I R M
The Institute for Responsible Management
200 Centennial Avenue, Suite 200
Piscataway, New Jersey 08854
Tel. 732-235-3460 Fax 732-235-9607
www.cresp.org

C R E S P

September 11, 2006

Mr. Joel T. Case
Idaho National Laboratories
P.O. Box 1625
Idaho Falls, ID 83415

Dear Mr. Case:

This letter report is a revision to the letter report provided on July 27, 2006 in response to your request for clarification based on new information provided in your request of August 24, 2006. Your letter request and original wording of Findings and Recommendations 8 and 16 are provided as Attachment 3 of this letter.

The following presents our findings and recommendations resulting from our review of the pilot-scale testing program in support of design of the steam reforming (SR) process for treating sodium bearing liquid wastes (SBW) currently stored in Tanks 187, 188 and 189 at the Idaho National Laboratory.

SCOPE OF WORK

Mr. Rick Provencher, Assistant Manager for Environmental Management, requested an independent review of the application of steam reforming for SBW to be organized by The Consortium for Risk Evaluation with Stakeholder Participation (CRESP) under the leadership of Prof. David Kosson (Vanderbilt University and CRESP). Dr. Kosson chaired the review team and selected Dr. James Mathis, Dr. John Garrick, and Dr. Stanley Sandler to participate as the additional team members. Biographies for each team member are provided in Attachment 1.

The specific objectives for the review team under the agreed upon scope of work are as follows:

1. Independently review the test plan, and results for the SBW steam reforming Engineering Scale Test Demonstration. This review should be carried out in the context of the overall project objectives, basis of design and current design for the SBW steam reforming project. Specifically the review should address the following questions:

    a. Are the objectives and scope of the SBW steam reforming pilot studies sufficient to address the key gaps in knowledge and engineering development necessary to design and safely implement the full-scale SBW steam reforming project? If not, what are the key gaps?

    b. What is the adequacy of the pilot scale testing completed to date to meet the stated test objectives and acceptance criteria?

2. Evaluate waste form qualification sample data against appropriate waste disposal criteria and provide recommendations on acceptability.

3. Participate in design reviews as an observer to independently evaluate if test results and lessons learned are being appropriately factored into facility design.

Objectives 1 and 2 above are addressed in this letter report.

APPROACH AND INFORMATION REVIEWED

The review team was provided the following information for review in advance of an in-person review meeting:

> Pilot Plant Testing Plan for Treating Sodium-Bearing Waste Surrogates Using the THOR Steam Reforming Process. THOR Treatment Technologies and Washington Group International, Document No. 28276-21-0015-01, rev. 01, Oct. 20, 2005.
>
> Pilot Plant Test Preliminary Completion Report for Treating Sodium Bearing Waste Surrogates Using the THOR Steam Reforming Process – Carbonate Flowsheet. THOR Treatment Technologies and Washington Group International, Document No. RT-ESTD-002, rev. 0, Feb. 28, 2006.
>
> Hydrogen Generation and Fate for the Sodium Bearing Waste Integrated Waste Treatment Unit. The Idaho Cleanup Project, Document No. EDF-6923, rev. 0, April 25, 2006.
>
> Approximately 30% Design Package (Multiple documents and drawings on DVD) Issued in support of CD-2 (May 2006) for the Integrated Waste Treatment Unit, The Idaho Cleanup Project.

The review meeting was on 19-21 July 2006 at the offices of The Washington Group and included a visit to Hazen Laboratories on 19 July. Participants in the meetings are listed in Attachment 2. Dr. Mathis was not able to attend the review meeting in-person, but rather provided detailed review comments in advance of the meeting and participated on 21 July by conference call with the review team.

This report represents a consensus of all four members of the review team.

FINDINGS AND RECOMMENDATIONS

We were very pleased with the high level of cooperation and professionalism from the CWI design team and Hazen Laboratories personnel. They were available, open and provided us with direct answers to our questions. We were very impressed by the high quality, knowledge and dedication of the design and testing team. Also, we were able to compare the proposed design with a similar steam reforming process that has operated commercially in Erwin, TN for approximately 7 years. Overall, we see no barriers to successful implementation of the proposed steam reforming process that cannot be resolved. However, successful implementation of the steam reforming process does not guarantee acceptable final disposition of the resulting processed product. We have identified several issues that should be addressed as part of the testing and design process. Below are our findings and recommendations concerning first the pilot-scale testing and associated full-scale design issues for the facility, and then broader issues that we believe warrant further consideration by DOE as part of their programmatic risk mitigation strategy. Some of our recommendations reinforce activities that are already planned.

Pilot-scale Testing and Associated Full-scale Design Issues

Finding 1. Documentation, data reduction and analysis are incomplete for the pilot-scale studies carried out to date at Hazen Laboratories (Pilot Plant Test Preliminary Completion Report, RT-ESTD-002, Feb. 2006). Thorough data packages from operational campaigns, including all operational measurements, sampling and analyses, laboratory quality control reports, and observations have not yet been completed. Some laboratory data were not available at the time of issuance of the preliminary report, in part awaiting results from external analytical laboratories. Consequently, thorough analysis of these data also has not been completed. Insufficient attention to these aspects of pilot-testing has been a cause of other DOE program failures.

Recommendation 1. Thorough documentation, data reduction and analysis of the results from pilot-scale testing carried out to date should be completed as soon as possible and to the extent practical before initiating the planned next stage of pilot-scale testing. Sufficient time and resources should be provided to complete thorough documentation and analysis of all pilot-scale testing. This analysis should include (i) comparison of observed mass (elemental and total) and energy balances for each campaign based on experimental observation and comparison of these results with theoretical balances used in pilot testing and for full-scale facility design, (ii) understanding of the causes of all excursions and upset conditions during pilot-scale testing, and (iii) transfer of lessons learned to the full-scale design. A schedule should be developed for future pilot-scale testing, evaluation and results documentation that includes integration of lessons learned in the full-scale design.

Finding 2. This facility will include "first of a kind" equipment for solids removal (auger/grinder system) from the first fluidized bed reformer (DMR), coal separation from the DMR solid product, and the canister filling station (which is especially complex and includes monitoring of canister fill levels). Operability and reliability of these systems is of particular concern.

Recommendation 2. Thorough, integrated testing of each of these systems should be carried out prior to completion of the facility design. Testing and evaluation should include repetitive cycling under expected performance conditions (e.g., particle size distribution, particle hardness, temperature).

Finding 3. While the safety analysis has followed DOE guidelines with emphasis on co-located workers and the maximally exposed individual at the site boundary, additional worker safety analysis and attention to most likely failure modes that impact worker safety is warranted.

Recommendation 3. Additional safety analysis that focuses on realistic worker safety and most likely operations and events that may lead to highest worker dose should be completed to identify opportunities for reducing potential worker risk. This analysis should include fault tree analysis of the DMR, rapid shut down systems, and other critical systems that can impact worker safety.

Finding 4. Reliability of the feed nozzles for the DMR and the high temperature filters (HTF) between the DMR and the second fluidized bed reactor (CRR) are of concern.

Recommendation 4. Testing should include full-scale demonstration of the performance of the final designs for the feed nozzles and pilot-scale demonstration of the high temperature filters.

Finding 5. The planned schedule for full-scale systemization (9 weeks) appears optimistic, while the schedule for start up operations (6 months at 50 percent of capacity operations) appears overly conservative.

Recommendation 5. The periods allotted for full-scale systemization and start up operations should be evaluated carefully to determine if sufficient time has been allowed for systemization and if ramp up to full capacity operations can be accelerated.

Finding 6. The current sequence for treating waste from the SBW tanks has the first campaign focused on the most complex waste stream (i.e., highest undissolved solids content). This approach does not facilitate learning plant operations and responses on simpler feeds and ramping up to more complex situations.

Recommendation 6. The sequence of campaigns for treating wastes from the SBW tanks should be reviewed and revised if appropriate, to provide for initial operations on simpler waste feeds to improve the operational learning curve. It may be beneficial to have an initial campaign processing a limited portion of the low solids waste to gain operational experience.

Finding 7. Mixing of the facility ventilation exhaust with the process gas exhaust just prior to the discharge stack appears to provide the potential for back flow from one system to the other during upset conditions.

Recommendation 7. The full-scale design should be evaluated for the potential for back flow from the HVAC to the process system or from the process system to the HVAC system during upset conditions. Use of different discharge stacks to separate the HVAC from the process exhaust, or other methods to prevent back flow or cross flow between the systems, should be considered.

Finding 8. Evaluation of the potential of the DMR product to be hygroscopic or deliquescent has not been carried out under sufficiently controlled conditions. Deliquescence, if present, may form free liquids in the material if stored without consideration of ambient humidity, complicating subsequent management. Hygroscopic behavior of the solid product may result in agglomeration during handling or storage, impairing future material transfers if required.

Recommendation 8. The potential for deliquescence and hygroscopic behavior of the steam reforming solid products should be evaluated over a range of controlled relative humidity conditions. If the product is found to be hygroscopic, modifications to the canister storage system should be considered that would prevent the uptake of moisture during storage.

Finding 9. Fuel solids used for the reformers (e.g., coal) may be a significant source of heavy metals and other contaminants.

Recommendation 9. Quality control requirements should be established for the solid fuels used in the steam reforming system to prevent unexpected system loading of contaminants.

Finding 10. The current shutdown interlock for hydrogen concentration in the DMR is planned to be at 8% hydrogen content, even though the operational window is between 0.5 and 3%. The typical guideline in nuclear facilities is to maintain a hydrogen concentration of less than 5%.

Recommendation 10. The basis for the shutdown interlock for hydrogen concentration in the DMR should be evaluated and the interlock threshold be revised if appropriate.

Finding 11. It is unclear whether only steady state or dynamic process simulations have been developed to determine process behavior during operating and upset conditions. Also dynamic process simulation can be useful for operator training, especially for understanding emergency conditions.

Recommendation 11. Use of dynamic simulation for assessing operating and upset conditions, and as an operator training tool should be implemented.

Finding 12. The complex nature of maintenance at the planned full-scale facility may lead to periods of operation with limited equipment functionality (e.g., with a limited number of feed injector nozzles functioning).

Recommendation 12. Pilot-scale testing should be used to evaluate system performance under limited equipment functionality if this is anticipated to be an acceptable operational condition.

Finding 13. The hot uncombusted coal from the DMR product potentially constitutes a risk of smoldering or ignition outside of the DMR during separation and transfer. The basis for requiring separation of uncombusted coal from the DMR product is also unclear.

Recommendation 13. The potential for uncombusted coal ignition or smoldering during separation from the DMR solid product and downstream handling (e.g., during canister filling) should be evaluated and appropriate design modifications made if needed.

Finding 14. Selected SR systems such as the ventilation system are dependent on backup from other INL facilities (i.e., INTEC) in the event of a power failure.

Recommendation 14. All SR dependencies on external systems should be reviewed to assure adequate backup capability in the event of site-wide failures of critical utilities.

Finding 15. As identified in 268.40 CFR and 268.48 CFR, wastes containing less than 260 mg/kg total mercury and that are residues from thermal treatment only, have to meet the mercury TCLP limit of 0.2 mg/L and the Universal Treatment Standard (UTS) limits for all metals. It is unclear if the used activated carbon from mercury capture in process gas will be subject to these standards or if it will require additional treatment prior to disposal because it is anticipated to contain up to 17 wt % total mercury.

Recommendation 15. Disposal requirements for used activated carbon containing up to approximately 17 wt% mercury should be verified.

<u>Programmatic Risk Mitigation Issues for DOE</u>

Finding 16. Waste acceptance criteria for remote handled transuranic waste disposal at the Waste Isolation Pilot Plant (WIPP) has not been finalized. Uncertainty with respect to the acceptability of the carbonate waste form from SR for disposal at WIPP represents the greatest programmatic risk. The carbonate waste form is highly water soluble, which likely presents a barrier to acceptance at Yucca Mountain, potentially an alternate disposal location. Production of a mineralized waste form (sodium-aluminum-silicate) may facilitate greater flexibility in disposal options. The costs for producing the mineralized waste form are likely to be far less if produced during initial treatment than if it is required at some point in the future, which would entail retrieval of the solid material from the storage canisters and further processing. Also, insufficient characterization (leaching, likely acceptance criteria) has been completed on both product forms.

Recommendation 16. (i) proceed with pilot testing for production of the mineralized waste form; (ii) complete more thorough product characterization and evaluation (including likely waste acceptance criteria and more appropriate leaching testing) of the carbonate and mineralized products as acceptable waste forms for disposal at WIPP and Yucca Mountain; and, (iii) carefully evaluate programmatic risks, costs and long-term benefits of directly producing the mineralized product rather than the carbonate product.

Finding 17. There are uncertainties regarding the future processing of stored calcine waste in the steam reforming facility. The facility shielding is being designed for the higher activity levels present in calcine, while the process design considers the plant functionality for only processing of the SBW tank wastes.

Recommendation 17. Review plant specifications for consistency with calcine processing (process requirements, canister requirements) and programmatic risks. Clarify the intended future use of the SR facility after completion of SBW treatment so that appropriate design criteria can be employed to meet future missions if specified.

CLOSING

The review team is available to answer any questions about this report or the review processes. In addition, the review team can review future pilot-scale test plans and reports on pilot-scale testing if requested.

Sincerely,

David S. Kosson, Ph.D.
Chairman, Review Team

B. John Garrick, Ph.D., P.E., NAE
Review Team Member

James F. Mathis, Ph.D., NAE
Review Team Member

Stanley I. Sandler, Ph.D., NAE
Review Team Member

cc:

R. Provencher, DOE-ID	M. Gilbertson, EM-20	C. Powers, CRESP
W. Owca, DOE-ID	I. Triay, EM-3	

Attachment 1

Biographies for INL Steam Reforming Review Committee Members:

- David S. Kosson
- B. John Garrick
- James F. Mathis
- Stanley I. Sandler

DAVID S. KOSSON

PROFESSIONAL PREPARATION

Rutgers, The State University of New Jersey, B.S. high honors, Chem. & Biochem. Eng., 1983
Rutgers, The State University of New Jersey, M.S., Chemical & Biochemical Eng., 1984
Rutgers, The State University of New Jersey, Ph.D., Chemical & Biochemical Eng., 1986

APPOINTMENTS

2000 - Present	Professor and Chairman, Vanderbilt University, Department of Civil and Environmental Engineering; also Professor of Chemical Engineering (2000-), Professor of Earth and Environmental Sciences (2005-)
1996 - 1999	Professor I**,** Rutgers, The State University of New Jersey, Department of Chemical and Biochemical Engineering
1990 - 1996	Associate Professor with Tenure, Rutgers, The State University of New Jersey, Department of Chemical and Biochemical Engineering
1986 - 1990	Assistant Professor, Rutgers, The State University of New Jersey, Department of Chemical and Biochemical Engineering

JOURNAL PUBLICATIONS (REPRESENTATIVE, >80 IN-PRINT OR IN-PRESS TO-DATE)

Van Gerven, T., Cornelis, G., Vandoren, E., Vandecasteele, C., Garrabrants, A.C., Sanchez, F. and Kosson, D.S. (2006) Effects of progressive carbonation on heavy metal leaching from cement-bound waste. AIChE J. 52(2):826-837.

Greenberg, M., Burger, J., Gochfeld, M., Kosson, D.S., Lowrie, K., Mayer, H., Powers, C., Volz, C. and Vyas, V. (2006) "End State Land Uses, Sustainable Protective Systems, and Risk Management: A Chalenge for Multi-Generational Stewards." *Remediation Journal* 16(1): 91-105.

Mayer, H., Greenberg, M., Burger, J., Gochfeld, M., Powers, C., Kosson, D.S., Keren, R., Danis, C. and Vyas, V. (2006) "Using Integrated Geospatial Mapping and Conceptual Site Models to Guide Risk-Based Environmental Clean-Up Decisions." *Risk Analysis*, 25(2):429-446.

Sanchez, F. and Kosson, D. S. (2006) "Probabilistic approach for estimating the release of contaminants under field management scenarios," *Waste Management*, 25, 463-472.

Burger, J., M. Gochfeld, D. S. Kosson, C. W. Powers, B. Friedlander, J. Eichelberger, D. Barnes, L. K. Duffy, S. C. Jewett, and C. D. Volz. (2005) Science, policy, and stakeholders: developing a consensus science plan for Amchitka Island, Laeutians, Alaska. *Environmental Management*, 35:557-568.

Wang, W., Shor, L., LeBoeuf, E., Wikswo, J. and Kosson, D.S. (2005) "Mobility of Protozoa Through Narrow Channels." *Applied and Environmental Microbiology*, 71(8)4628-4637.

Garrabrants, A.C., Sanchez, F., and Kosson, D.S. (2004) Changes in constituent equilibrium leaching and pore water characteristics of a Portland cement mortar as a result of carbonation. *Waste Management*, 24(1):19-36.

Gervais, C., Garrabrants, A.C., Sanchez, F., Barna, R., Moszkowicz, P., and Kosson, D.S. (2004) The effects of carbonation and drying during intermittent leaching on the release of inorganic constituents from a cement-based matrix. *Cement and Concrete Research*, 34(1):119-131.

Shor, L., Kosson, D.S., Rockne, K.J., Young, L.Y., Taghon, G.L (2004) Combined effects of contaminant desorption and toxicity on risk from PAH contaminated sediments. *Risk Analysis*, 24(5):1109-20.

Switzer, C., Slagle, T., Hunter, D., and Kosson, D.S. (2004) Use of rebound testing for evaluation of soil vapor extraction performance at the Savannah river site, *Ground Water Monitoring and Remediation*, 24(4):106-118.

Shor, L.M., Rockne, K.J., Young, L.Y., Taghon, G.L., and Kosson, D.S. (2004) Synergistic effects of contaminant desorption and toxicity: Implications for environmental risk assessment. *Risk Analysis,* 24(5):1109-1120.

Garrabrants, A.C., and Kosson, D.S. (2003) Modeling moisture transport from a Portland cement-based material during storage in reactive and inert atmospheres. *Drying Technology,* 21(5):775-805.

Sanchez, F., Garrabrants, A.C., and Kosson, D.S. (2003) Effects of intermittent wetting on concentration profiles and release from a cement-based waste matrix. *Environmental Engineering Science,* 20(2):135-153.

Shor, L.M., Lian, W., Rockne, K.J., Young, L.Y., Taghon, Gary L., and Kosson D.S. (2003) Intra-aggregate mass transport-limited bioavaibility of polycyclic aromatic hydrocarbons to mycobacterium strain PC01. *Environmental Science & Technology,* 37(8):1545-1552.

Shor, L.M, Rockne, K.J., Taghon, G.L., Young, L.Y., and Kosson, D.S. (2003) Desorption kinetics for field-aged polycyclic aromatic hydrocarbons from sediments. *Environmental Science and Technology,* 37(8):1535-1544.

Garrabrants, A.C., Sanchez, F., and Kosson, D.S. (2003) Leaching model for a cement mortar exposed to intermittent wetting and drying. *AIChe Journal,* 49(5):1317-1333.

Sanchez, F., Garrabrants, A.C., Vandecastelle, C., Moszkowicz, P., and Kosson, D.S. (2003) Environmental assessment of waste matrices contaminated with arsenic. *Journal of Hazardous Materials,* 96(2-3):229-257.

Sanchez, F., Massry, I.W., Eighmy, T., and Kosson, D.S. (2003) Multi-regime transport model for leaching behavior of heterogeneous porous materials. *Waste Management,* 23(3):219-224.

Hacherl, E.L., Kosson, D.S., and Cowan, R.M. (2003) A kinetic model for bacterial Fe(III) oxide reduction in batch cultures. *Water Resources Research*, 39(4):1-18.

Sanchez, F., Gervais, C., Garrabrants, A. C., Barna, R. and Kosson, D. S. (2002). Leaching of inorganic contaminants from cement-based waste materials as a result of carbonation during intermittent wetting. *Waste Management*, 22(2):249-260.

Garrabrants, A.C., Sanchez, F., Gervais, C., Moszkowicz, P. and Kosson, D. (2002) The effect of storage in an inert atmosphere on the release of inorganic constituents during intermittent wetting of a cement-based material. *Journal of Hazardous Materials* B91(1-3):159-185.

Kosson, D.S., van der Sloot, H.A., Sanchez, F. and Garrabrants, A.C. (2002) An integrated framework for evaluating leaching in waste management and utilization of secondary materials. *Environmental Engineering Science* 19(3):159-204.

Sanchez, F., Mattus, C., Morris, M. and Kosson, D.S. (2002) Use of a new leaching test framework for evaluating alternative treatment processes for mercury contaminated soils. *Environmental Engineering Science* 19(4):251-269.

Rockne, K.J., Shor, L.M., Young, L.Y., Taghon, G.L., and Kosson, D.K. (2002) Distributed sequestration and release of PAHs in weathered sediment: The role of sediment structure and organic carbon properties. *Environmental Science and Technology.* 36(12):2636-2644.

Hacherl, E.L., Kosson, D.S., Young, L.Y., and Cowan, R.M. (2001) Measurement of iron(III) bioavailability in pure iron oxide minerals and soils using anthraquinone-2,6-disulfonate oxidation. *Environmental Science and Technology,* 35(24):4886-4893.

Hacherl, E.L., Kosson, D.S., Young, L.Y., and Cowan, R.M. (2001). Measurement of iron(III) bioavailabilty in pure iron oxide minerals and soils using anthraquinone-2,6-disulfonate oxidation. *Environmental Science and Technology*, 35:4886-4893.

Schaefer, C.E., Arands, R.R., and Kosson, D.S. (1999) Measurement of pore connectivity to describe diffusion through a trapped non-aqueous phase in unsaturated soils. *Journal of Contaminant Hydrology,* 40(3):221-238.

Schaefer, C.E., Arands, R.R., van der Sloot, H.A., and Kosson, D.S. (1995) Prediction and experimental verification of liquid phase diffusion resistance in unsaturated soils. *Journal of Contaminant Hydrology*, 20(1-2):145-166.

DOE Related Reports

Switzer, C., Brown, K., Kosson, D.S., Clarke, J. and Parker, F. Preliminary Risk Evaluation of Calcined High-Level Waste Disposition at the Idaho Site. Consortium for Risk Evaluation with Stakeholder Participation, Institute for Responsible Management, Piscataway, NJ, 2005.

Brown, K., Switzer, C., Kosson, D.S., Clarke, J. and Parker, F. Preliminary Risk Evaluation of Options for Buried Waste Disposition at the Idaho Site. Consortium for Risk Evaluation with Stakeholder Participation, Institute for Responsible Management, Piscataway, NJ, 2005.

Powers, C.W., Burger, J., Kosson, D.S., Gochfeld, M. and Barnes, D., et al. Biological and Geophysical Aspects of Potential Radionuclide Exposure in the Amchitka Marine Environment. Consortium for Risk Evaluation with Stakeholder Participation, Institute for Responsible Management, Piscataway, NJ, 2005.

Kosson, D.S., Grogan, H., Higley, K., Maddalena, R., Whipple, C. Merit Panel Review of the C-Tank Farm Closure Performance Assessment. Consortium for Risk Evaluation with Stakeholder Participation, Institute for Responsible Management, Piscataway, NJ, 2004.

SYNERGISTIC ACTIVITIES

Chairman, Department of Civil and Environmental Engineering.
Co-PI on NSF IGERT Interdisciplinary Reliability and Risk Engineering and Management Doctoral Prog.
National Research Council Committees (Board on Army Science and Technology):
- Committee on Review and Evaluation of Alternative Technologies for Demilitarization of Assembled Chemical Weapons: Phase 2 (ACW II), Member 2000 to 2002.
- Chair, Committee on Review and Evaluation of the Army Chemical Stockpile Disposal Program (Standing Committee), July 1998-July 2000; Member, 1993-2000.
- Panel on Review and Evaluation of Alternative Chemical Disposal Technologies, Member,1995-1996.

Chairman of Leadership Committee - Vanderbilt Institute for Environmental Risk and Resources Management.
The Consortium for Risk Evaluation with Stakeholder Participant (CRESP) – Chairman of Remediation and Risk Mitigation Technology Center of Expertise

COLLABORATORS AND CO-EDITORS

David Stensel, University of Washington; Joel Massman, University of Washington, Mark Benjamin, University of Washington, David Stahl, University of Washington, Joanna Burger, Rutgers University, Micheal Greenberg, Rutgers University, Panos Georgopolous,Rutgers University, Lily Young, Rutgers University, Gary Taghon, Rutgers University, Taylor Eighmy, University of New Hampshire, William Rixey, University of Houston, Paul Lioy, University of Medicine and Dentistry of New Jersey. Institutional Conflict: Rutgers University

Thesis Advisor: Dr. Robert C. Ahlert (currently emeritus)

Total number of graduate students as primary advisor: 33 completed, 4 current
Total number of post-docs supervised: 10 completed, 2 current

B. John Garrick, Ph.D., P.E.

Dr. B. John Garrick was appointed to the U.S. Nuclear Waste Technical Review Board as Chairman on September 10, 2004, by President George W. Bush.

Dr. Garrick is an executive consultant on the application of the risk sciences to complex technological systems in the space, defense, chemical, marine, transportation, and nuclear fields. He served for 10 years (1994-2004), four years as chair, on the U.S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste. His areas of expertise include risk assessment and nuclear science and engineering. A founder of the firm, PLG, Inc., Dr. Garrick retired as President, Chairman and Chief Executive Officer in 1997. Before PLG's acquisition and integration into a new firm, it was an international engineering, applied science, and management consulting firm.

Dr. Garrick was elected to the National Academy of Engineering in 1993, President of the Society for Risk Analysis 1989-90, and recipient of that Society's most prestigious award, the Distinguished Achievement Award in 1994. He has been a member and chair of several National Research Council committees having served as Vice Chair of the Academies' Board on Radioactive Waste Management and as a member of the Commission on Geosciences, Environment, and Resources. He recently chaired the National Academy of Engineering's Committee on Combating Terrorism. Among other National Academy committees he has chaired are the Committee on the Waste Isolation Pilot Plant, the Committee on Technologies for Cleanup of High-Level Waste in Tanks in the DOE Weapons Complex, and the Panel on Risk Assessment Methodologies for Marine Systems. Other Academy committee memberships included space applications, automotive safety, and chemical weapons disposal. He is a member of the first class of lifetime national associates of the National Academies.

Dr. Garrick has published more than 250 papers and reports on risk, reliability, engineering, and technology; has written several book chapters; and was editor of the text, *The Analysis, Communication, and Perception of Risk*.

Dr. Garrick received his Ph.D. in engineering and applied science from the University of California, Los Angeles, in 1968. His fields of study were neutron transport, applied mathematics, and applied physics. He received an M.S. in nuclear engineering from UCLA in 1962, attended the Oak Ridge School of Reactor Technology in 1954-55, and received a B.S. in physics from Brigham Young University in 1952. He is a Fellow of three professional societies: the American Nuclear Society, the Society for Risk Analysis, and the Institute for the Advancement of Engineering. He is a registered professional engineer in California.

Dr. Garrick lives in Laguna Beach, California.

Curriculum Vitae, James F. Mathis

DOB	September 28, 1925	

Education

BSChE	Texas A&M University	1946
MS	University of Wisconsin	1951
PhD	University of Wisconsin	1953

Employment History

<u>ExxonMobil Corporation</u>

Research Engineer, Baytown TX	1946-49, 1953-61
Manager, Baytown R&D	1961-63
Manager, Specialty Products, Houston TX	1963-65
Vice President, ERE, Linden NJ	1966-68
Sr.VP, Director, Imperial Oil Ltd., Toronto Ontario	1968-1971
Vice President Technology, Exxon Chemical NJ	1971-80
Vice President, Science & Technology NY	1980-84

<u>Corporate Directorships</u>

NL Industries	1985-86
Laser Recording Systems	1989-93
Hanlin Corporation	1989-99
Beaver Lake Realty Company	1995-98

<u>Other Positions</u>

US Naval Air Corps	1944-45
Dir.& Chmn., Chemical Industry Institute of Toxicology	1975-83
Consultant, Arthur D Little	1985-92
Consultant, ChemShare Corp.	1989-92
Chairman, NJ Commission on Science & Technology	1988-96
Trustee & Pres., Wisconsin Alumni Research Foundation	1984-2004
Member, National Academy of Engineering	1990-
Member, NRC "Stockpile Committee"	1998-2003
Member, NRC ACWA Program Committee	2004-

Family & Residence

Married to Frances Ellisor, September 4, 1948
Son: Alan Forrest (dec.) Daughter: Lisa Lambeth, Grandson: James Lambeth
Residence: 2714 S Southern Oaks Dr, Houston TX 77068
Phone: 281-587-0117
Email: jfmathis@aol.com

STANLEY I. SANDLER

Present Employment: Department of Chemical Engineering, University of Delaware (since 1967)
Henry B. du Pont Chair (since 2000)
Director, Center for Molecular and Engineering Thermodynamics (since 1992)
Professor of Chemistry and Biochemistry (since 1993)
Editor, AIChE Journal (since 2000)
Place of Birth: New York City, New York
Education: B.Ch.E.City College of New York, (1962) , Ph.D.Univ. of Minnesota, (Chem. Eng. 1966)

Previous experience: University of Delaware
Interim Dean, College of Engineering (1992), Henry B. du Pont Professor (1982-2000)
Chairman, Department of Chemical Engineering (1982-86), Professor of Chem. Eng. (1973-82)
Associate Professor of Chem. Eng. (1970-73), Assistant Professor of Chem. Eng. (1967-70)

VISITING AND HONORARY PROFESSORSHIPS
Honorary Professorial Fellow, University of Melbourne (Australia), 2004-2009.
ExxonMobil Professor, National University of Singapore, 2006-2009.
University of California, Berkeley, Visiting Professor, Department of Chemical Engineering, 1995
Technische Universitat Berlin, Visiting Prof. Inst. fur Thermodynamik und Anlagentechnik, 1981, 1988-9
University of Queensland (Brisbane, Australia) Visiting Professor, Dept. of Chem. Eng. 1989, 1996
Universidad Nacional Del Sur (Bahia Blanca, Argentina) Visiting Professor in Departmento Ingenieria Quimica and Planta Piloto de Ingenieria Quimica, 1985
Imperial College (London)
Visiting Professor in the Department of Chemical Engineering and Chemical Technology 1973-1974

NATIONAL AND INTERNATIONAL HONORS AND AWARDS
Fellow, Institute of Chemical Engineers (Britian), 2004.
Chartered Engineer (Europe), 2004; Chartered Scientist (Europe), 2004
Miegunyah Fellow, Univ. of Melbourne (Australia), 2003.
E. V. Murphree Award, American Chemical Society, 1998·★
Rossini Lecturer, Commission 1.2, International Union of Pure and Applied Chemistry, 1998.
National Academy of Engineering, 1996
Warren K. Lewis Award, American Institute of Chemical Engineers, 1996. ★
Fellow, American Institute of Chemical Engineers, 1993.
Alexander von Humboldt Foundation Distinguished U.S. Senior Scientist Award, 1988.
3M Chemical Engineering Lectureship Award, American Society for Engineering Education, 1988.★
Professional Progress Award, American Institute of Chemical Engineers, 1984; Award Lecture, 1985.★
Research Fellowship, Alexander von Humboldt Foundation (Bonn, West Germany), 1980-81 for research at the Technical University of Berlin.
Camille and Henry Dreyfus Foundation Faculty - Scholar, 1971-1976.*

PROFESSIONAL AFFILIATIONS
- American Institute of Chemical Engineers
- American Chemical Society
- Society of Sigma Xi (Honor Society)
- Institution of Chemical Engineers (Britian)
- Tau Beta Pi (Honor Society)
- Omega Chi Epsilon (Honor Society)
- American Society for Engineering Education

★ Awarded to one chemical engineer nationwide each year.
☆ Awarded to one chemist, chemical engineer or physicist worldwide every other year.
* Generally awarded to only one chemical engineer nationwide each year.
▲ Awarded to one faculty member at the University of Delaware each year.

CURRENT RESEARCH INTERESTS

- Applied thermodynamics and phase equilibrium
- Environmental engineering (fate of chemicals in the environment, safety)
- Computational quantum chemistry
- Separations and purification (including of pharmaceuticals and proteins)
- Computer-aided process design
- Statistical mechanics

National Committee Activities

- National Research Council Committee on Review and Evaluation of Alternative Technologies for Demilitarization of Assembled Chemical Weapons I (1997-1999) and II (2000-2002).
- National Research Council/National Academy of Sciences/National Academy of Engineering Evaluation Panel for the Center for Chemical Engineering of the National Bureau of Standards (1985-87)

Consultancies (Recent)

- Aspen Technology, Cambridge, MA (Moderator, Web Site on Thermodynamics) 2000 - 2002
- Technical Advisory Board, Aspen Technology, Inc. 2001 - 2000
- Mobil Research and Development Corporation, Princeton, New Jersey, 1977 - 1997
- Mendes & Mount, LLP (attorneys), 1996 - 1977
- Sullivan & Cromwell (attorneys), 1997
- Chevron Oil Field Research Company, La Habra, California, 1979 - 1993.
- Union Carbide Corporation, S. Charleston, West Virginia, 1980 - 1993.

PUBLICATIONS

Books: 12, the most recent of which is "Chemical, Biochemical and Engineering Thermodynamics, Fourth Edition" by S. I. Sandler. J. Wiley & Sons, Inc., NY, published January 2006.

Refereed Research Papers: Approximately 340

National Research Council Reports (multi authored)

“Review and Evaluation of Alternative Technologies for Demilitarization of Assembled Chemical Weapons”, National Academy Press, Washington, DC, 1999.

“Evaluation of Demonstration Test Results of Alternative Technologies for Demilitarization of Assembled Chemical Weapons:”, National Academy Press, Washington, DC, 2000.

“Analysis of Engineering Design Study for Demilitarization of Assembled Chemical Weapons at Pueblo Chemical Depot” National Academy Press, Washington, DC, 2001.

“Evaluation of Demonstration Test Results of Alternative Technologies for Demilitarization of Assembled Chemical Weapons. A Supplemental Review for Demonstration II” National Academy Press, Washington, DC, December, 2001.

“Analsis of the Engineering Design Studies for Demilitarization of Assembled Chemical Weapons at Blue Grass Army Depot”, National Academy Press, Washington, DC, September 2002. 152 pages

Attachment 2

Meeting Attendance
July 17-21, 2006

Washington Group International
Integrated Engineering, Construction, and Management Solutions

Meeting : ______ **IWTU Independent Review** ______________________

Date : ___**July 19 – 21, 2006**________ **Location :** _**Denver, CO**__**N2-23L**___

Name	Company	Phone	Email
Paul Rutland	TTT	(509) 539-1337	Paul.Rutland@wgint.com
Bill Owca	DOE-ID	208-526-1983	OWCAWA@ID.DOE.GOV
Kathy Wolf	WGI/TTT	303 929 4418 (cell) 303.843.3283	kathy.wolf@wgint.com
Stan Sandler	Univ Del		
David Kosson	Vanderbilt	615-322-1064	David.kosson@Vanderbilt.edu
Joel Case	DOE	208-526-6795	casejt@id.doe.gov
B. John Garrick	Self	949 497 6802	bjgarrick@aol.com
Kevin Ryan	TTT	303-843-2292	Kevin.ryan@wgint.com
Brad Mason	TTT	404-915-3564	bmason@studsvik-inc.com
W. Scott Roesener	WGI	208-521-2534	scott.roesener@WGINT.COM
HARLEY KIRSCHENMANN	WGI/TTT	303-843-3142	HARLEY.KIRSCHENMANN@WGINT.COM
Jayson Mines	WGI	303-843-2677	jayson.mines@wgint.com
Navroze D. Amaria	WGI	303-843-3229	navroze.amaria@wgint.com
Dave Carroccia	WGI	303-843-2038	dave.carroccia@wgint.com

Attachment 3

- DOE-ID request for clarification and revision (August 24, 2006; FMDP-MTPP-06-023)

- Original wording of Findings and Recommendations 8 and 17[*] from letter of July 27, 2006

[*] Finding 17 in the July 27, 2006 version of this report is now revised to Finding 16 to correct a clerical error.

Department of Energy
Idaho Operations Office
1955 Fremont Avenue
Idaho Falls, ID 83415

August 24, 2006

David S. Kosson, Ph.D
Vanderbilt University
Department of Civil and Engineering VU Station B 351831
2301 Vanderbilt Place
Nashville, TN 37235

SUBJECT: Results of the Department of Energy – Idaho Operations Office (DOE-ID) Factual Accuracy Review of the Independent Review Panel's Report on Steam Reforming of Idaho Sodium Bearing Waste (FMDP-MTPP-06-023)

Dear Dr. Kosson:

DOE-ID appreciates the efforts of the independent review panel and the timeliness of their report. However, DOE-ID's factual accuracy review of the report identified that two findings and recommendations either conflict with DOE-ID's understanding of disposal requirements or require additional clarification. Findings and recommendations 8 and 17 (enclosed) are at issue and the following is a discussion of concerns. DOE-ID requests that the report be revised and reissued to address the factual accuracy concerns.

Finding and recommendation 8 involves the potential for deliquescence and hygroscopic behavior of the steam reforming solid product produced by treating Sodium Bearing Waste (SBW), and how this issue is to be resolved. The principal conflict identified is the statement in the report "Absence of deliquescence is an anticipated waste acceptance criterion for WIPP." A new Waste Acceptance Criteria that includes RH waste has been drafted by the DOE-Carlsbad Field Office, and has received concurrence by the U.S. Environmental Protection Agency without any discussion regarding deliquescence. There is no expectation that this criterion will be added. Free liquid is not allowed to be disposed at WIPP, and that criterion will remain for remote-handled waste. DOE-ID agrees that the product should and will be adequately characterized to ensure safe and effective storage. However, hygroscopic behavior and deliquescence are storage issues and have no bearing on WIPP disposal.

Finding and recommendation 17 involves the programmatic risk with disposing carbonate waste product in WIPP and/or Yucca Mountain, and the potential mitigation provided by mineralized waste form testing and implementation. DOE-ID agrees that there is risk related to disposing SBW in WIPP because a complete disposition path, including waste determination, permit modification, and waste acceptance criteria, has not yet been fully achieved by DOE-ID. However, the risk is dominated by the SBW Waste Determination and State of New Mexico permit modification, which are independent of treated waste form product solubility or durability performance. The Waste Determination is based on the source and characteristics of the waste stored in the tanks and will decide if SBW is transuranic waste or high level waste, which will determine if SBW is disposed in WIPP or the high level waste repository. The WIPP permit modification will determine the conditions under which the currently excluded tank waste from Idaho may be disposed at WIPP. However, DOE-ID has no expectation that the SBW tank waste permit modification or WIPP waste acceptance criteria will be any more restrictive than the existing waste acceptance criteria, which do not include any leaching or durability performance requirements. Therefore, the part of Finding 17 that states "although this may be a consideration as part of a permit modification at WIPP" conflicts with DOE-ID's understanding of the expected permit requirements for WIPP. Furthermore, the last sentence of Finding 17 regarding insufficient characterization of product forms conflict with DOE-ID's understanding of what is required for carbonate disposal in WIPP. Carbonates and other soluble waste forms are permitted for disposal in WIPP. The characterization plan for carbonate product that addresses the remote-handled waste acceptance criteria, and the hazardous waste characterization requirements in the Waste Analysis Plan, will be included in the final test report. If the panel believes additional characterization is needed to meet the WIPP waste acceptance criteria, please define the specific tests needed and the basis. The WIPP Land Withdrawal Act, which established the WIPP disposal site, specifically excludes waste disposed at WIPP from the land disposal restrictions. Waste disposed at WIPP does not have to meet the leaching and performance requirements for hazardous waste disposal.

DOE-ID agrees with the panel's recommendation for testing a mineralization steam reforming process and will conduct such tests later this year or early next year. Waste disposal requirements for the high level waste repository do include waste form performance standards which must be met for waste to be disposed there. DOE-ID agrees that the carbonate waste form produced by steam reforming is unlikely to satisfy the high level waste repository requirements without additional treatment, such as vitrification. The mineralized waste form from steam reforming has a much higher durability and leach resistance, and presents a treatment alternative that could enable steam reformed product to be disposed in the high level waste repository, if necessary. This process will be tested at the Hazen Research Inc. pilot plant and will include solid product characterization including leach tests appropriate for the high level waste repository. At that point, DOE-ID will have adequate data to evaluate the effectiveness and potential cost and risk factors associate with implementing the mineralized process for SBW treatment. Note that modifications to Yucca Mountain's acceptance criteria would also be required for any non-vitrified waste form such as steam reforming mineralized waste form.

Again, thank you and the panel for your rigorous and timely review of the Idaho Sodium Bearing Waste treatment project testing and design activities. DOE-ID appreciates your expert knowledge and professionalism and we believe that this review will contribute materially to the success of this project. Please take the time you need to consider and respond to the concerns identified in our factual accuracy review, and reissue the report at your earliest convenience.

Sincerely,

Richard B. Provencher, Deputy Manager
Idaho Cleanup Project

enclosure

cc: Mark Gilberton, EM-20
William Owca

UFC: 7450 MTPP.10
FMDP-MTPP-06-023

EXTERNAL bcc DISTRIBUTION:

ID DISTRIBUTION:
Administrative Support Center (Scanning)
! Administrative Support Center in Outlook (Elec.Copy)

CONCURRENCE: 8/22/06
Scott G. Van Camp SVC
Joel Case 8/22/06

RECORD NOTES:

1. Results of DOE's Factual Accuracy Review of the Independent Review Panel's Report on Steam Reforming of Idaho Sodium Bearing Waste (FMDP-MTPP-06-
2. This letter was prepared by William Owca and coordinated with David Moody (CBFO).
3. This letter/memo closes OATS number N/A
4. The attached correspondence has no relation to the Naval Nuclear Propulsion Program.

Original wording of Findings and Recommendations 8 and 17* from letter of July 27, 2006

Finding 8. Evaluation of the potential of the DMR product to be hygroscopic or deliquescent has not been carried out under sufficiently controlled conditions. Absence of deliquescence is an anticipated waste acceptance criterion for WIPP. Hygroscopic behavior of the solid product may result in agglomeration during handling or storage, impairing future material transfers if required.

Recommendation 8. The potential for deliquescence and hygroscopic behavior of the steam reforming solid products should be evaluated over a range of controlled relative humidity conditions. If the product is found to be hygroscopic, modifications to the canister storage system should be considered that would prevent the uptake of moisture during storage.

Finding 17. Waste acceptance criteria for remote handled transuranic waste disposal at the Waste Isolation Pilot Plant (WIPP) has not been finalized. Uncertainty with respect to the acceptability of the carbonate waste form from SR for disposal at WIPP represents the greatest programmatic risk. The carbonate waste form is highly water soluble, which likely presents a barrier to acceptance at Yucca Mountain, potentially an alternate disposal location (this is not currently considered a factor for disposal at WIPP, although this may be a consideration as part of a permit modification at WIPP). Production of a mineralized waste form (sodium-aluminum-silicate) may facilitate greater flexibility in disposal options. The costs for producing the mineralized waste form are likely to be far less if produced during initial treatment than if it is required at some point in the future, which would entail retrieval of the solid material from the storage canisters and further processing. Also, insufficient characterization (leaching, likely acceptance criteria) has been completed on both product forms.

Recommendation 17. (i) proceed with pilot testing for production of the mineralized waste form; (ii) complete more thorough product characterization and evaluation (including likely waste acceptance criteria and more appropriate leaching testing) of the carbonate and mineralized products as acceptable waste forms for disposal at WIPP and Yucca Mountain; and, (iii) carefully evaluate programmatic risks, costs and long-term benefits of directly producing the mineralized product rather than the carbonate product.

* Finding 17 in the July 27, 2006 version of this report is now revised to Finding 16 to correct a clerical error.