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CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Trip to ACNW Meeting (20-5708-861)

DATE/PLACE: September 25 through 27, 1996; Las Vegas, NV

AUTHOR: S. Stothoff

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PERSONS PRESENT:

The meeting was attended by S. Stothoff (CNWRA); J. Bradbury (NRC); Advisory Committee on Nuclear Waste (ACNW) members, associated staff members and consultants; several DOE staff and contractors; and interested parties from Nye County and the State of Nevada. Approximately 50 persons were present in total.

BACKGROUND AND PURPOSE OF TRIP:

An ACNW open meeting took place September 26 and 27, 1996, consisting of presentations by the DOE, DOE contractors, and ACNW consultants. The meeting was held to update the ACNW on the status of activities related to (i) flow and radionuclide transport at Yucca Mountain (YM); (ii) site characterization and performance assessment (PA); and (iii) repository design, as well as allowing normal ACNW activities such as preparation of reports and other committee activities. The presentations summarized the current status of issues related to flow and transport at YM, including PA and repository design. All of the issues are extremely significant for repository performance; accordingly, the meeting is of great interest to the NRC and CNWRA.

SUMMARY OF PERTINENT POINTS:

1. Agenda

The agenda for the meeting is attached. Hard copies of the overhead slides can be obtained from the author.

2. ACNW Members and Consultants

The ACNW comprises P. Pomeroy (chair), B. Garrick, W. Hinze, and G. Hornberger; ACNW staff members present comprise A. Campbell, V. Colton-Bradley, L. Deering, and H. Larson; ACNW consultants comprise R. Bassett [University of Arizona (UAZ)] and M. Steindler.

3. Presenters

DOE representatives made presentations. DOE contractors making presentations represented Los Alamos National Laboratory (LANL), Lawrence Berkeley National Laboratory (LBL), and Lawrence Livermore

National Laboratory (LLNL). In addition, representatives of Electric Power Research Institute (EPRI), Nye County, and UAZ made presentations.

SUMMARY OF ACTIVITIES:

The author attended all presentations and discussions not involved with ACNW report preparation or future agenda.

IMPRESSIONS/CONCLUSIONS:

1. Overall Impressions

The ACNW meeting was well run and quite informative. The DOE presenters were open in their presentations and the ACNW members consistently asked cogent, to-the-point questions that elicited frank responses.

2. Noteworthy Highlights

The current thinking on repository design uses (i) loads of 80 to 120 MTU/acre (as hot as possible), (ii) line emplacement in drifts, (iii) backfill, and (iv) concrete lining. The reference design limits the repository to the region between the Solitario Canyon, Ghost Dance, and Drill Hole Wash Faults, with a 60-m offset from the faults (120 m for the Ghost Dance Fault).

Five independent estimates of infiltration flux are now in the range of just under 1 mm/yr to 10 mm/yr, with the reference number on the order of 5 to 7 mm/yr.

Information on site-scale parameters indicates that fault zones are highly permeable to gas, more in the horizontal than the vertical. There are tendencies towards using permeabilities in the TSw unit orders of magnitude higher than measured due to calibration (with the consequence that little fracture flow would exist in the TSw despite the higher infiltration rates).

(A few) new experiments on fracture coatings show little or no impedience to radionuclide diffusion and this information may be used in TSPA-VA.

Reaction modeling suggests that immediately adjacent to the waste packages, porosity may increase from 10 percent to as much as 70 percent; however, minimal impacts are expected 5 to 10 m away. There was no discussion of the impact on structural integrity.

Nye County is proposing to drill up to 8 or 9 boreholes in the upcoming FY if the DOE will fund the activity. The boreholes would generally be south of the repository, with perhaps a slant borehole in Solitario Canyon.

3. Formal Presentations

J. Fabryka-Martin and B. Robinson (LANL) presented recent isotopic evidence for fracture flow at YM. After discussing the Fabryka-Martin ESF ^{36}Cl observations and planned future data collection, ongoing modeling work and recent results were presented. Reconstructed ^{14}C and ^{36}Cl atmospheric traces were used to construct an isotope correlation curve, which was compared with the samples where both ^{14}C and ^{36}Cl were measured to suggest that perched waters tend to be between 3 and 10 ky in age. Transport modeling work using a dual-continuum flow model also suggests that bomb-pulse ^{36}Cl in the ESF is

consistent with increased fracture permeability in the PTn in combination with infiltration rates of 1 mm/yr or more. Infiltration rates between 1 and 10 mm/yr are claimed to be required to match ESF observations. Future work will sample ^{129}I and ^{99}Tc, but only in a confirmatory mode.

G. Bodvarsson (LBNL) presented flow modeling and percolation work using the 3D site-scale unsaturated zone (UZ) model. Bodvarsson emphasized the integratory nature of the model, in which calibrations rely on observed gas pressure fluctuations, temperature profiles, core data, and surface infiltration maps. Several lines of evidence were compared for the purposes of estimating percolation flux (i.e., infiltration maps, saturations, isotopic data, fracture coatings, temperature data, and perched water data), all of which suggest that the areal-average percolation flux is in the range of just under 1 mm/yr to 10 mm/yr, with a suggested value of 5 mm/yr. The calibrations also suggest that fault zones have high horizontal permeabilities but low vertical permeabilities. Using the model, significant lateral flow occurs with low (0.1 mm/yr) infiltration, but using the latest A. Flint estimate (about 7 mm/yr for infiltration) lateral flow is de-emphasized. New 2D drift-scale simulations were briefly discussed to provide input into TSPA activities. A proposed study plan was outlined that would provide a nest of lateral boreholes in the vicinity of the thermal alcove to examine moisture flow patterns. Under questioning, Bodvarsson stated that the ECM is only appropriate for steady-state and gas-flow simulations; dual- or multiple-continuum approaches are more generally appropriate.

R. Bassett (UAZ) [no distributed overheads] discussed work at the Apache Leap Test Site and insights gained from the work. He based most of the presentation on observations at the Queen Creek site, where a two-day response time subsequent to creek flow is found for fracture flow 150 m below Queen Creek. At this site, the geochemistry is extremely important in unraveling whether perched water or meteoric water is flowing. It appears that there is very little imbibition from the fractures into the matrix at the site, and the matrix is noticeably moister near fractures. Bassett also discussed a vacuum-extraction method developed at UAZ that is substantially more effective than core squeezing for extracting samples. There was discussion of using this equipment or procedure at YM to enable additional ^{14}C sampling.

W. Glassley (LLNL) discussed near-field chemical effects and their impacts on release and transport. A method for estimating the region in which kinetic models would be required was presented.
Simulations of geochemistry evolution within the boiling and condensation zones were presented, and it was concluded that the rock dominates unless high-volume flow zones develop. Detailed chemistry evolution simulations suggest that porosity near the waste packages may increase to 70 percent, although by 5 m relatively little change may occur. Some discussion of cement and waste-package effects on water-waste interaction took place, and again water-rock interactions were dominated by rock.

B. Robinson [for I. Triay (LANL)] discussed laboratory experiments examining radionuclide transport through saturated core samples with fractures, particularly emphasizing retardation and diffusion through fracture coatings. One set of experiments fed a solution of ^{3}H, ^{95}Tc, or ^{237}Np through a 5 to 10 cm core sample containing a natural coated or uncoated fracture, and examined the recovery rates for the radionuclide. The other set of experiments oriented the fracture normal to the flow to examine diffusion from the fracture to the matrix. Robinson claims that based on the experiments, there is no evidence that fracture coatings prevent diffusion from the fracture to the matrix, and fracture flow does not necessarily result in a fast pathway for actinide migration. Upon questioning, Robinson admitted that unsaturated conditions would see smaller diffusivities, but the fracture would presumably see a near-saturation skin in the matrix.

J. Kessler (EPRI) discussed reasonable approaches for handling colloid-aided transport in fractures. He feels that although most colloids are probably nearly immobile in the UZ, this would be very difficult to demonstrate defensibly. If the colloids did migrate, they would likely move along an air-water interface

will be tentatively included in the reference design; drip shields will not be used. It will be important to take credit for burnup. A line-drift strategy is tentatively going to be used. There may be a pool for fuel handling. The waste package emplacement strategy calls for a low pedestal and a gantry able to emplace and retrieve WPs in back of other WPs.

M. Murphy (Nye County) discussed future borehole installation plans that would be undergone in the next FY if a funding proposal to the DOE is successful. These include 2 deep boreholes, 3 shallower UZ and SZ boreholes, and 4 connected with or complementary to the C-well complex. Perhaps one would be a slant borehole in Solitario Canyon, with the area south (downgradient) of the repository being of particular concern. P. Montazer (Nye County) discussed temperature, pressure, and relative humidity monitoring from instruments located in boreholes NRG-4 and ONC-1, and on the TBM. He interprets the readings to have two high-permeability faults connecting ONC-1 with the ESF (note: this is consistent with the interpretations of G. Bodvarsson). In the ESF, there is a temperature and relative humidity gradient from the walls to the center of the tunnel associated with ventilation. Montazer proposed that a passive natural-ventilation scheme be considered.

4. Question-and-answer session

An opportunity was provided to allow the ACNW panel and consultants to ask questions of A. VanLuik, J. Fabryka-Martin, G. Bodvarsson, B. Robinson, and R. Andrews. The thrust of the session was on relating site characterization to performance assessment, and relating performance assessment to design. Concerns with feedback between PA and design surfaced repeatedly throughout the meeting, with repeated assurances that indeed there was communication. The 3D model was probed, to find out critical parameters and insights (matrix permeability, fracture air-entry pressure, coupled gas/heat/moisture are all important), why abstractions from the 3D model are used (run times on the order of overnight to a week), incorporation of heterogeneity (C. Rautman from Sandia National Laboratories is providing interpretations of stochastic parameter variation). Strategies for handling the lack of thermal data were examined, since heater tests will not have provided data by the time the TSPA-VA exercise is done. Bodvarsson admitted that the single-heater test will not provide much information, but his experience in the geothermal area will help. Bodvarsson believes that coupling (other than TH coupling) will not have tremendous impact due to the extremely dense fracturing and high fracture permeabilities, since it would take bulk-permeability reductions of several orders of magnitude to strongly affect results. M. Steindler commented that he was amazed that iron and fluorine were being ignored in analyses and that concrete was being considered due to the caustic effect. It was brought out that expert elicitation will be used primarily to provide model parameters, so it will be a series of small-scale exercises. The idea of a peer-review panel also providing input to the TSPA-VA document generation (i.e., a management role) was questioned; VanLuik noted that the panel is to be selected to be sensitive to this issue.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

RECOMMENDATIONS:

None.

(i.e., film flow or bubbles) in fractures until reaching the water table. Migration in the saturated zone (SZ) is much better understood and experiments are much easier, so Kessler feels that a defensible approach might be to transport the colloids instantaneously to the water table and model SZ transport from there.

B. Robinson (LANL) presented 2D simulations addressing coupled flow and transport modeling. The ECM and dual-permeability simulations use an abstracted release rate from the waste package as a function of infiltration rate. ECM simulations are used for ranking radionuclides in terms of dose; ^{237}Np is the worst of the four considered. Some lateral flow along the Calico Hills formation was observed with the most recent properties from the 3D model, so that the retardation afforded by the zeolites may be bypassed. Comparing simulations using the USGS infiltration map with simulations using constant infiltration over the surface, much larger peaks in concentration arriving at the water table are observed. Essentially no impact on ^{237}Np flux is observed due to heating, assuming that material properties are unchanged due to thermal alteration. Reactive-transport models were used to examine variation in UZ concentrations due to pH and water chemistry.

A. VanLuik (DOE) discussed current work on implementing process-level models into TSPA. Examples of current work include UZ flow models, thermal hydrology models, and waste-package degradation models, with sensitivity analyses being a feature of the approach. VanLuik presented an example sensitivity analysis, using "conservative" and "optimistic" cases both based on TSPA95 with revised columns, a percolation flux of 7 mm/yr, and a dual-permeability flow model. The cases differed in dripping fluxes, particle-matrix transition rates, and waste-package protection. The conservative case generated doses similar to TSPA-1995, while the optimistic (but put forth as more realistic) case had doses orders of magnitude smaller. Apparently the Markov-transition transport model will be replaced with abstracted transport simulations in TSPA-VA. Schedules for TSPA-VA were also presented.

J. Bailey (CRWMS Management and Operations Contractor) discussed the current work on designing the repository. The strategy is to provide a single reference design for the viability assessment (VA), environmental impact statement (EIS), and license application (LA). Current focus is on issues impacting the VA (e.g., structure of the repository, corrosion-model inputs) as well as features that have radiological impact and do not have a regulatory precedent (e.g., fuel handling facilities, waste package design, ground support systems). Design issues include:

- Thermal loading strategy
- EBS enhancements
- Criticality control (fillers, control rods, WP load, DU)
- Drift support (steel, cast-in-place or precast concrete)
- Performance confirmation (monitoring and sampling)
- Retrievability
- Dry versus pool waste handling
- Disposal of site-generated waste (i.e., from fuel handling)
- Mapping during drift excavation
- Underground remote handling

Current thinking for the reference design was presented as well. The strategy will be to use high heat loads (80 to 120 MTU/acre). With a ventilation shaft underlying the drifts and vertical ventilation shafts to the drift, the repository would lie wholly between the Solitario Canyon Fault and the Ghost Dance Fault, with a 120-m offset from the Ghost Dance Fault and 60-m offsets from all other faults, leaving a 10 percent margin. If expansion is necessary, either from additional loads or poor ground conditions, first plans for expansion are north of Drill Hole Wash. Backfill does not appear to give much benefit but

ATTACHMENTS:

1. Meeting Agenda

See author for copies of presentation overheads.

REFERENCES:

None.

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