

## Enclosure 2

The NRC seeks voluntary responses to the following questions:

**Fuel Vendors**

*(1) What ATF concepts are you pursuing?*

Response:

Framatome is developing near-term and long-term advanced fuel solutions under the PROtect program for PWR and BWR applications. The PROtect near-term solution for PWRs is comprised of chromium-coated M5<sub>Framatome</sub> cladding with chromia-doped UO<sub>2</sub> fuel, denoted Cr-Cr. A very thin chromium coating is applied on the outer surface of an existing M5<sub>Framatome</sub> cladding tube using a physical vapor deposition (PVD) fabrication process to inhibit zirconium-steam reaction and achieve enhanced performance under normal operation and accident conditions. Chromia-doped pellets are comprised of standard UO<sub>2</sub> powder with small additions of chromia (Cr<sub>2</sub>O<sub>3</sub>) dopant. Framatome is pursuing reload readiness of this near-term solution in 2023. [

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The PROtect long-term solution features a silicon-carbide (SiC) based composite cladding with chromia-doped UO<sub>2</sub> fuel. Framatome is pursuing inserting Lead Test Rods (LTRs) in a commercial reactor in the mid-2020s time frame. Additionally, Framatome is investigating beneficial applications of [

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*(2) What lead test/lead use assembly campaigns do you plan to conduct or anticipate conducting?*

Response:

Ongoing Lead Test Assembly (LTA) Programs

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*Vogtle Unit 2:* Four (4) GAIA LTAs with four (4) ATF (Cr-Cr) rods in each assembly. These LTAs were inserted into Vogtle Unit 2 in March 2019.

*ANO Unit 1:* Eight (8) B-HTP LTAs with two (2) ATF rods (Cr-coated cladding with UO<sub>2</sub> fuel) in each assembly. An additional sixteen (16) Cr-coated rods with inert pellets were supplied for reconstitution into eight (8) burnt assemblies being shuffled to core baffle locations susceptible to baffle wear. These LTAs were inserted into ANO Unit 1 in November 2019.

*Gösgen (KKGg) in Switzerland:* Two (2) KKGg LTAs with ten (10) ATF (Cr-coated cladding with standard  $\text{UO}_2$  and chromia-doped  $\text{UO}_2$  fuel) rods in each assembly. [

] These LTAs were inserted into Gösgen in June 2019.

#### Upcoming LTA Programs

*Calvert Cliffs Unit 2:* Two complete CE-HTP fuel assemblies with a full complement of Cr-Cr rods will be fabricated for insertion into Calvert Cliffs in early 2021.

*EDF 900MWe reactor:* Four (4) AFA3G LTAs with six (6) ATF (Cr-coated cladding with standard  $\text{UO}_2$  and chromia-doped  $\text{UO}_2$  fuel) rods in each assembly. [

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*(3) What types of tests (e.g., material characterization, transient, ramp, loss-of-coolant accident, post-irradiation examination, criticality, fission product releases for applicable regulatory source terms) do you plan on conducting for the qualification of your ATF concepts, and what is your current schedule for such testing? When and how do you intend to engage with the NRC on these testing plans? Alternatively, do you intend to submit a draft ATF qualification plan for NRC review? If so, what is your estimated timeframe for completion of the draft qualification plan?*

#### Response:

##### **PROtect Near-Term Solution**

Various testing programs are currently ongoing or planned on Framatome's PROtect Cr-Cr design and more specifically for coated cladding. The NRC has approved use of chromia-doped pellets for Framatome's BWR applications. The ongoing testing is more limited and focused on supplementing current data to support extending application to PWRs and then high burnup applications. Much of this cladding testing supports development of a Framatome topical report needed to support license amendment requests for reload readiness of this fuel design at operating commercial plants potentially as early as 2023. These tests include:

#### Out-of-Pile Testing

January 17, 2020

Irradiation Test Programs

Numerous programs are gathering irradiation data:

January 17, 2020

Framatome intends to continue frequent communications with the NRC on these testing plans and rate of progress throughout development of the subject topical report.

## **PROtect Long-Term Solution**

Various testing programs are currently ongoing or planned on Framatome's PROtect silicon carbide (SiC) based cladding solution. [

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Current testing includes:

### Out-of-Pile Testing

### Irradiation Test Programs

Several testing programs on unfueled samples are ongoing or planned to gather irradiation data:

Framatome intends to continue frequent communications with the NRC on testing programs and rate of progress and any resulting changes to planned timeframes for submittals.

*(4) What topical reports or supplements do you plan on submitting to the NRC for review and approval to support ATF? What is your estimated timeframe for submitting those topical reports or supplements?*

Response:

#### **PROtect Near-Term Solution**

For the near-term ATF concept, chromium-coated M5<sup>Framatome</sup> cladding with chromia-doped UO<sub>2</sub> fuel (Cr-Cr), Framatome plans to submit a supplement to the NRC-approved topical report, ANP-10340P-A, "Incorporation of Chromia-Doped Fuel Properties in AREVA Approved Methods," to extend the material properties to PWR methodologies. Framatome plans to submit new topical reports to incorporate chromium-coated M5<sup>Framatome</sup> cladding into methods, [ ] Framatome's planned submittal dates for topical reports and supplements and requested approval timeframes are communicated to NRC, periodically, separate from this RIS response.

#### **PROtect Long-Term Solution**

Framatome's long-term concept is still too early in the development phase to define a list of topical reports. Framatome's schedule for submittal of topical reports to the NRC for review and approval for the long-term concept is dependent upon the rate of progress in R&D and LTA/LTR programs.

Framatome intends to continue frequent communications with the NRC on testing programs and rate of progress and any resulting changes to planned timeframes for submittals.

*(5) Do you plan to pursue ATFs with higher burnups than your currently approved values or enrichments greater than five (5) weight percent uranium-235 (U-235)? If so, what is the estimated timeframe for these submittals?*

Response:

Yes. Framatome plans to submit a topical report for NRC's review and approval to increase enrichment beyond 5 weight percent U-235 for current designs and the PROtect Cr-Cr design.

Framatome plans to submit topical reports to support increased burnup for current fuel designs and for the PROtect Cr-Cr design. Framatome's planned submittal dates for topical reports and supplements and requested approval timeframes are communicated to NRC, periodically, separate from this RIS response.

*(6) Do you anticipate that your concepts will require rulemaking or an exemption to any regulations under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," or 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants"?*

Response:

The PROtect Cr-Cr design is not anticipated to require rulemaking to implement. An exemption request for the chromium coated M5 Framatome cladding is anticipated for implementation. The SiC design is in an early development stage and it is too early to project its needs.

*(7) Do you anticipate that your concepts will require modification of existing NRC guidance or creation of new guidance?*

Response:

Yes. As noted in the NEI Subcommittee 1 Screening Review several changes to NRC regulatory guides and NUREG-0800 were identified as potentially being required while others may be impacted based on the final specifics of the ATF concepts.

*(8) Do you plan to submit a license application or license amendment for the production of ATF on either a lead test/lead use assembly scale or a production scale? If so, what is the estimated timeframe for such submittals? Are there hazards that are not addressed in currently licensed fuel fabrication facilities such as enrichments greater than five (5) weight percent U-235 or new chemical or process hazards?*

Response:

The PROtect Cr-Cr design does not require any revised licenses for the fabrication facility. Framatome is evaluating the potential implications of a move to greater than 5 weight percent U-235 is rationalized by an acceptable safety/economic case. In the event that Framatome pursues production of nuclear fuel with a U-235 enrichment of greater than 5 weight percent, any new chemical or process hazards would be assessed and resolved as part of a license amendment request and integrated safety analysis effort with the US NRC.

**Fuel Vendors and Transportation/Storage System Certificate Holders**

*(1) Do you plan to submit an application for an amendment of a certificate of compliance (CoC) or a letter authorization for a transportation package for shipment of fresh (unirradiated) ATF on either a lead test/lead use assembly scale or a larger scale to support fresh fuel reloads? If so, what is the estimated timeframe for such submittals? Will your application discuss new materials (e.g., cladding or fuel material) whose material properties are important for safety performance?*

Response:

The MAP12/13 Safety Analysis Report for Framatome's PROtect Cr-Cr design for PWRs was approved by the NRC in 2019 for shipments <5wt% U235. The CoC for the BWR fuel transport containers is under evaluation for update or exemption request based on potential ATF concepts currently in development.

*(2) Do you plan to submit an application for an amendment of a CoC of a transportation package for shipment of fresh fuel in pellet and/or powder forms? If so, what is the estimated timeframe for such submittals?*

Response:

Framatome currently has no near term plan to submit amendments for pellet or powder containers.

*(3) Do you plan to fabricate ATF with enrichments greater than five (5) weight percent U-235 that will necessitate an amendment of a CoC of a transportation package (e.g., for the shipment of uranium hexafluoride (UF<sub>6</sub>) or other forms of uranium at an enrichment greater than five (5) weight percent U-235)? If so, what is the estimated timeframe for such submittals?*

Response:

Yes. Framatome is evaluating increasing enrichment beyond 5 weight percent U-235 and, if pursued, will request amendments of the fresh fuel transportation packages. Framatome will continue to have frequent communications with the NRC as progress is made toward that end.

*(4) Do you plan to submit an application for an amendment of a CoC of a transportation package for shipment of spent ATF? Do you plan to submit an application for an amendment of a CoC of a dry storage system for spent ATF? If so, what is the estimated timeframe for such submittals? Do you expect new materials to be necessary for the fabrication of transportation packages and dry storage systems for use with spent ATF? If so, what are your plans for identifying additional needs (e.g., materials testing) for the fabrication of these designs?*

Response:

Framatome will communicate to NRC during the frequent engagements as such plans evolve.

*(5) Do you anticipate that your application for an amendment of a CoC of a transportation package or dry storage for fresh/spent ATF will require rulemaking or an exemption to any 10 CFR Part 71 or 10 CFR Part 72 regulations (e.g., maximum enrichment for use of moderator exclusion for UF<sub>6</sub> packages in 10 CFR 71.55(g)(4))?*

Response:

As noted in the NEI Subcommittee 2 screening review, Framatome's PROtect Cr-Cr design is not anticipated to require rulemaking or exemption to 10 CFR 71 or 10 CFR 72. The CoC applications to support these ATF concepts are also not anticipated to require rulemaking or an exemption.

While Framatome is not tying the planned ATF topical submittal to increased allowable enrichment and burnup, Framatome does anticipate going forward with additional licensing activities in the future. At that time, new rulemaking to remove the 5.0 wt% enrichment limit will be needed.

*(6) Do you anticipate the need for modification of existing NRC guidance or the creation of new guidance for the safety review of your application for an amendment of a CoC for a transportation package or dry storage system for fresh/spent ATF?*



Response:

As noted in the NEI Subcommittee 2 screening review, three Interim Staff Guidance (ISG) documents were identified that would need to be revised. These are ISG-5, ISG-15, and ISG-22.

ISG-5 is related to Dry Cask Storage Cask Confinement and page 6 of the ISG does reference  $\text{UO}_2$  fuel related to inert gas environments while page 10 contains a table with release fraction values from NUREG/CR-6487 that could be impacted by fuel/clad changes.

ISG-15 is related to the material properties of cask components and fuel for both Dry Cask Storage and Spent Fuel Transportation applications. Paragraph X.4.4 provides specific criteria for Zircaloy clad fuel and references PNL-4835 (Technical Basis for Storage of Zircaloy-Clad Spent Fuel in Inert Gases, Sept 1983). This would need to be updated for non-Zircaloy clad fuel. Paragraph X.5.4.1 also references Zircaloy along with advanced alloy cladding and has broader applicability. This section needs to be reviewed further in-depth and also references NUREG-1536.

ISG-22 is related to both Dry Cask Storage and Spent Fuel Transportation for potential rod splitting during loading operations for  $\text{UO}_2$  base fuel. A revision to address non-  $\text{UO}_2$  fuel or non-Zircaloy clads is likely needed.