Westinghouse Electric Company
Nuclear Services

2000 Day Hill Road
Windsor, CT 06095
USA

September 15, 2000
CEOG-00-277

NRC Project 692

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

Subject: Submittal of CE NPSD-911 and Amendment 1 "-A" Approved Version

Reference: Letter, S. A. Richards (NRC) to R. Phelps (CEOG), "Acceptance for Referencing of CE NPSD-911, 'Analysis of Moderator Temperature Coefficients in Support of a Change in the Technical Specifications End-of-Cycle Negative MTC Limit,' and Amendment 1 (TAC No. MA9036)"

Gentlemen:

By the referenced letter, the Nuclear Regulatory Commission (NRC) issued its Safety Evaluation Report (SER) for the Combustion Engineering Owner's Group (CEOG) topical report CE NPSD-911, "Analysis of Moderator Temperature Coefficients in Support of a Change in the Technical Specifications End-of-Cycle Negative MTC Limits," and Amendment 1. In accordance with the SER and NUREG-0390, the CEOG herewith submits fifteen (15) copies of the "-A" accepted version of CE NPSD-911 and Amendment 1 for NRC use. For the purposes of producing a cohesive document, CE NPSD-911 and Amendment 1, originally submitted separately, have been combined into a single document.

If you have any questions regarding this matter, please do not hesitate to call Chuck Molnar of our Nuclear Licensing staff (860) 285-5205.

Sincerely,

Gordon C. Bishoff
Project Manager
CE Owners Group

Enclosure: CE NPSD-911-A and Amendment 1-A (15 copies)

xc: J. S. Cushing (NRC) (letter only)

D047 1/15

CEOG COMBUSTION ENGINEERING OWNERS GROUP

CE NPSD-911-A
AND
AMENDMENT 1-A

ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATIONS END-OF-CYCLE NEGATIVE MTC LIMITS

CEOG TASK 1009

PREPARED FOR THE
C-E OWNERS GROUP
SEPTEMBER 15, 2000

CE NUCLEAR POWER LLC

COMBUSTION ENGINEERING OWNERS GROUP

CE NPSD-911-A
AND
AMENDMENT 1-A

ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATIONS END-OF-CYCLE NEGATIVE MTC LIMITS

CEOG TASK 1009

PREPARED FOR THE
C-E OWNERS GROUP
SEPTEMBER 15, 2000

CE NUCLEAR POWER LLC

Accepted Topical Report Version Overall Content

- NRC Safety Evaluation Report, June 14, 2000
- CE Nuclear Power LLC Letter, May 12, 2000
- CE Nuclear Power LLC Letter, April 11, 2000
- CE NPSD-911, May 1993
- CE NPSD-911, Amendment 1, January 1998

U.S. Nuclear Regulatory Commission
Safety Evaluation Report
June 14, 2000

Acceptance for Referencing of CE NPSD-911, "Analysis of Moderator Temperature Coefficients In Support Of A Change In The Technical Specifications End-Of-Cycle Negative MTC Limits," and Amendment 1 (TAC No. MA9036)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 14, 2000

Mr. Ralph Phelps, Chairman
CE Owners Group
Omaha Public Power District
P.O. Box 399
Ft. Calhoun, NE 68023-0399

SUBJECT: ACCEPTANCE FOR REFERENCING OF CE NPSD-911, "ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATIONS END-OF-CYCLE NEGATIVE MTC LIMIT," AND AMENDMENT 1 (TAC NO. MA9036)

Dear Mr. Phelps:

We have concluded our review of CE NPSD-911 and Amendment 1 submitted by Combustion Engineering Nuclear Power (CENP) dated May 1993 and January 1998, respectively. The report is acceptable for referencing in licensing applications for CE plants subject to the limitations specified in the report and in the associated NRC safety evaluation (SE), which is enclosed. The SE defines the basis of acceptance of the report.

We do not intend to repeat our review of the matters described in the report, and found acceptable, when the report appears as a reference in license applications, except to assure that the material presented is applicable to the specific plant involved. Our acceptance applies only to matters described in the report.

In accordance with procedures established in NUREG-0390, "Topical Report Review Status," we request that CE publish an accepted version of this topical report within 3 months of receipt of this letter. The accepted version shall incorporate this letter and the enclosed SE between the title page and the abstract. It must be well indexed such that information is readily located. Also, it must contain in appendices historical review information, such as questions and accepted responses, and original report pages that were replaced. The accepted version shall include an "-A" (designating accepted) following the report identification symbol.

Should our criteria or regulations change so that our conclusions as to the acceptability of the topical report are invalidated, the CEOG and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the topical report without revision of their respective documentation.

Sincerely,

Stuart A. Richards, Director
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 692

Enclosure: Safety Evaluation

cc w/encl:
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT CE NPSD-911, "ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATIONS END-OF-CYCLE NEGATIVE MTC LIMIT" AND AMENDMENT 1

PROJECT NO. 692

1.0 INTRODUCTION

By letter dated October 6, 1998, (Reference 1) Entergy Operations, Inc. (Entergy) requested changes to the Waterford 3 Technical Specifications (TS) and requested review of the Combustion Engineering Owners Group Topical Report, CE NPSD-911, "Analysis of Moderator Temperature Coefficients in Support of a Change in the TSs End-of-Cycle Negative MTC Limit" dated May 1993, and Amendment 1, dated January 1998. Amendment 1 provided the answers to the NRC request for additional information dated February 26, 1997. Additional information was provided by Entergy in a letter dated March 2, 2000 (Reference 2). In a letter dated April 11, 2000, the Combustion Engineering Owners Group (CEOG) requested issuance of a safety evaluation on CE NPSD-911 so that the methodology may be used by other CEOG member plants (Reference 3). A clarifying letter dated May 12, 2000, was submitted by Westinghouse Electric Company (Reference 4).

The TS provide limitations on the moderator temperature coefficient (MTC) to ensure that the assumptions used in the accident and transient analysis remain valid through each fuel cycle. The requirements to measure the MTC at the beginning-of-cycle (BOC) (one at hot zero power and one at power) and near end-of-cycle (EOC) (i.e., 2/3 expected core burnup) provide confirmation that the measured MTC value is within its limits and will remain in its limits throughout each cycle.

The purpose of Topical Report CE NPSD-911 and Amendment 1 was to provide the justification to support eliminating the need to determine the MTC upon reaching two-thirds of core burnup if the results of the MTC tests required at the beginning-of-cycle are within a tolerance of $\pm 0.16 \times 10^{-4}$ Δk/k/°F of the calculated MTC (design value). However, if the results of the first two tests are not within that limit, then performance of the 2/3 cycle surveillance will be required. The reports concluded that if the MTC at the beginning-of-cycle is within $\pm 0.16 \times 10^{-4}$ Δk/k/°F of the design value, then the MTC at the end-of-cycle will also be within $\pm 0.16 \times 10^{-4}$ Δk/k/°F of the design value.

2.0 EVALUATION

Accurate knowledge of the MTC at end-of-cycle is of prime importance in order to ensure that the most negative MTC will always be conservative with respect to the TS limit. If enough reliance can be placed on the analytical models and on the end of cycle predicted MTC, the surveillance test can be eliminated.

CE NPSD-911 and Amendment 1 used the following approach. Isothermal temperature coefficients (ITC) were used since they are measured quantities. The measured ITC was assumed to represent the true value. The impact of systematic errors in the measurements was reduced by combining the values obtained on several plants by several utilities. The best estimate ITC was then equal to the calculated value plus the bias (as established by the mean of the distribution of differences between measured and calculated values). The same bias and uncertainty is assigned to the MTC. Using the relationship ITC = MTC + FTC and assuming that MTC and FTC (fuel temperature coefficient) are statistically independent, it is conservative to assign the same uncertainty to the MTC and to assume that no additional uncertainty is introduced by the FTC.

The analysis used measured MTC data from several plants and compared that data to the calculated MTC. This was done to evaluate the methodology used in calculating the MTC. The reports concluded that evaluation of the data showed that if the MTC measured at the beginning-of-cycle is within $\pm 0.16 \times 10^{-4}$ Δk/k/°F of the calculated MTC, then the near end-of-cycle calculated MTC will be within $\pm 0.16 \times 10^{-4}$ Δk/k/°F of the true MTC. Thus, the method would adequately model the MTC for the entire cycle, and the near end-of cycle MTC surveillance would not be not required.

The NRC staff reviewed CE NPSD-911 and Amendment 1. The data base used for the analysis consisted of 105 data points taken from ten different Combustion Engineering plants (2700 MW, 2815 MW, 3400 MW and 3800 MW). The measurements used both the rod insertion and the power trade measurement techniques. For 15 cycles, all three conditions (BOC at hot zero power, near BOC at power, and near EOC at power) were analyzed. A total of 30 near EOC values were analyzed. Of the 105 data points, only one shows a residual deviation that equals the design margin.

ITC predictions were all made at the measured critical conditions so that no adjustments were needed. The test initial conditions (power level, exposure, inlet temperature, soluble boron concentration and lead bank insertion) were simulated, taking into account all thermal-hydraulics and xenon feedbacks. Then, without changing the xenon distribution, a change of ±3°F was applied to the inlet temperature, keeping the thermal-hydraulics feedback effects active. The core average temperature was obtained from edited output and the ITC calculated.

The 105 data points were analyzed for normality using the American National Standard Institute Standard Normality Test. The D' Test statistic was 301.39 which implied that the assumption of normality is appropriate based on the percentage points of the D' Test Statistic. The NRC staff reviewed the complete list of all measured and calculated ITCs. Data given consisted of the plants and cycles, the core enrichment and exposure, the operating conditions (PPM soluble boron, power and moderator temperature), the measured and calculated ITC and the difference (measured minus calculated) in units of pcm/°F (1pcm = $10^{-5}\Delta k/k$). In addition, the staff reviewed the statistical approach taken and determined that it was a straightforward approach and that it was correctly applied. The staff performed spot checks and found no discrepancies.

Since all of the work to support the analysis was performed using the CE methodology and the design margin was established using that methodology, the staff questioned the validity of using other methodologies for the calculations of MTC if it was desired to eliminate the EOC MTC test. It was determined that the approach would be restricted to using the CE methodology, unless further justification was submitted to the NRC for review and approval.

3.0 CONCLUSION

Based on the review as described in Section 2.0, the staff agrees that the approach described in CE NPSD-911 and CE NPSD-911 Amendment 1 is acceptable subject to the following conditions which were part of Amendment 1. A summary of Conditions 1 and 4 was restated in Reference 4 since the response to Question 8 in Reference 2 was confusing.

1. In order to ensure that the moderator temperature coefficient will not exceed the Technical Specification limit with a confidence/tolerance of 95/95 percent, the cycle must be designed, using the CE methodology, such that the best estimate MTC is:

   a. more negative than the BOC Technical Specification limit by the design margin
   b. more positive than the EOC Technical Specification limit by the design margin

2. The design margin is determined to be 1.6 pcm/°F at all times in life.

3. The analysis of the revised data base, including the most recent measured and calculated MTCs, has established that if the measured beginning-of-cycle moderator temperature coefficients are within 1.6 pcm/°F of the best estimate prediction, then it can be assumed that the end-of-cycle coefficient will also be within 1.6 pcm/°F of the prediction and its measurement is not required.

4. The measured data reduction must be based on the current CE methodology as described in the report.

5. If the beginning-of-cycle measurements fail the acceptance criteria of ±1.6 pcm/°F and the discrepancy cannot be resolved, the end-of cycle surveillance test must be performed.

4.0 REFERENCES

1. Letter from C. M. Dugger, Entergy to NRC Document Control Desk, dated October 6, 1998.

2. Letter from C. M. Dugger, Entergy to NRC Document Control Desk, dated March 2, 2000.

3. Letter from Ralph Phelps, Combustion Engineering Owners Group to NRC Document Control Desk, dated April 11, 2000.

4. Letter from Paul Hijeck, Westinghouse Electric Company to NRC Document Control Desk, dated May 12, 2000.

Principal Contributor: M. Chatterton

Date: June 14, 2000

CE Nuclear Power LLC Letter

May 12, 2000

Westinghouse Electric Company
Nuclear Services
CE Nuclear Engineering

2000 Day Hill Road
Windsor, CT 06095
USA

May 12, 2000
CEOG-00-145

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Applicability of CE Methodology to Topical Report CE NPSD-911

Reference:

1. C. M. Dugger, Entergy Operations letter to NRC submitting CE NPSD-911, "Analysis of Moderator Temperature Coefficients in Support of a Change in the Technical Specifications End-of-Cycle Negative MTC Limit," W3F1-98-0175, dated 10/6/98.
2. R. L. Phelps, CEOG letter to NRC, "Combustion Engineering Owners Group Endorsement of a Lead Plant Submittal," CEOG-00-093, dated 4/11/00.

Topical Report CE NPSD-911 and Amendment 1 were submitted for NRC staff review via Reference 1 The staff has completed the review of this report and has approved its application to Entergy Operations, Waterford-3.

The CEOG requested issuance of a Safety Evaluation on CE NPSD-911, as was stated in Reference 2. To support the staff's review in this regard, this letter is to clarify that CE NPSD-911 requires the use of CE methodology as specified in the Summary section of the report; the use of any other methodology for this purpose would require prior NRC approval.

If you have any questions, please contact me.

Very truly yours,

Paul Hijeck
Project Manager
CE Owners Group

cc: J. S. Cushing, NRC
G. C. Bischoff, W
J. A. Brown, W
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CE Nuclear Power LLC

Letter, April 11, 2000

CEOG COMBUSTION ENGINEERING OWNERS GROUP

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Arizona Public Service Co., Palo Verde 1, 2, 3 | Consumers Energy Co., Palisades | Florida Power & Light Co., St. Lucie 1, 2 | Northeast Utilities Service Co., Millstone 2 | Southern California Edison, SONGS 2,3

April 11, 2000
CEOG-00-093

Project 692

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

Subject: Combustion Engineering Owners Group Endorsement of a Lead Plant Submittal

Reference: (1) C. M. Dugger (Entergy Operations) to U.S. Nuclear Regulatory Commission Technical Specification Change Request NPF-38-212, letter W3F1-98-0175, dated October 6, 1998.

Gentlemen:

The purpose of this note is to clarify the lead plant status of a CEOG topical report. On behalf of the CEOG, Entergy Operations provided report CE NPSD-911, "Analysis of Moderator Temperature Coefficients in Support of a Change in the Technical Specification End of Cycle Negative MTC Limit". Report CE NPSD-911 was developed by the CEOG and evaluated the uncertainty in MTC prediction against measured values.

The Combustion Engineering Owners Group (CEOG) has reviewed the Entergy Operations proposed Technical Specification Change of Reference (1). We find the change to be applicable to other CEOG member plants and endorse the proposed change as a lead plant submittal for the CEOG. As is customary for lead plant submittals, the CEOG requests issuance of a Safety Evaluation on CE NPSD-911.

Please note that the approval of the report and all NRC review fees associated with the Entergy Operations lead plant submittal (including the review of CE NPSD-911) are to be applied to the Waterford 3 docket. Questions which regard the lead plant submittal should be addressed to the licensee (Entergy Operations).

If you have any questions, please contact me.

Very truly yours,

R J Phelps

Ralph Phelps
Chairman, CE Owners Group

cc: G. C. Bischoff, ABB
V. Paggen, ABB
J. Cushing, NRC

COMBUSTION ENGINEERING OWNERS GROUP

CE NPSD-911

ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATION END OF CYCLE NEGATIVE MTC LIMIT

FINAL REPORT

CEOG TASK 764

prepared for the

C-E OWNERS GROUP

May 1993

ABB Combustion Engineering Nuclear Power

ASEA BROWN BOVERI

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Analysis of Moderator Temperature Coefficients in Support of a Change in the Technical Specification of End-of-Cycle Negative MTC Limit.

Table of Content

Analysis of Moderator Temperature Coefficients

in Support of a Change in the Technical Specification

of End-of-Cycle Negative MTC Limit.

I. Introduction

The accurate knowledge of the moderator temperature coefficient (MTC) at end of cycle is of prime importance in the fuel management of long reload cycles. The designer must ensure that the most negative MTC will always be conservative to the Technical Specification limit. The required amount of conservatism depends on the accuracy of the calculational model, and on the uncertainty attached to the knowledge of the true MTC. If enough reliance can be placed on the calculational models and on the end of cycle predicted MTC, a surveillance test becomes unnecessary.

The calculational accuracy of the analytical models and the confidence assigned to the knowledge of the true MTC are established by comparing calculated and measured values. A moderator temperature coefficient design margin (uncertainty) is established such that if the best estimate design MTC is conservative relative to the Technical Specification limit by an amount equal to or greater than the design margin, then the Technical Specification limit will not be violated. The best estimate value is defined as the calculated value using the current ABB-CE methodology augmented by a bias term. Although the Technical Specification limit on negative MTC must be satisfied at end-of-cycle, it is shown that the design margin applies to all times in life. It is also established that if the measured beginning-of-cycle moderator temperature coefficients agree with the predictions within the design margin, then all measured coefficients for that cycle are expected to pool with the data base presented in this report, including the end-of-cycle MTC. Thus if the end-of-cycle MTC is expected to fall within the design margin, its measurement is not required.

In the analysis, isothermal temperature coefficients (ITC) are used since they are the measured quantities. The measured ITC is assumed to represent the true value. The impact of systematic errors in the measurements is reduced by combining values obtained on several plants by several utilities using different techniques. The accuracy of the model is expressed as a bias representing systematic differences between measured and calculated values, and the uncertainty is expressed as the random fluctuations between these values. The uncertainty can be viewed as a limitation in the search for the true value. Thus, to ensure compliance with the Tech. Spec. with a high confidence level, the most negative raw calculated design MTC at EOC must be less negative than the Tech. Spec. MTC by an amount equal to the bias plus total uncertainty.

II. Summary

In order to ensure that the moderator temperature coefficient will not exceed the Technical Specification limit with a confidence/tolerance of 95/95%, the cycle must be designed, using the ABB-CE methodology, such that the best estimate MTC is:

a. more negative than the BOC Technical Specification limit by the design margin, and
b. more positive than the EOC Technical Specification limit by the design margin.

The design margin is determined to be $0.16*10^{-4}\Delta\rho/°F$ at all times in life.

The analysis of a data base of measured and calculated MTC's has established that if the measured beginning-of-cycle moderator temperature coefficients fall within $0.16*10^{-4}\Delta\rho/°F$ of the best estimate prediction, then it can be assumed that the end-of-cycle coefficient will too and its measurement is not required.

The measured data reduction must be based on the current ABB-CE methodology as described in this report.

If the beginning-of-cycle fails the acceptance criteria of $\pm0.16*10^{-4}\Delta\rho/°F$ and the discrepancy cannot be resolved, then the end-of-cycle surveillance test must be performed.

III. Methodology

The determination of the design margin and the justification for removing the end-of-cycle surveillance test are outlined below:

1. Measured isothermal temperature coefficients (ITC) are collected for several plants and cycles under various operating conditions.

2. The ITC measurements are analyzed with the same calculational methods used to design future cycles. Care must be exercised to use consistent definitions of temperatures in the measured data reduction and in the analytical predictions. Predictions are made at the exact operating conditions of the measurements.

3. A statistical evaluation of the differences between measured and calculated values is performed. The mean of the distribution of differences establishes the bias, and the standard deviation of the distribution, when adjusted by the tolerance limit factor k, establishes the uncertainty. The bias covers both systematic calculational and measurement errors, which cannot be separated. The possibility of large systematic measurement errors contributing to the bias is reduced by incorporating into the data base measurements taken on many cycles and many plants operated by different utilities. The uncertainty is due to random components in the measured values and to correlating variables which are not included in the bias term. This uncertainty limits our ability to know the precise value of the true ITC, and therefore to calculate a best estimate coefficient.

4. The bias and uncertainty are correlated against a variable to which the ITC dependence is strong, i.e. the soluble boron concentration.

5. Statistical tests are performed on the residuals of the correlation to verify the assumption of normality, to verify poolability of various subsets of data and to verify the goodness of fit (correlation against boron concentration).

6. Poolability tests indicate that the residuals at BOC, high boron concentrations are part of the same population as end-of-cycle low boron concentration residuals, and that if the first subset falls

within the design margin, one can expect that the second subset will too and therefore does not have to be measured.

7. The best estimate ITC is then equal to the calculated value plus the bias. The same bias and uncertainty is assigned to the MTC. Using the relationship:

$$ITC = MTC + FTC$$

and assuming that MTC and FTC are statistically independent:

$$\sigma_{ITC}^2 = \sigma_{MTC}^2 + \sigma_{FTC}^2 ,$$

it is conservative to assign the same uncertainty to the MTC and to assume that no additional uncertainty is introduced by the fuel temperature coefficient (FTC). To ensure that the true ITC or MTC will never exceed the Technical Specification value, the best estimate coefficients must be less negative than the Tech. Spec. limit by an amount equal to the design margin, defined as the absolute value of the uncertainty.

The most negative calculated MTC_{calc} must therefore satisfy the relationship:

$$MTC_{calc} + bias - |uncert.| > MTC_{Tech.\ Spec.} \quad \text{at EOC}$$

IV. Data Base and Data Reduction

In analyzing moderator temperature coefficients, a distinction must be made between zero power and at-power measurements. Zero power measurements are well characterized since the core is isothermal, and since the reactivity changes are measured with the reactivity meter. At power, however, the core average moderator temperature is not defined by the inlet and outlet temperatures only, but is affected by the axial power and temperature distributions. These axial distributions change for three reasons during the ITC measurement: control rod motion, change in inlet temperature and change in power level. These changes, which impact the core average temperature and its reactivity, are characterized by the changes in axial shape index taking place during the measurement. This information is not always available, but it was established that it can be obtained from calculations.

The data base analyzed here contains 71 data points from 26 cycles and 10 reactors. It contains 43 zero power data points, 6 of which measured at end-of-cycle, and 28 at power points, 23 being measured with the rod insertion method and 5 with the power trade method.

The end of cycle data measured at Calvert-Cliffs Unit II cycle 5 is worth noting. This set of experiments consisted of moderator temperature coefficient measurements performed at full power followed by ITC and rod worth measurements at zero power, low boron concentration, during the xenon transient following the end of cycle shut-down. Seven data points were thus added to the data base, providing a good definition of the end of cycle bias and uncertainty.

Each data point in the data base is identified by the unit and cycle, the core average exposure, the moderator temperature, boron concentration, power, rod insertion and core average enrichment.

Zero power temperature coefficients were obtained from the startup reports of each unit and cycle. They were used without further interpretation.

At power measured coefficients were also reported in various startup and operating reports, but the raw site data was reinterpreted for consistency. The data reduction differed between the rod insertion technique and the power trade technique.

IV.a. Rod Insertion Technique

In this technique, the reactor is stabilized at or near full power with the lead control bank inserted approximately 20%. Then a temperature reduction of about 3°F is induced by inserting the rod bank, and a new steady state condition is obtained. The power is maintained constant. When the power and temperature readings are stable, they are recorded and a temperature increase of about 6°F is induced by withdrawing the rod bank. This operation is repeated 3 or 4 times. If a power coefficient measurement is also desired, a few more rod motions are performed, maintaining the reactivity constant by adjusting the power level.

For each swing, the inlet and outlet temperatures, the power and the control rod position are tabulated. The core average temperature and inserted rod worth are calculated as follows:

A. Core average temperature:

The core average temperature has traditionally been defined as:

$$T_{ave} = (T_{in} + T_{out})/2 \qquad (1)$$

This definition does not reflect the change in axial temperature distribution resulting from the change in inlet temperature and underestimates the change in core average temperature. Therefore it leads to excessively large negative coefficients, and can erroneously imply non conformance with the Tech. Specs.

The core average moderator temperature can be expressed as a linear function of the axial offset (ASI).

$$T_{ave} = (T_{in} + T_{out})/2 + \gamma * ASI * P/P_o \qquad (2)$$

in which γ is precalculated.

The change in ASI and the ensuing change in temperature during the test are due to both the control rod motion and the change in inlet temperature. The former is part of the rod worth and the latter is part of the temperature coefficient. The two components of the ASI change cannot be separated experimentally, and one has to rely on a calculation to relate T_{in}, T_{out} and T_{ave}.

The ability of the calculational model to predict the change in ASI and the change in core average temperature during the test was verified by performing a simulation of the St-Lucie Unit 2 cycle 5 end-of-cycle measurement. In this simulation, the ROCS reactivity was maintained constant by trading the reactivity loss due to the rod insertion against the reactivity gain due to the inlet temperature reduction. Measured and calculated changes in shape index due to both control rod motion and inlet temperature changes between the two critical states are shown in Figure 1.

The good agreement between measured and calculated ASI justifies the use of ROCS to infer the change in axial power and temperature distributions, and hence in core average moderator temperature for a given change in inlet temperature.

The change in core average temperature can be obtained from the change in inlet temperature at constant rod position and constant power by using the following expression:

$$\Delta T_{av} = (1.0 - a * P/P_o) * \Delta T_{in} \qquad (3)$$

or:

$$\Delta T_{av} = (1.0 + b * P/P_o) * \Delta[\tfrac{1}{2}(T_{in} + T_{out})] \qquad (4)$$

The a and b coefficients are precalculated as part of the test predictions. In the current data reduction presented in this report, the second expression was used, using the measured T_{in} and T_{out} temperatures. a and b were found to be a weak function of exposure, but a strong function of core height.

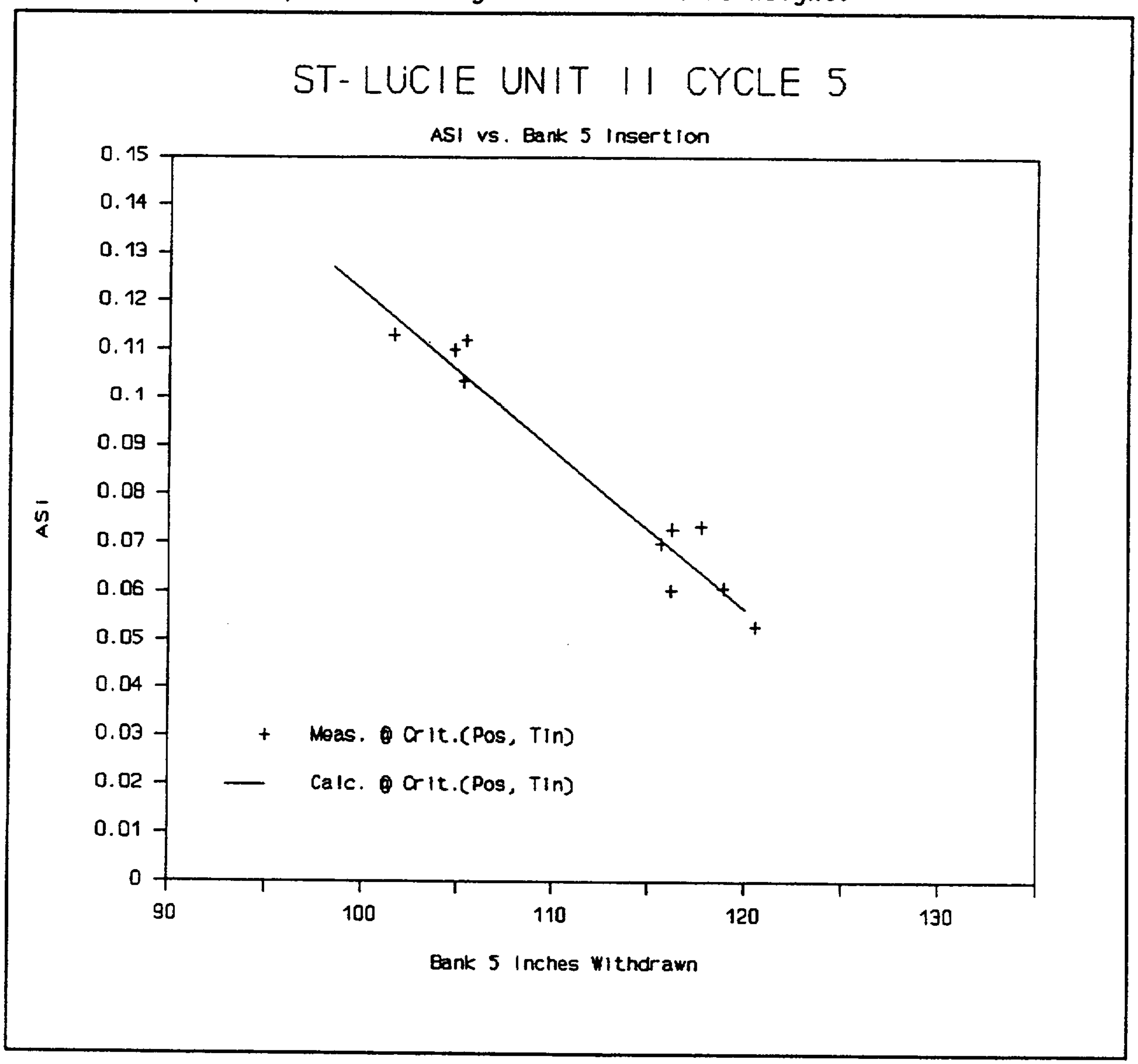

Figure 1

B. Rod Insertion Worth

The rod insertion curve is calculated by a three-dimensional neutronics code, in which the initial conditions correspond to the reactor initial conditions. Thermal-hydraulic and xenon feedback are included in the initial conditions. Then, without changing the xenon distribution and level, but maintaining the thermal-hydraulic feedback, the rod insertion curve is calculated by a series of insertion steps corresponding to axial planes of the nodal three-dimensional model, so as not to be affected be interpolation schemes for partial plane insertion. Curve fitting or interpolation is then used to determine the worth at the insertions recorded during the test. From this curve, for each one of the rod positions recorded during the test, the rod worth is tabulated.

When the data collection is completed, a reactivity balance is written between each consecutive step:

$$\alpha_P * \Delta P + \alpha_T * \Delta T + \Delta \rho = 0 \qquad (5)$$

in which:

- α_P is the power coefficient
- ΔP is the change in power level
- α_T is the isothermal moderator temperature coefficient
- ΔT is the change in core average moderator temperature due to the change in inlet temperature
- $\Delta \rho$ is the change in reactivity due to the control rod motion.

If the power swings are large enough so as to infer a power coefficient, a two dimensional regression leads to α_T and α_P. If the power swings are two small, a precalculated best estimate power coefficient is used in the term $\alpha_P * \Delta P$ and a one dimensional regression is used to define α_T.

IV.b. Power Trade Technique

In this measurement, the control rods are not moved, and the reactivity is maintained constant by compensating the effect of an inlet temperature increase by a power reduction. The reactivity balance is:

$$\alpha_P * \Delta P \ + \ \alpha_T * \Delta T = 0 \qquad (6)$$

A best estimate power coefficient is used in this equation to infer the temperature coefficient. Since relative errors in power coefficients are directly translated into relative errors in temperature coefficients, it is important to have confidence in the best estimate the power coefficient. Appendix A presents the analysis of a power coefficient data base, and defines the bias applicable to the calculated power coefficient to transform it into a best estimate.

The core average moderator temperature used in the above equation must also reflect the change in axial shape taking place during the test. A test simulation provides the relationship between T_{in}, P and T_{ave}, and a regression is performed to express the core average temperature as a linear combination of inlet temperature and power:

$$T_{ave} = a * T_{in} \ + \ b * P \qquad (7)$$

This linear relationship, which is valid over a narrow range of the variables, is applied to each pair of measured T_{in} and P to infer T_{ave}.

It is interesting to note that this definition of T_{ave} leads to lower values of ΔT_{ave} than the use of $\frac{1}{2}(T_{in}+T_{out})$, thus to more negative values of the measured ITC, in better agreement with the predictions.

The data reduction of all at power measurements is summarized in Appendix B. The format of the tables is comparable for all sets. First, the calculated rod insertion curve is given and fitted to a cubic polynomial. The fitted values are compared to the calculated values to provide a visual check of the fit. Then, the measured data is tabulated for each swing, and the measured lead bank insertion transformed into an inserted worth by use of the cubic fit. The change in core average moderator temperature is obtained from equation (4). If the power changes are small, the associated reactivity changes are obtained with the help of the best estimate power coefficient, and a one-dimensional regression is performed to defined the measured ITC. If the power changes are large, a two-dimensional regression provides both the ITC and the power coefficient.

V. ITC Predictions

ITC predictions have all been made at the measured critical conditions, so that no adjustments were needed. The test initial conditions (power level, exposure, inlet temperature, soluble boron concentration and lead bank insertion) were simulated, taking into account all thermal-hydraulics and xenon feedbacks. Then, without changing the xenon distribution, a change of ±3°F was applied to the inlet temperature, keeping the thermal-hydraulics feedback effects active. The core average temperature was obtained from edited output, and the ITC calculated.

VI. Results

A complete list of all measured and calculated ITC's is given in Table 1. This table lists the plants and cycles, the core enrichment and exposure, the operating conditions (PPM soluble boron, power and moderator temperature), the measured and calculated ITC and the difference (M-C) in units of $10^{-4}\Delta\rho/°F$. At the bottom of the table, the results of a regression analysis of C-M vs PPM is provided. This table indicates that the ITC error is best fitted to the expression:

$$\Delta ITC = M-C = -0.0136 - 0.913E\text{-}04 * PPM \quad (10^{-4}\Delta\rho/°F) \tag{8}$$

The standard deviation of the fit is 0.077, and the one-sided 95/95 confidence/tolerance limit is $\pm 0.153 * 10^{-4}\Delta\rho/°F$. This means that there is a 95% chance that 95% of the data points will display an error smaller than ±0.153 $10^{-4}\Delta\rho/°F$ from the best fit.

The residuals of the fit [(C-M) values - fitted values] are plotted in Figure 2 vs. soluble boron concentration. This figure indicates a fairly uniform distribution of points, with no obvious PPM dependence.

Two points in the figure seem a little outside the range. They are two full power measurements for:

St-Lucie II cycle 5 at 789 PPM

Palo Verde II cycle 3 at 456 PPM

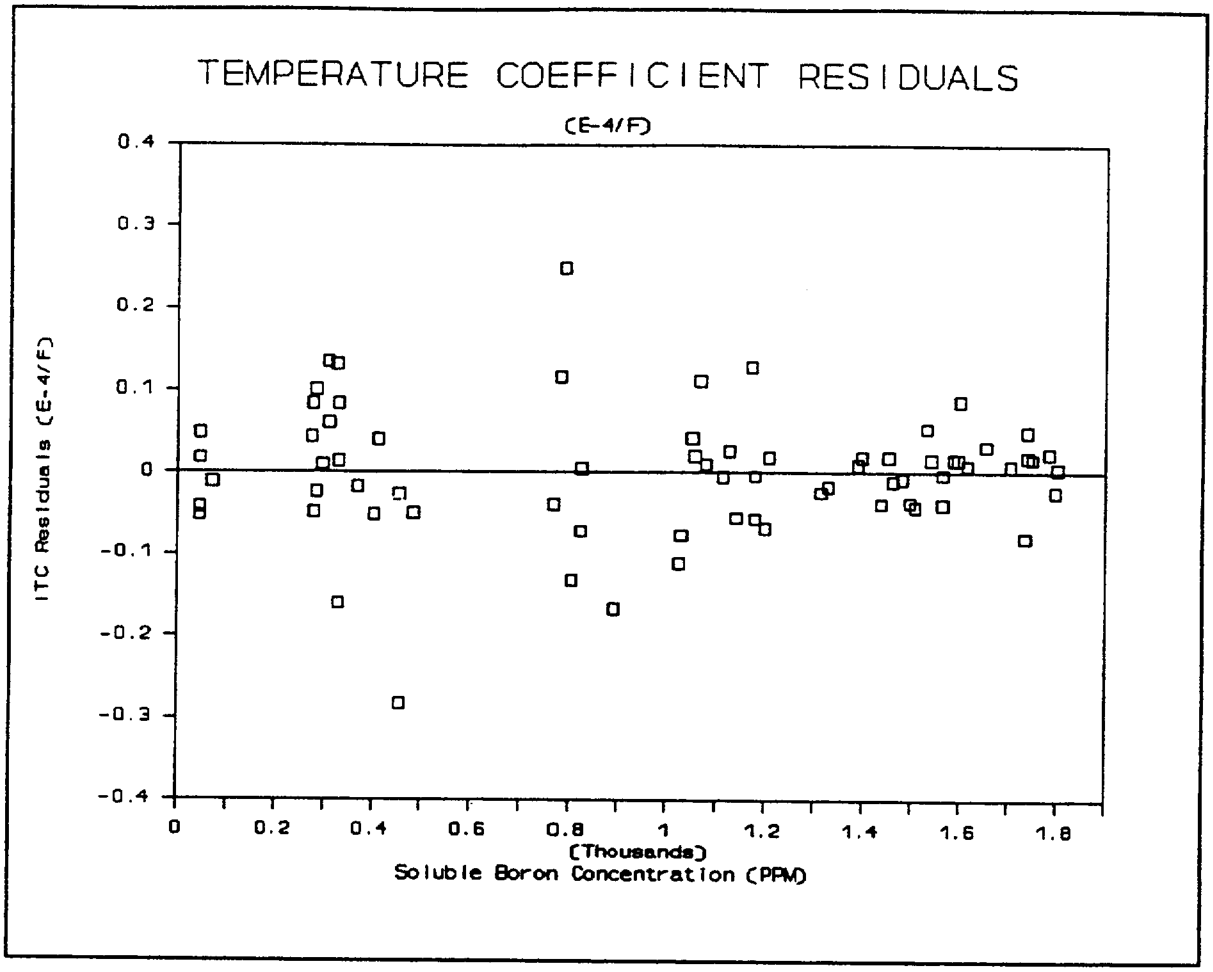

Figure 2

Prior to performing more rigorous statistical tests to verify normality and poolability of the data, some simple visual inspection is beneficial. The residuals of the fit are plotted vs. various parameters, to demonstrate independence of the residual against these parameters, and to show that no significant variables were omitted in the model, i.e. that the soluble boron is really the only correlating variable. The residuals are plotted vs. core exposure, enrichment, power, moderator temperature, fitted error and calculated ITC, in Figures 3 to 8.

In all Figures, the scatter of the residuals appears random, indicating that there is no correlation of the residuals against any of the chosen variables. One possible exception is Figure 4, which shows a slight upward trend of the residuals vs. enrichment. As shown later, the enrichment dependence of the residuals has an impact on the normality of the distribution, but can be ignored because its omission leads to more conservative (more negative) best estimate MTC at end of cycle in the range of enrichments currently used.

The results of the regression given at the bottom of Table 1 constitute the definition of the design margin for temperature coefficients. The end-of-cycle MTC monitoring procedure in the absence of a measurement is as follows:

If the isothermal temperature coefficients measured at zero power during the cycle startup program, and at power during the first power ascension, fall within the design margin (acceptance criteria) of $\pm 0.16*10^{-4}\Delta\rho/{}^{\circ}F$, then the end-of-cycle best estimate prediction will also be within $\pm 0.16*10^{-4}\Delta\rho/{}^{\circ}F$ of the true MTC. To establish compliance with the Technical Specifications, the best estimate end-of-cycle MTC must be less negative than the Tech. Spec. value by $0.16*10^{-4}\Delta\rho/{}^{\circ}F$.

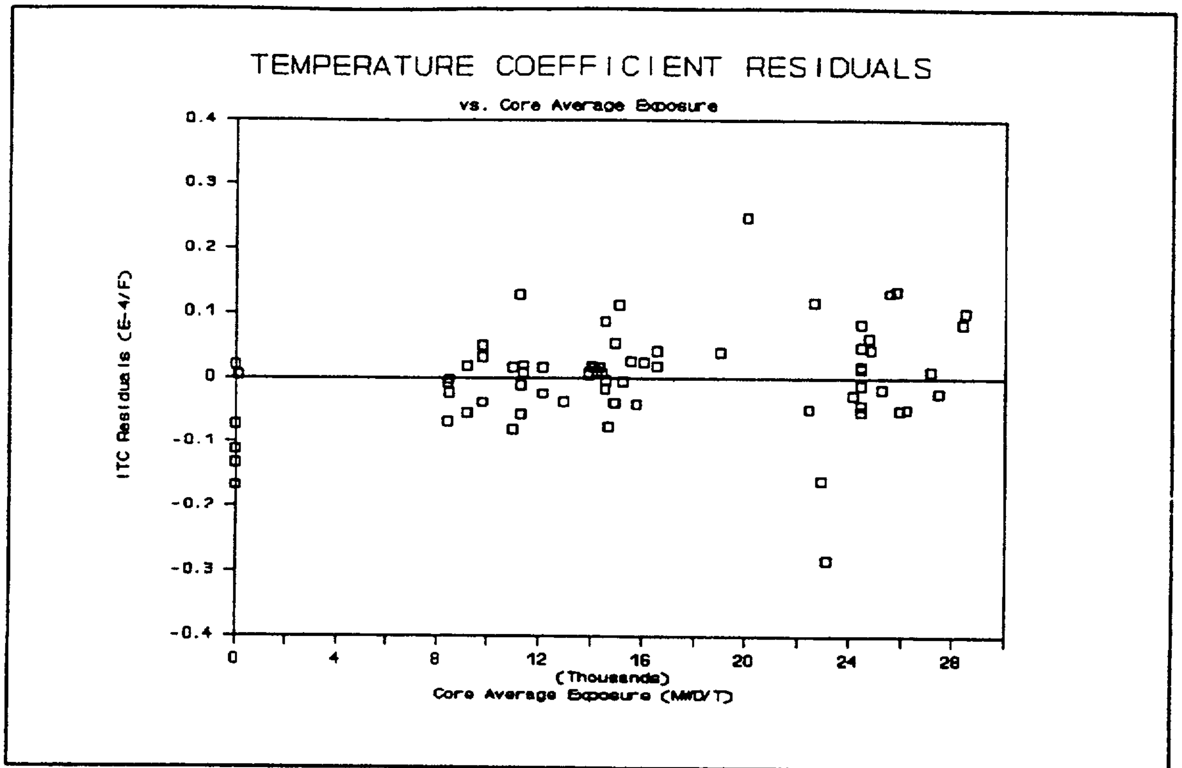

Figure 3

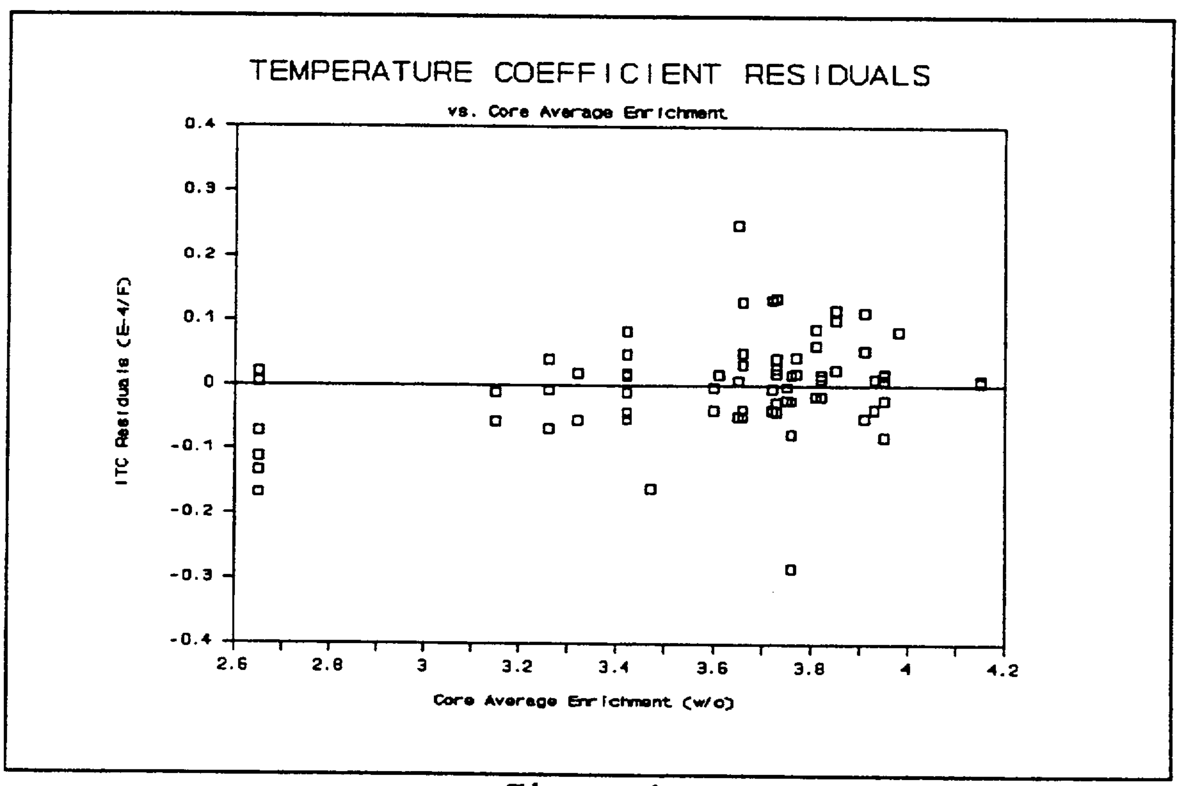

Figure 4

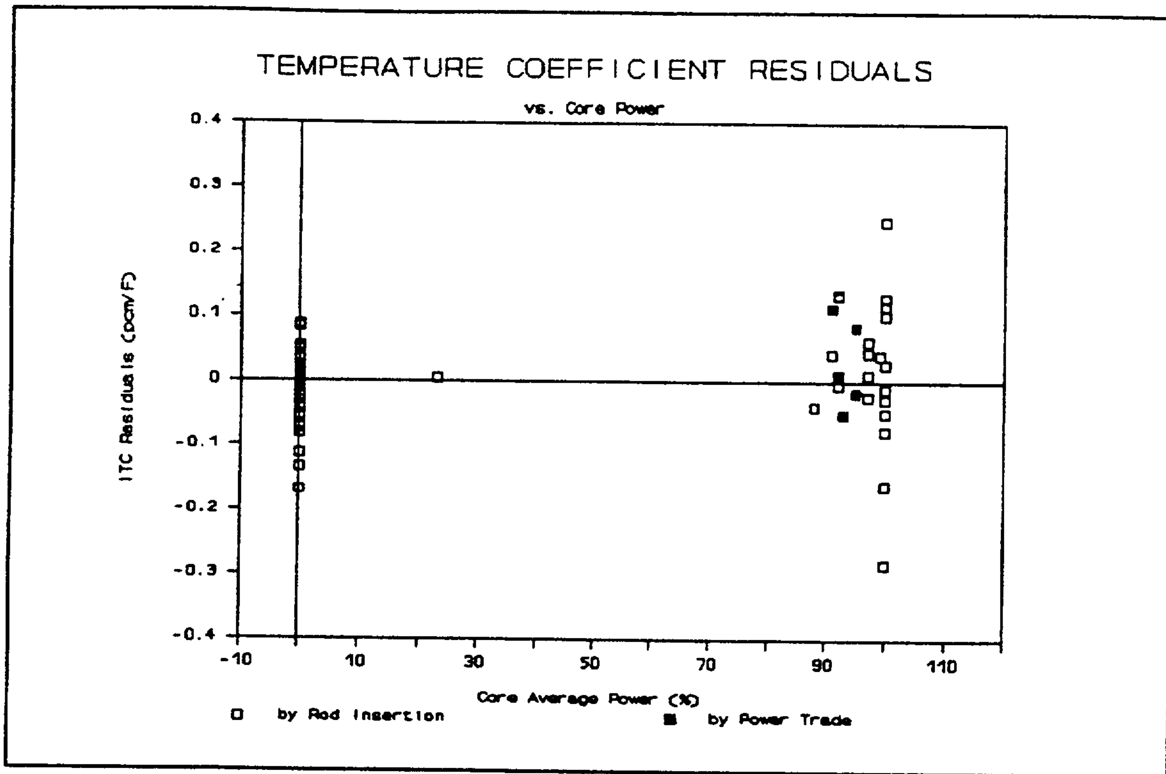

Figure 5

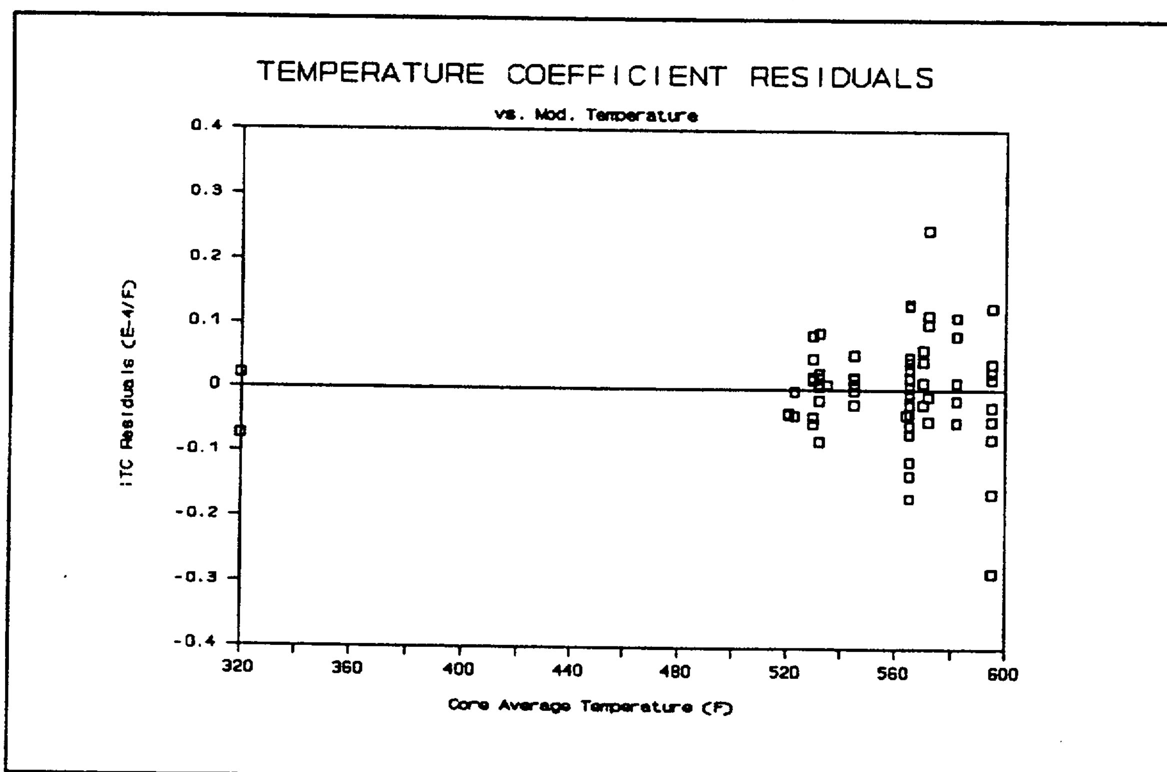

Figure 6

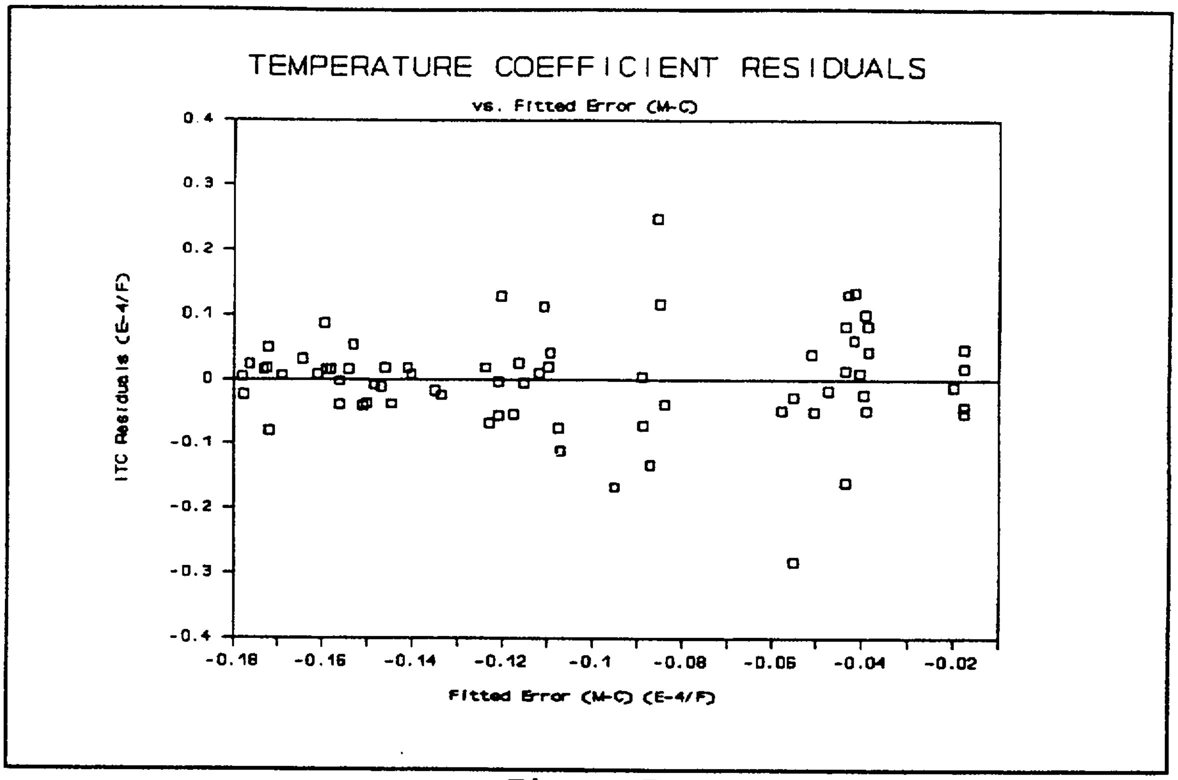

Figure 7

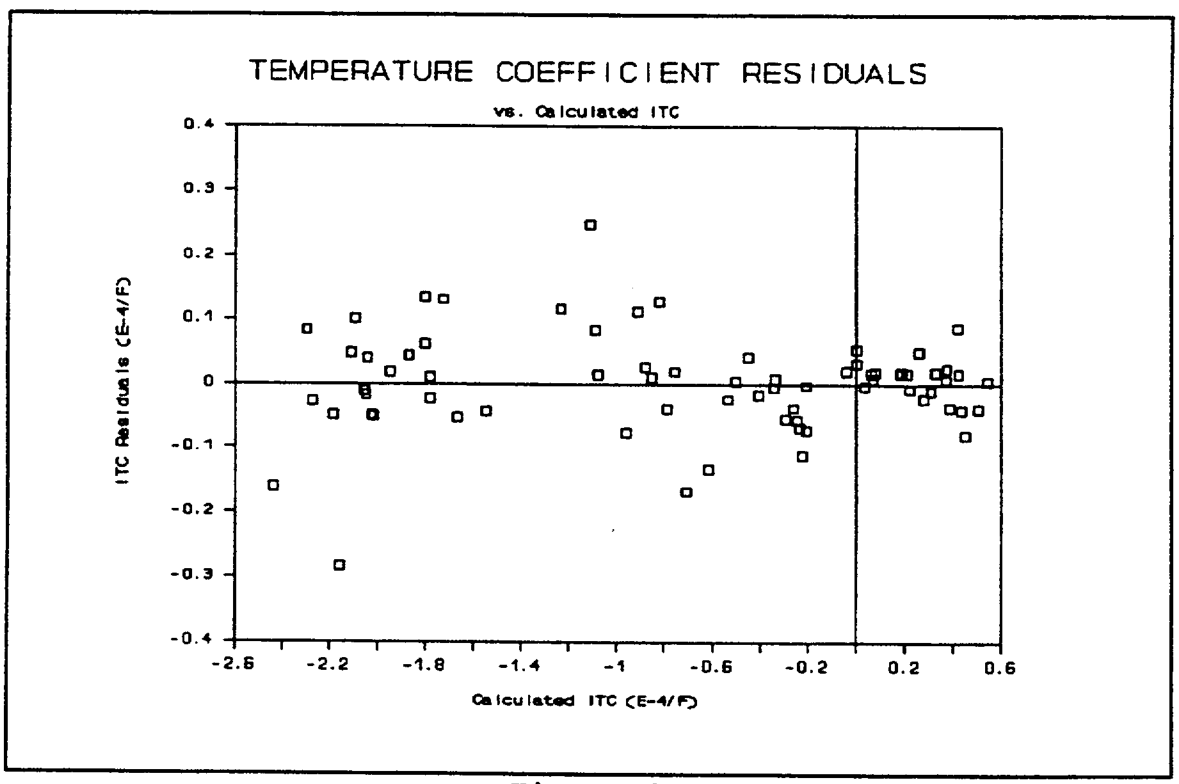

Figure 8

VI.a. Confidence Interval and Prediction Interval

Because the range of fitted residuals vs. boron concentration is finite, and because the sample size is also finite, the best fit has an uncertainty which is larger near the ends of the range. It is interesting to know whether the increased uncertainties of the fit at the end of the range, in particular at very low boron concentrations, is significant. If it is, an extra conservatism should be built into the best estimate EOC MTC. The 95% = 100(1-α)% confidence interval of the fit is given by:

$$\pm t_{N-2,\alpha/2}\, s \sqrt{\frac{1}{N} + \frac{x_i^2}{\sum_{k=1}^{N} (x_k^2)}} \qquad (9)$$

in which s is the standard deviation of the distribution of residuals x_i and t is the t-distribution. The prediction interval of any future observation is:

$$\pm t_{N-2,\alpha/2}\, s \sqrt{1 + \frac{1}{N} + \frac{x_i^2}{\sum_{k=1}^{N} (x_k^2)}} \qquad (10)$$

These calculations are presented in Table 2, and plotted in Figure 9. In these calculations, the two outlier points have been removed.

The confidence interval of the fit is indeed larger near the ends of the range, which affects the accuracy of best estimate values. But more important is the prediction interval which is fairly parallel to the best fit. This interval represents the range within which any future observation is likely to fall with a 95% confidence. The interval varies from 0.1295 to 0.1270 (see Table 2), thus is nearly constant over the operating range. This prediction interval is a little smaller than the design margin quoted above. This is due to the removal of the outlier points. No credit will be taken for it.

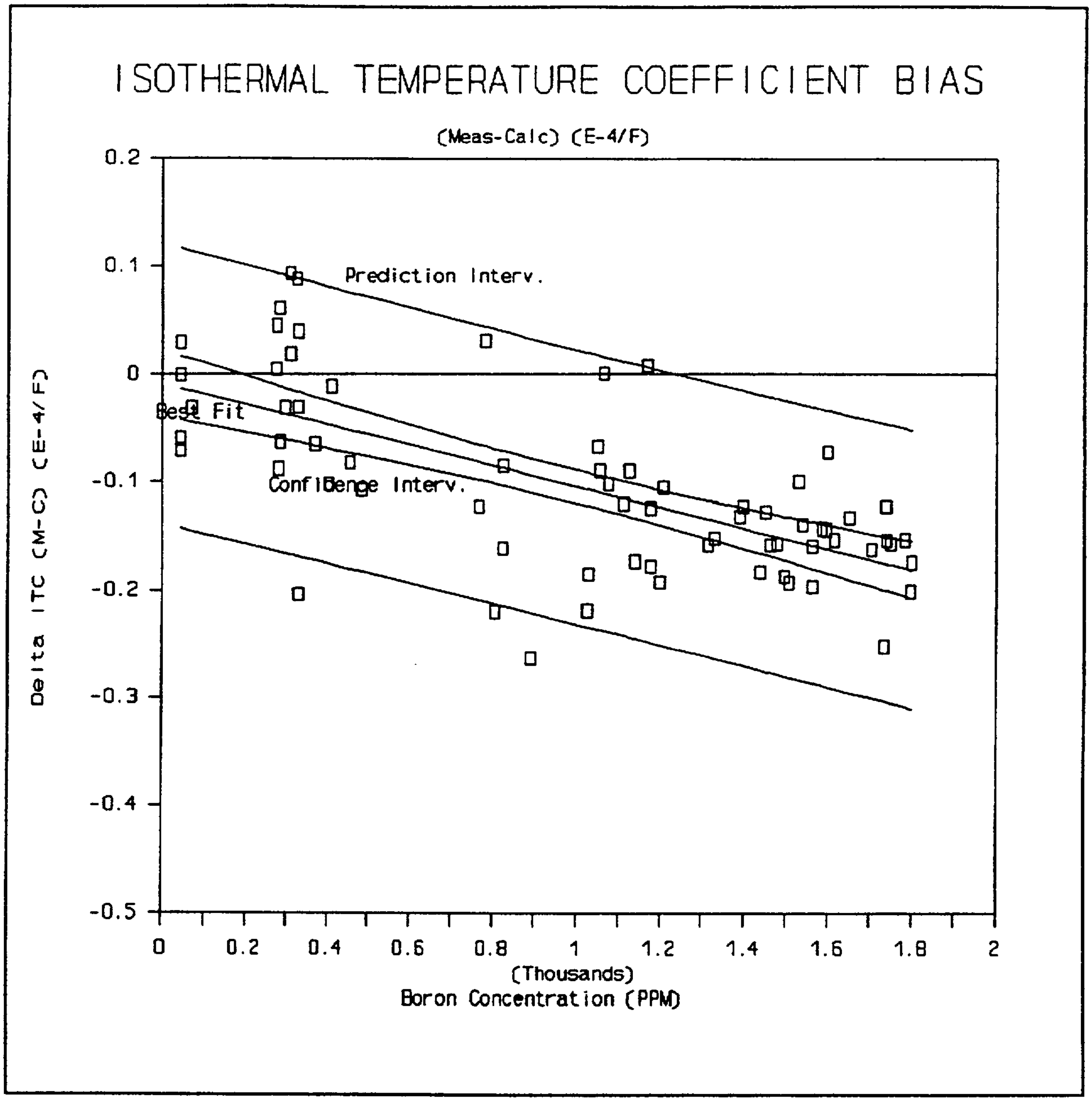
ISOTHERMAL TEMPERATURE COEFFICIENT BIAS
(Meas-Calc) (E-4/F)
Prediction Interv.
Best Fit
Confidence Interv.
Delta ITC (M-C) (E-4/F)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
(Thousands)
Boron Concentration (PPM)

Figure 9

VII. Normality and Poolability Tests

Statistical tests are performed on the distribution of residuals in order to establish that they are normally distributed and that any subset belongs to the total population. Residuals are the difference between the observed error in temperature coefficient (M-C) and the fitted error. The normality test ensures that the residuals are truly randomly distributed, and that no correlating variable is missing. A successful test lends confidence in the model and in its application to future observations. The poolability test ensures that the variability of the data is the same for all subsets, a subset being defined as a range of boron concentrations or a particular plant.

VII.a Normality Tests

Two normality tests were performed, i.e. the χ^2 test and the Kolmogorov-Smirnov test. The first application of the χ^2 test on the distribution of residuals listed in Table 2 failed, indicating that the model (PPM dependence of the residuals) was not satisfactory. Using the information provided by Figure 4, an enrichment dependence was added to the fitted residuals, as shown in Table 3. Here again, the two outlier points were removed. The best fit becomes:

$$\Delta ITC = M-C = -0.271 + 0.0754 * \epsilon - 0.0001046 * PPM \quad (10^{-4}\Delta\rho/°F) \qquad (11)$$

The standard deviation of the fit is 0.0572 and the 95/95 confidence band (uncertainty) is $\pm 0.114*10^{-4}\Delta\rho/°F$ (K = 1.993). This reduced value is due to the better fit, and the transfer of some uncorrelated residual components to an enrichment correlation. No credit will be taken for this lower uncertainty.

VII.a.1 χ^2 Test

The residuals X_i of the two dimensional fit were entered into the χ^2 test. This test compares the measured distribution to a normal distribution and evaluates the differences. The sorted residuals were distributed into 13 bins to produce an "Observed" distribution. The "Expected" distribution is defined as:

$$(E) = N * P_i = N * \int_{Z_{i-1}}^{Z_i} \frac{1}{\sqrt{2\pi}} e^{-\frac{Z^2}{2}} dZ \quad (12)$$

with:

$$Z = \frac{X}{S}$$

The quantity:

$$\sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i} \quad (13)$$

must be less than a critical χ^2 value.

The results of the test are given in Table 4. The test passes well, which indicates that the assumption of normality cannot be rejected.

VII.a.2. Kolmogorov - Smirnov Test

This test orders the residuals X_i, calculates $S_i = i/N$, $Z_i = X_i/S$ where S equals the standard deviation of the distribution X_i, then calculates $|F_i - S_i|$ and $|F_i - S_{i-1}|$, in which $F_i(Z_i)$ is the cumulative standardized normal distribution. The maximum of the quantities $|F_i - S_i|$ and $|F_i - S_{i-1}|$ must be less than a critical value. The results given in Table 5 indicate that the assumption of normality is fully justified.

These tests confirm the random nature of the residuals, as was suggested by Figures 2 through 8. This means that no parameter was found, either in the measurement or the prediction, which could lead to an unexpected error in the best estimate MTC.

The next statistical test establishes "Poolability", i.e. that various subsets of the data display the same variability, and are all part of the total population.

VII.b. Poolability Tests

The data base was divided into two types of subsets, i.e. subsets at various PPM levels, and subsets by plant.

A. Goodness of Fit Test - Bartlett's Test for Homogeneity of Variance at Various PPM Levels

The validity of combining data points from many plants and fitting the errors is justified by the Bartlett's test for homogeneity of variances. Eight data sets at various PPM levels including 69 data points are defined, and the test shows that each subset is part of the total distribution. The subsets are given in Table 6. The test consists of evaluating the quantity:

$$\chi^2_{K-1} = \frac{\nu_e \ln S_p^2 - \sum_{i=1}^{K} \nu_i \ln S_i^2}{1 + \frac{1}{3(K-1)} \left(\sum_{i=1}^{K} \frac{1}{\nu_i} - \frac{1}{\nu_e}\right)} \qquad (14)$$

in which K subsets have each ν_i degrees of freedom and a variance S_i^2, with a pooled variance:

$$S_p^2 = \frac{\sum_{i=1}^{K} \nu_i S_i^2}{\nu_e}$$

and a total degree of freedom:

$$\nu_e = \sum_{i=1}^{K} \nu_i$$

The χ^2 value of the data (13.79) is lower than the critical χ^2 at the 5% significance level ($\chi^2_{(n-1,\alpha/2)} = 16.01$), indicating that we cannot reject the assumption of linear fit.

B. Poolability of Data from Various Plants - Bartlett's Test

This test is comparable to the previous one, but here the subsets are defined by plant. Nine subsets including 68 points were used. Table 7 shows the test results. The χ^2 of the data is lower than the critical χ^2 at the 5% significance level, indicating that the assumption of poolability cannot be rejected. Thus all plants exhibit the same variability in the data and can correctly be pooled.

The successful results of the normality and poolability tests indicates that BOC and near EOC temperature coefficients display the same uncertainty, i.e. that the calculational models show equal performance in the predictions of these quantities. Thus, if the startup test program has established that the core is operating as intended, and if the beginning of cycle temperature coefficients fall within the design margin, then the end of cycle MTC must also be within the design margin and its measurement is not required.

VIII. Deviation from Normal Operation

All the points included in the data base were obtained from plants operating under normal conditions. Various plant parameters characterizing the operating conditions near end-of-cycle can vary within their Technical Specification limits and impact the MTC. A complete study of the MTC sensitivity to the EOC operating conditions of every plant is beyond the scope of this report and only a limited set has been evaluated for a given cycle. It must also be pointed out that, in case of deviation from normal operation, **it is always possible to do a best estimate MTC calculation under the exact operating conditions.** The accuracy of the models is not impacted by off-nominal conditions. The results of this calculation are then checked against the Tech. Spec. MTC.

Deviations from normal operation or deviations from the typical unrodded conditions of this data base have for the most part a very small impact on the end-of-cycle MTC. The following deviations have been investigated:

1. Deviations in boron letdown curve

2. Rodded operation

3. Shift in axial power distributions

Palo Verde Unit 2 cycle 4 was used to calculate some derivative rules.

The boron concentration has a strong impact on the MTC. The MTC becomes more negative, and therefore closer to the Tech. Spec. limit, if the boron concentration is reduced. However it cannot be reduced beyond its end of cycle value where the MTC is the most negative. Thus measured boron concentrations which are lower than expected are not a concern. On the other hand, if the boron concentration is higher than expected, the cycle can run longer and an increased burnup will drive the MTC more negative. At constant PPM, the burnup derivative of the MTC is very small:

$$\Delta MTC / \Delta BU = -.04 \times 10^{-4} \Delta\rho/{}^{\circ}F / 1000 \text{ MWD/T}$$

Thus a cycle should be substantially longer than designed for the MTC to be affected. If in doubt, an explicit calculation can be performed.

A rodded operation will also drive the MTC to be more negative. For a lead bank insertion to the PDIL, the combined effect of the rod insertion and of the reduced boron concentration will reduce the MTC by about $0.08 \times 10^{-4} \Delta\rho/{}^{\circ}F$.

A shift in axial shape has a very small impact on the MTC. The derivative rule is:

$$\Delta MTC / \Delta ASI = -0.08 \times 10^{-4} \Delta\rho/{}^{\circ}F / \text{ASI unit at constant rod insertion}$$

Within the allowable ASI band, the MTC will not show substantial changes.

Based on past experience, it is recognized that any departure from normal operation will manifest itself first in the power distributions, then in the reactivity or critical boron concentrations. The end of cycle moderator temperature coefficient is very insensitive to abnormal operation. Since power distributions and boron concentrations are monitored routinely, it is deemed that this monitoring is sufficient and that it is unnecessary to extend the monitoring requirements to other parameters in the absence of a 2/3 cycle MTC surveillance test.

IX. Conclusions

The analysis of a data base of measured and calculated moderator temperature coefficients has established a design margin of $\pm 0.16*10^{-4}\Delta\rho/°F$. This design margin is applicable to all operating conditions throughout the entire cycle of any ABB-CE plant designed with the current ABB-CE methodology.

The successful results of normality and poolability tests on the data base indicated that BOC and near EOC temperature coefficients display the same uncertainty, i.e. that the calculational models show equal performance in the predictions of these quantities. Thus, if the startup test program has established that the core is operating as intended, and if the isothermal temperature coefficients measured at zero power during the cycle startup program, and at power during the first power ascension, fall within the design margin (acceptance criteria) of $\pm 0.16*10^{-4}\Delta\rho/°F$, then the end-of-cycle best estimate prediction will also be within $\pm 0.16*10^{-4}\Delta\rho/°F$ of the true MTC. To establish compliance with the Technical Specifications, the best estimate end-of-cycle MTC must be less negative than the Tech. Spec. value by $0.16*10^{-4}\Delta\rho/°F$.

Table 1
MODERATOR TEMPERATURE COEFFICIENTS

PLANT	CYCLE	Core Av Enrich	Core Avg Burnup	PPM	PWR (%)	Tmod (F)	ITC MEAS E-4/F	ITC CALC E-4/F	M-C E-4/F
CC-1	10	3.95	10971	1750	0	532	0.265	0.422	-0.157
CC-1	10	3.95	10971	1735	0	532	0.200	0.452	-0.252
CC-1	10	3.95	27443	285	97	570	-1.844	-1.781	-0.063
CC-1	9	3.77	16502	1398	0	532	0.064	0.187	-0.123
CC-1	9	3.77	24783	275	97	570	-1.865	-1.870	0.005
CC-1	8	3.81	14526	1600	0	532	0.344	0.417	-0.073
CC-1	8	3.81	14526	1330	0	532	-0.560	-0.408	-0.152
CC-1	8	3.81	24723	310	97	570	-1.782	-1.801	0.019
CC-2	9	4.15	13895	1801	0	532	0.370	0.544	-0.174
CC-2	9	4.15	13895	1389	0	532	-0.470	-0.338	-0.132
CC-2	8	3.93	12937	1496	0	521	0.200	0.387	-0.187
CC-2	8	3.93	27120	297	97	570	-1.810	-1.779	-0.031
OPPD	12	3.73	15738	1507	0	523	0.240	0.433	-0.193
OPPD	12	3.73	16520	1050	91	565	-0.516	-0.448	-0.068
OPPD	12	3.73	25777	309	92	565	-1.711	-1.804	0.093
OPPD	13	3.72	14835	1563	0	521	0.310	0.506	-0.196
OPPD	13	3.72	15209	1113	92	565	-0.461	-0.341	-0.120
OPPD	13	3.72	25531	325	92	565	-1.640	-1.728	0.088
OPPD	14	3.60	14562	1178	0	523	-0.090	0.035	-0.125
OPPD	14	3.60	14916	768	88	564	-0.912	-0.789	-0.123
PV-1	1	2.65	0	1055	0	320	-0.128	-0.038	-0.090
PV-1	1	2.65	0	824	0	320	-0.369	-0.208	-0.161
PV-1	1	2.65	0	1025	0	565	-0.442	-0.223	-0.219
PV-1	1	2.65	0	893	0	565	-0.972	-0.709	-0.263
PV-1	1	2.65	82	825	23	565	-0.587	-0.502	-0.085
PV-1	2	3.15	11269	1462	0	565	0.150	0.308	-0.158
PV-1	2	3.15	11269	1178	0	565	-0.422	-0.244	-0.178
PV-1	3	3.66	9727	1739	0	565	0.133	0.256	-0.123
PV-1	3	3.66	9727	1438	0	565	-0.445	-0.262	-0.183
PV-1	3	3.66	9727	1653	0	565	-0.130	0.003	-0.133
PV-1	3	3.66	11209	1170	100	595	-0.813	-0.821	0.008
PV-1	3	3.66	22404	484	100	595	-2.291	-2.184	-0.107
PV-2	2	3.32	9123	1452	0	565	-0.048	0.080	-0.128
PV-2	2	3.32	9123	1140	0	565	-0.468	-0.295	-0.173
PV-2	3	3.76	12102	1595	0	595	0.065	0.209	-0.144
PV-2	3	3.76	12102	1315	0	565	-0.693	-0.535	-0.158
PV-2	3	3.76	14662	1029	100	595	-1.146	-0.961	-0.185
PV-2	3	3.76	23080	456	100	595	-2.495	-2.157	-0.338
PV-2	4	3.73	13988	1741	0	565	0.174	0.328	-0.154
PV-2	4	3.73	15516	1126	100	595	-0.972	-0.882	-0.090
PV-2	4	3.73	24121	455	100	595	-2.352	-2.270	-0.082
PV-3	1	2.65	0	805	0	565	-0.837	-0.617	-0.220
PV-3	2	3.26	8402	1479	0	565	0.061	0.218	-0.157
PV-3	2	3.26	8402	1200	0	565	-0.424	-0.232	-0.192
PV-3	2	3.26	19015	411	99	595	-2.054	-2.043	-0.011
PV-3	3	3.47	22874	330	100	595	-2.641	-2.437	-0.204
PV-3	4	3.61	14284	1586	0	565	0.040	0.183	-0.143
SONGS2	4	3.75	8419	1798	0	545	0.077	0.278	-0.201
SONGS2	4	3.75	8419	1563	0	545	-0.364	-0.205	-0.159
SONGS2	5	3.95	11355	1615	0	545	-0.082	0.071	-0.153
SONGS2	5	3.95	11355	1208	0	545	-0.860	-0.755	-0.105
ST-L-2	5	3.65	14397	1705	0	535	0.208	0.370	-0.162
ST-L-2	5	3.65	20035	789	100	572	-0.951	-1.114	0.163
ST-L-2	5	3.65	26200	280	100	572	-2.114	-2.026	-0.088
ST-L-2	6	3.85	16024	1784	0	532	0.219	0.372	-0.153
ST-L-2	6	3.85	22570	782	100	572	-1.203	-1.234	0.031
ST-L-2	6	3.85	28462	283	100	572	-2.033	-2.094	0.061
CC-2	5	3.42	24423	44	0	530	-1.610	-1.550	-0.060
CC-2	5	3.42	24423	44	0	530	-1.740	-1.670	-0.070
CC-2	5	3.42	24423	44	0	530	-1.950	-1.950	0.000
CC-2	5	3.42	24423	44	0	530	-2.080	-2.110	0.030
CC-2	5	3.42	24423	330	0	530	-1.050	-1.090	0.040

Table 1 (Cont'd)

MODERATOR TEMPERATURE COEFFICIENTS

PLANT	CYCLE	Core Av Enrich	Core Avg Burnup	PPM	PWR (%)	Tmod (F)	ITC MEAS E-4/F	ITC CALC E-4/F	M-C E-4/F
CC-2	5	3.42	24423	330	0	530	-1.110	-1.080	-0.030
CC-2	5	3.42	24423	69	100	572	-2.089	-2.058	-0.031
ANO-2	9	3.98	28367	276	95	582	-2.251	-2.296	0.045
WSES-3	4	3.82	14074	1540	0	545	-0.074	0.065	-0.139
WSES-3	4	3.82	14211	1077	92	582	-0.957	-0.855	-0.102
WSES-3	4	3.82	25206	370	95	582	-2.114	-2.049	-0.065
WSES-3	5	3.91	14898	1530	0	545	-0.097	0.003	-0.100
WSES-3	5	3.91	15040	1066	91	582	-0.912	-0.913	0.001
WSES-3	5	3.91	25907	404	93	582	-2.119	-2.017	-0.102

Fit Of (M-C) vs PPM

(E-4/F)

Regression Output:

Constant	-0.01356
Std Err of Y Est	0.07703
R Squared	0.31264
No. of Observations	71
Degrees of Freedom	69
X Coefficient(s)	-9.13E-05
Std Err of Coef.	1.63E-05
K (71) =	1.987
K*Sigma =	0.153 E-4/F

CALCULATION OF CONF./PREDICT. BANDS OF DISTRIBUTION OF (M−C) ITC ERRORS (E-4/F)

Table 2

NUMBER OF PTS N = 69 N−2 = 67

	X= PPM	Power (%)	X-Xav= x	Y MEAS= M-C	Y-Yav= y MEAS	Y CALC	RESID	CONFID	YCALC CONFI	YCALC -CONFID	PREDICT INTERV	YCALC +PRED	YCALC -PRED
CC-2	44	0	-957	0.030	0.1345	-0.0127	0.0427	0.0299	0.0172	-0.0425	0.1295	0.1169	-0.1422
CC-2	44	0	-957	0.000	0.1045	-0.0127	0.0127	0.0299	0.0172	-0.0425	0.1295	0.1169	-0.1422
CC-2	44	0	-957	-0.060	0.0445	-0.0127	-0.0473	0.0299	0.0172	-0.0425	0.1295	0.1169	-0.1422
CC-2	44	0	-957	-0.070	0.0345	-0.0127	-0.0573	0.0299	0.0172	-0.0425	0.1295	0.1169	-0.1422
CC-2	69	100	-932	-0.031	0.0735	-0.0151	-0.0159	0.0293	0.0142	-0.0444	0.1294	0.1143	-0.1445
CC-1	275	97	-726	0.005	0.1095	-0.0348	0.0398	0.0247	-0.0101	-0.0596	0.1285	0.0936	-0.1633
ANO-2	276	95	-725	0.045	0.1495	-0.0349	0.0799	0.0247	-0.0102	-0.0596	0.1285	0.0935	-0.1634
ST-L-2	280	100	-721	-0.088	0.0165	-0.0353	-0.0527	0.0246	-0.0107	-0.0599	0.1284	0.0931	-0.1637
ST-L-2	283	100	-718	0.061	0.1655	-0.0356	0.0966	0.0246	-0.0110	-0.0601	0.1284	0.0928	-0.1640
CC-1	285	97	-716	-0.063	0.0415	-0.0358	-0.0272	0.0245	-0.0113	-0.0603	0.1284	0.0926	-0.1642
CC-2	297	97	-704	-0.031	0.0735	-0.0369	0.0059	0.0243	-0.0127	-0.0612	0.1284	0.0914	-0.1653
OPPD	309	92	-692	0.093	0.1975	-0.0381	0.1311	0.0240	-0.0141	-0.0621	0.1283	0.0902	-0.1664
CC-1	310	97	-691	0.019	0.1235	-0.0382	0.0572	0.0240	-0.0142	-0.0622	0.1283	0.0901	-0.1665
OPPD	325	92	-676	0.088	0.1925	-0.0396	0.1276	0.0237	-0.0160	-0.0633	0.1283	0.0886	-0.1679
CC-2	330	0	-671	-0.030	0.0745	-0.0401	0.0101	0.0236	-0.0165	-0.0637	0.1282	0.0881	-0.1683
PV-3	330	100	-671	-0.204	-0.0995	-0.0401	-0.1639	0.0236	-0.0165	-0.0637	0.1282	0.0881	-0.1683
CC-2	330	0	-671	0.040	0.1445	-0.0401	0.0801	0.0236	-0.0165	-0.0637	0.1282	0.0881	-0.1683
WSES-3	370	95	-631	-0.065	0.0395	-0.0439	-0.0211	0.0228	-0.0212	-0.0667	0.1281	0.0842	-0.1720
WSES-3	404	93	-597	-0.102	0.0025	-0.0472	-0.0548	0.0221	-0.0251	-0.0693	0.1280	0.0808	-0.1752
PV-3	411	99	-590	-0.011	0.0935	-0.0479	0.0369	0.0220	-0.0259	-0.0698	0.1280	0.0801	-0.1758
PV-2	455	100	-546	-0.082	0.0225	-0.0521	-0.0299	0.0211	-0.0310	-0.0732	0.1278	0.0757	-0.1799
PV-1	484	100	-517	-0.107	-0.0025	-0.0549	-0.0521	0.0206	-0.0343	-0.0755	0.1277	0.0728	-0.1826
OPPD	768	88	-233	-0.123	-0.0185	-0.0821	-0.0409	0.0164	-0.0657	-0.0985	0.1271	0.0450	-0.2092
ST-L-2	782	100	-219	0.031	0.1355	-0.0835	0.1145	0.0163	-0.0672	-0.0997	0.1271	0.0436	-0.2106
PV-3	805	0	-196	-0.220	-0.1155	-0.0857	-0.1343	0.0161	-0.0696	-0.1017	0.1271	0.0414	-0.2127
PV-1	824	0	-177	-0.161	-0.0565	-0.0875	-0.0735	0.0159	-0.0716	-0.1034	0.1271	0.0396	-0.2145
PV-1	825	23	-176	-0.085	0.0195	-0.0876	0.0026	0.0159	-0.0717	-0.1035	0.1271	0.0395	-0.2146
PV-1	893	0	-108	-0.263	-0.1585	-0.0941	-0.1689	0.0155	-0.0787	-0.1096	0.1270	0.0329	-0.2211
PV-1	1025	0	24	-0.219	-0.1145	-0.1068	-0.1122	0.0152	-0.0916	-0.1220	0.1270	0.0202	-0.2337
PV-2	1029	100	28	-0.185	-0.0805	-0.1072	-0.0778	0.0152	-0.0920	-0.1223	0.1270	0.0198	-0.2341
OPPD	1050	91	49	-0.068	0.0365	-0.1092	0.0412	0.0152	-0.0939	-0.1244	0.1270	0.0178	-0.2361
PV-1	1055	0	54	-0.090	0.0145	-0.1096	0.0196	0.0152	-0.0944	-0.1249	0.1270	0.0173	-0.2366
WSES-3	1066	91	65	0.001	0.1055	-0.1107	0.1117	0.0153	-0.0954	-0.1260	0.1270	0.0163	-0.2377
WSES-3	1077	92	76	-0.102	0.0025	-0.1118	0.0098	0.0153	-0.0964	-0.1271	0.1270	0.0152	-0.2387
OPPD	1113	92	112	-0.120	-0.0155	-0.1152	-0.0048	0.0155	-0.0997	-0.1307	0.1270	0.0118	-0.2422
PV-2	1126	100	125	-0.090	0.0145	-0.1165	0.0265	0.0155	-0.1009	-0.1320	0.1270	0.0106	-0.2435

Table 2 (Cont'd)

PV-2	1140	0	139	-0.173	-0.0685	-0.1178	-0.0552	0.0156	-0.1022	-0.1334	0.1270	0.0092	-0.2448
PV-1	1170	100	169	0.008	0.1125	-0.1207	0.1287	0.0158	-0.1048	-0.1365	0.1270	0.0064	-0.2477
OPPD	1178	0	177	-0.125	-0.0205	-0.1214	-0.0036	0.0159	-0.1055	-0.1374	0.1271	0.0056	-0.2485
PV-1	1178	0	177	-0.178	-0.0735	-0.1214	-0.0566	0.0159	-0.1055	-0.1374	0.1271	0.0056	-0.2485
PV-3	1200	0	199	-0.192	-0.0875	-0.1236	-0.0684	0.0161	-0.1075	-0.1396	0.1271	0.0035	-0.2506
SONGS	1208	0	207	-0.105	-0.0005	-0.1243	0.0193	0.0162	-0.1082	-0.1405	0.1271	0.0028	-0.2514
PV-2	1315	0	314	-0.158	-0.0535	-0.1346	-0.0234	0.0174	-0.1172	-0.1520	0.1272	-0.0073	-0.2618
CC-1	1330	0	329	-0.152	-0.0475	-0.1360	-0.0160	0.0176	-0.1185	-0.1536	0.1273	-0.0088	-0.2633
CC-2	1389	0	388	-0.132	-0.0275	-0.1417	0.0097	0.0184	-0.1233	-0.1601	0.1274	-0.0143	-0.2691
CC-1	1398	0	397	-0.123	-0.0185	-0.1426	0.0196	0.0185	-0.1240	-0.1611	0.1274	-0.0151	-0.2700
PV-1	1438	0	437	-0.183	-0.0785	-0.1464	-0.0366	0.0192	-0.1272	-0.1656	0.1275	-0.0189	-0.2739
PV-2	1452	0	451	-0.128	-0.0235	-0.1477	0.0197	0.0194	-0.1283	-0.1672	0.1275	-0.0202	-0.2753
PV-1	1462	0	461	-0.158	-0.0535	-0.1487	-0.0093	0.0196	-0.1291	-0.1683	0.1276	-0.0211	-0.2763
PV-3	1479	0	478	-0.157	-0.0525	-0.1503	-0.0067	0.0199	-0.1304	-0.1702	0.1276	-0.0227	-0.2779
CC-2	1496	0	495	-0.187	-0.0825	-0.1520	-0.0350	0.0202	-0.1318	-0.1721	0.1277	-0.0243	-0.2796
OPPD	1507	0	506	-0.193	-0.0885	-0.1530	-0.0400	0.0204	-0.1326	-0.1734	0.1277	-0.0253	-0.2807
WSES-3	1530	0	529	-0.100	0.0045	-0.1552	0.0552	0.0208	-0.1344	-0.1760	0.1278	-0.0275	-0.2830
WSES-3	1540	0	539	-0.139	-0.0345	-0.1562	0.0172	0.0210	-0.1352	-0.1771	0.1278	-0.0284	-0.2840
SONGS	1563	0	562	-0.159	-0.0545	-0.1584	-0.0006	0.0214	-0.1370	-0.1798	0.1279	-0.0305	-0.2862
OPPD	1563	0	562	-0.196	-0.0915	-0.1584	-0.0376	0.0214	-0.1370	-0.1798	0.1279	-0.0305	-0.2862
PV-3	1586	0	585	-0.143	-0.0385	-0.1606	0.0176	0.0218	-0.1387	-0.1824	0.1279	-0.0326	-0.2885
PV-2	1595	0	594	-0.144	-0.0395	-0.1614	0.0174	0.0220	-0.1394	-0.1835	0.1280	-0.0335	-0.2894
CC-1	1600	0	599	-0.073	0.0315	-0.1619	0.0889	0.0221	-0.1398	-0.1840	0.1280	-0.0339	-0.2899
SONGS	1615	0	614	-0.153	-0.0485	-0.1634	0.0104	0.0224	-0.1409	-0.1858	0.1280	-0.0353	-0.2914
PV-1	1653	0	652	-0.133	-0.0285	-0.1670	0.0340	0.0232	-0.1438	-0.1902	0.1282	-0.0388	-0.2952
ST-L-2	1705	0	704	-0.162	-0.0575	-0.1720	0.0100	0.0243	-0.1477	-0.1963	0.1284	-0.0436	-0.3004
CC-1	1735	0	734	-0.252	-0.1475	-0.1749	-0.0771	0.0249	-0.1500	-0.1998	0.1285	-0.0464	-0.3034
PV-1	1739	0	738	-0.123	-0.0185	-0.1753	0.0523	0.0250	-0.1503	-0.2002	0.1285	-0.0468	-0.3038
PV-2	1741	0	740	-0.154	-0.0495	-0.1755	0.0215	0.0250	-0.1504	-0.2005	0.1285	-0.0469	-0.3040
CC-1	1750	0	749	-0.157	-0.0525	-0.1763	0.0193	0.0252	-0.1511	-0.2015	0.1286	-0.0478	-0.3049
ST-L-2	1784	0	783	-0.153	-0.0485	-0.1796	0.0266	0.0259	-0.1536	-0.2055	0.1287	-0.0509	-0.3083
SONGS	1798	0	797	-0.201	-0.0965	-0.1809	-0.0201	0.0262	-0.1547	-0.2072	0.1288	-0.0522	-0.3097
CC-2	1801	0	800	-0.174	-0.0695	-0.1812	0.0072	0.0263	-0.1549	-0.2075	0.1288	-0.0524	-0.3100

Table 3
MODERATOR TEMPERATURE STATISTICS

PLANT	Enr. (w/o)	PPM	Power	(M-C) (E-4)
CC-2	3.42	44	0	0.030
CC-2	3.42	44	0	0.000
CC-2	3.42	44	0	-0.060
CC-2	3.42	44	0	-0.070
CC-2	3.42	69	100	-0.031
CC-1	3.77	275	97	0.005
ANO-2	3.98	276	95	0.045
ST-L-2	3.65	280	100	-0.088
ST-L-2	3.85	283	100	0.061
CC-1	3.95	285	97	-0.063
CC-2	3.93	297	97	-0.031
OPPD	3.73	309	92	0.093
CC-1	3.81	310	97	0.019
OPPD	3.72	325	92	0.088
CC-2	3.42	330	0	-0.030
PV-3	3.47	330	100	-0.204
CC-2	3.42	330	0	0.040
WSES-3	3.82	370	95	-0.065
WSES-3	3.91	404	93	-0.102
PV-3	3.26	411	99	-0.011
PV-2	3.73	455	100	-0.082
PV-1	3.66	484	100	-0.107
OPPD	3.6	768	88	-0.123
ST-L-2	3.85	782	100	0.031
PV-3	2.65	805	0	-0.220
PV-1	2.65	824	0	-0.161
PV-1	2.65	825	23	-0.085
PV-1	2.65	893	0	-0.263
PV-1	2.65	1025	0	-0.219
PV-2	3.76	1029	100	-0.185
OPPD	3.73	1050	91	-0.068
PV-1	2.65	1055	0	-0.090
WSES-3	3.91	1066	91	0.001
WSES-3	3.82	1077	92	-0.102
OPPD	3.72	1113	92	-0.120
PV-2	3.73	1126	100	-0.090
PV-2	3.32	1140	0	-0.173
PV-1	3.66	1170	100	0.008
OPPD	3.6	1178	0	-0.125
PV-1	3.15	1178	0	-0.178
PV-3	3.26	1200	0	-0.192
SONGS2	3.95	1208	0	-0.105
PV-2	3.76	1315	0	-0.158
CC-1	3.81	1330	0	-0.152
CC-2	4.15	1389	0	-0.132
CC-1	3.77	1398	0	-0.123
PV-1	3.66	1438	0	-0.183
PV-2	3.32	1452	0	-0.128
PV-1	3.15	1462	0	-0.158
PV-3	3.26	1479	0	-0.157
CC-2	3.93	1496	0	-0.187
OPPD	3.73	1507	0	-0.193

Regression of (M-C) vs. Enrichment and PPM

Regression Output:		
Constant		-0.2712
Std Err of Y Est		0.0572
R Squared		0.5395
No. of Observations		69
Degrees of Freedom		66
	Enrich.	PPM
X Coefficient(s)	0.075406	-0.0001046
Std Err of Coef.	0.019126	0.0000124

Table 3 (Cont'd)

WSES-3	3.91	1530	0	-0.100
WSES-3	3.82	1540	0	-0.139
SONGS2	3.75	1563	0	-0.159
OPPD	3.72	1563	0	-0.196
PV-3	3.61	1586	0	-0.143
PV-2	3.76	1595	0	-0.144
CC-1	3.81	1600	0	-0.073
SONGS2	3.95	1615	0	-0.153
PV-1	3.66	1653	0	-0.133
ST-L-2	3.65	1705	0	-0.162
CC-1	3.95	1735	0	-0.252
PV-1	3.66	1739	0	-0.123
PV-2	3.73	1741	0	-0.154
CC-1	3.95	1750	0	-0.157
ST-L-2	3.85	1784	0	-0.153
SONGS2	3.75	1798	0	-0.201
CC-2	4.15	1801	0	-0.174

Table 4

NORMALITY TEST

CHI SQUARE TEST N = 69

SORTED RESID. (E-4/F)	BINS Xi from	BINS Xi to	Observed Distrib O	Expected Distrib E	(O-E)^2/E
-0.160	- inf	-0.200	0	0.069	0.0690
-0.098	-0.200	-0.130	1	0.759	0.0765
-0.097	-0.130	-0.060	7	9.315	0.5753
-0.090	-0.060	-0.045	4	4.692	0.1021
-0.083	-0.045	-0.035	8	3.795	4.6593
-0.064	-0.035	-0.025	6	4.278	0.6931
-0.063	-0.025	-0.010	5	6.762	0.4591
-0.061	-0.010	0.010	7	9.660	0.7325
-0.060	0.010	0.020	8	4.554	2.6076
-0.056	0.020	0.030	4	4.416	0.0392
-0.052	0.030	0.050	7	7.590	0.0459
-0.045	0.050	0.100	9	10.350	0.1761
-0.045	0.100	0.180	3	2.691	0.0355
-0.043	0.180	+ inf	0	0.069	0.0690
-0.043					
-0.042				SUM	10.340
-0.042				CHI square (11) =	21.290
-0.041					
-0.040					
-0.037					
-0.033					
-0.033					
-0.029					
-0.028					
-0.027					
-0.025					
-0.024					
-0.021					
-0.013					
-0.011					
-0.011					
-0.007					
-0.006					
-0.005					
-0.003					
-0.002					
-0.001					
0.005					
0.010					
0.011					
0.012					
0.014					
0.018					
0.018					
0.018					
0.018					
0.021					
0.022					

Zi=Xi/S	Fi	Pi = Fi-F(i-1)
-3.4945	0.001	0.001
-2.2714	0.012	0.011
-1.0483	0.147	0.135
-0.7863	0.215	0.068
-0.6115	0.270	0.055
-0.4368	0.332	0.062
-0.1747	0.430	0.098
0.1747	0.570	0.140
0.3494	0.636	0.066
0.5242	0.700	0.064
0.8736	0.810	0.110
1.7472	0.960	0.150
3.1450	0.999	0.039

CHI^2 > SUM
CHI^2 Test passes

CHI^2(k-1-2,alpha/2) = 21.92
k = 14
Since mean and variance were estimated,
we must remove 2 degrees of freedom

F = cummulative standardized
normal distribution
Ref.48, page 228
S = 0.0572 from Table 3

Table 4 (Cont'd)

Sorted Residuals (Cont'd)

0.023
0.029
0.032
0.035
0.035
0.036
0.045
0.045
0.048
0.054
0.057
0.071
0.073
0.078
0.088
0.089
0.092
0.094
0.113
0.115
0.126

Table 5

KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST

Residuals ti	i	Sn(ti)	Sn(ti-1)	zi=ti/std	Fi	ABS (Fi-Si)	ABS (Fi-Si-1)
-0.160	1	0.01449	0.00000	-2.795	0.0030	0.01149	0.00300
-0.098	2	0.02899	0.01449	-1.716	0.0427	0.01371	0.02821
-0.097	3	0.04348	0.02899	-1.698	0.0446	0.00112	0.01561
-0.090	4	0.05797	0.04348	-1.567	0.0590	0.00103	0.01552
-0.083	5	0.07246	0.05797	-1.457	0.0730	0.00054	0.01503
-0.064	6	0.08696	0.07246	-1.126	0.1310	0.04404	0.05854
-0.063	7	0.10145	0.08696	-1.097	0.1360	0.03455	0.04904
-0.061	8	0.11594	0.10145	-1.069	0.1420	0.02606	0.04055
-0.060	9	0.13043	0.11594	-1.046	0.1470	0.01657	0.03106
-0.056	10	0.14493	0.13043	-0.973	0.1660	0.02107	0.03557
-0.052	11	0.15942	0.14493	-0.911	0.1810	0.02158	0.03607
-0.045	12	0.17391	0.15942	-0.794	0.2150	0.04109	0.05558
-0.045	13	0.18841	0.17391	-0.778	0.2180	0.02959	0.04409
-0.043	14	0.20290	0.18841	-0.755	0.2250	0.02210	0.03659
-0.043	15	0.21739	0.20290	-0.750	0.2260	0.00861	0.02310
-0.042	16	0.23188	0.21739	-0.736	0.2310	0.00088	0.01361
-0.042	17	0.24638	0.23188	-0.731	0.2320	0.01438	0.00012
-0.041	18	0.26087	0.24638	-0.718	0.2360	0.02487	0.01038
-0.040	19	0.27536	0.26087	-0.706	0.2410	0.03436	0.01987
-0.037	20	0.28986	0.27536	-0.653	0.2550	0.03486	0.02036
-0.033	21	0.30435	0.28986	-0.575	0.2830	0.02135	0.00686
-0.033	22	0.31884	0.30435	-0.573	0.2840	0.03484	0.02035
-0.029	23	0.33333	0.31884	-0.506	0.3060	0.02733	0.01284
-0.028	24	0.34783	0.33333	-0.497	0.3100	0.03783	0.02333
-0.027	25	0.36232	0.34783	-0.478	0.3160	0.04632	0.03183
-0.025	26	0.37681	0.36232	-0.439	0.3300	0.04681	0.03232
-0.024	27	0.39130	0.37681	-0.428	0.3340	0.05730	0.04281
-0.021	28	0.40580	0.39130	-0.369	0.3560	0.04980	0.03530
-0.013	29	0.42029	0.40580	-0.225	0.4110	0.00929	0.00520
-0.011	30	0.43478	0.42029	-0.187	0.4260	0.00878	0.00571
-0.011	31	0.44928	0.43478	-0.184	0.4280	0.02128	0.00678
-0.007	32	0.46377	0.44928	-0.124	0.4500	0.01377	0.00072
-0.006	33	0.47826	0.46377	-0.109	0.4570	0.02126	0.00677
-0.005	34	0.49275	0.47826	-0.093	0.4620	0.03075	0.01626
-0.003	35	0.50725	0.49275	-0.060	0.4760	0.03125	0.01675
-0.002	36	0.52174	0.50725	-0.036	0.4860	0.03574	0.02125
-0.001	37	0.53623	0.52174	-0.010	0.4960	0.04023	0.02574
0.005	38	0.55072	0.53623	0.091	0.5360	0.01472	0.00023
0.010	39	0.56522	0.55072	0.177	0.5700	0.00478	0.01928
0.011	40	0.57971	0.56522	0.184	0.5740	0.00571	0.00878
0.012	41	0.59420	0.57971	0.215	0.5860	0.00820	0.00629
0.014	42	0.60870	0.59420	0.253	0.6000	0.00870	0.00580
0.018	43	0.62319	0.60870	0.309	0.6200	0.00319	0.01130
0.018	44	0.63768	0.62319	0.311	0.6220	0.01568	0.00119
0.018	45	0.65217	0.63768	0.312	0.6240	0.02817	0.01368
0.018	46	0.66667	0.65217	0.315	0.6250	0.04167	0.02717
0.021	47	0.68116	0.66667	0.361	0.6410	0.04016	0.02567
0.022	48	0.69565	0.68116	0.382	0.6500	0.04565	0.03116
0.023	49	0.71014	0.69565	0.403	0.6570	0.05314	0.03865
0.029	50	0.72464	0.71014	0.500	0.6920	0.03264	0.01814

Table 5 (Cont'd)

0.032	51	0.73913	0.72464	0.555	0.7100	0.02913	0.01464
0.035	52	0.75362	0.73913	0.614	0.7310	0.02262	0.00813
0.035	53	0.76812	0.75362	0.617	0.7550	0.01312	0.00138
0.036	54	0.78261	0.76812	0.636	0.7580	0.02461	0.01012
0.045	55	0.79710	0.78261	0.781	0.7830	0.01410	0.00039
0.045	56	0.81159	0.79710	0.785	0.7850	0.02659	0.01210
0.048	57	0.82609	0.81159	0.836	0.7990	0.02709	0.01259
0.054	58	0.84058	0.82609	0.946	0.8280	0.01258	0.00191
0.057	59	0.85507	0.84058	1.002	0.8420	0.01307	0.00142
0.071	60	0.86957	0.85507	1.248	0.8940	0.02443	0.03893
0.073	61	0.88406	0.86957	1.269	0.8980	0.01394	0.02843
0.078	62	0.89855	0.88406	1.367	0.9140	0.01545	0.02994
0.088	63	0.91304	0.89855	1.534	0.9380	0.02496	0.03945
0.089	64	0.92754	0.91304	1.552	0.9400	0.01246	0.02696
0.092	65	0.94203	0.92754	1.602	0.9450	0.00297	0.01746
0.094	66	0.95652	0.94203	1.636	0.9490	0.00752	0.00697
0.113	67	0.97101	0.95652	1.968	0.9750	0.00399	0.01848
0.115	68	0.98551	0.97101	2.013	0.9780	0.00751	0.00699
0.126	69	1.00000	0.98551	2.194	0.9860	0.01400	0.00049

Dmax = 0.05854

CRITICAL VALUES

n>35 Dn = k/SQRT(N)

Alpha	k	Dn
0.15	1.14	0.137
0.10	1.22	0.147
0.05	1.36	0.164
0.01	1.63	0.196

Dmax < Dn, so accept hypothesis of normality

Table 6

BARTLETT'S TEST FOR HOMOGENEITY OF VARIANCE

Subsets by PPM Level

PPM	RESID	i	nu	Si^2	ln(S^2)	nu*ln(S^2)	nu*S^2
44	0.048	1	5	0.001727	-6.36120	-31.80601	0.00864
44	0.018						
44	-0.042						
44	-0.052						
69	-0.011						
275	0.021	2	12	0.006661	-5.01153	-60.13838	0.07993
276	0.045						
280	-0.063						
283	0.071						
285	-0.060						
297	-0.025						
309	0.115						
310	0.035						
325	0.113						
330	0.018						
330	-0.160						
330	0.088						
370	-0.043	3	5	0.002928	-5.83339	-29.16695	0.01464
404	-0.083						
411	0.057						
455	-0.045						
484	-0.061						
768	-0.043	4	6	0.005881	-5.13601	-30.81603	0.03529
782	0.094						
805	-0.064						
824	-0.003						
825	0.073						
893	-0.098						
1025	-0.040	5	12	0.003903	-5.54589	-66.55070	0.04684
1029	-0.090						
1050	0.032						
1055	0.092						
1066	0.089						
1077	-0.006						
1113	-0.013						
1126	0.018						
1140	-0.033						
1170	0.126						
1178	-0.002						
1178	-0.021						
1200	-0.041	6	11	0.001101	-6.81120	-74.92316	0.01212
1208	-0.005						
1315	-0.033						
1330	-0.029						
1389	-0.028						
1398	0.010						
1438	-0.037						
1452	0.045						
1462	0.029						
1479	0.023						
1496	-0.056						

Table 6 (cont'd)

1507	-0.045	7	10	0.001400	-6.57124	-65.71244	0.01400
1530	0.036						
1540	0.005						
1563	-0.007						
1563	-0.042						
1586	0.022						
1595	0.011						
1600	0.078						
1615	-0.011						
1653	0.035						
1705	0.012	8	8	0.002012	-6.20850	-49.66800	0.01610
1735	-0.097						
1739	0.054						
1741	0.018						
1750	-0.001						
1784	0.014						
1798	-0.024						
1801	-0.027						
	Sum =		69	Sp^2 = 0.003298		-408.7817	0.2275

CHIsquare = 13.80

CHIsq crit 16.01

Table 7

BARTLETT'S TEST vs. PLANT

Test of Poolability between Plants

Plant	Resid	i	nu	Si^2	ln(S^2)	nu*ln(Si^2)	nu*Si^2
CC-1	0.021	1	8	0.003078	-5.78355	-46.26842	0.02462
CC-1	-0.029						
CC-1	0.010						
CC-1	-0.097						
CC-1	0.035						
CC-1	0.078						
CC-1	-0.060						
CC-1	-0.001						
CC-2	-0.025	2	11	0.002008	-6.21065	-68.31719	0.02209
CC-2	-0.056						
CC-2	0.088						
CC-2	-0.027						
CC-2	-0.042						
CC-2	-0.052						
CC-2	-0.028						
CC-2	0.048						
CC-2	0.018						
CC-2	-0.011						
CC-2	0.018						
OPPD	-0.013	3	8	0.004383	-5.43011	-43.44092	0.03506
OPPD	-0.045						
OPPD	0.113						
OPPD	-0.042						
OPPD	0.115						
OPPD	-0.043						
OPPD	-0.002						
OPPD	0.032						
PV-1	0.092	4	12	0.004504	-5.40270	-64.83234	0.05405
PV-1	-0.037						
PV-1	-0.040						
PV-1	-0.061						
PV-1	0.054						
PV-1	0.126						
PV-1	-0.003						
PV-1	0.035						
PV-1	-0.098						
PV-1	0.029						
PV-1	0.073						
PV-1	-0.021						
PV-2	-0.033	5	8	0.001922	-6.25441	-50.03529	0.01538
PV-2	-0.033						
PV-2	-0.045						
PV-2	0.018						
PV-2	0.018						
PV-2	0.011						
PV-2	-0.090						
PV-2	0.045						
PV-3	-0.160	6	6	0.006259	-5.07380	-30.44280	0.03755
PV-3	0.022						
PV-3	0.023						

Table 7 (Cont'd)

PV-3	-0.041						
PV-3	-0.064						
PV-3	0.057						
SONGS2	-0.007	7	4	0.000076	-9.49053	-37.96210	0.00030
SONGS2	-0.011						
SONGS2	-0.005						
SONGS2	-0.024						
ST-L-2	0.071	8	5	0.003711	-5.59636	-27.98180	0.01856
ST-L-2	0.012						
ST-L-2	0.014						
ST-L-2	-0.063						
ST-L-2	0.094						
WSES-3	-0.043	9	6	0.003621	-5.62090	-33.72537	0.02173
WSES-3	-0.083						
WSES-3	0.036						
WSES-3	0.005						
WSES-3	-0.006						
WSES-3	0.089						
				Sp^2 =			
	Sum =		68	0.003373		-403.0062	0.2293

CHIsquare = 15.12

CHIsq crit 17.53

Appendix A.

Power Coefficient Bias and Uncertainty

The analysis of measured moderator temperature coefficients obtained with the power trade technique requires the knowledge of the best estimate power coefficient at the time of the test. To define a bias term which must be combined with the calculated power coefficient to obtain the best estimate, a data base of power coefficient was analyzed. This data base contains 17 points from 11 cycles, and is given in Table A.1. A linear regression of the difference between measured and calculated coefficients vs. power level results in a bias equal to:

$$\Delta P.C. = M\text{-}C = 1.186E\text{-}05 - 2.983E\text{-}7 * P(\%)$$

Table A.1

POWER COEFFICIENT BIAS & UNCERTAINTY

UNIT/ CYCLE	% POWER	POWER COEFFICIENT DelRho/%P		(M-C)	(M-C)/C
		CALC	MEAS		(%)
BGE I,8	97	-7.870E-05	-9.960E-05	-2.090E-05	26.56
BGE I,9	97	-7.590E-05	-9.550E-05	-1.960E-05	25.82
BGE I,10	96	-8.056E-05	-9.950E-05	-1.894E-05	23.51
BGE II,8	95	-7.913E-05	-9.480E-05	-1.567E-05	19.81
BGE II,8	97	-8.200E-05	-1.126E-04	-3.060E-05	37.32
PV I,1	20	-1.211E-04	-1.180E-04	3.141E-06	-2.59
PV I,1	47	-1.053E-04	-1.045E-04	8.299E-07	-0.79
PV I,1	80	-9.179E-05	-9.860E-05	-6.811E-06	7.42
PV I,1	97	-8.256E-05	-9.210E-05	-9.544E-06	11.56
PV II,1	48	-1.062E-04	-1.070E-04	-8.000E-07	0.75
PV III,1	98	-8.804E-05	-9.250E-05	-4.457E-06	5.06
St-L II,5	98	-7.297E-05	-8.775E-05	-1.478E-05	20.25
OPPD 12	88	-8.890E-05	-1.135E-04	-2.460E-05	27.67
OPPD 12	93	-9.350E-05	-1.164E-04	-2.290E-05	24.49
OPPD 13	92	-8.380E-05	-9.630E-05	-1.250E-05	14.92
OPPD 13	92	-8.800E-05	-9.130E-05	-3.300E-06	3.75
OPPD 14	88	-9.870E-05	-1.200E-04	-2.130E-05	21.58

STATISTICS

Fit of (M-C) vs. Power
Regression Output:

Constant		1.186E-05
Std Err of Y Est		7.499E-06
R Squared		4.664E-01
No. of Observations		17
Degrees of Freedom		15
K * Sigma		1.924E-05
X Coefficient(s)	-2.983E-07	
Std Err of Coef.	8.239E-08	

Appendix B.

Data Reduction of At-Power Moderator Temperature Coefficients

The following Tables present the data reduction of at-power coefficients, as described in Section IV.

ANO2 CYCLE 9
328 EFPD, 276 PPM
CALCULATED ITC, POWER COEFF

Tin	Power	Tavg	React	Tavg-Tin	Tavg Fitted
549	92	575.01	0.004164	26.01	575.02
557	92	582.87	0.002385	25.87	582.87
549	98	577.13	0.003206	28.13	577.13
557	98	584.97	0.001380	27.97	584.98

Fit of Calculated ITC, Pwr Coeff

Regression Output:		
Constant		0.14383
Std Err of Y Est		0.00003
R Squared		0.99984
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	-8.284E-05	-2.296E-04
Std Err of Coef.	4.452E-06	3.286E-06
	Pwr Coeff	ITC
Best Est. Pwr Coe	-9.786E-05	

Fit of Tavg vs. Tin,Pwr

Regression Output:		
Constant		3.95542
Std Err of Y Est		0.01000
R Squared		1.00000
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	0.981	0.35167
Std Err of Coef.	0.001	0.00167

MEASURED ITC, PWR COEFF

Tin	BDT Pwr	Tout	Tavg Fitted	Tin+Tout /2	BDT Pwr	Sec Cal	Delta Tin+out /2	Delta Tave	Delta Pwr	Delta React
552.48	94.84	603.87	579.43	578.18	94.84	95.27				
550.23	97.71	603.31	578.23	576.77	97.71	98.45	-1.49	-1.20	2.87	2.81E-04
555.36	91.40	604.86	581.04	580.11	91.40	91.32	3.54	2.81	-6.31	-6.18E-04
550.08	98.03	603.30	578.20	576.69	98.03	98.75	-3.63	-2.85	6.63	6.49E-04
555.19	91.73	604.78	580.99	579.99	91.73	91.81	3.49	2.80	-6.30	-6.17E-04
550.11	98.12	603.31	578.26	576.71	98.12	98.88	-3.47	-2.74	6.39	6.25E-04
555.17	91.71	604.72	580.97	579.95	91.71	91.71	3.43	2.71	-6.41	-6.27E-04
550.10	97.93	603.32	578.18	576.71	97.93	98.66	-3.43	-2.79	6.22	6.09E-04
555.27	91.67	604.93	581.05	580.10	91.67	91.89	3.59	2.87	-6.26	-6.13E-04

Regression Output:		
Constant		0.000006
Std Err of Y Est		0.000021
R Squared		0.998836
No. of Observations		10
Degrees of Freedom		8
X Coefficient(s)	**-2.251E-04**	**= ITC**
Std Err of Coef.	2.716E-06	

BG&E I CYCLE 8
ITC TEST 310 PPM
10176 MWD/T

Calculated ITC, Pwr Coeff

P(%)	Tmod	React
97	566.93	0.002268
97	572.77	0.001216
93	570.27	0.001981
93	572.77	0.001531

Calc.ITC =	-1.801E-04
Calc. Pwr Coeff =	-7.866E-05

CALCULATED BANK 5 WORTH

BANK 5 % insert	BANK 5 in wthdr	wthdr^2	wthdr^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)	BANK 5 WORTH FITTED
0.00	136.70	18687	2554498	0.2630	-0.024	569.2	0.0000	
2.56	133.20	17742	2363292	0.2579	-0.020	569.2	-0.0048	
5.12	129.70	16822	2181874	0.2497	-0.013	569.4	-0.0126	-0.0124
7.68	126.20	15927	2009986	0.2388	-0.004	569.5	-0.0230	-0.0233
10.24	122.70	15056	1847371	0.2269	0.006	569.6	-0.0343	-0.0344
14.24	117.23	13744	1611239	0.2079	0.021	569.9	-0.0523	-0.0522
20.00	109.36	11960	1307903	0.1811	0.043	570.2	-0.0778	-0.0776
25.76	101.49	10299	1045248	0.1565	0.061	570.4	-0.1012	-0.1015
30.00	95.69	9157	876193	0.1393	0.073	570.6	-0.1175	-0.1174
100.00	0.00	0	0	-0.0691	-0.010	569.4	-0.3155	

Fit of Bank 5 Worth

Regression Output:

Constant		0.35530	
Std Err of Y Est		0.00034	
R Squared		0.99996	
No. of Observations		7	
Degrees of Freedom		3	
X Coefficient(s)	-1.691E-02	1.717E-04	-4.873E-07
Std Err of Coef.	5.032E-03	4.481E-05	1.323E-07

MEASUREMENTS

BG&E I CYCLE 8

ITC TEST 310 PPM

10176 MWD/T

SWING	BK 5 in wthdr	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	Inserted Worth
0	106.50	545.65	592.27		97.30	-0.000865
1	112.50	546.37	592.60		96.32	-0.000675
2	100.50	544.20	590.95		97.50	-0.001043
3	114.00	547.12	593.52		97.02	-0.000627
4	99.75	544.32	590.95		97.02	-0.001065
5	114.00	546.70	593.02		96.57	-0.000627
6	99.75	543.85	590.30		96.65	-0.001065
7	117.00	546.60	592.87		96.42	-0.000529
8	113.25	545.42	591.97		97.07	-0.000651
9	113.25	544.45	591.40		97.85	-0.000651
10	113.25	545.97	591.97		95.85	-0.000651
11	113.25	544.30	591.22		97.77	-0.000651
12	113.25	545.85	591.72		95.60	-0.000651
13	113.25	543.97	590.87		97.70	-0.000651
14	113.25	545.30	591.27		95.97	-0.000651
15	113.25	543.67	590.60		97.52	-0.000651
16	113.25	544.05	590.60		96.95	-0.000651

Best Estim. Power Coefficient:	0.00 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit	

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	0.544	-0.980	1.898		-1.898
2-1	-1.981	1.180	-3.680		3.680
3-1	2.847	-0.480	4.165		-4.165
4-3	-2.784	0.000	-4.377		4.377
5-4	2.307	-0.450	4.377		-4.377
6-5	-2.888	0.080	-4.377		4.377
7-6	2.758	-0.230	5.352		-5.352
8-7	-1.078	0.650	-1.219		1.219
9-8	-0.798	0.780	0.000		0.000
10-9	1.084	-2.000	0.000		0.000
11-10	-1.255	1.920	0.000		0.000
12-11	1.063	-2.170	0.000		0.000
13-12	-1.416	2.100	0.000		0.000
14-13	0.897	-1.730	0.000		0.000
15-14	-1.193	1.550	0.000		0.000
16-15	0.197	-0.570	0.000		0.000

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant		-0.242
Std Err of Y Est		0.605
R Squared		0.966
No. of Observations		14.000
Degrees of Freedom		11.000
X Coefficient(s)	-1.782	-0.996
Std Err of Coef.	0.103	0.146
	ITC	Pwr Coeff

BG&E I CYCLE 9
ITC TEST 275 PPM
8247 MWD/T

Calculated ITC, Pwr Coeff

P(%)	Tmod	React
97	566.99	0.002973
97	572.83	0.001881
93	570.32	0.002654
93	572.83	0.002185

Calc.ITC =	-1.870E-04
Calc. Pwr Coeff =	-7.592E-05

CALCULATED BANK 5 WORTH

BANK 5 % insert	BANK 5 in wthdr	wthdr^2	wthdr^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)	BANK 5 WORTH FITTED
0.00	136.70	18687	2554498	0.3362	-0.025	569.2	0.0000	
2.56	133.20	17742	2363292	0.3309	-0.020	569.2	-0.0050	
5.12	129.70	16822	2181874	0.3223	-0.013	569.4	-0.0132	-0.0130
7.68	126.20	15927	2009986	0.3109	-0.004	569.5	-0.0240	-0.0243
10.24	122.70	15056	1847371	0.2984	0.007	569.7	-0.0359	-0.0361
14.24	117.23	13744	1611239	0.2783	0.023	569.9	-0.0550	-0.0548
20.00	109.36	11960	1307903	0.2500	0.046	570.2	-0.0819	-0.0816
25.76	101.49	10299	1045248	0.2241	0.065	570.5	-0.1065	-0.1069
30.00	95.69	9157	876193	0.2060	0.079	570.7	-0.1237	-0.1235
100.00	0.00	0	0	-0.0088	-0.010	569.4	-0.3278	

Fit of Bank 5 Worth

Regression Output:

Constant		0.422825798	
Std Err of Y Est		0.000392499	
R Squared		0.999956917	
No. of Observations		7	
Degrees of Freedom		3	
X Coefficient(s)	-1.912E-02	1.926E-04	-5.481E-07
Std Err of Coef.	5.746E-03	5.117E-05	1.511E-07

BG&E I CYCLE 9
ITC TEST 275 PPM
8247 MWD/T

MEASUREMENT

SWING	BK 5 in wthdr	Meas Tave	Meas Tout	Meas Power (MW)	BDT Pwr (%)	INSERTED WORTH
0	108.00	568.32		2621.20	97.08	-0.000862
1	114.00	569.53		2613.90	96.81	-0.000659
2	99.75	567.16		2621.30	97.09	-0.001121
3	115.50	569.74		2625.60	97.24	-0.000608
4	99.75	567.16		2621.10	97.08	-0.001121
5	115.50	569.81		2622.80	97.14	-0.000608
6	99.75	567.13		2621.00	97.07	-0.001121
7	115.50	569.75		2624.60	97.21	-0.000608
8	108.00	568.50		2624.60	97.21	-0.000862
9	108.00	568.02		2656.40	98.39	-0.000862
10	108.00	569.17		2592.20	96.01	-0.000862
11	108.00	567.99		2659.20	98.49	-0.000862
12	108.00	569.40		2578.80	95.51	-0.000862
13	108.00	567.93		2656.80	98.40	-0.000862
14	108.00	569.38		2579.40	95.53	-0.000862
15	108.00	567.92		2655.50	98.35	-0.000862
16	108.00	568.53		2626.50	97.28	-0.000862

Best Estim. Power Coefficient: 0.00 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	1.255	-0.270	2.025		-2.025
2-1	-2.458	0.274	-4.618		4.618
3-1	2.675	0.159	5.132		-5.132
4-3	-2.675	-0.167	-5.132		5.132
5-4	2.748	0.063	5.132		-5.132
6-5	-2.779	-0.067	-5.132		5.132
7-6	2.717	0.133	5.132		-5.132
8-7	-1.296	0.000	-2.540		2.540
9-8	-0.498	1.178	0.000		0.000
10-9	1.193	-2.378	0.000		0.000
11-10	-1.224	2.481	0.000		0.000
12-11	1.462	-2.978	0.000		0.000
13-12	-1.524	2.889	0.000		0.000
14-13	1.504	-2.867	0.000		0.000
15-14	-1.514	2.819	0.000		0.000
16-15	0.633	-1.074	0.000		0.000

Fit of ITC and Power Coeff

(E-4)

Regression Output:

Constant		0.037
Std Err of Y Est		0.130
R Squared		0.999
No. of Observations		16.000
Degrees of Freedom		13.000
X Coefficient(s)	-1.865	-0.955
Std Err of Coef.	0.019	0.021
	ITC	Pwr Coeff

BG&E II CYCLE 8
ITC TEST 297 PPM
14125 MWD/T

Calculated ITC, Pwr Coeff

P(%)	Tmod	React
97	567.01	0.000138
97	572.84	-0.000899
93	570.35	-0.000128
93	572.84	-0.000570

Calc.ITC =	-1.779E-04
Calc. Pwr Coeff =	-8.202E-05

CALCULATED BANK 5 WORTH

BANK 5 % insert	BANK 5 in wthdr	wthdr^2	wthdr^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)	BANK 5 WORTH FITTED
0.00	136.70	18687	2554498	0.0657	-0.025	569.1	0.0000	
2.56	133.20	17742	2363292	0.0601	-0.021	569.2	-0.0056	
5.12	129.70	16822	2181874	0.0511	-0.014	567.3	-0.0146	-0.0144
7.68	126.20	15927	2009986	0.0391	-0.004	569.5	-0.0266	-0.0269
10.24	122.70	15056	1847371	0.0258	0.007	569.6	-0.0399	-0.0400
14.24	117.23	13744	1611239	0.0041	0.024	569.9	-0.0616	-0.0614
20.00	109.36	11960	1307903	-0.0276	0.048	570.2	-0.0933	-0.0931
25.76	101.49	10299	1045248	-0.0577	0.070	570.5	-0.1234	-0.1237
30.00	95.69	9157	876193	-0.0790	0.085	570.7	-0.1447	-0.1446
100.00	0.00	0	0	-0.3370	-0.012	569.3	-0.4027	

Fit of Bank 5 Worth

Regression Output:

Constant		0.458951077	
Std Err of Y Est		0.000337930	
R Squared		0.999976969	
No. of Observations		7	
Degrees of Freedom		3	
X Coefficient(s)	-2.232E-02	2.331E-04	-6.875E-07
Std Err of Coef.	4.947E-03	4.405E-05	1.301E-07

MEASUREMENT

BG&E II CYCLE 8

ITC TEST 297 PPM
14125 MWD/T

SWING	BK 5 IN WTHDR	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	Inserted Worth
0	105.00	545.60	591.55		97.05	-0.001103
1	114.00	547.25	593.15		97.37	-0.000744
2	99.75	544.32	590.40		97.25	-0.001302
3	114.00	547.35	593.32		97.12	-0.000744
4	99.75	544.25	590.47		97.32	-0.001302
5	114.00	547.37	593.27		97.15	-0.000744
6	99.75	544.32	590.42		97.17	-0.001302
7	114.00	547.10	593.25		97.50	-0.000744
8	105.00	545.67	591.67		97.07	-0.001103
9	108.75	545.45	591.97		98.25	-0.000955
10	100.50	546.02	591.27		95.50	-0.001274
11	108.75	545.30	591.95		98.60	-0.000955
12	100.50	545.97	591.30		95.65	-0.001274
13	108.75	545.45	592.02		98.25	-0.000955
14	100.50	546.00	591.40		95.77	-0.001274
15	105.00	545.65	591.65		97.32	-0.001103

Best Estim. Power Coefficient:	0.00 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit	

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	1.729	0.320	3.588		-3.588
2-1	-3.022	-0.120	-5.577		5.577
3-1	3.165	-0.130	5.577		-5.577
4-3	-3.165	0.200	-5.577		5.577
5-4	3.149	-0.170	5.577		-5.577
6-5	-3.139	0.020	-5.577		5.577
7-6	2.985	0.330	5.577		-5.577
8-7	-1.601	-0.430	-3.588		3.588
9-8	0.043	1.180	1.480		-1.480
10-9	-0.069	-2.750	-3.192		3.192
11-10	-0.021	3.100	3.192		-3.192
12-11	0.011	-2.950	-3.192		3.192
13-12	0.106	2.600	3.192		-3.192
14-13	-0.037	-2.480	-3.192		3.192
15-14	-0.053	1.550	1.712		-1.712

Fit of ITC and Power Coeff

(E-4)

Regression Output:

Constant		0.030
Std Err of Y Est		0.158
R Squared		0.999
No. of Observations		15.000
Degrees of Freedom		12.000
X Coefficient(s)	-1.810	-1.126
Std Err of Coef.	0.020	0.024
	ITC	Pwr Coeff

OPPD CYCLE 12
ITC TEST 1050 PPM
452 MWD/T

PREDICTIONS

ITC and Power Coefficient

% Pwr	Tmod	React
93.2	568.48	0.003903
93.2	560.77	0.004257
89.0	567.29	0.004338
89.0	559.57	0.004676

Regression Output:		
Constant		0.0376878
Std Err of Y Est		0.0000082
R Squared		0.9997761
No. of Observations		4
Degrees of Freedom		1
	Pwr Coef	ITC
X Coefficient(s)	-8.89E-05	-4.48E-05
Std Err of Coef.	1.98E-06	1.07E-06

Rod 4-1 Insertion Curve

Rod 4-1 % INSERT	Rod 4-1 Inches WTHDR	REACT (%)	ASI	Tave	Rod 4-1 Worth (%)	Rod 4-1 Worth Fitted
0.00	128.00	0.4140	-0.061	565.5	0.0000	
1.25	126.40	0.4133	-0.060	565.5	-0.0007	
3.75	123.20	0.4116	-0.059	565.5	-0.0024	-0.0017
6.25	120.00	0.4092	-0.057	565.5	-0.0048	-0.0049
8.75	116.80	0.4063	-0.055	565.6	-0.0077	-0.0082
12.00	112.64	0.4018	-0.051	565.6	-0.0122	-0.0126
17.00	106.24	0.3944	-0.046	565.7	-0.0196	-0.0197
23.00	98.56	0.3855	-0.040	565.8	-0.0285	-0.0284
30.00	89.60	0.3747	-0.033	565.9	-0.0393	-0.0388
37.00	80.64	0.3645	-0.029	566.0	-0.0495	-0.0493
43.00	72.96	0.3559	-0.026	566.0	-0.0581	-0.0581
50.00	64.00	0.3460	-0.025	566.0	-0.0680	-0.0680
57.00	55.04	0.3370	-0.027	566.0	-0.0770	-0.0773
63.00	47.36	0.3297	-0.030	565.9	-0.0843	-0.0846
70.00	38.40	0.3215	-0.035	565.9	-0.0925	-0.0922

Fit of Rod 4-1 Worth

Regression Output:			
Constant		-0.1079105	
Std Err of Y Est		0.0004060	
R Squared		0.9998790	
No. of Observations		13	
Degrees of Freedom		9	
X Coefficient(s)	-3.759E-05	1.361E-05	-5.118E-08
Std Err of Coef.	1.552E-04	2.013E-06	8.223E-09

MEASUREMENTS

Delta H = 72.54

SWING	Rod 4-1 Inches WTHDR	Meas Tin	PWR	Inserted Worth (%)	Hin	Hav	Tave (Have)	Hout	Tout(Hout)
1	113.04	540.37	93.18	-0.012207	535.35	569.15	567.39	602.95	592.67
2	76.50	530.47	93.88	-0.054064	523.58	557.63	558.38	591.68	584.43
3	113.31	540.67	93.19	-0.011916	535.72	569.52	567.67	603.32	592.94
4	76.18	530.60	93.33	-0.054431	523.73	557.58	558.34	591.43	584.25
5	113.58	540.21	92.62	-0.011626	535.16	568.76	567.08	602.35	592.24
6	113.22	539.88	91.41	-0.012013	534.76	567.92	566.43	601.07	591.32
7	53.73	539.85	86.16	-0.078585	534.73	565.98	564.93	597.23	588.51
8	113.31	539.84	91.13	-0.011916	534.72	567.77	566.32	600.82	591.13
9	56.88	539.37	86.24	-0.075442	534.15	565.43	564.50	596.71	588.13
10	113.49	539.71	90.97	-0.011723	534.56	567.55	566.15	600.55	590.94

Best Estim. Power Coefficient: 0.00 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	From ToutCalc DELTA Tave	DELTA PWR	Delta React Rod4-1 (E-4)	DELTA XENON	DELTA REACT Total
2-1	-9.334	0.700	-4.186		4.186
3-2	9.626	-0.690	4.215		-4.215
4-3	-9.652	0.140	-4.251		4.251
5-4	9.056	-0.710	4.280		-4.280
6-5	-0.645	-1.210	-0.039		0.039
7-6	-1.457	-5.250	-6.657		6.657
8-7	1.342	4.970	6.667		-6.667
9-8	-1.785	-4.890	-6.353		6.353
10-9	1.616	4.730	6.372		-6.372

Fit of ITC and Power Coeff (E-4)

Regression Output:		
Constant		-0.355
Std Err of Y Est		0.623
R Squared		0.990
No. of Observations		9.000
Degrees of Freedom		6.000
X Coefficient(s)	-0.516	-1.135
Std Err of Coef.	0.033	0.062
	ITC	Pwr Coeff

OPPD CYCLE 12
ITC TEST 309 PPM
9691 MWD/T

PREDICTIONS

ITC and Power Coefficient

% Pwr	Tmod	React
93.2	569.35	0.003342
93.2	561.54	0.004764
89.0	567.99	0.003993
89.0	560.17	0.005391

Regression Output:		
Constant		0.114786026
Std Err of Y Est		0.000012902
R Squared		0.999930540
No. of Observations		4
Degrees of Freedom		1
	Pwr Coef	ITC
X Coefficient(s)	-9.35E-05	-1.804E-04
Std Err of Coef.	3.12E-06	1.651E-06

Rod 4–1 Insertion Curve

Rod 4-1 % INSERT	Rod 4-1 Inches WTHDR	REACT (%)	ASI	Tave	Rod 4-1 Worth (%)	Rod 4-1 Worth Fitted
0.00	128.00	0.4034	-0.014	566.2	0.0000	
1.25	126.40	0.4019	-0.013	566.3	-0.0015	
3.75	123.20	0.3992	-0.011	566.3	-0.0042	-0.0033
6.25	120.00	0.3957	-0.008	566.3	-0.0077	-0.0080
8.75	116.80	0.3916	-0.006	566.4	-0.0118	-0.0125
12.00	112.64	0.3857	-0.001	566.5	-0.0177	-0.0182
17.00	106.24	0.3768	0.005	566.6	-0.0266	-0.0266
23.00	98.56	0.3671	0.011	566.7	-0.0363	-0.0361
30.00	89.60	0.3564	0.018	566.8	-0.0470	-0.0465
37.00	80.64	0.3472	0.022	566.8	-0.0562	-0.0561
43.00	72.96	0.3397	0.025	566.8	-0.0637	-0.0637
50.00	64.00	0.3314	0.025	566.9	-0.0720	-0.0720
57.00	55.04	0.3240	0.024	566.8	-0.0794	-0.0797
63.00	47.36	0.3179	0.021	566.8	-0.0855	-0.0857
70.00	38.40	0.3109	0.016	566.7	-0.0925	-0.0922

Fit of Rod 4–1 Worth

Regression Output:			
Constant		-0.1146132	
Std Err of Y Est		0.0004723	
R Squared		0.9998267	
No. of Observations		13	
Degrees of Freedom		9	
X Coefficient(s)	4.814E-04	2.278E-06	9.308E-09
Std Err of Coef.	1.806E-04	2.342E-06	9.566E-09

MEASUREMENTS

Delta H = 72.54

SWING	Rod 4-1 Inches WTHDR	Meas Tin	BDT PWR	Inserted Worth (%)	Hin	Hav	Tave (Have)	Hout	Tout(Hout)
1	114.75	540.37	95.11	-0.015306	535.35	569.85	567.93	604.35	593.68
2	35.26	535.23	95.46	-0.094397	529.20	563.82	563.25	598.45	589.41
3	115.47	540.40	95.23	-0.014315	535.39	569.93	567.99	604.47	593.77
4	35.10	535.29	95.55	-0.094506	529.27	563.93	563.33	598.58	589.50
5	115.38	540.34	95.05	-0.014439	535.32	569.79	567.88	604.27	593.63
6	43.96	540.23	90.19	-0.088256	535.19	567.90	566.42	600.61	590.98
7	115.47	539.99	94.64	-0.014315	534.90	569.22	567.44	603.55	593.11
8	48.29	540.23	89.72	-0.085004	535.19	567.73	566.28	600.27	590.73
9	115.47	539.76	94.72	-0.014315	534.62	568.97	567.25	603.33	592.95

Best Estim. Power Coefficient: 0.00 E–4/%P
Use 0.0 for 2–D fit, best estim. value for 1–D fit

SWINGS	From ToutCalc DELTA Tave	DELTA PWR	Delta React Rod4-1 (E-4)	DELTA XENON	DELTA REACT Total
2-1	-4.912	0.350	-7.909		7.909
3-2	4.974	-0.230	8.008		-8.008
4-3	-4.891	0.320	-8.019		8.019
5-4	4.784	-0.500	8.007		-8.007
6-5	-1.438	-4.860	-7.382		7.382
7-6	0.985	4.450	7.394		-7.394
8-7	-1.114	-4.920	-7.069		7.069
9-8	0.912	5.000	7.069		-7.069

Fit of ITC and Power Coeff (E-4)

Regression Output:		
Constant		-0.216
Std Err of Y Est		0.386
R Squared		0.998
No. of Observations		8.000
Degrees of Freedom		5.000
X Coefficient(s)	-1.711	-1.104
Std Err of Coef.	0.039	0.040
	ITC	Pwr Coeff

OPPD CYCLE 13
ITC TEST 1113 PPM
373 MWD/T

PREDICTIONS

ITC and Power Coefficient

% Pwr	Tmod	React
94.7	569.05	0.003779
94.7	561.35	0.004055
89.0	567.54	0.004321
89.0	559.72	0.004575

Regression Output:		
Constant		0.0311425
Std Err of Y Est		0.0000130
R Squared		0.9995167
No. of Observations		4
Degrees of Freedom		1
	Pwr Coef	ITC
X Coefficient(s)	-8.38E-05	-3.41E-05
Std Err of Coef.	2.34E-06	1.68E-06

Rod 4-1 Insertion Curve

Rod 4-1 % INSERT	Rod 4-1 Inches WTHDR	REACT (%)	ASI	Tave	Rod 4-1 Worth (%)	Rod 4-1 Worth Fitted
0.00	128.00	0.4023	-0.013	565.6	0.0000	
1.25	126.40	0.4015	-0.011	565.7	-0.0008	
3.75	123.20	0.3998	-0.009	565.7	-0.0025	-0.0017
6.25	120.00	0.3974	-0.006	565.8	-0.0049	-0.0050
8.75	116.80	0.3944	-0.003	565.8	-0.0079	-0.0084
12.00	112.64	0.3899	0.002	565.9	-0.0124	-0.0130
17.00	106.24	0.3824	0.009	566.0	-0.0199	-0.0200
23.00	98.56	0.3735	0.016	566.1	-0.0288	-0.0287
30.00	89.60	0.3629	0.024	566.2	-0.0394	-0.0389
37.00	80.64	0.3531	0.029	566.3	-0.0492	-0.0490
43.00	72.96	0.3447	0.032	566.3	-0.0576	-0.0575
50.00	64.00	0.3352	0.032	566.4	-0.0671	-0.0671
57.00	55.04	0.3265	0.031	566.4	-0.0758	-0.0762
63.00	47.36	0.3191	0.027	566.4	-0.0832	-0.0835
70.00	38.40	0.3106	0.021	566.3	-0.0917	-0.0913

Fit of Rod 4-1 Worth

Regression Output:			
Constant		-0.1122714	
Std Err of Y Est		0.0004840	
R Squared		0.9998224	
No. of Observations		13	
Degrees of Freedom		9	
X Coefficient(s)	2.181E-04	9.892E-06	-3.552E-08
Std Err of Coef.	1.851E-04	2.400E-06	9.803E-09

MEASUREMENTS

Delta H = 72.54

SWING	Rod 4-1 Inches WTHDR	Meas Tin	PWR	Inserted Worth (%)	Hin	Hav	Tave (Have)	Hout	Tout(Hout)
1	110.25	538.65	94.04	-0.015590	533.29	567.39	566.03	601.50	591.63
2	64.10	528.37	93.57	-0.067004	521.12	555.06	556.34	589.00	582.44
3	110.25	538.72	94.29	-0.015590	533.37	567.57	566.16	601.77	591.82
4	64.10	528.68	93.67	-0.067004	521.48	555.46	556.66	589.43	582.77
5	110.25	538.57	94.20	-0.015590	533.19	567.36	566.00	601.52	591.64
6	110.25	538.49	94.10	-0.015590	533.09	567.22	565.89	601.35	591.52
7	63.85	538.39	89.06	-0.067265	532.97	565.28	564.38	597.58	588.77
8	110.25	538.02	94.15	-0.015590	532.53	566.68	565.47	600.83	591.14
9	63.85	538.12	89.33	-0.067265	532.65	565.05	564.20	597.45	588.68
10	110.25	537.65	93.62	-0.015590	532.09	566.04	564.98	600.00	590.54

Best Estim. Power Coefficient: 0.00 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	From ToutCalc DELTA Tave	DELTA PWR	Delta React Rod4-1 (E-4)	DELTA XENON	DELTA REACT Total
2-1	-10.014	-0.470	-5.141		5.141
3-2	10.149	0.720	5.141		-5.141
4-3	-9.824	-0.620	-5.141		5.141
5-4	9.655	0.530	5.141		-5.141
6-5	-0.104	-0.100	0.000		0.000
7-6	-1.466	-5.040	-5.168		5.168
8-7	1.027	5.090	5.168		-5.168
9-8	-1.214	-4.820	-5.168		5.168
10-9	0.715	4.290	5.168		-5.168

Fit of ITC and Power Coeff (E-4)

Regression Output:		
Constant		-0.100
Std Err of Y Est		0.341
R Squared		0.997
No. of Observations		9.000
Degrees of Freedom		6.000
X Coefficient(s)	-0.461	-0.963
Std Err of Coef.	0.018	0.036
	ITC	Pwr Coeff

OPPD CYCLE 13
ITC TEST 325 PPM
10694 MWD/T

PREDICTIONS

ITC and Power Coefficient

% Pwr	Tmod	React
94.7	569.83	0.003812
94.7	562.01	0.005182
89.0	567.97	0.004654
89.0	560.14	0.005988

Regression Output:		
Constant		0.110611940
Std Err of Y Est		0.000018863
R Squared		0.999858070
No. of Observations		4
Degrees of Freedom		1
	Pwr Coef	ITC
X Coefficient(s)	-8.80E-05	-1.728E-04
Std Err of Coef.	3.40E-06	2.41E-06

Rod 4-1 Insertion Curve

Rod 4-1 (%) INSERT	Rod 4-1 Inches WTHDR	REACT (%)	ASI	Tave	Rod 4-1 Worth (%)	Rod 4-1 Worth Fitted
0.00	128.00	0.4667	-0.013	565.6	0.0000	
1.25	126.40	0.4652	-0.011	565.7	-0.0015	
3.75	123.20	0.4624	-0.009	565.7	-0.0043	-0.0032
6.25	120.00	0.4586	-0.006	565.8	-0.0081	-0.0083
8.75	116.80	0.4542	-0.003	565.8	-0.0125	-0.0133
12.00	112.64	0.4477	0.002	565.9	-0.0190	-0.0197
17.00	106.24	0.4377	0.009	566.0	-0.0290	-0.0290
23.00	98.56	0.4268	0.016	566.1	-0.0399	-0.0397
30.00	89.60	0.4148	0.024	566.2	-0.0519	-0.0513
37.00	80.64	0.4045	0.029	566.3	-0.0622	-0.0620
43.00	72.96	0.3961	0.032	566.3	-0.0706	-0.0707
50.00	64.00	0.3867	0.032	566.4	-0.0800	-0.0800
57.00	55.04	0.3785	0.031	566.4	-0.0882	-0.0886
63.00	47.36	0.3716	0.027	566.4	-0.0951	-0.0954
70.00	38.40	0.3636	0.021	566.3	-0.1031	-0.1027

Fit of Rod 4-1 Worth

Regression Output:			
Constant		-0.1273167	
Std Err of Y Est		0.0006023	
R Squared		0.9997752	
No. of Observations		13	
Degrees of Freedom		9	
X Coefficient(s)	5.096E-04	3.110E-06	7.556E-09
Std Err of Coef.	2.303E-04	2.986E-06	1.220E-08

MEASUREMENTS

Delta H = 72.54

SWING	Rod 4-1 Inches WTHDR	Meas Tin	PWR	Inserted Worth (%)	Hin	Hav	Tave (Hav)	Hout	Tout(Hout)
1	114.66	539.52	94.74	-0.016619	534.33	568.69	567.03	603.06	592.75
2	35.32	533.77	94.94	-0.105107	527.47	561.90	561.74	596.34	587.86
3	114.66	539.43	94.99	-0.016619	534.22	568.68	567.02	603.13	592.80
4	35.32	533.83	94.85	-0.105107	527.54	561.94	561.77	596.34	587.87
5	114.66	539.35	94.37	-0.016619	534.13	568.35	566.77	602.58	592.41
6	114.66	539.22	94.74	-0.016619	533.97	568.33	566.75	602.69	592.49
7	56.44	538.98	89.32	-0.087293	533.68	566.08	565.00	598.47	589.43
8	114.66	538.96	94.57	-0.016619	533.66	567.96	566.46	602.26	592.18
9	56.44	538.83	89.73	-0.087293	533.50	566.05	564.98	598.59	589.51
10	114.66	538.83	94.37	-0.016619	533.50	567.73	566.29	601.96	591.96

Best Estim. Power Coefficient: 0.00 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	From ToutCalc DELTA Tave	DELTA PWR	Delta React Rod4-1 (E-4)	DELTA XENON	DELTA REACT Total
2-1	-5.554	0.200	-8.849		8.849
3-2	5.534	0.050	8.849		-8.849
4-3	-5.501	-0.140	-8.849		8.849
5-4	5.253	-0.480	8.849		-8.849
6-5	-0.026	0.370	0.000		0.000
7-6	-1.726	-5.420	-7.067		7.067
8-7	1.425	5.250	7.067		-7.067
9-8	-1.459	-4.840	-7.067		7.067
10-9	1.277	4.640	7.067		-7.067

Fit of ITC and Power Coeff (E-4)

Regression Output:		
Constant		-0.179
Std Err of Y Est		0.507
R Squared		0.997
No. of Observations		9.000
Degrees of Freedom		6.000
X Coefficient(s)	-1.641	-0.913
Std Err of Coef.	0.046	0.052
	ITC	Pwr Coeff

OPPD CYCLE 14
ITC TEST 768 PPM
355 MWD/T

PREDICTIONS

ITC and Power Coefficient

% Pwr	Tmod	React
90.3	565.57	0.005536
90.3	555.92	0.006309
86.0	564.29	0.006073
86.0	554.62	0.006824

Regression Output:		
Constant		0.059063592
Std Err of Y Est		0.000011788
R Squared		0.999837917
No. of Observations		4
Degrees of Freedom		1
	Pwr Coef	ITC
X Coefficient(s)	-9.87E-05	-7.89E-05
Std Err of Coef.	2.77E-06	1.22E-06

Rod 4–1 Insertion Curve

Rod 4-1 % INSERT	Rod 4-1 Inches WTHDR	REACT (%)	ASI	Tave	Rod 4-1 Worth (%)	Rod 4-1 Worth Fitted
0.00	128.00	0.5599	-0.011	566.3	0.0000	
1.25	126.40	0.5585	-0.010	566.4	-0.0014	
3.75	123.20	0.5559	-0.008	566.4	-0.0040	-0.0031
6.25	120.00	0.5523	-0.005	566.4	-0.0076	-0.0078
8.75	116.80	0.5480	-0.002	566.5	-0.0119	-0.0126
12.00	112.64	0.5416	0.003	566.6	-0.0183	-0.0189
17.00	106.24	0.5309	0.011	566.7	-0.0290	-0.0291
23.00	98.56	0.5182	0.019	566.8	-0.0417	-0.0416
30.00	89.60	0.5028	0.029	566.9	-0.0571	-0.0564
37.00	80.64	0.4884	0.036	567.0	-0.0715	-0.0714
43.00	72.96	0.4759	0.040	567.1	-0.0840	-0.0841
50.00	64.00	0.4612	0.041	567.1	-0.0987	-0.0985
57.00	55.04	0.4480	0.040	567.1	-0.1119	-0.1124
63.00	47.36	0.4367	0.035	567.0	-0.1232	-0.1236
70.00	38.40	0.4239	0.028	566.9	-0.1360	-0.1356

Fit of Rod 4–1 Worth

Regression Output:			
Constant		-0.1694785	
Std Err of Y Est		0.0005519	
R Squared		0.9998940	
No. of Observations		13	
Degrees of Freedom		9	
X Coefficient(s)	4.037E-04	1.462E-05	-5.624E-08
Std Err of Coef.	2.110E-04	2.736E-06	1.118E-08

MEASUREMENTS

Delta H = 72.54

SWING	Rod 4-1 Inches WTHDR	Meas Tin	BDT PWR	Inserted Worth (%)	Hin	Hav	Tave (Have)	Hout	Tout(Hout)
1	114.57	540.95	90.31	-0.015962	536.05	568.81	567.12	601.57	591.67
2	57.01	529.51	90.90	-0.109385	522.45	555.42	556.63	588.39	581.99
3	114.57	540.58	90.73	-0.015962	535.61	568.52	566.90	601.42	591.57
4	76.01	540.60	86.15	-0.079053	535.63	566.88	565.63	598.13	589.17
5	114.57	540.18	90.53	-0.015962	535.13	567.96	566.47	600.80	591.12

Best Estim. Power Coefficient: 0.00 E–4/%P
Use 0.0 for 2–D fit, best estim. value for 1–D fit

From ToutMeas SWINGS Tave	From ToutCalc DELTA Tave	DELTA PWR	Delta React Rod4-1 (E-4)	DELTA XENON	DELTA REACT Total
2-1	-10.866	0.590	-9.342		9.342
3-2	10.623	-0.170	9.342		-9.342
4-3	-1.225	-4.580	-6.309		6.309
5-4	0.785	4.380	6.309		-6.309

Fit of ITC and Power Coeff (E-4)

Regression Output:		
Constant		-0.090
Std Err of Y Est		0.462
R Squared		0.999
No. of Observations		4.000
Degrees of Freedom		1.000
X Coefficient(s)	-0.912	-1.200
Std Err of Coef.	0.030	0.073
	ITC	Pwr Coeff

PALO VERDE I CYCLE 3
ITC TEST 1170 PPM
41 EFPD

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	150.00	22500.00	3375000.00	0.5508	-0.003	595.0	0.0000		
2.37	146.45	21446.14	3140679.68	0.5489	-0.002	595.0	-0.0019		
4.75	142.88	20413.27	2916545.33	0.5455	0.001	595.1	-0.0053		-0.0051
7.36	138.96	19309.88	2683301.15	0.5403	0.006	595.2	-0.0105		-0.0107
9.98	135.03	18233.10	2462015.61	0.5339	0.012	595.3	-0.0169		-0.0171
15.23	127.16	16168.39	2055892.14	0.5185	0.025	595.5	-0.0323		-0.0323
19.98	120.03	14407.20	1729296.32	0.5027	0.038	595.7	-0.0481		-0.0479
24.73	112.91	12747.54	1439260.89	0.4857	0.052	595.9	-0.0651		-0.0649
29.98	105.03	11031.30	1158617.53	0.4662	0.066	596.2	-0.0846		-0.0847
35.23	97.16	9439.09	917055.18	0.4462	0.079	596.4	-0.1046		-0.1048
39.98	90.03	8105.40	729729.24	0.4280	0.089	596.5	-0.1228		-0.1227

Fit of Bank 5 Worth

Regression Output:

Constant		-0.10293798	
Std Err of Y Est		0.000234373	
R Squared		0.999981055	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-4.841E-03	7.291E-05	-2.396E-07
Std Err of Coef.	9.085E-04	7.884E-06	2.254E-08

SWING IN	BK 5 WTHDR	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	INSERTED WORTH
0	135.97	567.62	620.81		98.20	-0.000155
1	111.83	561.37	614.99		97.90	-0.000676
2	135.93	567.37	620.70		98.30	-0.000156
3	112.18	561.29	614.95		98.10	-0.000667
4	138.80	567.52	620.74		98.40	-0.000109
5	112.18	561.07	614.59		98.00	-0.000667
6	140.76	567.42	620.87		98.50	-0.000080
7	127.21	564.40	618.03		98.50	-0.000321

Best Estim. Power Coefficient: -0.90 E-4/%P

Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	From ToutMeas DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-6.246	-0.300	-5.208		4.938
2-1	6.060	0.400	5.201		-4.841
3-2	-6.122	-0.200	-5.114		4.934
4-3	6.220	0.300	5.581		-5.311
5-4	-6.520	-0.400	-5.581		5.221
6-5	6.536	0.500	5.875		-5.425
7-6	-3.033	0.000	-2.415		2.415

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant	-0.090	
Std Err of Y Est	0.126	
R Squared	1.000	
No. of Observations	6.000	
Degrees of Freedom	4.000	
X Coefficient(s)	-0.814	
Std Err of Coef.	0.008	
	ITC	Pwr Coeff

PALO VERDE I CYCLE 3
ITC TEST 484 PPM
336 EFPD

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	150.00	22500.00	3375000.00	0.5942	-0.013	589.4	0.0000		
2.37	146.45	21446.14	3140679.68	0.5907	-0.010	589.5	-0.0035		
4.75	142.88	20413.27	2916545.33	0.5843	-0.005	589.6	-0.0099		-0.0091
7.36	138.96	19309.88	2683301.15	0.5744	0.003	589.7	-0.0198		-0.0204
9.98	135.03	18233.10	2462015.61	0.5625	0.012	589.9	-0.0317		-0.0325
15.23	127.16	16168.39	2055892.14	0.5359	0.034	590.3	-0.0583		-0.0582
19.98	120.03	14407.20	1729296.32	0.5112	0.053	590.7	-0.0830		-0.0823
24.73	112.91	12747.54	1439260.89	0.4874	0.071	591.0	-0.1068		-0.1063
29.98	105.03	11031.30	1158617.53	0.4628	0.088	591.2	-0.1314		-0.1318
35.23	97.16	9439.09	917055.18	0.4400	0.102	591.5	-0.1542		-0.1549
39.98	90.03	8105.40	729729.24	0.4208	0.112	591.6	-0.1734		-0.1729

Fit of Bank 5 Worth

Regression Output:

Constant		0.204594126	
Std Err of Y Est		0.000824607	
R Squared		0.999881449	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-1.389E-02	1.434E-04	-3.963E-07
Std Err of Coef.	3.197E-03	2.774E-05	7.932E-08

SWING	BK 5 IN WTHDR	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	INSERTED WORTH
0	140.70	566.48	619.81		99.43	-0.000153
1	96.68	560.39	614.32		99.20	-0.001562
2	140.63	566.32	619.52		99.32	-0.000155
3	96.68	560.16	614.04		99.23	-0.001562
4	140.61	566.15	619.36		99.58	-0.000156
5	97.06	560.20	614.17		99.19	-0.001552
6	140.67	566.07	619.52		99.48	-0.000154
7	125.63	564.21	617.88		99.46	-0.000633

Best Estim. Power Coefficient: -0.90 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	From ToutMeas DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-6.161	-0.230	-14.093		13.886
2-1	5.921	0.120	14.073		-13.965
3-1	-6.192	-0.090	-14.073		13.992
4-3	6.017	0.350	14.067		-13.752
5-4	-5.926	-0.390	-13.963		13.612
6-5	5.969	0.290	13.981		-13.720
7-6	-1.862	-0.020	-4.794		4.776

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant	-0.133	
Std Err of Y Est	0.192	
R Squared	1.000	
No. of Observations	6.000	
Degrees of Freedom	4.000	
X Coefficient(s)	-2.291	
Std Err of Coef.	0.013	
	ITC	Pwr Coeff

PALO VERDE II CYCLE 3
ITC TEST 1029 PPM
43 EFPD

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	150.00	22500.00	3375000.00	0.0692	-0.036	594.4	0.0000		
2.37	146.45	21446.14	3140679.68	0.0670	-0.034	594.5	-0.0022		
4.75	142.88	20413.27	2916545.33	0.0630	-0.031	594.5	-0.0062		-0.0058
7.36	138.96	19309.88	2683301.15	0.0569	-0.026	594.6	-0.0123		-0.0126
9.98	135.03	18233.10	2462015.61	0.0493	-0.019	594.8	-0.0199		-0.0203
15.23	127.16	16168.39	2055892.14	0.0315	-0.004	595.0	-0.0377		-0.0377
19.98	120.03	14407.20	1729296.32	0.0138	0.011	595.3	-0.0554		-0.0550
24.73	112.91	12747.54	1439260.89	-0.0044	0.026	595.5	-0.0736		-0.0734
29.98	105.03	11031.30	1158617.53	-0.0246	0.040	595.8	-0.0938		-0.0940
35.23	97.16	9439.09	917055.18	-0.0446	0.053	595.9	-0.1138		-0.1142
39.98	90.03	8105.40	729729.24	-0.0624	0.063	596.1	-0.1316		-0.1314

Fit of Bank 5 Worth

Regression Output:

Constant		0.002559818	
Std Err of Y Est		0.000419579	
R Squared		0.999947109	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-7.608E-03	9.377E-05	-2.865E-07
Std Err of Coef.	1.626E-03	1.411E-05	4.036E-08

SWING	BK 5 in wthdr	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	INSERTED WORTH
0	132.11	566.97	621.42		99.10	-0.000265
1	112.10	562.29	617.27		99.30	-0.000755
2	138.23	567.84	622.27		99.20	-0.000140
3	112.06	562.89	617.71		99.05	-0.000756
4	137.61	567.64	622.14		99.80	-0.000152
5	112.08	562.93	617.35		99.20	-0.000755
6	135.21	567.61	622.1		98.90	-0.000199
7	119.53	564.57	619.24		99.10	-0.000563

Best Estim. Power Coefficient: −0.80 E−4/%P
Use 0.0 for 2−D fit, best estim. value for 1−D fit

SWINGS	From ToutMeas DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-4.618	0.200	-4.900		5.060
2-1	5.518	-0.100	6.146		-6.226
3-2	-4.974	-0.150	-6.157		6.037
4-3	4.801	0.750	6.039		-5.439
5-4	-4.969	-0.600	-6.033		5.553
6-5	4.932	-0.300	5.558		-5.798
7-6	-3.086	0.200	-3.635		3.795

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant		-0.004
Std Err of Y Est		0.235
R Squared		0.999
No. of Observations		6.000
Degrees of Freedom		4.000
X Coefficient(s)	-1.145	
Std Err of Coef.	0.019	
	ITC	Pwr Coeff

PALO VERDE II CYCLE 3
ITC TEST 456 PPM
290 EFPD

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	150.00	22500.00	3375000.00	0.3499	-0.031	594.6	0.0000		
2.37	146.45	21446.14	3140679.68	0.3463	-0.029	594.6	-0.0036		
4.75	142.88	20413.27	2916545.33	0.3397	-0.023	594.7	-0.0102		-0.0093
7.36	138.96	19309.88	2683301.15	0.3297	-0.016	594.9	-0.0202		-0.0209
9.98	135.03	18233.10	2462015.61	0.3176	-0.006	595.0	-0.0323		-0.0331
15.23	127.16	16168.39	2055892.14	0.2911	0.014	595.4	-0.0588		-0.0586
19.98	120.03	14407.20	1729296.32	0.2671	0.032	595.7	-0.0828		-0.0821
24.73	112.91	12747.54	1439260.89	0.2443	0.049	596.0	-0.1056		-0.1052
29.98	105.03	11031.30	1158617.53	0.2210	0.065	596.3	-0.1289		-0.1293
35.23	97.16	9439.09	917055.18	0.1996	0.078	596.5	-0.1503		-0.1510
39.98	90.03	8105.40	729729.24	0.1819	0.086	596.6	-0.1680		-0.1676

Fit of Bank 5 Worth

Regression Output:

Constant		0.198922850	
Std Err of Y Est		0.000850981	
R Squared		0.999864693	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-1.314E-02	1.330E-04	-3.589E-07
Std Err of Coef.	3.299E-03	2.862E-05	8.186E-08

SWING	BK 5 In Wthdr	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	INSERTED WORTH
0	140.55	567.04	621.49		100.20	-0.000162
1	105.45	563.00	617.56		99.63	-0.001281
2	140.53	567.01	621.39		100.19	-0.000162
3	105.43	562.82	617.56		99.62	-0.001281
4	140.57	566.95	621.52		100.23	-0.000161
5	105.41	562.91	617.44		99.68	-0.001282
6	140.53	566.98	621.45		100.31	-0.000162
7	120.52	565.07	619.53		99.73	-0.000805

Best Estim. Power Coefficient: -0.90 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	From ToutMeas DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-4.272	-0.570	-11.193		10.680
2-1	4.202	0.560	11.187		-10.683
3-1	-4.299	-0.570	-11.192		10.679
4-3	4.336	0.610	11.204		-10.655
5-4	-4.352	-0.550	-11.210		10.715
6-5	4.331	0.630	11.198		-10.631
7-6	-2.053	-0.580	-6.426		5.904

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant		0.108
Std Err of Y Est		0.361
R Squared		0.999
No. of Observations		7.000
Degrees of Freedom		5.000
X Coefficient(s)	-2.495	
Std Err of Coef.	0.034	
	ITC	Pwr Coeff

PALO VERDE II CYCLE 4
ITC TEST 1126 PPM
40 EFPD

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	150.00	22500.00	3375000.00	0.4212	-0.045	594.3	0.0000		
2.37	146.45	21446.14	3140679.68	0.4194	-0.043	594.3	-0.0018		
4.75	142.88	20413.27	2916545.33	0.4160	-0.041	594.4	-0.0052		-0.0048
7.36	138.96	19309.88	2683301.15	0.4104	-0.036	594.4	-0.0108		-0.0111
9.98	135.03	18233.10	2462015.61	0.4036	-0.030	594.6	-0.0176		-0.0181
15.23	127.16	16168.39	2055892.14	0.3876	-0.016	594.8	-0.0336		-0.0335
19.98	120.03	14407.20	1729296.32	0.3722	-0.003	595.0	-0.0490		-0.0487
24.73	112.91	12747.54	1439260.89	0.3566	0.009	595.2	-0.0646		-0.0643
29.98	105.03	11031.30	1158617.53	0.3399	0.021	595.4	-0.0813		-0.0815
35.23	97.16	9439.09	917055.18	0.3237	0.032	595.6	-0.0975		-0.0979
39.98	90.03	8105.40	729729.24	0.3096	0.039	595.7	-0.1116		-0.1113

Fit of Bank 5 Worth

Regression Output:

Constant		0.070334822	
Std Err of Y Est		0.000442533	
R Squared		0.999918788	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-7.928E-03	8.922E-05	-2.618E-07
Std Err of Coef.	1.715E-03	1.489E-05	4.257E-08

SWING	BK 5 IN WTHDR	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	INSERTED WORTH
0	132.23	567.78	621.98	0.0504	99.64	-0.000234
1	108.11	562.36	617.04	0.082	99.79	-0.000748
2	130.55	567.42	621.57	0.057	99.53	-0.000267
3	108.09	562.41	616.98	0.087	99.62	-0.000749
4	130.55	567.49	621.45	0.0565	99.51	-0.000267
5	108.13	562.48	616.98	0.094	99.51	-0.000748
6	130.50	567.50	621.51	0.0565	99.60	-0.000268
7	107.98	562.41	616.88		99.62	-0.000751
8	120.22	565.20	619.49		99.35	-0.000482

Best Estim. Power Coefficient: -0.80 E-4/%P

Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-5.418	0.150	-5.147		5.267
2-1	5.016	-0.260	4.818		-5.026
3-2	-5.021	0.090	-4.823		4.895
4-3	4.995	-0.110	4.823		-4.911
5-4	-4.958	0.000	-4.814		4.814
6-5	4.995	0.090	4.804		-4.732
7-6	-5.084	0.020	-4.837		4.853
8-7	2.824	-0.270	2.688		-2.904

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant	-0.024	
Std Err of Y Est	0.095	
R Squared	1.000	
No. of Observations	7.000	
Degrees of Freedom	5.000	
X Coefficient(s)	-0.973	
Std Err of Coef.	0.007	
	ITC	Pwr Coeff

PALO VERDE II CYCLE 4
ITC TEST 455 PPM
267 EFPD

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	150.00	22500.00	3375000.00	0.1307	0.001	595.1	0.0000		
2.37	146.45	21446.14	3140679.68	0.1275	0.004	595.2	-0.0032		
4.75	142.88	20413.27	2916545.33	0.1215	0.009	595.3	-0.0092		-0.0085
7.36	138.96	19309.88	2683301.15	0.1123	0.016	595.4	-0.0184		-0.0190
9.98	135.03	18233.10	2462015.61	0.1017	0.024	595.6	-0.0290		-0.0297
15.23	127.16	16168.39	2055892.14	0.0789	0.042	595.9	-0.0518		-0.0516
19.98	120.03	14407.20	1729296.32	0.0589	0.057	596.2	-0.0718		-0.0712
24.73	112.91	12747.54	1439260.89	0.0401	0.071	596.4	-0.0906		-0.0903
29.98	105.03	11031.30	1158617.53	0.0210	0.084	596.6	-0.1097		-0.1100
35.23	97.16	9439.09	917055.18	0.0035	0.094	596.8	-0.1272		-0.1278
39.98	90.03	8105.40	729729.24	-0.0112	0.102	596.9	-0.1419		-0.1415

Fit of Bank 5 Worth

Regression Output:

Constant		0.075293292	
Std Err of Y Est		0.000696440	
R Squared		0.999870823	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-8.388E-03	8.654E-05	-2.235E-07
Std Err of Coef.	2.700E-03	2.343E-05	6.699E-08

SWING	BK 5 IN WTHDR	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	INSERTED WORTH
0	139.79	566.10	619.52		99.40	-0.000167
1	90.07	561.08	614.82		99.27	-0.001415
3	90.05	560.96	614.66		99.28	-0.001415
4	140.65	566.08	619.43		99.55	-0.000144
5	90.09	560.86	614.69		99.24	-0.001414
6	140.67	566.05	619.40		99.56	-0.000144
7	120.24	563.91	617.49		99.30	-0.000707

Best Estim. Power Coefficient: -0.90 E-4/%P

Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-5.210	-0.130	-12.473		12.356
3-1	-0.150	0.010	-0.004		0.013
4-3	5.301	0.270	12.708		-12.465
5-4	-5.339	-0.310	-12.701		12.422
6-5	5.306	0.320	12.707		-12.419
7-6	-2.171	-0.260	-5.630		5.396

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant		-0.003
Std Err of Y Est		0.241
R Squared		1.000
No. of Observations		6.000
Degrees of Freedom		4.000
X Coefficient(s)	-2.353	
Std Err of Coef.	0.022	
	ITC	Pwr Coeff

PALO VERDE III CYCLE 3
ITC TEST 330 PPM
301 EFPD

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	150.00	22500.00	3375000.00	0.5466	-0.043	588.8	0.0000		
2.37	146.45	21446.14	3140679.68	0.5421	-0.039	588.9	-0.0045		
4.75	142.88	20413.27	2916545.33	0.5339	-0.033	589.0	-0.0127		
7.36	138.96	19309.88	2683301.15	0.5218	-0.024	589.2	-0.0248		-0.0244
9.98	135.03	18233.10	2462015.61	0.5074	-0.013	589.4	-0.0392		-0.0398
15.23	127.16	16168.39	2055892.14	0.4751	0.011	589.9	-0.0715		-0.0716
19.98	120.03	14407.20	1729296.32	0.4458	0.033	590.2	-0.1008		-0.1004
24.73	112.91	12747.54	1439260.89	0.4182	0.052	590.6	-0.1284		-0.1283
29.98	105.03	11031.30	1158617.53	0.3901	0.071	590.9	-0.1565		-0.1569
35.23	97.16	9439.09	917055.18	0.3644	0.086	591.1	-0.1822		-0.1820
39.98	90.03	8105.40	729729.24	0.3431	0.096	591.3	-0.2035		

Fit of Bank 5 Worth

Regression Output:

Constant		0.314361282	
Std Err of Y Est		0.000564715	
R Squared		0.999954265	
No. of Observations		7	
Degrees of Freedom		3	
X Coefficient(s)	-1.731E-02	1.687E-04	-4.439E-07
Std Err of Coef.	4.957E-03	4.230E-05	1.194E-07

SWING	BK 5 in wthdr	Meas Tin	Meas Tout	Meas ASI	BDT Pwr	Inserted Worth
0	120.06	564.75	619.83		99.07	-0.001003
1	136.64	567.27	622.05		98.81	-0.000334
2	104.80	562.37	617.89		99.39	-0.001577
3	136.90	567.42	622.07		98.32	-0.000324
4	104.80	562.28	617.79		99.41	-0.001577
5	136.69	567.34	622.07		98.93	-0.000332
6	104.78	562.31	617.69		99.51	-0.001578
7	136.88	567.22	622.03		99.05	-0.000325
8	104.82	562.30	617.85		99.53	-0.001577
9	136.87	567.25	622.00		99.13	-0.000325
10	119.69	564.73	619.88		99.20	-0.001017

Best Estim. Power Coefficient: -0.90 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	2.539	-0.260	6.681		-6.915
2-1	-4.854	0.580	-12.429		12.951
3-1	4.945	-1.070	12.531		-13.494
4-3	-5.047	1.090	-12.531		13.512
5-4	5.004	-0.480	12.449		-12.881
6-5	-5.041	0.580	-12.456		12.978
7-6	4.956	-0.460	12.530		-12.944
8-7	-4.875	0.480	-12.517		12.949
9-8	4.875	-0.400	12.513		-12.873
10-9	-2.486	0.070	-6.919		6.982

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant	0.012	
Std Err of Y Est	0.286	
R Squared	1.000	
No. of Observations	8.000	
Degrees of Freedom	6.000	
X Coefficient(s)	-2.641	
Std Err of Coef.	0.020	
	ITC	Pwr Coeff

ST-LUCIE II CYCLE 5
ITC TEST 280 PPM
8795 EFPH

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	136.70	18686.89	2554497.86	0.4107	0.012	574.63	0.0000		0.0008
2.56	133.20	17742.37	2363291.92	0.4055	0.019	574.7	-0.0052		-0.0055
4.39	130.70	17082.19	2232623.53	0.3998	0.024	574.78	-0.0109		-0.0120
7.56	126.37	15968.23	2017833.62	0.3846	0.037	574.98	-0.0261		-0.0265
10.00	123.03	15136.38	1862228.94	0.3702	0.049	575.18	-0.0405		-0.0401
14.24	117.23	13743.79	1611238.61	0.3424	0.073	575.54	-0.0683		-0.0671
20.00	109.36	11959.61	1307902.91	0.3034	0.106	576.03	-0.1073		-0.1072
25.76	101.49	10299.42	1045248.21	0.2659	0.136	576.48	-0.1448		-0.1461
30.00	95.69	9156.58	876192.77	0.2394	0.156	576.76	-0.1713		-0.1706

Fit of Bank 5 Worth

Regression Output:

Constant		2.016012522	
Std Err of Y Est		0.001094180	
R Squared		0.999814651	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-6.742E-02	6.534E-04	-1.961E-06
Std Err of Coef.	9.021E-03	7.787E-05	2.226E-07

SWING	BK 5 IN WTHDR	Meas Tin	Meas Tout	Meas ASI	DeltaT Pwr	INSERTED WORTH
0	116.19	549.13	599.30	0.061	100.375	-0.000723
1	105.31	546.25	597.40	0.104	99.925	-0.001278
2	115.69	549.20	599.50	0.070	100	-0.000748
3	104.81	546.10	597.00	0.110	100.1	-0.001302
4	116.25	549.20	599.20	0.073	100.1	-0.000720
5	105.44	546.20	597.20	0.112	100.2	-0.001271
6	117.75	549.20	599.00	0.074	99.97	-0.000646
7	118.88	549.40	599.70	0.061	99.7	-0.000591
8	101.63	549.10	597.00	0.113	94.7	-0.001455
9	120.56	549.20	599.70	0.053	100.1	-0.000512

Best Estim. Power Co 0 E-4/%P
Use 0.0 for 2-D fits, best estim. for 1-D fit

SWINGS	From ToutMeas DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-2.471	-0.450	-5.548	0.1	5.448
2-1	2.613	0.075	5.297		-5.297
3-2	-2.898	0.100	-5.544		5.544
4-3	2.743	0.000	5.825		-5.825
5-4	-2.588	0.100	-5.513		5.513
6-5	2.484	-0.230	6.256	-0.3	-5.956
7-6	0.466	-0.270	0.548		-0.548
8-7	-1.553	-5.000	-8.639	-0.6	9.239
9-8	1.449	5.400	9.431	-0.2	-9.231

Fit of ITC and Power Coeff
(E-4)

Regression Output:

Constant		-0.101
Std Err of Y Est		0.471
R Squared		0.996
No. of Observations		9.000
Degrees of Freedom		6.000
X Coefficient(s)	-2.114	-1.159
Std Err of Coef.	0.073	0.067
	ITC	Pwr Coeff

ST-LUCIE II CYCLE 5
ITC TEST 789 PPM
4226 EFPH

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	136.70	18686.89	2554497.86	0.4018	0	574.41	0.0000		0.0004
2.56	133.20	17742.37	2363291.92	0.3987	0.005	574.45	-0.0031		-0.0032
4.39	130.70	17082.19	2232623.53	0.3948	0.009	574.51	-0.0070		-0.0074
7.56	126.37	15968.23	2017833.62	0.3846	0.018	574.66	-0.0172		-0.0176
10.00	123.03	15136.38	1862228.94	0.3743	0.028	574.81	-0.0275		-0.0274
14.24	117.23	13743.79	1611238.61	0.3533	0.047	575.1	-0.0485		-0.0477
20.00	109.36	11959.61	1307902.91	0.3225	0.075	575.52	-0.0793		-0.0792
25.76	101.49	10299.42	1045248.21	0.2914	0.102	575.91	-0.1104		-0.1112
30.00	95.69	9156.58	876192.77	0.2687	0.12	576.16	-0.1331		-0.1327

Fit of Bank 5 Worth

Regression Output:

Constant		1.317840007	
Std Err of Y Est		0.000624611	
R Squared		0.999899870	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-4.707E-02	4.726E-04	-1.454E-06
Std Err of Coef.	5.150E-03	4.445E-05	1.270E-07

SWING	BK 5 IN WTHDR	Meas Tin	Meas Tout	Meas ASI	DeltaT Pwr	INSERTED WORTH
0	115.6	548.5	599.8	0.0397	99.65	-0.000540
1	107.9	545.3	596.4	0.0638	100.00	-0.000852
2	115.3	548.6	599.2	0.0421	99.90	-0.000552
3	109.1	545.1	596.25	0.065	99.85	-0.000803
4	114.3	548.4	599.1	0.045	99.70	-0.000591
5	105.6	544.7	595.8	0.071	99.90	-0.000947
6	116.1	548.8	599.4	0.041	99.80	-0.000521

Best Estim. Power Coefficient: -0.87 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit.

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-3.416	0.350	-3.122		3.426
2-1	3.157	-0.100	3.004		-3.091
3-2	-3.338	-0.050	-2.509	-0.2	2.666
4-3	3.183	-0.150	2.115		-2.245
5-4	-3.623	0.200	-3.556		3.730
6-5	3.985	-0.100	4.262		-4.349

Fit of ITC only
(E-4)

Regression Output:

Constant	0.015
Std Err of Y Est	0.570
R Squared	0.980
No. of Observations	6.000
Degrees of Freedom	4.000
X Coefficient(s)	-0.951
Std Err of Coef.	0.067
	ITC

ST-LUCIE II CYCLE 6
ITC TEST 283 PPM
9380 EFPH

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	136.70	18686.89	2554497.86	0.5346	-0.012	574.2	0.0000		
2.56	133.20	17742.37	2363291.92	0.5286	-0.006	574.3	-0.0060		
4.39	130.70	17082.19	2232623.53	0.5210	0.001	574.4	-0.0136		-0.0131
7.56	126.37	15968.23	2017833.62	0.5024	0.016	574.6	-0.0322		-0.0331
10.00	123.03	15136.38	1862228.94	0.4843	0.031	574.9	-0.0503		-0.0503
14.24	117.23	13743.79	1611238.61	0.4510	0.058	575.3	-0.0836		-0.0831
20.00	109.36	11959.61	1307902.91	0.4038	0.097	575.9	-0.1308		-0.1305
25.76	101.49	10299.42	1045248.21	0.3581	0.133	576.4	-0.1765		-0.1772
30.00	95.69	9156.58	876192.77	0.3257	0.157	576.8	-0.2089		-0.2086

Fit of Bank 5 Worth

Regression Output:

Constant		1.241094101	
Std Err of Y Est		0.000814485	
R Squared		0.999940518	
No. of Observations		7	
Degrees of Freedom		3	
X Coefficient(s)	-4.917E-02	4.997E-04	-1.507E-06
Std Err of Coef.	1.088E-02	9.644E-05	2.835E-07

SWING	BK 5 IN WTHDR	Meas Tin	Meas Tout	Meas ASI	DeltaT Pwr	INSERTED WORTH
0	116.6	548.30	599.10	0.049	99.60	-0.000868
1	105.5	544.65	596.23	0.098	99.98	-0.001537
2	116.5	548.37	599.35	0.058	99.80	-0.000874
3	105.1	544.58	596.25	0.105	100.05	-0.001561
4	116.8	548.45	599.43	0.061	99.68	-0.000856
5	105.3	544.65	596.33	0.110	100.00	-0.001549
6	116.6	548.35	599.18	0.067	99.82	-0.000868

Best Estim. Power Coefficient: -0.89 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-3.381	0.380	-6.692	-0.1	7.130
2-1	3.547	-0.180	6.633	0	-6.793
3-2	-3.572	0.250	-6.871	-0.1	7.194
4-3	3.655	-0.370	7.048	0.1	-7.478
5-4	-3.578	0.320	-6.930	-0.1	7.314
6-5	3.396	-0.180	6.811	0.1	-7.072

Fit of ITC and Power Coeff
(E-4)

Regression Output:

Constant		0.072
Std Err of Y Est		0.248
R Squared		0.999
No. of Observations		6.000
Degrees of Freedom		4.000
X Coefficient(s)	-2.033	
Std Err of Coef.	0.029	
	ITC	Pwr Coeff

ST-LUCIE II CYCLE 6
ITC TEST 782 PPM
4879 EFPH

BANK 5 % INSERT	BANK 5 WTHDR	THDR^2	WTHDR^3	REACT (%)	ASI	Tave	BANK 5 WORTH (%)		BANK 5 WORTH FITTED
0.00	136.70	18686.89	2554497.86	0.2952	-0.002	574.4	0.0000		0.0005
2.56	133.20	17742.37	2363291.92	0.2907	0.005	574.4	-0.0045		-0.0045
4.39	130.70	17082.19	2232623.53	0.2858	0.01	574.5	-0.0094		-0.0102
7.56	126.37	15968.23	2017833.62	0.2721	0.022	574.7	-0.0231		-0.0235
10.00	123.03	15136.38	1862228.94	0.2587	0.034	574.9	-0.0365		-0.0363
14.24	117.23	13743.79	1611238.61	0.2319	0.059	575.3	-0.0633		-0.0623
20.00	109.36	11959.61	1307902.91	0.1928	0.094	575.8	-0.1024		-0.1023
25.76	101.49	10299.42	1045248.21	0.1535	0.128	576.3	-0.1417		-0.1427
30.00	95.69	9156.58	876192.77	0.1252	0.15	576.6	-0.1700		-0.1695

Fit of Bank 5 Worth

Regression Output:

Constant		1.705506574	
Std Err of Y Est		0.000817012	
R Squared		0.999894797	
No. of Observations		9	
Degrees of Freedom		5	
X Coefficient(s)	-6.034E-02	6.022E-04	-1.844E-06
Std Err of Coef.	6.736E-03	5.815E-05	1.662E-07

SWING	BK 5 IN WTHDR	Meas Tin	Meas Tout	Meas ASI	DeltaT Pwr	INSERTED WORTH
0	113.4	548.2	599.5	0.0504	99.73	-0.000814
1	105.3	544.2	595.95	0.082	100.2	-0.001235
2	112.7	548.1	599.1	0.057	99.6	-0.000850
3	104.7	544.05	596.2	0.087	99.9	-0.001265
4	113.4	548.25	599.4	0.0565	99.9	-0.000814
5	103.8	543.85	595.73	0.094	99.6	-0.001311
6	114	548.5	599.5	0.0565	99.7	-0.000784

Best Estim. Power Coefficient: -0.89 E-4/%P
Use 0.0 for 2-D fit, best estim. value for 1-D fit

SWINGS	DELTA Tave	DELTA PWR	DELTA REACT Bk 5	DELTA XENON	DELTA REACT Total
1-0	-3.907	0.470	-4.202	-0.1	4.720
2-1	3.648	-0.600	3.843	0	-4.377
3-2	-3.597	0.300	-4.151	-0.1	4.518
4-3	3.829	0.000	4.510	0.1	-4.610
5-4	-4.176	-0.300	-4.969	-0.1	4.802
6-5	4.357	0.100	5.274	0.1	-5.285

Fit of ITC and Power Coeff (E-4)

Regression Output:

Constant	-0.008	
Std Err of Y Est	0.148	
R Squared	0.999	
No. of Observations	6.000	
Degrees of Freedom	4.000	
X Coefficient(s)	-1.203	
Std Err of Coef.	0.015	
	ITC	Pwr Coeff

WATERFORD CYCLE 4
137 MWD/T, 1076 PPM
CALCULATED ITC, POWER COEFF

Tin	Power	Tavg	React	Tavg-Tin	Tavg Fitted
549	93	577.37	0.003529	28.37	577.37
557	93	585.04	0.002887	28.04	585.04
549	98	579.00	0.002992	30.00	579.00
557	98	586.66	0.002324	29.66	586.66

Fit of Calculated ITC, Pwr Coeff

Regression Output:		
Constant		0.06052
Std Err of Y Est		0.00001
R Squared		0.99975
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	-8.22E-05	-8.55E-05
Std Err of Coef.	2.75E-06	1.75E-06
	Pwr Coeff	ITC
Best Est. Pwr Coeff	-9.815E-05	

Fit of Tavg vs. Tin,Pwr

Regression Output:		
Constant		21.13687
Std Err of Y Est		0.004999
R Squared		0.999999
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	0.958125	0.325
Std Err of Coef.	6.25E-04	1.00E-03

MEASURED ITC, PWR COEFF

Tin	BDT Pwr	Tout	Tavg Fitted	Inst Pwr	BDT Pwr	Sec. CalPwr	Delta Tavg	Delta Pwr	Delta React
548.46	96.73	603.21	578.07	96.73	96.73	96.82			
556.71	90.38	607.85	583.91	91.03	90.38	90.77	5.84	-6.35	-6.23E-04
548.11	96.64	602.65	577.70	96.64	96.64	96.64	-6.21	6.26	6.14E-04
557.11	89.94	607.76	584.15	90.14	89.94	89.93	6.45	-6.70	-6.58E-04
548.04	96.07	602.32	577.45	96.07	96.07	95.70	-6.70	6.13	6.02E-04
556.92	89.38	607.26	583.78	89.65	89.38	89.35	6.33	-6.69	-6.57E-04
548.08	95.21	601.97	577.21	95.21	95.21	95.18	-6.58	5.83	5.72E-04
556.73	89.08	607.01	583.50	89.28	89.08	89.09	6.30	-6.13	-6.02E-04
547.78	94.86	601.66	576.81	94.86	94.86	94.94	-6.70	5.78	5.67E-04

Regression Output:		
Constant		-0.00003
Std Err of Y Est		0.000035
R Squared		0.997525
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	**-9.569E-05**	**= ITC**
Std Err of Coef.	1.95E-06	

WATERFORD CYCLE 4
295 EFPD, 370 PPM
CALCULATED ITC, POWER COEFF

Tin	Power	Tavg	React	Tavg-Tin	Tavg Fitted
549	93	577.42	0.005435	28.42	577.42
557	93	585.28	0.003846	28.28	585.28
549	98	579.31	0.004661	30.31	579.31
557	98	587.16	0.003031	30.16	587.16

Fit of Calculated ITC, Pwr Coeff

Regression Output:		
Constant		0.1314
Std Err of Y Est		0.0000
R Squared		0.9999
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	-8.17E-05	-2.049E-04
Std Err of Coef.	4.43E-06	2.740E-06
	Pwr Coeff	ITC
Best Est. Pwr Coeff	-9.757E-05	

Fit of Tavg vs. Tin,Pwr

Regression Output:		
Constant		3.3121
Std Err of Y Est		0.0050
R Squared		1.0000
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	0.981875	0.377
Std Err of Coef.	6.25E-04	1.00E-03

MEASURED ITC, PWR COEFF

Tin	BDT Pwr	Tout	Tavg Fitted	Inst Pwr	BDT Pwr	Sec Cal	Delta Tavg	Delta Pwr	Delta React
552.35	98.60	607.76	582.82	98.60	98.60	98.6			
557.32	92.82	609.32	585.52	93.09	92.82	92.66	2.70	-5.78	-5.64E-04
552.35	98.64	608.06	582.84	98.64	98.64	98.57	-2.69	5.82	5.68E-04
557.48	92.49	609.49	585.56	92.94	92.49	92.45	2.72	-6.15	-6.00E-04
552.46	98.52	608.04	582.90	98.52	98.52	98.53	-2.66	6.03	5.88E-04
557.50	92.54	609.72	585.60	93.15	92.54	92.61	2.69	-5.98	-5.83E-04
552.61	98.52	608.11	583.05	98.52	98.52	98.63	-2.55	5.98	5.83E-04
557.67	92.93	609.77	585.91	93.21	92.93	92.71	2.86	-5.59	-5.45E-04
552.79	98.42	608.34	583.19	98.42	98.42	98.78	-2.72	5.49	5.36E-04

Regression Output:		
Constant		0.000007
Std Err of Y Est		0.000037
R Squared		0.996820
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	-2.114E-04	= ITC
Std Err of Coef.	4.87E-06	

WATERFORD CYCLE 5
90EFPH, 1066 PPM
CALCULATED ITC, POWER COEFF

Tin	Power	Tavg	React	Tavg Tin	Tavg Fitted
549	93	576.85	0.005642	27.85	576.86
557	93	584.55	0.004952	27.55	584.55
549	98	578.48	0.005088	29.48	578.48
557	98	586.16	0.004373	29.16	586.17

Fit of Calculated ITC, Pwr Coeff

Regression Output:		
Constant		0.06613
Std Err of Y Est		0.00001
R Squared		0.99978
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	-8.37E-05	-9.135E-05
Std Err of Coef.	2.74E-06	1.744E-06
	Pwr Coeff	ITC
Best Est. Pwr Coeff	-9.962E-05	

Fit of Tavg vs. Tin,Pwr

Regression Output:		
Constant		18.9968
Std Err of Y Est		0.0100
R Squared		1.0000
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	0.96125	0.324
Std Err of Coef.	0.00125	0.002

MEASURED ITC, PWR COEFF

Tin	BDT Pwr	Tout	Tavg Fitted	Inst. Pwr	BDT Pwr	Sec. CalPwr	Delta Tavg	Delta Pwr	Delta React
548.39	96.15	602.80	577.29		96.15				
555.98	90.59	606.96	582.78		90.59		5.49	-5.56	-5.54E-04
547.97	95.62	602.06	576.71		95.62		-6.07	5.03	5.01E-04
556.50	89.52	606.70	582.94		89.52		6.22	-6.10	-6.08E-04
547.36	95.35	601.41	576.04		95.35		-6.90	5.83	5.81E-04
556.31	88.90	606.19	582.55		88.90		6.51	-6.45	-6.43E-04
547.76	94.25	600.94	576.07		94.25		-6.49	5.35	5.33E-04
556.24	87.85	605.53	582.15		87.85		6.08	-6.40	-6.38E-04
547.49	93.28	600.30	575.49		93.28		-6.65	5.43	5.41E-04

Regression Output:		
Constant		-0.00005
Std Err of Y Est		0.000014
R Squared		0.999534
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	**-9.119E-05**	**= ITC**
Std Err of Coef.	0.0000008035	

WATERFORD CYCLE 5
291 EFPD, 404 PPM
CALCULATED ITC, POWER COEFF

Tin	Power	Tavg	React	Tavg -Tin	Tavg Fitted
549	93	577.32	0.003743	28.32	577.33
557	93	585.19	0.002178	28.19	585.18
549	98	579.21	0.002973	30.21	579.21
557	98	587.06	0.001367	30.06	587.06

Fit of Calculated ITC, Pwr Coeff

Regression Output:		
Constant		0.12786
Std Err of Y Est		0.00002
R Squared		0.99984
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	-8.226E-05	-2.017E-04
Std Err of Coef.	4.630E-06	2.865E-06
	Pwr Coeff	**ITC**
Best Est. Pwr Coeff	**-9.817E-05**	

Fit of Tavg vs. Tin,Pwr

Regression Output:		
Constant		2.96450
Std Err of Y Est		0.01000
R Squared		1.00000
No. of Observations		4
Degrees of Freedom		1
X Coefficient(s)	0.9825	0.376
Std Err of Coef.	0.00125	0.002

MEASURED ITC, PWR COEFF

Tin	BDT Pwr	Tout	Tavg Fitted	Inst Pwr	BDT Pwr	Sec Cal	Delta Tavg	Delta Pwr	Delta React
552.04	95.21	606.05	581.14	95.21	95.21	95.01			
557.29	88.80	607.59	583.89	88.81	88.80	88.77	2.75	-6.41	-6.29E-04
551.15	96.67	605.67	580.82	96.67	96.67	96.51	-3.07	7.87	7.73E-04
557.46	89.08	607.76	584.16	89.08	89.08	88.72	3.35	-7.59	-7.45E-04
551.11	96.26	605.88	580.62	96.26	96.26	96.38	-3.54	7.18	7.05E-04
557.46	88.89	607.80	584.09	89.17	88.89	88.86	3.47	-7.37	-7.24E-04
551.29	96.35	605.88	580.83	96.35	96.35	96.47	-3.26	7.46	7.32E-04
557.65	89.33	608.11	584.44	89.33	89.33	88.87	3.61	-7.02	-6.89E-04
551.32	96.29	606.09	580.84	96.29	96.29	96.49	-3.60	6.96	6.83E-04

Regression Output:		
Constant		0.000005
Std Err of Y Est		0.000075
R Squared		0.991574
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	**-2.119E-04**	**= ITC**
Std Err of Coef.	0.0000079741	

Appendix C.

No Significant Hazard Report

The standards used to arrive at the determination that a request for amendment involves no significant hazards consideration are included in the Commission's regulation 10 CFR 50.92, which states that no significant hazards considerations are involved if the operation of the facility in accordance with the proposed amendment would not (1) involved a significant increased in the probability or the consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in a margin of safety. Each standard is discussed as follows:

(1) Operation of the facility in accordance with the proposed amendment would not involved a significant increased in the probability or the consequences of an accident previously evaluated.

Under the proposed change, the compliance with the Technical Specification is maintained by measuring the beginning of cycle temperature coefficients, and monitoring the plant operating conditions. Explicit calculations of the temperature coefficients can be performed under exact operating conditions to ensure further compliance.

The consequences of an accident previously evaluated will not be increased because this change does not require the modification of any assumptions used in the input to the safety analyses. The current safety calculations will remain valid because the allowed range of MTC values will not change.

(2) Use of the modified specification will not create the possibility of a new or different kind of accident from any accident previously evaluated.

Plant operation and plant parameters Technical Specification limits will remain unchanged, therefore no new accident can be initiated under the proposed changes.

(3) Use of the modified specifications will not involve a significant reduction in a margin of safety.

The margin to safety will not be reduced because the range of allowed temperature coefficients will not be changed. The surveillance program consisting of beginning-of-cycle measurements, of plant parameter monitoring and of explicit end-of-cycle MTC predictions will ensure that the MTC remains within the range of acceptable values.

Appendix D.

Technical Specification Markup

SURVEILLANCE REQUIREMENTS

4.1.1.3.1 The MTC shall be determined to be within its limits by confirmatory measurements. MTC measured values shall be extrapolated and/or compensated to permit direct comparison with the above limits.

4.1.1.3.2 The MTC shall be determined at the following frequencies and THERMAL POWER conditions during each fuel cycle:

a. Prior to initial operation above 5% of RATED THERMAL POWER, after each fuel loading.

b. At greater than 15% of RATED THERMAL POWER, prior to reaching 40 EFPD core burnup.

c. At any THERMAL POWER, within 7 EFPD of reaching two-thirds of expected core burnup.

The MTC determination of paragraph 4.1.1.3.2.c is not required if the results of the tests required in surveillance 4.1.1.3.2.a and 4.1.1.3.2.b are within a tolerance of $\pm 0.16*10^{-4}\Delta\rho/°F$ from corresponding design values.

CEOG COMBUSTION ENGINEERING OWNERS GROUP

CE NPSD-911
Amendment 1

Analysis Of Moderator Temperature Coefficients In Support Of A Change In The Technical Specifications End of Cycle Negative MTC Limit

CEOG TASK 1009

Prepared for the
C-E OWNERS GROUP
January 1998

ABB Combustion Engineering Nuclear Operations

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ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS
IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATION
END OF CYCLE NEGATIVE MTC LIMIT

Table of Contents

ANALYSIS OF MODERATOR TEMPERATURE COEFFICIENTS IN SUPPORT OF A CHANGE IN THE TECHNICAL SPECIFICATION END OF CYCLE NEGATIVE MTC LIMIT

I. Introduction

The accurate knowledge of the moderator temperature coefficient (MTC) at end of cycle is of prime importance in the fuel management of long reload cycles. The designer must ensure that the most negative MTC will always be conservative to the Technical Specification limit. The required amount of conservatism depends on the accuracy of the calculational model, and on the uncertainty attached to the knowledge of the true MTC. If enough reliance can be placed on the calculational models and on the end of cycle predicted MTC, a surveillance test becomes unnecessary.

The calculational accuracy of the analytical models and the confidence assigned to the knowledge of the true MTC are established by comparing calculated and measured values. A moderator temperature coefficient design margin (uncertainty) is established such that if the best estimate design MTC is conservative relative to the Technical Specification limit by an amount equal to or greater than the design margin, then the Technical Specification limit will not be violated. The best estimate value is defined as the calculated value using the current ABB-CE methodology augmented by a bias term. Although the Technical Specification limit on negative MTC must be satisfied at end-of-cycle, it is shown that the design margin applies to all times in life. It is also established that if the measured beginning-of-cycle moderator temperature coefficients agree with the predictions within the design margin, then all measured coefficients for that cycle are expected to pool with the data base presented in this report, including the end-of-cycle MTC. Thus if the end-of-cycle MTC is expected to fall within the design margin, its measurement is not required.

In this analysis, isothermal temperature coefficients (ITC) are used since they are the measured quantities. The measured ITC is assumed to represent the true value. The impact of systematic errors in the measurements is reduced by combining values obtained on several plants by several utilities using different techniques. The accuracy of the model is expressed as a bias representing systematic differences between measured and calculated values, and the uncertainty is expressed as the random fluctuations between these values. The uncertainty can be viewed as a limitation in the search for the true value. Thus, to ensure compliance with the Tech. Spec. with a high confidence level, the most negative raw calculated design MTC at EOC must be less negative than the Tech. Spec. MTC by an amount equal to the bias plus total uncertainty.

This Amendment 1 updates the data base and validates the conclusions of the original issuance with respect to the most recent plant predicted versus measured startup data available. Thirty-four data points have been added since the original report was issued, for a total of 105 data points. For 15 cycles, all three conditions (BOC at hot zero power, near BOC at power, and near EOC at power) have been analyzed. An additional set of six cycles consists of BOC hot zero power and near EOC at power. A total of 30 near EOC values have been analyzed. Of the 105 data points, only one shows a residual deviation which equals the design margin. This amendment demonstrates that enough reliance can be placed on the calculational models and on the EOC predicted MTCs, and that a surveillance test becomes unnecessary.

II. Summary

In order to ensure that the moderator temperature coefficient will not exceed the Technical Specification limit with a confidence/tolerance of 95/95%, the cycle must be designed, using the ABB-CE methodology, such that the best estimate MTC is:

a. *more negative than the BOC Technical Specification limit by the design margin, and*
b. *more positive than the EOC Technical Specification limit by the design margin.*

The design margin is determined to be 1.6 pcm/°F at all times in life.

The analysis of a revised data base including the most recent measured and calculated MTC's has established that **if the measured beginning-of-cycle moderator temperature coefficients fall within 1.6 pcm/°F of the best estimate prediction, then it can be assumed that the end-of-cycle coefficient will too and its measurement is not required.**

The measured data reduction must be based on the current ABB-CE methodology as described in this report.

If the beginning-of-cycle fails the acceptance criteria of ±1.6 pcm/°F and the discrepancy cannot be resolved, then the end-of-cycle surveillance test must be performed.

III. Methodology

The methodology used for this Amendment 1 is identical to that employed in the original issuance.

IV. Data Base and Data Reduction

The data base of cycles analyzed within this amendment and to be included in the previous data base of the original issuance are Waterford Unit 3 Cycle 8, Arkansas Unit 2 Cycles 11 and 12, Calvert Cliffs Unit 1 Cycle 12 and Unit 2 Cycle 11, Palo Verde Unit 1 Cycle 6, Palo Verde Unit 2 Cycle 6 and Cycle 7, and Palo Verde Unit 3 Cycle 6, and include 23 measurements. An additional set of 11 measurements had been added in the interim. The augmented data base contains a significant sample from all Combustion Engineering plants (2700 MW, 2815 MW, 3400 MW, and 3800 MW), using both the rod insertion and the power trade measurement techniques. The data reduction of all measurements and predictions for the most recent plant data is summarized in Table 1.

ITC predictions have all been made at the measured critical conditions, so that no adjustments were needed. The test initial conditions (power level, exposure, inlet temperature, soluble boron concentration and lead bank insertion) were simulated, taking into account all thermal-hydraulicsand xenon feedbacks. Then, without changing the xenon distribution, a change of ±3°F was applied to the inlet temperature, keeping the thermal-hydraulics feedback effects active. The core average temperature was obtained from edited output, and the ITC calculated.

The 105 data points were analyzed for normality using the American National Standard Institute Standard Normality Test. The D' Test statistic was 301.39 which implies that the assumption of normality is appropriate based on the percentage points of the D' Test Statistic.

V. Results

A complete list of all measured and calculated ITC's is given in Table 1. Table 1 lists the plants and cycles, the core enrichment and exposure, the operating conditions (PPM soluble boron, power and moderator temperature), the measured and calculated ITC and the difference (M-C) in units of pcm/°F.

The residuals of the fit [(M-C) values - fitted values] are plotted in Figure 1 vs. soluble boron concentration. This figure indicates a fairly uniform distribution of points, with no obvious PPM dependence. The residuals of the fit are also plotted vs. various parameters, to demonstrate independence of the residual against these parameters, and to show that no significant variables were omitted in the model, i.e. that the soluble boron is really the only correlating variable. The residuals are plotted vs. core exposure, enrichment, power, moderator temperature, bias and calculated ITC, in Figures 2 to 7. In all Figures, the scatter of the residuals appears random, indicating that there is no correlation of the residuals against any of the chosen variables when including the most recent plant data available.

The result of this Amendment 1 states that when the data base of measured versus predicted MTC includes the most recent plant data available, the conclusions of the original issuance remain valid. It is also concluded that the addition of more data beyond the present data base will not affect the current conclusions. Specifically, the end-of-cycle MTC monitoring procedure in the absence of a measurement is as follows:

If the isothermal temperature coefficients measured at zero power during the cycle startup program, and at power during the first power ascension, fall within the design margin (acceptance criteria) of ±1.6 pcm/°F, then the end-of-cycle best estimate prediction will also be within ±1.6 pcm/°F of the true MTC. To establish compliance with the Technical Specifications, the best estimate end-of-cycle MTC must be less negative than the Tech. Spec. value by 1.6 pcm/°F.

Table 1

Measured ITC's, Calculated ITC's, and Residual of ITC's

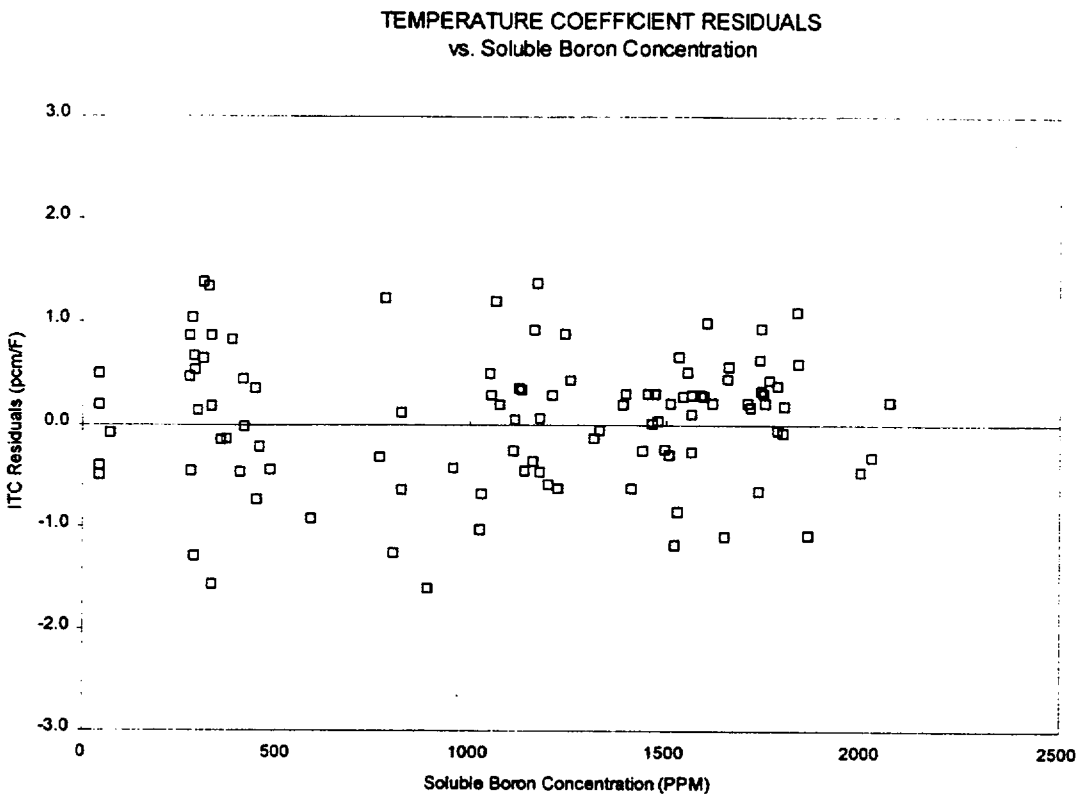
PLANT	Cycle	Core Avg Burnup	Core Avg Enrich	PPM	PWR (%)	Tmod (°F)	ITC Meas E-4/°F	ITC Calc E-4/°F	M-C pcm/°F	Bias pcm/°F	Residual pcm/°F
ANO-2	9	28367	3.98	276	95	580	-2.251	-2.296	0.450	-0.423	0.873
ANO-2	11	14949	4.00	1762	0	541	0.083	0.228	-1.450	-1.883	0.433
ANO-2	11	15320	4.00	1240	95.5	572	-0.623	-0.575	-0.480	-1.370	0.890
ANO-2	12	13806	4.01	1657	0	548	-0.110	0.012	-1.220	-1.780	0.560
ANO-2	12	14151	4.01	1110	98	578	-1.042	-0.892	-1.500	-1.243	-0.257
ANO-2	12	28843	4.01	288	97	575	-2.011	-2.022	0.110	-0.435	0.545
CC-1	8	14526	3.81	1600	0	532	0.344	0.417	-0.730	-1.724	0.994
CC-1	8	14526	3.81	1330	0	532	-0.560	-0.408	-1.520	-1.459	-0.061
CC-1	8	24723	3.81	310	97	570	-1.782	-1.801	0.190	-0.457	0.647
CC-1	9	16502	3.77	1398	0	532	0.064	0.187	-1.230	-1.526	0.296
CC-1	9	24783	3.77	275	97	570	-1.865	-1.870	0.050	-0.422	0.472
CC-1	10	10971	3.95	1750	0	532	0.265	0.422	-1.570	-1.871	0.301
CC-1	10	10971	3.95	1735	0	532	0.200	0.452	-2.520	-1.857	-0.663
CC-1	10	27443	3.95	285	97	570	-1.757	-1.781	0.240	-0.432	0.672
CC-1	12	15399	4.19	2024	0	535	0.440	0.580	-1.400	-1.071	-0.329
CC-1	12	15679	4.19	1521	100	567	-0.260	-0.116	-1.440	-0.577	-0.863
CC-1	12	31905	4.19	357	72	559	-1.770	-1.645	-1.250	-0.503	-0.747
CC-2	5	24423	3.42	44	0	530	-1.610	-1.550	-0.600	-0.195	-0.405
CC-2	5	24423	3.42	44	0	530	-1.740	-1.670	-0.700	-0.195	-0.505
CC-2	5	24423	3.42	44	0	530	-1.950	-1.950	0.000	-0.195	0.195
CC-2	5	24423	3.42	44	0	530	-2.080	-2.110	0.300	-0.195	0.495
CC-2	5	24423	3.42	330	0	530	-1.050	-1.090	0.400	-0.476	0.876
CC-2	5	24423	3.42	330	0	530	-1.110	-1.080	-0.300	-0.476	0.176
CC-2	5	24423	3.42	69	100	572	-2.089	-2.058	-0.310	-0.220	-0.090
CC-2	8	12937	3.93	1496	0	521	0.200	0.387	-1.870	-1.622	-0.248
CC-2	8	27120	3.93	297	97	570	-1.810	-1.779	-0.310	-0.444	0.134
CC-2	9	13895	4.15	1801	0	532	0.370	0.544	-1.740	-1.921	0.181
CC-2	9	13895	4.15	1389	0	532	-0.470	-0.338	-1.320	-1.517	0.197
CC-2	11	15926	4.21	1995	0	535	0.470	0.610	-1.400	-0.872	-0.477
CC-2	11	15962	4.21	1527	100	567	-0.228	-0.095	-1.330	-0.413	-0.917
CC-2	11	32372	4.21	284	100	567	-2.072	-1.900	-1.720	-0.431	-1.289
OPPD	12	15738	3.73	1507	0	523	0.240	0.433	-1.930	-1.633	-0.297
OPPD	12	16520	3.73	1050	91	565	-0.516	-0.448	-0.680	-1.184	0.504
OPPD	12	25777	3.73	309	92	565	-1.711	-1.804	0.930	-0.456	1.386

Table 1 Continued

PLANT	Cycle	Core Avg Burnup	Core Avg Enrich	PPM	PWR (%)	Tmod (°F)	ITC Meas E-4/°F	ITC Calc E-4/°F	M-C pcm/°F	Bias pcm/°F	Residual pcm/°F
OPPD	13	14835	3.72	1563	0	521	0.310	0.506	-1.960	-1.688	-0.272
OPPD	13	15209	3.72	1113	92	565	-0.461	-0.341	-1.200	-1.246	0.046
OPPD	13	25531	3.72	325	92	565	-1.640	-1.728	0.880	-0.471	1.351
OPPD	14	14562	3.60	1178	0	523	-0.090	0.035	-1.250	-1.309	0.059
OPPD	14	14916	3.60	768	88	564	-0.912	-0.789	-1.230	-0.907	-0.323
PV-1	1	0	2.65	1055	0	320	-0.128	-0.038	-0.900	-1.189	0.289
PV-1	1	0	2.65	824	0	320	-0.369	-0.208	-1.610	-0.962	-0.648
PV-1	1	0	2.65	1025	0	565	-0.442	-0.223	-2.190	-1.159	-1.031
PV-1	1	0	2.65	893	0	565	-0.972	-0.709	-2.630	-1.029	-1.601
PV-1	1	82	2.65	825	23	565	-0.587	-0.502	-0.850	-0.963	0.113
PV-1	2	11269	3.15	1462	0	565	0.150	0.308	-1.580	-1.588	0.008
PV-1	2	11269	3.15	1178	0	565	-0.422	-0.244	-1.780	-1.309	-0.471
PV-1	3	9727	3.66	1739	0	565	0.133	0.256	-1.230	-1.861	0.631
PV-1	3	9727	3.66	1438	0	565	-0.445	-0.262	-1.830	-1.565	-0.265
PV-1	3	9727	3.66	1653	0	565	-0.130	0.003	-1.330	-1.776	0.446
PV-1	3	11209	3.66	1170	100	595	-0.813	-0.821	0.080	-1.302	1.382
PV-1	3	22404	3.66	484	100	595	-2.291	-2.184	-1.070	-0.628	-0.442
PV-1	6	16533	3.84	1753	0	565	-0.044	0.038	-0.820	-1.033	0.213
PV-1	6	18110	3.84	1160	99	589	-1.095	-1.014	-0.810	-0.450	-0.360
PV-1	6	27460	3.84	415	100	589	-2.490	-2.342	-1.480	-0.560	-0.920
PV-1	7	16140	3.98	2070	0	565	-0.038	0.059	-0.970	-1.183	0.213
PV-2	2	9123	3.32	1452	0	565	-0.048	0.080	-1.280	-1.579	0.299
PV-2	2	9123	3.32	1140	0	565	-0.468	-0.295	-1.730	-1.272	-0.458
PV-2	3	12102	3.76	1595	0	595	0.065	0.209	-1.440	-1.719	0.279
PV-2	3	12102	3.76	1315	0	565	-0.693	-0.535	-1.580	-1.444	-0.136
PV-2	3	14662	3.76	1029	100	595	-1.146	-0.961	-1.850	-1.163	-0.687
PV-2	4	13988	3.73	1741	0	565	0.174	0.328	-1.540	-1.863	0.323
PV-2	4	15516	3.73	1126	100	595	-0.972	-0.882	-0.900	-1.258	0.358
PV-2	4	24121	3.73	455	100	595	-2.352	-2.270	-0.820	-0.599	-0.221
PV-2	6	17972	3.65	1563	0	565	-0.070	0.043	-1.130	-1.415	0.285
PV-2	6	19543	3.65	959	99.95	588	-1.219	-1.094	-1.250	-0.822	-0.428
PV-2	6	26022	3.65	385	100	589	-2.205	-2.235	0.300	-0.530	0.830
PV-2	7	13683	3.71	1784	0	565	-0.125	-0.038	-0.870	-0.816	-0.054
PV-3	1	0	2.65	805	0	565	-0.837	-0.617	-2.200	-0.943	-1.257
PV-3	2	8402	3.26	1479	0	565	0.061	0.218	-1.570	-1.605	0.035
PV-3	2	8402	3.26	1200	0	565	-0.424	-0.232	-1.920	-1.331	-0.589
PV-3	2	19015	3.26	411	99	595	-2.054	-2.043	-0.110	-0.556	0.446
PV-3	3	22874	3.47	330	100	595	-2.641	-2.437	-2.040	-0.476	-1.564
PV-3	4	14284	3.61	1586	0	565	0.040	0.183	-1.430	-1.710	0.280
PV-3	5	13153	3.76	1836	0	565	0.100	0.147	-0.470	-1.055	0.585

Table 1 Continued

PLANT	Cycle	Core Avg Burnup	Core Avg Enrich	PPM	PWR (%)	Tmod (°F)	ITC Meas E-4/°F	ITC Calc E-4/°F	M-C pcm/°F	Bias pcm/°F	Residual pcm/°F
PV-3	6	17053	3.91	1862	0	565	-0.285	-0.037	-2.480	-1.400	-1.080
PV-3	6	18631	3.91	1222	100	588	-1.253	-1.113	-1.400	-0.771	-0.629
PV-3	6	27676	3.91	449	99.95	586	-2.495	-2.362	-1.330	-0.593	-0.737
SONGS2	4	8419	3.75	1798	0	545	0.077	0.278	-2.010	-1.919	-0.091
SONGS2	4	8419	3.75	1563	0	545	-0.364	-0.205	-1.590	-1.688	0.098
SONGS2	5	11355	3.95	1615	0	545	-0.082	0.071	-1.530	-1.739	0.209
SONGS2	5	11355	3.95	1208	0	545	-0.860	-0.755	-1.050	-1.339	0.289
ST-L-2	5	14397	3.65	1705	0	535	0.208	0.370	-1.620	-1.827	0.207
ST-L-2	5	26200	3.65	280	100	572	-2.114	-2.026	-0.880	-0.427	-0.453
ST-L-2	6	16024	3.85	1784	0	532	0.219	0.372	-1.530	-1.905	0.375
ST-L-2	6	22570	3.85	782	100	572	-1.203	-1.234	0.310	-0.920	1.230
ST-L-2	6	28462	3.85	283	100	572	-2.033	-2.094	0.610	-0.430	1.040
ST-L-2	7	18519	3.93	1510	0	532	-0.063	0.080	-1.430	-1.636	0.206
ST-L-2	8	16648	3.86	1714	0	532	0.203	0.370	-1.670	-1.836	0.166
ST-L-2	9	16029	3.94	1550	0	532	-0.096	0.020	-1.160	-1.675	0.515
WSES-3	4	14074	3.82	1540	0	545	-0.074	0.065	-1.390	-1.665	0.275
WSES-3	4	14211	3.82	1077	92	582	-0.964	-0.855	-1.090	-1.210	0.120
WSES-3	4	25206	3.82	370	95	582	-2.129	-2.049	-0.800	-0.516	-0.284
WSES-3	5	14898	3.91	1530	0	545	-0.097	0.003	-1.000	-1.655	0.655
WSES-3	5	15040	3.91	1066	91	582	-0.918	-0.913	-0.050	-1.199	1.149
WSES-3	5	25907	3.91	404	93	582	-2.134	-2.017	-1.170	-0.549	-0.621
WSES-3	6	15524	3.95	1647	0	545	-0.114	0.173	-2.870	-1.770	-1.100
WSES-3	6	15524	3.95	1411	0	545	-0.600	-0.383	-2.170	-1.538	-0.632
WSES-3	6	15638	3.95	1131	90	578	-0.819	-0.726	-0.930	-1.263	0.333
WSES-3	6	27465	3.95	444	96	580	-1.898	-1.875	-0.230	-0.588	0.358
WSES-3	7	14974	3.95	1741	0	545	0.160	0.253	-0.930	-1.863	0.933
WSES-3	7	14974	3.95	1471	0	545	-0.435	-0.305	-1.300	-1.597	0.297
WSES-3	7	16199	3.95	1162	94	578	-0.703	-0.666	-0.370	-1.294	0.924
WSES3	8	14961	4.08	1833	0	548	0.139	0.224	-0.850	-1.953	1.103
WSES3	8	16054	4.08	1254	94.5	578	-0.736	-0.641	-0.950	-1.384	0.434
WSES3	8	26993	4.08	590	92	577	-1.749	-1.583	-1.660	-0.732	-0.928



TEMPERATURE COEFFICIENT RESIDUALS
vs. Soluble Boron Concentration
ITC Residuals (pcm/F)
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
0
500
1000
1500
2000
2500
Soluble Boron Concentration (PPM)

Figure 1

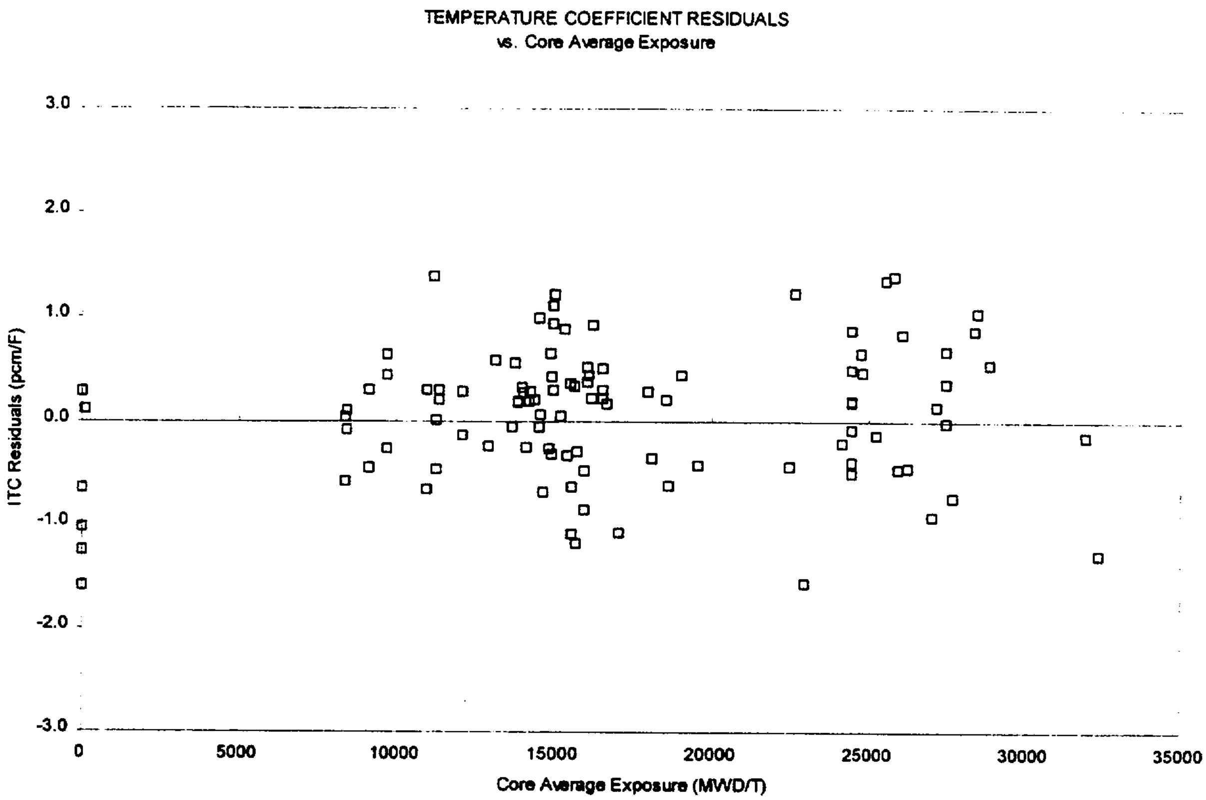

TEMPERATURE COEFFICIENT RESIDUALS
vs. Core Average Exposure
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
ITC Residuals (pcm/F)
0
5000
10000
15000
20000
25000
30000
35000
Core Average Exposure (MWD/T)

Figure 2

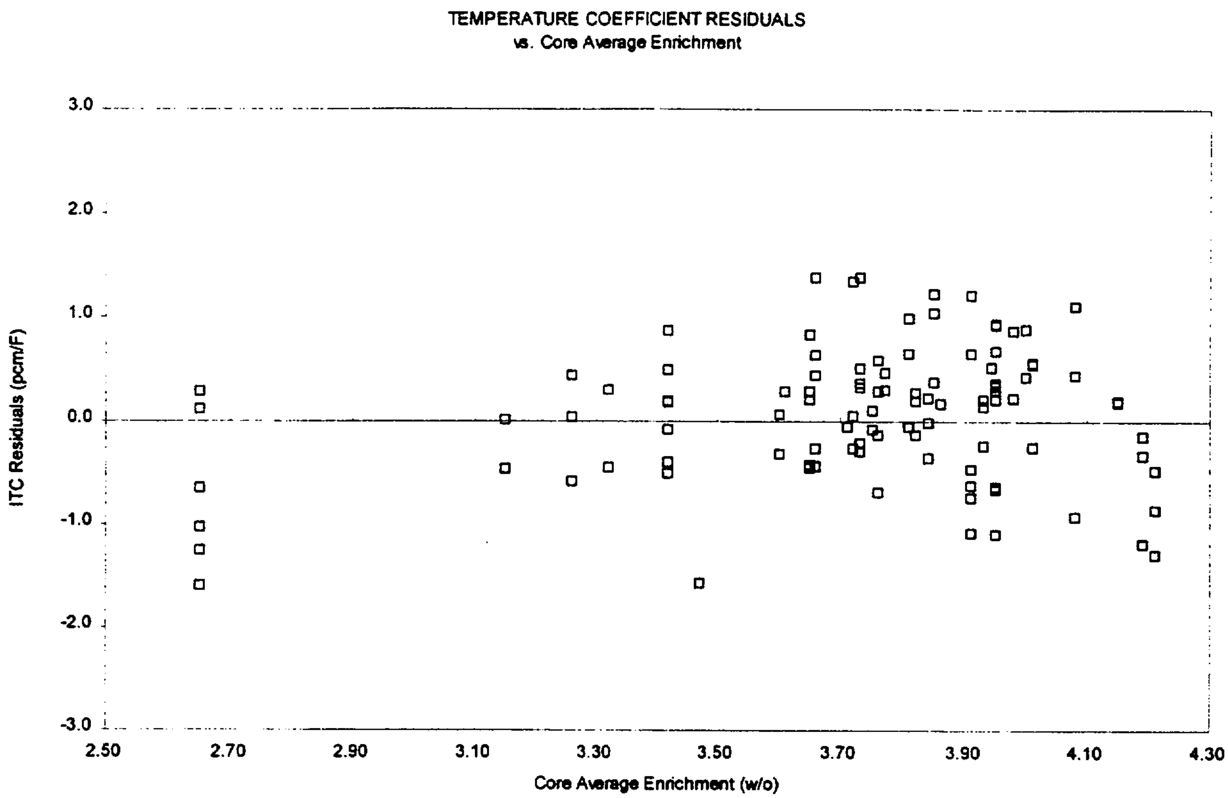

TEMPERATURE COEFFICIENT RESIDUALS
vs. Core Average Enrichment
ITC Residuals (pcm/F)
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
2.50
2.70
2.90
3.10
3.30
3.50
3.70
3.90
4.10
4.30
Core Average Enrichment (w/o)

Figure 3

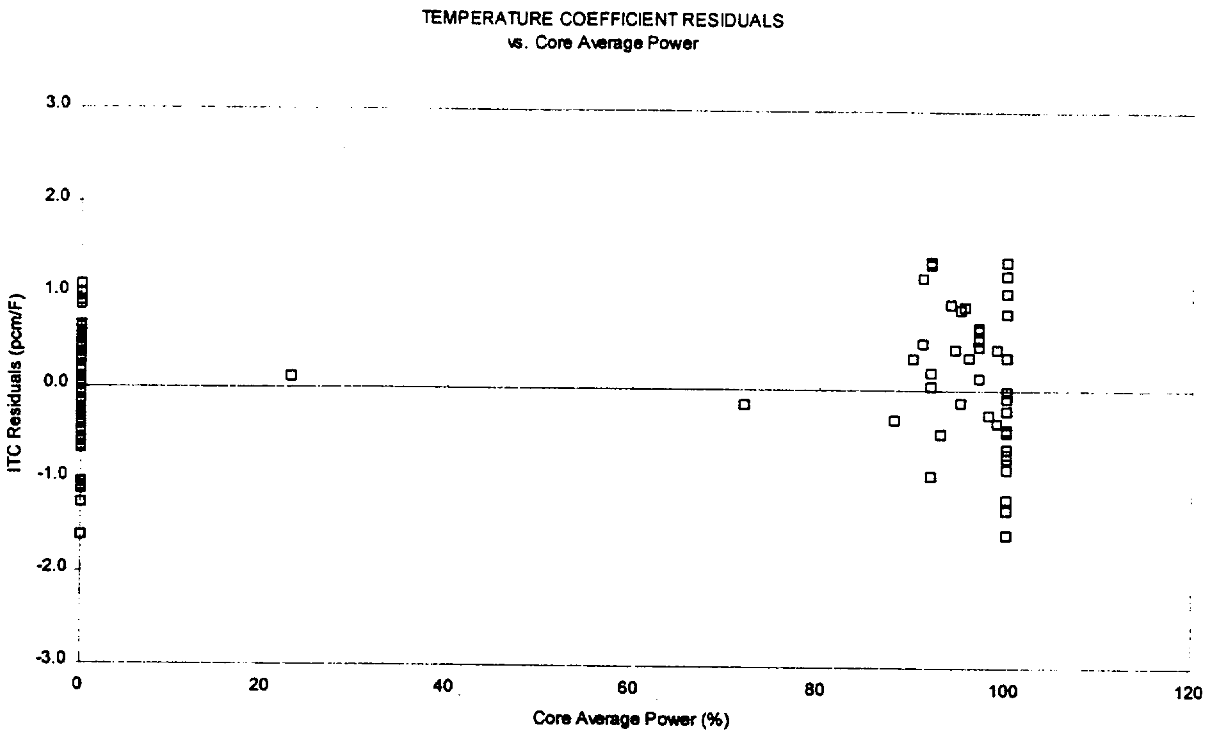

TEMPERATURE COEFFICIENT RESIDUALS
vs. Core Average Power
ITC Residuals (pcm/F)
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
0
20
40
60
80
100
120
Core Average Power (%)

Figure 4

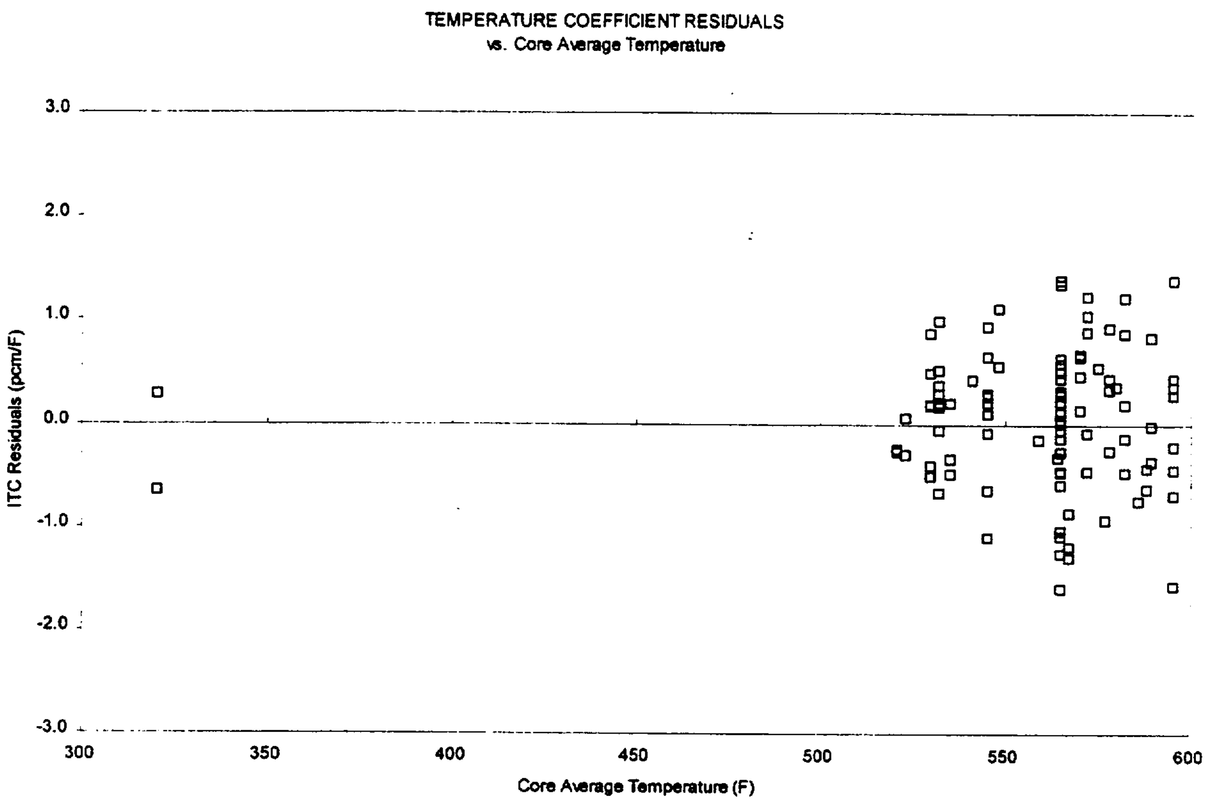

TEMPERATURE COEFFICIENT RESIDUALS
vs. Core Average Temperature
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
ITC Residuals (pcm/F)
300
350
400
450
500
550
600
Core Average Temperature (F)

Figure 5

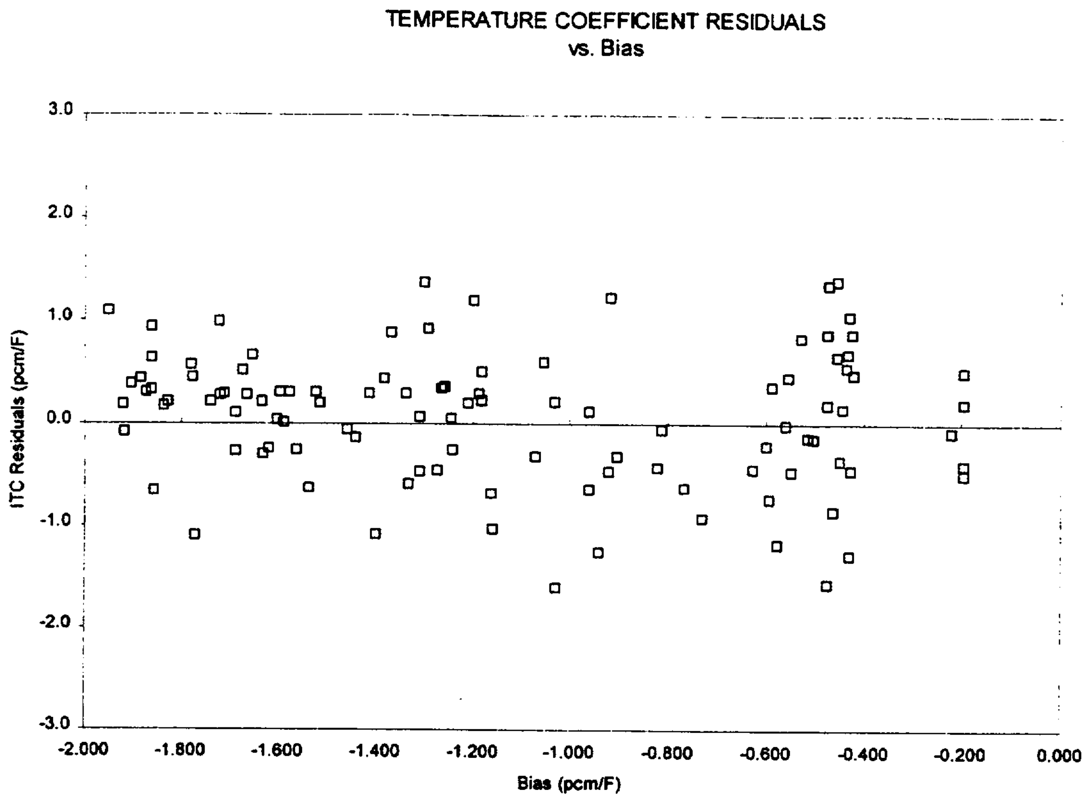

TEMPERATURE COEFFICIENT RESIDUALS
vs. Bias
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
ITC Residuals (pcm/F)
-2.000
-1.800
-1.600
-1.400
-1.200
-1.000
-0.800
-0.600
-0.400
-0.200
0.000
Bias (pcm/F)

Figure 6

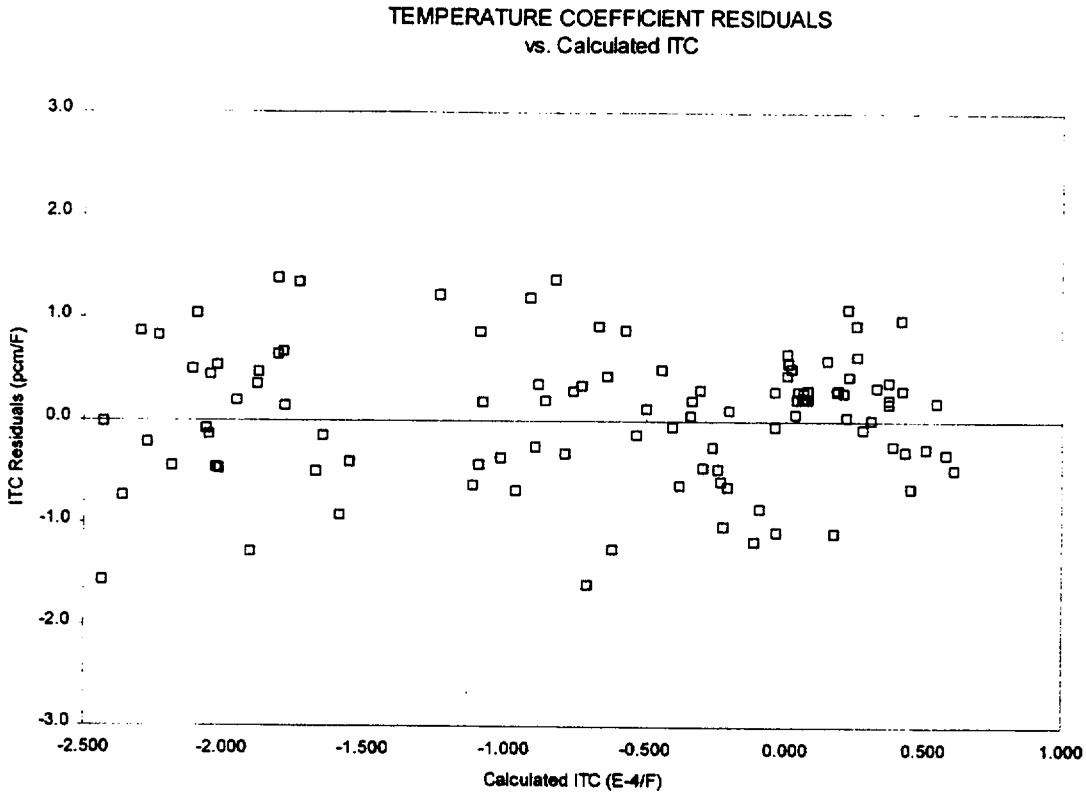

TEMPERATURE COEFFICIENT RESIDUALS
vs. Calculated ITC
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
ITC Residuals (pcm/F)
-2.500
-2.000
-1.500
-1.000
-0.500
0.000
0.500
1.000
Calculated ITC (E-4/F)

Figure 7

Appendix A

ABB-CE Response to Questions

This Appendix A has been prepared in response to a number of questions raised by the NRC on the original submittal.

1. *What methodology is used for calculating MTC?*

The Isothermal Moderator Temperature Coefficients (ITC) are calculated with the ROCS coarse mesh nuclear design code. (Reference 1) This code performs two- or three-dimensional flux calculations in full-, half- or quarter-core geometries. A typical ROCS core geometry consists of four radial nodes per fuel assembly and 20 to 30 axial planes. The nodal macroscopic cross sections are calculated from detailed isotopic concentrations and microscopic cross sections. The nuclides are divided into three categories:

Fuel:	Includes two uranium, one neptunium and four plutonium nuclides,
Fission products:	Includes I-135 and Xe-135, Pm-149 and Sm-149 and a lumped fission products,
Burnable absorbers:	Includes depletable boron (B-10), erbium or gadolinium nuclides.

The microscopic cross sections are functionalized vs burnup and operating conditions such as moderator temperature, moderator density, fuel temperature and soluble boron concentration. This treatment provides for a very accurate representation of the cross sections under any operating conditions, and for accurate spatial isotopic distributions, accounting for all history effects. During the flux calculation, thermal-hydraulic feedback and equilibrium xenon calculations are performed to ensure consistency between the power, moderator temperature and density, fuel temperature and xenon distributions. The local fuel temperature is determined from a correlation vs burnup and power, and from the local moderator temperature.

The calculation of the moderator temperature coefficient is performed as follows:

1. A reference calculation is performed to simulate the core conditions at the beginning of the testing program. All thermal-hydraulic and xenon feedback options are exercised, and the critical control rod position and soluble boron concentration are supplied.

2. Two off-nominal calculations are performed by changing the inlet temperature above and below that of the reference condition, usually by 3°F. The power level, xenon distribution, control rod insertion and soluble boron concentration are kept unchanged from the reference condition. The change in core reactivity is therefore due to the change in inlet temperature, and to the ensuing change in the distribution of the moderator temperature and density and of the fuel temperature. For the nominal and the off-nominal cases, the ROCS code provides an edit of the core reactivity and of the volume average moderator temperature. The moderator temperature coefficient is defined as the ratio of the reactivity change to the core average moderator temperature change.

The moderator temperature coefficient prediction is usually accompanied by one of two of the following calculations, depending upon the measuring technique. If the ITC is measured by the rod insertion technique, a prediction of the lead bank insertion worth curve is performed, using full thermal-hydraulic feedback, but keeping the power level, xenon distribution, inlet temperature and soluble boron concentration of the reference case. If the ITC is measured with the power trade technique, a prediction of the power coefficient is performed, again under the rod insertion, boron concentration and xenon distribution of the reference case.

2. Has the methodology changed since the data analysis presented in the report? If yes, please explain changes and the effect of these changes.

All results presented in this topical report and its amendment have been generated with the same methodology.

3. Is only the methodology referenced in answering question 1 involved or are there more than one methodologies involved?

The methodology described in paragraph 1 above is the only one which has been used in the preparation of this report.

4. Will Combustion Engineering perform the calculations in all cases or will the utilities perform them in some cases? If utilities perform the calculations, what codes will they use?

Combustion Engineering has performed all calculations presented in this report. Should Utilities perform such calculations in the future, they will use a consistent methodology. The analysis presented in this report has demonstrated the random nature of the residual between measured and predicted temperature coefficients. Since the residual cannot be correlated against any parameter, one can assume that it is due entirely to measurement uncertainties, and as such is independent of the analytical technique. Any NRC approved physics code system, e.g. DIT-ROCS or CASMO-SIMULATE, will lead to the same level of uncertainties. However, the calculational bias will be established for each code system.

5. Assuming Combustion Engineering has performed all the calculations, why is there not more data? In addition, please supply all additional data obtained since the report was prepared (Update Table 1 to include all data available)

The data base presented in the Topical Report contains a large number of measurements, collected under various operating conditions for all classes of Combustion Engineering plants. The purpose of the report was to present a large enough data base and to perform statistical tests to show that data from various plants, under various power levels or exposures, measured with various experimental techniques, belong to the same population. Therefore, the addition or removal of some data points will not impact the conclusions.

The data base was considered to be large enough to justify the conclusions reached in the report. Since the Report was issued in 1993, 34 data points have been added to the data base and are presented in this Amendment. The additional data provides a significant sample of all Combustion Engineering plants (2700 MW, 2815 MW, 3400 MW and 3800 MW), using both the rod insertion and the power trade measurement techniques. The extended data confirms the validity of the conclusions reached earlier. Because of the truly random nature of the data base, the sample size chosen for this amendment is deemed sufficient.

Some experimental data from earlier cycles of older plants has not been incorporated, because it was originally analyzed with slightly different methods and also because the fuel management used at the time was not representative of current fuel management practices.

6. In examining the data on Table 1, it appears that there are only a small number of sets (consisting of 3 measurements - a BOC, zero power measurement; - a BOC, full power measurement; and a near EOC full power measurement) of data. Why is this the case?

The data base presented in this amendment has been increased and now contains 15 sets of 3 measurements per cycle (- a BOC, zero power measurement; - a BOC, full power measurement; and a near EOC full power measurement). In addition, 6 sets of 2 measurements (- a BOC, zero power measurement and a near EOC full power measurement) are included. A total of 30 near EOC values are included in the data base.

7. From the data in Table 1, there are only 5 cases in which all three measurements fall within the acceptance criteria. Please discuss why this should be sufficient.

In the increased data base, only one data point shows a deviation equal to the design basis. Of the 15 sets of three measurements and 6 sets of 2 measurements, no data point exceeds the design basis.

Reference:

1. "The ROCS and DIT Computer Codes for Nuclear Design," CENPD-266-P-A, April, 1983.