Office of Nuclear Material Safety and Safeguards, Office of the General Counsel
and Center for Nuclear Waste Regulatory Analyses,
Joint Trip Report

SUBJECT: Participation in Field Trip to Yucca Mountain Site and Vicinity, Nevada and California

DATE: October 25 -27, 2005

PLACE: Overnight in Las Vegas and Pahrump, Nevada

AUTHORS: Shannon Colton, CNWRA
Al Csontos, NMSS
Jim Durham, CNWRA
Nathan Franklin, CNWRA
Christopher Grossman, NMSS
Philip Justus, NMSS
James Mancillas, CNWRA
Lawrence McKague, CNWRA
Patrick Moulding, OGC
Jack Parrott, NMSS
Rosemary Reeves, NMSS
Jim Rubenstone, CNWRA
Kevin Smart, CNWRA
Debbie Waiting, CNWRA
Marian Zobler, OGC

## SENSITIVITY

Non-sensitive

## BACKGROUND/PURPOSE/OUTLINE OF TRIP

The Nuclear Regulatory Commission (NRC) and Center for Nuclear Waste Regulatory Analyses (CNWRA here after Center) staffs are preparing to review a LA for a high-level waste repository at Yucca Mountain (YM), Nevada that the U.S. Department of Energy (DOE) indicated it will submit. Many of the staffs have made their own observations, measurements, and collected samples in the last two decades of site visits and interactions with DOE in Nevada. NRC and CNWRA staffs make observations and measurements of samples of rocks, soils and water taken via surface investigations, geologic and topographic maps, aerial photographs and satellite imagery, trenches, boreholes, and underground excavations. However, there are no scheduled field visits to the YM area for at least five months for the approximately two dozen new employees.

The purpose of this site tour was to familiarize the staff members to the integrated site characteristics on geology, hydrology, geophysics, volcanic history, erosion and deposition processes, land uses, cultural setting, underground operations, and the local environment. The objective was to facilitate the staff's pre-licensing preparation for review of a License Application

(LA) using personal observations in the field and to discuss the evolution of DOE's assessments and NRC's evaluations of selected issues.

The trip was attended by six staff members from NMSS, two from OGC and seven from CNWRA. Larry McKague, developed the draft field guidebook, arranged for the accommodations, DOE provided briefings and escorts for the Nevada Test Site segment, and led the three-day trip. Because of constraints on travel funds, half of the eligible staff were selected to participate in this site tour. The size of the group was appropriate for the field conditions. An other tour is planned for Spring 2006.

Our stops at geologic, hydrologic, and cultural settings that may be relevant to licensing considerations and requirements were selected to provide staff with both a broad overview as well as detailed information concerning the actual surface and underground features of the region surrounding DOE's YM site. To provide this background, the trip focused on stops that illustrated the following: (i) local and regional surface and subsurface hydrologic settings and evidence for paleohydrologic flow systems; (ii) geologic history of the YM Region, including geologic structures and stratigraphy; (iii) volcanology of both the tuffs at YM and the basalts in Crater Flat and the Amargosa desert, and the role of the latter in volcanic hazard analysis; and (iv) modern tectonics and seismicity. In addition, stops were made near the 18-km compliance boundary to discuss aspects of the Reasonably Maximally Exposed Individual and accessible environment, at several low level waste storage areas, at the Spent Fuel Test - Climax Crater in Yucca Flat, and at the site of previous nuclear tests with a discussion of the containment of radioactivity for the tests. Staff also visited the Exploratory Studies Facility at YM and the DOE Science Center in Las Vegas.

On the second day, DOE supported the trip at YM and at Frenchman and Yucca Flats. DOE personnel provided briefings and served as required escorts while in those areas. At YM, they provided safety briefing underground as well as technical briefing in Alcoves 1 and 2. They also escorted the group through various historic nuclear test sites and the nuclear waste management facilities on the Nevada Test Site (NTS). DOE staff were immensely helpful in expediting badging and entry, and briefing participants in the Exploratory Site Facility. Their briefing at the waste management site was particularly instructional. The NRC On-Site Representatives' Office ensured the completeness and timeliness of our badging request forms and provided field safety and logistical support.

The draft Field Trip Guidebook provided maps, mileage information, diagrams, photographs, descriptions of the sites, and references. Dr. McKague requested that each participant write critiques and comments in the guidebook to improve the next edition. He collected the books at the end of the trip. Future participants and visitors to YM will use the guidebook when the final version becomes available in the spring. The guidebook was arranged by days and covered the following sites and topics (see guidebook for details).

DAY 1 - LAS VEGAS VALLEY, CLARK COUNTY, TO BARE MOUNTAIN AND CRATER FLAT, NYE COUNTY

Stop 1: Corn Creek Spring and Lake Deposits, Clark County.
Topics: evidence of climate change, surface water hydrology, ground water hydrology, Basin and Range general geology, thrust faults, alluvial fans, tectonic history from 65 million years

ago to present, and movement on Las Vegas Valley shear zone.

Stop 2: Lee Canyon alluvial fan, Clark County.
Topics: playa evidence of dry climate and surface water discharge, evidence in mountain ranges of thousands of feet of vertical and lateral crustal displacements, listric faults, surface exposure of thousands of feet of Paleozoic sedimentary rocks that also underlie YM area, evidence of continuing vertical and lateral crustal movement. Weather limited visibility at this stop.

Stop 3: "Bonanza King Formation" Paleozoic carbonate rock formation, Nye County.
Topics: faulting and fracturing of carbonate rocks, the significance of faults as barriers or conduits for fracture-flow of groundwater, stability of fractured rock, and analog to fractured Paleozoic aquifer along YM saturated zone flow path.

Stop 4: Vantage point at Amargosa Valley (Lathrop Wells), Nye County.
Topics: largest surface mine in the world nearby; significance of measurements from nearby University of Nevada-Reno seismic and California Institute of Technology Global Positioning Satellite monitoring stations that demonstrate continuing tectonic activity in the area; geographic panorama of surrounding mountains and Amargosa Desert near YM; significance of predominantly volcanic rocks to the north and sedimentary rocks to the south of YM; significance of wind erosion as evidenced from large sand dunes; origin of YM by volcanism and tectonism; introduction to volcanic stratigraphy of YM.

Stop 5: Horse Springs Diatomite deposit, "sinkhole," and Nye County groundwater-monitoring well.
Topics: significance of spring deposits; evidence and significance of past wetter climate in Crater Flat; evidence and significance of dissolution in alluvium; evidence and significance of subsidence of southern Crater Flat (greater than northern part); evidence and significance of giant slide blocks and breccia; Affected Units of Local Governments' research and investigations (Nye County Early Warning Drilling Program Well 1DX) on technical, safety and environmental considerations of a HLW repository.

Stop 6: Steve's Pass At Bare Mountain and Crater Flat, Nye County.
Topics: evidence and significance of Bare Mountain tectonics influence on faulting and earthquakes at YM; erosion and alluvial fan deposition on Bare Mountain; subsidence and in-filling of Crater Flat; evidence and significance of vertical-axis rotation of YM; Bare Mountain fault; history of basalt volcanoes in Crater Flat and vicinity; factors governing the probability of future volcanism; significance of gold mines in Bare Mountain for future human intrusion; geology and stratigraphy of the west flank of YM; infiltration into YM by way of Solitario Canyon; significance of Solitario Canyon 'scissors' fault and its earthquake potential; U.S. Geological Survey runoff and groundwater-monitoring programs; confluence of Bureau of Land Management, Nellis Air Force Base and NTS political boundaries; alternative tectonic models of Crater Flat-YM.

Stop 7: U.S. Ecology Low Level Waste Site (not operating), Amargosa Valley, Nye County.
Topics: history of this Low Level Waste site.

Stop 8: Aeromagnetic anomaly "O," Amargosa Valley, Nye County.
Topics: evidence and significance of buried volcanoes; NRC's responsibility for independent technical review of relevant data; how far from the proposed site and at what level of detail should the geologic history be investigated; how variations in the Earth's local magnetic field provides clues to buried rock types and geologic structures, and why DOE and NRC consider

aeromagnetic surveying relevant to a LA.

DAY 2. NEVADA TEST SITE AND YM FROM FLATS, CREST, WASHES AND UNDERGROUND.

Stop 1: DOE Low Level Waste Sites (operational) and Overview of NTS, Nye County.
Topics: history of atmospheric and underground nuclear devices testing for defense and peaceful uses; current NTS operations, including waste management history at Area 5 and Area 3 sites; geologic and hydrologic bases for selecting sites for underground tests; Yucca Lake and Playa fracture-controlled drainage; U.S. Geologic Survey geologic mapping of NTS and early recommendation of HLW disposal sites in the U.S., including YM.

Stop 2: Sedan Crater, NTS.
Topics: peaceful uses of atomic energy; effects of blast on alluvium and rock; rate of erosion of crater wall and deposition in crater floor; rate of revegetation and environmental effects of invasive grass susceptible to lightning-induced fires.

Stop 3: Spent Fuel Test-Climax, and EPA's Experimental Farm, NTS.
Topics: granitic rock and tungsten mining; evidence of kilometers of uplift and erosion; project to demonstrate the emplacement, storage and retrieval of spent nuclear fuel in an underground drift in granitic rocks using remote-handling methods, repackaging of fuel in a hot-cell (Engine Maintenance and Disassembly Building is still operational in Jackass Flat); history of EPA's radiological-uptake monitoring on a simulated irrigation dairy farm (dismantled).

Stop 4: Carpetbag Fault, Yucca Flat, NTS.
Topics: Underground nuclear explosions generated vibratory ground motion that caused faulting of alluvium; unanticipated atmospheric releases of radionuclides resulted from phenomenology, engineering systems or the natural systems or interaction of these, overview of geology and hydrology of Yucca Flat

Stop 5: Trench 14, Exile Hill, YM Project (YMP) Site, NTS.
Topics: evidence from calcite and opal veins in faults that distinguish downward infiltrating water from upward moving water along faults and fractures and the significance to a repository of both processes; evidence and significance of faults regarding groundwater flow and geologic stability.

Stop 6: Exploratory Site Facility (ESF), North Portal, Alcoves 1 and 2, YMP, NTS.
Topics: underground safety; ESF tunnel construction, operation and testing; we inspected two test alcoves that had been used by DOE for various measurements and infiltration tests, some of which were still being conducted; we observed: ground support systems including steel sets, wire mesh, and shotcrete, examples of open and instrumented boreholes; fractured, welded tuff forming angular rock faces as a result of the drill and blast method of excavation; difference between drill and blasting and tunnel boring machine tunnel construction. On the North Portal pad, we observed buildings and support facilities, including the visitors center, and the drainage ditch above the portal designed to divert runoff from the tunnel entrance.

Stop 7: Yucca Crest, NTS.
Topics: this stop was the 'high point' of the trip - a panorama from the crest of YM repository block from Timber Mountain clockwise to the Calico Hills, Jackass Flat, Fortymile Wash, Little Skull and Skull Mountains, Busted Butte, Grapevine and Funeral Mountains of California, Lathrop Wells volcano, Big Dune, Crater Flat with Black, Red and Little Cones, Steve's Pass,

Bare Mountain and the Sterling gold mine on Bare Mountain, Jet Ridge across from Solitario Canyon and the other ridges that comprise "YM;" and an opportunity to reflect on and discuss the concepts of vertical movement, lateral extension across Crater Flat, potential sources of earthquakes and volcanism, rates of erosion and deposition, sense of the hydraulic gradient.

Stop 8: Distributary Channel Deposits of Fortymile Wash, Nye County.
Topics: evidence and significance of Fortymile Wash as a potential surface transport system of radionuclides; evidence and significance of rate and sizes of material potentially transportable; observations of rock types accumulated from the upstream sources; and the approximate location of the RMEI.

Stop 9: Lathrop Wells Volcano, Nye County.
Topics: basaltic volcanic eruptions at and near YM; geology of Lathrop Wells 76,000-year old volcano; characteristics of the eruption products; evidence of periodic basalt volcanism; consideration of effects of subsurface plumbing of magma and extrusion of lava flows and tephra (scoria, cinders and ash); evidence of wind and water erosion of the volcanic cone and surrounding deposits; the CNWRA study to estimate the transport and redistribution rates of tephra from this volcano; volcanic hazard and risk analysis, eolian (wind) deposits on lava flows.

DAY 3. ASH MEADOWS, NYE COUNTY, NV; MONITORING WELL, INYO COUNTY, CA; DEATH VALLEY NATIONAL PARK, CA

Stop 1: Chicago Pass Thrust.
Topics: crustal shorting by thrusting, similarities of Gass Peak thrust, Wheeler Peak thrust and Chicago Pass thrust.

Stop 2: Zeolite Mineral Quarry, Nye County.
Topic: occurrence of clinoptilolite in rocks beneath YM, the potential benefit of zeolites in Calico Hills formation beneath the repository and along the hydrologic flowpath; chemical properties of clinoptilolite, genesis of clinoptilolite.

Stop 3: Devil's Hole (Death Valley National Park), Nye County.
Topics: structural control of groundwater flow in Paleozoic limestones that underlie the YM saturated zone flowpath; 500,000-year climate record of Amargosa Desert area applied to future climate; persistence of water table in this location has been applied to future conditions; significant quantity of groundwater in Amargosa Desert accounts for irrigation-type agricultural development; relationship of Devil's Hole pupfish's endangered status to the water level in Devil's Hole and the use of groundwater in the valley.

Stop 4: Inyo County Monitoring Well BLM #1.
Topics: Affected Units of Local Governments' contributions to the YM Project database relevant to various potential licensing issues; discussion of Center's independent review of Inyo County drill core seeking to correlate Inyo County rocks with similar types around the Amargosa basin. Flow of groundwater into Death Valley from Amargosa Desert.

Stop 5: Calcite Vein Deposits in Faults and Fractures, Inyo County.
Topics: evidence and significance of calcite veins that represent multiple episodes of spring deposition emanating from below ground surface, compared to Trench 14 deposits; evidence of geologic structural control of groundwater pathways; local evidence and significance of water transport of boulders.

Stop 6: Travertine Point, Inyo County.
Topic: vertical fluctuations of hydraulic systems has occurred as evidenced from veins leading to spring deposits at the top of the cliff.

Stop 7: Texas Springs Campground, Death Valley National Park (N.P.).
Topic: evidence and significance of the ground water elevation surface gradient at this location is the active spring flowing at sea level, while the ground water elevation at Devil's Hole is +719 meters. Discussion of groundwater flow beneath or around Funeral Mountains

Stop 8: Zabriske Point, Death Valley N.P.
Topics: erosion and deposition characteristics of a fine-grained tuff deposit; discussion of construction-induced erosion.

Stop 9: Mormon Point - Death Valley Playa - Fault Scarp in Alluvial Fan, Death Valley N.P.
Topics: evidence and significance of the Death Valley-Furnace Creek tectonic system on the Crater Flat-YM seismotectonic hazards; evidence that running water is a significant agent of erosion and deposition in this desert environment.

SUMMARY OF PERTINENT POINTS:
The theme of the field trip was the interrelationship of geological features, events and processes that affect the potential YM repository at the drift, site and regional scales. The approach was to provide opportunities for staff members to make his/her observations of natural features and processes in the YM tunnel, at the YM site, and in the regional settings, directly - in the field, with knowledgeable colleagues available to address questions and keep the focus on potential LA issues.

The topics purposefully raised at the trip stops, enumerated above, enabled the trip leader and colleagues to outline some of the evolution of thinking by DOE and NRC on various licensing issues and on review methods in the YM Review Plan. The opportunity to comprehend issues regarding the interaction of the natural systems with engineered systems at different scales of interaction when the evidence is in view, and the relative scales of the systems are in sight, as opposed to visualizing them only from photographs and scaled drawings in documents, is unique to the field observation approach. The trip and evening meeting provided an opportunity for NRC and CNWRA staffs to work together as a team, get to know each other, discuss a variety of topics and develop mutual respect for each other. This was enhanced by having participants rotate between vehicles on a daily basis.

SUMMARY OF ACTIVITIES:

L. McKague led a three-vehicle, three-day geologic survey to YM and vicinity. He provided a prototype field guide and requested each participant to contribute written observations and comments for his consideration for the next trip. Each NRC and Center participant was directly exposed to the rocks, sediments, soils, vegetation, topography, weather, natural and cultural environments, geologic and hydrologic features (e.g., strata, faults, fractures, volcanoes, spring deposits, playas, washes) and processes (e.g., weathering, surface-mass-movement by erosion, deposition and transport of sediment by water, wind and gravity), potentially relevant to the review and evaluation of a potential LA for a YM, Nevada high-level waste repository.

CONCLUSIONS:

The NRC and Center staffs greatly benefitted from the experience of directly observing the natural and operational environments in and around YM and discussing various geologic models and interpretations associated with their preparations for a LA review. Potential LA reviewers gained a sense of the scale of the test facility, YM and vicinity that is not as apparent from reading or studying pictures and diagrams. Having 'been there' imparts a sense of realism to any commenter with a need to appreciate details of a project. Even more importantly, it contributes to a reviewer's confidence, competence, and, ultimately, to the credibility of his/her technical analyses and evaluations.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

Finalization of Field Trip Guidebook, spring 2006.

RECOMMENDATIONS:

NRC and CNWRA staff visits to the site help ensure and improve the effectiveness of his/her role in the project. The perspective obtained from such visits is invaluable and can be obtained from integrated trips, such as this one, specialized trips emphasizing specific features or processes, or by using a guidebook. All staff members should be encouraged to make a least one trip to the YM that includes many of the aspects of this trip.

POINTS FOR COMMISSION CONSIDERATION:

No specific Commission consideration is needed.

ATTACHMENTS:

None. [The Field Trip Guidebook was pre-decisional. A copy of the final version will be available in the spring, 2006.]

REFERENCES:

None.

SIGNATURES:

| | |
|---|---|
| R/A | 12/02/05 |
| Shannon Colton<br>Scientist, CNWRA | Date |
| R/A | 12/06/05 |
| Al Csontos<br>Project Manager, NMSS | Date |
| R/A | 12/02/05 |
| James Durham<br>Senior Research, CNWRA | Date |
| R/A | 12/2/05 |
| Nathan Franklin<br>Scientist, CNWRA | Date |
| R/A | 12/06/05 |
| Christopher Grossman<br>Systems Performance Analyst, NMSS | Date |
| R/A | 12/06/05 |
| Philip S. Justus<br>Senior Geologist, NMSS | Date |
| R/A | 12/2/05 |
| James Mancillas<br>Research Scientist, CNWRA | Date |
| R/A | 12/2/05 |
| H. Lawrence McKague<br>Principal Scientist, CNWRA | Date |
| R/A | 12/12/05 |
| Patrick Moulding<br>Staff Attorney, OGC | Date |
| R/A | 12/8/05 |
| Jack Parrott<br>Senior On-Site Licensing Rep., NMSS | Date |
| R/A | 12/5/05 |
| Rosemary Reeves<br>Mechanical Engineer, NMSS | Date |

| | |
|---|---|
| R/A | 12/8/05 |
| James Rubenstone<br>Geologist, NMSS | Date |
| R/A | 12/3/05 |
| Kevin Smart<br>Senior Research, CNWRA | Date |
| R/A | 12/2/05 |
| Deborah Waiting<br>Research, CNWRA | Date |
| R/A | 12/12/05 |
| Marian Zobler<br>Sr. Attorney, OGC | Date |