R10889164

RPP WTP

Memorandum

To:	See Below	Date:	March 13, 2008
From:	Walter L. Tamosaitis – MS4-B2	CCN:	168057
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Subject: **TEST FACILITY LESSONS LEARNED TECHNICAL EXCHANGE MEETING SUMMARY**

A two day meeting was held December 4 and 5 at Hanford and was hosted by the Waste Treatment Plant (WTP) Project and Department of Energy. About 60 people attended and included participants representing three national laboratories, Tessenderlo Kerley Services, Parsons, CH2, Energy Solutions, URS-Washington Division, Bechtel, the Idaho site, and THOR. Department of Energy participants included the Office of River Protection, Headquarters, and Savannah River. Personnel from several other groups attended the meeting as well as personnel from the WTP project and other Hanford site functions. A listing of presenters, topics, and sites represented is shown in Attachment #1.

The purpose of the Technical Exchange was to share experiences and the lessons learned in the operation of test facilities so that Department of Energy (DOE) Sites can improve the safety, efficiency and effectiveness of test facilities/test platform programs and operations. Opening presentations were made by WTP (Dr. Walter L. Tamosaitis), DOE-HQ (Dr. Steve L. Krahn), and DOE-ORP (Jim Wicks and Rob Gilbert). The three opening presentations are included in Attachments 2, 3, and 4, respectively. Attachment #2 includes the meeting objective, meeting flow, and agenda. Dr. Krahn's presentation highlighted the role and importance of the Environmental Management Roadmap and the need to incorporate technology needs.

Attachment #5 summarizes the 32 key lessons learned highlighted in the meeting. This summary combines comments from the meeting discussion, additional notes taken during the meeting by WTP personnel, and post meeting WTP discussions. One item receiving much discussion was simulants. As a result of the meeting discussion, the WTP designated a simulant coordinator, Dr. Vijay Jain, to coordinate simulant use from individual testing through to the actual plant. The charter for his role is shown in attachment #6. As part of his responsibilities, a simulant check list was developed. The latest version of this list is shown in attachment #7. Attachment #8 summarizes the simulant lessons learned from WTP programs.

The meeting discussion and the identification of the 32 key lessons learned was especially timely for the WTP which is constructing, installing, and will be operating a quarter scale test platform of the actual WTP Pretreatment facility. The test facility is called the Pretreatment Engineering Platform (PEP) and is scheduled to commence testing in fourth quarter 2008. The test facility will have about a 5000 ft2 foot print, 2 floors, and complete services. Pacific Northwest National Laboratory (PNNL) is an integral part of the installation, checkout, and testing. The PEP will be located in a PNNL facility. A three dimensional pictorial of the PEP is shown in Attachment #9.

The meeting was very successful and provided all personnel with an excellent summary of lessons learned in all aspects of scaled testing to full size testing. In particular, the session provided WTP and PNNL with timely input for consideration during the planning of the PEP installation and operation. In perspective of what has been operated recently across the DOE complex, the PEP is by far the largest and most complex test platform to be installed and tested. As a comparison, most other test units had about 100-200 instruments compared to nearly 1,500 on the PEP. The meeting discussion highlighted the complexity of the PEP and clearly emphasized the need for careful and thorough planning.

The lesson learned presentations were given in nine groupings comprised of 18 presenters. Copies of all presentations are posted on the WTP Research and Technology website under the title "Lessons Learned Workshop - December, 2008" or can be obtained from Donna Gier (509-371-3364). Further information on this meeting can be obtained from Jeff Markillie (509-371-3803).

Walter L. Tamosaitis
Deputy Chief Process Engineer
Research and Technology Manager
Process And Engineering Technology Department

WLT/dlg

Attachments:
1) Test Platform/Test Facility Technical Exchange: Speakers, Topics, and Sites Represented
2) Presentation: Test Platform / Test Facility Technical Session, December 4-5, 2007, coordinated by Dr. Walter L. Tamosaitis and Donna Gier
3) Presentation: EM Engineering & Technology: Reducing Technical Risks and Uncertainties in EM Projects, presented by Dr. Steven L. Krahn
4) Presentation: Overview Comments, presented by Rob Gilbert
5) Summary of the Key Lessons Learned from the Test Facility Technical Exchange
6) Charter Statement – WTP Simulant Development and Use Coordinator

7) Checklist – Simulant Development, Manufacturing, Storage, Transportation and Testing (Based on Simulant Lessons Learned)
8) Lessons Learned – Potential Delays and Problems Encountered During Simulant Development, Manufacturing, Storage, Transportation and Testing
9) PEP photograph

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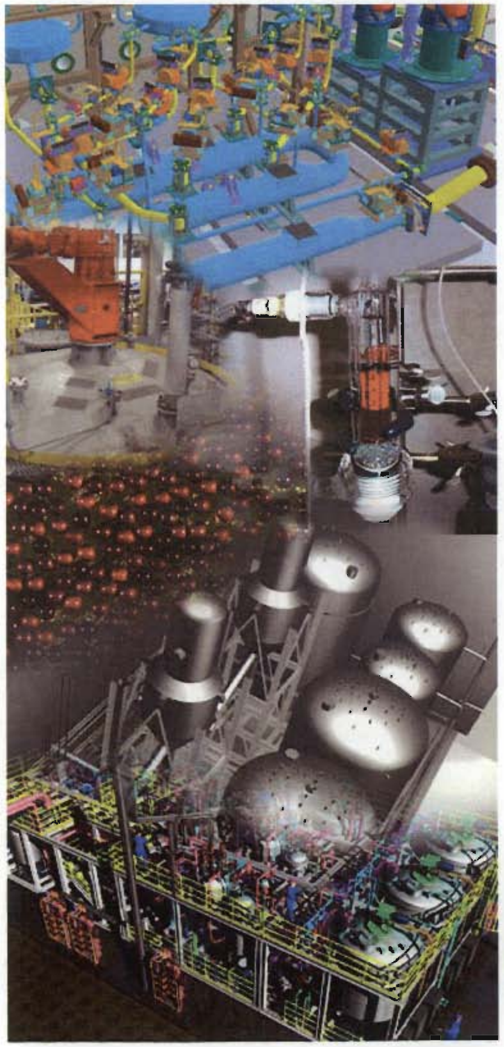
TEST PLATFORM/TEST FACILITY TECHNICAL EXCHANGE

SPEAKERS, TOPICS, AND SITES REPRESENTED

Site	Speaker	Test Facility Topic
Hanford - Waste Treatment Plant Project (WTP)	Steve Barnes	Pretreatment Engineering Test Platform (PEP) Testing Overview
Hanford - WTP	Chris Musick	PEP Design
THOR	Brad Mason	Steam Reformer Testing
Idaho	Keith Quigley	Tank Farm Retrieval Demonstrations
Savannah River Site (SRS)	Jack Kasper	Salt Waste Processing Facility (SWDF)
Savannah River National Laboratory (SRNL)	Russell Eibling	Simulant Support to the Waste Treatment Project and SRS
Savannah River National Laboratory	Dan Burns	WTP Pilot Testing at the Thermal Fluids Laboratory
Savannah River National Laboratory	Michael Poirier	Filtration and Solvent Extraction Testing for the SRS-SWDF
Savannah River National Laboratory	Richard Edwards	SRNL Pilot Testing Overview
Oak Ridge	Ken Wilson	Fuel Cycle Facility Testing
Oak Ridge	Paul Taylor	Small Tank Tetraphenylborate Stirred Reactor Testing
Oak Ridge	Ben Lewis	Test Support for Gunite Tank Remediation
Duratek/VSL	Glen Diener	Melters and Glass Testing
Hanford Tank Farm	Rick Tedeschi	Bulk Vitrification Dryer Testing
Hanford Tank Farm	Dennis Hamilton	Fractional Crystallization
Hanford Tank Farm	Rick Raymond	Cold Test Facility Testing
Tessenderlo Kerley Services	Stan Power, Steve Sailor	Commercial facility experiences
Pacific Northwest National Laboratory	Dean Kurath	Pulse Jet Mixer Program for Non-Newtonian Fluids
Pacific Northwest National Laboratory	Conselo Guzman-Leong	Large Scale Antifoam Agent Testing



Waste Treatment Plant Project

Test Platform / Test Facility Technical Session

December 4 – 5, 2007

Hanford, WA

Coordinators

Dr. Walter L. Tamosaitis, Ph.D., P.E.
Research and Technology Manager
Deputy Chief Process Engineer
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Donna Gier
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Office of River Protection

Bechtel National, Inc.

URS Washington Division

MEETING OBJECTIVE

Objective is:

"To share experiences and lessons learned in test facility and test platform operations so that all Sites can benefit and improve the efficiency and effectiveness of their testing".

Objective is not:

Meeting objective is ***not***: to discuss specifics of process performance, schedules, or site objectives

Requirement for an effective meeting:

Requirement for an effective meeting: Openness on the part of all participants to discuss their experiences and lessons learned, especially those things that did not do so well. We need to consider the meeting environment a "*safe zone*"

TEST PLATFORM / TEST FACILITY TECHNICAL SESSION
AGENDA
DECEMBER 4 - 5, 2007
TECHNICAL INFORMATION SHARING ON LESSONS LEARNED

Day 1
December 4, 2007

8:00 am to 8:30 am	Welcome and safety topic - Walt Tamosaitis • Meeting Purpose • Introduction of participants - Walt Tamosaitis • DOE - HQ Comments - Dr. Steve Krahn • DOE - ORP Comments - Jim Wicks • Agenda - Walt Tamosaitis
8:30 am to 9:30 am	WTP Pretreatment Engineering Test Platform (PEP) Overview and Objectives • Facility Design - Chris Musick • Test Program - Steve Barnes • Test Program Discussion Topics - Walt Tamosaitis
9:30 am to 9:45 am	Break
9:45 am to 10:45 am	Presentation # 1 - Thor - Steam Reforming Tests - Brad Mason / John Truax
10:45 am to 11:30 am	Presentation # 2 - Idaho Tank Farm Retrieval - Keith Quigley
~ 11:30 am to 12:15 pm	Lunch (on your own - see map)

TEST PLATFORM / TEST FACILITY TECHNICAL SESSION
AGENDA
DECEMBER 4 - 5, 2007
TECHNICAL INFORMATION SHARING ON LESSONS LEARNED

Day 1

December 4, 2007

12:15 pm to 1:30 pm	Presentation # 3 - Parsons - SWPF Testing – Jack Kasper
1:30 pm to 1:45 pm	Break
1:45 pm to 3:30 pm	Presentation # 4 - Savannah River National Laboratory • Simulant Experiences - Russ Eibling • WTP Testing - Dan Burns • Filtration/FRED/MCU Testing - Mike Poirier • Waste Handling/Summary - Richard Edwards
3:30 pm to 4:45 pm	Presentation # 5 - Oak Ridge National Laboratory • Operations with Uranium - Ken Wilson • TPB CSTR Tests - Paul Taylor • Fernald Slurry Testing - Paul Taylor • Gunite Tank Support - Ben Lewis
4:45 pm to 5:00 pm	Day's Summary
	Dinner - on your own

TEST PLATFORM / TEST FACILITY TECHNICAL SESSION
AGENDA
DECEMBER 4 - 5, 2007
TECHNICAL INFORMATION SHARING ON LESSONS LEARNED

Day 2
December 5, 2007

8:00 am to 8:15 am	Safety and Objective - Walt Tamosaitis
8:15 am to 9:30 am	Presentation # 6 - Energy Solutions - Melters and other Related Testing -Glen Diener
9:30 am to 9:45 am	Break
9:45 am to 11:15 am	Presentation # 7 - CH2 • IDMT Dryer Testing - Rick Tedeschi • DBVS Testing - Dave Shuford • Fractional Crystalization - Dennis Hamilton • Cold Test Facility/S-102 Testing - Rick Raymond
~ 11:15 am to 12:00 pm	Lunch (on your own - see map)

TEST PLATFORM / TEST FACILITY TECHNICAL SESSION
AGENDA
DECEMBER 4 - 5, 2007
TECHNICAL INFORMATION SHARING ON LESSONS LEARNED

Day 2
December 5, 2007

12:00 pm to 1:00 pm	Presentation # 8 - Tessenderlo Kerley Services - Commercial Experiences • Design and Installation - Stan Power • Startup and Operations - Ed Golden
1:00 pm to 2:15 pm	Presentation # 9 - Pacific Northwest National Laboratory • PJMs - Dean Kurath • Antifoam - Conselo Guzman-Leong
2:15 pm to 2:30 pm	Break
2:30 pm to 3:00 pm	WTP Pretreatment Engineering Platform Plans - John Truax
3:00 pm to 4:15 pm	Discussion and Group Input on planning considerations for the installation, startup, and operation of the WTP Pretreatment Engineering Platform.
4:15 pm to 4:30 pm	Wrap Up and Closing Comments

TECHNICAL INFORMATION SHARING
TEST PLATFORM / TEST FACILITY LESSONS LEARNED

MEETING FLOW

WTP PEP OVERVIEW AND OBJECTIVES

"Here is what we are building and what we plan to do"

⇩

EXPERIENCES AND 9 PRESENTATION LESSONS LEARNED

"What to watch out for and what are the keys to success"

⇩

DISCUSSION AND INPUT FOR THE PEP (and other Pilot Plants)

"What should we focus on to help ensure the PEP IS operated safely, efficiently, and effectively?"

EM U.S. Department of Energy
Office Of Environmental Management

EM Engineering & Technology: Reducing Technical Risks and Uncertainties in EM Projects

Dr. Steven L. Krahn
Office of Engineering & Technology

December 2007

Engineering and Technology Program

- Mission: To Identify Vulnerabilities and to Reduce the Technical Risk and Uncertainty of EM Programs and Projects

- Vision: Engineering and Technology initiatives will provide the engineering foundation, technical assistance, new approaches, and new technologies that contribute to significant reductions in risk (technology, environmental, safety, and health), cost, and schedule for completion of the EM mission.

Strategic Planning for Engineering and Technology Program Activities

- Strategic Planning Approach
  - Implement Roadmap Initiatives
  - Select critical, high-risk, high-payoff projects
  - Complete Technology Readiness Assessments
  - Complete External Technical Reviews
  - Review Risk Management Plans
  - **Conduct Technical Workshops and Exchanges**
- Collaboration with National Laboratories, **Private Sector**, and Universities for innovative technologies and technical exchanges
- Work with Federal Project Directors

Draft April 2007 Roadmap Revised In September 2007

- Incorporates Stakeholder comments and adds strategies for spent nuclear fuel and nuclear materials.
- Identifies technology risks in Waste Processing, Groundwater and Soil Remediation, and Deactivation & Decommissioning/Facility Engineering.
- Establishes strategic initiatives to address technical risks and identifies expected outcomes when implemented.
- Is a "living document".
- Will be available at http://www.em.doe.gov/Pages/EngTech.aspx

Roadmap Implementation

- Multiyear Program Plan (MYPP) being developed to implement Roadmap
- Staff from national laboratories and site offices across the DOE complex has been involved in formulating the E&T MYPP
- MYPP will address:
  - prioritized work activities, required budget, schedule
  - major products/deliverables, performance metrics, and performer selection

Sharing Technical Expertise and Lessons Learned to Reduce Risk and Technical Uncertainties

- Technology Exchange meetings have assured maximum benefits from outcomes of R&D performed across the DOE complex
- Focused workshops
  - Cementitious Workshop December 2006
  - Aluminum/Chromium Workshop January 2007
  - Technical exchanges among Savannah River, Idaho and Hanford on waste processing projects held in March and October 2007
  - In-situ Decommissioning Workshop September 2007
  - Proceedings posted on Waste Processing website
- Common Issues teleconferences have shared technical design, construction and operational experiences of mutual interest to EM waste projects
  - Cross Flow Filter Testing – sharing of test information among sites
  - Cesium Ion Exchange Research – future benefit to multiple sites
  - Technology Readiness Assessments – input for process development
  - Pulse Jet Mixers Erosion Wear – improving the testing parameters
  - Fire Resistant Structural Design – lessons learned in design
  - Waste Transport and Pipe Plugging - lessons learned from operations

External Technical Reviews & Technology Readiness Assessments Help to Resolve Risks and Uncertainties

- High profile EM projects prompted the use of External Technical Reviews, for example
  - Tank 48 at Savannah River
  - Demonstration Bulk Vitrification System (DBVS) at Hanford
  - Salt Waste Processing Facility Waste Treatment Plant (WTP) at Hanford
  - at Savannah River
  - Groundwater and Soil Remediation at Hanford and Paducah
  - Hanford Environmental Restoration Disposal Facility (ERDF)

- Important to organize engineering and scientific expertise, through a structured review process to address difficult technical problems or resolve project management issues
  - External Technical Reviews support EM projects in addressing their risks and uncertainties
  - E&T works with Federal Project Directors to put together ETR charters and lines of inquiry using subject matter experts
  - Identify and document risks in Risk Management Plans
  - Incorporate Lessons Learned and Response Plans into EM projects
  - ETR and TRA Guidance Manuals currently being developed

ETRs & TRAs (continued)

- Technology Readiness Assessments along with development of technology maturity plans early in project key to reducing risks
  - Provides status of given technology relative to attributes described in each successive Technology Readiness Level (1-9) or, in other words, what development has been done at a given point in time
  - Provides a tool for DOE-EM to evaluate and communicate status of technology development in a consistent manner; process is structured and systematic
  - Developed by NASA; mandatory for DOD by Congress
  - GAO recommends TRA process for DOE (GAO-07-336); draft FY2008 House Language requires it

- Eight Pilot TRAs conducted by DOE-EM to date
  - Hanford Waste Treatment and Immobilization Plant (WTP) Laboratory, Low Activity Waste (LAW) Facility and Balance of Facilities (3 TRAs)
  - WTP High-Level Waste Facility
  - WTP Pre-Treatment (PT) Facility
  - Hanford River Protection Project Low Activity Waste Treatment Alternatives
  - Hanford K Basins Sludge Treatment Process
  - Savannah River Tank 48H Waste Treatment Technologies

Conclusions

- Roadmap identifies strategies to reduce risks and improve technologies and processes at EM sites.
- External Technical Reviews have been proven useful in supporting critical project management decisions.
- Technology Readiness Assessments are a promising tool to delineate technical risk. Technology Maturity Plans are key to reducing project risk.
- Broader collaboration through technical exchanges are needed to ensure mission success

Office of River Protection (ORP) Waste Treatment Plant (WTP)

Rob Gilbert

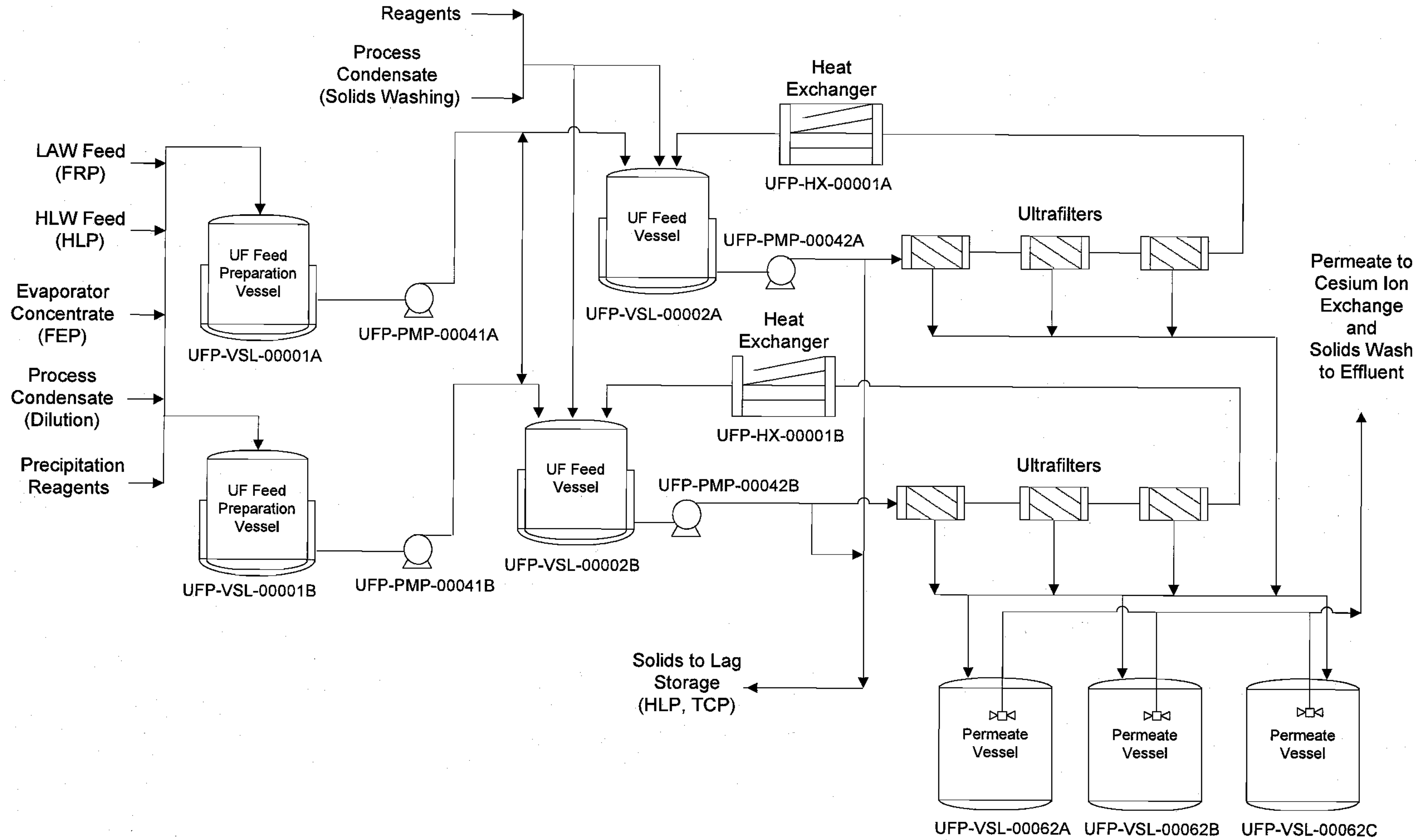
12/4/07

Lesson Learned

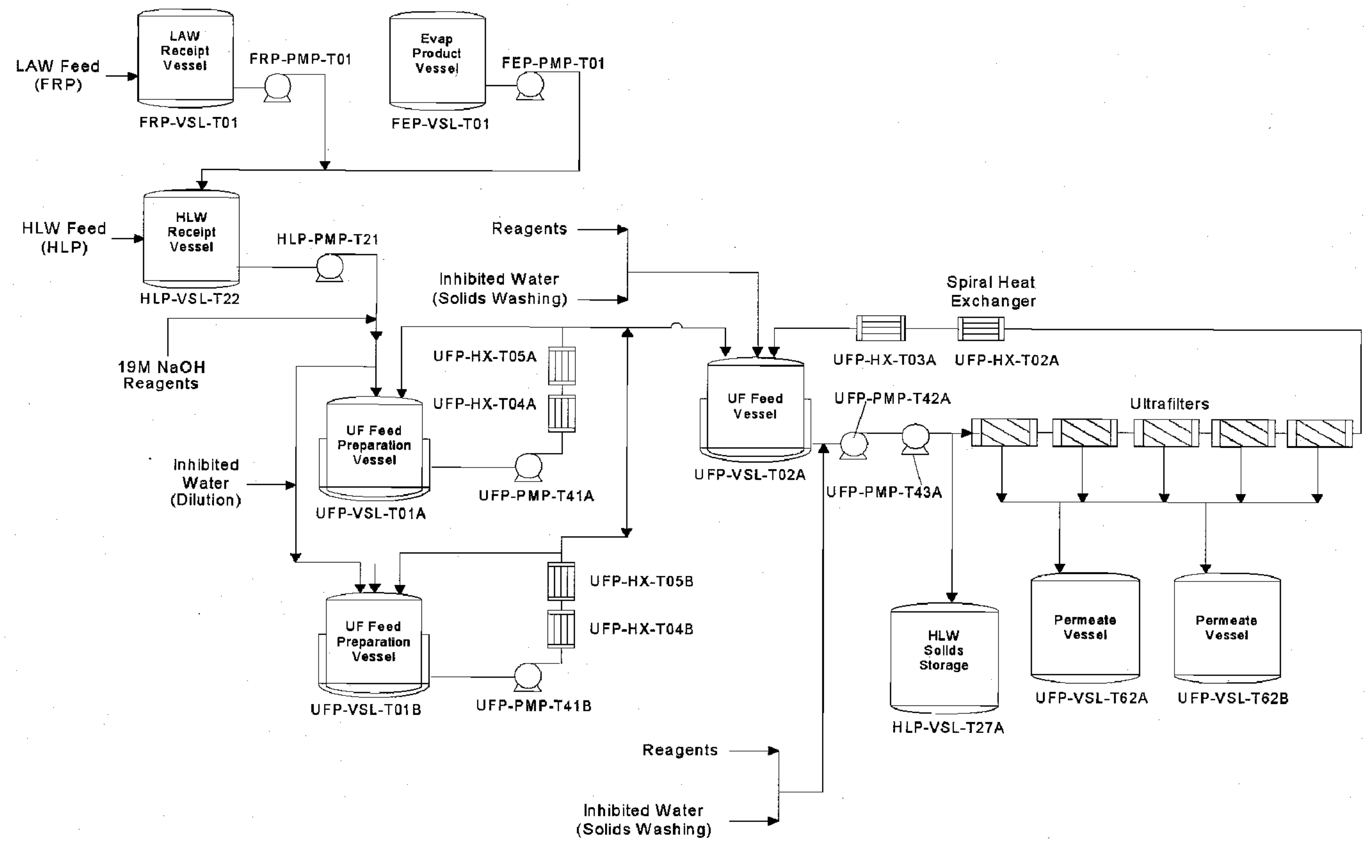
- WTP design and construction is well underway; however, significant issues requiring testing must be addressed
- ORP, Expert Flowsheet Review Team, and BNI assessments concluded engineering/pilot-scale testing of the ultrafiltration system was required
  - The ultrafiltration system and leaching processes had not been demonstrated beyond the bench scale and testing with conditions representing the WTP flowsheet had not been completed
  - Capacity of the ultrafiltration system was uncertain
  - Operating approaches for the ultrafiltration system were not demonstrated

Lesson Learned: Ensure processes have been demonstrated at appropriate scale and in a relevant environment to support final design

Ultrafiltration Flow Diagram



Simplified PEP Flow Diagram



UFP System Changes

- Significant changes made to address issues:
  - Increased filter surface area to achieve throughput
  - Added leaching capability in ultrafiltration feed preparation vessels
  - Added in-line mixing capability
  - Increased leaching temperature for boehmite disolution
  - Increased filtration temperature
  - Add caustic to permeate after filtration
  - Revised approach to flush filters

UFP System Issues

- Significant issues requiring testing or demonstration
  - Mixing
  - Leaching kinetics
  - Leaching effectiveness
  - Filter flux
  - Post filtration precipitation
  - Method of heating
  - System hydraulics
  - Performance with spectrum of tank waste

SUMMARY OF THE 32 KEY LESSONS LEARNED FROM THE TEST FACILITY TECHNICAL EXCHANGE

The purpose of the Test Facility Technical Exchange was to share experiences and lessons learned in the operation of test facilities so that Department of Energy (DOE) Sites could benefit and improve the safety, efficiency and effectiveness of test facilities operation. Based on the experiences shared by the presenters, 32 common lessons learned were compiled by WTP personnel and are shown below. These common lessons learned will be directly used in the planning, installation, and startup of the Waste Treatment Plant (WTP) Pretreatment Engineering Platform (PEP). A draft listing of these lessons learned was presented in the last session of the Technical Exchange. The listing below expands the listing shown during the meeting and incorporates notes taken during the meeting and in post meeting discussions. The text following each heading is a synthesis of input developed during the Technical Exchange coupled with results of further post meeting discussions among WTP and Pacific Northwest National Laboratory (PNNL) personnel.

In total, 32 lesson learned were identified for attention and follow up when planning and pursuing pilot plant testing and operations. The 32 lessons learned listing below does not represent priority or order of importance. They have been arranged into six groups only for the purpose of aiding review and use. Overlap exists between groupings and other groupings or subdivisions can be made and may benefit the user. Some comments pertinent to the PEP are included but not intended to provide a complete description. More complete status and basis of the PEP should be obtained from other sources.

I. Design

Document Process Scaling and Assumptions

Discussion: Prototypic scaling of systems designed to undergo testing in a Test Facility should be carefully considered. Establish early in conceptual design a scaling factor, along with the associated technical rationale, that can be applied to the key unit operations and equipment undergoing testing. Thoroughly document the assumptions and basis for the scaling.

PEP: In the PEP, a 4.5 scale (linear basis) factor was selected and applied for the prototypic leaching and filtration unit operations. This scale factor was chosen based on having an adequate scale up factor for mixing, using actual filter tube velocities and dimensions, and maintaining key process cycle times. Pipe lengths were not scaled, but flush volumes and hydraulics were designed to be prototypic.

Carefully Select the Site for the Test Facility

Discussion: The site/facility selected for testing should be carefully selected, based on the objectives and programmatic needs associated with the tests. Some private companies provide turnkey testing services including maintenance of environmental permits and may provide lower cost operations. Further, the agility with which private companies can respond to preliminary analyses and revise test instructions or make design changes provides potential benefits. On the other hand, testing within a DOE facility can provide a ready infrastructure for delivering needed services and conduct of operations. Proximity to the core of engineering and operating personnel provides for added input and sensitivity to the design but may require "tour" coordination. Facility location should also consider the long term use (disposition) of the facility.

PEP: The PEP will be located in PNNL's Process Development Laboratory - West (PDL-West) facility. This is a main part of the Hanford campus and in close proximity to engineering/operations personnel as well as project and customer management. It was chosen in part to provide easy visual/technical benefit to those visiting the project as well as project personnel. The facility provides sheltered and separated operations and is in close proximity to laboratories.

Logistics and Support Facilities are Important

Discussion: While thought is being put into locating the test equipment, do not overlook the facilities and things needed to support the operation. This includes space to unload supplies, parking, offices, as well as cafeteria and restroom facilities. Ensure that computer support, phones, and other such administrative support can amply be provided. Consider lighting, security, and other environmental type issues.

PEP: The PDL-West building was chosen in part for the PEP because it is a stand alone building with ample space around it. It already has office space. Ample lighting will be provided by both building lighting and lighting on the equipment.

Evaluate Equipment and Supply Delivery Details

Discussion: Shipping and delivery of equipment can present unusual problems especially if equipment is oversize or very large. Oversize equipment can require special shipping routes and times. Large equipment can require special protection, rigging and handling equipment. The weather can impact both shipping and on-site handling. Ensure equipment pieces are carefully and properly marked before shipment. Maintaining the safety and cleanliness of equipment during shipping can require special measures. The effect of seasonal and environmental variations, especially temperature, on simulants should be considered to ensure precipitation, gelling, etc is addressed. Having to re-clean equipment on-site can require unnecessary efforts as can re-identification of parts.

PEP: Special lifting equipment and handling plans were established for the PEP skid sections. Some equipment was rapped in a protection sheeting to keep equipment. Simulant or simulant constituents may be shipped cross country in the fall of 2008 and temperature effects will be addressed.

II. Test and Operational Planning

Have a Defined Safety Envelope (lockout tagout program; Hazards Analysis; How you Maintain Testing Within Envelope)

Discussion: Safety of Test Facility operations is paramount to obtaining quality data. A defined safety envelope should be established to ensure personnel safety and equipment protection. The safety envelope should be established through a multi-discipline hazards analysis and required controls incorporated into the project approach to configuration control.

PEP: The PEP design was subjected to a formal Operational Hazards Review (HazOp) process. Controls were incorporated into the design to ensure that testing evolutions could be performed in a safe manner.

Pre-plan Waste Management – Waste Disposal Path

Discussion: Materials handling, especially waste management should be planned, not reactive. A boundary should be drawn around the test facility and every input and exit stream identified and dispositioned in the initial planning stages. Waste management planning should address regular Test Facility operations, off-normal conditions, and maintenance and should be developed prior to initiating any test, especially if the simulant being used is designated as Hazardous Waste. In addition, do not overlook vessel heels and residuals in pipelines.

PEP: Waste management considerations were incorporated early into the PEP design, including secondary containment and interfaces with the PDL-West liquid effluent collection system. The PEP simulant will require the Hazardous Waste designation. Heel management will be incorporated into the PEP test instructions to ensure prototypic operations.

Know Where the "Cliff" is or Carefully Push the Limits

Discussion: When a test facility is operated, the systems interactions can lead to chemistry or control issues not originally envisioned. Conducting parametric testing at smaller scale prior to test platform operation can help define safe and efficient range of operations. Doing this type of testing at lab or bench scale is much lower cost than the larger facility operations. Do prior parametric testing where possible but recognize that some chemical interactions may be hard to duplicate on the bench. Therefore, be very careful of test facility operations as the operating ranges are pushed towards known limits. Potential "cliff" issues should be identified and understood prior to implementation of test plans. Recovery plans should be established incase operational difficulties are encountered. "Cliff" issues can include gelling, precipitation, inadequate mixing, plating out, loss of reaction, etc.

PEP: A concurrent External Flowsheet Review Team (EFRT) issue being worked is the process limits (M-6) which will provide input into PEP test planning. Broader process limits testing on the PEP will abe incorporated into Phase II, if approved.

Consider Data Needs in Planning Testing

Discussion: Existing testing activities can sometimes be leveraged to obtain additional useful information. These additional tests can include data type tests or operational testing. Data needs should be reviewed with all functions prior to writing a test plan. This helps to ensure that synergistic results can be obtained beyond normal process results. For example, corrosion/erosion testing, control scheme testing, or equipment testing may be incorporated.

PEP: Items for consideration in the PEP include coupon testing and parametric testing to identify operating limits. Potential expansion of Phase 1 PEP testing scope to resolve issues associated with process parameters, operating assumptions, erosion/corrosion, or other risk items will be considered. Incorporating the scope from the process operating limits evaluation into the scope of Phase 2 testing will be considered.

Consider Duplicate or Triplicate Samples

Discussion: Large numbers of analyses being sent to a single laboratory can cause schedule issues and delay results. Analytical bias may also be present if a single laboratory is used. One mitigation strategy for both concerns is to prequalify and use a number of laboratories for sample analysis. Further, instead of taking single samples, multiple samples should be taken in order minimize complete loss of the data due to analytical error. Triplicate samples should be taken if the analytical method is new or difficult; duplicate samples should be taken at a minimum. Blind (calibration) samples should be sent to laboratories periodically to monitor performance. Analysis priority should be established prior to testing.

PEP: Planning is underway to engage a number of laboratories to provide PEP sample analysis services. The number of samples to be taken during PEP testing evolutions is being re-evaluated.

Carefully Pre-Plan Testing and Operating Activities

Discussion: Sufficient time should be scheduled for planning and performance of equipment acceptance testing, testing the C&I systems, classroom and on-the-job training, equipment shakedown, actual testing, and sample and data analysis. Time to issue final reports should be included in planning. The transition from construction to shakedown and operations should also be carefully planned. A turnover process should be established, and the activities scheduled. Further, a transition issue identification and resolution process should be established and used to manage the resolution of issues identified during transition.

PEP: Due to the large number of samples to be taken during PEP testing, strategies for sample collection and management of samples and data should be developed and implemented. A strategy will be developed defining how the data obtained from the PEP will be used. Preliminary data products will also be identified. Interfaces between equipment delivery, acceptance testing, shakedown, and Phase 1 testing are being identified, placed on an integrated program schedule, and managed. Detailed test planning is based on a Test Specification and Test Plan that is being reviewed by the Hanford Waste Treatment Plant (WTP), U.S. Department of Energy Office of River Protection (ORP), the External Flowsheet Review Team (EFRT), and other groups such as the Consortium for Risk Evaluation with Stakeholder Participation (CRESP).

Have and Maintain Configuration Control

Discussion: Establishing and maintaining configuration control of Test Facility equipment design and testing documents (test specification, test plan, and associated procedures and instructions) is an essential component of the graded approach to conduct of operations. A hierarchy of design and testing documents is needed to ensure configuration control is maintained. Access to the design basis is important when purchasing equipment spares and replacements. A staffed document control station should be provided to enable convenient access to design documents (drawings, specifications, data sheets). The baseline configuration should be established and documented prior to commencing testing.

PEP: A documented approach to configuration control for the PEP is being developed and implemented. For the PEP, a list of essential design documents is being prepared that will form the basis for configuration management and an on-site document control area).

Implement a JTG with Defined Roles and Responsibilities

Discussion: A Joint Test Group (JTG) should be implemented that has the authority to make changes to the test program within the bounds of the facility's safety envelope. The JTG would review preliminary results of testing, ensure the integrity of the testing activities, and provide documented direction to the shift manager for the day's testing evolutions. The JTG should include representatives from all appropriate parties but yet be a manageable size so that decisions can be readily made. The JTG membership should designate voting and non-voting members.

PEP: Proposed members of the PEP JTG would include appropriate personnel from the WTP, PNNL, and DOE representing all critical functions including Engineering, Technical Support, Installations, Testing, and Operations. Changes to test instructions and procedures would be made by the JTG within the boundary of the PDL-W facility safety envelope and PEP hazard analysis.

Current planning calls for two JTGs to be established for the PEP:

- A JTG to oversee water and simulant shakedown activities
- Another JTG to oversee PEP testing.

Have a Disciplined Process to Allow Timely Change of Test Procedures and Configuration

Discussion: This lessons learned could be viewed as a subpart of the JTG responsibilities but is separately listed to highlight the need for quick response abilities. A documented approach to allow timely changes of test implementation documents and equipment configuration is needed to facilitate prompt response to preliminary test results. The goal is to enable the documented review and disposition of proposed changes to equipment configuration and test sequencing that arise real time. The following should be performed in order to implement this approach:

- First, a safe operating envelope would need to be established within which operating and testing conditions can be rapidly and safely changed.
- Then, a documented approach would need to be developed providing for the review and disposition of proposed exceedances from the normal operating envelope.

The means to provide rapid operating and testing conditions as well as the approach to review and disposition proposed changes may be documented either in the JTG charter or another test specific document.

PEP: Roles, responsibilities, and accountabilities, and authorities will be defined for the two JTGs using input from the Technical Exchange and lessons learned from other successful WTP test programs. A HazOp is being performed that will help determine the safe operating envelope for the PEP.

Perform Management Assessment(s) Prior to Testing

Discussion: A management assessment addressing the readiness of the PEP to safely begin testing should be scheduled and performed. Elements of the assessment should include equipment readiness, staffing, training, and maturity of procedures and instructions. The assessment could be graded and staged to address specific activities, such as: acceptance testing, shakedown, and testing. The assessment team should include independent participants such as those involved in test facility operation from other sites and companies. Further, follow up periodic independent assessments should be considered to determine the maturity of testing and operating documents, procedures, etc.

PEP: PEP planning includes a management assessment to be conducted prior to initiating simulant shakedown. Based on input from the Technical Exchange, the scope of the PEP management assessment is being re-assessed.

Have a Detailed Test Plan

Discussion: A clear, detailed test plan is essential to any successful testing campaign. Further, a method to change the test plan is essential as the learning process evolves. It is suggested that to ensure adequate understanding of the test plan that it be presented and reviewed by appropriate personnel in meeting rather than just by "read and sign".

PEP: For the PEP, a Test Specification and Test Plan have been prepared and were reviewed by ORP and WTP staff and members of the EFRT and CRESP. Primary and enabling objectives are included in these test planning documents.

Data – Know What You Need, How You are Going to Use it, and the Pedigree Needed

Discussion: As part of the test planning, the testing organization must understand what data are needed from the testing evolutions, how the data will be used, which organizations will use the data, and the type of quality attributes the data must exhibit. The standard(s) to be used to assure satisfactory quality should also be identified. This ensures that the right samples are taken, backup samples are take (as required), the right analyses are performed, the right quality standards are established, and the right information is developed from the data. Success criteria for testing should be established, understood, and agreed to before testing commences.

PEP: For the PEP, these considerations require use of an NQA-1 data acquisition system separate from the PEP's process control system. Plans are being developed to identify how PEP data will be used. The sampling plan is undergoing extensive review to ensure the appropriate samples are being taken when needed. As a result of the Technical Exchange, plans are being developed to staff a dedicated data assessment team during PEP testing evolutions.

Communication with Stakeholders

Discussion: A Test Facility communications plan should be developed and communicated that addresses management reporting and interaction with stakeholders. A planned periodic (daily, weekly, etc) communication package can greatly ease strain and confusion. The scope of the testing evolution needs to be outlined sot that key stakeholders have a global view of upcoming events. Daily e-mail reports to stakeholders and management can be used to effectively communicate key items of interest and preliminary data. Routine daily meetings (on site or remote) can also be established to reduce disruption of Test Facility evolutions, enabling staff to focus running the facility.

PEP: Key aspects of testing and key schedule events will be communicated prior to commencement of testing. WTP and PNNL communication offices will be actively involved during testing.

"Bus Stop" (Tour) Location

Discussion: A test facility can generate much interest in project personnel, oversight groups, community leaders, as well as any project or site tour groups. A "bus stop" (i.e., tour stop) should be established and maintained. Planning should be done to identify where, what, and who will communicate information when a tour is required. While this sounds like a task of limited value it can serve great purpose as a communications tool. Diagrams, smaller displays, tour routes, data summaries should all be addressed. Keeping data summaries current is vital as a representation of the importance of the data. Routine tours enable briefing staff to answer questions. Easy-to-read information boards regarding the status of equipment and testing evolutions should be present so that tourists can be provided general information without entering the operating area. Input from Public Affairs personnel should be sought on what items of interest should be included.

PEP: A "tour stop" location with pictures, diagrams, up to date status and test info is planned. The PEP has set up a temporary viewing gallery to allow visitors to safely observe activities and equipment during installation.

Emergency Communications

Discussion: In any operation or activity the unexpected may occur, requiring external communications, up to and including all forms of public communication (newspapers, TV, etc.), as well as local and national political figures. All organizations will typically have identified routes and points of communication; however, this could become an issue when multiple organizations are involved. For example, if one organization is responsible for the mechanical aspects, another for operations, and a third for oversight, establishing a system that provides for consistent communications and identifies the main communicator is important. Also the corporate internal communication chain may be different from the external communication chain. Backups for key links in these communication chains should be identified. Planning and even drills should be conducted to ensure the communication chain are operable.

The test facility operating team should have an established and tested emergency communication plan. Debugging these in a time of crisis is not a desired approach.

PEP: An emergency action and communications plan will be established utilizing both PNNL and WTP established procedures.

III. Personnel

Ensure Adequate and Appropriate Staffing of Activities

Discussion: Installation, acceptance testing, shakedown, and testing activities need to be staffed with the right number and mix of resources to ensure test objectives are safely and efficiently met. The following should be considered when developing the staffing plan:

- Appropriate management presence during testing activities to facilitate communications (especially up the chain of command) and to address questions and issues.
- A means should be provided to involve production engineering staff assigned to design of the full-scale system design with participating in or observing evolutions at a Test Facility.

During acceptance testing and equipment shakedown, interlock and software errors may be uncovered. Ensure resources are identified, available, and scheduled to resolve these and other control issues that may be identified. Proper staffing for operations, testing, sample and data analysis, and reporting is vital to the success of testing activities.

PEP: Based on input from the Technical Exchange, the PEP team is re-evaluating the staffing needed to achieve PEP operational and testing objectives. A mix of PNNL and WTP Project personnel will be used to staff the PEP operation.

Training: Train Staff to Process, Operating, Test, and Off-normal Procedures and Allow Sufficient Training Time

Discussion: All shift engineers, testing staff, and shift management need to be trained prior to initiating shakedown and testing activities. Procedures addressing normal operations, off-normal response and recovery, and testing need to be included in the training program. Sufficient time should be scheduled to ensure training is completed, and should include both required reading and on-the-job training as necessary.

PEP: Training of shift and testing personnel have been part of the planning basis for the PEP. Additional consideration needs to be made regarding the scope and timing of training activities. Lessons learned as a result of personnel training and PEP startup and shakedown can likely be applied to cold startup of the Pretreatment Facility. A lessons learned summary of the PEP should be scheduled and performed.

Establish a Formal Mechanism to Communicate to Test/Operating Shifts/Crews

Discussion: Testing conditions, equipment configuration, maintenance activities, standing orders, and night orders need to be communicated to the shift manager, shift engineers, and samplers. A mechanism to facilitate communication from the JTG to shifts and between shifts needs to be formalized and used. Do not depend totally on written communications. Meetings, group sessions, etc should be held in support of written communications whenever possible to ensure adequate understanding.

PEP: Test Instructions containing specific direction to shift and testing personnel have been planned for the PEP since the initial test planning documents were drafted. Based on THOR's testing experience at the Hazen facility, PEP test planners are evaluating implementation of a single sheet that lists equipment parameters and ranges as an additional communication tool.

Document all Roles, Responsibilities, and Authorities of Teams and Personnel

Discussion: Identification and documentation of roles, responsibilities, and authorities is a key element of a graded approach to conduct of operations for operating a Test Facility. Clear identification and documentation of roles, responsibilities, and authorities is important to the overall success of acceptance, shakedown, and testing activities.

PEP: A Project Execution Plan for the PEP is being developed that identifies and document roles, responsibilities, and authorities.

Have Knowledgeable Backups for Key Personnel

Discussion: A number of roles in the organization -- *especially* C&I engineers -- are critical to the success of a testing program. Other key roles include the shift manager and testing director. Key roles and personnel should be backed up to ensure the testing schedule can be maintained in the event that the key personnel are injured or become unavailable.

PEP: Based on input from the Technical Exchange, the PEP staffing plan is being re-examined to ensure key staff are backed up.

IV. Simulant

Simulant – Formulation, Handling, Manufacturing, Disposal - Many Factors to Consider

Discussion: The selection, development and use of simulants was one of the most discussed topics at Technical Exchange. The choice of the simulant, the relationship to actual waste, and its performance before and during the test can critically influence test results.

The physical/chemical parameters of the simulant and the attributes the simulant is being designed to mimic need to be carefully defined and approved by stakeholders prior to initiating procurement of the simulant components. Consideration should made for naming a single point of contact to address all simulant recipe, procurement, transportation, and batch testing activities. Additionally:

- Simulant procurement should be carefully managed to ensure the vendor is accurately formulating the simulant in accordance with the recipe
- Scale-up should be considered, as necessary, to ensure the simulant can be successfully engineered from bench-scale to full-scale production
- An understanding of how the vendor is preparing the simulant should be obtained, including recipe steps and the quality of the ingredients (commercial or reagent grade)

- Ensure through dialogue and site visits that the vendor understands and can implement the simulant recipe
- Understand how the simulant ages, and procure simulant "just-in-time" to support receipt analysis and subsequent use in the Test Facility
- Procure enough simulant to ensure sufficient quantities are present to support testing as well as an allowance for potential reformulation, spills, or additional test runs
- Ensure sufficient time is provided in the schedule to allow for pre-testing by the simulant vendor, receipt analysis by the testing vendor, and testing prior to operating the Test Facility
- An early batch of the simulant should be tested prior to ensure that it is satisfactory.

Simulant transportation and handling requires prior planning:

- Simulant components may require careful handling to preclude potential transportation and storage issues associated with settling, mixing, moisture, aging, or changes in temperature
- Determine if the simulant shipment requires use of an inert environment (i.e., nitrogen blanketing) during shipping
- If aging is an issue, the ability to mix the simulant locally must be provided
- The containers in which the simulant is shipped (totes, tank trucks) drives the equipment and tools required for receipt by the testing vendor
- Receipt of simulant shipments, including parking, secondary containment, and simulant conveyance (pumps, fork trucks, etc.) needs to be planned to ensure receipt activities are efficient and comply with environmental and personnel safety requirements
- A primary and backup simulant mixing strategy (mixing by the vendor, mixing at the testing location, both) should be identified and implemented as necessary to help ensure testing schedules are met

PEP: The importance of simulant attributes, procurement, storage, and use prompted a several follow up meetings among WTP and PNNL staff to further evaluate the input from the Technical Exchange participants. The above considerations are being incorporated by PEP planners to ensure simulant management is effective and timely. A WTP Simulant coordinator position was established. The charter for this position is shown in attachment #6. A checklist of simulant issues and considerations is shown in attachment #7. Attachment #8 is a summary of the simulant lessons learned from WTP test programs.

V. Equipment

Address Maintenance

Discussion: Maintenance activities should be planned, including: periodicity of maintenance activities, number and type of spares, parts procurement, and instrument calibration/recalibration. An appropriately scoped and designed maintenance program should be considered to ensure to maximize the availability of the equipment for testing. Maintenance staffing should also be considered to ensure trained craft are available to perform planned maintenance and repair actions.

PEP: Although the PEP is not prototypic for remote equipment removal, a maintenance plan should be established. The planning basis for the PEP is to staff maintenance activities with available craft from the PNNL craft pool. Consideration will be made regarding whether to obtain the services of dedicated craft to support PEP testing. Critical spare parts have been ordered.

C&I, Including Programming Verification, Will take Longer than Expected. If Possible, Use Manual Rather than Automated Control

Discussion: Due to the complexity, acceptance testing of the controls, instrumentation, and NQA-1 data acquisition systems will likely take longer than expected. Acceptance testing and shakedown of these systems -- along with verification of the control logic software programming -- should be planned and realistically scheduled with sufficient time for issue resolution prior to initiating functional and integrated testing. On test platforms, it may be useful to use a manual control scheme instead of automated control. A manual control scheme allows the test equipment to be brought on line more quickly. Further, consideration needs to be made regarding the frequency to take data and write to the DAS. Key process parameters should be taken at a higher frequency, while less-important parameters should be taken at a lower frequency. Carefully analyzing the data needs will ensure the Test Facility's C&I system is optimized.

PEP: For the PEP, an integrated program schedule is being developed using input from PNNL, WTP, and service vendors and subcontractors to plan installation, acceptance testing, shakedown, and Phase 1 testing. Based on the results of the Technical Exchange, special consideration is being made to incorporate the complexity of the PEP controls and instrumentation into the schedule. The ultrafiltration and leaching unit operations of the PEP are being performed in part to demonstrate the functionality of the prototypic Pretreatment Facility control scheme. Use of a manual control scheme was therefore not considered.

Consider the Long Term Plan for the Facility – It Could have Uses Beyond the Testing Envisioned for Today

Discussion: Test facilities can have used beyond initial testing. Options include operator training, process engineer training, process troubleshooting, optimization, and alternative equipment testing. Further, design revisions can be tested to demonstrate the mitigation of risk. Contractor management and the Department of Energy should consider developing a long-term plan for test facilities. Also, long term consideration of the end use of the facility may influence the initial location. The materials processed in the test facility (simulants or actual material), the scale of the facility, and cost to operate are just a few of the factors that must be considered in the long term disposition.

PEP: Longer term uses have been reviewed for the PEP and were discussed with DOE-ORP on March 23, 2007. Currently the long term disposition outlines the PEP to be used for optimization and alternate equipment testing or to be donated to local universities. Funding is required to do optimization and equipment testing which may not be available through the WTP Project. The preferred disposition path will be determined in later.

VI. Operations

Good Conduct of Testing/Operations is Essential

Discussion: A graded, documented conduct of operations approach is essential to ensure safe and effective Test Facility operations and testing evolutions. This graded approach includes clearly identified roles, responsibilities, authorities, training, startup and operating procedures, test procedures and implementing instructions, and a document hierarchy. Within the graded approach, implement a rapid, disciplined process to change test procedures and equipment configuration. Further, use of shift mentors to train less-experienced staff should be considered, along with back-stopping key personnel. If a large number of samples to be taken and the complexity of the equipment, a dedicated sampling group should be used to collect samples for analysis. Consistent with having clear lines of authority, a single shift manager would be responsible for all shift activities, including operations and testing.

PEP: Experienced shift engineers will be selected to staff the PEP and mentor younger engineers. Planning is in progress to incorporate and document a graded conduct of operations approach for the PEP.

"Expect the Unexpected"

Discussion: While the phrase "expect the unexpected" is often overused, it still has direct applicability to all facilities, especially test facilities. Off-normal events can occur during operating and testing evolutions. An event management process to address response to off-normal events should be developed and implemented. Graded plans and procedures addressing event response, reporting, recovery, and event communications should be developed and used if necessary. Preplanned responses to testing and facility upsets need to be addressed, as well as non-time-critical issues such as actions to take if Test Facility equipment and instrumentation are degraded after shipping. Additionally, a planned startup sequence should be used to minimize equipment and facility upsets.

PEP: A HazOp is being performed to postulate potential operational issues with the PEP and identify and implement strategies to mitigate these issues. Further, response procedures are being developed concurrent with the PEP operating procedures to ensure that responses to off-normal events are planned. Surveillance procedures are also being developed to ensure PEP equipment is operating as indicated by the control system. Addressing off-normal events will be considered for inclusion in the PEP Communications Plan.

Use Event Investigation/Corrective Action Tools

Discussion: As a follow up to "expecting the unexpected", event investigation and corrective action tools can be used to identify the factors influencing an event and subsequent resolution of identified issues, and the identification and resolution of adverse conditions. These tools can also be used to as part of an issue resolution trending process. As for any large testing program, identify the event investigation and corrective action tools that may be useful for executing the project, and implement the elements of these programs that are appropriate for testing evolutions. Follow-up assessments and surveillances may also be performed to determine the effectiveness of the corrective action. Establish a lessons learned procedure for the operations of the Test Facility. Communications of these lessons learned is especially important due to the short duration of testing that the facility may engage in.

PEP: These tools will be used if needed. In a broader sense, they already have been implemented by conducting this technical exchange and soliciting input on recommended actions from other sites.

"Failures" are Important Test Outcomes

Discussion: Results from carefully-planned testing evolutions can be used to obtain understanding of system being tested, regardless of whether the results are deemed a "success" or a "failure". Unexpected outcomes from testing should not be labeled as failures, but should be considered opportunities to understand the system, fully documented, analyzed and issues resolved prior to full-scale facility commissioning. Failure conditions should be analyzed to determine initiating factors and added to the body of knowledge gained from "successful" tests.

PEP: All data will be investigated. No data will be disregarded without sufficient explanation. Data from unexpected results will be thoroughly analyzed.

<u>CHARTER STATEMENT</u>

<u>WTP SIMULANT DEVELOPMENT AND USE COORDINATOR</u>

During the course of WTP technology development and plant testing, many simulants have been used and will continue to be used. As testing expands from the lab to test facilities to the PEP and finally to the actual plant, ensuring proper simulant selection is a must to obtain proper test results. Coordinating simulant selection with prior testing also provides for expanded use of the results. In addition, lessons learned with simulants from prior programs should be utilized in current programs to ensure least difficulties.

To help ensure the proper coordination of simulants, PETD Simulant Coordinator, Dr. Vijay Jain, will be responsible to review simulants used in all test programs from the laboratory to the actual plant. His WTP-PETD Simulant Coordinator role includes items such as:

- Providing recommendations, lessons learned, and other information to engineers and researchers on simulant development and use. As simulant coordinator, his input should be sought either in review or to aid in development.
- Reviewing simulant selection to maximize coordination with prior tests.
- Outlining tests to confirm a new simulant performance
- Maintain a lessons learned database for simulant development and use. This includes manufacture, delivery, and use.
- Maintain a master matrix of all simulants used and their properties. The master matrix will include prior testing done at VSL/Duratek, SRNL, and Battelle/PNNL.
- Provide technical assistance in trouble shooting simulant performance.
- Develop simulants as requested and funded.
- Coordinate identification, selection and pre-testing of simulants for cold commissioning
- Representing WTP as appropriate on the subject of simulants
- Provide a quarterly update documenting simulant activities

Researchers and engineers should consult the PETD Simulant Coordinator:

- Prior to initiating new simulant development work.
- Prior to approval of test specification and plan involving use of simulants
- If simulant problems develop during a test.

An example of the simulant coordinator's role is typified with the PEP. The PEP team will analyze actual waste samples and decide on a simulant to use. The simulant selection should then be reviewed with the simulant coordinator to ensure maximum alignment and use of lessons learned with prior simulants such as those used in the SIPP, dissolution tests, and mixing tests as well as with a forward look towards commissioning simulants. Other examples include helping to address issues such as weight percent solids vs. rheology as well as vendor production issues.

Within 3 months the PET Coordinator will (in existing or new documents):

- Issue a lessons learned/issues list database for simulant development
- Issue a master matrix of all simulants used and their properties.

Checklist
Simulant Development, Manufacturing, Storage, Transportation and Testing (Based on Simulant Lessons Learned)

The document “"Guideline for R&T Simulant Development, Approval, Validation, and Documentation" 24590-WTP-GPG-RTD-004 was developed to provide guidelines to R&T project personnel responsible for the development of simulants to support R&T activities requiring simulants for testing. The procedure covers the following:

1. Define simulant use;
2. Define simulant composition or range of compositions;
3. Define simulant design requirements;
4. Review and approve simulant development activities;
5. Verify and validate simulant design requirements;
6. Verify that simulant is consistent with flowsheet predictions; and
7. Document simulant development activities and preparation procedures.

The procedure, however, doesn't incorporate the lessons learned from testing conducted to date. The purpose of this checklist is to incorporate lessons learned from various programs such as simulants used at Vitreous State Laboratory/Duratek for vitrification, simulants used for large scale testing for gas retention at PNNL, and simulants used at SRNL. The checklist will assist in the development, manufacture, storage, transportation and testing of simulants.

#	Checklist	Response
1	**SIMULANT DEVELOPMENT CONSIDERATIONS**	
	What is purpose of simulant development?	
	List key performance variables to be matched or evaluated, and what are acceptable variability (e.g., leaching rate, gas retention, settling, etc.)?	
	How are key performance criteria to be validated (e.g., match to actual waste, match specific characteristic or property)?	
	Provide basis for selecting simulant. Why is existing simulant recipe is adequate (e.g., SRNL or Hanford recipe for simulant)?	
	Provide basis for selecting of raw materials [compatible with planned use of simulant materials (Reagent vs. commercial grade)]	
	Provide the basis for sequence of chemical or material addition	
	List documents that provide information on simulant development, performance, and validation (e.g., approved Test Specification or Test Plan)?	

#	Checklist	Response
	Verify that a documented review of the simulant has been performed by R&T staff and/or technical experts. Provide plans to conduct independent review of simulant preparation instructions for clarity before procurement or on-site preparation.	
	Perform detailed schedule review. The schedule should include time required to complete V&V of custom software, perform NQA-1 chemical analyses, and calibration time line for instruments in use (e.g. accounting for instruments requiring long lead time).	
2	**SIMULANT TESTING (LABORATORY)**	
	Describe how laboratory studies are based on planned prototypic chemical or material addition and mixing system. If not prototypic, why?	
	What controls are imposed to prevent introduction of contaminants from test equipment or to ensure tanks are clean, such as analysis of blanks or visual inspection? – dissolution of steel products or copper products can act as a chemical catalyst, or corrosion/erosion products.	
	List approved test, measurement and characterization procedures to be used for simulant development and testing.	
	Provide documentation that analytical techniques are compliant with existing procedures such as: Smith GL and K Prindiville. May 2002; Guidelines for Performing Chemical, Physical, and Rheological Properties Measurements; 24590-WTP-GPG-RTD-001 Rev. 0, BNI, Richland, Washington	
	Document methods of introducing chemicals/materials in the tank or vessel, and provide basis if they are not prototypic (dump on the surface or introduce/inject at the bottom - e.g., hydrogen peroxide should be introduced in well-mixed turbulent region)	
	Document methods of mixing chemicals (e.g., gas retention behavior was different in impeller type and PJM/sparger type systems) and provide basis if they are not prototypic.	
	Describe method for concentrating simulant (centrifuging, settling) and provide basis if they not prototypic.	
	Describe basis for determining the stability of simulant (age, gel, change in particle size, shape or pH etc) and shelf life. If this is not an issue, explain why.	

#	Checklist	Response
3	**SCALE UP CONSIDERATIONS**	
	How is intermediate scaling considered?	
	For a system representing multiple batches, how are batch-to-batch variations physical and chemical properties considered? (significant variation may result from batch to batch, e.g. chemical composition discrepancies, % total solids, rheology, foaming, gelling). This information should be documented in test instructions or procedures, as applicable.	
	Provide plans to evaluate the stability and consistency in properties of simulant during scale up – lab scale performance could be significantly different (gelling and foaming has been observed on scale up).	
	How are performance of measurement and characterization instruments and equipment documented? – differences in methods could cause unexplained differences (e.g. total solids – differences in drying time and temperature; yield stress determination based on up or down curve)	
4	**SIMULANT PROCUREMENT/PREPARATION CONSIDERATIONS (VENDOR)**	
	How is the information from this checklist included in the detailed simulant preparation procedure for the vendor. This includes procurement of chemicals, their purity, particle size and shape, use of water (e.g. plant vs. deionized, acceptable level of impurities in plant water).	
	Confirm that the schedule includes provision for technical experts to travel to the vendor location to review their capabilities (facility, equipment, and staff) to prepare large batches and to walk through the simulant preparation procedure?	
	How are the locations to collect samples at different stages of the simulant preparation process identified and considered? This information should be included in procurement documents. This will allow determination of potential source of error in case simulant did not pass the defined acceptance criteria.	
	Document the schedule for regular telecons with the vendor to evaluate progress, review data and results at key steps during the simulant preparation process.	
	How is the prototypic chemical addition, such as mixing and concentration being performed using vendor equipment, as defined during the laboratory development program?	

#	Checklist	Response
	How are process parameters during simulant preparation maintained under close tolerance? (e.g. if you state the temperature should be maintained below 90 C, the vendor could prepare at 70 C that may result in very different simulant characteristics especially if precipitate of certain size are desired.	
	Will samples of simulant at the end of simulant procedure be taken? And if so, how and when?	
	How will aging of vendor simulant be examined?	
	Before shipping the simulant to the site, how will it be ensured that the properties still meet target?	
	Provide details on shipping container (should be compatible to the storage requirements at the testing facility) and maximum fill height of simulant to ensure insertion of mixing devices.	
5	**STORAGE AND SHIPPING CONSIDERATIONS**	
	Provide basis for acceptable simulant storage requirements to avoid any potential for microbial growth (storage in sunny area could promote algae growth), degradation of simulants due to changes in storage conditions.	
	Provide basis for simulant stability during transportation (e.g., temperature variations during transportation could cause simulant aging, settling, or gelation).	
6	**IN-HOUSE VERIFICATION OF SIMULANT**	
	How will the contents of the delivery container be mixed and sampled upon delivery?	
	Document in test instructions, the use of same protocols for analyses as done during simulant preparation stage (rheology, total solids, composition etc) as specified in 24590-WTP-GPG-RTD-001 Rev. 0?	
7	**STORAGE ON SITE**	
	What is the expected length of time for simulant storage (ensure during that time simulant is not subjected to changes in physical/chemical properties due to aging or microbial growth). What tests are planned prior to use.	

#	Checklist	Response
	Should biocide be added as applicable/appropriate to avoid microbial growth?	
	How often should the sampling be done during storage?	
8	**TRANSFERRING SIMULANT FROM STORAGE CANISTERS TO TESTING VESSEL**	
	Discuss evaluation of simulant mixing tools for shipping containers.	
	Are plans in place to check simulant properties prior to transfer (visual as well as physical/chemical properties, if needed)? If so, describe.	
	If simulant is transferred to existing chemicals in a tank, determine appropriate rate of transfer.	
9	**BACKUP PLAN**	
	Define actions required, if simulant fails to perform as determined.	

Lessons Learned
Potential Delays and Problems Encountered During Simulant Development, Manufacturing, Storage, Transportation and Testing

The table below provides a summary of issues that have been encountered during the development, manufacturing, transportation, storage and testing of simulants for various WTP programs that have either delayed the start of program or halted the programs. List below is based on the presentations made at the Waste Treatment Plant Project Test Platform - Test Facility Technical Exchange, December 4-5, 2007.

Problem Description	**Stage**	**Potential Solution**
Delay in procurements of equipment, instruments and simulants for testing	Development	Order equipments/instruments as soon as possible. Schedule should include sufficient time for procurement. Obtain quotations well in advance of placing orders.
Custom software for collecting data not ready in time for simulant testing	Development	Provide sufficient time for V&V for custom software in the schedule.
Premature development of simulants before characterization information is finalized	Development	Characterization should be complete prior to the development of simulant recipes.
Simulant specification provided to vendor has insufficient details.	Manufacturing	Define simulant preparation recipe in detail (including order of mixing and components to use). Powder chemicals should be kept in dry atmosphere during storage and transportation. Technical expert should visit vendor site.
Unstabilized clay shipped to testing site.	Manufacturing	Stability should be checked prior to shipment. Allow time for kaolin/bentonite properties to stabilize before shipment. Technical staff visit prior to shipment is recommended.
Scaling problems - larger batches require centrifuging instead of settling	Manufacturing	Define simulant recipe based on available manufacturing capabilities and testing requirements
Variability between batches - both physical and chemical properties. Foaming observed in some batches. Particle size distribution different in different batches.	Manufacturing	Batches should be characterized per standard procedures and acceptable variability should be established prior to start of the program. Test at vendor site, on receipt and prior to use. Periodic tests may be needed during long storage times. Backup plans to address out-of-specification simulants should be developed.

Problem Description	Stage	Potential Solution
Plant water is different than deionized water or plant water from other sites	Manufacturing	Ensure the water used for preparing simulants is same if more than one location is used for preparing simulants
Insufficient head space in shipping container to resuspend simulants	Manufacturing	A minimum void volume to accommodate mixer for re-suspension should be included in the simulant specification and procurement documents to avoid spills.
Market depletion of certain required chemicals	Manufacturing	Alternate sources and substitutes should be evaluated.
Iron contamination in scrub feed tank provided sodium aluminum precipitation site. The tank was not thoroughly cleaned	Manufacturing Testing	Test instructions as well as contract specification for vendors should include criteria for cleanliness such as analysis of blank samples and visual inspections.
Vendor mis-understood the SOW for simulant preparation instructions that resulted in a severely underestimating the time and equipment required for preparation.	Manufacturing	Independent review of instructions for clarity before procurement. Consider review of all potential vendors prior to placing order.
Energy imparted to simulant during small and large scale mixing may cause permanent physical change in simulants (gelling)	Scale Up	Examine this and other potential scaling issues prior to start of simulant manufacturing.
Crystallization of LAW and HLW melter feeds which was minor at the bench scale became a larger problem at pilot scale.	Scale Up	Scaling at different levels should be evaluated prior to manufacturing a large batch. External drum warmer successful in re-dissolving borate crystals.
Scale up issues - precipitation due to trace impurities, substitution of alternate raw materials, sequence of addition steps	Scale Up	Established sequence and raw materials should not be changed without additional testing
Scaling issues observed when producing large quantities - impact of mixing (shear) during precipitation; temperature	Scale Up	Intermediate scaling is recommended to ensure stability of the simulants
Biological growth in clays; temperature sensitivity	Storage	Add biocide to simulants that may have a potential for biological growth. Store in location that doesn't promote biological growth.
One year old chemical simulant underwent chemical and physical	Storage	Determine shelf life under expected storage and transportation conditions.

Problem Description	**Stage**	**Potential Solution**
changes during storage		Characterize simulant prior to use.
Lack of identification of packaging size and container type	Storage	Simulant procurement documents should be sufficiently detailed on transportation requirements. Inadequate size and shape may limit placement at the testing site.
Stability issues - carbonate increase due to CO2 absorption, chemical reaction between glass formers and simulants	Storage	Aging and stability of simulants should be established and verified.
Lack of adequate time in schedule for sample analyses	Testing	Schedule should include adequate time for NQA-1 analyses. Priorities should be established and negotiated with the analytical laboratory.
Lack of spare parts	Testing	Maintain a good inventory of spare parts especially pumps and power supplies on hand or available on short notice.
Lack of availability of calibrated equipment	Testing	Complete calibration of test instruments prior to testing. Include calibration timeline in the schedule (special attention should be paid to items requiring long lead time for calibration).
Rheology problems in the testing vessels	Testing	Mix/dilute and stabilize simulant in totes prior to transferring into test vessel to avoid stratification.
Laboratory priorities change	Testing	Negotiate analytical laboratory well in advance of testing. Have backup support established.
Simulant settling and re-suspension issues due to equipment failure	Testing	Need for backup equipment should be evaluated.
Unanticipated reaction between glass bead and clay water system	Testing	Laboratory testing should be done prior to introducing new physical simulants in the system. Even benign components could under go chemical reaction and changes characteristics of the simulant.
Test equipment corrosion during testing	Testing	Evaluate simulant interaction with test equipment components for potential corrosion. Verify metallurgy of pumps, handling equipment and seal materials of construction for compatibility with simulants

Problem Description	Stage	Potential Solution
Seemingly minor and irrelevant concessions to design fidelity lead to significant operational problems (flow anomalies due to non-prototypic pipe size/routing/connections)	Testing	Prototypic equipments should be used to the greatest extent possible.
Batches required additional mixing and dilution for transfer	Transfer	Mixing tools should be evaluated and available prior to transfer.
Temperature variation and delay in transport lead to compaction, crystallization, settling and change in rheology	Transportation	Potential impacts on simulants during storage and transportation should be evaluated prior to manufacturing
Synchronization between test sequence and delivery frequency	Transportation	Schedule should be discussed with the vendor on a regular basis.