Presentation of the 2007 Richard S. Hodes, M.D. Honor Lecture Award

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Abstract

Perma-Fix Environmental Services, Inc. Chief Operating Officer Larry McNamara is the 2007 recipient of the distinguished Richard S. Hodes, M.D. Honor Lecture Award from the Southeast Compact Commission for Low-Level Radioactive Waste Management. This award recognizes Mr. McNamara's innovation in the commercialization of mixed waste treatment processes for the nuclear industry, and the significant role that these innovations have played solving low-level radioactive waste (LLRW) management problems in the United States with specific emphasis on low-level mixed wastes. Low-level mixed wastes (LLMW) have historically been the most difficult wastes to treat because of the specialized equipment, permits and experience needed to deal with a large variety of hazardous constituents.

Prior to innovations in the mixed waste treatment industry championed by Mr. McNamara, wastes were stored at generator sites around the country in regulated storage areas, at great cost, and in many cases for decades.

In this paper, Mr. McNamara shares lessons he has learned over the past seven years in developing and implementing innovative waste management solutions that have helped solve one of the nation's biggest challenges. He also describes the future challenges facing the industry.

Introduction

As recently as the mid-1990's, commercial mixed waste treatment options in this country were limited or non-existent for many waste types. The nation's largest generator of LLMW, the Department of Energy (DOE), was required under the Federal Facilities Compliance Act (passed by Congress in 1992) to submit Site Treatment Plans to address treatment and disposal of tens of thousands of mixed waste containers across the complex. However, just as treatment capacity in the commercial sector was lacking, treatment capacity within the DOE was limited to a few technologies and the limited available treatment was not very accessible to all sites.

From this "technology gap" that existed, only two plausible outcomes could arise: (1) the federal government would have to develop funding and resources to permit and construct treatment facilities, with agreement from stakeholder groups, on DOE-owned property across the complex, or (2) the commercial sector would step in and commit its own capital to fill the void.

As it turned out, mixed waste treatment did become a commercial venture. Companies like Perma-Fix Environmental Services, Inc. stepped in to invest millions of dollars on permits, equipment, and facilities needed to address the large volume and variety of LLMW around the country. With the benefit of hindsight, one could have predicted this outcome because it is generally easier for a private entity to implement an idea or technology faster and more cost effectively than a government entity like the DOE. However, the private sector did face enormous challenges and continues to face those challenges today as we work through the problems of legacy waste and newly generated waste from around the country.

What I have learned through experience is that there are some key questions that must be addressed when developing and implementing technologies:

- Can the technology that was demonstrated in a Research and Development (R&D) setting or laboratory be transferred to a production facility?
- Have we identified all of the stakeholders (DOE, State and Federal regulatory agencies, concerned citizens, etc.) and do we have a plan to achieve stakeholder involvement during the permitting and construction phases?
- Do we have the necessary controls, equipment, and expertise to deal with the unique properties of mixed waste?
- Can we develop a "first-of-a-kind" technology under our existing regulatory and safety envelope?
- Do we have a disposal outlet for the final treated waste forms?
- For Class B and C mixed waste generated by a government agency, can we get the waste buried at the DOE Nevada Test Site (NTS), the only available disposal outlet for greater than Class A LLMW, prior to closure of the mixed waste cell in 2010?

I will discuss each one of these questions in further detail and include successful strategies that we have employed to address them. In addition, I will present actual examples of successful technology applications. Lastly, I will present my thoughts on the future of the mixed waste treatment industry using the lessons that we have learned along the way.

Strategies for Successful Commercialization

Transferring a Technology to the Production Floor

If a technology is developed in a research facility (either commercial or DOE-owned facility) several issues must be worked out before it can be transferred to a production environment. First, who owns the rights to the technology? If the intellectual property is protected, then a usage or lease agreement must be implemented, an arrangement to purchase the technology outright must be made, or you must enter into a business partnership with the technology owner.

In dealing with the challenges of taking a process from bench-scale to full-scale, a processor must rely on sound engineering practices as well as accurate market research. Overbuilding the process can use up valuable facility space and utilities. Each treatment process in a facility competes for space and power needs. If market research indicates that only small volumes of specific wastes requiring use of the technology are available then it is not practical to construct a large and elaborate system that will sit idle nine months out of the year.

Lastly, the permitting and siting of the process must be accomplished. In the case of Perma-Fix, where we have three distinct treatment facilities, a decision must be made on where the new process best complements existing capabilities. Sometimes the geographic location of our customers or the regulatory climate in a particular State may factor into the decision. As identified in the table below, you can see that Perma-Fix has been successful in applying its technologies to numerous problem wastes.

Continuing implementation of innovative technologies to address problem wastes has reduced long term storage costs and reduced risks to the health and safety of workers and the public and the environment.

Another issue that must be considered is whether there is a final disposal outlet available once a waste is treated. During the process of identifying all of the required elements for the treatment of "orphan" waste streams, we at Perma-Fix identified the need for access to alternate (non-commercially available) disposal outlets that could accommodate the final treated waste forms for DOE's "orphan" wastes. We sought out and recently achieved the first and only disposal certification for a commercial processor to dispose of both LLRW and LLMW at the NTSdisposal site through our own certification program. This achievement was previously thought to be unattainable.

The table below identifies the waste streams which were identified by the Department of Energy's Mixed Waste Focus Group as "orphan wastes" with no available disposition path. Since that time, we have successfully developed and implemented the technologies to treat these wastes and others like them to meet regulatory requirements. It is important to note that although the orphan wastes listed here are DOE wastes, commercial generators have similar waste streams in typically much smaller volumes. Therefore, the technologies that are developed to deal with the larger government legacy waste streams can also be utilized on the smaller commercial waste streams.

"Orphan" Waste Category[1]	Waste form	Technology Applied	Generator
Mercury Waste	soil/sludge containing >260 ppm mercury, organics, and PCBs	Thermal Desorption	Oak Ridge, TN Bechtel Jacobs Company LLC
Organic Liquid Stabilization	140,000 gallons of sodium-bearing mixed waste liquids required onsite stabilization to meet NTS WAC due to high activity; Waste liquid resulted from HLW retrieval and vitrification activities at West Valley Demonstration Project.	Organic Liquid Stabilization	West Valley Nuclear Services Company

"Orphan" Waste Category[1]	Waste form	Technology Applied	Generator
High Activity Thermal Treatment	Organic Non Debris with Dose rates up to 70mR/hr on package surface with inner package dose rates exceeding 100mR/hr;	Thermal Desorption	Fluor Hanford

[1] Waste stream categories are as identified in the report from the Department of Energy, Office of Technical Program Integration, EM-22 "Mixed Waste Focus Group".

Reactives, Pyroforics	Variety of reactive and pyrophoric chemicals from the accelerated clean up project	Chemical Deactivation	Rocky Flats Environmental Technology Site
Uranium & Thorium Chips	555 containers of depleted uranium chips in oil and contaminated soil and oil excavated from the Hanford 618-4 burial ground;	Stabilization	Bechtel Hanford
TSCA Waste	PCB Remediation Waste from accelerated cleanup project	Thermal Desorption	Bechtel Jacobs, Oak Ridge Site
Alpha MLLW	evaporator system sludges, residues, and used water filters; Waste had been mixed with diatomaceous earth absorbent and in many cases compacted; Extensive activity and dose rate issues;	Solidification	ETEC Boeing (Rocketdyne)
Beryllium	Beryllium contaminated waste	Solidification	Rocky Flats Environmental Technology Site
TRU Other	506 cubic meters of legacy MLLW contaminated with Pu-239; Organic and inorganic contaminated soil, elemental Hg lab packs, >260 ppm, <260 ppm Hg;	Thermal Desorption; amalgamation; stabilization	Lawrence Livermore National Laboratory
Oil with Metals	Oil with metals are routinely thermally destroyed via combustion	Combustion	Multiple DOE & Commercial sites
Inorganic Liquid	>130,000 gallons of F-Canyon Depleted Uranyl Nitrate (DUN) waste for Westinghouse Savannah River Company. DUN, a byproduct of nuclear material production, contained significant quantities of Pu-239 that exceeded Class A disposal limits and thus required disposal at NTS;	Stabilization	Washington Savannah River Company

Stakeholder Involvement

When a new treatment permit is sought, it is important to have regular communications with the appropriate stakeholders. When we made the decision to pursue a Polychlorinated Biphenyls (PCB) permit to allow us to thermally destroy PCBs in our Industrial Boiler at DSSI, we approached DOE for input into the permit. We wanted to understand their existing waste stream challenges and any operational issues with their existing TSCA Incinerator in Oak Ridge. Besides being restricted to DOE waste, the incinerator has strict limits on heavy metals and a cumbersome waste approval process. Also, the incinerator faces infrastructure issues as the former K-25 plant continues its decommissioning efforts.

Throughout the permitting process, we conducted regular face-to-face meetings with EPA regulators and maintained regular communication. It was important that we discussed our permit application with the regulators and addressed any concerns they had before we submitted our permit application. This approach seems to work well so that the interested parties can provide their input early in the permitting process.

Handling the Complexities of Mixed Waste

Because of the large variety of physical, chemical, and radiological forms, the treatment of mixed waste can be particularly daunting. Fixed-based facilities must be designed to address odd-sized containers and must be equipped with roll-up door access and overhead cranes. Pollution control devices must be designed to filter out mobile radiological constituents as well as organic vapors, mercury and other heavy metals, and nuisance dust from handling vermiculite and solidification agents. Work areas must be designed to handle multiple treatment campaigns simultaneously so the ability to work in separate rooms and enclosures is critical. Storage areas must be laid out for easy access to processing areas and the storage areas should accommodate standard material handling equipment such as fork trucks without the problems of overhead clearance, truck emissions, etc.

Disposal Outlets

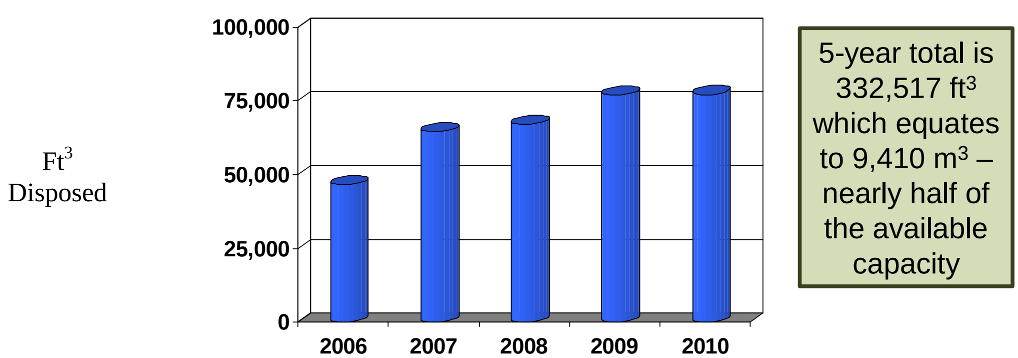
The final mixed waste form is a critical component to the overall treatment process. If the final waste form exceeds limits for Class A, then the options for disposal narrow greatly. Other issues that arise are the successful treatment of all underlying hazardous constituents. When the waste is received for treatment at the processor's facility, have all of the constituents been accurately identified? One of the problems that Perma-Fix encounters is the unexpected appearance of underlying hazardous constituents that were not identified up front (during the profiling process). Therefore, because we didn't know certain constituents were there prior to treatment, the waste must be retreated once analytical results identify the unprofiled constituents. It is best to collect as much information on the front end as possible including inbound sampling and analysis data to avoid problems later.

Other problems may be regulatory in nature. Differences in the way States regulate the treatment of hazardous and mixed waste may pose challenges. For example, a waste stream that is treated in the State of Tennessee by macroencapsulation (using a sealed stainless steel container), may not meet Land Disposal Restrictions in the State of Utah. Perhaps the State of Utah takes a more conservative definition of macroencapsulation and does not allow for a container to be used as a barrier to reduce surface exposure of the waste in a landfill environment. These are all considerations when treating mixed waste and must be factored in to the acceptance process as well as the costs.

NTS Closure

For government wastes, especially higher activity mixed wastes; DOE operates an important disposal resource in the Nevada desert west of Las Vegas. The NTS accepts LLRW and LLMW exceeding the levels of radioactivity that can be disposed of commercially. NTS' ability to dispose of LLMW is very finite, however. The current RCRA permit issued by the State of Nevada to the DOE for disposal of mixed waste at NTS is scheduled to expire in 2010. Because NTS is the only current option for Class B and C government generated waste, this will present problems for a number of sites across the complex that have not addressed all of their high activity waste during this period. There is the possibility of LLMW disposal becoming available at DOE's Hanford, WA site sometime in the future, but that may be well after the 2010 deadline. Because Perma-Fix has its NTS certification for both low-level and low-level mixed waste, we are working closely with several sites to start receiving material that requires disposal in Nevada. However, due to the complex treatment and certification activities that must be performed, the window of opportunity is rapidly closing and each site needs to be aware of this issue. The following chart indicates how under-utilized the NTS LLMW cell currently is.

NTS MLLW Five-Year Disposal Forecast [2]



The Future of Mixed Waste Treatment in the U.S.

The majority of the large volumes of DOE legacy mixed wastes have now been successfully treated and disposed. In terms of legacy wastes that still require disposition, the smaller volume and more complex wastes will require an even greater focus to safely and cost effectively manage. In addition, there are some commercial LLMW that have yet to be addressed until now since the larger volumes had previously used up treatment capacities. Examples include the following:

[2] Waste stream information as identified by the NTS annual report.

- Waste with high quantities of special nuclear material;
- Classified Waste;
- Dioxins;
- High activity waste exceeding Class A;
- Reactive Wastes; and
- Gas Cylinders.

The challenge for commercial facilities is to remain flexible enough to manage these hard to handle waste streams while doing it in a cost effective manner. Previous mixed waste cost models will not apply to these waste streams because of their low volumes and significant controls. DOE sites must understand this reality and budget accordingly. Factored in this equation is the limited timeframe for disposing of treated waste at the NTS mixed waste cell. With less than 4 years remaining for access to the mixed waste cell, the capacity at commercial treatment outlets will be further tested in the next few years.

As the overall volumes of radioactive and mixed waste in this country continue to decrease due to completion of storage backlogs and better waste minimization practices, the industry will likely experience some consolidation. At the time of this paper, Perma-Fix is in the final stages of acquiring Pacific EcoSolutions Inc. (PEcoS) in Richland, WA. This acquisition will complement our existing facilities both from the standpoint of capabilities and a geographic standpoint. With the addition of PEcoS' radioactive and hazardous waste permits and licenses, we will expand our services (to include product lines like thermal treatment of animal carcasses, compaction of low density waste and source encapsulation) and be more accessible to our customers in the western U.S. Another example of consolidation in 2006 was the merger of Duratek with Energy*Solutions*.

From a domestic security standpoint, I would advocate better coordination between the Office of Homeland Security and commercial radioactively-licensed facilities with licenses for radioactive waste. A sound emergency preparedness policy should include agreements in place between the Federal government and licensees. For example, Perma-Fix will now have four facilities (in three distinct geographic regions) to respond quickly to a radiological accident or deliberate action by one of our nation's adversaries. It does not make sense for this Country to have these resources and not have a coordinated plan to use them during a time of crisis (and we hope the need never arises).

On the international front, the commercial mixed waste treatment industry in the U.S. continues to be the technological leader in the world. Other nations will rely on the U.S. to share technology and in some cases, process waste. With nations emphasizing nuclear energy as a means to reduce dependence on Middle East oil, the safe and environmentally sound disposal of mixed waste is and will continue to be not just a problem for this country, but for all countries engaged in nuclear power research and development. Currently, over 100 countries have either built/operated nuclear power plants or have the capability to do so.