Accident Tolerant Fuel Lead Test Assemblies

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Irradiating Lead Test Rods / Lead Test Assemblies

LTR/LTAs play an important role in seeking NRC approval for new design features by

1) demonstrating in-reactor performance,

2) providing pool-side, post-irradiated examination (PIE) data collection for in-reactor characterization, and

3) providing irradiated material for subsequent hot-cell examination and research.

Existing Regulatory Provisions

Plant Technical Specification allow for the irradiation of a **limited** number of LTAs in **nonlimiting** core regions

- The determination of a limited number of new design features may be based on engineering judgment and unapproved codes and methods
- The determination of nonlimiting core region may be based on engineering judgment and unapproved codes and methods

Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

Limited Number Determination

- For unproven, first of a kind design features, the number of candidate designs should be limited such that in the event of anomalous behavior including failure (e.g., loss of fission barrier),
  1) plant monitoring systems and Operators would be capable of detecting and responding, as necessary,
  2) predicted offsite and control room radiological consequences remain within allowable limits following a postulated accident,
  3) coolable geometry is maintained and the plant is capable of achieving safe shutdown following a postulated accident, and
  4) new design features do not negatively interact with co-resident fuel or plant systems.

- The level of confidence increases with irradiation experience acquired through test reactors and LTA programs and the characterization of irradiated properties and performance.

- The number of LTAs considered a reasonable “limited” number would tend to increase with the level of confidence.

Nonlimiting Location Determination

- Past LTA programs have limited peak linear heat generation rate (LHGR) to 90-95% of the peak core value to justify a nonlimitng location.

- Several of the EATF candidates may be paired with design features aimed at improving the overall economics of the new fuel design (e.g., high density fuel). For these designs, it may be prudent to develop a commercial LTA program where the fuel is placed in a more limiting location and is being pushed at power densities and achieving exposures at or exceeding the target design values. For this application, a license amendment request demonstrating reasonable assurance of safe performance in the limiting core location would be required.

LTR/LTA Safety Assessment

- Any changes in fuel geometry and/or fissile content must be accounted for in core physics and TH predictions
- Any changes in fuel composition or fissile content must be accounted for in radiological consequence predictions
- As a minimum, research must be conducted on any new material or design feature to fully characterize the unirradiated material, mechanical, chemical, thermal, and nuclear properties and its performance under a wide range of accident conditions
- As irradiation experience grows and irradiated material characterization matures, the latest state-of-knowledge must be considered in subsequent irradiation cycles and to justify the “limited” number and “nonlimiting” core locations for additional LTR/LTA programs.

Is an exemption from 50.46/50.46c required for LTR/LTAs?

- Applicability of 50.46 limited to UO_2 pellets within cylindrical zircaloy or ZIRLO cladding
  - 50.46 does not provide a means to comply with GDC-35 for any other fuel system combination
  - Exemptions have been issued to expand applicability to other zirconium-based cladding alloys (with UO_2 pellets)
    - Demonstration (via testing) of acceptable performance up to 2200F/17%ECR analytical limits

- An exemption to 50.46 is <u>not</u> required for LTR/LTAs irradiated under Technical Specification provisions
  - Safety assessment must address GDC-35 via knowledge of fuel performance under LOCA conditions and determination of limited quantity and nonlimiting core location

- 50.46c recognizes that plant Technical Specifications allow for the irradiation of LTR/LTAs

- An exemption to 50.46c is <u>not</u> required for LTR/LTAs irradiated under these provisions
  - Safety assessment must address GDC-35 via knowledge of fuel performance under LOCA conditions and determination of limited quantity and nonlimiting core location

10 CFR 50.46c(k) Use of NRC-approved fuel in reactor.

(1) Fuel load. A licensee may not load fuel into a reactor unless the licensee determines that the fuel meets either the requirements of paragraph (d) of this section or, for uranium oxide and mixed uranium-plutonium oxide pellets within cylindrical zirconium-alloy cladding, the fuel specific analytical limits and requirements in paragraph (g) of this section, ***or otherwise complies with technical specifications governing lead test assemblies in its license.***