Lead Test Assembly Program

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Introduction

In today's competitive market place, many NPPs see the value of having multiple fuel vendors qualified to provide core reloads. Qualification of alternative fuel and/or fuel with new design features requires specific licensing and design activity. Most alternative fuel designs are based on a previous operating design with some improvements or modifications including new material utilization. To gain operating experience and better understand the fuel compatibility issues, utilities introducing new fuel into a core have typically initiated a Lead Test Assembly (LTA) program. Most LTA programs involve placing six or more fuel assemblies in a non-limited core power location. Placing a limited number of lead test assemblies (LTA) into an operating core is a preferred way for obtaining necessary in reactor experience. This paper will explore activities associated with successful implementation of an LTA program.

Plant Licensing Basis and Regulatory Requirements

While most countries do not have specific regulations regarding the placement of LTAs, this activity can involve a regulatory review in three separate areas. First a review of regulatory design and operating criteria may be required to determine if the LTA design complies with the NPPs country regulatory criteria. Most of the LTAs design features will already have been reviewed and approved by the fuel vendor's country regulatory authority or by a regulatory authority where the fuels design features are now operating. A compatibility review of design and operating criteria will determine if additional evaluations or analyses are required to demonstrate compliance with the operating plants country regulations.

After a compatibility review of criteria is performed, an additional review will need to be performed to determine if there are any formal requirements for development of licensing documentation. In the US, a safety evaluation following the requirements of 10 CFR 50.59 is required to be preformed. This evaluation is not submitted to the regulatory authority. Most countries do not have specific regulations for introducing a limited number of fuel assemblies with new design features into an existing operating core. Where this is the case, a utility should follow the same process for making a design change in the plant. All necessary documentation should be identified and a schedule established that is consistent with the placement of the LTA reload.

An LTA program may require the acceptance of new technology in the form of computer codes that will also accompany the new fuel design. Westinghouse computer codes for fuel designs have already been through an extensive review by US and International regulatory agencies where the fuel is being used. In many cases a regulatory review may only require a review of the approvals granted by other regulatory authorities. Regulatory involvement may also be involved in review and acceptance of the quality assurance programs that are used in the design and manufacture of new fuel. This review typically requires submittal of the QA program followed by an audit. The most important aspect of the gaining regulatory acceptance for the LTA program is to identify and schedule all evaluations, analyses, reports and reviews so that they can be accomplished in a schedule consistent with the plant's reload.

Plant interface review.

LTA programs will require a careful review of all plant procedures to ensure compatibility with the operating NPP. This review should address the fuel handling requirements for both the handling tool compatibility and any new requirements for mechanical stresses introduced on by the new fuel (LTA) design. These reviews need to be conducted in the new fuel storage areas, reactor core and spent fuel storage pools. In addition, any start up restrictions on power accention should be reviewed to ensure compatibility with both the existing and LTA assemblies.

Compatibility with Resident Fuel and Reactor Environment

In addition to being compliant with regulatory criteria, alternative fuel designs should be compatible with resident fuel and the reactor environment (mechanical, hydraulic, nuclear design, chemistry and instrumentation). Mechanical compatibility must be maintained with all core internals, which the LTAs come in contact with. These include the upper and lower core plates, and instrumentation tubes. Mechanical compatibility is assured through a combination of mechanical test and analyses. Hydraulic compatibility is accomplished by designing new fuel with pressure drop closely matching the pressure drop of the resident fuel. Matching the pressure drop minimizes cross flow between the new and the resident fuel. Uncertainties in matching pressure drops are considered in the evaluation of DNB margins. The LTA approach, with a limited number of LTAs placed in non-limiting core power locations should not impact existing DNB margin and power peaking factors. Chemistry compatibility can be assured with a combination of test programs, material selection and previous reactor experience. For example, comparison analysis of the reactor condition of PWR and VVER-1000 affected to the corrosion performance (such as coolant temperature, heat flux, void fraction and pH regimes) indicates that PWR chemistry conditions are bounding and the advanced alloy is expected to have similar corrosion performance in the VVER coolant chemistry.

Safety Analysis

Implementing alternative fuel by a LTA program requires addressing all design basis events of the existing core design. The LTA program must demonstrate that the fuel meets established safety criteria during normal operation and postulated transient conditions. Most LTA programs require no changes to plant control or protection systems Westinghouse has demonstrated that in most cases, only an evaluation is required to demonstrate that existing safety analysis remain applicable. This evaluation will review a limiting number of accident analyses key parameters to determine if the existing fuel features bound the LTA fuel. For example, the LTAs are placed in non-limited locations. This means that all of the rods in the LTAs will produce less power then the core hot rods. The margin in peak power between the LTAs and the existing fuel should be sufficient to offset any transition core effects that may reduce relative flow to the LTAs.

Post Radiation Examination

The intent of the LTA program is to determine how well the new fuel is behaving in the resident core. While important information will be gained during the core operation, a post radiation program will also provide valuable information on the new fuel design reliability and compatibility. During manufacture, data characterizing the LTAs should be collected and documented in a formal report. This information could then be used as the basis for comparison with actual post irradiation examination measurements taken on the LTAs. Following each cycle of irradiation, the LTAs should be inspected. Specific areas of examination could include rod length, peripheral rod corrosion, diameter measurements and assembly bow.

Conclusion

Implementation of the new/alternative fuel requires addressing all aspects of the fuel assembly design basis (Mechanical, fuel handling, thermal-hydraulic, nuclear design, chemistry, safety analysis and licensing and including mix core effects. The scope of the work is minimized by implementing an LTA program with a limited number of assemblies (6 or more), using approved designed features, and placing the LTAs in a non-limited core power location. The LTA program is a prudent means of introducing new core designs into existing cores.

Biographical Sketch

Dennis Popp has been working in the Nuclear industry for thirty-five years, with Westinghouse Electric. He has managed the licensing of projects in the US, Europe and Asia. Mr. Popp lead the Westinghouse licensing team in gaining regulatory approval for the Temelin Fuel and I&C. He is now actively involved in the regulatory efforts of placing six lead test assemblies in the South Ukraine NPP.