Department of Energy
Office of Science
Fermi Site Office
Post Office Box 2000
Batavia, Illinois 60510

October 24, 2024

Mr. Marc Clay
Interim Chief Safety Officer
Fermilab
P.O. Box 500
Batavia, IL 60510

SUBJECT: NATIONAL ENVIRONMENTAL POLICY ACT DETERMINATION AT FERMI NATIONAL ACCELERATOR LABORATORY IMPROVED PAVEMENT PROCESSES USING COMPACT SUPERCONDUCTING RADIOFREQUENCY ELECTRON ACCELERATORS

Reference: Memorandum from M. Clay to R. Hersemann; Subject: National Environmental Policy Act Environmental Evaluation Notification Form for Improved Pavement Processes Using Compact Superconducting Radiofrequency Electron Accelerators; Dated: October 17, 2024,

Dear Mr. Clay:

The Fermi Site Office (FSO) has reviewed the National Environmental Policy Act (NEPA) Environmental Evaluation Notification Form (EENF) for Improved Pavement Processes Using Compact Superconducting Radiofrequency Electron Accelerators. Based on the information provided in the EENF, the following categorical exclusion (CX) is approved.

Project Name	Approved	CX
Improved Pavement Processes Using Compact Superconducting Radiofrequency Electron Accelerators	10/22/2024	B3.6, B3.10

Enclosed is a signed copy of the EENF for your records. No further NEPA review is required. This project falls under categorical exclusions provided in 40 *CFR* 1021, as amended in November 2011.

If you have any questions, please contact Rick Hersemann, of my staff, at (630) 840-4122 or by email at rick.hersemann@science.doe.gov.

Sincerely,
ROGER SNYDER
Digitally signed by ROGER SNYDER
Date: 2024.10.24 09:49:32 -05'00'
Roger E. Snyder
Manager, Fermi Site Office

Enclosure: As Stated

Cc:
J. Sawyer, FRA
M. Michels, FRA
L. Huntoon, FRA
S. Panock, FRA
R. Hersemann, DOE-FSO
J. Scott, DOE-FSO
S. Wallace, DOE-FSO

FERMILAB ENVIRONMENTAL EVALUATION NOTIFICATION FORM (EENF) for documenting compliance with the National Environmental Policy Act (NEPA), Department of Energy (DOE) NEPA Implementing Regulations, and the DOE NEPA Compliance Program of DOE Policy 451.1

Project/Activity Title: Improved Pavement Processes Using Compact Superconducting Radiofrequency Electron Accelerators
ES&H Tracking Number: 2024-0074

I hereby verify, via my signature, the accuracy of information in the area of my contribution for this document and that every effort would be made throughout this action to comply with the commitments made in this document and to pursue cost-effective pollution prevention opportunities. Pollution prevention (source reduction and other practices that eliminate or reduce the creation of pollutants) is recognized as a good business practice which would enhance site operations thereby enabling Fermilab to accomplish its mission, achieve environmental compliance, reduce risks to health and the environment, and prevent or minimize future Department of Energy (DOE) legacy wastes.

Fermilab Action Owner: Jayakar C. Thangaraj
Signature and Date Jayakar Digitally signed by Jayakar Date: 2024.10.17 15:37:54 -05'00'

I. Description of the Proposed Action and Need

Purpose and Need: The purpose for this proposed experiment is for the United States Army Engineer Research and Development Center (ERDC) project team and Fermi National Accelerator Laboratory (Fermilab) in Batavia, IL, to design, build, and operate a radiation generating device (RGD) that meets the requirements specified by the ERDC material science program. Based on initial investigation, the use of 9.8 MeV electron energy appears to be an appropriate compromise between penetration depth, equipment size, and shielding requirements. Therefore, the experiment aims to build a 9.8 MeV, 20 kW electron beam RGD based on superconducting radiofrequency technology. The need for this experiment is to fulfill the scientific mission of the ERDC material science program and ultimately contribute to the overall scientific mission of Fermilab.

Proposed Action:
The project team will collaborate with Fermilab experts and experienced industry partners to integrate the RGD system into the trailer and prepare for a 9.8MeV transportable electron beam RGD. The process will be continuously evaluated with respect to testing results and aligned accordingly.

The scope of work for this project may include the following:

- A custom truck manufacturer designed a custom trailer to handle the constraints needed for the e-beam system (weight, access, etc.). The RGD will be integrated, but not operated in a trailer matching these specifications.
- The preliminary design and analysis of the beam delivery system are currently being developed for pavement treatment via an industry partner. The project team will procure the beam delivery system components, including the scan horn, beamline elements, and beam instrumentation.
- The project team will install the RGD, peripherals, and equipment into the custom trailer. This will include installing necessary infrastructure (power systems, cooling, etc.), the RGD itself, and peripheral equipment such as cryocoolers and solid-state amplifiers.

Alternatives Considered:
The "do nothing" alternative would prohibit the ERDC project team from achieving the mission of the ERDC material science program and would result in breach of our commitments to the US Army Corps of Engineers (we are committed to delivering on this project via interagency agreements).

II. Description of the Affected Environment

Meson Detector Building and Heavy Assembly Building

III. Potential Environmental Effects (If the answer to the questions below is "yes", provide comments for each checked item and where clarification is necessary.)

A. Sensitive Resources: Would the proposed action result in changes and/or disturbances to any of the following resources?

- ☐ Threatened or endangered species
- ☐ Other protected species
- ☐ Wetland/Floodplains
- ☐ Archaeological or historical resources
- ☐ Non-attainment areas

B. Regulated Substances/Activities: Would the proposed action involve any of the following regulated substances or activities?

- ☐ Clearing or Excavation
- ☐ Demolition or decommissioning
- ☐ Asbestos removal
- ☐ PCBs
- ☐ Chemical use or storage
- ☐ Pesticides
- ☒ Air emissions
- ☐ Liquid effluents
- ☐ Underground storage tanks
- ☒ Hazardous or other regulated waste (including radioactive or mixed)
- ☒ Radioactive exposures or radioactive emissions
- ☐ Radioactivation of soil or groundwater

C. Other Relevant Disclosures: Would the proposed action involve any of the following actions/disclosures?

- ☐ Threatened violation of ES&H permit requirements
- ☐ Siting/construction/major modification of waste recovery or TSD facilities
- ☐ Disturbance of pre-existing contamination
- ☐ New or modified permits
- ☐ Public controversy
- ☒ Action/involvement of another federal agency
- ☐ Public utilities/services
- ☐ Depletion of a non-renewable resource

IV. Comments on checked items in section III.

Air Emissions

Cryocoolers containing refrigerants will be used. Accidental release/fugitive emission of refrigerants (gaseous helium) will be reported to the Fermilab Environmental Programs Department (EPD). Mobile power supply may be utilized.

Hazardous or Other Regulated Waste

Equipment exposed to beam may become impacted and/or hazardous. Disposal of any waste will be coordinated with Fermilab Hazard Control Technology Team (HCTT).

Radioactive Exposures or Radioactive Emissions
The Fermilab Radiation Safety team will be consulted during commission, operation, and decommissioning of the experiment to evaluate for potential exposure and ensure worker and environmental safety.

Action/involvement of another federal agency
This project is a collaboration between Fermilab and the United States Army Engineer Research and Development Center (ERDC) project team.

V. NEPA Recommendation

Fermilab staff has evaluated the proposed action and believe that several Categorical Exclusions apply. It is believed that the proposed action meets the description found in DOE's NEPA Implementation Procedures, 10 CFR 1021, Subpart D, as follows:

B 3.6 Small Scale Research and Development
Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment.

B 3.10 Particle Accelerators
Siting, construction, modification, operation, and decommissioning of particle accelerators, including electron beam accelerators, with primary beam energy less than approximately 100 million electron volts (MeV) and average beam power less than approximately 250 kilowatts (kW), and associated beamlines, storage rings, colliders, and detectors, for research and medical purposes (such as proton therapy), and isotope production, within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible), or internal modification of any accelerator facility regardless of energy, that does not increase primary beam energy or current.

Fermilab NEPA Program Manager: Samantha Panock Samantha Panock Digitally signed by Samantha Panock Date: 2024.10.17 14:44:51 -05'00'
Signature and Date

VI. DOE/Fermi Site Office (FSO) NEPA Review

Based upon my review of information conveyed to me and in my possession concerning the proposed action, as NEPA Compliance Officer (as authorized under DOE Policy 451.1), I have determined that the proposed action fits within the specified class of actions, the other regulatory requirements set forth above are met, and the proposed action is hereby categorically excluded from further NEPA review.

FSO NEPA Compliance Officer: Rick Hersemann RICK HERSEMANN Digitally signed by RICK HERSEMANN Date: 2024.10.22 10:07:59 -05'00'
Signature and Date

VII. Diagrams

ERDC Statement of Work

Fermi National Accelerator Laboratory

Fermilab

Improved Pavement Processes Using Compact Superconducting Radio-Frequency (SRF) Electron Accelerators

Statement of Work – Phase 4
May 2024

IARC @ Fermilab Project Team

U.S. DEPARTMENT OF ENERGY | Office of Science

Managed by Fermi Research Alliance, LLC for the U.S. Department of Energy Office of Science

www.fnal.gov

Project Objective

The project team will collaborate with FNAL experts and experienced industry partners to integrate the accelerator's system into the trailer and prepare for a transportable electron beam accelerator. The process will be continuously evaluated with respect to testing results and aligned accordingly.

Background and Context

The Fermilab technology development project aims to design, build, and operate an electron accelerator that meets the requirements specified by the ERDC material science program. Based on initial investigation, 10 MeV electron energy appears to be an appropriate compromise between penetration depth, equipment size, and shielding requirements. Therefore, we aim to build a 10 MeV, 20 kW electron beam accelerator for ERDC based on superconducting radio-frequency technology.

Statement of Work

Using the previous phases of ERDC funds, we are working on the assembly and will commission and operate a 10 MeV accelerator at Fermilab.

This Phase IV advances our work and moves the prototype to a mobile system. We do this by procuring a custom trailer, fabricating a beam delivery system, and integrating the accelerator into the mobile platform.

Trailer

As part of Phase III of this project, a custom truck manufacturer designed a custom trailer to handle the constraints needed for the e-beam system (weight, access, etc.). The accelerator system will be housed in a trailer matching these specifications.

Stage IV of work involves the following:

- Reach out to trailer fabricators to communicate specifications and order requirements.
- Procure a trailer from a US-based vendor and perform an initial inspection.
- Perform any modifications to the trailer body as required.

Beam Delivery System

The preliminary design and analysis of the beam delivery system are currently being developed for pavement treatment via an industry partner. In phase 4, the project team will procure the beam delivery system components, including the scan horn, beamline elements, and beam instrumentation. We are collaborating with experienced industrial partners to deliver the system. This stage of work involves the following:

- Final review of beam delivery system to ensure beam accuracy and effectiveness.
- Integrate necessary instrumentation to monitor and control the beam parameters.
- Fabrication of a scan horn to distribute the electron beam uniformly over the target pavement area.

Integration of Accelerator

The project team will integrate the accelerator, peripherals, and equipment into the custom trailer. This will include installing necessary infrastructure (power systems, cooling, etc.), the accelerator itself, and peripheral equipment such as cryocoolers and solid-state amplifiers.

- Develop an integration plan detailing the layout and connections of all systems within the trailer.
- Install the vibration dampening system.
- Install radiation shielding.
- Assemble and install the beam delivery system.
- Integrate all electrical and control systems.
- Conduct comprehensive system tests to validate the integration.

Yearly Breakdown of SOW

Year 1

The project team will initiate the procurement process for the trailer promptly to ensure its timely arrival within the designated performance period. This will allow the necessary equipment to be integrated into the trailer without delay, ensuring seamless progress in project activities.

Additionally, the beam delivery system will undergo a comprehensive final review. This review will incorporate findings from sample testing and relevant design considerations, ensuring the system meets all required specifications and performance standards.

The project plan also includes the following key activities: conducting irradiations of new potential formulations, operating, and maintaining the A2D2 system, and performing administrative tasks associated with its operation. Furthermore, the project team will perform dosimetry and experimental work to support the testing of bitumen samples, ensuring accurate and reliable data collection and analysis.

Year 2

The project team will continue to work closely with the trailer fabricator to ensure that the trailer is specifically designed and constructed to meet the requirements of the pavement application. During this period, the fabrication process is expected to advance towards its final stages of

completion. Ensuring the trailer's suitability for its intended use is critical, and any necessary adjustments will be coordinated with the fabricator.

The procurement process for the beam delivery system will be initiated. This includes identifying and selecting a qualified vendor to meet the project's stringent specifications. After the selection, the beamline elements and scan horn will be fabricated. This phase marks significant progress in the development of the beam delivery system, ensuring that all components are manufactured to the highest standards.

The project plan also includes the following key activities: conducting irradiations of new potential formulations, operating, and maintaining the A2D2 system, and performing administrative tasks associated with its operation. Furthermore, the project team will perform dosimetry and experimental work to support the testing of bitumen samples, ensuring accurate and reliable data collection and analysis.

Year 3

During this phase, the project team will prepare to integrate the beam delivery system into the trailer.

Once the trailer's fabrication is completed, the project team will start making necessary modifications. These modifications include structural reinforcements, material removal, and other essential adjustments to prepare the trailer for its intended use. In addition, the team will install critical infrastructure components such as power systems and cooling lines to ensure the trailer is fully operational. We anticipate receiving equipment like vibration-dampening systems and shielding, which will be installed. By this time, the fabrication of the beam delivery system should be complete and will be prepared for integration. This preparation involves ensuring all components are ready for seamless installation and that the trailer infrastructure can support the beam delivery system.

Year 4

Working with ERDC, the project team will integrate the beam delivery system, accelerator, and peripheral equipment into the trailer and conduct system tests to validate the successful integration.

Deliverables

An annual report documenting technical achievements and financial status will be provided to the ERDC by 31 OCT annually during the period of performance.

Budget

DOE National Laboratory Announcement
Proposal Title

Budget Period Start Date	10/1/2024
Budget Period End Date	9/30/2028

Principal Investigator: Jayakar Thangaraj

	Year 1 Hours	Year 1 Cost	Year 2 Hours	Year 2 Cost	Year 3 Hours	Year 3 Cost	Year 4 Hours	Year 4 Cost	Total Project Hours	Total Project Cost
Labor			Escalation:	3.8%	Escalation:	3.8%	Escalation:	3.8%		
Bitumen Analysis	375.0	$ 59,852.80	375.0	$ 62,127.21	-	$ -	-	$ -	750.0	$ 121,980.01
Systems Engineering	375.0	$ 35,601.07	375.0	$ 36,953.90	300.0	$ 30,686.53	300.0	$ 31,852.61	1,350.0	$ 135,094.11
Mechanical Engineering	275.0	$ 26,107.45	225.0	$ 22,172.34	225.0	$ 23,014.90	225.0	$ 23,889.46	950.0	$ 95,184.15
Assembly/Fabrication	275.0	$ 21,288.96	225.0	$ 18,080.13	450.0	$ 37,534.36	475.0	$ 41,125.15	1,425.0	$ 118,028.60
Radiation Shielding/Beamline	350.0	$ 22,857.95	300.0	$ 20,337.06	225.0	$ 15,832.40	275.0	$ 20,086.03	1,150.0	$ 79,113.44
Radiation Chemistry	250.0	$ 19,871.28	250.0	$ 20,626.40	-	$ -	-	$ -	500.0	$ 40,497.68
Project Management/Accelerator Physics	200.0	$ 26,314.53	200.0	$ 27,314.48	200.0	$ 28,352.43	200.0	$ 29,429.82	800.0	$ 111,411.26
Total Salary, Wages and Fringe Benefits	**2,100.0**	**$ 211,894.04**	**1,950.0**	**$ 207,611.52**	**1,400.0**	**$ 135,420.62**	**1,475.0**	**$ 146,383.07**	**6,925.0**	**$ 701,309.25**
Materials and Supplies (M&S)										
Applications Testing Materials		$ -		$ 180,000.00		$ -		$ -		$ 180,000.00
Beam Delivery System Fabrication		$ -		$ -		$ -		$ 885,000.00		$ 885,000.00
Mobile Shielding		$ -		$ -		$ 50,000.00		$ -		$ 50,000.00
Trailer Fabrication		$ -		$ -		$ 100,000.00		$ -		$ 100,000.00
Project Contingency		$ 590,577.16		$ -		$ -		$ -		$ 590,577.16
Travel Costs (Vendor Visits, Conferences, Etc.)		$ 7,500.00		$ 7,500.00		$ 7,500.00		$ 7,500.00		$ 30,000.00
Total Direct Costs (Labor + M&S)		**$ 809,971.20**		**$ 395,111.52**		**$ 292,920.62**		**$ 1,038,883.07**		**$ 2,536,886.41**
Other Indirect Costs (Overhead)		**$ 236,192.57**		**$ 242,696.45**		**$ 160,509.16**		**$ 218,715.41**		**$ 858,113.59**
Total Direct and Indirect Costs		**$ 1,046,163.77**		**$ 637,807.97**		**$ 453,429.78**		**$ 1,257,598.48**		**$ 3,395,000.00**
DOE Administrative Fee (3% of Total Funding)		$ 105,000.00								$ 105,000.00
Total Direct + Indirect Costs + Admin Fee	**2,100.0**	**$ 1,151,163.77**	**1,950.0**	**$ 637,807.97**	**1,400.0**	**$ 453,429.78**	**1,475.0**	**$ 1,257,598.48**	**6,925.0**	**$ 3,500,000.00**

Point of Contact

The technical contact is the person responsible for the technical planning and execution of the work with the project manager. The business contact is the person who will be responsible for reviewing and approving the legal terms and conditions, negotiating intellectual property provisions, and signing the agreement. Reporting requirements include bi-weekly meetings and quarterly face-to-face and an annual written status report on a need-by basis.

For Fermilab:

	Technical Contact (Principal Investigator)	**Business Contact**
Contact name	Jayakar Charles Thangaraj	Mauricio Suarez
Street address	MS 312, Fermilab	MS 312, Fermilab
City, State, Zip	Batavia, IL 60510	Batavia, IL 60510
PO Box	500	500
Phone	630 840 3135	630 840 6947
Email	jtobin@fnal.gov	suarez@fnal.gov

For ERDC:

	Technical Contact (Principal Investigator)	**Business Contact**
Contact name	Click here to enter text.	Click here to enter text.
Phone	Click here to enter text.	Click here to enter text.
Email	Click here to enter text.	Click here to enter text.