The Consortium for Risk Evaluation with Stakeholder Participation III

*Consortium Universities: **Vanderbilt University**, Howard University, Oregon State University, Robert Wood Johnson Medical School, Rutgers University, University of Arizona, University of Pittsburgh*

March 19, 2007

Ms. Shirley Olinger, Acting Manager
U.S. Department of Energy
Office of River Protection
P.O. Box 450 MSIN: H6-60
2440 Stevens Center Place
Richland, WA 99354

RE: CRESP Review Team Letter Report 2

Dear Ms. Olinger:

The Consortium for Risk Evaluation with Stakeholder Participation (CRESP) Review Team for the Office of River Protection (ORP), waste treatment plant (WTP) carried out its second review meeting with WTP personnel on Feb 15-16, 2007 at ORP. All CRESP review team members participated; however, David Kosson and Richard Calabrese participated through conference call rather than in person because of weather related travel disruptions. Charles Powers, CRESP Co-PI, was present for part of the meeting. The agenda for the meeting is provided as Attachment A. Below we provide the CRESP team observations and recommendations regarding each of the review topics. The CRESP team appreciates and thanks all of your staff and that of the WTP contractors for their extensive efforts in preparation for and during this review meeting.

General Comments

1. Project Reports and Presentations for CRESP Review

   It is our goal for CRESP reviews to be of maximum value to DOE and ORP. It is our understanding that our role is to provide an independent technical evaluation of projects and already identified problem areas, as well raise concerns that may not have been previously considered. Further, it is our understanding that, unless otherwise indicated, the written reports are to be considered the controlling documents. Confusion arose at the February meeting because we were hearing differences of opinion among the contractor, External Flow Sheet Review Team (EFRT) and DOE people without us being able to put those comments or concerns into proper context. However, we want to emphasize that we do not want to stifle

VANDERBILT UNIVERSITY

Vanderbilt University
Department of Civil and Environmental Engineering
VU Station B Number 351831
Nashville, TN 37235
Phone: 615-322-2697 Fax: 615-322-3365
www.cresp.org

such discussions since we believe they are helpful for all participants, and also help focus CRESP attention. Thus, we would like to suggest the following for future meetings:[1]

a. the relevant document, or parts of very large documents, for each technical issue to be considered should be identified before the meeting;

b. the technical or project leader for each such report be listed together with the rest of the project team and their affiliations and roles in the project area;

c. any personnel changes that have been made since the preparation of the documents being reviewed be identified;

d. if, at the meeting, the project leader is not the presenter, the role and affiliation of the presenter be identified; and

e. if the presentation includes information, plans, etc. that are different from the documents mentioned in item a) that these differences be specifically identified and explained in the presentation (for example, these may be a result of new data that have become available, new problem(s) that have been identified, a change in engineering direction, differences of opinion, etc.). It is important that CRESP reviewers understand these changes and their basis.

2. Project Definition Documents Submitted to DOE - Resolution of many of the issues that ORP is striving to address requires research and development that depends heavily on the expertise and continuity of the assigned project team. Therefore, we recommend that issue response plans and documents that define major project components for DOE include identification, reporting structure, and personnel history relevant to the project of the leadership and key technical personnel for the overall scope and primary tasks[2]. These individuals should be the responsible authors of the required documentation and presenters at reviews, from planning through issue closure. This will improve DOE's ability to evaluate the issue resolution efforts and provide clear ownership by the key personnel. Clear tracking of key personnel will also facilitate addressing any questions regarding the outcomes should additional insights be required at some time long after the work has been completed.

3. Test Plans – In general, test plans and specifications represent a critical step in understanding (i) the issues and specific questions to be addressed by a testing program, (ii) the approach, (iii) experimental design, and (iv) data usage to meet test program objectives. Therefore, all test plan specifications should be subject to careful review.

4. Tracking Uncertainty - A high level of uncertainty is an inevitable part of first-of-a-kind process development and implementation, especially for the complex set of technical issues ORP is addressing. Uncertainty will propagate from basic

[1] We recognize that some of these suggested actions have occurred for our meetings to-date.
[2] We view the documents that define scopes of work as analogous to research proposals, where documentation of the qualifications of personnel assigned to the proposed work is an important component of proposal review.

experimentation and observations through technical models and assumptions used in process design and evaluation. Identifying the sources of uncertainty and quantifying the magnitude of uncertainty for each source is important to provide realistic understanding of issues and to ascertain where resources may be best applied to reduce overall programmatic uncertainty. Therefore, we recommend that formal tracking of uncertainty be included in all issue response and design efforts. Effective and consistent reporting of uncertainty also will improve program credibility.

WTP Site Tour

The WTP site tour was very helpful in facilitating our understanding of the current level of construction completion and the impact of design modifications on already completed construction. Site tours for ORP stakeholders and the public would improve general understanding of the challenges ORP faces and improve credibility.

WTP Flowsheets and Flowsheet Analysis Tools

Discussion of the WTP flowsheets and flowsheet analysis tools was not a focus of the CRESP review, but rather was provided to improve our background understanding. However, within this context, we believe the following comments may be helpful:

1. Uncertainty estimates and analysis should accompany flowsheet results (e.g., reporting range or confidence interval with the point estimate of results) to improve process understanding and identify project risks. The bases for any assumptions about uncertainties should be systematically listed. In some cases, it is understood that estimates may be heuristic, but the important issue is to attempt to make uncertainty estimates and to be explicit about the basis for these.
2. Steady-state flowsheet simulation (using software by Aspen Technology, Inc.) is currently being used for overall process evaluation. While this is appropriate for early stage analysis, WTP is largely a sequence of coupled batch processes that are inherently dynamic. Dynamic flowsheet simulation of unit operations would be a beneficial tool for improved process understanding and planning, would facilitate organization of information and uncertainty analysis, and also is an important precursor to operator training modules.
3. Several separate models are being used for process analysis[3]. It is unclear how these models integrate and how information flows between models.
4. It is unclear how new basic data being developed through the current issue response programs will be incorporated into process models (e.g., OLI thermodynamics models, process kinetics models, flowsheet models) and who will be responsible for such efforts. Clear understanding of model data requirements, data fitting and

[3] The three models discussed were the (i) operations research assessment – OR Model, (ii) tank utilization assessment – G2 Model, and the (iii) material balance and flowsheet model – AES Model.

sensitivities is an important component of experimental design to insure the greatest benefit from experimental results.

Antifoam and Hydrogen Release During Intermittent Mixing of Non-Newtonian Fluids

The issue response plan as written does not clearly describe the scenario(s) or potential problem(s) to be addressed, nor adequately describes potential and likely hydrogen retention and release mechanisms. It is unclear whether there are two different cases of concern – during normal operations and during upset conditions. In addition, the plan as written also does not reflect an adequate understanding of the current literature on bubble rise and bubble column behavior in non-Newtonian fluids, nor anti-foam surfactants. As a result, the proposed experimental plan and associated results may not help in resolving the identified issue or worse provide misleading direction. Suggestions on specific mechanisms to consider, initial direction on the current literature and experts to consult will be the subject of a separate letter report by the CRESP review team.

Leaching and Ultrafiltration Engineering Scale Test program

1. The report entitled "Integrated Leaching and Ultrafiltration Engineering Scale Test System Scale Factor Selection"[4] is intended to provide the rationale for scaling factors used for pilot-scale testing of different components of the WTP pretreatment process. The CRESP review team identified this as important documentation needed as part of the test system development. Design and procurement of the engineering scale test system has proceeded in parallel with the development of this document. The document provides useful background information and defines requirements for the engineering scale test system. However, the report fails to provide sufficient detail on the scaling of the pulse jet mixers in relation to the primary reaction vessels (Section 6.1) and is unclear and confusing on the integration of mixing with filtration (Section 7). Scaling time should not be a factor for essentially decoupled leaching and filtration processes, but rather, achieving comparable solids loading on the engineering scale and full-scale filtration systems is important. Thus, the relevance of "Operational Mode 2" is unclear.
2. The current design for the engineering scale test system appears to be well thought out and reasonable. Enough flexibility should be maintained to adjust the positioning and operation of the pulse jets mixers to address mixing concerns that have been raised by the EFRT.
3. The most important next step for the engineering scale test system will be the careful definition of the objectives, specific questions to be answered, and experimental design for the planned testing program. Establishment of the planned use of the data gathered, including identifying model parameters that need to be measured or derived, and logic for selection of specific test conditions also should be documented. This information is to be documented in the test program specification, which is

[4] J. Huckaby, *Integrated Leaching and Ultrafiltration Engineering Scale Test System Scale Factor Selection*, Bechtel, document no. CCN 151228, January 23, 2007.

anticipated to be available in the June 2007 time frame. The test program specification should be subject to careful review.

4. Selection of waste simulants is an important part of the testing program for resolution of many of the EFRT issues. Different simulants will be needed to test different process components and operating conditions. Selection of simulants requires compromises on the properties of the simulant relative to actual wastes, and therefore, it is very important to carefully define relevant simulant properties for each process step or process aspect being evaluated. For example, for evaluation of filtration, the particle size distribution, particle morphology, and solution/suspension rheology as a function of process conditions are likely to be the most critical simulant parameters. In contrast, for evaluating aluminum leaching, aluminum phase mineralogy and morphology, and the solution composition (hydroxide, other major species present) are likely to be the most critical simulant parameters.

   We recommend the development of a guide for simulant requirements and applications that describes (i) the important physical and chemical characteristics of the waste in each part of the process, (ii) the key simulant requirements relevant to specific evaluation requirements (e.g., leaching kinetics, filtration, mixing, gas release), (iii) the simulant or simulants and their composition and characteristics most closely matching these characteristics, and (iv) the waste characteristics that are not being mimicked by the simulant. As there is significant history of the use of waste simulants for process development at Hanford and Savannah River, this guide should also include a summary of the history and prior experience with each simulant. The resulting guide would serve as the basis for use of current simulants, identify gaps in simulant applicability, and the development of new simulants.

5. The planned program for testing actual waste samples for leaching kinetics in small batches and small-scale processing characteristics in the cell ultrafiltration unit (CUF) represents a well thought out aggressive program for understanding waste characteristics in the context of limited sample availability. This program should be given high priority because it is necessary for effective selection of simulants for the engineering scale test program.

6. One on-going and important issue raised by the EFRT that will be evaluated in the engineering scale test program is the drainage of the planned horizontal ultrafiltration assemblies. Evaluation of filtration should also consider the potential for precipitation of solution constituents in the filters as a consequence of local conditions that may be differ from the bulk fluid. This is also an instance where careful selection of a simulant is important if the effect of process stoppage and start up is to be evaluated.

Evaluation of Mixing in Pretreatment Vessels

Understanding mixing in the pretreatment vessels will be an on-going need in response to changes in waste characteristics and process conditions. Currently, extensive experimentation is planned to evaluate mixing in pretreatment vessels using simulants. A scaled-testing based approach will be used to generate data from which correlations will be generated for solids re-suspension and solids vertical distribution, mixing times, and

blending times. The intent is provide sufficient data from the testing such that the correlations are applicable to all solids-containing vessels over the expected range of waste slurry physical properties.

Preliminary computational fluid dynamics (CFD) simulation provides a mechanism to focus test conditions and reduce testing requirements. The currently planned mixing test program provides an opportunity to apply and verify CFD simulation focused on the pulse jet and air sparging mixing in the pretreatment vessels. Once validated, a CFD model will serve as a robust tool for tailoring mixing and operating conditions to specific waste characteristics, and will be a more cost effective for screening operating conditions, and focusing future testing programs to minimize testing costs. However, CFD modeling should include careful selection of experienced modelers. It is the view of the team that that over the time frame of this project, CFD promises to make a major impact on process operation and upset evaluation. Hence, it is important that CFD expertise experienced with mixing in vessels be devoted to this part of the project[5].

The CRESP Review Team looks forward to further discussion regarding these topics and future review meetings.

Sincerely,

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

Richard Calabrese, Ph.D.

Willard Gekler

Robert Powell, Ph.D.

Stanley I. Sandler, Ph.D.

Cc: M. Gilbertson (EM-20)
C. Powers (CRESP)

[5] CFD expertise also may be very beneficial in resolving fluid mechanics and rheology issues throughout WTP, such as the potential for particle settling and pipeline plugging.

Attachment A

CRESP Ultrafiltration and Anti-Foam Issue Review
February 15-16, 2007

Location: 2440 Steven Center/Room 2212/Richland Washington

Overall Consortium for Risk Assessment with Stakeholder Participation (CRESP)
Review Objective: To provide independent review and input to the Manager of the Office of River Protection Project on adequacy of available data, test plans and testing results to support design, integration and operation of specific component processes and issue resolution for the Waste Treatment Plant (WTP)

Purpose of February 15-16, 2007 review:

1) WTP construction site tour with focus on the Pretreatment Facility.
2) Review of WTP flowsheets.
3) Review test strategy and plans for Issue M12, Undemonstrated Leaching Process.
4) CRESP present observations from of Atlanta Cr and Al leaching workshop.
5) Review Issue M1, Line Plugging, particle size and density report.
6) Review Issue M3, Inadequate Mixing System Design, test plan.
7) Review the Issue Response Plan for Effects of Anti-foam Agent on Gas Retention/Release.

Agenda:
February 15, 2007

0730 Obtain Site Visitor Badges (2440 Stevens Center Lobby)

0800 Depart for WTP Site Tour.

- General Walking Tour of WTP Construction Site. (Gilbert)
- Detailed tour through the Pretreatment Facility. (Hard hats and safety glasses will be provided. Please bring substantial footwear, warm coats, and gloves.) (Gilbert)
- Tour large scale PJM test setup in 336 building. (Brouns)

1200 Lunch

1300 Introductions and review of agenda

1330 Review of WTP flowsheets

- Describe models used for assessment. (Saunders)
- Review the distribution of key elements through the process (Al, Cr, Tc, I, Pu, U, Am, Cs, Np, S, P, Oxalates, and organics). Focus discussion on ultrafiltration system and contributions from feed and recycle streams. (Saunders)
- Describe the quantity and nature of organic constituents in tank waste feed. (Papp)

- Describe the impacts of organics on the ultrafiltration process. (Papp)
- Describe UFP cycles and modes of operation. (Saunders)

1530 Break

1545 CRESP provide discussion of observations from the January 2007 Atlanta Al and Cr Workshop. (Kosson and Calabrese)

1615 Review the Issue Response Plan for Effects of Anti-foam Agent on Gas Retention/Release. (Jain)

1645 CRESP internal discussions

1900 Dinner at Red Lion (Notify Walt Tamosaitis if you plan to attend)

<u>February 16, 2007</u>

0730 Review test strategy and plans for Issue M12, Undemonstrated Leaching Process

- Overall testing program including objective and strategies to address key issues. (Barnes)
    - Radioactive waste characterization
    - Simulant development
    - Radioactive bench scale testing
    - Simulant bench scale testing
    - Engineering Scale Demonstration

0930 Break

1000 Review test strategy and plans for Issue M12 (cont.)

- Engineering Scale Demonstration
    - Basis for scale (Barnes)
    - Schedule (Musick)
    - Status of design (Musick)

1200 Lunch (Box lunch working session for CRESP)

1300 Review of Issue M1, Line Plugging, particle size and density report as it pertains to the ultrafiltration system. (Chiaramonte)

1330 Review of Issue M3, Inadequate Mixing System Design, test plan as it pertains to the ultrafiltration system. (Saunders)

1400 CRESP internal discussions

1600 CRESP outbrief

Background Material

24590-WTP-RPT-PT-02-005, Flowsheet Bases, Assumptions, and Requirements

Presentations from Atlanta Al and Cr Workshop

- Rob Gilbert
- Jonas Addai-Mensah
- Reid Peterson

24590-WTP-PL-RT-07-00001, Issue Response Plan for Effects of Anti-foam Agent on Gas Retention/Release

TP-RPP-WTP-467, Characterization and Small Scale Testing of Hanford Wastes to Support the Development and Demonstration of Leaching and Ultrafiltration Pretreatment Process

WTP-RPT-151, Review of Caustic Leaching Testing With Hanford Tank Waste Sludges

24590-WTP-PL-ENG-06-0024, Issue Response Plan for Implementation of External Flowsheet Review Team (EFRT) Recommendations – M12, Undemonstrated Leaching Process

24590-PTF-3YD-UFP-00002, Performance Requirements for Engineering Scale Pretreatment System

24590-PTF-RPT-RT-07-001, Integrated Leaching and Ultrafiltration Engineering Scale Test System Scale Factor Selection

24590-PTF-TSP-RT-06-007, Scaled Testing to Determine the Adequacy of the WTP Pulse Jet Mixer Designs

WTP-RPT-153, Estimate of Hanford Waste Insoluble Solid Particle Size and Density Distribution