

Department of Toxic Substances Control

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15 March 1999

Mr. Kim Abbott
U.S. Department of Energy
Oakland Regional Office
1301 Clay Street
Oakland, California 94612-5208

Subject: Cal/EPA - UC Berkeley Bioremediation Reference Laboratory, Report.
(Grant No. DE-FG03-96SF21196/A000)

Dear Mr. Abbott:

On behalf of this Department I like to express my appreciation of your support for the bioremediation component of Cal/EPA's environmental technology certification programs. In the following I describe our accomplishment so far and provide an outlook for the program. I also hope that DOE will continue to avail itself of the California program to assist in the successful commercialization of DOE-sponsored technologies and to facilitate regulatory acceptance of new technologies that support DOE's environmental mission.

Background

Beginning in 1994, Cal/EPA's Department of Toxic Substances Control, Water Resources Control Board, and Air Resources Board received authorization under several California statutes to certify novel environmental technologies. Certification is intended to accelerate public and regulatory acceptance and the deployment of novel technologies

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through independent verification and certification as to verified performance, reliability, and protectiveness. Cal/EPA's certification programs are coordinated by Cal/EPA's Office of Environmental Technology. Customers range from small developers to large U.S. agencies. Over 60 technologies have been certified so far.

Cal/EPA certification facilitates regulatory acceptance in the U.S. and abroad. Interstate cooperation occurs through the Six-State Memorandum of Understanding (California, New Jersey, Massachusetts, Illinois, New York, and Pennsylvania), and the Interstate Technology Regulatory Cooperation workgroup which is sponsored by DOE. In addition, a Memorandum of Agreement on mutual acceptance of technical verification testing was signed with the Government of Canada (ETV Canada). The government of the Republic of Korea is interested in obtaining similar status. In addition, the California program is associated with U.S. EPA's technology verification pilot program and the Rapid Commercialization Initiative sponsored by the U.S. Department of Commerce, DOE, and U.S. EPA.

In 1996, Cal/EPA decided on the inclusion of bioremediation technologies in the certification program, as bioremediation technologies offer considerable promise for the low-energy, low-cost treatment of major contamination problems and the control of solid, aqueous, and gaseous waste streams. Cal/EPA convened a multidisciplinary workgroup to draft acceptance criteria and process standards ("protocol") for the verification and certification of bioremediation technologies that are based on the action of microbes. This report was subject to external technical and stakeholder review and has become the Cal/EPA guidance document for bioremediation technology verifications together with a generic other sector-specific protocols. These documents are presently being published under the Cal/EPA logo. In the meantime, the bioremediation protocol has become the basis for a corresponding document by ETV Canada.

In order to include bioremediation technologies in its program, Cal/EPA was in need of a specialized laboratory that would validate the findings of other laboratories, and would make available highly specialized diagnostic tests not available in commercial laboratories. The laboratory staff would develop standard operating protocols for novel testing procedures, oversee the preparation of test plans, and provide quality oversight in verification testing.

Implementation

Establishment of Cal/EPA-UICB Bioremediation Reference Laboratory

The DOE funds were essentially used to establish the laboratory and to maintain a core function to guarantee the Laboratory's independence. As is required under California statute, laboratory efforts expended on behalf of individual technologies are paid for by the technology proponents. About \$30,900 of DOE support were applied to the state expended by the DTSC, and the project officer in managing the project and \$1,500 were applied to one trip by the project officer to a bioremediation conference, other travel to conferences by the project officer was paid for by Cal/EPA-DTSC.

The Laboratory was established under a Memorandum of Agreement with the University of California Berkeley. The decision to locate the Laboratory at Berkeley was influenced by several factors: (1) The UC system-wide biotechnology program is headquartered on the Berkeley campus. (2) UC Berkeley departments and Lawrence Berkeley National Laboratory administer a section of the inter-campus Bioremediation Education, Science and Technology (BEST) Program sponsored by DoD. (3) The Berkeley campus offers first-rate expertise in biochemical and molecular diagnostic techniques for bioremediation processes. (4) DOE's own Lawrence Berkeley National Laboratory with its Center for Environmental Biotechnology (CEB) and Bioremediation Department are located adjacent to the UC campus. (5) The UCB College of Natural Resources offered temporary space for the core laboratory facility.

The agreement with the University continued through 30 September 1998 on the basis of the present grant. It has been extended till 30 November 1999 on redirected DOE funds granted to Cal/EPA's Department of Toxic Substances Control for participation in the Rapid Commercialization Initiative.

Physical Plant and Personnel

The physical laboratory is housed on the third floor of Hilgard Hall in laboratory and office space of the University's College of Natural Resources, Department of Plant Biology. Professor Bob B. Buchanan has been the Principal Investigator for the Project. A management team of one representative each from Cal/EPA, UCB, and LBNL was formed. The management team established the Laboratory and hired a most competent and quality assurance-oriented PhD-level microbiologist (Dr. Keun-Chan Oh, associate scientist) and one assistant scientist (temporary appointment, now replaced by student assistants as needed). The members of the management team are Dr. G. Wolfgang Fuhs for Cal/EPA, Professor Terry Leighton, Director of BEST for UCB, and Dr. Jennie C. Hunter-Cevera, Director of CEB for LBNL.

Beginning in March 1999, the Laboratory's quarters will be affected by seismic retrofitting of Hilgard Hall and adjacent buildings. After discussions with UC and LBNL, it was decided that the Laboratory would relocate to suitable quarters at LBNL, with a permanent location still to be decided.

Testing Methods

It was decided that the Reference Laboratory would act as the core and quality assurance laboratory for the project. As such, the laboratory would not necessarily carry out the specialized, highly instrumented techniques available on the UC Campus or at LBNL, unless these techniques would be carried out frequently enough to warrant dedicated equipment.

In-house capability would, at a minimum, consist of:

- (1) Experimental and testing design for technology verification;
- (2) Sample taking, accessioning, and pre-treatment prior to analysis;
- (3) Carrying out bench-scale verifications;

(4) Microbial biomass determination by a variety of techniques including signature compounds, but not including the preparation of molecular probes (available at UCB) and signature fatty acid analysis (available at LBNL);

(5) Microbial physiologic spectrum analysis with the BIOLOG system.

(6) Pollutant and metabolic product and inhibitor reference analytical techniques (COD, soil gas analysis, gas chromatography, atomic absorption spectrometry).

(7) Respirometry for rapid screening of degradation and mineralization in bench-scale and field systems.

Over the grant period, these capabilities have been established. Procedures were documented in a system of Standard Operating Procedures.

The Associate Scientist directly assists the Cal/EPA Project Officer in the scientific evaluation of testing data and other information submitted by proponents.

Projects

Under California statute, the costs of actual verification efforts are to be borne by technology proponents. Consequently, it has been the priority for the Management Team to publicize the availability of the Cal/EPA program for bioremediation technologies, to identify technologies that offer high potential for successful verification ("benchmark technologies"), and to identify proponents who are able to pay the cost of verification. By special agreement with USEPA, proponents that have Small Business Innovative Research (SBR) Phase-II support may apply part of this support to California Certification.

The Management Team elected a DOE-sponsored technology for enhanced in-situ degradation of trichloroethylene using gaseous co-substrate and nutrients. The technology was developed at the DOE/Westinghouse Savannah River facility. It appears well enough documented to be certified by Cal/EPA without additional field testing. Cal/EPA expects to conclude its evaluation by Mid-1999.

Earlier the Management Team examined five other applications for certification but found three wanting in merit or not ready for commercialization (a program requirement). The team was interested in accepting two technologies into the program. The first technology has been in commercial use for some time. The company felt that they were successfully marketing the technology without having to comb their archives for supporting data. They expressed, however, strong interest in bringing another technology for certification that is now being patented. The proponent of the other technology, a bioaugmentation product, has not yet entered into a contract with Cal/EPA and has not presented data that would make certification likely.

New Technology Sector-Specific Protocols

Over the past months we have received a flurry of new inquiries by companies that distribute bioactive absorbents and bioaugmentation products. For greater efficiency and to create a level playing field, in such a situation the program develops sector-specific acceptance criteria and process guidance ("protocol"). A protocol for these products is now in draft form and is undergoing internal and external review. As soon as the testing

protocol is in place and the cost of the testing established, we will discuss specific performance claims with the companies and negotiate contracts.

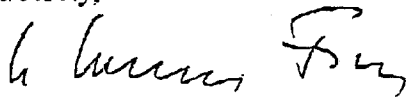
Great interest was also expressed by the biofilter industry which presently comprises about 24 companies, 20 of them located in California. Recently, biofilters have been the subject of research and successful pilot installations to treat gaseous emissions in a number of industries. To date, the most promising applications of biofilters are vapors containing unchlorinated solvents (alcohols, ketones, light hydrocarbons), mercaptans, and hydrogen sulfide. Other applications are still being investigated to improve process controls. After two meetings with researchers and developers in the field it was decided to convene a multi-disciplinary work group for the formulation of a technology-specific protocol (acceptance criteria and process guidance) for biofilters. An outline for discussion is being drafted. Beginning in spring 1999, meetings will be held to produce a protocol for external and stakeholder review. Cal/EPA certifications for biofilters would be issued jointly by DTSC and the California Air Resources Board.

Marketing

Cal/EPA needs to undertake a broad marketing effort to recruit promising technologies into the program. The capitalization of small bioremediation firms is often low, especially at the point of commercialization. The bioremediation program was highlighted in an issue of BIO, newsletter of the Biotechnology Industry Organization, and in a presentation to the Society for Industrial Microbiology at Notre Dame University in Spring 1998. The ongoing evaluation of a major DOE technology (which was actively solicited by the program) is expected to bring other DOE technologies to the program. DTSC has met with stakeholders to discuss various issues important to the program. A focus group is to meet in May 1999 to discuss alternative funding concepts. In addition, the marketing effort on behalf of the bioremediation component of the program is supported by the program's coordinating office (Cal/EPA's Office of Environmental Technology, Sacramento).

In the past two weeks I have worked with the UC and DTSC business units to close out the present grant and to transition the project to DOE-RCI funding. You should hear from the DTSC business office shortly. Again, thank you for your support. Please feel free to contact me by telephone or e-mail (wfuhs@dtsc.ca.gov or gwfuhs@aol.com). My normal office hours are in Berkeley on Mondays and Tuesdays, in Sacramento on most Wednesdays and on Thursdays and Fridays. You may call me in Berkeley at (510) 540-3076, in Sacramento at (916) 445-2928.

Sincerely,



G. Wolfgang Fuhs, Dr. sci. nat.
Manager, Technology Evaluation,
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