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Created By:	Woodford, John B.

Environmental Review Form for Argonne National Laboratory

Creator

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

General Information

Project/Activity Title: Uranium Chloride Salt Preparation

ASO NEPA Tracking No.: Type of Funding: SPP

B & R Code: Identifying Number: NE18-002

SPP Proposal Number: 2018-18092 CRADA Proposal Number:

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

Other (explain):

List appropriate NEPA Owners:

Division: NE 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

Ternary mixtures of NaCl, UCl3, and UCl4 would be prepared in molten NaCl and provided to TerraPower, LLC for use as feedstock for the Molten Chloride Fast Reactor (MCFR) Integral Effects Test (IET). The work would be divided into two phases; in Phase 1, small quantities (<1 kg) of the ternary mixtures will be produced under the ASO-CX-325 generic bench-scale categorical exclusion (CX) to determine the rate of chlorination and other process parameters. In Phase 2, a total of 1000 kg of ternary salt mixture would be prepared, in 100 kg batches. Production of the ternary salt mixture would be carried out in an inert-atmosphere glovebox with a heated furnace well in a two-step process. In the first batch process, UCl3 is formed by directly chlorinating depleted uranium (DU) metal with chlorine gas at 800°C. The uranium would be contained in a low-melting DU-Ni alloy, which would be melted in a crucible immersed in molten NaCl. Chlorination takes place via bubbling chlorine gas through the melt. Gas addition would take place sufficiently slowly that there would be time for it to react completely, so no chlorine would escape into the vessel headspace. Periodic additions of depleted uranium metal would maintain the alloy composition in a range that's molten at 800°C. As UCl3 forms in the DU-Ni melt, it would dissolve into the surrounding NaCl; when the NaCl/UCl3 mixture reaches the eutectic composition, the process would be terminated. During synthesis, the redox potential of the molten salt mixture would be monitored to identify when to terminate the chlorination process. Maintaining an excess of U metal in the molten alloy and controlling the gas addition rate ensures that the volatile higher chlorides such as UCl5 and UCl6 would not form during the initial chlorination process. Once the eutectic mixture has formed, the crucible and remaining U-Ni alloy would be removed from the melt. In the second chlorination step, additional chlorine gas would be added to the binary eutectic mixture to form a ternary UCl3/UCl4/NaCl mixture of the desired composition. The melt temperature would be reduced to approximately 550°C before further chlorine addition. For this step, the sparge gas would be a mixture of chlorine and argon, offering a higher degree of control over the chlorination process. The flow rate and chlorine concentration in the sparge gas would be be controlled such that only UCl4 is formed. As with the synthesis of the eutectic salt, electroanalytical techniques would be used to monitor the chlorination process and the UCl4/UCl3 ratio. The chlorine/argon sparge would be terminated when the desired UCl4/UCl3/NaCl ratio was reached. After allowing sufficient time for the ternary molten salt to fully homogenize, samples of the salt mixture would be taken for analysis, and the remainder of the salt transferred to molds in a casting vessel. The salt mixture would be analyzed to confirm the Na:U:Cl ratio and measure impurity concentrations to ensure that the material meets TerraPower's purity requirements. In addition, differential scanning calorimetry (DSC) would be used to measure the transition temperature of the salt mixture, further corroborating the composition measurement. The salt would be cast inside the glovebox as 5-kg ingots under dry argon, cleaned of any adhering surface materials after solidification, packaged in mylar pouches that are heat-sealed under a dry argon blanket using ultrapure argon, and placed in a can for interim storage before transport to TerraPower. Staff would monitor the system throughout the chlorination/conversion process. Due to the high thermal mass of the melt, though, it would be left at temperature overnight. No gas flow would take place at this time.

Description of Affected Environment

The work would take place in an inert-atmosphere glovebox in Bldg. 205, Rm. J117. The glovebox has been used for similar work in the past, so it has the necessary hardware for salt preparation. In addition, it is equipped with chlorine sensors. Although the sensor heads will need to be replaced prior to the start of work, the rest of the hardware should still be functional. Functionality of the system will be verified prior to the start of work. The system will have two setpoints--if chlorine gas is detected at the 0.5 ppm level, an interlock will halt the flow of chlorine to the melt, and a alert will sound. If the chlorine concentration rises to 1.0 ppm despite the cessation of flow to the melt, a second alert will sound, notifying the operator of the issue. The differential scanning calorimeter used to verify composition is in a separate glovebox in the same laboratory, so DSC analysis can be carried out without having to remove samples from the laboratory. The offgas stream from the headspace over the melt is scrubbed through heated steel wool before venting to the glovebox atmosphere, which will remove any traces of chlorine gas that might escape from the melt during chlorination. A similar scrubber system is in place in a glovebox Bldg. 205 Rm. G118. The work done in the G118 glovebox was designed to generate chlorine gas as a byproduct of actinide chloride electrolysis, but despite this the scrubber functioned well enough that the detection system never alerted. That is, although no scrubber system is perfect, this system was able to maintain the glovebox atmosphere below 0.5 ppm chlorine despite the presence of over 200 g chlorine gas fed through the scrubber at up to 250 mL/minute. TerraPower, LLC is located in Bellevue, WA, USA. Salt ingots and other samples will be sent there through Argonne's Shipping department, and the material will be packaged in compliance with all relevant United States Department of Transportation requirements at the direction of Argonne's Materials Control and Accountability group.

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	●	○	Before starting the process, the amount of chlorine needed to produce the full 1000 kg will be determined, and only as much chlorine as is needed will be obtained.
2.	Air Pollutant Emissions	●	○	There is a potential for chlorine or volatile uranium chlorides to escape from the reaction vessel and pass into the ventilation system. This risk is mitigated by the scrubber mentioned above, by the use of interlocked chlorine sensors which will halt the sparge gas flow if chlorine is detected in the glovebox, by maintaining the melt temperature only as high as it needs to be for the desired reaction to take place rapidly, and by the physical nature of the uranium chloride. That is, even if UCl_4 evaporates from the melt, it will quickly condense on colder surfaces such as the heat shields around the furnace or even the rest of the glovebox interior.
3.	Noise	○	●	
4.	Chemical/Oil Storage/Use	●	○	Significant quantities of chlorine gas, depleted uranium, and NaCl will be necessary to synthesize the ternary salt mixtures, as will a much smaller quantity of nickel metal.
5.	Pesticide Use	○	●	
6.	**Toxic Substances Control Act (TSCA) Substances**			
	6a. Polychlorinated Biphenyls (PCBs)	○	●	
	6b. Asbestos or Asbestos Containing Materials	○	●	
	6c. Other TSCA Regulated Substances	○	●	
	Import or Export of			

	6d.	Chemical Substances	○	◉	
7.	Biohazards		○	◉	
8.	Effluent/Wastewater (If yes, see question #12 and contact Peter Lynch (HSE) at 2-4582 or lynch@anl.gov)		○	◉	
9.	**Waste Management**				
	9a.	Construction or Demolition Waste	○	◉	
	9b.	Hazardous Waste	○	◉	
	9c.	Radioactive Mixed Waste	○	◉	
	9d.	Radioactive Waste	◉	○	Low-level waste will be produced during the synthesis. Any disposable personal protective equipment used when handling uranium and its compounds must be disposed of as LLW, as will the analytical samples, residual salt resulting from glovebox cleanup activities, etc.
	9e.	Asbestos Waste	○	◉	
	9f.	Biological Waste	○	◉	
	9g.	No Path to Disposal Waste	○	◉	
	9h.	Nano-material Waste	○	◉	
10.	Radiation		◉	○	The work entails handling/being in close proximity to significant quantities of depleted uranium. Although the radiation hazard is small, it is still present.
11.	Threatened Violation of ES&H Regulations or Permit Requirement		○	◉	
12.	New or Modified Federal or State Permits		○	◉	
13.	Siting, Construction, or Major Modification of Facility to Recover, Treat, Store, or Dispose of Waste		○	◉	
14.	Public Controversy		○	◉	
15.	Historic Structures and Objects		○	◉	
16.	Disturbance of Pre-existing Contamination		○	◉	
17.	Energy Efficiency, Resource Conserving, and Sustainable Design Features		◉	○	Electrical power use for heating is minimized by 1) maintaining insulation on the furnace, and 2) keeping the melt temperature as low as possible while still allowing the necessary chlorination reactions to take place. Only the chlorine and other reagents (depleted uranium, NaCl, and Ni metal) needed will be purchased.
Section B (For Projects that Occur Outdoors)			**Yes**	**No**	
18.	Threatened or Endangered Species, Critical Habitats, and/or other Protected Species		○	◉	
19.	Wetlands		○	◉	
20.	Floodplain		○	◉	
21.	Landscaping		○	◉	
22.	Navigable Air Space		○	◉	
23.	Clearing or Excavation		○	◉	

24.	Archaeological Resources	○	◉	
25.	Underground Injection	○	◉	
26.	Underground Storage Tanks	○	◉	
27.	Public Utilities or Services	○	◉	
28.	Depletion of a Non-Renewable Resource	○	◉	
Section C (For Projects Outside of ANL)		**Yes**	**No**	
29.	Prime, Unique, or Locally Important Farmland	○	◉	
30.	Special Sources of Groundwater (such as sole source aquifer)	○	◉	
31.	Coastal Zones	○	◉	
32.	Areas with Special National Designations (such as National Forests, Parks, or Trails)	○	◉	
33.	Action of a State Agency in a State with NEPA-type Law	○	◉	
34.	Class I Air Quality Control Region	○	◉	

Categorical Exclusion

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?	○	◉
Is the project connected to other actions with potentially significant impacts or related to other proposed action with cumulatively significant impacts?	○	◉
If yes, is a categorical exclusion determination precluded by 40 CFR 1506.1 or 10 CFR 1021.211?	○	○
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 project/activity can be excluded under the following category of Appendix B of Subpart D of 10 CFR Part 1021: B 3.6 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
Williamson, Mark A.	52376	Principal Investigator	

Notifications

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

Badge	Name	Division	Delete

ASO-CX Number

ASO-CX- 353

Comments:

This NEPA ERF categorical exclusion (CX) is tracked as ASO-CX-353 Uranium Chloride Salts Preparation.

Approval

Approver	Action	Date Routed	Action Date	Approval Reason / Comments	Approval Type
Woodford, John B.	APPROVED	2018-04-26	2018-04-26 18:31:36.0	Creator :	PRIMARY
Woodford, John B.	APPROVED	2018-04-26	2018-04-26 18:31:36.0	Project Manager :	PRIMARY
Williamson, Mark A.	APPROVED	2018-04-26	2018-04-27 06:34:12.0	Principal Investigator :	PRIMARY
Riel, Roberta T.	APPROVED	2018-04-27	2018-04-27 06:38:52.0	NEPA Owner Approval for Argonne Environmental Review :	PRIMARY
Ptak, Jill S.	APPROVED	2018-04-27	2018-04-27 10:42:26.0	ANL NEPA Reviewer :	PRIMARY
Hellman, Karen B.	APPROVED	2018-04-27	2018-04-27 10:51:06.0	ANL-985 Review and Approval :	PRIMARY
Stine, Gail Y.	APPROVED	2018-04-27	2018-04-27 15:38:18.0	ANL-985 Review and Approval :	PRIMARY
Kearns, Paul K.	APPROVED	2018-04-27	2018-05-03 14:54:13.0	ANL-985 ANL COO Review and Approval : **Prior to conducting this work - walk through of the procedure and pre-job brief with Gary Francis WPC Project Office is required.**	PRIMARY
Joshi, Kaushik N.	APPROVED	2018-05-03	2018-05-03 15:41:01.0	ANL-985 DOE-ASO Review and Approval : **This ERF CX is being tracked as ASO-CX-353**	PRIMARY
Siebach, Peter R.	APPROVED	2018-05-03	2018-05-04 09:42:20.0	ANL-985 DOE NEPA Compliance Officer Review and Approval :	PRIMARY
