INL/EXT-21-61331
Revision 2

Pre-conceptual Evaluation of Department of Defense Pele Microreactor Sites at Idaho National Laboratory

September 2021

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Changing the World's Energy Future

Idaho National Laboratory

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SUMMARY

Members of the Idaho National Laboratory (INL) Land Use Committee met to discuss pre-conceptual siting recommendations for the Pele microreactor demonstration project proposed at INL. The Pele microreactor prototype will be a Department of Energy-authorized reactor. The evaluation team of subject-matter experts (SMEs) was asked to consider both indoor and outdoor sites.

A preliminary evaluation was performed by the SME team and, based on those discussions, the following recommendations were made: (1) present the Experimental Breeder Reactor-II as the most suitable indoor site and (2) use Critical Infrastructure Test Range Complex (CITRC) Pads A–D as a system of outdoor demonstration and testing sites. Each pad has its own set of attributes that have been established to enable equipment testing and can provide options for various configurations when the group of pads are used as a system of testing sites. Utilizing CITRC Pads A–D as a system of sites enables flexibility in scheduling to meet existing program requirements and future Pele Program demonstration and testing needs with the least programmatic impact.

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CONTENTS

FIGURES

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CITRC	Critical Infrastructure Test Range Complex
DBT	Design Basis Threat
DOD	Department of Defense
DOE	Department of Energy
EBR-II	Experimental Breeder Reactor II
INL	Idaho National Laboratory
MFC	Materials and Fuels Complex
N&HS	National and Homeland Security
NE	(DOE Office of) Nuclear Energy
NRC	Nuclear Regulatory Commission
NRIC	National Reactor Innovation Center
PBF	Power Burst Facility
RFS	request for solutions
SCO	(DOD) Strategic Capabilities Office
SME	subject-matter experts
SNM	special nuclear material

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Pre-conceptual Evaluation of DOD Pele Microreactor Sites at Idaho National Laboratory

1. OVERVIEW

In April 2019, the Department of Defense (DOD) issued a request for solutions (RFS) through the Strategic Capabilities Office (SCO) to solicit proposals for a prototype microreactor development program called the Pele Program. The SCO is partnering with the Department of Energy (DOE), and Nuclear Regulatory Commission (NRC) to develop, review, authorize, build, and demonstrate a mobile nuclear reactor.

The Pele Program uses a two-phased approach. Phase I will include the development of a mobile nuclear reactor design, completed in approximately 24 months. Phase II will include building and demonstrating the prototype developed in Phase I.

In preparation for a potential Pele microreactor demonstration, members of the Idaho National Laboratory (INL) Land Use Committee met on November 19, 2020, to conduct a preconceptual evaluation of options and make recommendations for siting a Pele demonstration at INL. Pele will be a DOE-authorized reactor. Recommended options will include an indoor site for initial assembly and testing and an outdoor site for additional testing while connected to an electric grid. The agenda, objective, and list of evaluation participants are identified in Appendix A.

1.1 Site Evaluation Process

To ensure an objective and consistent evaluation process, the team followed a similar process to the one described in INL/EXT-20-57821, *Evaluation of Sites for Advanced Reactor Demonstrations at Idaho National Laboratory*, and initiated the analysis with the criteria established in that siting evaluation (INL 2020a). The pre-conceptual siting evaluation process included the following:

1. Identify high level assumptions
2. Identify siting criteria concepts
3. Identify candidate sites
4. Apply “Must” or “Go/No go” screening criteria to all candidate sites
5. Evaluate remaining candidate sites
6. Recommend the most suitable sites.

1.2 Assumptions

High level assumptions applied during the siting evaluation include the following:

1. Experimental Breeder Reactor (EBR)-II modifications will meet the Pele microreactor design requirements. There are currently no plans to modify other existing buildings to meet these design requirements (INL 2020c).
2. Per Environmental Checklist (EC) INL-18-045, “Environmental Checklist for the Haul Road,” the road has a design capacity for a 100,000-lb gross vehicle weight, double-droop, three-axle trailer with a 6-in. ground clearance. Shipments not exceeding 80,000 lb would occur from 2010 to 2050.
3. The Pele Program has identified a potential need for a temporary long-term storage area following completion of a demonstration and testing project. The most-likely site for this storage area is assumed to be near the Materials and Fuels Complex (MFC), based on preliminary discussions between the INL senior technical advisor on microreactors and MFC management. The actual

location of this storage area will be determined at a future date through a separate siting evaluation when siting requirements are available.

4. There will be additional security requirements from a special nuclear material (SNM) categorization protection perspective. Based on basic radiological information obtained thus far a radiological release analysis was conducted and it has been determined this project meets the DOE O 470.3C Design Basis Threat (DBT) protection level (PL)-6 definition and threshold. Based on the PL-6 designation, security alarms and access controls will be required if this project is located at CITRC. When more details of the various radiological holdings and inventories are provided, additional analysis can be conducted to determine if this project meets the PL-5 definition and thresholds.

2. CRITERIA SELECTION

Based on initial conceptual requirements of the Pele microreactor program, the following list of "must" criteria were used in the high level screening of candidate site concepts.

2.1 Must Criteria

The sites must have the following characteristics to meet the screening requirements:

1. Is located on a previously impacted site of a minimum 0.25 acre
2. Enables transportation of microreactor on a semi-trailer between assembly site, demonstration sites and long-term storage site within boundaries of INL Site
3. Is located at a DOE Office of Nuclear Energy (NE) managed site
4. Enables connection of microreactor to an electrical grid that can be made independent from any commercial grid for testing
5. Meets microreactor design requirements
    - Provides egress from demonstration site large enough to accommodate Conex box plus shielding, 15.6 ft tall × 14-ft wide minimum
    - Is able to keep the temperature inside the demonstration site facility below 115°F for optimal reactor performance
    - Enables connection of the reactor module to support modules (inside or outside) using 3-to-4 in. cables with large connectors
    - Provides a demonstration-site facility with a floor-loading capacity of 42 tons minimum to support the reactor and shielding during operation
    - Enables movement of shielded reactor in and out of facility, if applicable
    - Enables lifts of 10 tons, maximum, to move piping within facility, if applicable.
6. Is located away from population centers of greater than 25,000 people
7. Is located more than 5 miles from hazardous sites
8. Is located outside wetland areas
9. Is located outside of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites
10. Is located outside of a 100-year floodplain
11. Enables electric grid connectivity by 2024 (INL 2020d).

3. IDENTIFICATION OF CANDIDATE SITES

The previously referenced siting study, INL/EXT-20-57821 (INL 2020a), was used to facilitate the evaluation of concept sites. Based on the requirement to enable "connection of the Pele microreactor to an electrical grid that can be made independent from a commercial grid for testing," locations at the Critical Infrastructure Test Range Complex (CITRC) were included in the evaluation. The sites considered at CITRC are illustrated in Figure 1.

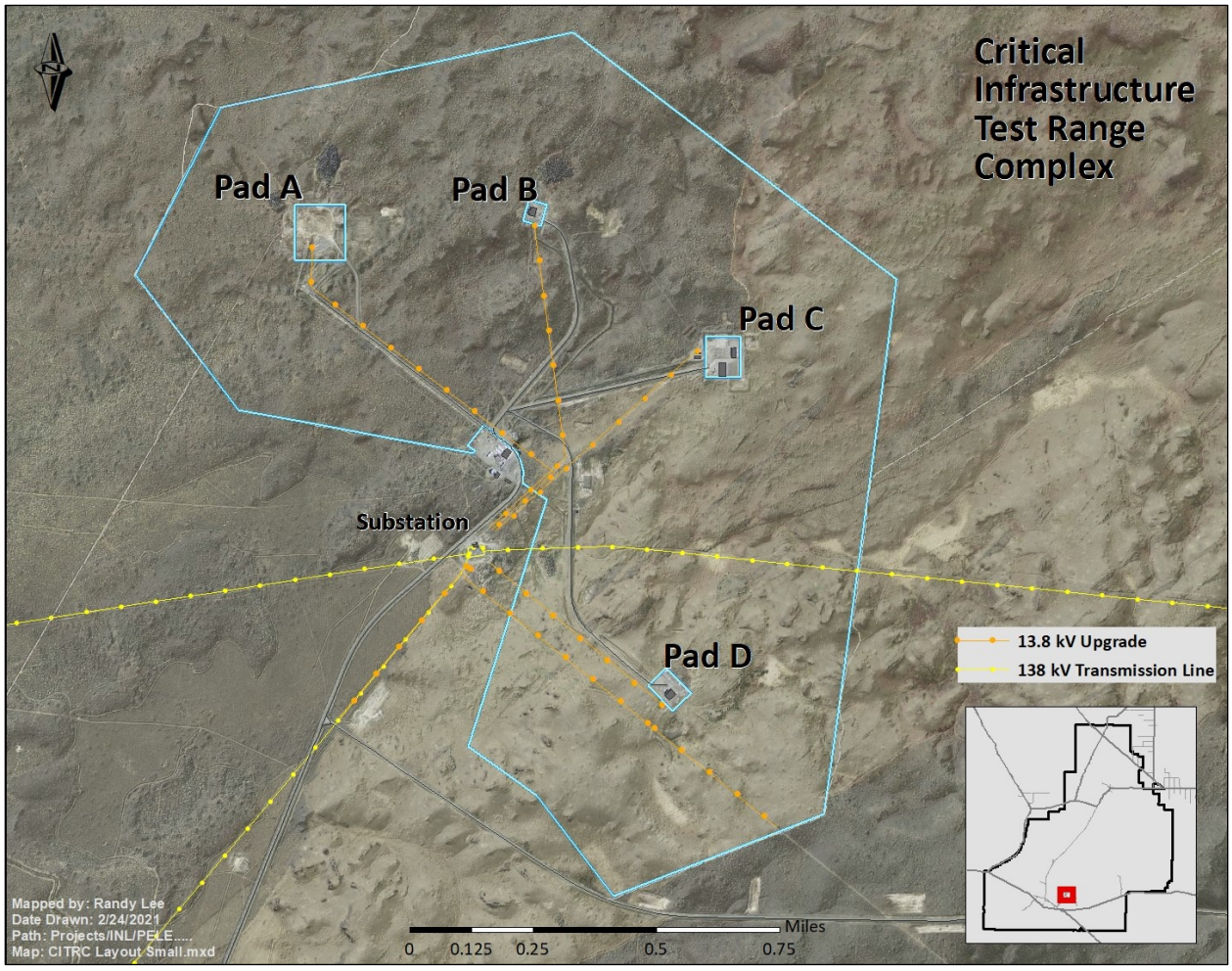

Figure 1. Candidate sites at CITRC.

4. EVALUATION RESULTS SUMMARY

The outcome of the initial evaluation of siting concepts against the must criteria showed one indoor site, EBR-II, and four outdoor sites, CITRC Pads A–D, that could potentially meet the high level siting requirements of the Pele microreactor on the INL Site. High level failing criteria for each site are shown in Appendix B.

4.1 Indoor Sites Evaluation Summary

The National Reactor Innovation Center (NRIC) is developing and implementing a framework to enable nuclear reactor demonstration and testing projects at INL. One piece of this framework is to

upgrade existing facilities to support these future projects. NRIC envisions utilizing EBR-II to host reactor demonstrations and other nuclear projects (INL 2020c).

The EBR-II dome is cylindrical in form, with a usable 70-ft diameter; it is 80-ft high. NRIC is looking at modifying EBR-II to provide safety-class confinement to support the operation of nuclear reactors. Other specifications and considerations include:

Existing

- Floor-loading capable of 3,750 psf
- 200 kVA, 480 V electrical service available
- ~4,800 ft^2 available within dome
- Hazards and Safeguards Category 2
- Near ground-level entry point for installation of equipment and reactor packages.

Planned

- 10 MW heat-rejection capability with variable controls
- Aimed towards single-package microreactor innovators which can accept 20-ft-long International Organization for Standardization shipping containers through confinement boundary
- Available Class 1E battery backup power as well as a non-safety-related 100 kW diesel generator
- Available compressed gas systems (INL 2020b).

NRIC is currently in the process of planning the upgrades needed at EBR-II to meet potential future microreactor-design and operational requirements. The targeted ready-for-demonstrations date is January 1, 2024. Because it is the only building planned for the upgrades listed above, EBR-II is the most-suitable indoor-demonstration and testing site.

4.2 Outdoor Sites Evaluation Summary

As stated previously, based on the high level requirement to "enable connection of the Pele microreactor to an electrical grid that can be made independent from a commercial grid for testing," CITRC Pads A–D were included in the evaluation and conceptually may meet the Pele microreactor must requirements for outdoor demonstrations and testing.

Each pad has its own set of attributes, established to enable equipment testing. The pads can provide options for various configurations when the group of pads are used as a system of testing sites. An environmental assessment team recently completed surveys of the disturbed areas at CITRC Pads B–D. Pad A was not evaluated for cultural-resource concerns. If it is determined that a future test will require area around a pad, a minor review of the planned area off the pad will be required at Pads B–D, and a more complete survey will be required at Pad A. Below is a description of the site attributes at each pad.

4.2.1 CITRC Pad A

The National and Homeland Security (N&HS) Directorate currently operates a program on that site. The program plans to use the site for a limited number of years, but a specific completion date is not yet planned. A significant investment has been put into making this location an operational site, including:

- An expanded gravel pad
- A trailer on site for housing program operations
- Access to the test grid, ground grid, current transformers, potential transformers, house power, and fiber-optic connectivity.

4.2.2 CITRC Pad B

CITRC Pad B comprises:

- A gravel pad
- Adjacency to an old reactor building, the Power Burst Facility, Building 612 (PBF-612), with an asphalt apron approximately 20 ft out from the building
- Access to the test grid, ground grid, current transformers, potential transformers, house power, and fiber optic connectivity.

4.2.3 CITRC Pad C

CITRC Pad C comprises:

- An expanded asphalt-pad area
- A project trailer onsite, supporting multiple program operations
- Adjacency to old support buildings, PBF-622/623
- Adjacency to a large previously disturbed area that was the location of PBF-609, now demolished
- Access to the test grid, ground grid, current transformers, potential transformers, house power, and fiber-optic connectivity
- Potential scheduling constraints due to existing active operations in the area.

4.2.4 CITRC Pad D

CITRC Pad D comprises:

- A gravel pad
- Adjacency to an old reactor building, PBF-613, with a significant amount of asphalt-adjacent areas
- Access to the test grid, ground grid, current transformers, potential transformers, house power, and fiber-optic connectivity.

5. RECOMMENDATIONS

Based on this evaluation, pre-conceptual siting outcomes indicate EBR-II is the most-suitable indoor site and CITRC Pads A–D as the most suitable outdoor-demonstration and testing sites. As stated previously, each pad has its own set of attributes, established to enable equipment testing, and each can provide options for various configurations when the group of pads are used as a system of testing sites. Using CITRC Pads A–D as a system of sites offers flexibility in scheduling activities at CITRC to meet Pele microreactor program schedule.

6. REFERENCES

INL. 2020a. “Evaluation of Sites for Advanced Reactor Demonstrations at Idaho National Laboratory.” INL/EXT-20-57821.

INL. 2020b. “EBR-II Test Bed Information, Materials and Fuels Complex Building 767 – Experimental Breeder Reactor II.” 20-GA50250_02_R0.

INL. 2020c. “Pre-Conceptual Design of Demonstration Reactor Test Bed.” NRIC Test Beds 5.13.20forWeb at https://nric.inl.gov/news-archive/.

INL. 2020d. “DOD Mobile Microreactor, Nuclear Science and Technology Strategic Advisory Committee Meeting,” presented August 2020.

Yde, Eric A., email conversation with A. Conner, November 18, 2020.

Appendix A
Meeting Agenda and List of Participants

Microreactors Siting – Pele Sites Evaluation

Objective: Create recommendation for siting demonstration and testing of Pele reactor at INL.

Agenda, November 19, 2020:

3:00 Introductions

3:05 Project Overview

3:15 Review Go/No Go or "Must" Criteria and Initial Screening of Candidate Sites

3:35 Capture Technical Input and Subject Matter Experience on Remaining Candidate Sites

4:15 Formulate Siting Recommendations

4:45 Adjourn

Meeting Participants:

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Appendix B
Must Criteria High Level Screening Results

Site	Criteria (P = Pass, F = Fail)										
	Must be located on a previously impacted site of a minimum 0.25 acre	Must enable transportation of microreactor on a semi-trailer between demonstration sites and long-term storage site within boundaries of INL Site[3 & 4]	Must be an NE managed site	Must enable connection of microreactor to an electrical grid that can be made independent from a commercial grid for testing[5]	Must meet microreactor design requirements[1]	Must be located away from population centers of >25,000 people	Must be located >5 miles from hazardous site	Must be located outside wetland areas	Must be located outside of CERCLA sites	Must be located outside of 100-year floodplain	Must enable electric grid connectivity by 2024
Indoor Sites											
CPP-691	P	P	**F**	**F**	**F**	P	P	P	P	P	**F**
EBR-II[2]	P	P	P	P	P	P	P	P	P	P	P
ZPPR	P	P	P	P	**F**	P	P	P	P	P	**F**
PBF-612	P	P	P	P	**F**	P	P	P	P	P	P
PBF-613	P	P	P	P	**F**	P	P	P	P	P	P
Outdoor Sites											
6	P	P	P	**F**	n/a	P	P	P	P	P	**F**
7	ATR Complex site inside the fence – No longer available due to new construction										
8	**F**	P	P	P	n/a	P	P	P	P	P	P
9	**F**	P	P	P	n/a	P	P	P	P	P	P
10	**F**	P	P	P	n/a	P	P	P	P	P	P
11	**F**	P	P	P	n/a	P	P	P	P	P	P
12	**F**	P	P	P	n/a	P	P	P	P	P	P
13	**F**	P	P	P	n/a	P	P	P	P	P	P
14	**F**	P	P	P	n/a	P	**F**	P	P	P	P
15	**F**	P	P	P	n/a	P	P	P	P	P	P
16	**F**	P	P	P	n/a	P	P	P	P	P	P
17	**F**	P	P	P	n/a	P	P	P	P	**F**	P
18	**F**	P	P	P	n/a	P	P	P	P	P	P
19	**F**	P	P	P	n/a	P	P	P	P	P	P
20	**F**	P	P	P	n/a	P	**F**	P	P	P	P
21	**F**	P	P	P	n/a	P	P	P	P	P	P
22	**F**	P	P	P	n/a	P	**F**	P	P	P	P
23	**F**	P	P	P	n/a	P	**F**	P	P	P	P
24	**F**	P	P	P	n/a	P	**F**	P	P	P	P
25	**F**	P	P	P	n/a	P	P	P	P	P	P
26	**F**	P	P	P	n/a	P	P	P	P	P	P
27	**F**	P	P	P	n/a	P	**F**	P	P	P	P
28	**F**	P	P	P	n/a	P	P	P	P	P	P
29	**F**	P	P	P	n/a	P	P	P	P	P	P
30	**F**	P	P	P	n/a	P	P	P	P	P	P
31	**F**	P	P	P	n/a	P	P	P	P	P	P
32	P	P	P	**F**	n/a	P	P	P	P	P	**F**
CITRC Pad A	P	P	P	P	n/a	P	P	P	P	P	P
CITRC Pad B	P	P	P	P	n/a	P	P	P	P	P	P
CITRC Pad C	P	P	P	P	n/a	P	P	P	P	P	P

Site	Criteria (P = Pass, F = Fail)										
	Must be located on a previously impacted site of a minimum 0.25 acre	Must enable transportation of microreactor on a semi-trailer between demonstration sites and long-term storage site within boundaries of INL Site[3 & 4]	Must be an NE managed site	Must enable connection of microreactor to an electrical grid that can be made independent from a commercial grid for testing[5]	Must meet microreactor design requirements[1]	Must be located away from population centers of >25,000 people	Must be located >5 miles from hazardous site	Must be located outside wetland areas	Must be located outside of CERCLA sites	Must be located outside of 100-year floodplain	Must enable electric grid connectivity by 2024
CITRC Pad D	P	P	P	P	n/a	P	P	P	P	P	P
TAN	P	P	P	**F**	n/a	P	**F**	P	P	**F**	**F**

1. Below are the distinguishing design requirements of the Pele microreactor for an indoor demonstration and testing site:

- Must provide egress from demonstration site large enough to accommodate Conex box plus shielding, 15.6 ft tall x 14 ft wide, minimum
- Must be able to keep the temperature inside the demonstration site facility below 115°F for optimal reactor performance
- Must enable connection of the reactor module to support modules (inside or outside) using 3–4-in. cables with large connectors
- Must provide a demonstration site facility with a floor loading capacity of 42 tons minimum to support the reactor and shielding during operation
- Must enable movement of shielded reactor in and out of facility, if applicable
- Must enable lifts of 10 tons maximum to move piping within facility, if applicable.

2. **Assumption:** EBR-II modifications will meet the Pele microreactor design requirements. There are no plans to modify other existing buildings to meet the Pele microreactor design requirements, currently.

3. **Assumption:** Per EC INL-18-045, "Environmental Checklist for the Haul Road," the road has a design capacity for a 100,000-lb gross vehicle weight, double-droop, three-axle trailer with a 6-inch ground clearance. Shipments not exceeding 80,000 lbs (40 tons) would occur from 2010 to 2050.

4. **Assumption:** The most likely site of a potential temporary long-term storage area in support of the Pele Program is assumed to be near MFC based on preliminary discussions between the INL senior technical advisor on microreactors and MFC management. The actual location of this storage area will be sited at a future date through a separate siting evaluation.

5. The "Electric Grid Testing Capabilities" project (also known as the Raghorn Project) is installing 16.5 miles of 138 kV overhead powerline from the Scoville Substation at the Central Facilities Area to MFC. This new powerline will be the primary power source on the south leg of the loop. The existing 138 kV powerline can then be used for testing purposes without disrupting the loop. The installation of power poles is in progress, as are modifications to the Scoville Substation. The current schedule shows completion of this project in the spring of 2021 (Yde 2020).