

## Task 2: Regulatory Framework Fuel Facilities, Transportation and Storage

The regulatory oversight of the production, transportation, and post-irradiation management for accident tolerant fuel (ATF) (i.e., the ATF fuel cycle) may involve some technical issues that are different from those addressed in the regulatory oversight of current, largely zirconium/UF<sub>4</sub>-based, nuclear fuel.

The regulations that are applicable to fuel cycle activities (Title 10 of the *Code of Federal Regulations* (10 CFR) Parts 70, 71, and 72) are general in nature and identify performance requirements rather than design approaches or design requirements. This type of regulatory language has been necessary because of the broad spectrum of facilities and designs that are licensed under these regulations. As a result, the regulations themselves are not expected to need modification to accommodate ATF.

Current review guidance is more specific and draws on industry experience in fabrication, transportation, and storage of zirconium clad UF<sub>4</sub> of up to 5 percent enrichment. It is possible that some of this guidance may need to be supplemented to address safety-related issues that could arise from certain ATF designs or the facilities and systems used to produce or manage the ATF. Potential areas where review guidance may have to be expanded include criticality safety for systems where the enrichment is greater than 5 percent and evaluation of failure mechanisms for irradiated fuel other than zirconium clad UF<sub>4</sub>.

The following table identifies the current documents that provide review guidance for fuel facility licensing, transportation package review, and spent fuel storage design review. As noted above, there may be specific topics that are not adequately covered in these documents for certain ATF designs or the facilities and systems that will produce or manage the ATF.

NRC Fuel Cycle Review Guidance

Review Guidance Document	Title
NUREG-1609	Standard Review Plan for Transportation Packages for Radioactive Material
NUREG-1520	Standard Review Plan for Fuel Cycle Facilities License Application
NUREG-2215	Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities

To facilitate industry preparation of ATF-fuel cycle applications, the Office of Nuclear Material Safety and Safeguards (NMSS) will monitor industry progress in obtaining approval for in-reactor use of ATF designs and fuel cycle industry activities in developing designs and systems for producing and managing ATF. The staff will then examine the information in the current guidance documents and identify where supplemental information or guidance may facilitate the preparation and review of applications involving the production, transportation, and storage of ATF designs. This examination will be facilitated by information on industry's fuel

cycle plans related to ATF manufacturing, transportation, and storage. These insights will be shared with stakeholders throughout the process.

#### Facility, Transportation, and Storage Reviews

The regulatory reviews to support development and deployment of ATF will occur in several fuel cycle areas over the near term to support irradiation of lead test assemblies (LTAs) and over the longer term to support batch deployment of ATF. These various reviews are discussed in the following paragraphs.

#### **Fuel Facility Reviews**

The staff expects fuel fabrication vendors to manufacture LTAs at currently licensed facilities. The ATF fabrication operations with  $\text{UO}_2$ -based fuel are expected to involve operations that are similar to currently licensed operations. Based on modifications currently anticipated for the production of LTAs using  $\text{UO}_2$ , the 10 CFR 70.72 change process is likely to support these changes without NRC approval. Licensees are expected to review the change and seek review when necessary.

License amendment requests for the fuel fabrication facilities, particularly if there is large scale production of ATF assemblies that are substantially different from the current  $\text{UO}_2$  based fuels, are possible. If enriched uranium greater than 5 percent  $\text{U}235$  is needed, amendment requests are expected to authorize the plants to produce the higher enriched material. Any facility change to produce  $\text{U}_3\text{Si}_2$ -based or uranium metal-based ATF is expected to require an amendment which will likely require greater effort than an amendment request for the production of  $\text{UO}_2$ -based ATF. It is expected that any such requests would be made later. These activities are expected to be addressed in future updates of this plan as industry plans become more certain.

#### **Unirradiated Fuel Transportation Package Reviews**

In the near term, the staff expects vendors developing ATF to request approval of packages for transporting LTAs from the fabrication facilities to reactors for test irradiation. These requests will be reviewed against the requirements of 10 CFR Part 71 and the staff will use NUREG-1609 for review guidance.

As industry prepares for batch loading of ATF, the staff expects there will be requests for the approval of transportation packages that allow large-scale shipment of unirradiated ATF assemblies. It is expected that any such requests will be made later and such activities are expected to be addressed more specifically in future updates of this project plan as industry plans become more certain.

#### **Irradiated Fuel Transportation Package and Storage Cask Reviews**

It is expected that any shipments of irradiated ATF LTAs or rods from ATF LTAs will be made in NRC-approved shipping packages. It is possible there will be requests under 10 CFR Part 71 for a limited number of shipments of irradiated LTAs over a limited timeframe similar to what is expected for unirradiated LTAs.

For batch loading of ATF, the staff expects there will be requests for the approval of transportation packages under 10 CFR Part 71 that allow large scale shipment of irradiated ATF assemblies. It is expected that any such requests will be made after FY2020 and such activities will be addressed in future updates of this project plan as industry plans become more certain.

If ATF assemblies other than LTAs are used in NRC-licensed reactors there will be a need for storage systems for irradiated ATF that are licensed under 10 CFR Part 72. This need for irradiated ATF storage systems is expected to develop later and are expected to be addressed in future updates of this project plan as industry plans become more certain.

### Potential Challenges

Certain aspects of ATF designs and/or fuel cycle implementation strategies could affect the scope, level of complexity, and schedule of the staff's review.

The major fuel cycle changes that are possible as a result of ATF development include (1) higher enriched uranium (e.g., greater than 5 % enrichment), (2) different fuel material (e.g., Cr-doped UO<sub>2</sub>, U<sub>3</sub>Si<sub>2</sub> or metallic fuel material) and (3) different cladding; (e.g., FeCrAl, SiC, or coated zirconium cladding). The number and nature of changes in these areas affect the effort required to review proposed fuel cycle changes. The following table identifies potential regulatory actions for the fuel cycle facilities and operations that might be required for these potential changes.

Potential ATF Fuel Cycle Action	Potential Regulatory Actions at Affected Facilities/Operations			
	Enrichment Facility	Fuel Fabrication Facility	Transportation Operations	Irradiated Fuel Storage Facility
Higher Enrichment	License amendment to produce higher enrichment material	License amendment to manufacture higher enriched fuel	Application for amendment to or new transportation packages (fuel material)	Applications for amendments to or new spent fuel storage systems are expected regardless of ATF enrichment (see box below)
Different Fuel Material, Cladding		Facility changes. Ones with greater safety significance (e.g., 10 CFR 70.72(c)) will require NRC approval	Application for amendment to or new transportation packages (unirradiated fuel, irradiated fuel)	Applications for amendments to or new spent fuel storage systems with ATF-specific license conditions

The greater the differences between an ATF design and zirconium-clad UO<sub>2</sub>, the more likely that supplemental review guidance will be required and the more likely the review will require greater staff effort. As an example, one potential ATF fuel material, U<sub>3</sub>Si<sub>2</sub>, is more susceptible to chemical reactions (e.g., water, air) than UO<sub>2</sub>. This hazard needs to be considered in the design and operation of a facility producing or storing this material and the facility design and operating plans will have to be reviewed in the licensing process.

### Lead Test Assemblies

There will be limited fuel cycle activities associated with the fabrication and transportation of LTAs. The regulatory challenges associated with LTA programs are expected to be limited, but the experience will provide insight into issues that may have to be addressed for batch use of ATF.

### Initiating Activity

The staff expenditures associated with developing regulatory strategies and the framework for design-independent ATF fuel cycle licensing began in FY2017 and will continue as long as the Department of Energy and industry are actively pursuing ATF development. The staff expenditures to support design-specific fuel cycle regulatory hurdles will begin with the receipt of an application which presents the details that the staff must review.

### Deliverables

There are near term fuel cycle regulatory actions assumed to be associated with the approval of transportation packages for unirradiated and irradiated LTAs. These are presented in the following table. Other regulatory deliverables may be identified in future revisions of the plan after industry actions become clearer.

<b>Working Title</b>	<b>Assumed Submittal Due</b>
Review of unirradiated LTA 1 transportation package	2017
Review of unirradiated LTA 2 transportation package	2018
Review of unirradiated LTA 3 transportation package	2019
Review of irradiated LTA 1 transportation package	2018
Review of irradiated LTA 2 transportation package	2019
Review of irradiated LTA 3 transportation package	2020

*Technical Leads:*

*Fuel Facilities: NMSS/FCSE/FMB, Transportation and Storage: NMSS/SFM/RMB*