

# CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

## TRIP REPORT

**SUBJECT:** United States Nuclear Waste Technical Review Board: Winter 2001 Meeting on Scientific and Technical Issues

**DATE/PLACE:** January 30–31, 2001; Amargosa Valley, Nevada

**AUTHORS:** D. Hughson, O. Pensado, and G. Wittmeyer

**DISTRIBUTION:**

**CNWRA**

W. Patrick  
CNWRA Directors  
CNWRA Element Managers  
D. Hughson  
O. Pensado  
G. Wittmeyer

**NRC-NMSS**

J. Linehan  
D. DeMarco  
E. Whitt  
B. Meehan  
J. Greeves  
J. Holonich  
B. Reamer  
T. Essig  
S. Wastler  
D. Brooks  
K. Stablein  
T. McCartin  
J. Firth  
D. Esh  
B. Leslie  
J. Pohle  
R. Codell

**SwRI**

T. Nagy (SwRI Contracts)

# **CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES**

---

## **TRIP REPORT**

**SUBJECT:** Nuclear Waste Technical Review Board: Winter 2001 Meeting, Scientific and Technical Issues

**DATE/PLACE:** January 30–31, 2001; Amargosa Valley, Nevada

**AUTHORS:** D. Hughson, O. Pensado, and G. Wittmeyer

### **PERSON(S) PRESENT:**

In addition to the three CNWRA staff, T. Ahn, B. Leslie, T. McCartin, B. Reamer, S. Wastler from NRC also attended. Approximately 200 people attended this meeting, including DOE YMP managers and investigators, representatives of the state of Nevada, Nye County, Clark County, and Eureka County, as well as members of the public representing themselves or non-governmental organizations.

### **BACKGROUND AND PURPOSES OF TRIP:**

The Nuclear Waste Technical Review Board (NWTRB) is charged by the U.S. Congress with reviewing the technical and scientific validity of the U.S. Department of Energy (DOE) activities related to civilian radioactive waste management. The objective of the meeting was to discuss DOE efforts to characterize Yucca Mountain, Nevada, as a possible location of a permanent repository for high-level radioactive waste. The overall thrust of the NWTRB's questions to DOE was the treatment of uncertainty in their safety assessments.

We attended this meeting for an update of the DOE YMP studies including the management transition to the Bechtel SAIC Company, to observe impressions by the NWTRB and the public, to acquire a better understanding of the TSPA-SR document, and to learn about the EPRI TSPA.

### **SUMMARY OF PERTINENT POINTS:**

January 30, 2001

Chairman Jared Cohon's prepared opening remarks emphasized the Board's four main priorities for the SR report. The following priority areas have been recommended by the NWTRB to the DOE:

- meaningful quantification of conservatisms and uncertainties in the performance assessment
- understanding of fundamental processes involved in predicting waste package corrosion rates
- evaluation of low temperature designs
- development of independent lines of evidence supporting the safety case

For this meeting, the NWTRB asked the DOE to address questions about waste package corrosion, transport in the unsaturated zone and the saturated zone, the total system performance assessment, and the repository design. Technical discussions on January 30, 2001 were aimed at responding to these questions.

Following Dr. Cohon's opening remarks, Jeff Taguchi, Commissioner of Nye County formally welcomed all attendees to Nye County and Amargosa Valley and then briefly discussed the County's role and position on the proposed Yucca Mountain repository. Taguchi emphasized that while Nye County is officially neutral on the YMP, they have always insisted that any decision be based on sound science. To that end, Nye County implemented the Early Warning Drilling Program, which has substantively contributed to the understanding of the saturated zone south of Yucca Mountain. Taguchi also noted that while 97% of Nye County is controlled by the Federal Government, Nye County, unlike the State of Nevada, has no right of refusal for the YMP or other Federal projects.

Lake Barrett, acting director for OCRWM, thanked Mr. Taguchi for his remarks and stated that the Nation owes much to Nye County for their hosting Federal facilities. Addressing the NWTRB, Barrett agreed that DOE must strengthen the technical bases for their safety case and indicated that OCWRM's communications with and responsiveness to the NWTRB need to be improved. Barrett stated that the YMP technical program will be improved by adherence to the principles of continuous learning, informed decision-making, and responsible stewardship. These principles will be applied to improve understanding and quantification of previously unquantified uncertainties, refining models of WP corrosion, developing a low temperature design for the proposed repository, and making greater use of natural and anthropogenic analog data to support PA models. To further bolster the legitimacy of their PA models and methods, DOE has commissioned the OECD/NEA to undertake a formal, independent peer review of the TSPA-SR. A. van Luik noted that they hope to have this peer review completed by September, 2001. In closing, Barrett confirmed that the SRCR will be delayed until after the IG has completed its investigation of the controversial SRCR overview report prepared by the previous M&O contractor.

Ken Hess, General Manager of Bechtel-SAIC updated the Board on the progress of contractor transition and introduced some of the senior Bechtel-SAIC staff attending the meeting. Hess said that Bechtel-SIAC will retain the "desired incumbent workforce" and that most of the transition was complete. Hess also stated that Bechtel-SAIC will use its experience in the nuclear power industry to imbue the YMP with the nuclear regulatory culture.

Guest speaker Jean-Claude Duplessy, member of the French National Scientific Evaluation Committee, spoke briefly about the French HLW program, which focuses on waste partitioning, transmutation, and conditioning, as well as on deep geological disposal. Dr. Duplessy asserted that the French HLW disposal programs relies 100% on the geology. This bold statement evoked approving nods from those interveners who believe the U.S. program places inordinate emphasis on the engineered barriers; however, the experience of the U.S. and most other European HLW programs suggest that once the French begin site characterization in earnest, the uncertainties inherent in the geology and hydrology will lead them to reconsider their stance.

In discussing the Regulatory and Performance Framework, Stephan Brocoum said there will either be a safe geological repository or "we will not go on." He gave a list of additional information to be completed this year (2001) for a possible SR decision. This work includes a repository design with lower operating temperatures, updated AMRs reflecting this cooler design, TSPA for the cooler design including new site characterization data, and identification and quantification of selected uncertainties. At the top of the list for additional characterization data is thermal/hydrologic/chemical (THC) testing and analyses. Also on this list are corrosion testing, radionuclide transport studies, engineered barrier/near-field environment studies, and

work to address agreements made at the Technical Exchanges with NRC to close KTIs. Regarding TSPA evaluation of individual barriers, Brocoum said this was done "for insight only." He also characterized the DOE's performance confirmation plan for compliance with proposed regulations as a "subset of a more extensive program." In responding to a question on an external peer-review of the TSPA-SR, Abe Van Luke (DOE) commented that negotiations are under way with the Nuclear Energy Agency (NEA) to carry out a peer review which could start early in April, 2001. The NEA peer-review panel will review Rev 00 of the TSPA-SR; however, it is planned that the panel will evaluate Rev 1 in time for Site Recommendation. In regard to schedule, Brocoum indicated that the DOE had no control over the schedule of the peer-review because the reviewers didn't "want to be rushed" and implied that if their review was to be schedule-driven the DOE should "go get someone else" to do the review. In response to P. Nelson (NWTRB) questions about how the TSPA-SR would be modified to simulate the alternate low temperature repository, R. Andrews stated that in addition to reducing the areal mass loading, the thermo-chemistry models will be revised. In response to a question by D. Bullen (NWTRB), R. Andrews indicated that Revision 1 of the TSPA-SR should be completed by July, 2001 and P. Russell (DOE) added that the results of a waste package corrosion peer-review will be included in the SR.

Gerald Gordon delivered a presentation aimed at responding to the question of the scientific basis for long-term extrapolation of the life of Alloy-22. Gordon summarized the basis for the long-term extrapolation, highlighted that the selected corrosion rates are "conservative" and that the test environments represent "bounding chemistries." G. Gordon added that tests in solutions containing lead (1% PbCl<sub>2</sub> added) indicate "no deleterious effects on localized corrosion or stress corrosion". Josephinite (a natural mineral containing Ni and Fe) will be studied by the DOE as a natural analog for Alloy-22 that has survived millennia. Alberto Sagiés (NWTRB) pointed out that the evidence for extrapolation is entirely empirical and that fundamental understanding of the corrosion processes and oxide stability is necessary to strengthen the predictions. G. Gordon responded that professors from several universities (Penn State University, MIT, University of Virginia) are being funded by the DOE to provide the fundamental understanding necessary to give validity to the long-term predictions. Although some results are expected to be produced within a year, G. Gordon agreed that this endeavor could take years, well into the performance confirmation program. R. Parizek (NWTRB) remains concerned that the assumed chemistry of the water in contact with the waste package is based on J-13 well water, not the UZ pore waters. In response to question by P. Nelson (NWTRB), Gordon indicated that efforts have begun on characterizing the chemistry of the dust that is expected in the emplacement drifts.

During the public comment period, Dr. Paz of JNL Environmental Services (Las Vegas, NV) gave a presentation on complex mixtures and risk assessments. Parts of his talk referred to tritium migration from underground explosions and formation of H<sub>2</sub>S by oxidation-reduction reactions. Dr. Paz also felt that YMP PAs should include the contribution of the millions of curies of radionuclides produced by underground testing as well as the chemical toxicity of the heavy metals released from the repository. Dr. Paz handed a proposal to Jared Cohon and promised copies of his overheads.

Sally Devlin of Pahrump, NV announced the formation of a new Nevada County, including Pahrump and extending north to the Mercury gate of the Nevada Test Site (NTS), to be called Mercury County. West Shoshone spiritual leader Corbin Harney spoke about killing of the animal life and the legacy we are leaving for our grandchildren. "Look at all the damage you've done", he said. "You've only been here for 600 years and look at all the damage you've done." C. Harney also insisted that the DOE must not use words such as "think, might, or should" when referring to the safety of the proposed repository. The public should have complete assurance that the repository is safe, Harney asserted, and the NWTRB must help "protect us against the DOE."

Leuren Moret, Past President of the Association for Women Geoscientists, read a letter she had written to Dr. Craig Walton, Professor of Philosophy and Dr. Alan Zundel, Assistant Professor of Political Science at University of Nevada Las Vegas in response to their report: Environmental Justice in the DOE Yucca Mountain DEIS: An Analysis of the Treatment of Environmental Justice Issues in the Dept. of Energy "Draft Environmental Impact Statement" For the Proposed Nuclear Waste Repository At Yucca Mountain and Other Documents. The complete text of this letter, and a link to the Walton and Zundel report, are available on the World Wide Web at <http://www.nativeweb.org/pages/legal/moret.html>.

Judy Treichel spoke last during this public comment period and asked a question that was not answered. During Brocoum's talk he said that the "SR process has been extended to address certain internal issues" referring to the ongoing Inspector General's investigation "and to address external concerns to enhance the technical basis for an SR decision." Treichel noted that the investigation had prevented release of the SRCR in December 2000 and wondered why the DOE felt there was sufficient site characterization to submit the SRCR in December 2000 but now had a list of site characterization activities that needed to be completed before the SR. The authors feel that DOE officials missed a good opportunity to foster greater public confidence when they chose not to respond to this simple question.

Following lunch, G.S. "Bo" Bodvarsson made a presentation on Unsaturated Zone (UZ) Flow and Transport in response to the Board's question, "[w]hat is the mean and variance of the travel time for a conservative species from the repository horizon to the water table?" In answer to this question, Bo gave a mean travel time of over 1000 years with a variance (on a log scale) of about one, determined using the calibrated UZ model of YM. As corroborating evidence, Bo cited geochemical data such as Cl distributions along drifts, calcite profiles along boreholes, Sr depletion in zeolites, and bomb-pulse  $^{36}\text{Cl}$  representing "fast flow". He said total Cl values, increased  $\text{Sr}^{87}/\text{Sr}^{86}$  ratios within the PTn, and  $^{36}\text{Cl}$  at or below background levels in the ESF all indicate that net infiltration is small and that the PTn slows and redistributes infiltration. Bo indicated that he thought travel times estimated in the UZ PMR REV00 are "conservative and bounding". Recent refinements in the UZ model have shown increased travel times of greater than 3000 years for 20% breakthrough versus 300 years and 7,000 years for 50% breakthrough versus 3700 years, where the shorter times are from the UZ PMR REV00. Two other major model refinements, model studies to examine seepage parameters and reducing the extent of perched water bodies, were presented with no comments regarding their effects on travel time. Another aspect of the capillary diversion phenomenon exploited by the seepage models is being investigated as potentially having a big impact on travel times. That aspect is the "shadow" of reduced flux that forms underneath the drifts as a consequence of diversion of unsaturated flow around the opening. This "shadow" is being investigated as a "potential diffusion barrier" resulting from reduced saturation and reduced advective flux. During questioning by the NWTRB, R. Parizek (NWTRB) emphasized the notion of this "shadow" zone as a potentially good investment of the project's time and money. He indicated that if the concept could be demonstrated by field or laboratory tests then the project could get several thousand years of "credit" from the natural system. Parizek also questioned Bodvarsson's on the role of the faults in UZ flow, noting that in some cases they appear to be barriers and in others fast conduits. D. Knopman (NWTRB) asked Bodvarsson to identify the "soft spots" in the UZ model. Bodvarsson responded to Knopman's questions with fairly lengthy discussions of (i) the effect of geologic structure, presence of perched water, and fracture saturations on estimates of travel times; (ii) the effects of THC processes on seepage between the pillars and fracture sealing by precipitates; and (iii) the need to address NRC concerns about accounting for evaporation during seepage tests.

The second presentation of the afternoon was by Al Eddebarh answering the Board's question, "[w]hat is the mean and variance of the travel time for a conservative species from the water table to the accessible environment 20 km down gradient of the repository?" Eddebarh stated that the mean breakthrough time

from the TSPA-SR for a conservative species from the water table to the accessible environment 20 km down gradient from the repository is 640 years using median parameter values, and 900 years using mean parameter values. However, more current data and refinements in the model have resulted in a mean breakthrough time of 1300 years. The most important parameter for the SZ model is specific discharge. Low, medium, and high flux specific discharge cases, ranging over about 3 orders of magnitude from less than 0.1 to almost 10 m/yr, were used in the SZ model. Probabilities used to weight these 3 discrete specific discharge fluxes for TSPA are based on expert elicitation. Knopman (NWTRB) asked whether the current SZ models take credit for dispersion, to which Eddebarh responded that no credit is taken and it is assumed that all mass crossing the 20 km “fence” is dispersed into the water pumped by the critical group. P. Craig (NWTRB) was very concerned about the large range of travel times estimated for the SZ and expressed disappointment over DOE reliance on expert elicitation for estimates of the Darcy flux

Robert W. Andrews responded to the question by the NWTRB about the role of different barriers in the Total System Performance Assessment. Andrews concluded that the computed dose tends to be proportional to the WP degraded surface area. For the base case, the crack area is greater than the general-corrosion degraded area or “patch area” at times less than 40,000 yr. This causes diffusive release through cracks to be the predominant cause of dose at times less than 40,000 yr. At times greater than 40,000 yr, advective release through the “patch area” and diffusive release through the crack area contribute in a similar extent to the dose. Andrews presented results from other cases such as juvenile failures, all-breached WPs, and igneous intrusion. In the igneous intrusion case, Andrews discussed results for an intrusive event where 200 waste packages plus drip shield and cladding were neutralized, not including the  $1.6 \times 10^{-8} \text{ yr}^{-1}$  frequency for igneous events. The resulting maximum of the mean dose rate was  $\sim 0.5 \text{ rem/yr}$  in 50,000 years. For the other cases, maximum dose rates did not exceed 1 rem/yr in 100,000 years. J. Cohon asked the effect of removing the WP, and Andrews responded that the dose rate could be obtained by multiplying the all-breached-WPs case by 60 (the associated maximum dose rate would be of the order of 30 rem/yr). In response to a question by D. Bullen (NWTRB), Andrews replied that the difference in dose for the extrusive versus intrusive igneous scenario was about 10 rem for the unweighted dose.

Paul Harrington gave the last presentation of the day addressing the NWTRB question of the repository design and design objectives. Harrington’s presentation was quite thorough and provoked few substantive technical questions from the NWTRB—the lateness of the hour may also account for the dearth of good questions. Nonetheless, J. Cohon (NWTRB) took issue with a bullet item on one of Harrington’s slides that appeared to tie the risk posed by the repository to the probability of its being licensed. Cohon (NWTRB) asserted that such a statement only serves to invite public cynicism.

January 31, 2001

Mark Peters gave a fairly broad overview of those Scientific and Engineering tests that have been planned and those that are already underway. The Drift Scale Heater Test underway in Alcove 5 is in its fourth year of heating and cool down is planned to start in December 2001. At this time Peters said the boiling front is about 3 m into the rock. Regarding the analyses to resolve differences in LANL and LLNL measured  $^{36}\text{Cl}$  in the ESF, he said a final report was scheduled for later this calendar year. At the Alcove 8 – Niche 3 seepage test, water application began Aug 28, 2000 and 773 L have been applied in 120 days. There has been no seepage observed in Niche 3 to date. Pre- and post- excavation air permeability tests have been completed in Niche 5 in the ECRB prior to conducting liquid injection seepage tests. Post-excavation geometric mean permeabilities are on the order of  $1.0 \times 10^{-12}$  to  $3.8 \times 10^{-11} \text{ m}^2$  and preliminary indications are that the Tptll is less susceptible to the so-called “excavation-induced permeability enhancement” phenomenon than the Tptmn. Systematic hydrological characterization is underway in the ECRB. Tests will be conducted in 20

m long boreholes at regularly spaced intervals along the drift to establish distributions of hydrological properties and liquid release seepage tests will be conducted in low angle boreholes at the crown every 30 m along the drift. Gas tracer tests will be conducted in horizontal boreholes extending from the drift rib every 90 m. Regarding the sealed ECRB, Peters said the most recent entry was late in January 2001 and that "there was no evidence of seepage", the condensation was likely due to high humidity and small temperature variations, and that organic material was declining in abundance. D. Knopman (NWTRB) asked Peters about how wet the dripcloth's were. "Soaked", she asked and he indicated that was true. This exchange was picked up by Mary Manning and reported in the Las Vegas Sun (<http://www.lasvegassun.com/sunbin/stories/text/2001/feb/01/511378606.html>). At Busted Butte, injection stopped October 30, 2000 and overcoring was completed January 2001. Mineback is planned to start in February 2001. One of the conclusions from the test is that heterogeneity needs to be included in the model of transport processes at Busted Butte. Peters presented some of the work being done as part of the Nye County Early Warning Drilling Program. Two of three planned single-well tracer tests at the Alluvial Testing Complex (ATC) have been completed and the single well hydraulic tests are complete. The remaining injection and monitoring wells and Phase III wells are planned for installation during FY01. Cross-hole hydraulic and tracer tests are planned to start in late FY01. Switching to the Engineered Barrier Systems testing at the Atlas Facility in North Las Vegas, Peters said Phase I of the ventilation test was completed in December 2000, Phase II is planned to start in February 2001, and Phase III is planned to start in the summer of 2001. Column testing of THC processes appeared to reach steady state with pH stabilizing at 10.3. Tests of the waste package materials were characterized as "long-term" if underway for more than 2 years. A. Sagüés (NWTRB) asked a question about repeatability or reproducibility of the tests and used the column test as an example. Sagüés indicated that reproducibility of test results was a fundamental aspect of the scientific method. Peters replied that test reproducibility would have to be considered on a case by case basis and that he was leaving that aspect of the testing program up to the individual scientists "who are world-class", he said, "to make that call." D. Runnells (NWTRB) was concerned that LLNL and LANL will wind up agreeing on a single method for conducting <sup>36</sup>Cl analysis in the UZ, but will fail to unequivocally determine whether there are or are not fast paths through the mountain. D. Knopman (NWTRB) further questioned the basis for Peters's assertion that the water saturating the drip cloths in the bulkheaded portion of the ECRB is from condensation and not from dripping. In response, Peters described the large quantity of temperature, windspeed, and barometric data obtained from the ECRB, but did not appear to directly answer Knopman's question.

Paul Herrington discussed the repository design evolution focusing on a new design for the closure lids for the inner waste package (stainless steel), which now employs a shear ring. A. Sagüés (NWTRB) suggested that inclusion of such a shear ring could be detrimental to the performance of the waste package. Herrington responded by saying that "no credit is taken for the stainless steel inner canister in the TSPA computations." Sagüés used Herrington's response as an opportunity to describe how conservative modeling can cloud design selection. If the stainless steel overpack can be used as a radionuclide barrier, then it must be so, and a good design should be selected to accomplish containment. According to Herrington, construction of the stainless steel canister is facilitated by the inclusion of a shear ring. L. Barrett (DOE) appeared to discount the shear ring design option, when he pointedly remarked that the integrity of a potential barrier will not be compromised.

William Boyle discussed the treatment of unquantified uncertainties (UU). Boyle summarized results from a project aimed at reducing uncertainties in the TSPA. The selection of parameter distributions and the choice of "bounding" values are being revised to more accurately reflect the technical expert's best estimate of uncertainty. Boyle presented some preliminary results from this re-evaluation process. Results from this project will be published in an integrated report, which will include not only unquantified uncertainties but also a review of the quantified uncertainties, conservatisms, and the results from sensitivity analyses. D.

Knopman (NWTRB) asked about model uncertainty, since evidently it cannot be addressed by Boyle's approach to re-evaluating UU. Boyle responded that model discrimination is being carried out as part of the TSPA model building. Models are compared to data, the model predictions are evaluated, and the "best" model is selected for use in the TSPA. J. Cohon (NWTRB) stated that the DOE has made significant progress in addressing previously unquantified uncertainties, but then pointed out that the new model for Np solubility no longer includes the largest measured value. P. Craig (NWTRB) cautioned Boyle not to assume that order-of-magnitude variations imply that the measured data are log-normal.

A round-table discussion was carried out with the topic "decision-making in a learning environment" lead by R. Dyer, R. Andrews, L. Barrett, and W. Boyle. D. Bullen (NWTRB) inquired about the action plan in case "bad data" are discovered during the performance confirmation. Dyer responded that the Test Evaluation Plan has information in that regard and more detailed information is yet to be developed. D. Knopman (NWTRB) applauded the YMP's embrace of the "learning approach", but feared that DOE may have a hard time losing their "compliance organization" mind set. J. Cohon (NWTRB) followed up on Knopman's observation, noting that the culture of compliance may stifle innovation—Cohon seemed to imply that by focusing too much on TSPA, DOE may miss the "bigger (public) picture." P. Craig (NWTRB) complained that the sheer volume of paper produced by the YMP made it hard (for him) to identify the bottom line of DOE's findings.

The round table discussion was continued by a presentation of the Repository Safety Strategy by W. Boyle. Boyle ended his presentation with a question to the NWTRB dealing with the meaning of independent multiple lines of evidence. Boyle complemented his question with a couple of examples where it was not evident the independence aspect of the lines of evidence. Ulterior discussion spun around this topic. D. Bullen (NWTRB) mentioned the existence of a simplified TSPA. Bob Andrews confirmed the existence of the simplified TSPA and promised release in March, 2001.

Tom Buqo of Nye County presented progress of the Early Drilling Warning Program. Phase III plans include geophysics and chemical sampling at well 2DB, 6000 ft from the ATC. This well has a significant "lost circulation" zone in the lowermost Tertiary unit. At the ATC, cross-hole tests will be conducted between two 1500 ft wells with water levels in the alluvium. A 48 hour pumping test will be completed before the tracer tests. At well 22S on the NTS next to 40 Mile Wash another well is planned to be drilled to a depth of about 2000 ft. Wells 15D and 12D near the Highway 95 fault will be used in a future pumping test to examine drawdown across the fault. Buqo said Nye County had recently filed 10 applications for municipal water diversions. A significant motivation for these diversion applications appears to be acquisition of water rights in the arid region. Buqo digressed from his talk on Yucca Mountain topics briefly to discuss the shenanigans of water speculators trying to profit by selling water to California and attempts by the Las Vegas Municipal Water District to claim water rights over a large portion of the state. Buqo also talked about plans to archive water samples, annual monitoring of wells, surface geophysics to delineate the configuration of the paleozoic surface, and aero-magnetic surveys of three East-West trending features between Jackass Flats and Lathrop Wells. Buqo commented on DOE's FEP 1.4.07.01.00 (water management activities). According to Buqo, screening out this FEP on the basis of regulatory disposition is not adequate. He argued that water demands will increase in the future, and all of the water available will be put to beneficial use by the community (~50 yr in the future). This may have consequences on the saturated flow and transport in the proposed YM system.

John Kessler presented results from EPRI's fifth performance assessment. Kessler mentioned that EPRI planned to release a white paper on the particle tracking method used by DOE in the SZ model. Apparently EPRI believes this particle tracking method is incorrect and results in overly conservative travel times.

Kessler showed results from an analysis EPRI conducted to measure the contribution made by any barrier to overall performance. He concluded that the natural and engineered systems are both important for the proposed repository at YM. He also concluded that "DOE's TSPA is conservative." A. Sagüés (NWTRB) challenged results indicating 50<sup>th</sup> percentile failure times for cladding greater than 30,000 years. Sagüés mentioned that this result is difficult to believe for a material that is only a fraction of millimeter thick. Kessler responded that the researchers who made these estimates (Shoosmith and Massari) know their subject and that they should have defensible arguments to back up the results.

Other speakers during the public comment periods were a representative of Citizen's Alert from Pahrump, two members of the Shundahai Network (<http://www.shundahai.org/>) and Jerry Symanski. Comments included transportation safety concerns, the Ruby Valley Treaty of 1863, and outrage that Nevada should be singled out as the only site considered for a HLW facility. Symanski talked about fluid inclusion studies presented at the GSA 2000 meeting in Reno, Nevada showing that the probability of hydrothermal upwelling is greater than  $10^{-6}$ /yr.

## **IMPRESSIONS/CONCLUSIONS**

The effort by the DOE in responding to the five technical questions by the NWTRB around which this meeting was centered is to be noted.

It is evident that the NWTRB has had significant influence in the program by causing DOE

- consider cold designs
- have a more critical evaluation of non-considered uncertainties
- aim efforts at the evaluation of the long-term stability of Alloy-22

With respect to the presentation by G. Gordon, it is not clear how studies on josephinite will enhance the basis for long-term extrapolation. The protective oxide on Alloy 22 is chromium oxide, not nickel or iron oxide. And josephinite does not contain Cr. G. Gordon mentioned several times that the long-term extrapolation was based on empirical and theoretical evidence. However, A. Sagüés pointed out that the evidence is entirely empirical and that no mechanistic model has been established.

In the UZ flow and transport presentation, Bodvarsson mentioned that recent refinements in the UZ model have shown increased travel times of greater than 3,000 years for 20% breakthrough versus 300 years, and 7,000 years for 50% breakthrough versus 3,700 years, where the shorter times are from the UZ PMR REV00. However, it is not clear exactly what refinements are providing the increased travel times since the major model refinements of including the effects of fractures in the Calico Hills vitric unit and examining the effects of fault properties were presented as showing "no significant difference."

Regarding Paul Harrington's presentations on Repository Design Objectives and Repository Design Evolution, there is a seemingly unquestioned assumption in these presentations that appears to be based more on the NWTRB position than on any careful evaluation. From the Repository Design Objectives slide page 8 it is stated that "[l]ower temperatures may reduce uncertainties in localized corrosion, rock alteration, and coupled processes in the natural system" and on page 10 it is stated that "[l]ow thermal loading design is a surrogate for decreased uncertainty in the repository design." In addition, from the Repository Design Evolution slide page 17 it is asserted that "[m]uch of the recent engineering effort is directed at reducing uncertainties through identification of various approaches to achieving a lower temperature design." These statements should be accompanied by a caveat, since the uncertainty reduction achieved by constructing a below-boiling repository appears wholly based on observations of above-boiling processes. Uncertainties

in below-boiling processes may, in fact, increase. For example, recently the sealed-off ECRB was entered and dripping was observed at many locations—the drip cloth's were completely saturated, and rock bolts and parts of the conveyor belt were corroded. Most opinions from the project say this is condensation resulting from small thermal gradients in the drift and temperature variations between metal and rock. However, there is significant uncertainty and no one knows if or when the dripping in the sealed ECRB will end. In the cooler repository design there is to be about a 2 m spacing between WPs and the mean WP temperature is to remain below 85°C. But variations in thermal output from various waste forms creates the possibility that numerous thermal convection cells could form and condensate dripping could be widespread. If condensate dripping occurs from the rock bolts, which appears likely, it could react with the metal and grout and not be entirely benign to the engineered barriers. This example is only meant to illustrate that there are uncertainties with lower temperature designs and to assume that total uncertainty is reduced with reduced temperatures may not be entirely correct.

The premise behind the validity of the treatment as discussed by William J. Boyle is that the TSPA is a reasonably complete model. Boyle's approach does not address alternative conceptual models and processes not accounted for by the TSPA. Model discrimination as envisioned by Boyle (see above text) does not account for the fact that experimental data may be not be available and that current capability to model complex phenomena is limited. The involved time scales add another layer of difficulty to model discrimination. It must be recognized that the treatment of UU is a difficult problem.

**PROBLEMS ENCOUNTERED:** None.

**PENDING ACTIONS:** None.

**RECOMMENDATIONS:**

Try to obtain the "simplified TSPA" when available. Continue attending future NWTRB meetings.

**AUTHORS:**

Debra Hughson  
D. Hughson, Sr. Research Scientist

Date: Feb 27 2001

O. Pensado  
O. Pensado, Research Engineer

Date: 2/27/2001

G. Wittmeyer  
G. Wittmeyer, Manager  
Performance Assessment Element

Date: 2/26/2001

**CONCURRENCE:**

Budhi Sagar  
Budhi Sagar, Technical Director

Date: 2/28/2001