SECTION A. Project Title: XPeRT

SECTION B. Project Description and Purpose:

The Idaho National Laboratory, the lead nuclear laboratory for the DOE, nuclear engineering expertise draws upon multiple disciplines required to analyze, design, demonstrate, deploy, and operate nuclear systems. Tehse include capabilities in neutronics, thermal hydraulics, structural-design analyses for small- and large-scale experiments, mechanistic and probabilistic safety and other risk analyses, development of robust materials for nuclear environment, and development of destructive and nondestructive nuclear materials detection and safeguards technologies. IN order to take advantage of these capabilities X-Energy, LLC is developing a 75 MWe pebble-bed reactor known as the Xe-100 project. The Xe-100 project requires the testing of fuel to support the development of the reactor. To that end, INL will support nuclear irradiation testing and analysis. DOE proposes to support the Xe-100 project by performing the following:

1. Irradiate TRISO-X fuel in the ATR South Flux Trap position (67 mm).

2. The fuel form will be reduced diameter pebbles. Pebble diameter shall be maximized to the extent possible for the south flux trap position.

3. A minimum of 75,000 triso particles shall be irradiated.

4. Maximum particle packing fraction in the reduced size pebbles: 15%
(X-energy prefers using their prototypical packing fraction of 9.5%).

5. U-235 fuel enrichment: 15.5%.

6. The test shall be equipped with active temperature control. Thermocouples shall be used to measure temperature and a He/Ne gas blend system shall be used to control temperature.

7. Temperature measurements shall be taken by inserting thermocouples into the graphite holders surrounding the pebbles. X-energy would like INL to evaluate the feasibility of inserting thermocouples into the graphite rinds of two pebbles.

8. Temperature control gas gaps shall be sized to achieve a beginning of life (BOL) fuel meat volume average temperature of 1000±75°C for all pebbles, except for a single designated high temperature pebble. The volume average temperature of the high temperature pebble at BOL shall be 1200±75°C. To the greatest extent possible, these volume averaged temperatures shall be maintained within ±125°C throughout the duration of the irradiation. It is expected that this will be achieved through the use of burnable neutron poisons.

9. The test shall be equipped with at least one fission product monitoring system similar to that used for the AGR-1 and AGR-2 tests. If the pebble stack can be separated into more than one chamber with sweep gases going to separate fission product monitors, this will be beneficial so as to help localize any observed fuel particle failures (and to provide better temperature control across the pebble stack).

10. The maximum particle power limit is 400 mW.

11. The fuel burn up goal is as follows: Achieve maximum Fissions Per Initial Metallic Atom (FIMA) given schedule constraints of ATR, with an extraction date no later than 08/01/26 (Est. 200 Irradiation Days). Note that if only 3 ATR cycles can be accomplished, then less than 200 irradiation days will be achieved to meet the extraction deadline.

12. The fuel fast fluence goal is as follows: All pebbles to receive fast fluence between 2x1025 and 5x1025 n/m2 (>0.18 MeV).

The project will be conducted at ATR TTAF, HFEF, AL , FCF, IMCL. The project will generate air emissions from the gases used to control the temperature in the experiment as part of a once-through system and discharged to the atmosphere. The temperature control system will use helium-neon gas mixture with a ratio varying from 100% helium to 100% neon. The maximum expected flow rate discharged will be 250 cc/min. The expected annual gas discharge is given below, assuming maximum ATR operating performance (80%) and maximum expected flow rates for all test assemblies.

GAS :Helium/neon 105 m3/yr

-Chemical Use/Storage - Isopropyl alcohol and acetone will be used as a cleaning agents in the assembly process.

-Solid Waste - Some project activities will generate small quantities of solid waste such as machining chips, also waste in the form of personal protective equipment (PPE), gloves, etc.

-Radioactive Waste Generation - The proposed project will generate approximately 9 cubic yards of low level radioactive waste, such as anti-contamination clothing, gloves, rags, stainless tubing, flux wires, etc.

Equipment will be purchase and will included, but is not limited to materials to buy/develop/build fixtures to do PIE.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

The project will generate air emissions from the gases used to control the temperature in the experiment as part of a once-through system and discharged to the atmosphere. The temperature control system will use helium-neon gas mixture with a ratio varying from 100% helium to 100% neon. The maximum expected flow rate discharged will be 250 cc/min. The expected annual gas discharge is given below, assuming maximum ATR operating performance (80%) and maximum expected flow rates for all test assemblies.

GAS :Helium/neon 105 m3/yr

Discharging to Surface-, Storm-, or Ground Water

NA

Disturbing Cultural or Biological Resources

Cultural: Pursuant to the 2023 Programmatic Agreement, this federal undertaking does not trigger Section 106 review as the proposed activity has no potential to cause effects to historic properties.

Generating and Managing Waste

-Chemical Use/Storage - Isopropyl alcohol and acetone will be used as a cleaning agents in the assembly process.

-Solid Waste - Some project activities will generate small quantities of solid waste such as machining chips, also waste in the form of personal protective equipment (PPE), gloves, etc.

-Radioactive Waste Generation - The proposed project will generate approximately 9 cubic yards of low level radioactive waste, such as anti-contamination clothing, gloves, rags, stainless tubing, flux wires, etc.

Releasing Contaminants

When chemicals are used during the project there is the potential for spills that could impact the environment (air, water, soil).

Using, Reusing, and Conserving Natural Resources

Project description indicates materials will need to be purchased or used that require sourcing materials from the environment. Being conscientious about the types of materials used could reduce the impact to our natural resources.

Environmental Justice

NA

SECTION D. Determine Recommended Level of Environmental Review, Identify Reference(s), and State Justification: Identify the applicable categorical exclusion from 10 Code of Federal Regulation (CFR) 1021, Appendix B, give the appropriate justification, and the approval date.

For Categorical Exclusions (CXs), the proposed action must not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, or similar requirements of Department of Energy (DOE) or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment or facilities; (3) disturb hazardous substances, pollutants, contaminants, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources (see 10 CFR 1021). In addition, no extraordinary circumstances related to the proposal exist that would affect the significance of the action. In addition, the action is not “connected” to other action actions (40 CFR 1508.25(a)(1) and is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1608.27(b)(7)).

References: B3.6 "Small-scale research and development, laboratory operations, and pilot projects"

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

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) ☐ Yes ☒ No

Approved by Robert Douglas Herzog, DOE-ID NEPA Compliance Officer on: 1/16/2024