Highlights Environmental Management Engineering and Technology

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Office of Environmental Management (EM) Commits to Renewable Energy

At the Department of Energy's (DOE) Savannah River Site (SRS), two new energy-efficient boilers, including one that uses renewable biomass fuel, have replaced a 1950s vintage coal-fired steam plant that had outlived its usefulness. The new boiler system uses less energy, lowers operating and maintenance costs, and complies with new Clean Air Act Standards. It also conforms with two of the DOE Transformational Energy Action Management (TEAM) Initiatives, which call for improved energy efficiency and reduced greenhouse gases, as well as renewable energy generation.

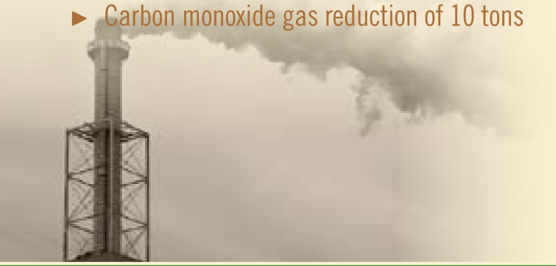
TEAM Initiatives require DOE sites to

- Improve energy efficiency and reduce greenhouse gases
- Implement renewable energy generation projects on agency property for agency use

As the SRS mission evolved over the years and old facilities were torn down, the A-Area coal-fired steam plant provided steam to fewer facilities, leaving it oversized and inefficient, venting significant quantities of excess steam, and incurring high maintenance and repair costs.

Annual air quality benefits:

- Particulate matter reduction of 400 tons
- Sulfur dioxide gas reduction of 1,742 tons
- Nitrous oxide gas reduction of 218 tons
- Carbon monoxide gas reduction of 10 tons



To replace it with a new energy efficient and environmentally friendly plant, SRS installed two energy-efficient 30,000 pounds-per-hour steam boilers. One is a wood-fired unit, which utilizes local biomass, a renewable energy source, as the feed. The new wood-fired boiler provides the majority of the steam required for A Area, which includes the Savannah River National Laboratory (SRNL) and some SRS administrative facilities. The source of the biomass, estimated to be about 27,000 tons annually, comes from waste wood from nearby logging companies. SRS is investigating using on-site biomass materials to augment the existing feed source. The second boiler is a standby, fuel-oil fired boiler, which operates during maintenance periods for the wood-fired boiler and during peak steam demand times.

Construction of the new steam plant began in August 2007 and was completed on schedule in September 2008. The new plant was designed and built as part of a collaborative process among DOE, Washington Savannah River Company, and Honeywell Building Solutions. Savannah River Nuclear Solutions, LLC, which became the management and operating contractor for the site in August 2008, completed the startup testing and is responsible for the plant's operation.

SRS utilized an innovative third-party financing plan, an Energy Savings Performance Contract (ESPC), to fund the project. With an ESPC, contractor-guaranteed savings in energy and operational costs are used to fund the project under a financed mortgage. The arrangement doesn't increase the SRS budget or annual cost of operating the facilities included in the project scope. When the mortgage is paid off, all savings accrue to the federal government.

Financials for the SRS A-Area Biomass Project:

- Construction and financing costs: $13.8 million
- First-year operations savings: $1.5 million
- ESPC contract terms: 9 years

The Office of Deactivation & Decommissioning and Facilities Engineering within the Office of Engineering and Technology (OET) manages, implements, and monitors EM site energy management activities for facilities and infrastructure for those sites and assets with enduring missions. More information about the biomass steam plant is available at **www.srs.gov/general/news/releases/NR2008_SteamPlant.pdf.**

In this Issue

Engineering-scale Tests to Confirm Tank Waste Pretreatment System Performance

To ensure the success of the DOE Hanford Site's Waste Treatment and Immobilization Plant (WTP), DOE commissioned the construction of a Pretreatment Engineering Platform (PEP), so that the WTP pretreatment processes could be tested at one-quarter the scale of an actual system. Testing technologies at this large a scale will confirm their performance, while also reducing uncertainties associated with system scale-up.

The WTP is being built to stabilize 53 million gallons of Hanford's radioactive tank waste in a matrix of glass. The glass product will be placed in stainless steel canisters for safe storage in an offsite repository to isolate the long-lived radionuclides for thousands of years. The WTP is comprised of five major components: pretreatment, high-level waste vitrification, low-activity waste vitrification, an analytical laboratory, and the balance of facilities. Pretreatment is the largest, most complex component in the WTP. The importance of getting the process right in the first component in the treatment-train cannot be overstated.

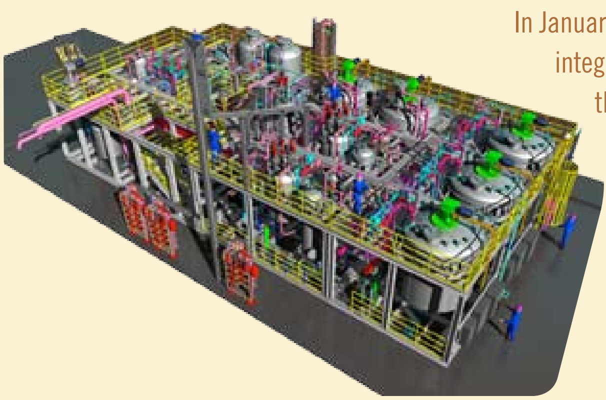
The WTP pretreatment facility will be designed to significantly reduce the volume of high-level waste that must be vitrified by removing non-radioactive chemicals present in high volumes from the high-level waste stream, as well as removing radionuclides from the low-activity waste stream. The following activities will be performed during pretreatment in the WTP:

- The waste feed from the tanks will have caustic chemicals added to dissolve or leach aluminum, sodium, and other non-radioactive constituents from the waste.
- Oxidative leaching using sodium permanganate will be performed to dissolve chromium.
- The waste will run through "ultra filters" to separate liquids from solids.
- The solids will be the main feed for the high-level waste melters in the vitrification portion of the plant.
- The liquids will receive additional treatment to separate radioactive cesium that will be combined with the solids sent to the high-level waste melters, ensuring that the remaining liquids can be sent to the low-activity waste melters as low-activity waste.

The low-activity waste glass will be disposed on the Hanford site, while the high-level waste glass will be shipped to an offsite repository.

OET's Office of Waste Processing supported the PEP design and construction through expert reviews, reducing technical uncertainty and project risk. In 2006, OET recommended and worked with the WTP contractor, Bechtel National, Inc. to organize an external technical review of every aspect of the WTP Flowsheet. One of the findings of this review team was that technical uncertainty and risk associated with the pretreatment flowsheet could be significantly reduced if the planned processes were tested at an appropriate scale, thus, leading to development of the PEP. The PEP testing was recommended because:

- the leaching processes and ultrafiltration system had not been demonstrated beyond bench-scale, and testing with conditions representing the WTP flow sheet had not been completed;
- the capacity of the ultrafiltration system was uncertain; and
- operating approaches for the ultrafiltration system were not demonstrated.



In January of 2009, the PEP began integrated testing to confirm the effectiveness of critical high-level tank pretreatment processes and technologies.

In 2007, OET sponsored the Test Facility Lessons Learned Technical Exchange to bring together staff from DOE sites to share lessons learned regarding engineering-scale testing and operations involving nuclear waste. Thirty-two lessons learned based upon experience with operations of test facilities at DOE sites were shared so they could be incorporated into PEP planning activities. In late 2008, the PEP, designed by Tessenderlo Kerley Services under contract with Bechtel, was installed in a facility at the Pacific Northwest National Laboratory (PNNL), started up, and is being operated by PNNL staff. In January of 2009, the PEP began integrated testing to confirm the effectiveness of critical tank waste pretreatment processes and technologies.

Innovative Ideas Reduce Mercury in Oak Ridge Stream

The DOE Office of Groundwater and Soil Cleanup sponsored a collaborative effort between Oak Ridge National Laboratory (ORNL) researchers and environmental compliance staff at the Oak Ridge Y-12 National Security Complex to demonstrate an innovative approach to reducing mercury contamination in the East Fork Poplar Creek (EFPC) in Oak Ridge, TN.

EFPC has been posted with a fish consumption advisory due to contamination from historical losses of mercury at Y-12. Remedial actions at Y-12 have reduced mercury inputs to the creek by more than 80%, but creek water and fish remain contaminated. In a negotiated agreement with the Tennessee Department of Environment and Conservation, a flow augmentation system to maintain creek water levels typical of the late 1980's was emplaced in upper EFPC in 1996 to improve ecological conditions in the stream. As an unintended consequence of this action, mercury that had been deposited in the localized streambed was mobilized into the water in the creek, making it more available to fish. The challenge remains to reduce or eliminate mercury inputs associated with the flow augmentation system, while retaining its ecological benefits.

In January 2008, the Office of Groundwater and Soil Cleanup sponsored an External Technical Review to identify technical uncertainties associated with the mercury contamination

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at Y-12 and recommend ways to address these uncertainties. One of several recommendations was to eliminate or reduce flow augmentation in the reach of stream where subsurface deposits of metallic mercury were present. The experts hypothesized that the amount of surface water infiltrating into the contaminated streambed was proportional to the amount of flow. Thus, reducing the flow should generate a corresponding decrease in mercury being mobilized from stream sediments.

In June 2008, ORNL, with assistance from the Y-12 staff, began a field test of the reduction and diversion of flow augmentation to evaluate the impact on mercury levels in EPFC water. In July and August 2008, 50% of the flow augmentation water entering the uppermost section of EFPC was diverted to a site 2.5 km downstream, near the point where increased stream flow was required. Total waterborne mercury concentrations were measured daily at six locations along the length of EFPC for two weeks prior to the diversion, during the two-week diversion, and for two weeks after flow was restored to its prior configuration. Preliminary test results were promising; mercury flux to surface flow within the source reach was reduced by approximately 37.5%. However, heavy rainfall and a large leak in the flow diversion system during the test period made comparisons difficult. Nevertheless, reduction in mercury flux from the stream bed source was clearly measurable during the field test. Additional chemical and hydraulic data are being analyzed to provide other lines of evidence for the reduction in flux of mercury observed in the field pilot study.

These preliminary results show that diverting 50% or more of the flow augmentation input away from contaminated sediments has the potential to eliminate up to 20% of the mercury input to EFPC from the Y-12 Site at essentially no cost. Further testing is needed to determine whether the observed reduction in mercury flux persists over the long term, but successful implementation of the action tested in this project has the potential to move EFPC closer to achieving compliance with its designated uses under the Clean Water Act: recreation and the propagation of fish and wildlife.

Innovative Technology Shows Promise for Waste Treatment

OET-sponsored testing of Hot Isostatic Pressing (HIP) indicates that this proven industrial process may also offer promise as a treatment for some of DOE's nuclear wastes that do not, as yet, have a clearly defined disposal path (i.e., Challenging Materials).

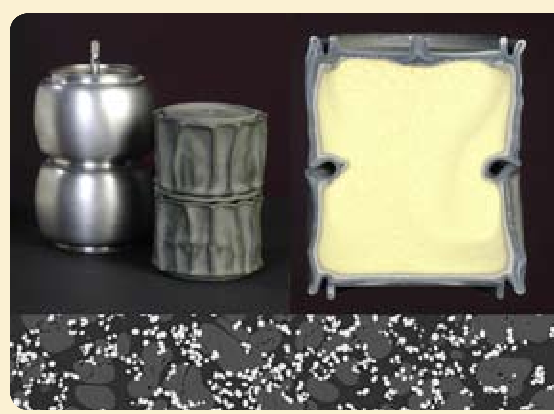
HIP, which is used by aircraft, ceramics, and other industries, is based upon a carefully controlled combination of heat and pressure to form metal and ceramic pieces of all shapes and sizes, including cylindrical billets, flat rectangular bar billets, solid shapes with complex external geometry, and complex shapes with internal cavities. The resulting products are high-density metal or ceramic waste forms. Key advantages to processing materials using this method are that they are free of voids (an absolute requirement in many applications), the net shape of the object may be maintained, and the final product exhibits maximum volume reduction.

A HIP system consists of a furnace located inside a pressure vessel. Typical materials processed consist of monolithic components (such as cast metal forgings) or canned powders. Prior to processing, gases are evacuated from the components. The temperature and pressure under which the process takes place can be readily tailored to suit the characteristics of the materials being processed; typical conditions are 2300 °F and 15,000 psi. As pressure is applied to a waste container using a gas, usually argon, it is uniform in all directions (isostatic), which results in maximum densification.

As a treatment for DOE Challenging Materials, HIP has several advantages:

- HIP can immobilize a variety of solid waste streams, almost regardless of shape. DOE must dispose of many types of spent fuels, each with a different shape.
- Because the waste is processed inside a sealed can, there are no high-temperature off-gas emissions, and the waste doesn't come into contact with the processing equipment, minimizing decontamination costs.
- HIP compacts the waste, especially powdered materials, to produce a very dense product. This compaction can result in a significantly reduced volume of waste needing disposal and, as a result, waste disposal costs are less.
- HIP improves the leaching characteristics of the final waste form. Tests are currently under way to test leachability of HIP-processed DOE wastes.
- HIP is largely independent of the characteristics of the material being processed.

Preliminary HIP testing of DOE wastes is being conducted by the Australian Nuclear Science and Technology Organization (ANSTO) in collaboration with the DOE Idaho National Laboratory to assess the feasibility of treating a granular material waste that currently requires disposal as high-level radioactive waste in a deep geologic repository. Such disposal requires great structural integrity and very low leaching from the final waste form. Two types of granular waste were selected for testing, one is high in alumina (aluminum oxide) and the other is high in zirconia (zirconium dioxide). Non-radioactive surrogates of each waste type, which also contains hazardous material constituents, were processed and tested for leachability, using the Toxicity Characteristic Leaching Procedure.



The testing results are encouraging, as all the chemicals of interest in the leachate were well below the regulatory limit, with many even below the limit of detection.

These results, while preliminary, suggest that HIP of solid radioactive wastes provides a waste form with desirable leaching characteristics. Although HIP clearly is not suitable for all of DOE's Challenging Materials, DOE is planning future tests to investigate its applicability to a variety of DOE wastes. Potentially attractive applications may include immobilization in a leach-resistant matrix or simple volume reduction without treatment. One such application involves radioactive sludge, either from legacy spent nuclear fuel storage or high-level waste storage. These sludges can be characterized as "challenging," as they can be difficult to handle and may require additional processing to render into a form suitable for disposal or long-term storage. HIP treatment of these sludges may produce a dense, immobilized waste form that may be acceptable for long-term disposal.

> The challenge is to investigate on-going waste tank integrity and life extension activities with the goal of identifying opportunities and recommending solutions for both the Savannah River and Hanford sites.

Information Sharing Advances Safe Operation of Radioactive Tanks

To advance the safe operation and management of the tanks currently storing high-level radioactive waste at the DOE Savannah River and Hanford sites, experts from within and outside DOE gathered for a High-Level Liquid Waste Tank Integrity Workshop, hosted by SRNL on May 13-15, 2008. The focus of this workshop was to discuss and develop an action plan to address technology needs for maintaining the integrity of the high-level waste tanks, based on evolving waste processing and tank closure requirements and the need to continue waste storage operations.

DOE has approximately 90 million gallons of high-level waste contained in underground storage tanks at the Savannah River, Hanford, and Idaho sites. Many of these tanks were constructed in the late 1940s and early 1950s and are currently beyond their design life. The earliest constructed tanks were single-shelled, and some have leaked a portion of the contents to the subsurface. Because the radioactive waste treatment program is currently predicted to continue for 35 years, mechanisms to extend the life of the current tanks are needed. New methods of monitoring tank integrity and minimizing future deterioration in tank integrity are critical to ensuring continued safe operations.

Workshop participants included, representatives from OET, national laboratories, private industry, academia, and the Defense Nuclear Facilities Safety Board. The workshop was designed to achieve two primary goals:

- Identify any significant impediments to the continued safe operation and management of the storage tanks at the two sites
- Establish groundwork for collaborative efforts aimed at eliminating these impediments.

After informational presentations, the 40 workshop participants defined an optimal state as "having a complete technical basis for optimizing risk reduction for safe extension of mission duration of the high-level waste tanks at the Hanford and Savannah River sites." Next, they identified steps to achieve that state, while discussing current activities and prioritizing future collaborative activities.

During these discussions, they identified the following positive characteristics of tank integrity activities at the two sites:

- Motivated technical teams, with excellent relationships between operations and supporting organizations at each site;
- Good knowledge of processes and safe operations, with updated information added regularly to the respective site databases;
- Value added from oversight, such as the Expert Panel Oversight Committee for Corrosion Chemistry Optimization at Hanford;
- Open communications among stakeholders, which has improved in recent years; and,
- Improvements to tank monitoring and inspection tools and technology.

The following collaborative action items were identified as critical to attaining the optimal state:

- Improve understanding of current in-tank conditions;
- Develop a better understanding of corrosion mechanisms and methods to optimize corrosion controls;
- Improve non-destructive examination techniques for primary and secondary containment, including concrete; and,
- Develop a tank integrity roadmap and execution plan including a mentoring/training program, a knowledge center, and a retention plan.

Conference presentations are located online at: **http://srnl.doe.gov/hlwtiw/index.htm.**

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