

PROVIDING INDUSTRY SOLUTIONS TO DOE'S MIXED WASTE REMEDIATION EFFORTS

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ABSTRACT

The Department of Energy (DOE), Office of Environmental Management (EM) continues to pursue cost-effective, environmental cleanup of the weapons complex sites with a concomitant emphasis on deployment of innovative technologies as a means to this end. The *Accelerating Cleanup: EM Paths to Closure* document delineates strategies that entail competitive procurements based on end-state performance specifications, technology deployment, privatization, outsourcing and mortgage reduction, which require a competitive private sector supplier base to meet EM needs. The EM Office of Science and Technology (OST) supports technology development and deployment through investments in partnerships with private industry to enhance the acceptance of their technology products within the DOE market.

Since 1992, OST and the Federal Energy Technology Center (FETC) have supported the research and development of technology products and services offered by small businesses, such as the three discussed in this paper: Bio-Imaging Research Inc., Vortec Corporation, and SpinTek Systems. These successful partnerships between DOE and Industry have resulted in viable options for EM's cleanup needs, and require continued marketing efforts to ensure that the technology solutions are used at the DOE sites. The scientific and engineering bases for these technologies have been well established through research and development (R&D) activities that have ensued for 10 to 20 years, mostly without the support of the EM programs. In all cases there are significant market opportunities external to the DOE weapons complex that provide broader incentives for private companies to adapt their technologies for DOE's use. These companies have entered contractual agreements with the DOE, as a result of competitive solicitations issued by FETC, based on the needs established by the DOE sites at the time of the solicitation. While the specific needs have changed over the years as site specific requirements have been better defined, private industry has continued to adapt their technologies to changing needs. Accurate and realistic requirements issued by the government and establishment of working relationships with the DOE site contractors are two essential elements of successful partnerships. These companies continue to work cooperatively with the Government to align their businesses with DOE's requirements so they can offer competitive commercial products and services to meet the needs of end users at the sites -- typically the site contractor organizations. Private companies, external to the DOE weapons complex, have difficulty in getting the attention of EM decision makers at the sites, even if they have documented cost and performance data. It is a continuous challenge for these companies to penetrate the DOE market. The Mixed Waste Focus Area, in conjunction with FETC and other supporting organizations, has worked to facilitate these site working relationships.

INTRODUCTION

The mission of the Environmental Management (EM) Program is to clean up the environmental legacy of U.S. nuclear weapons production, with the goal of completing cleanup activities at most Department of Energy sites within a decade. The *Accelerating Cleanup: EM Paths to Closure* document (hereafter referred to as the *Paths to Closure* document) challenges sites to develop and deploy innovative and more efficient approaches and technical solutions. EM's Office of Science and Technology (OST) research and development (R&D) activities are to provide technological solutions that reduce costs and accelerate schedules associated with cleanup activities, reduce health and safety risks, and enable intractable problems to be solved. Industry Programs works cooperatively with the EM Focus Area teams, including Mixed Waste, by providing the mechanism to partner with private sector companies to assist them in developing their technologies through full scale demonstrations that result in deployment of technological solutions at DOE sites.

Partnerships with private industry will reap significant benefits to the DOE's cleanup efforts, provided that the DOE sites maintain an open market to the private sector. Significant benefits will be realized by cost savings through widespread use of technologies and services provided by private sector companies in response to competitive procurements issued by the DOE sites. The *Paths to Closure* document requires a supply of technology systems from private sector companies. Strategies that entail competitive procurements based on end-state performance specifications, technology deployment, privatization, outsourcing and mortgage reduction require a competitive supplier base to meet EM needs. Industry Programs provides an effective mechanism that industry can use to fill the information gaps needed to confidently bid on cleanup projects at the DOE sites.

SUCCESSFUL GOVERNMENT-INDUSTRY PARTNERSHIPS

One of OST's strategies is to ensure that private industry, other Federal agencies, and universities are major participants in developing and deploying new and emerging technologies. This is accomplished, in part, through a strong and stable financial commitment for building public and private-sector partnerships through the Industry Programs, which is implemented through the Federal Energy Technology Center (FETC). FETC partners with private sector entities such as colleges, universities, not-for-profit institutions, and industry in developing, demonstrating, and implementing improved technologies that address the needs of DOE sites. The approach is via government contracting mechanisms, primarily competitively procured contracts and financial assistance agreements.

A key to effective Government-Industry partnerships is establishing shared goals and objectives that meet the expectations of the parties entering the agreement. Industry has many incentives to expedite R&D work, including financial expediency, market entry and internal corporate goals. Government, on the other hand, generally acts on mandates of policy from executive and legislative branches, and is driven by goals and objectives of established programs. Within the EM program, it is difficult to accomplish true partnerships because of the multitude and diversity of individuals and organizations involved in decision-making processes. For example, it is often

necessary to elicit the support of DOE headquarters, DOE field offices, site contractors, regulators, and various stakeholder groups in order to move forward with innovative solutions to cleanup problems.

One means through which partnerships can be developed in an R&D environment is a competitive procurement process that affords the private sector the opportunity to offer their approaches to solving problems that the DOE identifies. The DOE has the major responsibility in establishing effective partnerships with private industry for innovative technology development and eventual deployment within the DOE complex. In the procurement process the Government must define the technology need, which establishes the technical requirements and desired outcome of the research. This would include defining:

- the purpose of the need - specific drivers, regulatory requirements, site treatment plans, lack of cost-effective approach
- a description of the need - types and quantities of contaminants, characteristics of the matrix, magnitude of the problem
- baseline methods - description, performance, cost, alternatives tried, ongoing R&D
- schedule requirements
- performance or desired end state
- known constraints - ES&H, site working relationships, site-specific conditions

In addition, the DOE needs to independently assess their desired cost targets and aide in establishing the acceptable bounds of technical and financial risks. The better the DOE can define and articulate their requirements, the more likely they will attain the desired results, at the best price. The breadth and complexity of the problems at the DOE sites and conflicting needs among the sites, have made it difficult for DOE to clearly define specific requirements. Private sector companies tend to see the DOE market for innovative environmental technologies much larger than it really is, based on EM budget numbers and published reports, and often perceive the opportunities as moving targets.

Industry partners have the obvious responsibility of performing work in accordance with the cost, schedule and performance requirements of their contract with the Government. The FETC-managed contracts are implemented in Phases (or options) that allow either side to withdraw, at designated decision points, thus minimizing the Government's liabilities and allowing opportunities to redirect work based on changing customer requirements. In most respects, for the industry partner, the contract is the vehicle through which their technology product or service is introduced into the DOE complex (market access), with potential for much broader commercial application. In general, most private sector organizations have a vested interest in technologies, as a result of numerous years of research, prior to working with DOE EM. Companies are expected and willing to share in financial and technical risks, and consistently have, particularly if there is broader commercial application. Because of the uncertainty of the DOE environmental market and scarcity of risk capital for environmental technologies, cost sharing is typically less than 20 percent. Cost sharing would be greater if the incentives existed to warrant greater private sector risk; there is little assurance that there is an available market

following the R&D. Within the Industry Programs activities, the industry partners have worked to align their business plans with respect to the Government's needs and with few exceptions are committed to offering their concepts commercially, once cost and performance data are documented. With the assistance of DOE representatives, specifically the Focus Area teams, (as well as, site personnel and support contractors), the industry partner is responsible for marketing technology solutions within the DOE community.

Execution of Industry Programs activities requires working closely with the private sector developer, DOE technical managers (primarily Focus Area representatives), DOE Headquarters program personnel, and site personnel (which may include regulators and public stakeholders) to ensure that end user requirements are met. The end user is the site contractor responsible for the cleanup job or a second tier contractor that has the capability to bid on jobs at DOE sites. In some cases, the developer may have this capability. FETC's emphasis has always been to have the technology developer working closely with the end user(s) early in the development process to effect multisite deployment of technologies. It is difficult for private sector companies to understand site-specific requirements and access to site information is restrained, unless they have experience in working in this environment. Private companies have difficulty in getting the attention of EM decision-makers at the sites, even if they have documented cost and performance data. The complexity of site organizations, inadequate communications, preferences of site personnel, potential conflicts of interest, budget and schedule issues and many other factors may contribute to ineffective working relationships. FETC, in conjunction with the Focus Areas, has worked to facilitate these site working relationships. The EM Focus Area teams play a major role in ensuring that DOE-funded technologies are successfully deployed.

A particular challenge to many of FETC's industry partners is to obtain an understanding of the DOE market. The DOE-EM market is fragmented and uncertain due to the numerous sites, organizations, individuals, problem characteristics, desired performances, purchasing preferences, institutional and regulatory constraints, and, in many cases, uncertain schedules that must be considered. The Site Technology Coordinating Groups (STCG) and the Focus Area teams have been critical in developing assessments of the top priority technology needs at each DOE facility, essentially resulting in an internal market study. Additional documentation and studies, such as the *Paths to Closure* document and the EM Integration Program have helped to define the broader DOE market, but are not intended to accurately define the specific opportunities, commitments to competing technologies, time frames for technology insertion and cost and performance targets. These studies have not had significant input from private sector technology development organizations, but are moving in the right direction. It is extremely challenging, time consuming and costly for private companies to enter into the DOE market. The diversity of sites, unclear and evolving requirements, the numerous decision-makers that must be marketed, difficulty in establishing correct contacts and other factors contribute to this challenge. Through diligence on the part of the company and the DOE the challenges however can be overcome, leading to successful partnerships providing benefits to all involved parties. Again, within the OST programs, the Focus Area teams play a significant role in defining and consummating opportunities for private sector companies.

Three successful partnerships, which are discussed below, deal with significantly different technologies. All have a long, but not unusual, developmental history backed by business organizations that are dedicated to the success of the technology for DOE applications. In all three cases, problems with DOE market penetration are significant obstacles for these small businesses, despite their efforts to design and test their technologies specifically for DOE problems, and aligning their business interests to DOE market opportunities. These technologies and the corresponding companies are:

- Waste Inspection Tomography - Bio-Imaging Research (BIR), Inc.
- Cyclone Melter System (CMS) - Vortec Corporation
- High Shear Rotary Membrane Filtration (ST-II) - SpinTek Systems, LP

The intent of these discussions is not to delineate the technical merit of work conducted on behalf of the DOE, but rather to discuss efforts that have been made to consummate the DOE/Industry partnerships.

WASTE INSPECTION TOMOGRAPHY

Technology Description:

Waste Inspection Tomography (WIT) is a mobile, self-sufficient, semi-trailer unit that can be brought to a waste site to perform tomographic characterization of nuclear waste drums using a variety of different inspection techniques. (Figure 1) The system uses Computed Tomography (CT) and Digital Radiography (DR) for non-destructive X-ray examination (NDE). DR provides entire drum projection, while CT provides slice plane and volume x-ray imaging of drum contents. Two gamma cameras with photomultiplier tubes and a sodium iodide crystal are used to localize gamma emissions in a drum. Collimated Gamma Scanning (CGS) identifies the isotopes present using gamma spectroscopy and Active and Passive CT (A&PUT) determines the total alpha activity. NDE determines the drum content, whereas the gamma-based non-destructive assay (NDA) technologies identify and quantify the radioactivity within the drum.



Figure 1. BIR, Inc. Waste Inspection Tomography

Status:

BIR, Inc. is a small company formed in 1980 and located in Lincolnshire, Illinois that has established itself as a world class leader in medical imaging technology. The basic concepts for the WIT technologies were derived from their previous experiences dating back to the mid-70's when EMI Medical invented Computed Tomography (CT) and held all of the patents on CT. BIR, Inc. was established as an R&D organization separate from EMI Medical to develop the next generation of CT scanners. This experience formed the basis for their proposals to the Department of Energy.

Development specific to DOE needs began in 1990 with a grant from the DOE Small Business Innovative Research (SBIR) program. The SBIR work determined the feasibility of using CT to inspect nuclear waste drums. The SBIR grant results were used in proposals to the DOE –EM OST, which allowed for the adaptation of BIR's existing medical x-ray CT technology, and included the technology transfer of CT gamma assay techniques developed by Lawrence Livermore National Laboratory (LLNL). Two FETC/OST contracts resulted in development and field testing of the WIT trailer. These contracts were designed to result in a commercially viable option that DOE could use to meet their drum assay requirements, with BIR positioned to offer the required services. The DOE SBIR and both OST contracts with BIR all originated from competitively bid solicitations. WIT developed practical field experience with deployments at three DOE sites and one commercial site including: LLNL, Rocky Flats Environmental Technology Site (RFETS), Idaho National Engineering and Environmental Laboratory (INEEL), and Babcock & Wilcox-Lynchburg.

In 1997 WIT participated in the Capability Evaluation Program, an OST sponsored inter-comparison performance test program. WIT performance was verified through a competitively bid cooperative agreement under the Rapid Commercialization Initiative (RCI). The RCI team of verifiers included the DOE, Environmental Protection Agency (EPA), Army Corps of Engineers, and numerous state environmental regulators who prepared a verification statement. WIT is also participating in the Carlsbad Area Office's certification process that includes periodic quality assurance audits and evaluations under the Performance Demonstration Program.

Most recently BIR, Inc. formed a new division, the Waste Inspection Technology Company (WITCO), specifically to provide WIT services to DOE customers and is actively pursuing jobs, with limited success. WITCO has partnered with a team of mobile characterization service providers to supply DOE with all of the required technologies to certify transuranic (TRU) waste drums for Waste Isolation Pilot Plant (WIPP) disposal, including WIT; this partnership resulted in a characterization services contract at the Nevada Test Site (NTS). In October 1998, the team completed characterization of 187 drums under Phase I of the contract; WIT provided spectroscopy and NDE for all the drums. WITCO and its partners expect to process an additional 300-350 drums at NTS, pending authorization to initiate the subsequent phase of their contract.

In the Spring of 1999, WITCO will complete developmental efforts under FETC/OST sponsorship. The objective is to increase WIT assay throughput such that the system is commercially viable. Specifically, the goal is to increase the throughput (or reduce the time

required for the completion of assay and data collection) for WIT NDA. from 24 hours per drum to less than 1 hour per drum. Additionally, WIT is to add a bar code reader for the identification of waste drums. FETC/OST's objective is to allow WITCO to purchase the equipment back from the Government, so they can pursue commercial applications. However, it has not been possible for BIR, Inc. to raise capital for the equipment purchase because of the continued uncertainty of prospective DOE jobs. This uncertainty is illustrated below.

The EM-30 Integrated Data Base Report of 1995 identifies about 577,000 retrievably stored drums and the National Transuranic Waste Management Plan indicates about 675,000 drums; 159,000 drums have been identified as prime candidates for the mobile systems market. However, the portion of the market that is available to private industry providers of mobile NDE/NDA services is fraught with large uncertainties. Furthermore, while 316,000 additional drums have been tagged as "potential market" for mobile systems, current planning is to build or upgrade existing fixed facilities at the major sites such as INEEL, SRS and Hanford to perform NDE/NDA on this inventory. Consequently, the potential vendors for the mobile systems market find themselves in a Catch 22. The vendors must demonstrate cost savings to have a chance at the bigger market; however, it is currently targeted for fixed DOE-facilities. Consequently, bids are based on a smaller market, which results in higher per-drum costs (i.e. less drums to recover capital investment) with significant uncertainty surrounding additional markets.

WITCO and other mobile characterization vendors continue to pursue jobs as they arise, including potential opportunities at RFETS, INEEL, Mound and others. WITCO believes that characterization contracts for 20,000 to 25,000 drums over the next five years are needed to secure private capital investment.

CYCLONE MELTER SYSTEM

Technology Description:

This process is an extension of an advanced, multi-fuel capable, combustion and melting technology developed for commercial glass manufacturing and waste processing/recycling. The unique features of this technology provide the potential for a cost-effective and safe process for vitrification of contaminants.

The primary components of the basic Cyclone Melter System (CMSTM) are a counter rotating vortex (CRV) combustor and a cyclone melter. (Figure 2) A unique feature of the process is the rapid suspension heating and oxidation of feedstock materials in the CRV heater prior to the physical-chemical melting processes that occur within the cyclone melter. The use of the Vortec CRV combustor in conjunction with the cyclone melter distinguishes the Vortec combustion and melting technology from other types of cyclone combustion systems. In the CMSTM process, granular glass-forming ingredients and other feedstocks are introduced into the top region of the CRV combustor along with fuel and combustion air. As a result of the intense counter-rotating vortex mixing, it is possible to achieve a stable reaction in the presence of large quantities of inert particulate matter. Both convection and radiation heat transfer mechanisms contribute to the rapid heating of the feedstock materials within the CRV heater. The Vortec process is able to

rapidly heat inert solids to melting temperatures at gas to solids mass ratios on the order of 2:1. Any organic contaminants in the feedstocks are also effectively oxidized.

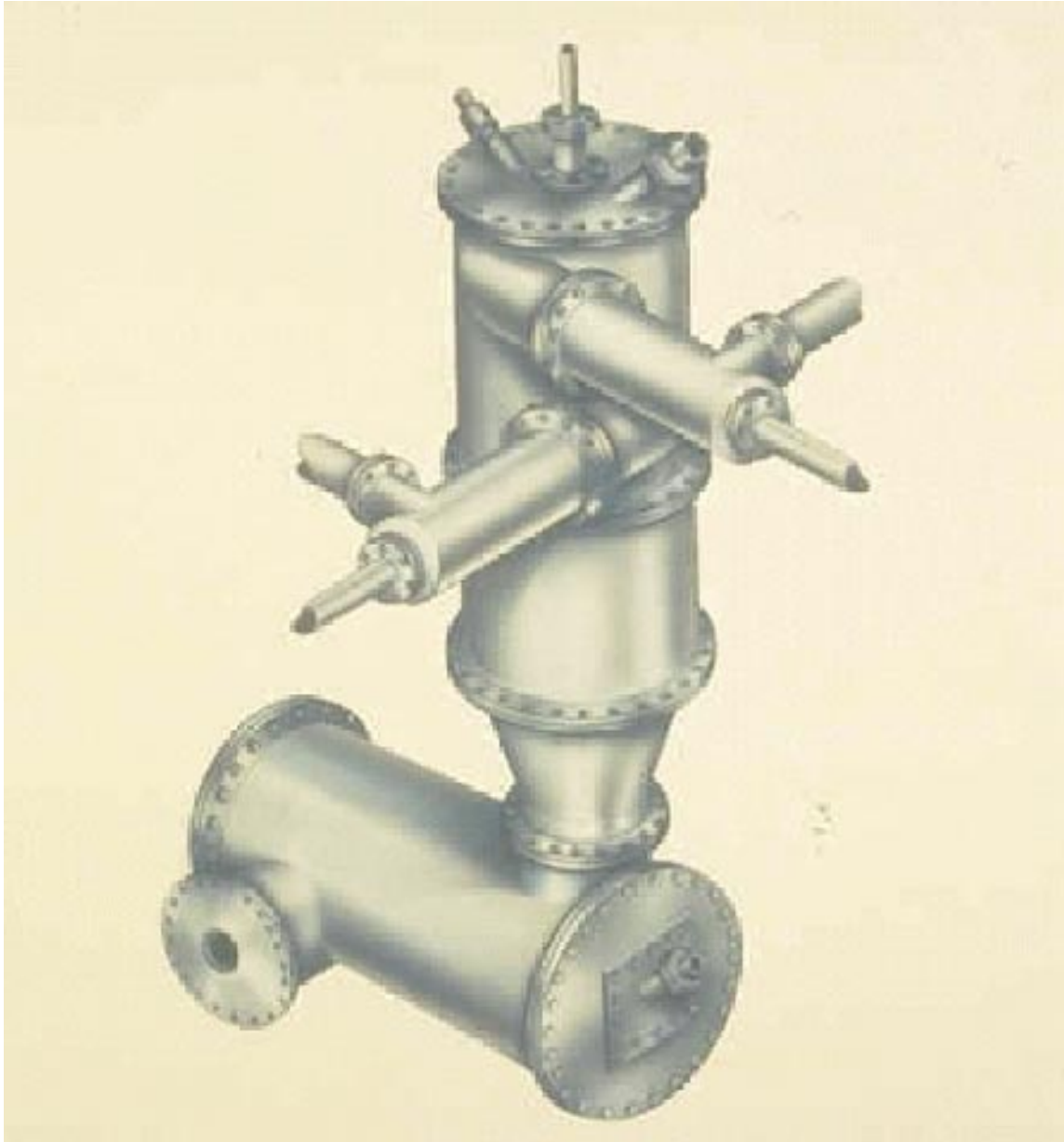


Figure 2. Vortec Cyclone Melter System (CMS™)

The Vortec process is designed to treat a variety of waste streams, including: soil, rock, sand, and concrete wastes that contain PCBs and other organic compounds. The process produces an inert, glass frit that passes leachate and toxicity tests, resulting in less costly and more efficient storage and disposal options.

Status:

Vortec Corporation is a small company formed in 1983 and located in Collegeville, Pennsylvania that has established itself as a leading supplier of glass melting and waste vitrification technology. Developmental efforts on the rapid glass melter began in 1982 through funding by the Gas Research Institute (GRI), initially at AVCo in Everett, MA and then at Vortec Corp. GRI supported several years of developmental testing at Vortec from 1983 through 1987.

Vortec has operated a 10-20 ton per day pilot test facility at the University of Pittsburgh's Applied Research Center since 1988. This facility was initially designed and constructed under a program sponsored by the DOE's Fossil Energy Program through FETC Pittsburgh, from 1987 to 1994. During this time, Vortec conducted vitrification tests on a wide variety of waste materials such as glass container cullet, coal fired boiler ash, and municipal incinerator ash. This DOE-sponsored work then led to several SBIR grants and other privately funded research involving the vitrification of industrial wastes such as electric arc furnace dust, metal plating wastes, automobile shredder residue ash, and spent aluminum smelting pot liners. In addition, Vortec participated in the EPA Superfund Innovative Technology Evaluation (SITE) Program to investigate and conduct sub-scale experiments to evaluate the feasibility of vitrifying soils introduced to the CMS as a slurry.

Vortec's development efforts for the processing of radioactive wastes were initiated in 1992, as a result of a competitive procurement issued by FETC/OST. Originally, the work targeted soil washing fines at the DOE Hanford site; this included surrogate testing to develop system design data and site specific process designs. However, funding constraints and regulatory considerations at Hanford caused them to withdraw their commitment to the test program. In 1995 the FETC/OST project was redirected through a competitive process among the DOE sites, where the Paducah Gaseous Diffusion Plant (PGDP) indicated the greatest need and commitment to process 55,000 drums of stored low level waste, including radioactive soils and sludges, TSCA, and RCRA wastes. This major development program with FETC/OST will culminate in the construction and 30-day demonstration of a vitrification system that, if successfully demonstrated, would be used for several years to process wastes at PGDP. Paducah continues to be committed to the CMSTM technology and has included Vortec in their project baseline. Vortec and its subcontractors have already completed surrogate testing to develop system design data, most of the final design packages, fabrication and delivery of major system components and site preparation. Operation of this plant is scheduled to be initiated in 1999, but has been delayed in order to assimilate additional documentation in response to inquiries under the National Environmental Policy Act process.

Vortec has incorporated a new company, SPL Recycling, Inc., that is providing recycling services to the aluminum production industry. This business will use the CMSTM technology to recycle spent aluminum potliner (K088) into value added glass and ceramic products. The Ormet Aluminum installation, located in Hannibal, OH, is the new company's first commercial venture. The system is designed to process 50 tons-per-day of the waste material and produce a glass frit

that will be used in glass and ceramic manufacturing operations. The initial vitrification operation at the Ormet plant began in 1997.

As part of its strategy to serve the aluminum industry, Vortec has established a strategic business alliance with Hoogovens Technical Services (HTS) for the development and commercialization of equipment and services related to recycling industrial waste materials generated by the aluminum and steel industries. HTS is a world leader in providing technology and services to the steel and aluminum industries. HTS' expertise in flue gas cleaning, engineering, and construction is a strong complement to the Vortec technology. Several engineering and design projects for industrial waste recycling are planned throughout the world for the new partners. A formal agreement was executed on August 20, 1996. Vortec plans to expand its success in the aluminum and steel sector with the help of HTS.

In another teaming opportunity, Vortec established a strategic alliance with Welko Industriale S.p.A. (Italy), a major leader in the ceramic tile manufacturing equipment industry. The two companies have teamed to develop and commercialize the use of Vortec's engineered glass products as a new substitute material for the manufacturing of various ceramic products, which provides Vortec with the capability of building turnkey waste-to-ceramic tile recycling plants.

Vortec also has a joint strategic business agreement with Mitsubishi Chemical Engineering Company and Japan Robles Minerals Company for the marketing and licensing of their CMSTM vitrification technology in Japan. With these new partners, Vortec expects to design and install several industrial waste recycling facilities in Japan. Vortec's initial focus will be on the recycling of municipal incinerator ash in Japan with assistance from its new business partners. This recycling of industrial waste material will provide a reliable, low-cost source of glass and ceramic products in Japan and other Asian countries.

Simultaneously with the development of the Demonstration Plant to be operated at Paducah, Vortec continues to be active in promoting the use of the CMSTM technology for other DOE applications. Once the DOE/Vortec demonstration is completed at PGDP there will be sufficient performance information to estimate the applicability of the technology to the remediation of DOE's waste inventory. In 1994, Vortec demonstrated the capability of the CMSTM to process the high level waste stored in the Hanford tanks, and has recently received requests for additional information and demonstrations from Hanford. Additionally, in December 1998, a 72-hour, proof-of-principle test was completed for Fluor Daniel Fernald at Vortec's pilot test facility at the University of Pittsburgh's Applied Research Center. These tests simulated vitrification of low level waste from the Fernald silos, consumed approximately 10 tons of slurry feed, produced about 5,400 pounds of glass and were completed in accordance with Fernald's approved work plan. Test results are currently being analyzed. Since significant quantities of DOE waste are still uncommitted to a treatment option, vitrification vendors, such as Vortec, continue to seek opportunities to penetrate the DOE market.

HIGH SHEAR ROTARY MEMBRANE FILTRATION

Technology Description:

The DOE has many nuclear weapons-related facilities requiring the separation of radioactive materials from a liquid waste or process stream to reduce the quantity of radioactive material for disposal. In addition to waste minimization, DOE is also interested in concentrating organic materials and in fractionating closely sized particles. The SpinTek ST-II High Shear Rotary Membrane Filtration is able to 1) efficiently reject radioactive and other contaminants, 2) produce a permeate that is relatively free of radionuclides and other contaminants, and 3) reach large concentration factors while maintaining a high permeate flux.

The SpinTek ST-II High Shear Rotary Membrane Filtration System (Figure 3) uses a series of flat, round membrane disks (only one disk is shown) set on a hollow rotating shaft inside a cylindrical housing. The influent enters the membrane chamber under pressure and is distributed across the membrane surface. Permeate is forced through the membrane and is collected in the hollow shaft and is discharged. The concentrate exits at the edge of the membrane packs.

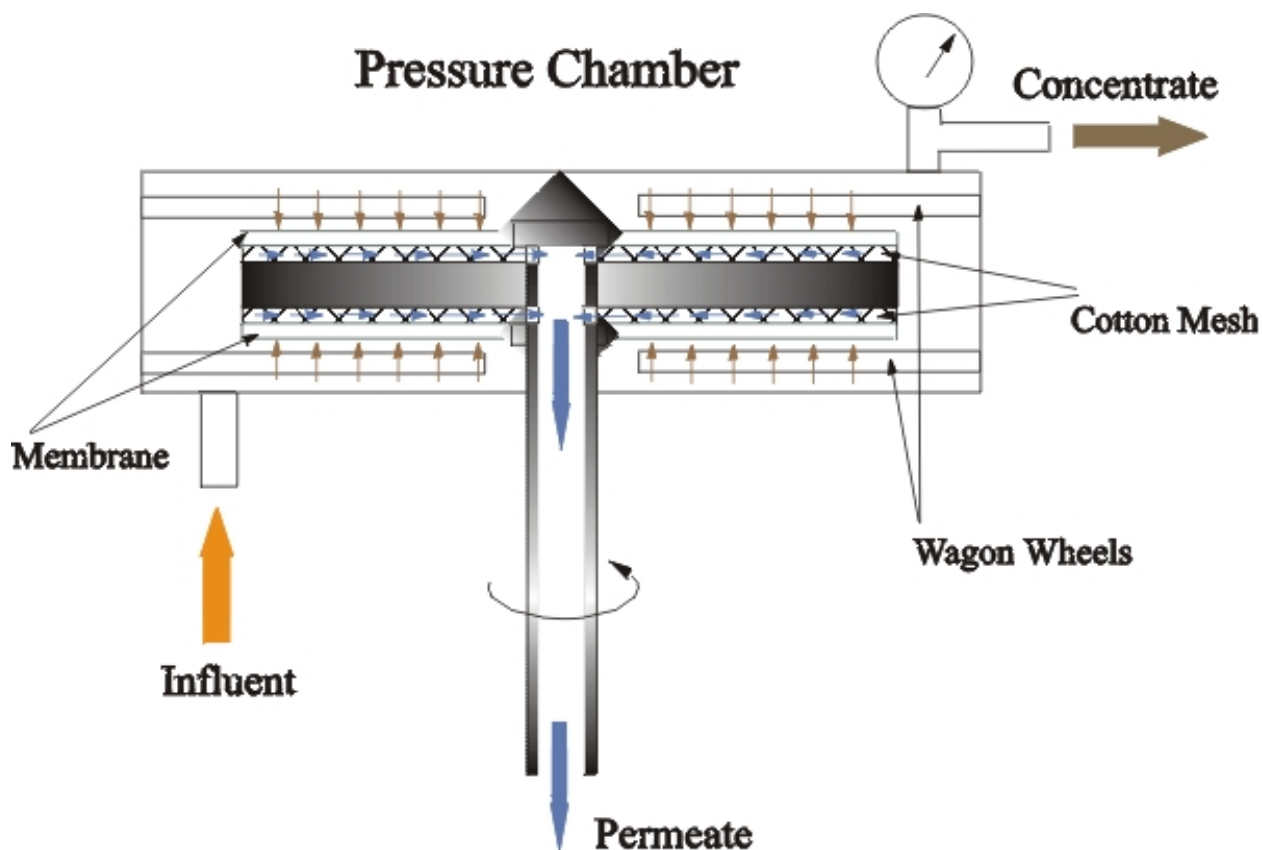


Figure 3. SpinTek ST-II High Shear Rotary Membrane Filtration System

In conventional membrane systems, the buildup of rejected material at the membrane surface ("concentration polarization") is reduced by recycling a large portion (98%) of the concentrate

back to the membrane unit so that large liquid velocities are produced near the membrane surface. The large velocities increase turbulence which reduces the thickness of the solute boundary layer.

In the SpinTek ST-II High Shear Rotary Membrane Filtration System, the rotation of the membrane disks produces the turbulence required to effectively eliminate the solute boundary layer. In addition to the rotational action, turbulence promoters ("wagon wheels") are located on each side of the membrane to prevent rotational flow (vortex formation) from occurring.

Maximum liquid velocities of about 15 feet per second (ft/s) are possible using conventional membrane systems, while the SpinTek ST-II system liquid velocities are typically 60 ft/s. As the filtrate is concentrated with treatment time, a conventional membrane system is not able to maintain the high cross-flow velocities because of the difficulty in pumping viscous material at high flow rates. The SpinTek ST-II system does not rely on pumping to produce the required liquid velocities. Therefore, extremely concentrated wastes can be treated.

Status:

SpinTek Systems, LP is a small company, formed in 1987 and located in Huntington Beach, CA that is well established in hydro-metallurgy, such as copper, nickel and zinc mining. The company was incorporated as AquaTechnology Resource Management, Inc. and formed a limited partnership with Exxon Chemical in 1991 to form SpinTek Systems, LP. Since 1994 the company has been privately held by the founders, and has focused company resources on its innovative rotating membrane technology. Research on the technology dates back to 1969, when Dresser Industries conducted tests on a Centrifugal Ultrafilter (CUF) at Stanford Research Institute. At that time, specific applications were to clean the wastewater generated by oil field operations, and provide solids separation in the pulp and paper industry. Dresser received patent rights to the CUF in 1978 and on the membrane packaging in 1985. SpinTek obtained rights to the technology from Dresser Industries in 1987. Early developmental efforts by SpinTek focused on system scale-up and working with membrane manufacturers to obtain an effective and reliable membrane material. Several prototype membrane systems were built and sold between 1988 and 1992 including a system to Lindsay Olives for processing olive brine, two systems to Westinghouse Savannah River for waste processing and a system to Westinghouse Hanford for waste processing. Current information indicates that the units sold to DOE sites were never deployed due to reprioritization of site operations activities.

Beginning in 1993, SpinTek built the new SpinTek ST-II prototype and applied for a patent for this process in August 1994. Further prototype testing, system optimization and membrane evaluations resulted in the sales of a unit to the National Research Council, Canada for new separation processes for industry and to the Province of Scandinavia Agriculture organization in 1995. SpinTek began developmental work on the ST-II prototype for DOE applications in 1995, as a subcontractor to both the Energy and Environmental Research Center in North Dakota and West Virginia University, both of which have cooperative agreements with FETC. These studies were to assess specific DOE problems and enhance the performance of the prototype. As a result

of these supporting studies, SpinTek established a working relationship with Los Alamos National Laboratory (LANL) that resulted in the sale of a ST-II unit to LANL in May, 1996. The LANL system is for the Technical Area 50 Radioactive Liquid Waste Treatment Facility. The system consists of a tubular crossflow ultrafiltration unit, a SpinTek-II centrifugal microfilter, and a reverse osmosis unit for final clarification. Dedication of the facility occurred in September 1998. Following successful operation on the non-radioactive waste stream, the system is expected to start processing radioactive liquid waste this winter. This system will be used to treat all of the radioactive liquid waste generated at the LANL through processing of legacy waste or current research activities. The SpinTek system will replace the existing LANL wastewater treatment process, which is comprised of a precipitation/ filtration setup that generates about 350 barrels of low level waste each year from the 5-8 million gallons of waste water processed. The SpinTek system will reduce this to only one barrel a year, utilizing a concentration factor of 10,000 to 1 in place of the previous 320 to 1. The relationship developed with LANL is a key to successful commercialization within the DOE market as a successful demonstration at LANL will likely lead to additional opportunities throughout the DOE complex.

SpinTek has been aggressively testing pilots in target markets. This has led to the installation of a commercial unit in 1996 at Reichold Chemicals, a latex manufacturer and RAC (Century Aluminum). It also led to additional business relationships that may result in the installation of commercial units at Englehard, a kaolin clay company. SpinTek has also been pursuing a site for testing in the produced water (oil industry) market.

SpinTek is currently under contract to FETC/OST to complete developmental studies, which have enhanced the ST-II unit design. A number of DOE sites have indicated a need and expressed a desire to utilize the SpinTek technology to solve their solid/ liquid separation problems, including Hanford, Savannah River, Oak Ridge, LLNL, INEEL, and other facilities of LANL. While SpinTek is pursuing numerous opportunities, the near term deployment appears to be at the Savannah River Site (SRS) Consolidated Incineration Facility (CIF) where there is a requirement to reduce the particulate level in the blowdown stream to make the stream acceptable for the SRS Effluent Treatment Facility. SpinTek is working with BNFL personnel at SRS to obtain the necessary design data to incorporate the ST-II unit into the CIF system.

CONCLUSIONS

As evidenced from the preceding discussions, it is a continuous challenge for private companies, especially small businesses, to understand and penetrate the DOE market with innovative technology-based solutions to mixed waste problems. In many cases these efforts are more challenging and resource intensive than technology development activities. It is extremely beneficial to DOE for private companies to pursue opportunities across the DOE sites, and to commit to commercial applications external to the DOE. Operating experience and cost saving approaches are gained, which are directly applicable to the DOE problems. The DOE, especially the Focus Area teams, have responsibilities to accurately define R&D requirements for site problems and facilitate working relationships between private companies and the appropriate end users. Private companies have demonstrated that they can offer cost-effective solutions, and are

willing to align their businesses with DOE's requirements, but internal assistance is crucial in gaining the acceptance and approval of the site decision makers. The EM Focus Area teams and OST continue to assist private companies, because successful Government-Industry partnerships are key to accomplishing the mission of the EM cleanup program.

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