April 4, 2006

MEMORANDUM TO: John T. Larkins, Executive Director, ACRS/ACNW
ACNW Members

THRU: Michael R. Snodderly, Acting Chief, TSB, ACRS/ACNW ***/RA/***

FROM: Latif Hamdan, Senior Staff Scientist, ACNW/ACNW **/RA/**

SUBJECT: NAS Project on Assessing the Performance of Surface and Subsurface Engineered Barriers (NAS Project ID # BESR-U-02-08-A)

At the Committee's request, I attended the second NAS committee meeting on Assessing the Performance of Surface and Subsurface Engineered Barriers, held in Irvine, California on February 14-15, 2006 (see meeting agenda in Attachment 1). The first/kickoff meeting for this project was held in Washington, D.C. on October 27, 2005. This project involves a 20-month study to develop and describe an improved framework for assessing the effectiveness of surface and subsurface engineered barriers (see project description including committee membership in Attachment 2).

Trip Purpose

The purpose of this trip was to attend the NAS committee meeting and to obtain information on the technical issues of concern to the NAS committee. The findings of this study including any interim findings will inform an ongoing ACNW activities regarding the performance of engineered barriers and cementitious radioactive waste forms at NRC-licensed facilities. It is noted that the ACNW plans to conduct a related working group meeting in FY 2006 on the performance of cementitious materials.

Attendance

Ten of 11 Committee members including the Committee Chairman were present. Also present were three NAS staff personnel. Outside attendance included only two persons: Kelly Madalinski representing the EPA, and Latif Hamdan representing the ACNW

Meeting Overview

The meeting included two open sessions: a one-day session on February 14, and a half day session on February 15. The first day session involved field visits to three waste sites; the second day session included two technical briefings by invited speakers.

McColl Site

McColl is a closed industrial waste site that occupies 22 acres in a built-up area and a residential neighborhood of Orange County. The site has been rehabilitated and part of the reclaimed site area was converted into a golf course. In the early to mid 1940s the McColl site was used for disposal of acidic refinery sludge, and in 1982, it was placed on the National Priorities List (NPL). The waste at this site is reportedly known to release volatile organic compounds (VOCs) and sulfur dioxide (SO2) whenever disturbed. Since 1984, the entire site has been covered with soil to minimize atmospheric emissions of VOCs and SO2.

Engineered barriers at the McColl site include a geomembrane cover, a clay liner, and soil-bentonite slurry walls. The slurry walls are constructed in the unsaturated zone around the site perimeter. The site is monitored for gaseous leaks (mainly benzene) and there is a gas treatment/collection system onsite. The surface cover is monitored for settlement, and groundwater and surface water are monitored for offsite contamination.

Additional information about the McColl site can be found at the following EPA web site: http://yosemite.epa.gov/r9/sfund/overview.nsf/0/b2b5752655751e278825660b007ee661?OpenDocument

Operating Industries, Inc. Landfill (OII)

The OII landfill site occupies 190 acres in Los Angeles County. Available public information indicates that approximately 23,000 people live within three miles of the site, and 2,100 people live within 1,000 feet of the landfill. Some residences are only a few feet from the site perimeter. Landfill operations at this site started operation in an unlined sand and gravel pit in 1948. Wastes include residential and commercial refuse, liquid wastes, and various hazardous wastes. Other concerns include earthquake potential, cover settlement (about 1 foot a year for the past 20 years), and the absence of a liner. The landfill is currently 90 feet below grade and 200 feet above grade. The State of California placed this landfill on the California Hazardous Waste Priority List and was closed in late 1984. The U.S. EPA proposed to include this site on the National Priority List in the same year and began conducting studies and taking actions to protect the local environment and those who live near the site.

Engineered barriers and systems at this site include a landfill cover, and gas and liquid collection systems. There is also a groundwater monitoring system at the site perimeter, which is designed to better understand groundwater contamination and the effectiveness of natural attenuation in protecting the groundwater offsite. The understanding is that if natural attenuation is ineffective, a groundwater pump and treat system will be considered.

Additional information about the OII site can be found at the following EPA web site: http://yosemite.epa.gov/r9/sfund/overview.nsf/ef81e03b0f6bcdb28825650f005dc4c1/c82725eb32ecc0588825660b007ee698?OpenDocument.

Puente Hills Landfill

The Puente landfill is located in a built-up area of Los Angeles County. It is reportedly the largest municipal landfill in the world: it occupies 1,365 acres, and receives 13,000 tons of municipal waste per day. It has a waste separation facility, as well as gas and material recycling and recovery systems. It generates 50 megawatts of power from recovered gas, for example.

The landfill has groundwater and gas containment and collection systems. The groundwater containment includes subsurface barriers (cement bentonite slurry), a composite liner, and liquid collection and removal (sumps and extraction wells). Groundwater quality is monitored upgradient and downgradient of the barriers, and in the unlined portion of the site. It was reported that there is a decreasing trend in VOC concentrations in the down-gradient groundwater monitoring wells after the barriers were installed.

Additional information about the Puente Hills landfill can be found at the following Sanitation Districts of Los Angeles County web site:
http://www.ciwmb.ca.gov/Landfills/ComplyStudy/Landfills/InDepth/PuenteHills.htm

Presentations & Discussion

The presentations session included a brief introduction by the Committee Chairman, and two technical presentations by invited experts. The Committee Chairman indicated that the plan was to gather input on barrier systems, and determine how to approach the main task: assessing the performance of engineered barriers.

Presentation by Rachel Detwiler

Rachel J. Detwiler (Senior Materials Engineer, Braun Intertec, Minneapolis, MN) gave a presentation titled “Concrete for Barrier Systems”. She addressed the following main topics:

- Concrete basics
- Getting concrete to do what we want
- Examples of concrete barriers
- Non-destructive evaluation of as built structure
- Some ideas about monitoring

Presentation highlights:

- Current experience: our experience with concrete to date is from the construction industry.

- Concrete properties: Concrete properties can be controlled by the use of admixtures, but there are false claims out there and one should deal with reputable and experienced companies that one knows and trusts.

- Concrete as a barrier: Concrete barriers can be used as a physical barrier and/or a chemical barrier. Examples of sites using concrete barriers cited included the Savannah River, Barnwell, and Oak Ridge sites, and three sites outside the U.S., in France (2) and Spain (1).

- Concrete as a water barrier: Concrete ought not be used as a physical barrier for water, because concrete matrix has permeability, and sooner or later cracks will also develop.

- Performance life: The performance life for concrete in the construction industry is 50-100 years, there is no database or experience on the durability of concrete as a barrier over long time periods. More work is needed to predict concrete performance. Concrete performance will have to monitored. Some opportunities and limitations of long-term monitoring were briefly discussed.

- Non-destructive testing/monitoring: There are some nondestructive techniques for monitoring and testing of concrete structures, and "NRC staff has expressed interest in such techniques".

- Performance models: NIST has the best model on concrete performance. DOE's models are very conservative.

- Possible next steps: It was indicated that the NAS committee report on the management of certain radioactive waste streams will be issued in March 2006, and will include some recommendations for actions that could be undertaken to assess the long-term performance of concrete barriers (an ACNW briefing by members of the NAS committee preparing this report is scheduled for May 2006).

Presentation By Ron Johnson

Ron Johnson (GeoSyntec Consultants; also with GSM Consultancy, Malaysia)) gave a presentation titled "Containment of Low-Level Radioactive Waste, a Worldwide Perspective." He addressed the following topics:

- Waste classification
- Facility Types
- Barrier systems
- Performance monitoring

Mr. Johnson specifically discussed disposal design involving proper waste form, and engineered subsurface and surface barriers; disposal methods and designs in different countries (UK, France, Sweden, Canada, and U.S.); LLW "repositories" (engineered disposal mound, disposal trench, engineered earth trench, engineered disposal vault, and tile hole disposal structure); barrier systems and containment (capping, land encapsulation, cryogenic barriers, vertical barriers, and chemical barriers); monitoring (performance monitoring, air monitoring, water/groundwater monitoring, leachate monitoring, biological monitoring, and soil monitoring).

Presentation highlights:

- Design philosophy: Mr. Johnson advocated a design philosophy that relies on waste containment and slow release and transport of contaminants at a rate that will always meet the regulatory standard. (dose-BASED design, not just dose informed) for thousands of years. This would give the radionuclides a chance to decay sufficiently and for the industry to come up with better and improved techniques for better containment, treatment, reprocessing, and disposal.

- Waste isolation: The waste isolation can be realized by the use of proper waste form, and reliance on robust and long lasting covers (25,000 years lifetime), liners, subsurface engineered barriers including chemical and geochemical barriers, redundant systems, open or closed bottoms, and all kinds of monitoring. The underlying concept is to allow the radionuclides to be released at such a slow rate that the standard dose is not exceeded over long periods (thousands of years).

- Monitoring: Monitoring is necessary to verify/validate, design, performance, and models

- Design diversity: There are many designs to consider. Foreign countries such as France is ahead of the US

Notes and Observations

- Cement barriers can be used as physical barriers as well as chemical barriers (alkaline, high pH, protect steel enforcement). The performance of barriers is site specific: it depends on the waste type and site conditions (e.g., temperature), and the planned project life. Challenges include assessment of performance over long time frames (documentation of long-term performance is lacking or very limited).

- There are two types of vertical barriers: in the U.S., soil bentonite slurry walls (bentonite+native soil) produces a 10^{-7} cm/sec permeability; in Europe, bentonite cement is popular (Portland cement+bentonite+fly ash) produces an initial permeability of about 5x 10^{-7}, but it is claimed that the cement bentonite permeability decreases over time and ultimately approaches 10^{-7} when the cement cures.

- There is apparently not enough information or experience on the performance of cement barriers at this time, and steps will need to be undertaken to shore up the assessment of long-term performance off concrete. Knowledge of concrete performance over long periods would benefit from a targeted research program, to develop improved models, approaches, and monitoring techniques to assess long term performance, and a national database on concrete performance.

- The ACNW will want to take advantage of the report by the NAS committee on certain tank waste streams which is scheduled for release in March 2006, as well as the ACNW briefing by the NAS committee on the same topic scheduled for May 2006. Also, this NAS report may contain useful background information for the ACNW working group meeting on the performance of cementitious materials scheduled for July 2006.

- A design and waste management philosophy that involves waste containment and slow release of contaminants in amounts that do not exceed established standards has appeal, but the validity of this approach will have to demonstrated by performance monitoring over long periods.

- The cooperative experience of the Los Angeles County's 24 sanitary districts responsible for the Puente Hills landfill seems to be unique and exemplary. The operation is both effective and may also be economially viable. Furthermore, there is apparently no serious NIMPY (not in my back yard) issues with any of the sites visited, despite potential contamination. There are lessons that can be learned from the waste management experience at these California sites.

- This was a good and timely meeting for the NAS committee. Ms. Detwiler's presentation amounted to a primer on concrete performance, and Mr. Johnson's presentation exposed the committee members to the broad spectrum of radionuclide waste disposal issues, facility designs, modeling, and monitoring. Both presentations addressed topics that are relevant to nuclear radioactive waste disposal. The site visits gave the committee members a good opportunity to see disposal sites and operations first hand.

- The Committee did not discuss the final scope of the project in the open session, and the definition of barrier performance was also deferred for discussion in the closed session. So the project scope may still be work in progress.

Attachments:

1) Meeting agenda
2) NAS Project description including Committee membership

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