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DUKE POWER

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U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Document Control Desk

Subject: McGuire Nuclear Station
Docket Numbers 50-369 and -370
Catawba Nuclear Station
Docket Numbers 50-413 and -414
Mark-BW Fuel Assembly Replacement Skeleton (Cage) Design

Introduction

This letter is to advise the NRC of Duke Power Company's intent to use non-mixing vane fuel assembly cages in the event that recaging of Mk-BW (mixing vane) fuel is necessary at McGuire and Catawba Nuclear Stations. Non-mixing vane cages will be used in order to eliminate a potential for fuel failure which may result from damaged mixing vanes during the recaging process.

Background

Duke Power is committed to improving its nuclear fuel reliability, and in 1991 adopted a zero defect objective. Elimination of leaking nuclear fuel minimizes hot particles, contaminants, and helps to reduce personnel dose exposure.

Duke has communicated with the NRC several times concerning its overall plan of fuel examinations, fuel repair, and the intended use of natural UO_2 replacement rods. Occasionally during such reconstitution campaigns a leaking fuel rod will break during removal, generally because of severe secondary hydriding. Although such occurrences have been infrequent and the frequency should become even less as Duke repairs all leakers at the end of their initial cycle of failure, nevertheless some broken rods may occur.

Duke's approach to recover from a broken rod at Oconee Nuclear Station has been to recage the assembly. That is, to remove all non-failed rods and install them into a new specially designed skeleton from B&W Fuel Company (BWFC). As part of Duke's nuclear fuel reliability program, Duke is now having replacement skeletons

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(cages) manufactured by BWFC for use at McGuire or Catawba. The cages would be used should a broken rod occur in a BWFC Mk-BW 17 x 17 fuel assembly.

Discussion

Generic analyses have been performed to evaluate the performance of the non-mixing vane cage design in terms of mechanical, thermal hydraulic, and LOCA criteria. These evaluations support future event specific 10CFR50.59 analyses which shall be performed to justify recaged fuel assembly operation.

Spacer grid mixing vanes are located on the top side of spacer grids and protrude inboard the individual grid cells, limiting the available rod insertion path and increasing the likelihood of bending vanes during fuel recaging procedures. Certain conditions possibly resulting from bent mixing vanes can be detrimental to fuel reliability. These include an increased potential for grid to rod fretting should a bent vane vibrate against the rod cladding during operation due to flow forces. Also, bent vanes could negatively impact fuel performance by creating localized flow blockages or reduced mixing within the subject assembly.

Both fuel rod and fuel assembly bow contribute to the possibility of bending mixing vanes during rod insertion. The straightness of replacement cages is controlled during fabrication, therefore assembly bow should not contribute to the bent vane condition during a recage. However, since previously irradiated fuel rods are transferred into the fresh replacement cage during recaging procedures, even slight rod bow could increase the likelihood of bending mixing vanes during rod insertion procedures.

The non-mixing vane cage will contain only zircaloy-clad fuel containing natural or enriched UO_2 pellets and is structurally identical to the standard Mk-BW fuel design with the exception of the absence of mixing vanes. However, the lack of mixing vanes creates two differences that must be evaluated from a DNB perspective. First, the non-mixing vane Zircaloy grids have a lower form loss coefficient (FLC) and therefore will cause some local flow re-distribution. Flow will be diverted out of the adjacent mixing-vane assemblies and into the non-mixing vane caged assembly. Therefore, this change affects both the adjacent assemblies and the recaged assembly. The recaged assembly will have lower DNB performance because of the absence of mixing vanes. However, the non-mixing vane fuel assembly receives more net flow due to the lower FLC's of the grids, thereby significantly offsetting the thermal penalty of the vane removal.

These two changes were evaluated by Duke with the VIPRE-01 thermal-hydraulic code using approved models and methods (References 1 and 2; see attached list of References). The BWC critical heat flux correlation (Reference 3) was used to evaluate the DNB performance of the non-mixing vane cage, and BWCMV critical heat flux correlation (Reference 4) was utilized for the standard Mk-BW fuel. For a conservative assembly configuration, the impact of each effect was calculated. From these calculations, a generic DNB penalty was determined to bound each of the two effects. Cycle designs that include a non-mixing vane caged assembly and will be reviewed against this generic evaluation. All methods used in this evaluation have been previously reviewed and approved by the NRC.

The differential flow conditions discussed above will have a negligible impact on the mechanical and thermal performance of the fuel. In the event of a recage, approved methodologies will be utilized to justify the operation of the replacement cage and remaining fuel assemblies of the given cycle design in these performance areas. The cage design has been evaluated by BWFC in terms of compatibility with irradiated fuel rods considering differential rod and assembly growth, compatibility with other irradiated fuel assemblies with respect to differential assembly growth, and structural adequacy considering normal and faulted operational loads. The design was determined structurally acceptable in each of these areas up to 61,300 MWd/mtU.

The impact of the non-vaned grids on the LOCA driven linear heat rate (LHR) limits has also been evaluated by BWFC. This evaluation was necessary since B&W's Mk-BW large break LOCA analysis (described in Reference 5) utilizes grid models which take credit for mixing vanes. Previously documented analyses which compared mixing vane and non-mixing vane grid effects on LOCA behavior were utilized to justify a conservative LHR penalty for the recaged assembly.

Conclusion

Duke plans to proceed with the use of non-mixing vane cages if required for fuel reconstitution, unless there are questions from the NRC. If any more information is desired, please call Scott Gewehr at (704) 382-7581.

Very truly yours,

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References

1. VIPRE-01: A Thermal-Hydraulic Analysis Code for Reactor Cores; EPRI NP-2511-CCM, Vol. 1-4, Battelle Pacific Northwest Laboratories, July 1985.

2. DPC-NE-2004P-A, Duke Power Company McGuire and Catawba Nuclear Stations Core Thermal-Hydraulic Methodology Using VIPRE-01, December 1991.

3. BWC Correlation of Critical Heat Flux, BAW-10143-A, Babcock & Wilcox, April 1985.

4. BWCMV Correlation of Critical Heat Flux in Mixing Vane Grid Fuel Assemblies, BAW-10159, Babcock & Wilcox, May 1986.

5. Mark-BW Reload LOCA Analysis for the Catawba and McGuire Units, BAW-10174A Revision 1, Babcock & Wilcox, September 1992.