Detroit Edison

Fermi 2
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(313) 586-4000

Nuclear Operations

October 23, 1996
NRC-96-0124

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

2) Detroit Edison Letter to NRC, "Supplemental Information Regarding Proposed Technical Specification Change (License Amendment) - Safety Limit - Minimum Critical Power Ratio (MCPR)," NRC-96-0119 dated October 14, 1996

Subject: Supplemental Information Regarding Proposed Technical Specification Change - Safety Limit - Minimum Critical Power Ratio (MCPR)

On October 14, 1996 Detroit Edison provided supplemental information regarding a proposed License Amendment to change the Minimum Critical Power Ratio (MCPR) Safety Limits in Technical Specification 2.1.2. Included with that submittal was a proprietary report from General Electric which provided an explanation of differences between the Fermi 2 cycle specific calculation and the generic calculation for the Minimum Critical Power Ratio (MCPR) Safety Limits. Attachment 1 to this letter provides a version of that report having the proprietary information excised.

AOO1/,

If you have any questions, please contact Mr. Joseph Conen at (313) 586-1960.

Sincerely,

Peter W. Smith
Director, Nuclear Licensing

Attachment

cc: A. B. Beach
M. J. Jordan
A. J. Kugler
A. Vegel
Supervisor, Electric Operators, Michigan
Public Service Commission, J. R. Padgett

ATTACHMENT 1

DESCRIPTION OF FERMI 2

CYCLE SPECIFIC ANALYSIS

AND

COMPARISON TO GENERIC ANALYSIS

(NONPROPRIETARY)

Non GE Proprietary Edition

GE Nuclear Energy

Nuclear Fuel-Americas
Mail Code A33
*Fax 8*292-5684*

October 8, 1996
LB# 262-96-159

cc: R.J. Bragg
C.L. Heck
J.L. Rash
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ETS 290TAC
Mr. B.L. Myers
Principal Engineer, Nuclear Fuel
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SUBJECT: **Fermi 2 Cycle 6 SLMCPR Licensing Clarification**
Non GE Proprietary Edition

REFERENCES:

1. NEDC-32505P, *R-Factor Calculation Method for GE11, GE12 and GE13 Fuel*, November 1995.
2. Licensing Topical Report, *General Electric BWR Thermal Analysis Basis (GETAB): Data, Correlation and Design Application*, NEDO-10958-A, January 1977.
3. *General Electric Standard Application for Reactor Fuel*, NEDE-24011-P-A-13-US, August 1996.

Dear Mr. Myers:

In order to assist in answering the NRC questions about the Fermi 2 Cycle 6 Safety Limit MCPR (SLMCPR) calculation the following information is being provided:

1. Control Rod Pattern Development for the Fermi 2 Cycle 6 SLMCPR Analysis

Projected control blade patterns for the rodded burn through the cycle were used to deplete the core to the cycle exposures to be analyzed. At the desired cycle exposures, the bundle exposure distributions and their associated R-factors, determined in accordance with Reference 1, were utilized for the SLMCPR cases to be analyzed. The use of different rod patterns to achieve the desired cycle exposure has been shown to have a negligible impact on the actual calculated SLMCPR. An estimated SLMCPR was obtained for an exposure point near beginning of cycle (BOC), middle of cycle (MOC), and end of cycle (EOC), in order to establish which exposure point(s) would produce the highest (most conservative) calculated SLMCPR. For Fermi-2 Cycle 6, a middle-of-cycle (MOC) point of 6000 MWd/STU was used in lieu of the peak hot excess reactivity (PHE) exposure point since the peak hot excess reactivity for Cycle 6 occurs at BOC.

The Safety Limit MCPR is analyzed with radial power distributions that maximize the number of bundles at or near the Operating Limit MCPR during rated power operation. This approach satisfies the stipulation in Reference 2 that the number of rods susceptible to boiling transition be maximized. GENE has established criteria to determine if the control rod patterns and resulting radial power distributions are acceptable. These criteria were discussed with the NRC inspection team during the May 5-9, 1996 inspection and have since been incorporated into the GENE technical design procedures. These criteria include no gross violations of Technical Specification operating limits (e.g., MCPR, MAPLHGR, LHGR), criticality (calculated, normalized k_{eff} near one) and total number of

bundles within 0.20 of the MCPR of the core. Different rod patterns were analyzed until the criteria on the above parameters were met. The rod pattern search was narrowed by starting from a defined set of patterns known from prior experience to yield the flattest possible MCPR distributions. This was done for the two most limiting exposure points in the cycle (the BOC point was excluded by criteria as non-limiting). A Monte Carlo analysis was then performed for the MOC and EOC-1000 MWd/STU exposure points to establish the maximum SLMCPR for the cycle.

2. Why the Fermi 2 Cycle 6 SLMCPR is 1.09 versus the Generic GE11 Value of 1.07

Table 1 summarizes the relevant input parameters and results of the SLMCPR determination for both the generic GE11 core and the Fermi 2 Cycle 6 core.

GESTAR II (Reference 3) specifies that the SLMCPR analysis for a new fuel design shall be performed for a large high power density plant assuming a bounding equilibrium core. The GE11 product line generic SLMCPR (1.07) was determined according to this specification.

Fermi 2 Cycle 6 is not an equilibrium core. It is a mixed core of mainly GE11 with a smaller proportion of GE9B and GE6 fuel. Also, the Fermi 2 Cycle 6 core is loaded such that the fresh batch of GE11 has the highest enrichment (3.66%), as compared to a core average enrichment of 3.30%, as shown in Table 1.. By way of comparison, the generic GE11 equilibrium core has batch and core average enrichments of 3.25%.

Over the last two cycles, the average enrichment for the fresh fuel has progressively increased in the Fermi 2 cores. The once-burnt and twice-burnt GE11 bundle enrichments are 3.53% and 3.31%, respectively. The GE6 has the lowest enrichment (1.76% and 2.19%), with the GE9B enrichment at 3.21%. Higher enrichment in the fresh fuel (compared to the rest of the core) produces higher power in the fresh bundles relative to the rest of the core. The fact that the is on the average producing a is not apparent from the lower maximum and for the Fermi-2 Cycle 6 transition core as compared to the generic GE11 equilibrium core as depicted in Table 1. This suggests that the with respect to the bundles within has been made by distributing the more uniformly among the (for Fermi-2 Cycle 6 versus for the generic GE11).

The higher power loading on the GE11 fuel in the Fermi 2 Cycle 6 transition core causes more of these bundles to be closer to the core MCPR. In Table 1 it is shown that of the total bundles have MCPR that are within in CPR of the core MCPR. For the generic GE11 equilibrium core only of the bundles are within in CPR of the core MCPR. The closer the bundles operate in CPR to the core MCPR, the more rods these bundles will contribute to the calculated number of rods susceptible to boiling transition. Note that the number of bundles within ΔCPR of the core MCPR is less in Cycle 6, but a much larger number of uncontrolled bundles are close to the core MCPR. This is an important distinction which is discussed in more detail below.

For the Fermi 2 Cycle 6 transition core, more bundles have MCPRs that are within ΔCPR of the core MCPR. These bundles with lower MCPRs contribute more rods calculated to be susceptible to boiling transition than bundles with higher MCPRs. In general, the calculated safety limit is dominated by two key parameters: (1) and (2) in either parameter yields more rods susceptible to boiling transition and thus a higher calculated SLMCPR. The Fermi 2 Cycle 6 core has a flatter core MCPR distribution than the generic GE11 equilibrium core. This is the primary reason the calculated SLMCPR for the Fermi 2 Cycle 6 core is 0.02 higher than the calculated SLMCPR for the generic GE11 equilibrium core.

The uncontrolled bundle pin-by-pin power distributions were compared between the dominant Cycle 6 GE11 bundle and the GE11 bundle used in the generic SLMCPR analysis. For the Fermi 2 Cycle 6 bundle, there is a slightly flatter distribution of uncontrolled R-factors for the highest power rods in each bundle, which in the calculation are rods very likely to be susceptible to boiling transition. This slightly flatter uncontrolled R-factor distribution causes a slightly higher calculated SLMCPR, but the uncontrolled R-factor differences provide only part of the explanation for the calculated 1.09 SLMCPR result in Cycle 6.

Another important difference is that the Cycle 6 analysis uses completely uncontrolled bundles in the SLMCPR analysis, whereas in the generic GE11 analysis only of the bundles within ΔCPR of the core MCPR were uncontrolled. By keeping the limiting bundles uncontrolled, one is assured of having the flattest possible pin-by-pin R-factors in the SLMCPR calculation. By design, the R-factor distributions are optimized for their uncontrolled state, and control blade insertion causes the distributions to become more peaked (or less flat). Therefore, the most conservative approach is to perform the SLMCPR calculation where the "base" rod pattern places all the potentially limiting bundles in an uncontrolled state. This contrasts to the GE11 generic study where only about of the limiting bundles (out of) were uncontrolled.

Table 1: Comparison of Generic GE11 and Fermi 2, Cycle 6 Cores

Quantity, description	GE11 Generic	Fermi 2 Cycle 6
Number of Bundles in Core	764	764
Limiting Cycle Exposure Point	PHE	EOC-1000
Cycle Exposure at Limiting Point [MWd/STU]	5500	8800
Latest Reload Batch Fraction [%]	32.46%	23.04%
Latest Reload Average Weight % Enrichment	3.25%	3.66%
Core Average Weight % Enrichment	3.25%	3.30%
Core MCPR	1.2565	1.3319
% bundles within ΔCPR of Core MCPR		
% bundles within ΔCPR of Core MCPR		
% bundles within ΔCPR of Core MCPR		
% uncontrolled bundles within ΔCPR of Core		
Maximum Relative Power		
% bundles within of Maximum Relative Power		
Calculated Safety Limit MCPR	1.07	1.09

3. Why is the Single Loop SLMCPR Adder Equal to 0.02 instead of 0.01?

A number of plant-specific single loop operation (SLO) SLMCPR calculations have been performed for GE11 and the other fuel product lines. These calculations use the same procedure as described above for the cycle-specific dual-loop SLMCPR calculation, except that they apply the larger uncertainties specified by Reference (2) for SLO conditions. The conclusion of these calculations is that the SLO adder is . For the appropriate SLO SLMCPR adder is 0.02. This result is contrasted to the 0.01 SLMCPR adder calculated in the generic GE11 safety limit calculation, . The 0.02 SLO SLMCPR adder is applicable for Fermi-2 Cycle 6, and results in a SLO SLMCPR of 1.11. Based on the verified data accumulated to the present, the 0.02 adder is conservative for

Summary

Based on all of the facts, observations and arguments presented above, it is appropriate to conclude that the calculated SLMCPR value of 1.09 for the Fermi 2 Cycle 6 transition core is reasonable. It is reasonable that this value is 0.02 higher than the 1.07 value calculated for the generic GE11 equilibrium core. Furthermore, the trend in the calculated SLMCPR values versus the cycle exposure are also consistent with the fact that in this specific transition cycle the calculated SLMCPR is dominated by the high-enrichment batch of GE11 fuel. At MOC and EOC the calculated SLMCPR (based on the Monte Carlo analysis) values are 1.07 and 1.09, respectively. A flat to slightly upward trend in the calculated values through the cycle is characteristic of transition cores where the fresh batch of fuel dominates as is the case for the Fermi 2 Cycle 6 core. By analyses we have confirmed that the calculated SLMCPR value of 1.09 for this specific Fermi 2 Cycle 6 core meets the Safety Limit confirmation requirements in Reference 3. In addition, the SLO SLMCPR of 1.11 is reasonable and conservative for application to Cycle 6.

Sincerely

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