September 10, 2004

Mr. Gordon Bischoff, Manager
Owners Group Program Management Office
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: DRAFT SAFETY EVALUATION FOR TOPICAL REPORT WCAP-16011P, "STARTUP TEST ACTIVITY REDUCTION PROGRAM" (TAC NO. MB8724)

Dear Mr. Bischoff:

On May 31, 2003, the Westinghouse Owners Group (WOG) submitted Topical Report (TR) WCAP-16011P, "Startup Test Activity Reduction Program" to the staff for review. Enclosed for the WOG's review and comment is a copy of the staff's draft safety evaluation (SE) for the TR WCAP-16011P.

Pursuant to 10 CFR 2.390, we have determined that the enclosed SE does not contain proprietary information. However, we will delay placing the draft SE in the public document room for a period of ten working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects. If you believe that any information in the enclosure is proprietary, please identify such information line-by-line and define the basis pursuant to the criteria of 10 CFR 2.390. After ten working days, the draft SE will be made publicly available, and an additional ten working days are provided to you to comment on any factual errors or clarify concerns contained in the SE. The final SE will be issued after making any necessary changes and will be made publicly available. The staff's disposition of your comments on the draft SE will be discussed in the final SE.

To facilitate the staff's review of your comments, please provide a marked-up copy of the draft SE showing proposed changes and provide a summary table of the proposed changes.

If you have any questions, please contact Girija Shukla at 301-415-8439.

Sincerely,

/RA/

Robert A. Gramm, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 694

Enclosure: Draft Safety Evaluation

cc w/encl: See next page

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DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

WCAP-16011P, "STARTUP TEST ACTIVITY REDUCTION PROGRAM"

WESTINGHOUSE OWNERS GROUP

PROJECT NO. 694

1.0 INTRODUCTION

By letter dated March 31, 2003, the Combustion Engineering Owners Group (CEOG) (hereafter referred to the Westinghouse Owners Group [WOG]) submitted Topical Report (TR) WCAP-16011P, for NRC staff review. Additional information was submitted on September 29, 2003, and April 21, June 30, and July 21, 2004. The NRC staff exchanged information with the WOG staff in the form of a telephone conference on several occasions in the course of this review.

The TR describes changes to pressurized water reactor reload startup testing to reduce testing operations and testing time while achieving the following objectives: (1) ensure that the core can be operated as designed, and (2) employ normal operating procedures in the startup evolution. In this context the use of the reactivity computer is not considered to be a "normal operating procedure."

WCAP-16011P describes a method to reduce the time required for startup testing. To this end, the TR proposes to eliminate the control element assembly (CEA) worth and isothermal temperature coefficient (ITC) measurements at hot zero power (HZP). The TR also proposes to substitute the measured value of the moderator temperature coefficient (MTC) at HZP with an alternate MTC value consisting of the predicted (calculated) MTC and measured critical boron concentration (CBC) at HZP. An ITC measurement at intermediate to hot full power (HFP), and applicability requirements for core design, fabrication, refueling, startup testing and CEA lifetime viability will also be added.

This method will be applied to cores that are well characterized by an existing database. The proposed testing is called the startup test activity reduction (STAR) program and will be the basis for technical specification compliance verification for the MTC and in some Combustion Engineering (CE) plants, the shutdown margin (SDM).

2.0 REGULATORY EVALUATION

The regulations (10 CFR Part 50) do not deal explicitly with startup testing. In the past, the NRC staff exercised oversight based on the provisions of the applicable American National Standard Institute (ANSI), in this case ANSI/ANS 19.6.1. However, except for the NRC staff's general interest in preventing core abnormalities through startup testing, the value of the MTC (a quantity measured and validated in the startup tests) is in the technical specifications, and therefore, is subject to regulatory oversight.

This review is based on the provisions of the most recently approved, but not yet issued, version of ANSI/ANS 19.6.1. WCAP-16011P references the earlier version that was approved in 1997. However, the last response to the NRC staff's requests for additional information (dated July 21, 2004) references the currently approved version of ANSI/ANS 19.6.1.

3.0 SUMMARY OF WCAP-16011P

Section 3 of the TR delineates the series of tests run by participating CE plants that Westinghouse calls the generic startup testing program. The generic program is considered to be representative of the acceptable set of startup tests. This generic program is compared to the STAR program. Section 3 also lists applicability requirements which need to be satisfied for a specific plant and specific loading to apply the STAR program.

3.1 Evaluation of the Impact of Changes to the Generic Program

Section 4 of the TR discusses the proposed changes in detail. The concept of the "problem" is adopted from the ANSI/ANS 19.6.1 standard for reload physics testing. Core configurations which are not explicitly accounted for in the analysis are referred to as problems. Startup testing can detect as well as initiate problems. Each problem is evaluated separately because it may be impacted by all changes in the program. The problems are divided into three groups:

- Design prediction problems (i.e., accuracy of the design methods);
- As-built core problems, related to core design, fabrication, or reassembly; and
- Test performance problems, related to use of test equipment, processes, or results.

Four design, nineteen as-built, and three test performance problems were identified for evaluation. The systematic approach used to identify problem types, and the structure of the database are discussed in Appendices A, B, and C of the TR. Appendix D discusses test performance problem initiation, Appendix E discusses problem evaluation, and Appendix F discusses deviations from the generic program by participating plants.

3.1.1 Impact of Changes on the Design Prediction Problems

The parameter inaccuracies of interest in this TR are those measured in the startup evolution, i.e., CEA worth, CBC, ITC, MTC and power distribution. The TR describes the criteria, the information required for the evaluation, and the process used to perform the evaluation of the measured results for each of the measurements listed.

3.1.2 Impact of Changes on the As-Built Core Problems

The 19 as-built problems are: CEA worth, CBC, ITC, power distribution, MTC noncompliance, SDM noncompliance, fuel fabrication error, fuel misloading, fuel distortion, fuel poison loss, fuel crudding, CEA fabrication error, CEA misloading, CEA uncoupling, CEA distortion, CEA absorber loss, CEA finger loss, reactor coolant system (RCS) anomaly, and RCS Boron-10 (B-10) depletion. The TR includes a short description and analysis of the impact of each of the 19 problems.

3.1.3 Impact of Changes on the Test Performance Problems

The TR evaluates the impact of changes on test performance, i.e., test-initiated errors which have the potential to significantly affect the operation of the core. The test performance errors which were identified for evaluation are test equipment errors, test process errors and test results errors. Unique or infrequently used equipment or practices have the potential to result in errors impacting core operation. Likewise, erroneous results have the potential of impacting operation through substitution of measured values for predicted values. The report describes the performance problem evaluation criteria, the required information, and the performance evaluation.

3.1.4 Changes to the Generic Testing Program

The TR concludes that the STAR testing program should eliminate the need for measuring CEA worth at HZP, the ITC at HZP, and the MTC at HZP. The program adds an alternate MTC at HZP, an ITC at intermediate to HFP, core design applicability requirements, fabrication applicability requirements, refueling applicability requirements, startup testing applicability requirements, and CEA lifetime applicability requirements. (Note: under some circumstances the MTC at HZP is maintained.)

3.1.5 Impact of Changes to the Generic Startup Test Program

The TR summarizes the conclusion of the analysis (in Section 4.0) that the STAR program is essentially the same or better than the generic program in ensuring that the core will operate as designed.

For parameters which are not measured in the STAR program, the uncertainties are bounded by the analyses. This is ensured by the addition of the applicability requirements. Similarly, the ITC accuracy remains the same when the ITC at HZP is replaced with the ITC measurement at power.

Regarding the as-built core problems, the TR draws a similar conclusion that the STAR program results are the same or better than the generic program based on the addition of the applicability requirements. A similar conclusion is drawn for the evaluation of the test performance problems.

The TR briefly discusses the acceptability for the CEA flux change or flux rate change as an alternative to the CEA drop characteristic test. The elimination of the middle-of-cycle (MOC) at power ITC measurement to verify end-of-cycle (EOC) MTC compliance with the technical specifications is acceptable for plants that eliminated this measurement using the methodology in Amendment 1 of TR CE-NPSD-911-P-A.

3.2 Appendices

3.2.1 Appendix A: Review of Industry Problems

This appendix describes the method by which relevant databases were searched to identify documents related to the identification and analysis of problems related to the STAR program. The searches included the NRC databases, the Institute for Nuclear Power Operations (INPO) databases, the Westinghouse databases and the participating plant databases. The searches turned up 110 documents that might apply to the STAR program.

3.2.2 Appendix B: Review of Startup Tests

The purpose of this appendix is to describe the analyses of the data. The analyses determine the best estimate (BE) value of the parameters which are involved in the STAR measurements. The BE value is the calculated average value of the parameter corrected for the bias between the measured and the calculated value. The objective of the analyses is to justify the elimination of the ITC and CEA measurements at HZP. In addition to the bias, the analyses examine data variability and poolability for CEA and ITC.

3.2.3 Appendix C: As-Built Core Problem Detection

This appendix describes methods used in detecting as-built core problems during startup testing. The purpose of these methods is to determine the effectiveness of pre-operational activities, STAR applicability requirements, and startup tests in detecting as-built core problems. The method is based on information from the ANSI/ANS 19.6.1 - 1997 standard on startup tests. The searches for as-built core problems are structured as matrices to consider types of problems most likely to occur, typical method of performing the test, and typical test criteria used.

3.2.4 Appendix D: Test Performance Problem Initiation

This appendix describes the development of a matrix that provides the likelihood that the various startup tests will initiate test performance problems. The information is used to determine changes in the likelihood between the generic and the STAR programs. The considerations are test equipment problems, test process errors, and test result errors.

3.2.5 Appendix E: Problem Evaluation

This appendix evaluates the effect of the changes to the generic program that result from implementation of the STAR program. The evaluation is concerned with problems in design prediction, as-built cores and test performance. The purpose of the evaluation is to establish the acceptability of the STAR program to replace the generic startup test program. This appendix examines each one of the tests to establish the acceptability of the change.

3.2.6 Appendix F: Deviations from the Generic Program by Participating Plants

Plants with deviations from the generic program are not considered in this review because the applicability requirements do not apply.

4.0 TECHNICAL EVALUATION

This review is focused on the proposed elimination of CEA, ITC, and MTC at HZP, the addition of the alternate MTC at HZP, the measured ITC at intermediate power, the critical boron concentration (CBC) at HZP, the addition of the estimation of the applicability requirements for core design, fabrication, refueling, startup testing, and CEA lifetime requirements.

Basically, the proposed method eliminates the CEA, ITC, and MTC measurements at HZP and adds applicability requirements which ensure the similarity of the core under consideration to the cores used to construct the database. The uncertainties of the calculated parameter values (of the eliminated HZP measurements) bound the uncertainties of the measured values, thereby, ensuring core safety. This is reasonable because of the applicability requirements and the performance record of the analytical methods in calculating the core reload parameters.

For the CE plants which contributed to the database and for core loadings which meet the STAR applicability requirements, technical specification changes will be required to implement the STAR program. The MTC value must be verified to be within the plant-specific core operating limits report (COLR) limits before entering Mode 1 operation.

4.1 Design Uncertainty Prediction Evaluation

As it was noted earlier, the accuracy of the design parameters of interest in the startup testing are CEA worth, CBC, ITC, MTC and power distribution. The power distribution could affect any or all of the parameters of interest.

The evaluation criterion to be satisfied for each parameter is that the analytic uncertainties of the parameter that is eliminated in the STAR program be bounded by the uncertainties from the comparison of measured and calculated values of similar cores of similar plants.

The value of each measured parameter during startup is compared to the calculated value of the same parameter. A database is used to determine a mean value and an uncertainty for each parameter. These uncertainties are specific to the core design method and the type of plant. A parameter can be eliminated in the startup tests if its analytic best estimate value is bounded by the historical best estimate and uncertainty determined from previous measurements and predictions. The uncertainty values are analyzed for normality (in accordance with ANSI N15.15) and probability of the data using the Bartlett test.

Appendix B of the report contains a substantial database of analyses of recent startup test results. The analytical methods used for the determination of the parameters are DIT/ROCS, PHOENIX/ANC, and CASMO/(SIMULATE or XGT or PRISM). The results constituting the database are recent, meaning that they have been compiled after the methods have undergone substantive modifications. Therefore, recent does not imply chronological scale rather an evolutionary stage of the analytical tools. The data covers a wide range in the evolution of core designs including variations in fuel management, fuel enrichment, poison type, poison loading, and fuel exposure.

Individual CEA bank worth data analysis demonstrates that there is no bias and the subsets for the three methods are poolable. The same holds true for the total-worth data, i.e., the sum of the CEAs in the core. Examination of the data justifies the elimination of the measurement of CEA at HZP.

The same conclusion is reached in the analysis of the ITC data at HZP, i.e., there is no bias and recent calculated values are well within the uncertainty limits. The ITC probability was extended to different core burnups to demonstrate that the data provided the same information for all of the core conditions examined. This justifies the elimination of the ITC measurements at MOC and EOC, which verify MTC compliance with the COLR and technical specification requirements. This supports the conclusion of ANS-19.6.1 in eliminating MOC and EOC measurements to validate technical specification requirements for MTC.

A review of the database revealed three instances of CEA problems (i.e., instances where the CEA worth was not bounded by the uncertainty analysis). Examination of the causes for the deviations revealed failure to account for plutonium decay, failure to apply the proper bias, and failure to benchmark a low-leakage core loading. Hence, there was a failure to recognize that these cores did not comply with the core applicability requirements.

A similar search for CBC problems revealed only one case of inaccuracy which was not discovered during HZP testing, but at MOC. The STAR program does not affect the CBC surveillance.

A search of the database for ITC inaccuracies at HZP did not identify any such cases. The ITC at HZP is eliminated in the STAR program and replaced with an ITC measurement at power. Analysis shows that the ITC at HZP can be eliminated because the data are poolable and adherence to the applicability requirements ensures that the core is similar to the cores used to generate the database.

Search of the database did not identify any instances of power distribution inaccuracy problems. However, the power distribution measurements are not affected by the STAR program. Based on the preceding discussion, the NRC staff concludes that as far as design prediction uncertainties are concerned, the STAR program is acceptable because the applicability requirements ensure that the design parameter uncertainty is bounded by the safety analyses.

4.2 Impact of Changes on the As-Built Core Problems

This section examines the impact of the changes to the generic program on the as-built core problems. As-built core problems are deviations from the intended core design and are errors in the core design or physical characteristics of the core. Identification of as-built problems is based on experience and engineering judgment. The following 19 areas were identified for evaluation: CEA worth, CBC error, MTC error, power distribution error, noncompliance in MTC and SDM, fuel fabrication error, fuel misloading error, fuel distortion error, fuel loss of poison error, fuel crudding, CEA fabrication error, CEA misloading error, CEA uncoupling error, CEA distortion error, CEA absorber loss error and CEA finger loss error, RCS anomaly, and RCS Boron-10 depletion.

The criterion for determining the effectiveness of problem evaluation is to eliminate the occurrence of problems. The information required for the evaluation is the effectiveness of preoperational activities, startup activities, and the applicability requirements in detecting as-built core problems. The process involves the construction of matrices for each activity (pre-operation, startup testing, and applicability requirements) where the effectiveness of each problem entry is empirically rated as "good," "fair," and "poor." The process evaluates and compares the effectiveness of the generic program, the program changes, and the STAR program in detecting as-built problems.

Using the above criterion, information and evaluation process, ability of the STAR test series to detect as-built core problems in the 19 identified problem areas are evaluated in the following.

- CEA worth error detection

  CEA worth errors are those resulting from errors in the application of core design methods. A search of the database did not identify any such errors. However, the STAR method for CEA error detection is judged to be as effective as the generic program. This is due to the addition of the core design applicability requirements, which will flag core design errors which could impact CEA worth.

  The NRC staff concludes that the STAR CEA worth error effectiveness is as good as that of the generic program, and therefore, it is acceptable.

- CBC error detection

  CBC errors result from faulty application of core design methods. A review of the database did not reveal any instances of such errors. The STAR program retains the CBC measurement at HFP but removes the ITC and the CEA worth at HZP. Analytical errors affecting CBC are also likely to affect ITC and CEA worth. However, detecting CBC errors from CEA measured values of CEA worth, ITC, or power distribution is not effective because the CBC is more sensitive than the other three parameters.

  The NRC staff concludes that the STAR CBC error detection is at least as effective as the generic program, and therefore, it is acceptable.

- ITC error detection

  ITC errors result from faulty application of core design methods. A review of the database did not reveal any instances of such errors. The STAR program replaces the ITC-at-HZP measurement with an ITC-at-HFP measurement. It is shown that the HFP measurement is just as effective as the HZP measurement because the added core design applicability requirements are effective in identifying ITC errors prior to reactor operation.

The NRC staff concludes that the STAR program ITC error detection is as effective as the generic program, and therefore, it is acceptable.

- Power distribution error detection

Power distribution errors result from faulty application of core design methods. A review of the database revealed one case of a power distribution error. The error was detected by the incore flux symmetry at power. This test is included in the STAR program.

The NRC staff concludes that the ability of the STAR program to detect power distribution errors compared to the generic program is not affected, and therefore, it is acceptable.

- MTC noncompliance detection

MTC values which are outside technical specification limits are noncompliant, although a review of the database revealed many instances of MTC values outside the technical specification limits. In all cases corrective actions were implemented and no technical specification violations were recorded. Review of the database did not reveal any discrepancies in the calculated values of either MTC or ITC. The measured MTC values in the data base were collected from HZP measurements. The STAR program substituted the MTC at HZP with an alternate surveillance test which adjusts the calculated MTC value at HZP using the CBC at HZP to produce a best-estimate MTC at HZP. The test criteria for MTC will result in the detection of MTC noncompliance, because they are used to establish the technical specification limits for MTC.

The NRC staff concludes that the STAR program uses the core design applicability requirements, which in combination with the core design quality assurance criteria is as effective in the detection of MTC noncompliance as the generic program, and therefore, it is acceptable.

- SDM noncompliance detection

SDM values which are outside technical specification limits are noncompliant. A review of the database revealed one instance of SDM noncompliance involving shutdown CBC detected by core design quality assurance. The STAR program does not alter CBC or the quality assurance program. The addition of the core design applicability requirements enhances the core design error detection which impacts the SDM. SDM is not a technical specification requirement in the CE Standard Technical Specifications. However, verification of the SDM at HZP is a technical specification requirement in some plants.

The NRC staff concludes that the addition of the core design applicability requirements in the STAR program and the core design quality assurance is more effective in identifying SDM errors than the generic program, and therefore, it is acceptable.

- Fuel fabrication error detection

  Fuel fabrication errors occur when the as-built fuel characteristics are different than those for the intended design. Fuel parameters which could contribute to fuel fabrication errors are enrichment, poison loading, fuel pellet size and location, fuel rod placement and poison rod placement. Review of the database revealed fourteen instances of fuel fabrication errors. Eight of these errors were detected before fuel shipment, three were identified by plant receipt inspection, and three were identified by incore power distribution tests at power.

  The NRC staff concludes that the STAR program does not affect fuel fabrication quality assurance, utility receipt inspection, or the core power distribution test at power, and therefore, the STAR fuel fabrication error detection is acceptable.

  Recent improvements in the fabrication process such as gamma scanning to verify enrichment and use of bar codes instead of serial numbers have reduced the frequency of fuel fabrication errors.

- Fuel misloading detection

  An error in the placement of fuel in the core is a misloading error. Review of the database revealed five instances of fuel misloading. One was detected by core quality assurance, two were detected by the core symmetry test at power, and two by the power distribution test at power.

  The STAR program does not affect the core design quality assurance, the core flux symmetry, or the core power distribution test. All of the fuel misloading methods are carried over to the STAR program. Therefore, the NRC concludes that the STAR method fuel misloading detection program is acceptable.

- Fuel distortion detection

  Fuel distortion occurs when changes due to operation or assembly result in operating characteristics different than the design assumptions. Reactor operation can result in fuel distortions such as bowing. Fuel handling or assembly can result in fuel distortions such as cracks or breaks. Review of the database revealed eight instances of fuel distortion. Three were detected by CEA drop time tests, two by CEA manipulations, two by CEA trips, and one by CEA inspection.

  The STAR program retains the CEA drop time test and the other methods used to identify fuel distortion. The changes from the generic program do not affect the CEA drop time test or the other detection methods. Therefore, the NRC staff concludes that the STAR fuel distortion detection methods are acceptable.

- Fuel poison loss detection

  Fuel poison degradation occurs when burnable poison is degraded through burnup depletion or physical loss. Review of the database did not reveal any recorded instances of fuel poison loss.

  The STAR program retains the methods for fuel poison detection, and the changes from the generic program do not affect the fuel poison loss detection. Therefore, the NRC staff concludes that the STAR fuel poison detection methods are acceptable.

- Fuel crudding detection

  Fuel crudding occurs when deposits of foreign material accumulate outside the fuel cladding, distorting flow, heat transfer and poison distribution. Review of the data base identified five instances of crudding detected by incore flux mapping at power.

  The STAR program retains the fuel crudding detection program. The changes to the generic program do not affect the crudding detection. Therefore, the NRC staff concludes that the STAR program crudding detection program is acceptable.

- CEA fabrication error detection

  CEA fabrication errors occur when the as-built CEA characteristics are different than the intended design. A review of the database revealed one instance of a CEA fabrication error, which was discovered by CEA fabrication quality assurance.

  The STAR program does not affect the CEA fabrication quality assurance program. Therefore, the NRC staff concludes that the STAR program fabrication assurance capability is acceptable.

- CEA misloading detection

  Misloading would result if a CEA is placed in the wrong core location and/or orientation. A review of the database did not identify any CEA misloadings. However, the proposed changes do not impact the CEA misloading program.

  Therefore, the NRC staff concludes that the STAR program CEA misloading detection capability is acceptable.

- CEA uncoupling detection

  An uncoupling error is an improper assignment of the individual control rods of a CEA or loss of connection to the driving mechanism. A review of the database indicates that there have been eight recorded instances of CEA uncoupling. Four were detected by HZP flux symmetry tests, one was detected by flux symmetry at power, one by the incore power distribution at power, and two were detected by position indications.

The uncoupling detection using incore flux symmetry and power distribution tests is not affected by the STAR program. In addition, the STAR program includes the flux symmetry test at power, which is effective at detecting CEA uncoupling. In general, the STAR program does not affect the CEA uncoupling detection. Therefore, the NRC staff concludes that the uncoupling detection capability of the STAR program is acceptable.

- CEA distortion detection

CEA distortion due to neutron exposure can prevent normal insertion and/or result in absorber loss, either of which could affect the ability to trip. Review of the data base identified 12 instances of recorded CEA distortion. Ten were detected by CEA inspection, one was detected by CEA insertion, and one was detected by CEA manipulation.

The STAR program does not impact the CEA distortion detection procedures. Therefore, the NRC staff concludes that the STAR CEA distortion detection is acceptable. The addition of the applicability requirements enhance the STAR's ability to detect CEA distortion.

- CEA absorber loss detection

Absorber loss can result through leaching, loss of CEA physical integrity, and absorber transport. CEA absorber loss can result in degradation of CEA performance. Loss of absorber can coincide with CEA distortion and interference with CEA movement.

A review of the database identified four recorded instances of absorber loss. Two were detected by CEA inspection, one by CEA manipulation, and one by EOC CEA insertion. The addition of the STAR applicability requirements makes the loss of the absorber detection method more effective than the standard program. Therefore, the NRC staff concludes that the STAR CEA absorber loss program is acceptable.

- CEA finger loss detection

Finger loss refers to physical separation of CEA fingers from the CEA. The fingers remain in the fuel when the CEA is withdrawn. A review of the database identified four recorded instances of finger separation. Two were identified by CEA inspection, one by the power distribution test at power, and one by CEA manipulation.

Although the STAR program eliminates the CEA worth test at HZP, its ability to detect CEA finger loss is not impaired because the most effective techniques are still part of the program and because of the addition of the applicability requirements. The NRC staff concludes that the STAR CEA finger loss detection capability is acceptable.

- RCS anomaly detection

RCS anomalies are changes in the local RCS temperature and flow. A review of the database (limited to CE design plants) did not identify any instances of RCS anomalies.

The STAR program does not change anything which could impact its ability to detect RCS anomalies. Therefore, the NRC staff concludes that the STAR RCS anomaly detection program is acceptable.

- RCS B-10 depletion detection

  B-10 depletion is caused by burnup of the high absorption component of RCS boron. Isotopic boron depletion could bring the core to conditions outside those calculated as safe in core analysis if only boron concentration is monitored. A review of the database did not reveal any recorded instances of boron depletion with safety significance.

  The STAR program does not impact the B-10 isotopic composition detection method. Therefore, the NRC staff concludes that the STAR program is acceptable for B-10 depletion detection capability.

4.3 Impact of Changes on the Test Performance Problems

Test performance problems can also result in non-detection of as-built core problems and subsequent operation outside the safety limits. The problems identified for evaluation are test equipment errors, test process errors, and test result errors.

As with the first two problem groups discussed, the TR describes the evaluation criteria, the required information for the evaluation, and the process used in the evaluation. The test performance criterion is that the performance of the test will not increase the probability of core operation outside the safety limits. To evaluate the information needs, the TR assesses the likelihood for each procedure in the generic and the STAR programs in terms of "greatest," "intermediate," and "smallest." The tests eliminated in the STAR program, i.e., CEA worth, ITC, and MTC at HZP, are estimated to have the highest probability of resulting in operation outside the safety limits. Using the results of the categorization, the proposed changes in the STAR program are evaluated. A test is found acceptable if the likelihood for core operation outside safety limits is smaller than the corresponding value for the generic program. Following the process indicated above, the TR summarized the results of the evaluation to show that the likelihood of the STAR program to initiate startup testing problems is very small to intermediate. An evaluation of each of the identified problems follows.

- Test equipment errors

  Test equipment errors are associated with installation of equipment to carry out the testing program. Unique operating processes (such as the use of the reactivity computer) introduce a significant likelihood for error. The STAR program has eliminated the use of the reactivity computer. A review of the database indicates that there are 12 recorded instances of test equipment errors. Six occurred during CEA worth measurement, one during a flux symmetry test, and the remaining five during unidentified tests. As was pointed out above, the STAR program eliminated the use of the reactivity computer and thus eliminated the main source of test equipment errors.

  The STAR equipment error identification process is as effective or better than the generic program, and therefore, the NRC staff concludes that it is acceptable.

- Test process errors

  Test process errors are associated with the steps involved in conducting the startup tests. These steps may involve unique operating practices as well as normal operating procedures. Unique operating practices involve unusual CEA configurations and require frequent operator intervention to complete the test evolution. Such operations may introduce the likelihood of core operation outside analyzed limits. A review of the database identified 10 cases of test process errors. Six were associated with CEA worth measurement, one with an ITC test and the remaining were not identified with a specific measurement.

  The STAR program eliminates the CEA worth measurement at HZP. The added tests do not utilize the reactivity computer, thus, minimizing the likelihood of a process error, and therefore, the NRC staff concludes that it is acceptable.

- Test result errors

  Test result errors can be caused by instrument calibration, hardware malfunction, faulty connections, faulty equipment reading and similar causes. Faulty measurement results, if substituted for calculated values, can cause core operation outside safety limits. A review of the database identified three documented instances of test result errors. All three test result errors were associated with MTC surveillance measurements.

  The STAR program does not change test result error detection. Therefore, the NRC staff concludes that the test result error detection process for the STAR method is acceptable.

In summary, analyses of the data and comparison of recent measurements justify the elimination of the CEA and ITC at HZP, the substitution of the MTC at HZP with an alternate MTC at HZP, the addition of an ITC at HFP, the addition of the ΔCBC HZP-HFP test at HFP. Application of these changes is subject to the addition of applicability requirements for core design, fabrication, refueling, startup testing, and CEA lifetime viability.

5.0 CONCLUSIONS

WCAP-16011P, "Startup Activity Reduction Program" was submitted for staff review and approval. The objective of the STAR program is to reduce the time required to perform the startup evolution. To this end, the WOG eliminated measurements of the CEA worth and ITC at HZP and substituted the MTC at HZP with an alternate surveillance MTC at HFP. The WOG added an ITC at intermediate to HFP and added applicability requirements for core design, fabrication, refueling, startup testing and CEA lifetime viability. Analyses of the participating plant databases defines a band for the differences between the measured and calculated parameters normally measured in startup testing as defined in the ANSI standard ANSI/ANS 19.6.1. For participating plants with a qualified database and for core configurations satisfying the applicability criteria, the NRC staff finds that the STAR program is reasonable and acceptable.

6.0 CONDITIONS AND LIMITATIONS

Considering the results of this evaluation, the NRC staff finds the proposed STAR program acceptable subject to the following conditions and limitations:

1. The STAR program is applicable only to the participating plants as defined in Table 3-1 of the TR.

2. Should any of the parameters of the STAR program fall outside the existing limits, either the cause of the discrepancy will be identified to ascertain the continuing validity of the applicability criteria, or the STAR program will be discontinued for that loading.

3. The Staff requires each licensee using STAR to submit a summary report following the first application, either successful or not, of STAR to its plant. The report should (a) identify the core design method used, (b) compare the measured and calculated values and the differences between these values to the corresponding core design method uncertainties and (c) show compliance with the STAR applicability requirements. If the application of STAR is unsuccessful, identify the reasons why the STAR application failed.

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