DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-21-028

SECTION A. Project Title: Zero Power Physics Reactor (ZPPR) Modifications for National Reactor Innovation Center (NRIC) Demonstrations

SECTION B. Project Description and Purpose:

The mission of the National Reactor Innovation Center (NRIC) is to accelerate the demonstration and deployment of advanced nuclear energy. NRIC is a national program led by Idaho National Laboratory (INL) that enables collaborators to harness the world-class capabilities of the U.S. National Laboratory System. NRIC is designed to bridge the gap between research, development, and the marketplace to help convert advanced nuclear reactors into commercial applications.

In addition, the Materials and Fuels Complex (MFC) at INL is a world leader in innovative nuclear energy technology and is the hub of INL nuclear energy research. Activities at MFC support core research in nuclear fuels and cladding, radiation damage in core structural materials, chemical separations and fuel recycling, nuclear nonproliferation and nuclear forensics, space nuclear power and isotope technologies, and transient testing of reactor fuels.

To support the MFC and NRIC missions, INL needs to maintain effective nuclear Research, Development, Demonstration & Deployment (RDD&D) capabilities at MFC and improve facility availability to meet customer demand. To meet these needs, INL proposes to modify the Zero Power Physics Reactor (ZPPR) cell. The proposed action refurbishes ZPPR to support potential future advanced reactor demonstration systems that operate at less than 500 kWth. Because advanced reactor demonstration proponents have not designed or fully developed a specific advanced reactor demonstration project, the physical and operational changes to convert ZPPR for a specific demonstration are beyond the scope of this Environmental Compliance Permit (ECP). If a demonstration project is developed and determined to be feasible, additional analyses in compliance with the National Environmental Policy Act (NEPA) will be performed to evaluate the physical and operational changes needed and to disclose the environmental impacts associated with the demonstration. INL will prepare separate ECPs or other relevant NEPA evaluations for RDD&D projects proposed in the future.

The scope of this ECP covers only those modifications to ZPPR necessary to prepare the facility to support future demonstrations that align with the current mission of NRIC and INL. Modifications not discussed herein require revising this ECP, unless such modifications are necessary for and connected to future demonstration projects or proposals, in which case project specific review under NEPA is required. See 40 CFR § 1501.9(e)(1) for the definition of "connected actions."

ZPPR operated as a critical facility from April 1969 until 1990. The U.S. Department of Energy (DOE) used the facility to test nuclear reactor physics, design analytical tools, and evaluate nuclear data relevant to advanced reactor designs. DOE placed the reactor into standby in April 1992, and removed and disposed of the reactor and most of the associated equipment in 2009.

The ZPPR cell structure is a 50-foot inner diameter concrete cylinder with 16-inch reinforced walls. A 6-foot, 11-inch wide and 4-foot, 6-inch tall ring beam is located at the top of the cylinder. There are two openings into the cylinder, one to the west from the normal access corridor and one to the north east for the emergency egress tunnel. The concrete portion of the structure is about 32.5 feet tall. A steel super structure sits on top of the ring beam. The steel structure is a 24-sided polygon, which extends beyond the ring beam an additional ~4 feet. The steel structure is roughly 28 feet tall. An earthen mound (see Figure 1) surrounds the structure (covers the corridor, workroom, and vault) from grade up to a height 27.5 feet above the floor level, 5 feet above the top of the ring beam (5 feet of the steel structure is buried).

Figure 1. Picture of ZPPR Cell Mound.

The baseline objective is for the ZPPR Cell to act as a confinement structure capable of siting demonstration reactors that utilize Safeguards Category 1 material for operations. The major areas for modification include the following:

- Installing an access door
- Electrical Power
- Heat Removal
- Ventilation in the Cell
- Potential Future Reactor Installation.

The final facility safety classification will be determined in accordance with the DOE-STD-1189-2016 process. INL will perform modifications in accordance with DOE-STD-1189-2016, *Integration of Safety into the Design Process*. The following discussion describes the proposed modifications:

Exterior Layout

The proposed action includes an open yard for items and operations located outside the ZPPR cell. The yard area consists of a large equipment staging area (gravel and soil) and concrete pad.

Reactor Loading and Removal

Loading a prefabricated demonstration reactor module into the ZPPR cell requires an opening in the side of the facility. Consideration of a top access concept, including location of support systems on the roof, is not a viable option. INL considered two side entry options. Each option requires a new penetration, modification or construction of an access tunnel, and includes one or more hatches. Option A is preferred over Option B. Option A will be pursued pending successful structural evaluation.

Option A cuts into the cell lower containment structure and constructs a new access tunnel. This option installs a 13 feet by 13 feet clear opening seal hatch and covers the new tunnel with an earthen mound, leaving the exterior rolling security door exposed. This option requires a seal hatch and three rolling security doors. Figure 2 gives a conceptual overview of Option A. Future security requirements may be necessary such as a second hardened hatch at the exterior. Option A includes the construction steps listed below:

1. Excavate Mound
2. Prepare Foundation and Install Concrete Slab

3. Install Foundation Posts
4. Install Temporary Structural Reinforcements to Support Cell Wall
5. Cut Cell Wall and Floor for Installation of Seal Hatch Frame
6. Install Interior Seal Hatch and Frame (13 feet by 13 feet clear opening)
7. Build Access Tunnel Walls and Roof
8. Install Three Rolling Security Doors
9. Replace Mound and Asphalt Liner.

Option B cuts into the existing northeast vestibule and installs a seal hatch and hardened hatch. The existing vestibule is 12 feet wide by 10 feet high; therefore, the hatch clear opening dimensions are constrained to 10 feet by 10 feet, with modification to the vestibule roof surrounding the hatch frame. The overall length of the existing northeast vestibule is less than the length of the proposed new access tunnel in Option A. The northeast vestibule requires an exterior hardened hatch due to the shorter vestibule length and also requires that a retaining wall be added on the south and west areas. The Fuel Manufacturing Facility (FMF) is north of the ZPPR facility. The earth mound must not be disturbed north of the emergency egress tunnel (running east to west); therefore, a retaining will likely need to be added to the north area. Figure 3 gives a conceptual overview of Option B. Future security requirements may require extending the tunnel. Option B includes the construction steps listed below:

1. Excavate Mound
2. Dissect Personnel Egress Tunnel
3. Prepare Foundation and Install Concrete Slab
4. Install Temporary Structural Reinforcements to Support Existing Vestibule Roof
5. Cut Vestibule Wall and Floor for Installation of Seal and Hardened Hatch Frame
6. Install Interior Seal Hatch and Frame (10 feet by 10 feet clear opening)
7. Install Exterior Hardened Hatch and Frame (10 feet by 10 feet clear opening)
8. Reinforce Tunnel Roof
9. Install Retaining Walls and Personnel Egress Doors

Proposed facility modifications include installing ladders, platforms and catwalks, if needed, to give access to equipment mounted to the interior walls of the ZTB confinement (e.g., air handling units for the cell air cooling system), and on the outside of ZPPR confinement (e.g., chillers).

<u>Mechanical Systems</u>

All mechanical equipment outside the ZPPR cell will be placed on concrete pads on the exterior.

Decay Heat Removal

While the ZPPR containment can handle anticipated decay heat produced by a demonstration reactor, the ability of any future demonstration reactor to withstand its own decay heat will be considered in the NEPA evaluation for any proposed demonstration.

Cooling Systems

The proposed heat rejection/cooling system consists of a central plant comprised of two separate subsystems. A chilled water/glycol system provides cooled air to maintain the temperature in the ZPPR cell during reactor operation. A 500 kW direct reactor cooling system (e.g., Dowtherm Q) will supply cooling fluid to reactor cooling coils designed and furnished by the reactor demonstration proponent for direct reactor cooling. The cooling systems will be installed to the east of the ZPPR mound. The cooling systems will require piping through the new access from the cell to the equipment outside the facility.

Figure 2. Option A New Entrance Conceptual Overview.

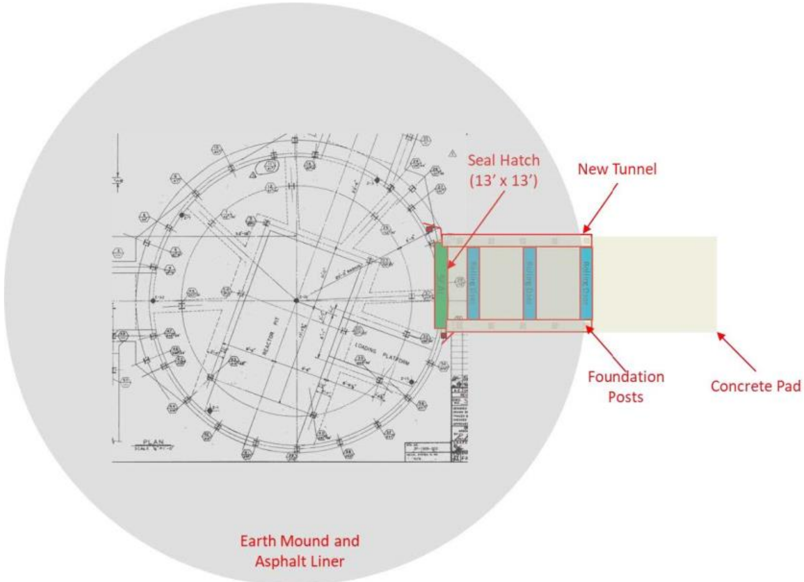
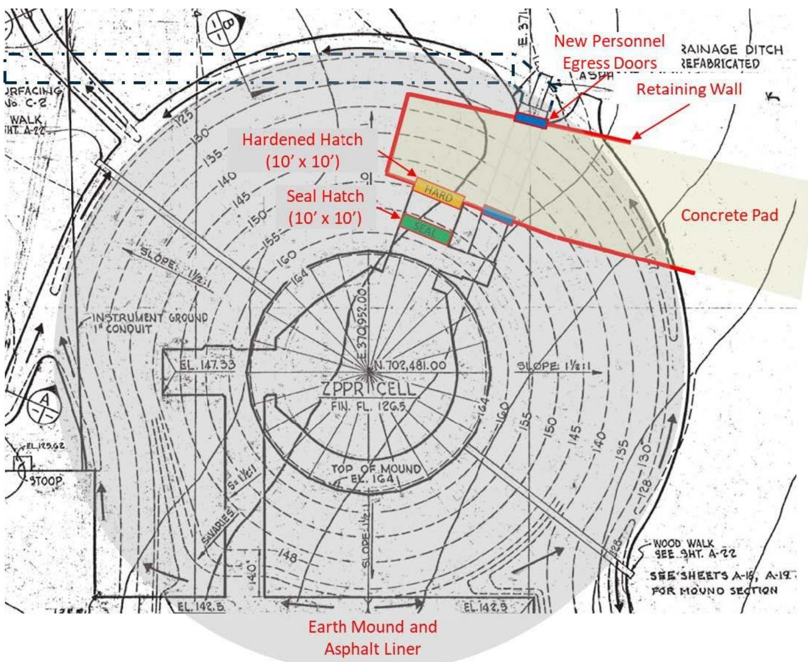


Figure 3. Option B – Modify Existing Entrance Conceptual Overview



Confinement Air Cooling

The originally proposed system had two 70-ton air-cooled chillers operating in parallel with both chillers served by one variable speed pump to circulate chilled water/glycol in a primary-only piping loop and included two pumps for both chillers. One pump is for stand-by service. The operating chilled water pump provides a constant flow of 380 gallons per minute (gpm) with 190 gpm flowing through each chiller to supply 40°F chilled water/glycol to three cooling coils contained within three 11,500 cfm air-handling units (AHUs) with two supply fans each. Each AHU supplies air to the cell to maintain temperature. Three-way modulating control valves serving the cooling coils control the supply air temperature. Based on trade studies performed since the pre-conceptual design was completed, it is anticipated that the air cooling system can be much smaller. If a smaller system is sufficient, it will be installed.

Reactor Cooling

The proposed reactor cooling system uses three dry coolers operating in parallel with the dry coolers served by a variable speed pump to circulate a heat transfer fluid (e.g., Dowtherm Q) in a primary only piping loop. There are two pumps for all three dry coolers. One pump is for stand-by service. The proposed system has one large cooler, one medium cooler, and one small cooler. Three-way modulating control valves located at each dry cooler control the load capacity for each dry cooler. The system supplies heat rejection equipment/coils with a constant Dowtherm Q fluid temperature of 110°F at variable flow rates based heat rejection operating conditions.

Pump House
The proposed action installs a modular prefabricated pump house (29 feet long by 8 feet 6 inches wide by 10 feet 6 inches tall) to house the chilled water/glycol pumps and thermal fluid pumps. One 480 Volt 3-Phase Electrical Power Panel, one 208 Volt 3-Phase electrical power panel, and one 480 Volt – 208 Volt transformer will be located on the outside wall of the pump house module. There is one chilled water fan coil unit with an electric heater located on the pump house roof.

Heating
To heat the ZPPR cell, the proposed modifications include installing three 15 kWe unit heaters mounted to the underside of the AHU structural support platforms.

Ventilation, Stack, and Monitor
The ZPPR ventilation system ties-in with other facilities within the ZPPR mound including the workroom and vault. In the original configuration, ventilation dampers acted as an isolation boundary between the cell and other mound area rooms. These dampers are no longer in service and need to be refurbished or replaced. Currently the exhaust ventilation has single stage HEPA filtration. The proposed modifications install a second stage of HEPA filters in the ZPPR cell to reduce contamination from the cell entering the exhaust header. The proposed action also installs fire dampers in the exhaust and supply ducts to isolate the cell from other areas within the mound. The proposed action requires a new stack and stack monitoring system. A system similar to those used at the Fuel Manufacturing Facility (FMF) and the Irradiated Materials Characterization Laboratory (IMCL) serve as the basis for the design of the new stack monitor. There is sufficient room within MFC-777 (south of the stack) for the stack monitoring equipment.

Trade studies will be performed to determine if a separate standalone ventilation, stack and monitoring system dedicated to the ZPPR cell would be more cost effective than the scope of modifications required to support this action. If a new system is pursued, it will meet all requirements.

Over/Under Pressure Protection

The ZPPR confinement ensures that potential releases from a demonstration reactor filter through the ventilation system. During accident scenarios the cell must not be over/under pressurized. A system to prevent over/under pressurization may be required that would result in piping/ducting routed through the new access to equipment outside the cell. If this system is required, it would include HEPA filtration of any exhaust.

Doors
There are two seal doors in the corridor to the ZPPR cell. Until a few years ago, INL maintained these seals as part of the preventive maintenance program. The proposed action requires refurbishing the seal doors and bulkheads to perform their original function.

The proposed action also installs a security door in the corridor to the ZPPR corridor between the workroom and the cell.

<u>Gas Supplies</u>

Compressed Air
Compressed air is already available for use in the ZPPR cell, and the proposed modifications do not alter the system.

Compressed Argon
Compressed argon from a bulk cryogenic tank is available in the ZPPR workroom. The proposed action supplies a connection to this system.

<u>Electrical and I&C Systems</u>

Normal Power
INL anticipates the new cooling systems will require a 600A 480V service and reactor demonstrations will require a 400A 480V service. Together these two services require about 500 kW of power. The ZPPR substation has about 800 kW of capacity remaining. The substation also has available breaker positions. The proposed action installs conduit from the substation to the cable routing room to supply power to the ZPPR cell. From the cable routing room, there are penetrations into the ZPPR cell with multiple 4-inch conduits. There is also an existing 4-inch conduit run to the desired location for the reactor power panel. Reactor control cables will also have to pass through seal boxes. There is the possibility that the power lines (400A service) could interfere with the signals. The project will install shielding for the power lines, but may need to route electrical power to the ZPPR cell without using the penetrations from the cable routing room.

The 600A service to the cooling equipment will be installed. This power will come from the ZPPR substation if a path through the ZPPR facilities can be identified and it can be determined that the power will not result in interference to the reactor control cables. However, it may be necessary to install duct bank (~500ft) from the SSPSF substation to the east side of the ZPPR mound to support the equipment.

Non-Safety Backup Power
The existing diesel generator for ZPPR is original equipment from initial construction and does not have sufficient excess capacity to supply the needed loads. The proposed action installs a new diesel generator (about 350 kW) south of building MFC-774 and adjacent to building MFC-725. The project also

installs about 100 feet of duct bank to connect the new diesel generator to the basement of building MFC-774 and makes a connection available to allow for connecting additional power generation to the facility.

Safety Backup Power
The proposed action constructs a new battery building next to the new diesel generator and utilizes the duct bank for the diesel generator. The battery building is a simple concrete block building on slab with a concrete roof. The proposed action supplies power to the building for charging the batteries, lighting in the building, and environmental controls.

The battery system is nominally 24VDC at 50A with a capacity to support up to 10 instruments (or equivalent) for up to 72 hours. The batteries require support systems to maintain the required conditions for their operation. The environmental controls are a simple mini-split heating/cooling with a simple temperature feedback.

The list below describes the major system components:

1. Battery – 12 plus 1 spare
2. Battery disconnects – 1
3. Battery chargers – 1
4. Voltage regulators – 1
5. Transformers – 1
6. Isolation breakers – 2
7. Distribution panels and associate breakers – 1

Control Room and I&C
The ZPPR control room will include a Programmable Logic Controller (PLC) that provide operator interfaces and control functions for the cooling and ventilation systems. The confinement oxygen monitoring system will also be connected using the same PLC or as a stand-alone PLC using the MFC Private Facility Control Network (PFCN).

The proposed action locates the control room in building MFC-774 just outside the entrance to the ZPPR mound in the ZPPR control room, which formerly housed the control equipment for the original ZPPR reactor. The proposed action completes the following renovations for the control room:

1. Frame new walls
2. Restore conduits from the control room to the cable routing room
3. Route conduit and fiber optic cable from the control room to the existing PFCN in the basement of the Electron Microscopy Laboratory (EML)
4. Provide general telecommunications connections to the room (i.e., phone, and INL Intranet)
5. Install operator workstations (computers separate from the control system)
6. Install furniture (e.g., operating consoles, monitor mounts, tables, chairs, etc.)
7. Install a service window to allow communications with the control room personnel without entering.

Network
The MFC PFCN offers a secure backbone for transmitting data internal to INL and has provisions for transmitting data through multiple firewalls and DMZ to outside entities. To connect to the MFC-PFCN and for data transmission beyond the PFCN, the project will install a network cabinet in the control room. In addition, a high-availability, controlled storage segment for NRIC and two high availability routers will be required in building MFC-1728 (dial room).

Life Safety

Fire Protection
The proposed ZPPR modifications will support a wide variety of advanced reactor concepts, many of which may include reactive materials (e.g., sodium) as design components, which limits the options for the fire suppression system. If INL identifies an effective fire suppression option, INL will pursue the option. Various reactors at MFC have operated in the past without active fire suppression systems for these same reasons. If an active fire suppression system is determined to be infeasible, hazardous, or ineffective, INL will complete and submit an evaluation justifying the position for approval by the INL Fire Marshal and DOE. In this situation, INL would pursue a fire detection system as the next most effective strategy for mitigating fire hazards. Along with other controls, such as non-combustible facility construction, fire barriers, and combustible loading program, fire detection systems help provide an equivalent means of protection. A fire protection system that is compliant with DOE-STD-1066 will be installed. This ECP will be revised prior to making a decision to install a fire suppression system to evaluate the environmental impacts of proposed systems and detection equipment.

Oxygen Monitoring
Based on the possible presence of non-trivial quantities of inert gases that may be used, the proposed action installs a PLC controlled oxygen monitoring system with four oxygen area monitors for personnel protection. The monitors will be equipped with strobe lights and audible alarms and positioned about equally around the perimeter of the confinement with one at the personnel entrance to the confinement near ground level. The PLC will be located in the control room with the wires from each monitor passing through an existing conduit back to the control room for termination in the PLC.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Using the ZPPR containment to demonstrate future reactors creates the potential to emit radionuclides into the environment. Subpart H of the National Emissions Standards for Hazardous Air Pollutants requires that a sampling probe be located in the exhaust stack in accordance with criteria established by the American National Standards Institute/Health Physics Society Standard N13.1-2011. The standard requires that the transport of aerosol particles from a sampling nozzle to a collector or analyzer take place in a manner that minimizes changes in concentration and size distribution of airborne radioactive materials within the constraints of current technology. The monitoring system needs to be placed in close vicinity to the stack to minimize losses in the transport lines.

This ECP does not cover emissions from potential future projects. INL will design the proposed new stack to meet the Subpart H ANSI standards in preparation for potential future emission. Emissions from projects that would have their own NEPA evaluation. INL will design the new stack in accordance with the Nuclear Air Cleaning Handbook and applicable SMACNA standards. The Nuclear Air Cleaning Handbook recommends a stack exit velocity of at least 3000 ft3/min to avoid downdraft from winds up to 22 mph, to keep rain out, and to keep condensation from draining down the stack.

INL will perform testing following modification of the ZPPR containment to ensure seal doors and filters perform as designed. Seal doors will be leak/pressure tested as applicable and filtered exhaust are anticipated to be DOP tested.

Disturbing asbestos containing building materials has the potential to contribute to air emissions.

Project activities have the potential to generate fugitive dust. The project will take reasonable precautions to control fugitive dust. If dust control methods are required, the project will record in the project records the date, time, location, and amount/type of suppressant used. Personnel are responsible for working with the Program Environmental Lead (PEL) to determine if any permitting requirements apply to generators and other equipment and, if necessary, obtaining the permit and maintaining a file of the documentation.

Mobile sources such as generators, welders, and compressors may be used temporarily (less than six months) during construction activities. These sources would be required to meet IDAPA 58.01.01.625 visible emission opacity requirements.

INL will complete an Air Permitting Applicability Determination (APAD) for the new diesel generator before installing it, and an APAD for any proposed future reactor demonstrations.

Certified refrigeration technicians will perform the installation, maintenance, servicing, and repairing of refrigeration equipment in accordance with regulatory requirements.

Discharging to Surface-, Storm-, or Ground Water

The proposed action has the potential to change storm water drainage patterns and soil porosity. These changes have the potential to cause soil erosion. However, minor soil erosion and changes in stormwater run-off us unlikely to impact groundwater quality. No wells that provide direct conduits to groundwater are located in the project area. There are also no streams or other bodies of surface water in the project area. The proposed action does not include activities that physically or chemically alter surface water resources.

Wastewater discharges from the proposed facility modifications are not anticipated.

Disturbing Cultural or Biological Resources

A cultural resource review is required for the proposed activities. Working directly with the CRMO on design modifications, adjustments, etc. will prevent potential time and monetary delays regarding the proposed activities. Furthermore, given the size and extensive scope of this undertaking, the CRMO will likely suggest consultation between DOE and the State Historic Preservation Office (SHPO) prior to the work being cleared for implementation.

ZPPR is considered a historic property (and iconic resource at the INL), and is subject to review for any potential modifications (internal and external) proposed within this EC. Modifications to the structural features of the dome (e.g. addition of penetrations for piping, etc.) may directly or indirectly effect the historic character of this building.

Generating and Managing Waste

The proposed action has the potential to generate Low Level, Hazardous, Universal, and CERCLA Wastes. Project activities involving structures and/or equipment built or manufactured before 1982 (e.g. capacitors, lubricants/dielectric fluids, transformers, painted surfaces, caulking, joint sealers, ventilation duct gaskets or insulation, electrical conduit and cable trays, other electrical equipment) may generate PCB waste (ZPPR was built before 1982).

All identified waste streams have an existing, mature disposition path, Waste Generator Services (WGS) will manage all waste. The LLW has a disposition path to the DOE Nevada National Security Site (NNSS), Clive, or Waste Control Specialists disposal facilities. The Hazardous and Universal Waste has a disposition path to one or more commercial treatment and disposal facilities. The CERCLA Waste has a disposition path to the Idaho CERCLA Disposal Facility (ICDF) or commercial disposal facilities. If Mixed Low Level Waste is generated, disposition would be available to commercial treatment and disposal facilities. Based on the volumes anticipated, these potential new waste streams are expected to have minimal impact in the INL Waste Management Program.

Releasing Contaminants

Chemical use has the potential to result in spills to air, water, and soils. While not anticipated, spills of construction products, chemicals, petroleum, and PCBs may occur.

Using, Reusing, and Conserving Natural Resources

The proposed action requires purchasing or using materials sourced from natural resources. Project activities will release known greenhouse gases (GHGs) to the atmosphere and increase INL's energy and water usage. INL's goals are that all new construction result in sustainable buildings that meet the 2016 Federal Guiding Principles as outlined by the Whitehouse Council of Environmental Quality (CEQ) and buildings are operated in the most efficient manner possible while ensuring employee safety, productivity and comfort.

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:
10 CFR 1021, Appendix B to subpart D, items B3.6, "Small-scale research and development, laboratory operations, and pilot projects."

Justification:
Project activities are consistent with 10 CFR 1021, Appendix B, B3.6, "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 Jason Anderson, DOE-ID NEPA Compliance Officer on:05/20/2021