CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: 2001 International Containment & Remediation Technology Conference (20.01402.158 and 20.01402.661)

DATE/PLACE: June 10–13, 2001
Orlando, Florida

AUTHOR: L. Browning and D. Hughson

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PERSONS PRESENT:

L. Browning and D. Hughson from the Center for Nuclear Waste Regulatory Analyses (CNWRA) attended the 2001 International Containment & Remediation Technology Conference in Orlando, Florida. The conference was sponsored by a consortium of the U.S. Department of Energy, E.I. du Pont de Nemours & Co., Inc., U.S. Environmental Protection Agency, National Aeronautics & Space Administration, the IT Group, the U.S. Navy, and Florida State University and was attended by scientists and technicians from various U.S. and international organizations.

BACKGROUND AND PURPOSE:

The purpose of the 2001 International Containment & Remediation Technology Conference and Exhibition was to provide a venue for scientists, regulators, and members of the private sector to discuss problems and innovative technologies related to contaminant remediation. The purpose of this trip was to gather technical information that would be useful for CNWRA technical assistance activities in U.S. Nuclear Regulatory Commission (NRC) programs by participating in these workshops: (i) *in situ* thermal remediation and (ii) *in situ* chemical oxidation using permanganate. In particular, insights gleaned from modeling thermal processes in vadose zones bear directly on our review of the U.S. Department of Energy (DOE) approach to modeling thermal response in a geological repository. Also, near-surface thermal remediation of radionuclides may be relevant for the Title II U Mill Surety Fund Evaluation task. The physical and chemical principles involved in reactive transport modeling of remediation barrier technologies apply directly to reactive transport models used to support issue resolution for the Quantity and Chemistry of Water Contacting the Waste Packages and Waste Forms Integrated Subissue.

SUMMARY OF CONFERENCE HIGHLIGHTS:

Technical presentations at the 3 day conference were daily oral sessions, with invited and contributed papers, and evening poster sessions. These oral and poster sessions were designed to encourage audience and presenter interaction. In addition, more than 30 exhibitors had displays representing industry, government, and academia. Technical focus areas of the conference were:

- Thermal and Chemical Remediation Technologies
- Biological Remediation Technologies
- Modeling Plume Migration and Containment Performance
- Barriers and Permeable Reactive Walls

- Characterization, Monitoring, and Verification
- Vadose Zone Issues Influencing Remediation
- Regulatory Acceptance of Technologies
- Multi-Agency Remediation Strategies
- Sediments Remediation, and
- Long Term Stewardship

The workshop: *In Situ* Thermal Remediation, hosted by the IT Group, convened for the morning of June 10, 2001 with presentations by seven speakers followed by interactive discussions with the audience. Two special sessions on June 12 focused on *In Situ* Thermal Treatment of Organic Contaminants and Poster Sessions June 11–12 included aspects of Modeling and Thermal and Chemical Remediation Technologies.

In situ thermal remediation depends on changes in chemical and porous media properties, in response to heating, that enhance contaminant remediation. Heating increases vapor pressure, reduces viscosity, increases mobility, and physically displaces recalcitrant dense, nonaqueous phase liquids (DNAPLs) including chlorinated solvents, creosote, heavy oils, and polyaromatic hydrocarbons. In contrast, demobilization is the strategy used for *in situ* thermal treatment of radionuclides. B.P. Spalding of Oak Ridge National Laboratory presented experimental results showing that heating Hanford Reservation soil to temperatures of 1,000 °C immobilized radioisotopes ^{83}Sr, ^{57}Co, ^{134}Cs, and U. He proposed thermal treatment as a "general and promising technique for environmental treatment of contaminated soil."

Heating of the subsurface is accomplished by several methods including radio frequency heating, hot air injection, steam injection, electrical resistance heating, and electrical conductivity heating. Not just steam injection, but all of these methods involve coupled thermohydrological subsurface processes. For example, in the situation where a DNAPL has contaminated a dense clay layer at depth, a remedial action plan might include heating the clay layer to boil pore water, thus assisting cleanup with steam generated *in situ*. Steam generated by boiling water trapped in pores of the soil may be more effective than injecting steam from the surface due to the problem of heterogeneity controlled preferential flow.

The nature of subsurface coupled processes was discussed in the workshop: *In Situ* Chemical Oxidation Using Permanganate, organized by Robert Siegrist of the Colorado School of Mines. This workshop focused on chemical oxidation technologies using $KMnO_4$ or $NaMnO_4$ delivered into the subsurface as liquids or solids through vertical and horizontal injection probes and wells. Coupled processes encountered in these technologies include permanganate effects on permeability and subsurface conditions. A book on the topics covered in this workshop entitled, Principles and Practices of *In Situ* Chemical Oxidation Using Permanganate, by R.L. Siegrist et al., is forthcoming.

A surprisingly small proportion of the oral discussions, exhibits, and posters presented at the conference involved numerical modeling efforts. One notable exception was S. Yabusaki of PNNL who presented results of reactive transport modeling on the interpretation of field performance of a funnel and gate TCE treatment system in pilot-scale operation at Moffett Field, California. Yabusaki's code includes surface complexation. Yabusaki was invited to submit a paper for an upcoming special issue of the Elsevier journal Geoscience and Computers on Reactive Transport being edited by L. Browning and W. Murphy. As noted, Yabusaki's modeling work appeared to be an exception at this conference, where the rule seemed to be modeling minimalism. In fact, some skepticism was expressed during the discussion forums regarding models and modeling by both presenters and audience members.

Some participants argued that the use of simple analytical models for thermal remediation design of *in situ* energy requirements is adequate. Heating occurs primarily through conduction, which is a large volume-averaging process. Energy costs for heating are small compared to other costs. Heating by conduction tends to follow the low permeability, low electrical resistivity clay layers while the vapor generated tends to follow the more permeable zones. Thus thermal design for DNAPL remediation requires only limited characterization and having a rough estimate for adequate heat flux. Practitioners of subsurface remediation do not appear to find more complex modeling useful. If this skepticism is based on lack of understanding, then modelers need to communicate more effectively.

The conference opening address was given by Carolyn Huntoon, Assistant Secretary for Environmental Management with the DOE, on the role of science in environmental remediation. This was followed by a panel discussion on the key scientific issues associated with environmental cleanup. Following are brief summaries of a few sessions pertinent to NRC interests.

The IT group hosted a session on common vadose zone issues influencing remediation. B. Looney of Westinghouse Savannah River Company summarized vadose technology problems and solutions, based on the DOE book entitled, Vadose Zone Science and Technology Solutions. Looney argued that the influence of the vadose zone should be routinely incorporated into conceptual models of contaminant behavior at waste site and industrial facilities and that more rigorous techniques should routinely be employed for direct vadose zone monitoring. Several innovative techniques were presented in this session for the characterization of contaminants in the vadose zone. For example, A. Tartre of the Canadian firm Ecoremedition Inc. described an innovative sampling technique for petroleum contaminated sites that involves purging the soil with a noncontaminated gas in the vicinity of a sample probe, and then estimating the rate at which vapor contaminants are transferred to the soil gas phase. The purge is then stopped altogether, and the rebounds in vapor contaminant concentration are measured to delineate the plume.

The DOE and Florida State University co-hosted a session on long term nuclear stewardship. Presentations in this session covered a variety of topics, but focused on performance evaluation issues, and the optimization of long-term environmental monitoring. S. R. Brechbill, of the DOE (Miamisburg, OH), discussed the Fernald long-term stewardship plan. This pilot program will identify site needs, and find or develop and deploy technologies that will meet those needs. The goal is to have the site be ecologically restored before 2010. The stewards are preparing for final closure of the plant by monitoring the contaminants, maintaining the site, and working to identify the most appropriate technologies to remediate the contaminants.

The DOE also hosted a session describing improvements to the Subsurface Contaminants Focus Area (SCFA) program. The SCFA program was first established by the DOE in 1995, then modified by management in 2000 to focus the program toward the most important problems.

IMPRESSIONS/CONCLUSIONS

Staff found this conference to be interesting and useful. Discussions on the use of models with scientists in other fields of environmental and public health protection were especially informative. Communication between model developers and the end users of modeling results seems especially important.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

None.

RECOMMENDATIONS:

This conference is focused on important issues and current procedures in environmental remediation and was very useful. Participation by CNWRA and NRC staff at the next International Containment & Remediation Technology Conference in 2005 is recommended.

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