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Proof of Principle (POP) for Using Electron Beam to Destroy Contaminants in Samples from a Test Superfund Site (PAGs, PCBs, Dioxins and Furans)

Cooperative Research and Development Agreement Final Report

CRADA Number: FRA 2019-0027

Fermilab Technical Contact: Charles Cooper

Summary Report
20 October 2021

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In accordance with Requirements set forth in Article X of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

CRADA number: FRA 2019-0027

CRADA Title: Proof of Principle (POP) for Using Electron Beam to Destroy Contaminants in Samples from a Test Superfund Site (PAHs, PCBs, Dioxins and Furans)

Parties to the Agreement: Anchor QEA, LLC and Fermi Research Alliance, LLC

Sponsoring DOE Program Office(s): Office of Science, High Energy Physics

DOE Funding Commitment Table:

	Year 1		
Funding Type	Funds-in	In-kind	Totals
Dept. of Energy	\$7,194.48		\$7,194.48
Totals	\$7,194.48		\$7,194.48
Grand Totals	\$7,194.48		\$7,194.48

Abstract of CRADA work:

Fermi Research Alliance, LLC (FRA) operates Fermilab under contract with the U.S. Department of Energy and has patents on technologies and applications of a novel mobile electron beam accelerator. A high-power version of this mobile accelerator based on FRA-developed SRF technology is under development at IARC and can enable several new applications that have significant commercial potential. One such application is the e-beam treatment of contaminated sediment sites. The contaminants of concern are a variety of organic chemicals, including dioxins, furans, polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Anchor QEA is interested in determining if electron beam (e-beam) technology can be used to cost effectively destroy contaminants for three specific remediation projects. The goal of this study is to do proof-of-principle (POP) work to evaluate the cost-effectiveness of e-beam treatment in removal of contaminants of concern. The study will be conducted using the Accelerator Applications Development and Demonstration (A2D2) machine at Fermilab's IARC.

Summary of Research Results:

Close out report for a collaboration between Anchor QEA and Fermilab to do Proof of Principle (POP) studies on using electron beam to destroy contaminants in samples from the Passaic River (dioxins, furans), Casco Bay (PAHs, PCBs) and the Duwamish River Superfund Site (PAHs, PCBs) in Seattle. All or most all of these contaminants and types of contaminants have been demonstrated to be broken down by electron beam before.

Anchor QEA provides a full spectrum of environmental planning and restoration services. They offer environmentally sensitive solutions for design and construction that incorporate habitat restoration and public access. Anchor QEA was interested in determining if electron beam (e-beam) technology can be used to cost effectively destroy contaminants for three specific remediation projects. The idea is that if soil and sludge from the banks and bottom of these water ways can be removed, treated nearly in place, and put back where they came from large transportation and fill replacement costs can be avoided. Also, the worries of secondary contamination from transportation of large volumes of contaminated materials will be eliminated.

Fermi National Accelerator Lab (Fermilab) is a world-renowned expert in accelerator technology and has facilities to do proof of principle work to explore if e-beam technology can be used for remediating these contaminants of concern. The main driver for finding the cost needed to remediate these different sites via e-beam is the total dose needed to decompose the contaminants. Fermilab received samples and treated them using IARC's demonstration e-beam accelerator (Accelerator Applications Development and Demonstration – A2D2) with various dose rates and total doses in order to determine the total dose needed to meet environmental regulations. Anchor QEA provided the samples with the expected contaminants and their concentration and performed the post-treatment analysis of the samples to determine the effectiveness of e-beam at removing the contaminants.

Anchor QEA specified the sample treatment plan.

Sample #	Dose, kGy	% Solids	Notes
0	0	25	
1	0	25	
2	10	25	
3	20	25	
4	20	25	N2 Purge
5	20	50	
6	50	25	
7	50	50	
8	100	25	
9	200	25	
10	200	25	N2 Purge

After Fermilab received, treated and returned the samples, Anchor QEA analyzed the samples to find the degree of degradation of the contaminants from e-beam.

The results were inconclusive and Anchor QEA decided not to continue with any additional analytical work. Analytical results showed no significant breakdown of any contaminant and even showed that the concentration of some of the contaminants had increased. Given that some of the contaminants are known to break down at low doses, it was confirmed that the doses were being delivered accordingly and that the analytical results were difficult to understand. As Anchor QEA did not want to pursue the work after the first batch of 10 samples, no useful conclusions could be pulled from the work.

Related Reports, Publications, and Presentations:

None

Subject Inventions listing:

None

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