved. To date, 58 KTU's have been identified.

OVERVIEW OF THE HLW RESEARCH PROGRAM

The KTU identification and evaluation process has led to the establishment of 12 major projects at the CNWRA. Parallel management, evaluation and information dissemination activities for each project are maintained by NRC/RES. Shown in Table 1 are the FY94 funding levels for each project, along with a planning/management category that is not discussed explicitly. Also, RES is working directly in two areas (Geochronology and Mantle Dynamics) not funded at the CNWRA, and is managing three projects at other locations. This additional information is also presented in Table 1. Total expenditures are \$4747K for the CNWRA, \$5700K for NRC/RES and \$500K for the projects at other locations, for an FY94 grand total of \$10,947,000.00.

In Figure 2, the CNWRA projects are shown within the administrative structure of that organization. If the CNWRA research projects are lumped into the discipline-oriented areas of Tectonics/Volcanism (Volcanism of the Basin and Range + Field Volcanism + Tectonics of the Basin and Range), Geochemistry (Geochemistry + Geochemical Natural Analogs + Sorption Mechanisms), Hydrology (Thermohydrology + Stochastic Flow and Transport + Regional Hydrology), Waste Package Studies, Performance Assessment and Seismic Rock Mechanics, the percent of total expenditures allocated to each area in FY94 are 24%, 21%, 17%, 13%, 11% and 11%, respectively. Including the HLW projects administered or performed directly by NRC-RES changes the respective percentages to 29%, 20%, 21%, 10%, 8% and 8%.

1) Volcanic Systems of the Basin and Range Research Project

This project has 3 major objectives: a) Put the Yucca Mountain area into a regional volcanic context; b) Develop and test probability models for igneous activity in the Yucca Mountain region; and c) Construct models for regional and local tectonic control on igneous activity. KTU's motivating the research are listed in Table 2.

Good progress is being made on this project. As mentioned in a previous report, the HLW Subcommittee endorses the use of a probabilistic approach in evaluating volcanic hazards.

2) Field Volcanism Research Project

This is a new project that focuses on field studies of volcanism at the Yucca Mountain site and at other sites having similar origins and climates. Recent accomplishments are listed in Table 3.

3) Tectonics Research Project

KTU's and objectives for the Tectonics Research Project are listed in Table 4. This is a key project that brings together earthquake, volcanism and crustal deformation. Taken together, these first three projects constitute a major research emphasis at the CNWRA.

4) Geochemistry Research Project

This is an older research project due to be phased out at the end of FY94. Objectives and KTU's are listed in Table 5. Phase out does not mean that geochemistry is being de-emphasized. The topic is a central theme in other projects, and new projects involving geochemistry are expected to be added in the near forure.

5) Sorption Modeling Research Project

As illustrated in Table 6, this project is composed of experimental and modeling sub-studies. KTU's are related to the phenomenon of retardation of various radionuclides. As with the geochemistry research in general, the subcommittee was concerned with the types of nuclides being studied. This will be discussed in more detail later in this report.

6) Seismic Rock Mechanics Research Project

This project seems to be progressing well. KTU's and related information are listed in Table 7. Included in this project is a cooperative study entitled the "International Co-operative Project for the Development of Coupled Models and their Validation against Experiments in Nuclear Waste Isolation (DECOVALEX)." The KTU, objectives and technical approach associated with the DECOVALEX effort are listed in Table 8.

7) Integrated Waste Package Experiments Project

As indicated by the KTU's and technical approach listed in Table 9, this project deals with many aspects of the waste package and the chemistry to which the package would be exposed in a repository. Much current research involves studies of c crosion chemistry related to candidate materials for HLW containers. Corrosion mechanisms considered include microbiologically-influenced corrosion.

8) Geochemical Natural Analogs Research Project

Task structure and KTU's for the Natural Analogs Research Project are listed in Table 10. In last years report, the HLW Subcommittee identified this area of study as one with a high potential for generation of new knowledge. Discussion along these lines continued during the 94 December meeting and will be presented later.

9) Performance Assessment Research Project

Performance Assessment is the project that ultimately is supposed to "bring inings together" into an overall assessment of repository performance. Information and capabilities developed in other projects should serve as input to the PA effort. PA capability should increase and become more refined as other research projects are completed and new projects started. The regulatory basis, KTU's and project structure associated with PA are listed in Table 11.

Shown in Figure 3 is a flow chart depicting the PA process. Because of the changing knowledge base, PA is an iterative process-meaning it is continuously updated as new ideas and insights become available. The current status of PA research for Yucca Mountain is shown in Table 12.

10) Stochastic Flow and Transport Research Project

This project is also due for phase out at the end of FY94. It deals with large-scale processes in unsaturated fractured rock, with a strong emphasis on mathematical modeling. Project objectives and KTU's are listed in Table 13.

In the case of the present research project, it does appear to the Committee that phase-out represents a shift in emphasis from computer-oriented to more experimental/field-oriented activities in the hydrology area. More will be said later concerning this observation.

11) Reg onal Hydrology Research Project

This project dealing with hydrologic processes in the Death Valley region is aimed at understanding regional-scale, hydrology-dependent phenomena in and around Yucca Mountain. Objectives and KTU's are listed in Table 14.

It appears to the committee that this project is important and will play a central role in the PA process. Knowledge from this research should ultimately define the overall hydrologic context within which PA develops. There are potentially important couplings with seismicity, tectonics, climate change and future regional development.

12) Thermohydrology Research Project

Objectives and KTU's for this research project are shown in Table 15. As mentioned in the DOE Overview, a high-temperature storage scenario is under active study. This increases the relevance and importance of thermohydrology research by the NRC, which in any case will play a key role in short-to intermediate-term PA.

In addition to the 12 HLW projects at the CNWRA, 3 projects are administered directly by the NRC. An overview of each is presented below.

 Validation Studies for Assessing Unsaturated Flow and Transport Through Fractured Rock and Scale Effects in Fluid Flow (Two Projects, University of Arizona)

Research in this subject area emphasizes field activities and is performed at three sites: the a) Covered Borehole Site, b) Deep Slant Borehole Site, and c) Queen Creek-Never Sweat Tunnel Site. Most of the research is basic experimental in nature and appears to be fundamental to the PA of a repository in unsaturated, fractured rock. The research on scale effects has potential longer-term importance. The various tasks and their technical objectives are listed in Tables 16 through 21.

14) Global Positioning Satellite Project (California Institute of Technology)

This project started in FY93, and it falls within the subject area of tectonic systems research. The overall objective is to measure directly the recent strain rates and displacements in the Yucca Mountain -Death Valley region and place this information within a historical context reaching back on the order of 16 million years. This is another field-oriented project that appears central and fundamental to PA of the proposed Yucca Mountain Repository.

OVERALL PROGRAM EVALUATIONS

In accordance with the Subcommittee's request, the Center provided updates on the progress being made in the research areas. Specific Subcommittee comments will be given later in this report. In general, the Subcommittee was impressed with the professionalism of the Center Staff, the progress of the work, the output of technical papers, and on the independence permitted in expressing individual

judgements. [For an example, see the comments on Geochemical Natural Analog Research.] The Center has a program for staff development and also undertakes some student work-study programs and master degree research. Currently the Center will be filling four positions for specialized experts and will be at maximum staffing (as restrained by budget requirements).

Staff members from RES were very helpful in the Subcommittee's discussions of the various research projects in clarifying issues, and in providing additional information on RES staffing, expertise, and budgets. The information collected will be used by the full Committee in preparing a response to the Commissioners covering commitments made by the NSRRC in its July 1993 meeting with the Commissioners.

The Subcommittee agrees with RES and the Center that research programs undertaken to establish independent expertise, data bases, and methodologies have to be thoroughly evaluated and documented to achieve acceptance by peers and the public in general. The Subcommittee in carrying out its oversight responsibilities believes that these goals are being achieved. This is the time to avoid any possible future semantic difficulties in interpreting what is meant by "uncertainties" and lack of knowledge in describing the processes for model and code assessments. [Currently, the term "validation" is used.] In particular, there needs to be a justifiable basis for selecting scenarios which can challenge the robustness of the proposed repository. All steps used in solicitation of expert judgements should involve an open process that can achieve resolution. The Subcommittee recommends that RES provide guidance on when and how peer reviews are to be made. The Subcommittee recognizes that Center and RES staff are already involved in making presentations at workshops and at national and international forums.

Based on information supplied at the 93 San Antonio Meeting, the Subcommittee has the distinct impression that the CNWRA is filling its role as a Federally Funded Research and Development Center and doing an excellent job overall. Staffing at the center is stable and of high quality. Presentations were well organized, on time and the research personnel have a solid grasp of their subject areas. NRC and SwRI administrators have worked together to provide an environment that has attracted and retained outstanding personnel who have become or are in the process of becoming experts in HLW problems. We think the NRC is spending its money well at the CNWRA.

The two university projects were of high quality also, and there appears to be no reason why more specialized university-based research can not be mixed appropriately with CNWRA activities. However, there is little doubt that the CNWRA is a superior organization for developing and maintaining a knowledge base, and providing continuity of support to the NRC over the long period of time demanded by the HLW program. A research/administrative unit is needed that can collect, create, maintain and update knowledge relevant to the Nation's HLW program. It must also be able to supply timely and unbiased support to the NRC. It is our opinion that the CNWRA is fulfilling this role.

RESEARCH EVALUATIONS

I. Tectonics/Volcanism Research

In dollar terms, approximately 29% of the HLW research effort falls in this area, making this topic, along with geochemistry and hydrology, one of the "big three" within the program. The current emphasis is consistent with past committee recommendations, and the research is well balanced. Much of the work is field-oriented and aimed at gathering basic information. The committee endorses this

orientation and cautions against moving too rapidly into highly theoretical activities such as solely computer model-based projects. The decision to use geographical information systems (GIS) to manage and display the accumulating data is viewed as a plus. One committee member pointed out that new and very high resolution satellite imagery data and technology is being declassified by the U.S. government. This may be of potential use in future tectonics research.

II. Geochemistry-Oriented Research

This research area, which includes natural analogs and sorption, commands about 20% of the HLW research funding. At our previous meeting the Committee expressed the concern that too much emphasis was being placed on uranium chemistry at the expense of more traic nuclides such as plutonium or neptunium. At the 93 San Antonio meeting, a report on the sorption modeling for high level waste performance assessment was presented. It was clear from the presentation that the work is centered on uranium behavior. The subcommittee again questions whether this emphasis is appropriate. The important concern is the migration of toxic radionuclides which might escape from the stored material. Various priority listings involving half life and toxicity of nuclides have been made. Uranium is not high on the list. The subcommittee therefore feels that the emphasis on uranium behavior may not be appropriate. When the speakers were questioned we understood one response to be along the following lines.

The argument, as we understand it, is that knowledge on uranium behavior can be applied to neptunium. The migration of this nuclide is of direct interest. However, the solution chemistry of neptunium is significantly different from that of uranium. This means that the behaviors in solution will be different.

It is recognized that experiments with highly toxic radionuclides are expensive, particularly in the United States where many regulatory requirements must be met. This may be playing a role in shifting the emphasis toward uranium. The argument was also made that uranium chemistry dominates or possibly bounds that of other radionuclides, and therefore should receive special study. The Subcommittee requests a written response to the concern that the study of radionuclide transport from a potential repository is weighed too heavily toward uranium. We also wish to be kept informed on the progress and evolving justification for research performed in this area.

For some time the NSRRC has maintained the opinion that natural analog studies promise to provide broad and useful information. A year ago the concern was also expressed that analog information was not being developed and incorporated into IPA in a sufficiently rapid manner. At the 93 San Antonio meeting, the Subcommittee had the benefit of discussions which focused on the difficulties of using natural analogs for assessing models used in PA's. However, limited objectives might be achievable at selected sites. The Center's report, "The Role of Natural Analogs in Geologic Disposal of High-Level Waste," September 1993, CNWRA 93-020, illustrates how dissenting views can be expressed by Center staff members. This is considered healthy. Specific sites being investigated by the Center are field sites at Pena Blanca and Akrotiri.

The Subcommittee now agrees that it will be extremely difficult and perhaps essentially impossible to use natural analog information to truly validate complex mathematical models of radionuclide transport. Even if a model could be made to fit a data set exactly, one could not be certain that the underlying physico-chemical process in the model was, in fact, that which mediated the natural development of the data set. There are too many free parameters. Collecting information on all these parameters is a field

activity that is very expensive.

It is probable that the major value of natural analog studies will be in evaluation of the "big picture" that results and the implications for repository behavior, rather than the collection of data sets specifically for model validation.

III. Hydrology Research

At approximately 21% of program expenditures, hydrology and related work receives major emphasis in the HLW research program. The committee was pleased to see that the study emphasis appears to be shifting somewhat from model/theoretical - based studies towards field/experimental-based studies. The ongoing work at Apache Leap by the University of Arizona seems particularly well conceived.

One of the presenters pointed out that although the official title of the Arizona contract is "Validation Studies for Assessing Unsaturated Flow and Transport Through Fractured Rock" the work being done is actually <u>calibration</u> not validation. To calibrate one varies parameters representing physical/chemical properties in order to fit a model to data. Validation requires that all physical/chemical properties be measured independent of the model and then model predictions be compared to data. If the comparison is good, the model may be claimed to be validated. Since lack of the ability to measure highly heterogeneous physical/chemical properties in the field is the main limitation to model validation, it is essentially impossible at the present time to truly validate complex hydrogeochemical transport models. This is why many individuals characterize models as "twols" that aid understanding, extrapolation in time, and scenario evaluation, but not as validated predictors of future events. The Committee asks the NRC to keep these points in mind and to maintain an evolving dialogue as the HLW research program progresses.

IV. Waste Package Research

Good progress has been made in crevice corrosion research. Tests ranging from a few months to five or more years are underway to verify predictions made on the basis of corrosion potentials. Slow strain rate testing of type 316 stainless steel and alloy 825 (ICALOY) are in progress or planned. Consideration is being given to possible enhanced corrosion under conditions of alternate wetting and drying. In visiting the laboratory, opportunities were provided for viewing tests in progress, types of specimens exposed, and further discussion of the approach being used in the research program.

A presentation was made on a literature survey of microbiologically induced corrosion (MIC). One conclusion is that it may be possible to determine that the biogenetics of the processes involved would not sustain a disruption of the waste package.

V. Performance Assessment Research

The Subcommittee continued its oversight of the Iterative Performance Assessment (IPA) program. The Phase II report is in draft form and should be available in Spring, 1994. The Subcommittee requests copies of this report. The agenda for this meeting, however, concentrated on the Center's research program involved only with Performance Assessment (PA). Discussions were held on the disruptive scenarios involving volcanic events, climatic change, seismo/tectonics, human intrusion, and combinations of these events. In response to the Subcommittee's request, the Center presented

comparisons on how these scenarios are handled by other organizations preparing PA's for the Yucca Mountain site. The Subcommittee commends the Center for the progress being made on PA research. Future possible changes in EFA requirements were discussed and how such changes (i.e., doses) can be accommodated in the research programs.

The Subcommittee called attention to RES's high priority severe accident research plan (SARP) and the strategies and methodologies being used to resolve high consequence but low probability issues. Experience acquired in these activities may be useful in developing rational approaches for treatment of disruptive scenarios.

VI. Seismic Rock Mechanics

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Research in the seismic rock mechanics area is aimed at developing the necessary expertise to evaluate DOE's anticipated application. The DECOVALEX program appears to be cost effective and helps maintain awareness of HLW rock mechanics research performed in the international community. The committee notes that DOE's tentative long-term, high-temperature storage concept has possible implications for seimsic rock mechanics research. Thus developments in the high temperature area should be followed closely.

APPENDICES A AND B

A: Meeting Agenda

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B: Documents Made Available to the Subcommittee

(A)

AGENDA

HLW RESEARCH PROGRAM REVIEW

NUCLEAR SAFETY RESEARCH REVIEW CONMITTEE

WASTE SUBCONMITTEE MEETING

Centor for Nuclear Waste Regulatory Analyses Southwest Research Institute 6220 Culebra Road, Building 189 San Antonio, Texas 78238-5166 December 16 through 17, 1993

Day 1 - December 16, 1993

2.2

PROGRAM OVERVIEW

8:00 am	Introductory Remarks	F. Molz/NSRRC
8:15 am	Opening Remarks	W. Patrick/CNWRA
8:20 am	Program Introduction and Review of Agenda/Structure	M. Silberberg/ NRC/RES
8:45 am	Status of DOE HLW Program	M. Knapp/NRC/NMSS
as 00:0	Organization and Staffing of the Center	B. Sagar/CIWRA
9:30 am	Identification and Prioritization of Work at CNWRA: The Systematic Regulatory Analysis Approach	P. Mackin/CNWRA
10:15 am	BREAK	
10:30 am	HLW Research Prioritization Considerations	W. Ott/NRC/RES
	GEOLOGIC SETTING	
10:50 am	Volcanology of the Basin & Range	B. HITT/CNVRA
11:20 am	Field Volcanism Project	C. Connor/CNWRA
11:50 am	LUNCH	
1:00 pm	Tectonics	5. Young/CNWRA
1:30 pm	Contemporaneous Deformation in the Death Valley Region	8. Wernicke/ Cal. Tech
2:00 pm	Unsaturated Mass Transport (Geochemistry)	W. Murphy/CNWRA

2:45	pm	BREAK	
3:00	pm	Sorption Mechanisms - Laboratory Studies - Modelling Sorption Phenomena	R. Pabalan/CNWRA
REPOS	ITORY	AND ENGINEERED BARRIER SYSTEMS	
3:45	20	Seismic Rock Mechanics Project - Project Overview Laboratory and Field Studies	S. Hsiung/CNWRA
		- DECOVALEX Coupled Modeling	M. Ahola/CNWRA
4:30	pm	Integrated Waste Package Experiments - Localized Corrosion Studies - Slow Strain Rate Testing - Naterials Stability	N. Sridhar/CNWRA
		- Microbiologically Influenced Corrosion	G. Cragnolino/ CNWRA
5:30	pa	ADJOURN	

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Day 2 - December 17, 1993

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8:00	3.0	Geochemical	Analogues	of	Transport	₩.	Murphy/CNWRA

PERFORMANCE ASSESSMENT AND HYDROLOGY

8:30	3.00	Introduction to Performance Assessment Hydrology Research	M. Silberberg/ NRC/RES
8:45	am	PA Research	R. Baca/CNWRA
9:15	8.00	Field Studies at the Apache Leap Tuff Site	R. Bassett/UAZ
10:00	8.00	BREAK	
10:15	mø	Stochastic Analysis of Flow & Transport	R. Bagtzoglou/ CNWRA
10:45	am	Relationship Between Permeability Field Test Data and Site Characterization Issues	A. Guzman/UA2
11:15	am	Regional Hydrology	G. Wittmeyer/CNWR
11:45	am	LUNCH	
1:00	pm	Laboratory Visits (Building 51)	A11

2:00 000	Thermohydrology Project (In Lab)	R. Green/CMWRA
2:30 pm	Summary Perspective (Back in Building 189)	M. Silberberg/ NRC/RES
2:45 pm	BREAK	
3:00 pm	Subcommittee Discussion	F. Nolz and Subcommittee
5.00 pm	AD TOURN	

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