DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-20-032

SECTION A. Project Title: Fission Gas Restraint Furnace

SECTION B. Project Description and Purpose:

Fission Gas Restraint System Description

INL is planning to design, build and install a high-pressure high-temperature furnace (hot isostatic press [HIP]) at the Materials and Fuels Complex (MFC). The purposes of the tests are to identify how pressure impacts the geometry of the irradiated fuel samples at very high temperature and measure the release of noble fission product gases from the test sample. The sample material for initial testing is currently on-hand in the Hot Fuel Examination Facility (HFEF). If any more material is required, similar materials must be obtained from the customer; all potential sample materials are already in stock at the INL. The sample size for each test is expected to be 1-5 grams. Approximately 50 runs are expected to be performed over a time frame of ~10 years. The irradiated fuel samples have a defense determination.

The following is a system description for the fission gas restraint (FGR) system that will be installed in the Fuel Conditioning Facility (FCF) air cell. The main component in the FGR system is a custom-built hot isostatic press (HIP). The FGR will be used for the measurement of fission gas release from spent fuel test specimens under overpressure restraint. The testing consists of constraining a test specimen under high-pressure inert gas and monitoring for fission gas release at elevated temperatures. To maximize the collection efficiency of fission gas released from the test specimen, the HIP must be equipped with an isolation chamber that is located solely in the hot zone of the furnace. The isolation chamber will allow for the gas surrounding the specimen to be isolated from the gas in the furnace and pressure vessel. This will allow for smaller gas volumes in the gas-sampling system, resulting in higher concentrations of fission gas. The isolation chamber will be held at a slight pressure separation from the pressure vessel. This will prevent the fission gas from escaping into the pressure vessel and only allows the gas to exit through the gas analysis system. These gases will be trapped in a cryogenic trap and measured with a gamma spectrometer. Once the test is over the trap will be heated and the gases will be released back into the hot cell or directly into FCF suspect exhaust. All condensable material released from the specimen is expected to be trapped in a filter located in the seal base of the isolation chamber. This filter may undergo additional gamma spectrometry testing but will need to be disposed of after each test. Any particles that make it past this filter will be captured in a HEPA filter in the exhaust gas piping that is part of the FGR system. The piping and filter will be considered waste once the testing campaign is over. The piping downstream of this HEPA filter will tie into FCF suspect exhaust.

The FGR system shall be capable of evacuating the HIP and isolation chamber, backfilling with inert gas, pressurizing the system up to a maximum of 30,000 pounds per square inch (psi), and ramping to a maximum temperature of 2500°F (1372°C) at a user-defined rate. At a minimum, the unit shall consist of the following components:

- Water-cooled pressure vessel
- Isolation chamber/monitored gas system
- Internal furnace and associated insulation package
- Internal structure for support of test specimens
- Vacuum system
- Pressurized gas supply and compressor system
- Venting system with overpressure protection
- Closed-loop cooling system (limited to 20 gallon capacity)
- Off-the-shelf chiller with refrigerant
- Control and data-acquisition system.

Waste Streams for Each Test Run

Test specimens: The test samples will be run at very high temperatures which will result in a loss of geometry; any and all of the fission gases (Kr-85) are expected to be released from the sample material, collected in a cryo-cooler, and measured for gamma activity. All of the TRU isotopes and solid fission products are expected to be retained within the material. After testing, the material will either be, 1) combined and melted down with EBR-II metal waste product to obscure its origin, or 2) dissolved in a strong acid, mixed with other "like" dissolved material(s) to obscure its origin, and solidified. The test samples have a defense determination.

Seal base filter: During heating of the test samples, Kr-85 will be released from the test material, transported through the piping and measured at a cryo-cooler, and exit the cryo-cooler to facility suspect exhaust. Any TRU and/or fission products that become gaseous when test material is heated to high temperatures will cool as it leaves the heat affected zone and subsequently filtered/trapped in the seal base filter prior to leaving the sample chamber. No TRU or fission products are expected to be transported to the exit piping during testing/operations. Other gases, such as tritium, may also be released, but in smaller amounts. Details on potential releases are detailed, below.

Waste Streams Once Testing Campaign is Completed

As noted above, during theating of the test samples, Kr-85 will be released from the test material, transported through the piping and measured at a cryo-cooler, and exit the cryo-cooler to facility suspect exhaust. Any TRU and/or fission products that become gaseous when test material is heated to high temperatures will cool as it leaves the heat affected zone and subsequently filtered/trapped in the seal base filter prior to leaving the sample chamber. No TRU or fission products are expected to be transported to the FGR system exit piping during testing/operations.

There is potential the interior of the seal base and isolation chamber will be contaminated with TRU and fission products. The isolation chamber will require destructive examinations (i.e., surveys/analysis) to determine the isotopic distribution of the contamination within the chamber. The amount of TRU isotopes is expected to be less than threshold quantities for TRU waste.

Pressure piping between the seal base and HEPA filter and the HEPA filter is not expected to be TRU contaminated; as noted above, the very small amount(s) of TRU will be contained within the filter base.

The 20-gallons of cooling water is used in a radiologically clean closed loop. However, since the water has flowed through a system that could have potential, however small, of contaminating the water, the water will be verified as radiologically clean via radiochemistry prior to disposal.

The customer has characterized the radionuclide content of the irradiated fuel sample using the Origen modeling software. The model assumed decay through 2015, so an additional 5 yrs of decay has reduced the amount of each isotope by a factor based on its half-life. The 2015 values have been used when estimating potential unmitigated air emissions. The FCF stack is equipped with a sampling system. For the purpose of estimating unmitigated rad emissions, the following assumptions will be used: 1) each radionulclide is present at the estimated 2015 concentration, in Ci/gram, in the irradiated fuel sample; 2) six tests per year would be performed; and 3) each test would use the maximum estimate of 5 gram of sample.

Testing is expected to begin in 2022; testing is expected to continue for a period of 10 years.
The estimated cost of the work to install the furnace is estimated at about $6M. The total cost of the test runs is estimated to be $2,500,000.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

The proposed activities could result in an increase in radioactive air emissions from the FCF main stack. The INL Site FEC-PTC (PER-152) must be revised or an APAD must be completed to determine if this modification will require an approval to construct as defined in 40 CFR 61.96 or if PER-152 will need to be revised. All radiological emissions from the FCF are passed through two stages of HEPA filters prior to being emitted to the atmosphere through the MFC Main Stack which is equipped with a continuous stack monitoring system.

Discharging to Surface-, Storm-, or Ground Water

N/A

Disturbing Cultural or Biological Resources

FCF was constructed in 1963 and is eligible for listing on the National Register of Historical Places; therefore, a cultural resource review is required.

Generating and Managing Waste

This work has the potential to generate radioactive waste in the form of Low-Level, Remote-handled Low Level and TRU-Contaminated (<100 nCi/gm) Low Level. Generation of TRU waste is not anticipated. If TRU waste is generated, it would be classified as Defense-related waste and be eligible for disposal at WIPP. The estimated amount of TRU waste generated will be < 1 cubic foot.

Used test materials will be: 1) combined with EBR-II metal waste product to obscure its origin, or 2) dissolved in a strong acid, mixed with other “like” dissolved sample material(s) to obscure its origin, and solidified for disposal. The second option has the potential to generate acidic TRU material coupled with Accountable Nuclear Material. This material will be managed as Accountable until the nuclear material has been determined to be no longer needed; then the material will be managed under RCRA.

Bulk product PCB waste may be generated if PCB-contaminated paint is disturbed.

Polychlorinated biphenyl (PCB) waste could be generated when modifying buildings built before 1982 or working with pre-1982 equipment/materials. Examples include electrical equipment/components, painted surfaces, caulking, join sealer, and insulation.

Releasing Contaminants

Although not anticipated, there is a potential for spills when using chemicals. In the event of a spill, notify facility Environmental Staff. If the Environmental Staff cannot be contacted, report the release to the Spill Notification Team (208-241-6400). Clean up the spill and turn over spill cleanup materials to WGS.

May not knowingly release refrigerants to the environment.

Using, Reusing, and Conserving Natural Resources

Irradiated fuel samples will be used for this work rather than irradiating new samples. This effectively reuses material otherwise "spent" material.

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" and B1.31, "Installation or relocation of machinery and equipment"

Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement and Record of Decision (DOE/EIS-0203, 1995) and supplemental analyses (DOE/EIS-0203-SA-01 and DOE/EIS-0203-SA-02) and the Amended Record of Decision (1996)

Final Environmental Impact Statement for the Waste Isolation Pilot Plant (DOE/EIS-0026, October 1980) and Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant (SEIS-I) (DOE/EIS-0026-FS, January 1990)

Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997) and Waste Isolation Plant Disposal Phase Supplemental EIS (SEIS-II) (DOE/EIS-0026-S-2, September 1997)

Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426, December 2014)

Final Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site (DOE/EA-1793, 2011).

Justification: The proposed R&D activities are consistent with CX 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); smallscale 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 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."

The proposed activity are consistent with CX B1.31, "Installation or relocation and operation of machinery and equipment (including, but not limited to, laboratory equipment, electronic hardware, manufacturing machinery, maintenance equipment, and health and safety equipment), provided that uses of the installed or relocated items are consistent with the general missions of the receiving structure. Covered actions include modifications to an existing building, within or contiguous to a previously disturbed or developed area, that are necessary for equipment installation and relocation. Such modifications would not appreciably increase the footprint or height of the existing building or have the potential to cause significant changes to the type and magnitude of environmental impacts."

NEPA coverage for the transportation and disposal of waste to WIPP are found in Final Waste Management Programmatic Environmental Impact Statement [WM PEIS] (DOE/EIS-0200-F, May 1997) and Waste Isolation Plant Disposal Phase Supplemental EIS (SEIS-II) (DOE/EIS-0026-S-2, Sept. 1997), respectively. The 1990 ROD also stated that a more detailed analysis of the impacts of processing and handling TRU waste at the generator-storage facilities would be conducted. The Department has analyzed TRU waste management activities in the Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) (DOE /EIS-200-F, May 1997). The WM PEIS analyzes environmental impacts at the potential locations of treatment and storage sites for TRU waste; SEIS-II addresses impacts associated with alternative treatment methods, the disposal of TRU waste at WIPP and alternatives to that disposal, and the transportation to WIPP.

The environmental impacts of transferring LLW from the INL Site to the Nevada National Security Site were analyzed in the 2014 Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada (DOE/EIS-0426) and DOE's Waste Management Programmatic EIS (DOE/EIS-200). The fourth Record of Decision (ROD) (65 FR 10061, February 25, 2000) for DOE's Waste Management Programmatic EIS established the Nevada National Security Site as one of two regional LLW and MLLW disposal sites.

Onsite disposal of RH-LLW was analyzed in the Final Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site (DOE/EA-1793, 2011).

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

Approved by Jason Sturm, DOE-ID NEPA Compliance Officer on: 5/5/2020