DOE-ID NEPA CX DETERMINATION

CX Posting No.: DOE-ID-21-123

SECTION A. Project Title: Continuation of Development of LWR Fuels with Enhanced Accident Tolerance (incl. High Burnup and High Enrichment Activities)

SECTION B. Project Description:

Framatome has been working since 2012 with the support of Department of Energy (DOE) to develop and implement Enhanced Accident Tolerant Fuels (EATF) into the US commercial nuclear industry. This proposal addresses the formal DOE Request for Financial Assistance Application Continuation of Work for the Accident Tolerant Fuel Project (CLN210122) letter dated October 29, 2020 and provides the proposed program overview and strategy that will govern the project execution over the next 48-month period from February 1, 2021 through January 31, 2025. The key objectives stated in the extension request are as follows:

DOE EATF Objectives

(1) Install the first reload quantities of accident tolerant fuel in commercial U.S. nuclear power plants by the mid 2020's. Support the qualification of this fuel for use up to 68 GWd/MTU with increased enrichments (>5 w/o U^{235}) as necessary.
(2) Continue to install accident tolerant fuel in subsequent reloads and expand the use beyond the first plants by 2026. Support the qualification of the fuel for use up to 75 GWd/MTU with increased enrichments as necessary (>5 w/o U^{235}) as necessary.
(3) Continue the pursuit of existing advanced cladding concepts (i.e., SiC) under development.

Key assumptions to these are that objectives (1) and (2) shall focus on coated metallic claddings and may include doped UO_2 pellet concepts currently under development. Proposed actions may also include work needed to scale up manufacturing processes to fabricate reload quantities of fuel at enrichments above 5 w/o of U^{235} as necessary.

The Framatome Team has developed a strategy that advances both a near-term (Coated Clad) and long-term (SiC-SiC Clad) EATF solution in alignment with the above-stated program objectives. The high-level strategy outline for Coated Cladding implementation (Objectives 1 & 2 above) is as follows:

1. Complete all characterization testing of Coated claddings and chromia-doped Pellets.
    a. Out-of-pile testing to development significant data on material and mechanical properties.
    b. In-pile (i.e., test reactors and commercial LTA programs) steady-state testing to generate irradiation dependent data and confirm behavior of models reliant on out-of-pile testing.
    c. Transient testing (out-of-pile and in-pile) as needed to confirm accident behavior and develop appropriate models.
    d. Continue a., b., and c. for high-burnup EATF cladding tubes and pellets
2. Develop appropriate material and mechanical models and implement them in Framatome's advanced codes and methods suite (ARCADIA/COBRA-FLX/GALILEO/S-RELAP5/GOTHIC) to support licensing analysis on EATF concepts.
3. Submit and support NRC review and approval of Framatome's updated licensing methods.
    a. Submit for normal burnups (or extended up to 68 GWd/MTU) for EATF fuel assemblies
    b. Submit later topical supplements for higher enrichments (>5 w/o) and burnups (up to 75 GWd/MTU) for EATF fuel assemblies
4. Complete optimization of coating manufacturing processes to achieve tightly adherent coatings with high reproducibility and minimal scrap
5. Develop non-destructive examination techniques to allow quicker quality certification of final product with less scrap.
6. Scale-up coating machinery to achieve capability to manufacture several hundred tubes per batch.
    a. Extend current prototype to advanced prototype in 2021
    b. Use lessons learned to scale up to a larger pilot coating machine
7. Implement coating manufacturing capability at Framatome's Paimbouef cladding plant.
8. Modify the HRR Fuel Fabrication Plant in Richland, WA to allow production with fuel > 5 w/o U^{235}.
    a. Includes design, criticality evaluation, license amendment for the site, and actual plant modifications and startup testing and qualification.
9. Assist utilities with identify changes and prepare their plants to receive higher-enriched fuel and burn it to burnups up to 75 GWd/MTU
10. Establish a contract with a US utility to provide a base reload of EATF fuel by the mid-2020's.
    a. Includes design, manufacture, and licensing support for a full batch reload of EATF fuel
11. Establish a new or follow-on contract to provide EATF licensed to high-burnups (up to 75 GWd/MTU)

The strategy for Objective 3 is to focus on early high value out-of-pile scoping tests to allow focusing in on the most promising candidate SiC architectures that have the highest probability of success before moving forward with expensive in-pile testing. Much of the next four-year period will be focused on optimizing a rod concept sufficiently with limited out-of-pile and in-pile testing to first:

- Fabricate and irradiate fueled SiC test specimens in a test reactor such as ATR.
- Contract with a commercial US reactor to fabricate and irradiate a segmented fueled SiC rod.

SECTION C. Environmental Aspects / Potential Sources of Impact

The Framatome Integrated Management System manual (D02-ARV-01-101-817) describes the Quality, Occupational Health and Safety (OH&S) and Environmental Management System implemented within Framatome Inc. It applies to all Framatome Inc. facilities located in the U.S. including Lynchburg, VA, and Richland, WA. It also applies to the European Framatome affiliates based overseas in Paris, Lyon, Romans-sur-Isère, Pierlatte, Paimboeuf, Rugles, Montreuil-Juignè, and Jarrie, France as well as Erlangen, Lingen, and Karlstein, Germany.

Regarding activities out of the Framatome nuclear market described in the manual, all stakeholders' codes and standards compliance is managed within the specific contracts monitored by Framatome, Inc. entities or Divisions.

The manual fulfills the requirements of the following codes, standards, and regulations:

References	Titles
National codes and standards	
Order of February 7, 2012	Order of February 7, fixing main rules relative to basic nuclear Installations (French Regulation)
KTA 1401 (11/2017)	General Requirements Regarding Quality Assurance (KTA - Kerntechnischer Ausschuss = German Nuclear Safety Standards Commission)
10 CFR 50 Appendix B	Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants (U.S. Regulation) (CFR – Code of Federal Regulations)
10 CFR 71 subpart H	Packaging and transportation of radioactive material – Quality Assurance requirements (U.S. Regulation) (CFR – Code of Federal Regulations)
10 CFR 21	Reporting of defects and noncompliance (U.S. Regulation) (CFR – Code of Federal Regulations)
ASME NQA-1 (edition2015)	Quality Assurance Requirements for Nuclear Facility Applications (ASME – American Society of Mechanical Engineers)
CSA N299.1:19	Quality Assurance Program Requirements for the Supply Of Items And Services For Nuclear Power Plants, Category 1 (Canadian Standard)
International codes and standards	
GSR part 2 (2016)	IAEA Safety Standards – Leadership and Management for Safety. The manual remains compliant with GS-R-3(2006), IAEA 50 C-QA (rev 1), IAEA 50 C-Q (1996)
ISO 9001:2015	Quality Management Systems – Requirements (ISO - International Organization for Standardization)
ISO 14001:2015	Environmental Management Systems – Requirements with guidance for use (ISO – International Organization for Standardization)
ISO 45001:2018	Occupational Health & Safety Management Systems – Requirements with guidance for use
ISO 19443:2018	Quality management systems - Specific requirements for the application of ISO 9001:2015 by organizations in the supply chain of the nuclear energy sector supplying products and services important to nuclear safety (ITNS)

Radioactive Material Use

The proposal involves production of nuclear fuel components (comprised of enriched UO_2 - <6.5 w/o. During the period of performance, thousands of kgs of enriched uranium will be fabricated into test rodlets and full-length fuel rods at

Framatome's Richland, WA fuel fabrication facility (HRR). They will be used for irradiation test programs at U.S. research reactors such as ATR and TREAT and for lead test assembly programs at U.S. commercial reactors and potentially the first batch reloads of EATF fuel. These quantities are insignificant relative to the several hundred metric tons of material processed during normal operations at HRR. All production will be performed under requirements dictated by the Framatome Integrated Management Systems (IMS) manual described above which ensures compliance with federal, state, and international regulations.

Radioactive Waste Management
As noted in the Radioactive Material Use section, Framatome will be producing nuclear fuel components (thousands of kgs of radioactive material) which will be irradiated and contribute to used nuclear waste. Waste material originating from test rodlets will be generated at DOE test facilities like ATR, TREAT, and HFIR, and therefore ultimate handling and disposal will be dictated by the DOE procedures for those facilities. Waste material originating from LTA fuel rods will be generated at commercial reactor sites and will be handled and disposed of in accordance with the sites NRC license and approved procedures. All radioactive waste that remains at the HRR facility will be processed in accordance with standard site procedures to extract uranium for reuse and dispose of remaining low-level waste in accordance with U.S. Federal and Washington State law. Again, all processes are developed and performed under requirements dictated by the Framatome Integrated Management Systems (IMS) manual which ensures compliance with federal, state, and international regulations.

Mixed Waste Generation
Framatome's fuel production process generates mixed waste in the form of clothing, gloves, and other production materials during standard production processes that are contaminated with uranium oxide at low levels. Quantities of waste produced directly through this proposal are insignificant (hundreds of kgs) relative to the waste volumes produced during normal HRR facility operations and are disposed of at federally licensed mixed waste disposal facilities. Framatome processes these wastes in accordance with Framatome's Integrated Management Systems (IMS) manual which ensures compliance with federal, state, and international regulations.

Chemical Use/Storage/Disposal
Framatome's fuel production processes use a a variety of chemicals during the normal fabrication of nuclear fuel components. Quantities of each needed for the proposal are on the order of tens to hundreds of kgs which is insignificant relative to the quantities used during normal daily fuel production. All new development activities and production operations related to this proposal will be controlled by Framatome's Integrated Management Systems (IMS) manual which ensures compliance with federal, state, and international regulations.

Hazardous Waste Generation
Framatome's fuel production processes a number of hazardous waste streams in the normal fabrication of nuclear fuel including hydrofluoric acid. Many streams are recycled and/or reused. The total quantity of hazardous waste generated in on the order of tens to hundreds of kgs which is small relative to the quantities of waste produced during normal daily fuel production. All production operations related to this proposal will be controlled by Framatome's Integrated Management Systems (IMS) manual which ensures compliance with federal, state, and international regulations.

Industrial Waste Generation
Framatome fuel production processes generate several industrial waste streams as part of the normal operation. Additional waste streams created through the proposal would include Cr_2O_3 dopant mixed in with UO_2 powder, depleted chromium targets used in the PVD coating process, and SIC waste stream associated with the production of SiC cladding. The quantity of waste generated as a result of this proposal is on the order of tens to hundreds of kgs. The development of new production processes that lead to these new waste streams is controlled by Framatome's Integrated Management Systems (IMS) manual which ensures compliance with federal, state, and international regulations.

Air Emissions
This proposal includes the addition of Cr_2O_3 dopant to the fuel. This fuel is sintered in furnaces which can potentially volatilize the chromium. Framatome process development procedures are controlled by Framatome's Integrated Management Systems (IMS) manual which ensures compliance with federal, state, and international regulations. This includes the monitoring of airborne samples to ensure all OSHA requirements are met with regard to exposure to hexavalent chromium.

SECTION D. Determine the Level of Environmental Review (or Documentation) and Reference(s): Identify the applicable categorical exclusion from 10 CFR 1021, Appendix B, give the appropriate justification, and the approval date.

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Note: 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, including requirements of DOE orders; 2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities; 3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; 4) adversely affect environmentally sensitive resources. In addition, no extraordinary circumstances related to the proposal exist which would affect the significance of the action, and the action is not “connected” nor “related” (40 CFR 1508.25(a)(1) and (2), respectively) to other actions with potentially or cumulatively significant impacts.

References: 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). For purposes of this category, “demonstration actions” means actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment. Demonstration actions frequently follow research and development and pilot projects that are directed at establishing proof of concept.

Justification: The activity consists of the pursuit of a near-term evolutionary EATF solution focused on coated claddings with doped pellets and a long-term revolutionary EATF solution focused on SiC which has the potential to bring very significant improvements in safety and reliability to the nuclear fuel being operated in nuclear plants.

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 10/15/2021.