FINAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT WCAP-13360-NP, SUPPLEMENT 1, REVISION 0,

"CLARIFICATION ON USE OF DYNAMIC ROD WORTH MEASUREMENT (DRWM)

IN INITIAL PLANT START-UP APPLICATIONS"

WESTINGHOUSE ELECTRIC COMPANY

PROJECT NO. 700

1.0 INTRODUCTION

In a letter dated March 9, 2011 (Reference 1), the Westinghouse Electric Company (Westinghouse) submitted to the U.S. Nuclear Regulatory Commission (NRC) staff Topical Report (TR) WCAP-13360-NP, Supplement 1, Revision 0, "Clarification on Use of Dynamic Rod Worth Measurement (DRWM) in Initial Plant Start-up Applications," for the staff review and approval. Specifically, this submittal is to request NRC approval to use the DRWM on initial plant start-ups.

The DRWM technique is a method of measuring the reactivity worth of individual control and shutdown rod banks. It is a fast process that is accomplished by inserting and withdrawing the bank at the maximum stepping speed, without changing boron concentration, and recording the signals on the ex-core detectors. The recorded signals are processed on a conventional reactivity meter, which solves the inverse point kinetics equation with proper analytical compensation for spatial effects.

The DRWM has proven to be an accurate and safe physics testing method with over 200 applications around the world. In this submittal, Westinghouse is requesting to use this accurate and proven methodology for initial plant start-ups.

This application would be limited to Westinghouse-designed Nuclear Steam Supply System (NSSS) with Westinghouse licensed fuel products and would include the additional requirements noted herein.

ENCLOSURE

By letter dated January 5, 1996 (Reference 2), the NRC approved the use of the DRWM technique at Westinghouse pressurized water reactors. In the Safety Evaluation Review, the NRC staff made the following conclusions about the DRWM technique:

> Based on our review as outlined in the evaluation in Section 2.0 above, we conclude that the dynamic rod worth measurement technique is acceptable for measurement of rod worth at the beginning of reload cycles for two, three, and four loop Westinghouse cores.

This acceptance is based on using the technique as outlined in Attachment B of Reference 3, and applying the evaluation criteria and remedial actions also outlined in Reference 1. It is also limited to use with the rod patterns and rod worths bounded by those used in the sensitivity studies provided in Reference 2.

2.0 TECHNICAL EVALUATION

In this submittal, Westinghouse pointed out that the original TR, WCAP-13360-P, did not stipulate that the DRWM methodology was limited to reload applications only. However, the NRC staff did stipulate this requirement in the approval, which Westinghouse accepted at that time, since initial plant start-ups were not envisioned when the TR was initially approved. The Westinghouse DRWM methodology calculates the dynamic spatial factors for the banks each cycle, on a plant-specific basis. Consequently, there is no reliance on previous cycle data to determine sensitivity correlations.

2.1 Changes to review criteria

An initial core has no history; consequently, there is a lack of fuel burnup and fission product distribution data. The measurements performed on a clean core (initial core) are expected to be much more accurate than those of a reload core. For that reason, Westinghouse has tightened the review criteria on individual bank worths to 10 percent or 75 percent mille (pcm). The criteria specified in the NRC approved TR are 15 percent or 100 pcm. This change to the review and criteria is specific to the initial plant start-up applications only and is based on prior initial plant start-up experience.

2.2 Replacement of 5 percent FLUX map

Attachment B of Reference 3 describes the actions to be taken upon failure of the individual bank worth review criteria. Failure of these criteria indicates a possible inconsistency in the core power distribution caused by differences between the design and the as built core, or a core anomaly (dropped rod, misloading, etc.). For this reason, a power distribution measurement (full core flux map) is required prior to exceeding 5 percent power when the measurement difference is confirmed. This is consistent with the misload analysis in place for Westinghouse plants at the time of the approval.

When WCAP-13360-P-A was written, it was applicable only for plants equipped with a moveable in-core detector system; however, many of the Westinghouse NSSS plants that will be going through initial start-ups will have a fixed in-core detector system. Although fixed in-core detector systems have been reviewed and approved by the staff, fixed in-core detectors lack the ability to perform a power distribution measurement below ~20 percent power.

Westinghouse has proposed in this submittal that for the initial plant start-up, any bank that is confirmed to fail the individual bank worth review criteria, as stated above, will be re-measured by either Boron Dilution or the Rod Swap methodology. Both of these methods are NRC approved for first cores and within the licensing basis for these new units coming on-line.

In addition, in any case that the results from subsequent measurement using either of these other two methods fails the bank worth criteria, then power ascension is halted. The collected data will be reviewed considering other measurement information to determine a possible cause (e.g., unlatched rod control cluster assembly, misloaded assembly). The core design analyst will then assess the particulars of the failure, such as magnitude and consequences, and provide a safety assessment to allow power ascension to ~25 percent rated thermal power (RTP).

The plant will then perform a fixed in-core detector based power distribution measurement. In addition, Regulatory Guide 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” Revision 2, specifically recognizes that initial flux maps can be taken above 5 percent power, depending on the sensitivity and approval of the in-core instrumentation.

Westinghouse pointed out in this submittal, that throughout WCAP-13360-P-A, Westinghouse did not stipulate that this methodology was limited to reload applications only. The NRC stipulated this requirement in the approval, which Westinghouse accepted at that time, since initial plant start-ups were not envisioned when the TR was initially approved. Since Westinghouse calculates the dynamic spatial factors for the banks each cycle, for each plant, there is no reliance on previous cycle data to determine sensitivity correlations. Table 1 below from the Westinghouse submittal (Reference 1) compares reload core review criteria and resolution with the initial core review criteria and resolution.

Table 1: Reload vs. Initial Core Criteria and Resolution

Reload Core Review Criteria and Resolution	**Initial Core Review Criteria and Resolution**
Individual Bank Worth Review Criteria	Individual Bank Worth Review Criteria
□ Within 15 percent or 100 pcm	□ Within 10 percent or 75 pcm
If the individual bank worth fails	If the individual bank worth fails
□ Investigate the failure by re-measurement	□ Investigate the failure by re-measurement with Dynamic Rod Worth Measurement
If the individual bank worth fails the investigation/re-measurement	If the individual bank worth fails the investigation/re-measurement
□ Measure the bank by dilution or swap	□ Measure the bank by dilution or swap
If any of the failures cannot be resolved by re-measurement	If any of the failures cannot be resolved by re-measurement
□ Review data in detail to see if there is a probable cause (e.g., unlatched rod cluster control assembly (RCCA), misloaded assembly).	□ Review data in detail to see if there is a probable cause (e.g., unlatched RCCA, misloaded assembly).
□ Perform a full core flux map prior to exceeding 5 percent power	□ The core design analyst will evaluate the magnitude of the failure and provide a safety assessment to allow power ascension to ~25 percent Rated Thermal Power to perform a fixed in-core detector based power distribution measurement.

3.0 CONCLUSION

In summary, the NRC staff has reviewed the request by Westinghouse dated March 9, 2011. The submittal contained a request to utilize the DRWM for initial plant start-ups. The requested application is limited to Westinghouse-designed NSSS and Westinghouse licensed fuel products. The submittal also contained additional requirements for use of the DWRM methodology for initial plant start-ups. Based on the review, the staff concludes that the DRWM methodology is acceptable for use with initial cores subject to the criteria specified in the Table 1 of the submittal (Reference 1), and the acceptance criteria stipulated in Appendix B of Reference 3.

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the safety evaluation will not be inimical to the common defense and security of the health and safety of the public.

4.0 REFERENCES

1. J. Gresham, Westinghouse Electric Company, LTR-NRC-11-9, WCAP-13360-NP, Supplement 1, Revision 0, “Clarification on Use of Dynamic Rod Worth Measurement (DRWM) in Initial Plant Start-up Applications,” dated March 9, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML110740612).

2. NRC Letter, submitted to the N. Liparulo, Westinghouse Electric Company, WCAP-13360-P, “Westinghouse Dynamic Rod worth Measurement Technique,” dated January 5, 1996 (ADAMS Accession No. ML063410295 (Non-publicly available)).

3. NRC Letter, submitted to the N. Liparulo, Westinghouse Electric Company, Appendix B of “Westinghouse Dynamic Rod worth Measurement Technique,” dated July 30, 1998 (ADAMS Accession No. ML063410295 (Non-publicly available)).

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