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Dynamic Partnership: A New Approach to EM Technology Commercialization and Deployment

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DYNAMIC PARTNERSHIP: A NEW APPROACH TO EM TECHNOLOGY COMMERCIALIZATION AND DEPLOYMENT

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I. INTRODUCTION

The task of restoring nuclear defense complex sites under the U.S. Department of Energy (DOE) Environmental Management (EM) Program presents an unprecedented challenge to the environmental restoration community. Effective and efficient cleanup requires the timely development or modification of novel cleanup technologies applicable to radioactive wastes. Fostering the commercialization of these innovative technologies is the mission of EM-50, the EM Program Office of Science and Technology. However, efforts are often arrested at the "valley of death," the general term for barriers to demonstration, commercialization, and deployment. The Energy & Environmental Research Center (EERC), a not-for-profit, contract-supported organization focused on research, development, demonstration, and commercialization (RDD&C) of energy and environmental technologies, is in the second year of a cooperative agreement with the U.S. Department of Energy (DOE) Morgantown Energy Technology Center (METC) designed to deliver EM technologies into the commercial marketplace through a unique combination of technical support, real-world demonstration, and brokering. This paper profiles this novel approach, termed "Dynamic Partnership," and reviews the application of this concept to the ongoing commercialization and deployment of four innovative cleanup technologies.

II. DYNAMIC PARTNERSHIP: CONCEPT AND APPROACH

The "valley of death" takes many forms. For the small business technologist, commercialization prospects are hampered by limited testing and demonstration capabilities, limited capital, and, specific to the EM program, a limited knowledge of DOE and EM site needs. Successful commercialization and deployment may hinge on the successful resolution of technical issues outside the traditional focus of the technology developer. Deployment of the technology depends on scientifically sound, representative field tests coupled with knowledge of the market within the DOE complex and access to cleanup sites.

The Dynamic Partnership approach is designed to minimize commercialization barriers, particularly for the small business technologist, through an active process involving focused technical assistance, partnership brokering, and real-world demonstration. In order to realize this goal, Dynamic Partnership uses a mix of core funding from DOE and joint venture capital from the private sector to support its activities and to ensure stakeholder involvement. DOE funding of the METC–EERC EM Cooperative Agreement provides seed money for Dynamic Partnership activities. The EERC works to expand and supplement this core funding by pursuing funding under other research programs and in the private sector. The development of joint private sector–public funding partnerships is the cornerstone of this Dynamic Partnership, which brings government and private sector interests together to facilitate commercialization and ensure a private sector stake in the technology.

The Dynamic Partnership approach is used with select technologies nearing commercialization. Once the technologies have been identified, the EERC role in Dynamic Partnership includes the following:

- Partnerships are developed with small business technologists and technology vendors.

- Key technology commercialization barriers are identified, and a strategy is developed to address those barriers.

- Focused technical support is applied to resolve key technical barriers. The EERC brings to the program a wide range of technical expertise and state-of-the-art facilities for investigating chemical and physical processes. The EERC facilities are capable of testing and demonstrating technologies from laboratory to pilot scale and are suitable to conduct tests representing a wide range of physical conditions. An evaluation of the EERC core expertise with respect to EM-50 technology needs is illustrated in Table 1. Core competency is particularly strong for extraction/analysis, treatment, and separations, which translates into strengths in the crosscutting technology areas of separations and treatment. Matches for EM focus areas are particularly strong for plumes, tank wastes, and decontamination and decommissioning.

- Field testing needs are evaluated, and field test design and site access are addressed. Because of regulatory constraints and liability concerns, access to field test sites can be a formidable obstacle to the demonstration of promising EM technologies for inexperienced technology providers. The EERC's growing family of industrial partners provides the potential for access to a wide variety of technology demonstration sites. For example, the EERC has access to a remediation demonstration site in Alberta, Canada, through a relationship with the Canadian Association of Petroleum Producers, Gulf Canada, and the DOE Jointly Sponsored Research Program. Further, the EERC has an established track record for scientifically sound field test design, oversight, and evaluation.

Creating a marketable technology to address EM cleanup needs accomplishes only part of the EM-50 mission. Technologies must be successfully deployed at EM sites to justify the public and private investment. A variety of cultural, institutional, and communication barriers within the DOE complex must be addressed to achieve effective deployment. Under the Dynamic Partnership approach, the EERC works as an active partner to understand client site issues and technology needs, to support the development of the information packages required by client sites for the evaluation and deployment of innovative cleanup technologies, and to support the brokering of technology access.

III. DYNAMIC PARTNERSHIP: CURRENT APPLICATIONS

The METC–EERC Dynamic Partnership approach is currently facilitating the EM deployment of four innovative cleanup technologies: supercritical fluid extraction/Fourier transform infrared (SFE/FT-IR) analysis, thermal plastics treatment, laser surface cleaning, and centrifugal membrane filtration (see Table 2). The choice of these candidate technologies reflects the commitment to ensuring fully applicable commercial EM cleanup technologies. First, the technologies were a solid match with the needs of EM site cleanup. As illustrated in Table 1, these technologies have primary applications in the Mixed Waste, Tank Waste, and Decontamination and Decommissioning focus areas. Application potential is high in other focus areas for most of the technologies. Second, these technologies represent a solid match with the EERC's core technical strengths; that is, the EERC can provide solid technical support. As shown on Table 1, the activities fall under the Extraction/Analysis, Thermal Conversion, and Separations core strength areas. Third, the technologies either came from the private sector or were determined, based on preliminary inquiries, to have a high probability of attracting private sector partners. In other words, the technologies were judged to be marketable in the private sector. At the time of this writing, as shown in Table 2, all of the technologies have a private sector partner or private sector partnerships are pending. The candidate technologies represent a mix of private sector technologies and technologies developed at the EERC. Appropriate steps have been taken to address conflict of interest concerns.

In the following sections, the candidate technologies are profiled and the role of Dynamic Partnership in commercialization and deployment strategies is described.

A. SFE–IR/FT-IR Rapid Organics Field Screening Unit

Obtaining cost-effective, accurate, and precise analyses for organic contaminants in soils presents a major challenge to site cleanup.

Field Determining organic pollutants on soils is usually limited by extraction methods need prior to analysis. SFE is very portable, and can be used to extract samples for conventional chromatographic analysis or can be combined with IR to make an on-line extraction/detection system.

Field trials using SFE for polycyclic aromatic hydrocarbon (PAH)- and polychlorinated biphenyl (PCB)-contaminated soils showed the following: 1) complete extraction of PAHs and PCBs from field samples in 30 minutes (versus 14 to 18 hours with conventional extraction procedures), 2) SFE instruments performed well on a field generator unit, 3) total solvent use for field SFE was ca. 5 mL per sample, and 4) soil extractions were immediately ready for analysis without further cleanup or concentration.

An inexpensive simple-to-operate field instrument, consisting of SFE coupled with IR, intended for the extraction and analysis of organics at ppm detection levels, is being developed in-house at the EERC. This field method, based on SFE with CO_2, is highly accurate, rapid, and nonpolluting. The unit has applications in several EM focus areas, including Mixed Wastes, for characterization and sensing and is expected to be particularly useful as a screening tool. Through Dynamic Partnership, the EERC has provided testing facilities, technical support, support for private sector partnership development, access to field sites, field testing, and deployment support.

On-line SFE has been coupled with FT-IR detection, based on a fiber optic interface in a prototype unit. Results of field tests indicate that 1) SFE/FT-IR gives good quantitative results for petroleum-contaminated soil in 20 minutes with no organic solvent (compared to a 4-hour lab extraction with 150 mL of Freon-113), 2) detection limits were in the ppm to ppb range for organics in soils, and 3) the interface is easily adaptable to most FT-IR and IR instruments. An agreement has been reached with Suprex Corporation of Pittsburgh, a major SFE instrument company, to commercialize the fiber-optic interface. Activities in the future will focus on the optimization of the interface to meet the conditions of field testing and sustained field use. As of this writing, discussions are under way with candidate EM sites for the deployment of the field unit.

B. Thermal Treatment of Organics in Mixed Waste

The diverse nature of mixed-waste plastics has thwarted application of conventional methods for their reprocessing to yield recyclable chemical feedstocks or safely disposable materials. Because of their unique chemistry, polyethylene terephthalate (PET) and polyvinyl chloride (PVC) pose particular reprocessing challenges for plastics, and the presence of radionuclides compounds the challenge. The EERC, in partnership with the American Plastics Council, DOE, and other U.S. companies, has developed an innovative technology to thermally decompose conventional organic waste streams, including automotive shredder wastes and chemical spill residuals. This process, which utilizes a low-temperature fluidized-bed technology, is being modified to form the basis of a commercially viable recycling process able to accommodate a wide variety of mixed- waste organics from laboratory and production facilities that handle low-level nuclear materials. Through Dynamic Partnership, the EERC has provided testing facilities, technical support, support for private sector partnership development, access to EM site sample materials, and support for EM site deployment.

A variety of feedstocks and bed materials have been tested in the EERC 1-kg/hr pilot-scale continuous fluidized-bed reactor (CFBR) unit at temperatures between 480° and 600°C. Feedstocks used in the tests consisted of postconsumer plastic wastes mixed with radionuclide surrogates selected to represent the following radioactive species: thorium, uranium, plutonium, neptunium, americium, cesium, strontium, ruthenium, rhenium, and iodine.

Results from the pilot-scale tests indicate that the EERC thermal decomposition process can 1) be successfully applied to a wide variety of plastics, including PET and PVC; 2) yield a condensate product with a chlorine content of less than 100 ppm from a feedstock mixture containing up to 10% PVC; 3) concentrate radionuclide surrogates in a dry, particulate solids product; and 4) yield a condensate product with radionuclide surrogate concentrations of less than 5 ppm (the analytical detection limit used in these tests) from a feedstock mixture containing surrogate concentrations of about 3000 ppm.

The EERC has contracted with Stone & Webster Environmental Technology & Services (S&W) for assistance in technology assessment and has initiated discussions with other commercialization partners regarding technical and economic evaluation of the EERC process as a commercial treatment option. These discussions have indicated that initial commercialization efforts should be targeted at application of the process to spent (fully loaded) ion-exchange resins used to remove radionuclides from aqueous solution at nuclear power facilities. Upcoming process demonstration work will focus on tests conducted with commercial ion-exchange resin loaded (at the EERC) with saturation levels of nonradioactive cesium. Tests will also be conducted with surrogate-spiked postconsumer plastic waste containing weighed amounts of polycarbonate, Tyvec®, nylon, and acrylonitrile butadiene stryrene (ABS), which are significant components of nuclear industry laboratory waste streams. For both the resin and waste plastic tests, analytical detection limits will be lowered to 5 to 50 ppb to provide a more definitive demonstration of process performance.

C. Centrifugal Membrane Filtration

Large volumes of liquids contaminated with heavy metals and radionuclides exist at DOE and Department of Defense sites. SpinTek Systems, LP, has developed a uniquely configured centrifugal membrane filtration process to produce a clean, filtered liquid stream and a low-volume concentrate stream. Unlike conventional technologies, the technology does not require hazardous chemicals or result in secondary waste streams. Based on previous demonstrations of the SpinTek process, the unit has excellent potential for a variety of liquid streams, including tank wastes, process liquids, or contaminated groundwater, and is appropriate for a number of EM site applications, with potential application in all focus areas.

Under the Dynamic Partnership approach, the EERC is undertaking six tasks to support rapid technology deployment: 1) a literature review; 2) a preliminary verification of process capability; 3) membrane optimization; 4) a process performance evaluation on EM surrogate waste; 5) extended testing on membrane cleaning, scaling, fouling, and corrosion; and 6) preparation of a final assessment report.

At the time of this writing, Activities 1–3 have been completed. Current efforts are focused on testing and evaluation of a pilot filtration unit and discussions in support of technology deployment are under way.

D. Laser Cleaning of Contaminated Painted Surfaces

Paint contaminated with radio nuclides and other hazardous materials is common in DOE facilities. Facility decommissioning and decontamination requires the removal of contaminated paint. Paint removal technologies include laser and abrasive based systems. F2 Associates are utilizing a pulsed-repetition CO_2 laser that produces a 2.5-cm diameter beam which can be scanned across a 30- x 100-cm raster and, when placed on a robot, can be designed to clean any surface that the robot can be programmed to follow. Causing little or no damage to the substrate (concrete, steel, etc.) the laser ablates the material to be removed from a given surface, ablated material is then pulled into a filtration and collection (VAC-PAC) system to prevent the hazardous substances from entering into the atmosphere. The VAC-PAC system deposits the ablated material into 23 gallon waste drums which may be removed from the system without compromising the integrity of the seal, allowing a new drum to be set up for collection without leakage of the ablated material into the atmosphere.

Under the Dynamic Partnership approach, EERC is supporting F2 Associates development activities for their laser-based coating removal system in the areas of 1) on-line sensors for cleaning optimization, 2) the development of a surface cleaning cost model to facilitate the comparison of competing decontamination technologies, and 3) the development of an engineering handbook to facilitate design modifications for improved unit decontamination.

In the near term, activities are focused on the development of strategies for on-line sensors and preliminary work on the cost analysis model. The addition of on-line sensors is particularly noteworthy, because it provides key capabilities while resulting in significant operational cost savings. First, on-line sensors optimize the cleaning process by allowing a smaller number of iterations on the survey, clean, survey cycle typically employed in the removal of contaminated coatings from floors and walls in DOE facilities. Second, on-line sensors offer the potential for real-time, in-situ chemical analysis of coatings, including radioactive components, resulting in reduced assay costs for waste materials collected by the VAC-PAC system. Work on the design for easy decontamination handbook will take place in the second year.

IV. SUMMARY

Dynamic Partnership is a "hands-on" approach consisting of a customized program of focused technical support, partnership brokering, and field demonstrations that provides a vehicle for rapid commercialization and deployment. The EERC plays a vital role in this process through its technical expertise, state-of-the-art facilities, growing family of government and commercial partners, and access to field demonstration sites. Dynamic Partnership removes the barriers between government and the private sector and between the technologist and the client EM sites. As a result, parties in the public and private sectors can function as true partners in the commercialization and deployment process. The search for additional candidate technologies and commercial partners is ongoing.

V. ACKNOWLEDGMENTS

We wish to acknowledge Venkat Venkataraman, our METC Contracting Officer's Representative, and Madhav Ghate, Director of METC's Technology Base Projects Management Division. Key components of commercialization activities in the EM program include knowledge of the marketplace, technical expertise, and the ability to forge partnerships with industry and government.

Table 1 Matrix of EERC Core Expertise and EM Technology Needs

EERC Core Expertise	EM Focus Areas 1	2	3	4	5
Extraction/Analysis	▒	B	▒	▒	A
Cementation	▒	▒			▒
Vitrification	▒	▒			▒
Leaching Assessment	▒	▒			▒
Catalysis	▒	▒			▒
Thermal Conversions (liquefaction, pyrolysis, FBC)		C	▒	▒	▒
Plasma		▒			▒
Biotreatment	▒	▒		▒	▒
Carbon Sorbents		▒			▒
Separations	▒	▒	D	▒	▒

■ Active Program
▒ Potential Match
☐ No Current Match

1 Plume Containment and Remediation
2 Mixed-Waste Characterization, Treatment, and Disposal
3 Radioactive Tank Waste Remediation
4 Landfill Stabilization
5 Facility Stabilization, Decommissioning, and Final Disposition

A Laser Surface Cleaning
B SFE/FT-IR
C Thermal Treatment Organic Mixed Waste
D Centrifugal Membrane Filtration

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Table 2 FY96 Technology Commercialization Activities under the METC–EERC EM Cooperative Agreement

Technology	Commercial Partner	Description
Field SFE–IR/Field SFE–FT–JR Unit	Suprex Inc.	EERC technology for extraction and analysis of organic pollutants by supercritical fluid extraction (SFE) in CO_2 and infrared/Fourier transform infrared (IR/FT-IR) analysis.
Thermal Treatment of Organics in Mixed Waste	To be determined	EERC technology for thermal conversion and destruction of organic substances and separation of inorganics based on pyrolysis of mixed organic wastes and staged low-severity depolymerization, hydrolysis, and hydrogenation.
Laser Surface Cleaning	F2 Associates	Technical support for development of on-line analytical systems for trace metals; economic assessment; laser cleaning unit decontamination design.
Centrifugal Membrane Filtration	SpinTek Membrane Systems, Inc.	Technical support for optimizing separation of organics and inorganics from liquid waste streams using selective self-cleaning membranes.