



**Environmental Review Form for Argonne
National Laboratory**

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| Form: | ANL-985 |
| Version: | 5 |
| Your Form ID: | ANL-985-1753 |
| Form Status: | Approved |
| Date: | 4/20/2022 4:28:40 PM |
| Created By: | Woodford, John B. |

Creator

| | | | |
|--------------|----------------------------|----------------|---------------------------------|
| Badge: | 51790 | Name: | Woodford, John B. |
| Cost Center: | 254 | Division: | ESH |
| Job Title: | Safety Specialist 5 | Employee Type: | Regular Full-Time Exempt |
| Building: | 208 | Lab Extension: | 2-0910 |

General Information

Project/Activity Title: A Zero-Emission Process for Direct Reduction of Iron by Hydrogen Plasma in a Rotary Kiln Reactor

ASO NEPA Tracking No.: _____ Type of Funding: ARPA-E

B & R Code: CJ0100000 Identifying Number: CJ0100000

SPP Proposal Number: _____ CRADA Proposal Number: _____

Work Project Number: _____ ANL Accounting Number: _____ (Item 3a in Field Work Proposal)

Other (explain): Project Code PRJ1010168

List appropriate NEPA Owners:

Division: NSE NEPA Owner: _____

Financial Plans

To select a Financial Plan, click the magnifying glass icon to open a search window.

Cost Center: Project: Phase: Task:

Description of Proposed Action

This project is intended to demonstrate a continuous hydrogen plasma process for reducing iron ore to iron. It would be conducted in two parts: in the first part, a hydrogen plasma nozzle, using radiofrequency (RF) between 20 kHz and 13.6 MHz to generate the plasma, would be designed and tested with small amounts (<1.5 kg) of iron ore. Once the plasma nozzle had been tested and optimized, the second part would consist of construction and testing of a rotary kiln reactor. In this design, granulated/powdered iron ore would be fed in from the top of the slanted (slant angle <20°) rotary kiln, while hydrogen gas is fed in from the bottom of the kiln. Hydrogen plasma jets would impinge on the iron ore as it slid down the rotating kiln body, reducing the iron oxide to iron metal and releasing water vapor. Iron metal sponge would exit the kiln from the bottom, while excess hydrogen and water vapor would exit from the top. The exhaust gas stream would pass through a condenser to remove water vapor for later measurement, while the remaining hydrogen would be routed to building exhaust. It is possible that nitrogen or argon would be used as a sweep gas in the exhaust stream, to ensure that the concentration of hydrogen in air did not exceed the lower explosive limit at any point. The target production rate for the rotary kiln apparatus is 1 kg iron metal per hour, over 1-2 hours. This would require up to 3.5-4 kg iron ore as feedstock, which exceeds the bench-scale weight limit. In addition to the iron ore, the rotary kiln would require 17 L hydrogen gas per minute, exhausting up to 7 L per minute. The rotary kiln would be 3.5 meters in length.

Description of Affected Environment

The research work is proposed to take place in Room G-275 in Bldg. 212. A survey by Argonne subject matter experts in fire protection, industrial hygiene, and nonionizing radiation (RF), as well as Infrastructure Services HVAC engineers have evaluated the room for suitability and have found that it has adequate power and ventilation, and the RF field should not interfere with work in the surrounding laboratories.

Potential Environmental Effects

- Attach explanation for each "yes" response near bottom of form.
- See Instructions for Completing Environmental Review Form.

| Section A (Complete For All Projects) | | Yes | No | Explanation |
|---------------------------------------|---|----------------------------------|----------------------------------|---|
| 1. | Project evaluated for Pollution Prevention and Waste Minimization opportunities and details provided under items 2, 4, 6, 7, 8, 16, and 20 below, as applicable | <input checked="" type="radio"/> | <input type="radio"/> | The only emission from the rotary kiln should be excess hydrogen. |
| 2. | Air Pollutant Emissions | <input checked="" type="radio"/> | <input type="radio"/> | Impurities in the iron ore may react with hydrogen to form toxic materials--primarily hydrogen sulfide from sulfur compounds in the ore. The production rate of hydrogen sulfide is expected to be below EPA limits. Although the production of phosphine (PH ₃) from iron phosphide is not thermodynamically favored (equilibrium coefficient of 1.4E-08 at 1000°C), Argonne Industrial Hygiene would survey for it. |
| 3. | Noise | <input type="radio"/> | <input checked="" type="radio"/> | |
| 4. | Chemical/Oil Storage/Use | <input checked="" type="radio"/> | <input type="radio"/> | Hydrogen gas and iron ore would be used as feed materials, and argon or nitrogen may be used as a sweep gas in the exhaust. |
| 5. | Pesticide Use | <input type="radio"/> | <input checked="" type="radio"/> | |
| 6. | Toxic Substances Control Act (TSCA) Substances | | | |
| 6a. | Polychlorinated Biphenyls (PCBs) | <input type="radio"/> | <input checked="" type="radio"/> | |
| 6b. | Asbestos or Asbestos Containing Materials | <input type="radio"/> | <input checked="" type="radio"/> | |
| 6c. | Other TSCA Regulated Substances | <input type="radio"/> | <input checked="" type="radio"/> | |
| 6d. | Import or Export of Chemical Substances | <input type="radio"/> | <input checked="" type="radio"/> | |
| 7. | Biohazards | <input type="radio"/> | <input checked="" type="radio"/> | |
| 8. | Effluent/Wastewater (If yes, see question #12 and contact Peter Lynch (HSE) at 2-4582 or lynch@anl.gov) | <input type="radio"/> | <input checked="" type="radio"/> | |
| 9. | Waste Management | | | |
| 9a. | Construction or Demolition Waste | <input type="radio"/> | <input checked="" type="radio"/> | |
| 9b. | Hazardous Waste | <input checked="" type="radio"/> | <input type="radio"/> | If necessary, the exhaust gas would pass through a water scrubber to trap hydrogen sulfide; the scrubber contents would be disposed of as hazardous waste. |
| 9c. | Radioactive Mixed Waste | <input type="radio"/> | <input checked="" type="radio"/> | |
| 9d. | Radioactive Waste | <input type="radio"/> | <input checked="" type="radio"/> | |
| 9e. | Asbestos Waste | <input type="radio"/> | <input checked="" type="radio"/> | |
| 9f. | Biological Waste | <input type="radio"/> | <input checked="" type="radio"/> | |
| 9g. | No Path to Disposal Waste | <input type="radio"/> | <input checked="" type="radio"/> | |
| 9h. | Nano-material Waste | <input type="radio"/> | <input checked="" type="radio"/> | |
| 10. | Radiation | <input type="radio"/> | <input checked="" type="radio"/> | |
| 11. | Threatened Violation of ES&H Regulations or Permit Requirement | <input type="radio"/> | <input checked="" type="radio"/> | |
| 12. | New or Modified Federal or State Permits | <input type="radio"/> | <input checked="" type="radio"/> | |
| 13. | Siting, Construction, or Major Modification of Facility to Recover, | <input type="radio"/> | <input checked="" type="radio"/> | |

| | | | | |
|---|---|----------------------------------|----------------------------------|---|
| | Treat, Store, or Dispose of Waste | | | |
| 14. | Public Controversy | <input type="radio"/> | <input checked="" type="radio"/> | |
| 15. | Historic Structures and Objects | <input type="radio"/> | <input checked="" type="radio"/> | |
| 16. | Disturbance of Pre-existing Contamination | <input type="radio"/> | <input checked="" type="radio"/> | |
| 17. | Energy Efficiency, Resource Conserving, and Sustainable Design Features | <input checked="" type="radio"/> | <input type="radio"/> | The design of the rotary kiln would minimize the need for external heating. |
| Section B (For Projects that Occur Outdoors) | | Yes | No | |
| 18. | Threatened or Endangered Species, Critical Habitats, and/or other Protected Species | <input type="radio"/> | <input type="radio"/> | |
| 19. | Wetlands | <input type="radio"/> | <input type="radio"/> | |
| 20. | Floodplain | <input type="radio"/> | <input type="radio"/> | |
| 21. | Landscaping | <input type="radio"/> | <input type="radio"/> | |
| 22. | Navigable Air Space | <input type="radio"/> | <input type="radio"/> | |
| 23. | Clearing or Excavation | <input type="radio"/> | <input type="radio"/> | |
| 24. | Archaeological Resources | <input type="radio"/> | <input type="radio"/> | |
| 25. | Underground Injection | <input type="radio"/> | <input type="radio"/> | |
| 26. | Underground Storage Tanks | <input type="radio"/> | <input type="radio"/> | |
| 27. | Public Utilities or Services | <input type="radio"/> | <input type="radio"/> | |
| 28. | Depletion of a Non-Renewable Resource | <input type="radio"/> | <input type="radio"/> | |
| Section C (For Projects Outside of ANL) | | Yes | No | |
| 29. | Prime, Unique, or Locally Important Farmland | <input type="radio"/> | <input type="radio"/> | |
| 30. | Special Sources of Groundwater (such as sole source aquifer) | <input type="radio"/> | <input type="radio"/> | |
| 31. | Coastal Zones | <input type="radio"/> | <input type="radio"/> | |
| 32. | Areas with Special National Designations (such as National Forests, Parks, or Trails) | <input type="radio"/> | <input type="radio"/> | |
| 33. | Action of a State Agency in a State with NEPA-type Law | <input type="radio"/> | <input type="radio"/> | |
| 34. | Class I Air Quality Control Region | <input type="radio"/> | <input type="radio"/> | |

Categorical Exclusion

Other (Use field below to enter other categorical exclusion)

App B3.6 Small-scale research and development, laboratory operations, and pilot projects

ANL NEPA Reviewer Use Only

- My approval is the final approval necessary
 This form requires additional approval from DOE

To be Completed by DOE/ASO

| Section D | Yes | No |
|---|-----------------------|----------------------------------|
| Are there any extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal? | <input type="radio"/> | <input checked="" type="radio"/> |
| Is the project connected to other actions with potentially significant impacts or related to other proposed action with cumulatively significant impacts? | <input type="radio"/> | <input checked="" type="radio"/> |
| If yes, is a categorical exclusion determination precluded by 40 CFR 1506.1 or 10 CFR 1021.211? | <input type="radio"/> | <input type="radio"/> |

Can the project or activity be categorically excluded from preparation of an Environment Assessment or Environmental Impact Statement under Subpart D of the DOE NEPA Regulations?



If yes, indicate the class or classes of action from Appendix A or B of Subpart D under which the project may be excluded:
This experiment may be excluded under the following class of action from Appendix B to 10 CFR Part 1021, Subpart D: B3.6 Small-scale research and development, laboratory operations, and pilot projects.

If no, indicate the NEPA recommendation and class(es) of action from Appendix C or D to Subpart D to Part 1021 of 10 CFR.

Attachments

File Description:

Comments

Add Approver

| Approver Name | Approver Badge | Reason | Delete |
|-----------------------|----------------|------------------------|--------|
| Pfeiffer, Mark Albert | 232188 | Air emissions reviewer | |
| Zeng, Zuotao | 52635 | Co-PI | |
| Kopasz, John P. | 35889 | Co-PI | |

Notifications

The approval notification email will be copied to the people listed below.

| Badge | Name | Division | Delete |
|-------|------|----------|--------|
|-------|------|----------|--------|

ASO-CX Number

ASO-CX- 394

Comments:

This DOE approval of the NEPA ERF CX is tracked as ASO-CX-394.

Approval

| <u>Approver</u> | <u>Action</u> | <u>Date Routed</u> | <u>Action Date</u> | <u>Approval Reason / Comments</u> | <u>Approval Type</u> |
|-----------------------|---------------|--------------------|--------------------------|---|----------------------|
| Woodford, John B. | APPROVED | 2022-05-10 | 2022-05-10 11:41:06.0 | Creator : | PRIMARY |
| Woodford, John B. | APPROVED | 2022-05-10 | 2022-05-10 11:41:06.0 | Project Manager : | PRIMARY |
| Kopasz, John P. | APPROVED | 2022-05-10 | 2022-05-10 13:25:08.0 | Co-PI : | PRIMARY |
| Zeng, Zuotao | APPROVED | 2022-05-10 | 2022-05-10 17:57:22.0 | Co-PI : | PRIMARY |
| Pfeiffer, Mark Albert | APPROVED | 2022-05-10 | 2022-05-11 09:06:22.0 | Air emissions reviewer : | PRIMARY |
| Harris, Amy M. | APPROVED | 2022-05-11 | 2022-05-11 09:23:05.0 | NEPA Owner Approval for Argonne Environmental Review : | PRIMARY |
| Ptak, Jill S. | APPROVED | 2022-05-11 | 2022-05-11 09:48:19.0 | ANL NEPA Reviewer : Expected project duration to be 2 years | PRIMARY |
| Hellman, Karen B. | APPROVED | 2022-05-11 | 2022-05-16 15:56:16.0 | ANL-985 Review and Approval : | PRIMARY |

| | | | | | |
|-----------------------|----------|------------|--------------------------|---|---------|
| Dunn, Michael W. | APPROVED | 2022-05-16 | 2022-05-16 16:33:51.0 | ANL-985 ANL Deputy COO Review and Approval : | PRIMARY |
| Joshi, Kaushik N. | APPROVED | 2022-05-16 | 2022-05-19 11:39:39.0 | ANL-985 DOE-ASO Review and Approval : This DOE approval of NEPA ERF CX is tracked as ASO-CX-394. | PRIMARY |
| Siebach, Peter Rudolf | APPROVED | 2022-05-19 | 2022-05-22 17:55:09.0 | ANL-985 DOE NEPA Compliance Officer Review and Approval : | PRIMARY |
