Whatever the Waste, New Facility Takes It On

FROM a 19-kiloliter tanker truckload of wash water to a test-tube-size container of an unusual blend of noxious chemicals, Lawrence Livermore's new Decontamination and Waste Treatment Facility (DWTF) will take it all, fulfilling its role of helping the Laboratory keep "clean" when it comes to waste.

DWTF is a new, integrated facility for storing and processing the Laboratory's wastes, whether they be hazardous, low-level radioactive, transuranic radioactive, or mixed (that is, both chemically hazardous and radioactive). More than 20 years in the making, DWTF is scheduled to open by the end of September 2003. According to Stephanie Goodwin, division leader for Radiological and Hazardous Waste Management, DWTF will provide safe, cost-effective waste operations and will broaden Livermore's overall internal waste management capabilities. "Our role is to develop and improve ways of managing wastes generated at the Laboratory to ensure that the environmental impact of by-products is as negligible as possible," she says. "To that end, we first investigate and then design, develop, and acquire new, more efficient ways to handle, stabilize, treat, certify, and dispose of waste. DWTF is key to all those efforts."

Facility Does It All

Unlike a commercial industry that turns out widgets and produces the same kinds of waste streams in basically the same quantities day after day, Lawrence Livermore's unusual and diverse research and development activities generate comparatively small quantities of waste of widely varying composition. Waste Treatment group leader John Bowers explains, "For example, we get sink drainings, water cuttings, wax that has been stripped off floors of buildings where radioactive materials are used, and contaminated water from the Contained Firing Facility at Site 300 [Livermore's high-explosives research facility]." Those waste streams and others can contain alpha, beta, and gamma particles and emitters, as well as organic constituents such as oils and solvents, and even

Many of the systems in the Decontamination and Waste Treatment Facility are computer controlled, including the off-gas system, the evaporator, and the tank farm. Here, engineer John Fitzpatrick is shown by the portable operating interface for the liquid waste processing area. In the background at left is the tank farm's central control panel, which shows the conditions of all tanks—how full they are, their temperature, pH, conductivity, and oxidation and reduction potential—and the status of pumps and valves. Every 20 milliseconds, the computer program reads all inputs and outputs and updates the color coding on the panel, providing real-time feedback on the systems.

heavy and transition metals. "It can be a real diverse brew," he concludes. "We've got to be ready to deal with all of these waste streams in ways that protect human health and environment and comply with standards, orders, and regulations. DWTF was designed from the start to do this very job."

The new facility is actually a complex of buildings that includes new indoor storage areas and a California-permitted treatment plant—all connected to an impressive ventilation system. For treating wastes, there's a 2,200-square-meter building for processing solid waste while liquid waste is processed in a 1,600-square-meter building. "An important goal in processing is to reduce the volume of waste," says chemical engineer Dave Larsen. "Since most waste disposal sites charge by volume, not mass, we do everything we can to compact and reduce waste volume, both solid and liquid." So liquid wastes are evaporated—resulting in water, suitable for sending down a sewer, and a much-reduced solidified secondary waste. Solid wastes generated at Livermore are shredded to further squeeze down their volume.

The solid-waste processing building is equipped with two 4.5-metric-ton bridge cranes that can move large items, drum crushers that can mash drums of all sizes into flat pancakes, and a transuranic waste repackaging glovebox that can be used to open, repackage, segregate, and ready for disposal the contents of 55-gallon (200-liter) waste drums.

The centerpiece of the liquid waste processing building is an enormous enclosed "tank farm" with nine 17-kiloliter, closed-top tanks, an arrangement that offers many advantages over the previous open-air tank farm, which has six open-top 5.5-kiloliter treatment tanks and four 17-kiloliter storage tanks. Reagents are delivered directly into the new tank farm using an integrated system.

The advantages of the new system are that the tanks are larger and off gases generated during treatment can themselves be treated, an option that wasn't available in the old facility. Additionally, DWTF offers greater control through an enhanced programmable logic control system. More monitoring is available through augmented sensors, and waste streams are more segregated through the additional tanks and isolation plumbing. DWTF's liquid-processing building includes a process development laboratory that can be used for treatability studies, process verification, and small-scale treatment. The building also includes gloveboxes, fume hoods, and a high-ventilation room to process reactive and highly toxic materials.

The solid- and liquid-processing buildings share a ventilation system designed to control the direction of air flow throughout the facility. "With all doors closed and the facility ventilation system functioning normally," says Larsen, "there is a difference of 0.03 in water-gauge pressure between zones. When the roll-up doors are opened to let a truck into the truck bay, for instance, the pressure differential falls dramatically, but the air flow direction is still into the building, not out."

All the air in the two buildings is fed through enormous banks of high-efficiency particulate air (HEPA) filters—over 90 of them—before it goes out the stacks. "We monitor what goes out the stacks and make sure it meets all standards," notes Bowers. Even the choppers and shredders have their own HEPA filters. Air is filtered first at the stations before being sucked into the building's ventilation system and filtered again at the main HEPA filter banks. A similar process occurs in the tank farm, where the gases and vapors that accumulate in the tanks are routed to a special process off-gas system that scrubs the gas and uses carbon adsorption to eliminate acid gas and organic vapor. The end result of having an integrated ventilation system and operations performed in

Glossary of Radiological and Hazardous Waste

Hazardous waste: Waste that can pose a substantial or potential hazard to human health or the environment when improperly managed. It possesses at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity—or appears on special Environmental Protection Agency lists.

High-level waste: Radioactive waste that results from the reprocessing of spent fuel elements from nuclear reactors. It also includes reprocessed military wastes, such as sludges.

Low-level waste: A general term for a wide range of wastes having low levels of radioactivity. Low-level waste is radioactively contaminated industrial or research waste such as paper, rags, plastic bags, protective clothing, cardboard, packaging material, organic fluids, and water-treatment residues. Low-level wastes containing source, special nuclear, or by-product material are acceptable for disposal in a land disposal facility.

Mixed waste: This waste contains a hazardous waste component and a radioactive material component. Examples include liquid scintillation cocktails; corrosive organics; waste oils; and cleaning, degreasing, and miscellaneous solvents, which are also radioactive.

Transuranic waste: Transuranic refers to atoms of synthetic elements that are heavier (higher in atomic number) than uranium. Transuranic waste materials have been generated in the U.S. since the 1940s, mostly from nuclear weapons production facilities for defense programs. The most prominent element in most transuranic waste is plutonium. Some transuranic waste consists of items such as rags, tools, and laboratory equipment contaminated with radioactive materials. Other forms of transuranic waste include organic and inorganic residues or even entire enclosed contaminated cases in which radioactive materials were handled.

enclosed spaces is that the public, the workers, and the environment are all protected.

Dealing with the Unusual

DWTF uses conventional, tried-and-true techniques and technologies such as evaporation to treat wastes as simply as possible, whenever possible.

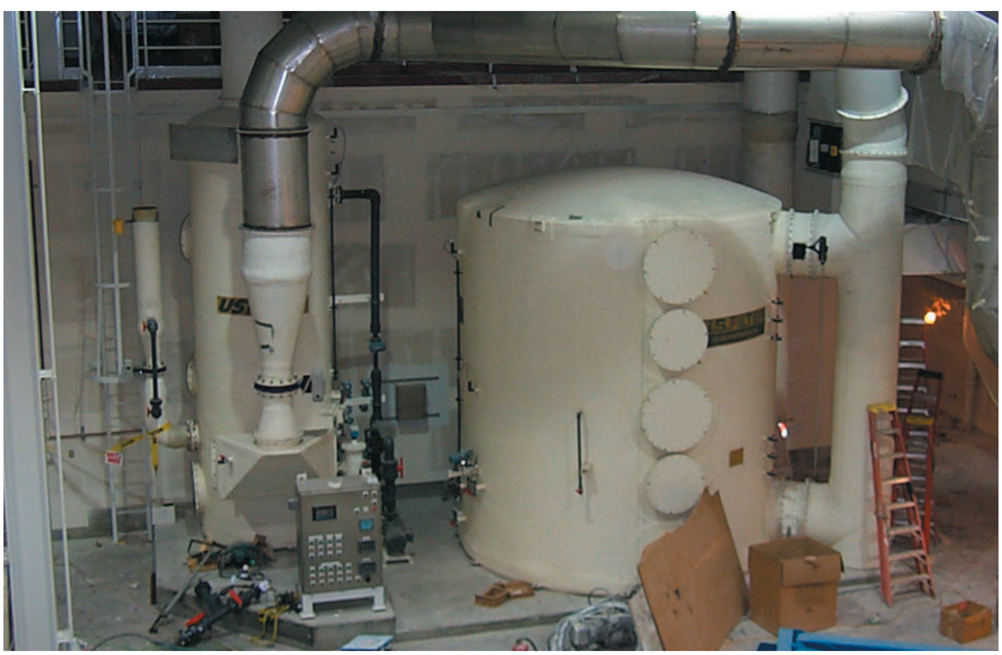
Yet, with the Laboratory being what it is, DWTF and its people need to be ready to take care of waste streams that, as environmental engineer Dianne Gates-Anderson explains, are unique and unusual and require individual attention and specialized treatment. Such as those aforementioned HEPA filters. HEPA filters are designed to remove at least 99.97 percent of airborne particles with diameters greater than or equal to 0.3 micrometers. Eventually, a HEPA filter traps so many particles that it no longer can hold any more and must be replaced. In many cases, these spent HEPA filters are highly contaminated and must be treated.

Gates-Anderson says, "We generate a lot of spent HEPA filters at the Laboratory that require treatment before offsite disposal. The Laboratory has also been storing old legacy HEPA filters, such as those used in gloveboxes, that are often defined as mixed waste because they are contaminated with both radioactive and hazardous constituents."

These mixed-waste filters didn't have a lot of attractive treatment alternatives—until Gates-Anderson and a team of waste treatment engineers and technicians developed the patented In Situ Stabilization and Filter Encapsulation (IS*SAFE) process. This process uses a commercially available resin that has a waterlike consistency for 3 hours before it turns solid. A vacuum pump sucks the watery resin into the spent filter, and the resin fills the interior of the filter, sealing contaminants in place. Once the resin hardens, the contaminants cannot be removed. The resulting encapsulated HEPA filter, if originally classified as a mixed waste, is now considered low-level waste and can be disposed of in a regulated waste disposal site. This reclassification is significant because low-level waste disposal costs are approximately 10 times cheaper than mixed-waste disposal costs.

Gates-Anderson notes that the IS*SAFE process has many advantages over previous treatments. The most important advantage is that it's safe for workers and easy to use. "Workers don't have to destroy, shred, or dismantle the filter," she points out. "Any time workers handle waste less, worker safety is increased." Another advantage is that IS*SAFE doesn't generate a secondary waste stream. There's no off-gassing, very little heat generated during curing, and the process can be used on older wood-frame HEPA filters and newer stainless-steel ones. "The IS*SAFE process shows how a complicated problem can be solved without a complicated solution," says Gates-Anderson.

A second example of a simple, innovative solution for problematic waste streams involves depleted uranium waste. Uranium is a highly reactive metal that oxidizes (burns) easily—sometimes even igniting spontaneously (a quality



The Decontamination and Waste Treatment Facility's (DWTF's) process off-gas system does double duty removing acid and organic gases and vapors from off-gases generated throughout the facility. In the scrubber (the column to the left) off-gases pass over a hydroxide solution, which neutralizes any acid vapors and traps them in the basin at the bottom of the scrubber. The large tank in the middle holds a pair of carbon adsorption columns that trap organic vapors. Once the off-gas has been scrubbed clean, it passes through DWTF's central ventilation system and its banks of high-efficiency particulate air filters for a last scrubbing before exiting through the facility's stacks.

defined as pyrophoric). Pyrophoric depleted-uranium wastes are typically placed in steel drums and covered with liquid prior to storage. In addition to being radioactive and reactive, uranium metal is also chemically toxic at high concentrations. The Laboratory has an inventory of about 11,700 kilograms of pyrophoric depleted uranium. “No disposal facility will accept pyrophoric depleted uranium,” says Gates-Anderson, “so our goal was to find a way to convert this waste to something nonpyrophoric that would be accepted at a low-level radioactive waste disposal facility. We can’t make uranium disappear, but we can make it safe for disposal.”

Gates-Anderson headed a three-year Laboratory Directed Research and Development project to find a way to make uranium safe for disposal. Her team developed a three-step process of pretreatment, chemical dissolution with acid, and stabilization of the dissolution products. Their research focused on the second step—dissolving the solid uranium metal, which usually involves using a variety of nasty acids. “Since we have a sizable amount of depleted uranium to deal with, we didn’t want a process that would generate even more waste that we would have to dispose of in turn,” she explains.

The team explored the possibilities of using a number of reagents singly and in combination, including hydrochloric, sulfuric, and phosphoric acids as well as sodium hypochlorite, sodium hydroxide, and hydrogen peroxide. They zeroed in on a combination of hydrochloric and phosphoric acids. The process yields a semisolid uranium (IV) and phosphate compound, which is nonpyrophoric. “All we need to do at that point is neutralize its pH, solidify the material using conventional methods, and then we can dispose of the uranium as a low-level waste,” she says.

Waste Away

There’s no way around the fact that a by-product of the Laboratory’s national security missions is an unusually diverse variety of wastes—some hazardous, some radioactive, some both. There is no magic wand one can wave to make this waste disappear or transform. But DWTF offers a realistic and responsible solution. Goodwin concludes, “The Laboratory has the responsibility to manage its waste from ‘cradle to grave.’ The researchers and scientists generate the waste in their work—the cradle—and here in our division we have to get it in the grave in ways that are safe, appropriate, and meet all regulatory requirements. DWTF enables the Hazardous Waste Management Division to better support the Laboratory’s programs and missions and to address community concerns with its environmental safety and health compliance.”

—Ann Parker

Dianne Gates-Anderson holds a piece of encapsulated high-efficiency particulate air (HEPA) filter. The IS*Safe process she and others developed encapsulates contaminants in used HEPA filters easily, safely, and without generating secondary waste as other processes do. This is good news for the DOE complex, which annually generates thousands of used HEPA filters that must be treated before disposal.

Key Words: Decontamination and Waste Treatment Facility (DWTF); depleted uranium; hazardous, radioactive, and mixed waste; In Situ Stabilization and Filter Encapsulation (IS*SAFE).

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