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Waterford 3

W3F1-2001-0102
A4.07
PR

October 23, 2001

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

SUBJECT: Waterford Steam Electric Station, Unit 3
Docket No. 50-382
Supplemental Information in Support of TSCR NPF-38-234
Replacement of Part-Length Control Element Assembly

REFERENCE: W3F1-2001-0063, dated July 9, 2001 (TAC No. MB2379)

Gentlemen:

Entergy Operations, Inc. (Entergy) submitted under the referenced letter a request for changes to the technical specifications to reflect the replacement of the part-length control element assemblies and the removal of the 'four-element' control element assemblies. In response to informal questions provided by the NRC staff, and discussions during a teleconference on October 3, 2001, Entergy provides the attached supplemental information to support the NRC staff review of the requested change. In particular, two scoping studies performed to evaluate the technical feasibility of this change and to assess the potential impacts on the plant safety analyses, operating margin, and reactivity control are included as Attachments 2 and 3.

The scoping studies contained in Attachments 2 and 3 are proprietary.

Entergy had requested approval of the proposed amendment by February 22, 2002. This date is required in order to support planned implementation of the CEA changes during the upcoming refueling outage scheduled to begin in March, 2002. Although this request is neither exigent nor emergency, your prompt review is requested.

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As noted above, the scoping studies contained in Attachments 2 and 3 are both proprietary. Non-proprietary versions of the scoping studies are included in Attachments 4 and 5. An affidavit signed by an officer of the Westinghouse Electric Company is attached in support of a request that the proprietary information be withheld from public disclosure. This request is made pursuant to 10CFR2.790. The address of the Westinghouse Electric Company is:

Westinghouse Electric Company
2000 Day Hill Road
Windsor, CT 06095

Entergy commits to implement the CEA replacement changes only after both NRC staff approval of the requested technical specification changes has been received and acceptable conclusions from the 10CFR50.59 evaluation of the reload analyses report have been determined.

The original changes were evaluated in accordance with 10CFR50.91(a)(1), using the criteria in 10CFR50.92(c), and were determined to not involve any significant hazards consideration. The attached information does not impact that determination.

All commitments made in this supplement are listed in Attachment 7. If you have any questions or require additional information, please contact D. Bryan Miller at (504) 739-6692.

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 23, 2001.

Sincerely,

A. J. Harris
Director, Nuclear Safety Assurance

AJH/DBM/cbh

Attachments:

1. Overview of Scoping Studies
2. Scoping Study of PLCEA Replacement at Waterford 3 (Proprietary Version)
3. Elimination of 4-Rod CEAs from CE NSSS 217 Fuel Assembly Cores (Proprietary Version)
4. Scoping Study of PLCEA Replacement at Waterford 3 (Non-Proprietary Version)
5. Elimination of 4-Rod CEAs From CE NSSS 217 Fuel Assembly Cores (Non-Proprietary Version)
6. Affidavit Supporting the Withholding of Proprietary Information
7. Summary of Commitments

cc: E.W. Merschoff, NRC Region IV
N. Kalyanam, NRC-NRR
J. Smith
N.S. Reynolds
NRC Resident Inspectors Office
Louisiana DEQ/Surveillance Division
American Nuclear Insurers

Attachment 1

To

W3F1-2001-0102

Overview of Scoping Studies

Introduction

The technical specification change request submitted by Entergy Operations, Inc. (Entergy) in the letter dated July 9, 2001 requested approval of changes to reflect planned modifications to replace the part-length control element assemblies (PLCEA) with full-length CEAs (FLCEA) and to eliminate the four-element CEAs. In order to evaluate various options and to identify a change configuration that would satisfy the design and regulatory requirements and plant commitments for safe operation, Entergy had conducted some significant design and safety analysis reviews. Two of the products of this review effort are scoping studies documented in the attached reports. Additional information on each study effort is provided below.

The two scoping studies were developed independent of each other. The PLCEA replacement scoping study, Attachment 2, was performed with the four-element CEAs in the core while the four-element scoping study assumed the PLCEAs were present. In January 2001, an Entergy cross-discipline team recommended that these two projects be combined into one task. Westinghouse, after careful consideration of the inputs, methods, and outputs of the two studies, concluded that these two projects could indeed be combined and that the conclusions of the two studies remained valid.

PLCEA Replacement Study

In January 2000, a cross-discipline team was organized to address the replacement of all eight of the PLCEAs, which were approaching the end of their design lifetime. The team was comprised of members from Operations, Engineering (Design, System, and Reactor), Safety Analysis, Core Design, Licensing, and Westinghouse. The charter of the team was to recommend a replacement option that would increase operational margin and control while maintaining similar accident analysis and core physics results.

Five replacement options were considered:
- Replacement with Full Length Control Element Assemblies (FLCEAs) and reconfiguration of the CEA groups
- Replacement with FLCEAs and configure these new FLCEAs as a new Group P (similar to the change approved for use at ANO-2 in 1995)
- Replacement with PLCEAs (like for like)
- Replacement with Hybrid Rods (i.e., Gray/Black CEAs with a strong neutron absorber at the top of the CEA and a weaker neutron absorber at the bottom of the CEA)
- Replacement with Full Length, Part Strength CEAs (Inconel)

In May 2000, based on the evaluation and on lessons learned at Arkansas Nuclear One - Unit 2 which had previously replaced PLCEAs with FLCEAs, the team recommended the replacement of the PLCEAs with FLCEAs with reconfigured CEA groups.

Once the replacement option was selected, the Entergy team, with input from Westinghouse, narrowed down the potential CEA reconfigurations to three patterns. The current pattern is shown on Page 28 of Attachment 2. The alternative configurations considered are described below:

Pattern A (see page 29 of Attachment 2)
- Group P comprised of four FLCEAs currently in the outer subgroup of Group 4
- Group 4 comprised of the eight CEAs currently in Group P (as FLCEAs)
- Group A augmented with four FLCEAs currently in the inner subgroup of Group 4

Pattern B (see page 30 of Attachment 2)
- Group P comprised of four FLCEAs currently in the inner subgroup of Group 4
- Group 4 comprised of the four FLCEAs currently in the outer subgroup of Group 4, plus the four FLCEAs currently in the main diagonal subgroup of Shutdown Group A
- Group A augmented with eight FLCEAs currently in Group P, and with four main diagonal FLCEAs mentioned above removed

Pattern C (see page 31 of Attachment 2)
- Group P comprised of the four FLCEAs currently in the main diagonal subgroup of Group A
- Group 4 unchanged
- Group A augmented with eight FLCEAs currently in Group P, and with four main diagonal FLCEAs mentioned above removed

Note: The Waterford Steam Electric Station, Unit 3 (Waterford 3) technical specifications utilize the term "group" while the studies contained in the attachments utilize the term "bank." "Group" and "bank" are equivalent. Also, shutdown groups are designated by an "A" or "B" while regulating groups are designated by a number.

In September 2000, Westinghouse was contracted to perform a detailed scoping study (non-Quality Assured), which performed parametric evaluations of the three potential patterns over Cycles 10, 11, and 12 (Waterford 3 was in Cycle 10 at the time and is currently in Cycle 11). The study was broken up into two tasks. Task 1 would obtain a sufficient set of data to allow the selection of a single CEA pattern (from the three listed above) to be evaluated in more detail in Task 2. Task 1 evaluations, discussed in detail on pages 3-8 of Attachment 2, included CEA group insertions, physics evaluations, sequential CEA withdrawal, and single CEA ejection data. Task 1 was completed in November 2000 and judged that all of the potential CEA configurations are feasible for implementation at Waterford 3. Pattern C was recognized as the best choice for further evaluation in Task 2 based on the least severe impact on CEA group insertion, sequential CEA withdrawal, and Hot Zero Power CEA ejection cases. It was also noted that of the three potential patterns, pattern C minimized the number of CEAs to be shuffled; it required changes to only Group P and Shutdown Group A.

Following the selection of Pattern C, Task 2 commenced with a more detailed scoping of the proposed change (see pages 9-26 of Attachment 2). The effort consisted of generating physics data for various events and assessing the impact of the proposed change on the safety analyses. It also involved an assessment of the impact on the Core Protection Calculators (CPCs), the Core Operating Limits Supervisory System (COLSS), and the control element drive mechanism control system (CEDMCS).

Task 2 was completed in January 2001 and concluded that the implementation of Pattern C as part of a PLCEA replacement would be feasible and would represent an enhancement for Waterford 3. Neither the single CEA drop analysis of record nor the single CEA withdrawal within deadband analysis of record would require changes due to the PLCEA replacement. The single CEA ejection analysis showed some adverse results with the current power dependent insertion limits (PDILs) (which includes regulating group 4), but would be similar to current cycles if regulating group 4 was removed from the PDIL. The CPCs and COLSS required changes would be feasible and within the deliverables of the reload process and the CEDMCS changes were identified and determined to be feasible. The implementation of Pattern C would also enhance operational margin/control and result in increased available Shutdown Margin.

Deletion of the Four-Element CEAs Study

During the above timeframe, the Combustion Engineering Owner's Group (CEOG) was completing (November 2000) a feasibility study on the elimination of the four-element CEAs from CE Nuclear Steam Supply System 217 assembly cores (see Attachment 3). The report investigated mechanical issues, such as increased bypass leakage flow and flow distribution, fuel rod vibration, shroud operating temperature, etc. (reference pages 6-10 of Attachment 3). No adverse factors were identified. Core design and safety analysis issues were investigated on pages 11-15 of Attachment 3 for cycle 11, cycle 12, and for extended 24-month cycles (for scoping purposes). Key physics inputs were determined for the post-trip steamline break (the analysis of record potentially impacted) and a comparison was made between the cases with and without the four-element CEAs. With the exception of the extended 24-month cycle (which Entergy is not currently pursuing for Waterford 3), the elimination of the four-element CEAs was determined to have a minimal and benign impact on the safety analyses, including the main steamline break. Pages 20-21 of Attachment 3 identify the required changes to CPCs, COLSS, and CEDMCS, as well as determining the feasibility of these changes.

Conclusion

In summary, it is recognized that the design change to replace the PLCEAs and eliminate the four-element CEAs has an effect on the core design and analysis. As stated in the original submittal, power dependent insertion limits will be developed using methodologies previously approved by the NRC staff for each CEA group and included in the Core Operating Limits Report (COLR). The final demonstration of the acceptability of the change will be the Reload Analysis Report (RAR) and the associated 10 CFR 50.59 evaluation. The RAR will evaluate the final configuration of the fuel and CEAs. It will ensure that, with the COLR-required insertion limits, the technical specification requirements for shutdown margin, rod worth, and axial flux shaping continue to be met and are adequate to protect the safety limits. While the final RAR is not complete, the scoping studies described above and provided as Attachments 2 and 3 have provided Entergy with the confidence that the proposed changes would be found acceptable from design, safety, and operations perspectives.

Since January 2001, the reload process work (which is performed by Westinghouse) has consisted of constructing the appropriate physics, fuel, and thermal hydraulic models. The reload process is scheduled to have the final RAR and COLR completed by early March 2002. The implementation of this change is contingent upon the successful completion of the reload process with a passing 10CFR50.59 evaluation. The reload 10CFR50.59 evaluation will address the PLCEA replacement and four-element CEA changes as they relate to the accident analyses.

Attachment 4

To

W3F1-2001-0102

Scoping Study of PLCEA Replacement at Waterford 3

(Non-Proprietary Version)

Scoping Study of PLCEA Replacement at Waterford 3

Introduction

The purpose of this report is to describe the results of the scoping study performed for Entergy Operations, Inc. (EOI) by Westinghouse to examine the replacement of the eight (8) Part Length Control Element Assemblies (PLCEAs) at Waterford 3.

In this scoping study, Westinghouse evaluated the replacement of the PLCEAs with Full Length Control Element Assemblies (FLCEAs). The current configuration of the Waterford 3 CEA Banks is shown in Figure 1. The PLCEA replacement involves the reconfiguration of the CEAs banks as necessary such that Bank P (currently comprised of the eight PLCEAs) will be made up of four (4) FLCEAs.

Three potential CEA Bank configurations associated with the reconfiguration of Bank P were selected for evaluation in the initial, or "Task 1" portion of the scoping study. Full-core maps of these configurations are shown in Figures 2, 3, and 4; quarter-core maps are shown together in Figure 5.

The goal of Task 1 was to obtain a set of data sufficient to allow the selection of a single CEA configuration to be evaluated in the more detailed, or "Task 2" portion of the scoping study. Both of these evaluations are discussed below.

Executive Summary

In this scoping study, Westinghouse established the viability of implementing a PLCEA replacement in Cycle 12 of Waterford 3. This was achieved by minimizing the impact on the plant through a careful selection process regarding the pattern of full-length, full-strength CEAs and their bank assignments.

Overall, the replacement of the PLCEAs with FLCEAs was shown to result in improvements in plant control and operational flexibility. Shutdown Margin and available Scram Worth will be enhanced, as will the ability to control the core's Axial Power Shape. Finally, all CEAs will be of the same design, enhancing flexibility in areas such as CEA shuffling.

Summary of Findings

Based on the information developed in this scoping study, Westinghouse concludes that it would be feasible to use CEA Pattern C as part of a PLCEA implementation for Cycle 12 at Waterford 3.

The results of Task 1 indicate that of the three cycles examined, the PLCEA replacement results for Cycle 12 were the most limiting due to the nature of the fuel management pattern for that cycle. All three of the CEA patterns examined in Task 1 had positive and negative aspects of the individual physics results. Indeed, the Task 1 results indicate that it would be feasible to implement any of the three PLCEA replacement configurations at Waterford 3. However, an overall evaluation of the Task 1 results led to the selection of CEA Pattern C as the best candidate for the further evaluations of Task 2.

The evaluations of Task 2 show that the Analyses of Record (AORs) for both Single CEA Drop and Single CEA Withdrawal within Deadband should not require changes in order to accommodate a PLCEA replacement. The current Single CEA Ejection AOR does not bound certain physics data calculated herein for Cycle 12, even with the current PLCEAs; the PLCEA replacement was seen to induce even more limiting results. To address this issue, the current AOR could be revised. Alternatively, consideration could be given to removing Bank 4 from the PDIL (at least for Cycle 12) as a means of eliminating the most limiting physics data.

An examination of the CPCS and COLSS shows that no hardware or programming changes would be required to implement a PLCEA replacement; only the data values of individual system parameters would be required. These were identified by Westinghouse as part of Task 2.

An examination of the CEDMCS shows that only system wiring changes would be required to implement a PLCEA replacement. No additional wiring or other changes in the CEDMCS should be required. Westinghouse identified the impacted CEA subgroup-related interface signals of the CEDMCS and the specific wiring changes that would be needed as part of an implementation effort.

Westinghouse also identified some of the key tasks that are recommended for inclusion in a PLCEA replacement implementation. It is noted that if EOI still plans to complete such an effort in time for Cycle 12 (Spring, 2002), these tasks will need to be performed in parallel with the normal reload design processes.

CEA Insertion Limits

Prior to generating data for the scoping study, it was necessary to develop the Power Dependent Insertion Limits (PDIL curves) for the Regulating CEAs and for Bank P that would be assumed in the evaluations. During power operations, the current Waterford 3 PDIL curve (shown in Figure 10) allows for the sequential use of Banks 6, 5, and 4 as Regulating CEA groups, and also allows for the use of Bank P as an independent CEA group for maneuvering purposes.

The [

] "new" PDIL curves selected for use in the scoping study (shown in Figure 11) maintain the current ranges of allowable insertion for the Regulating CEA Groups and continue to permit the independent use of Bank P. Moreover, the PDIL curve developed for the new 4-FLCEA Bank P allows deeper insertions at higher powers than is permitted by the current PDIL.

Task 1

In Task 1 Westinghouse generated physics data using standard design methods (i.e., at nominal operating conditions) for the three potential CEA configurations, for each three Waterford 3 cycles.

The evaluations of Task 1 included:

- Physics evaluations, at nominal operating conditions, of:
  - CEA Bank Insertion data
  - Sequential CEA Bank Withdrawal data
- Preliminary physics evaluations of Single CEA Ejection data

The following cycles were selected for examination:

- Cycle 10 (92 Fresh Assemblies, EOC = 530 EFPD - see Figure 6)
- Cycle 11 (76 Fresh Assemblies, EOC = 524 EFPD - see Figure 7)
- Cycle 12 * (84 Fresh Assemblies, EOC = 505 EFPD - see Figure 8)

* As developed in the Waterford 3 Cycle 11 Final Core Design Report

Note: Quarter-core loading maps for these cycles are shown in Figure 9.

CEA Bank Insertion Data

The CEA Bank Insertion data evaluated in Task 1 included cycle maximum reactivity worth and planar peaking (F_{XY}) associated with the insertion of each of the Regulating CEA Banks in the core at hot full power conditions. Three times in each of the three cycles were surveyed as part of this evaluation, for each of the three potential CEA configurations. For comparison purposes, additional data associated with the original CEA configuration was generated for each cycle.

The reactivity worth data for the individual bank insertion cases is shown in Figure 12. It is observed that, for the reconfigured CEA patterns, the rodded cases with Bank P provide [ ] additional reactivity insertion relative the current CEA configuration. This is directly consistent with the higher worth of the four FLCEAs relative to the eight PLCEAs. It is also observed that the core reactivities for rodded configurations without Bank P are very similar to the original CEA configuration. The only notable differences are seen in the cases with Bank 4 inserted [ ]. These observations are directly consistent with the differences between each of the CEA configurations in which particular eight CEAs comprise Bank 4.

It is inferred from the above CEA Bank worth data that all three of the CEA Patterns would exhibit similar behavior in terms of their ability to control the core's axial power distribution. Furthermore, it is inferred that all three of the CEA Patterns would allow a greater degree of control over axial power distribution at Waterford 3 than is possible with the current PLCEAs.

The planar peaking (F_{XY}) data associated with the individual bank insertion cases are shown graphically in Figure 13. [ ] CEA Patterns A and B generally exhibit the highest peaking, especially for the heavily rodded conditions and CEA Pattern C generally has the lowest peaking. These results imply that CEA Pattern C will yield more available overpower margin than will CEA Patterns A or B.

The cycle-specific F_{XY} planar peaking data is also used in [ ] the [ ] integrated radial peaking (F_R) as a function of power parameter that is used in the transient analyses to model initial event conditions. [ ]

Figures 14 through 25, organized as cited below, show the individual F_{XY}'s for each bank configuration [ ].

CEA Pattern	Cycle 10	Cycle 11	Cycle 12
Original	Figure 14	Figure 15	Figure 16
Pattern A	Figure 17	Figure 18	Figure 19
Pattern B	Figure 20	Figure 21	Figure 22
Pattern C	Figure 23	Figure 24	Figure 25

[ ]

The F_R versus power synthesis results show that [ ] overpower margin trade-offs will be required [ ] or [ ], AOPM recovery efforts will be required. Based on an examination of these results, CEA Pattern C is judged to have the least severe impact on the F_R as a function of power data for Waterford 3.

Note also that the F_{XY} synthesis shown in the above Figures uses [ ] values of the hot channel axial power shapes, which must also be confirmed as being applicable to the current cycle. [ ] For isolated instances in which the hot channel axial power shapes can not be confirmed, the use of cycle specific axial shapes may provide a short term solution. However, [ ] a new axial shape analysis may be required in order to develop less bounding hot channel shapes. Based on an examination of these results, CEA Pattern C is judged to have the least severe impact on the distortion factor data for Waterford 3.

Based on an overall assessment of the above HFP CEA Bank Insertion data, CEA Pattern C is judged to be the preferred CEA configuration to examine in Task 2.

Sequential CEA Withdrawal Data

The CEA Withdrawal (CEAW) event was assessed in Task 1 by evaluating the changes in core reactivity (both absolute and differential) and the magnitude of peaking associated with the sequential withdrawal of the Regulating CEA Banks (along the PDIL) at both hot full power and hot zero power conditions. The BOC and EOC timepoints in each of the three cycles were surveyed as part of this evaluation, for each of the three potential CEA configurations. Furthermore, since Bank P can be independently inserted in the core relative to the Regulating CEA Groups, the impact of Bank P placement was also assessed.

For HFP conditions, Banks 6 and P may be inserted up to 28%, as shown in Figure 11. Data was therefore generated for the withdrawal of Bank 6 both with Bank P held at 28% insertion and with Bank P out of the core. The results are [ ] associated with [ ] the Reactivity Insertion Rate (RIR).

The CEAW results obtained at HFP conditions are shown in Figure 26. It is observed that there are small variations in reactivity insertion rate and in maximum F_Q with respect to time-in-cycle, Bank P position, CEA configuration, and core design. [ ]

From the standpoint of the HFP CEAW event, none of the results, or variations in the results, are "outstanding" enough to help narrow the selection of which potential CEA configuration to evaluate in Task 2 of the scoping study.

For HZP conditions, Figure 11 indicates that Bank 4 may be inserted up to 40%, and Banks 5, 6 and P may be fully inserted. Data was therefore generated for the withdrawal of Banks 4 and 5 along the PDIL with Bank 6 fully inserted. To investigate the impact of Bank P placement, data was generated with Bank P held at 100% insertion, at 50% insertion, and with Bank P out of the core. The results are [

] the RIR and the Maximum F_Q.

The CEAW results obtained at HZP conditions show larger variations than the HFP data with respect to time-in-cycle, Bank P position, CEA configuration, and core design. Since the end-of-cycle conditions yielded by far the more limiting results, this data is shown in Figures 27 and 28. All of the HZP RIRs are seen to be [ ], with the CEA Pattern A results being the least severe. Many of the maximum F_Q results are seen to [ ], with the CEA Pattern B results being the most severe.

Based on an overall assessment of the above CEA Withdrawal data, either CEA Pattern A or CEA Pattern C would be a viable candidate for the preferred CEA configuration to examine in Task 2.

Preliminary CEA Ejection Data

The CEA Ejection event was assessed in Task 1 by evaluating the changes in core reactivity and peaking associated with the ejection of one CEA from the core. [ ] As in the other Task 1 analyses, each of the three cycles were surveyed as part of this evaluation, for each of the three potential CEA configurations. For comparison purposes, additional data associated with the original CEA configuration was also generated for each cycle.

The CEA Ejection cases for HZP conditions are based upon having Banks 6, 5, 4, and P fully inserted, consistent with the PDIL curve shown in Figure 11 (Bank 4 may be inserted up to 40%, and Banks 5, 6 and P are permitted to be fully inserted). There is no need to assess the impact of Bank P placement on the CEA Ejection data since the most severe results will be obtained with Bank P fully inserted. The results are [ ] post-ejected F_Q as a function of ejected reactivity worth. [ ]

The CEA Ejection results for HZP conditions are shown in Figure 29 for Cycle 10, Figure 30 for Cycle 11, and Figure 31 for Cycle 12. It is observed that for CEA Patterns B and C the limiting ejected CEA is the Bank 4 CEA in [ ]. For the original CEA Pattern and for CEA Pattern A, the limiting ejected CEA is located [ ]. For Cycles 10 and 11, the original CEA pattern data bounds the reconfigured CEA Patterns, but for Cycle 12, CEA Patterns B and C are most limiting. [ ]

It is noted that for Banks 5 and 4 (whose use is associated with lower-power core conditions) CEA Patterns B and C are most limiting. For Banks 6 and P (whose use is associated with higher-power core conditions) CEA Pattern A is most limiting. Therefore, it may be inferred that at lower (i.e., $\leq$50%) powers the CEA Ejection analysis results would be less severe with CEA Pattern A. Conversely, at higher (i.e., $\geq$50%) powers the CEA Ejection analysis results would be less severe with CEA Patterns B or C. These conclusions would also be expected to apply to the results of the CEA Withdrawal within Deadband analysis results due to the similarities in the importance of CEA worth to that event.

From the standpoint of the HZP CEA Ejection event, none of these preliminary results, or variations in the results, are "outstanding" enough to help narrow the selection of which potential CEA configuration to evaluate in Task 2 of the scoping study.

Summary of Task 1

Based on the information developed in Task 1, all of the potential CEA configurations are judged to be feasible in terms of their ability to be successfully implemented for Waterford 3. However, the results of this effort suggest that CEA Pattern C is the best choice for the further evaluations of Task 2. This judgement is based on the following observations of the Task 1 analysis results:

- The CEA Bank insertion cases indicate that CEA Pattern C has the least severe impacts on reactivity worth and peaking data, including the F_R versus power parameter.

- The Sequential CEA withdrawal cases indicate that all three of the potential CEA configurations have acceptable HFP and HZP reactivity worth and insertion rate data (with CEA Pattern A being the least severe), and either CEA Pattern A or CEA Pattern C would have the least severe impacts on HZP peaking data.

- The preliminary HZP CEA Ejection cases indicate that all three of the potential CEA configurations have acceptable ejected reactivity worths as a function of peaking. The ejected reactivity worth results imply that, for the CEA Ejection and CEA Withdrawal within Deadband analyses, CEA Pattern A would yield better results at lower powers and, conversely, CEA Patterns B or C would yield better results at higher powers. Considering that the pin peaking data for the various CEA Bank insertion cases show that CEA Patterns A and B have notably higher peaking than CEA Pattern C, there is an overall indication that CEA Pattern C will have the least severe impact on the CEA Ejection and CEA Withdrawal within Deadband analyses.

Separately, it is noted that of the three potential CEA configurations, CEA Pattern C minimizes the potential impact on hardware-related swapping of CEAs between various Banks. While CEA Patterns A and B require changes to Banks 4, P, and A, CEA Pattern C only requires changes to Banks P and A.

Task 2

With the concurrence of EOI, CEA Pattern C (shown in Figure 4) was selected for as the basis for the subsequent "Task 2" evaluations of the PLCEA replacement scoping study.

The scope of Task 2 included:

- Generating physics data for:
  - Single CEA Drop
  - Single CEA Withdrawal within Deadband
  - Single CEA Ejection
- Assessments of the above physics data from a transient analysis perspective to determine the impact of the PLCEA replacement on the associated Analyses of Record (AORs) that form the basis of the Waterford 3 Reload process.
- Examinations of the Core Protection Calculator System (CPCS) software and the reload data block to identify impacted parameters and other significant changes that may be required.
- Examinations of the Core Operating Limit Supervisory System (COLSS), including the applicability of the current overall uncertainty analysis (OUA) case set, to identify significant changes that may be required.
- Examinations of the Control Element Drive Mechanism Control System (CEDMCS) to identify the impacted CEA subgroup interface signals and to identify significant changes to system logic and interfacing, cabinetry, and wiring.

Physics and Transient Analysis Assessments of PLCEA Replacement Pattern "C"

Building on the work of Task 1, Westinghouse generated detailed physics data for some of the most limiting reload transient analyses for Waterford 3. This physics data generated in Task 2 is based on the implementation of CEA Pattern C in Cycle 12 (as developed in the Waterford 3 Cycle 11 Final Core Design Report). Cycle 12 was specifically selected because its design is expected to provide the best available estimate of the core conditions under which a PLCEA replacement would occur. The fuel management pattern for Cycle 12 is shown in Figure 8.

The generation of the Task 2 physics data and the assessments of impact on the Waterford 3 transient analyses are presented together, for each of the three AORs, in the following sections:

Single CEA Drop Data

The Single CEA Drop event considers the impact of an inadvertent drop of a single CEA into the core. [

] Various initial rodded states of the core are considered, including ARO, Bank 6, Bank P, or Banks 6+P inserted conditions. The maximum change in F_R, also referred to as the Distortion Factor[ ].

For Task 2, the combinations of overall bank insertions and candidate 'dropped' CEAs were modified to account for the implementation of Pattern C as part of a PLCEA replacement. The single CEA Drop physics data obtained for Waterford 3 Cycle 12 [ ] is seen to be very similar to the results obtained for Waterford 3 Cycle 11, as shown in the following Table:

	Maximum CEA Drop Distortion Factor Results			
	Cycle 11		**Cycle 12**	
Parameter	**BOC**	**EOC**	**BOC**	**EOC**
[ ]	[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]	[ ]

The above data are consistent with the expectation that the main impact of the PLCEA replacement on this event – changing the initial complement of CEAs present in the core prior to a single CEA drop – would have only a minor impact on dropped CEA reactivity worths and distortion factors. The variations in the distortion factor results are judged to be typical of that seen on a cycle-to-cycle basis due to changes in fuel management.

Based on this data, Westinghouse concludes that the PLCEA replacement would have little impact on the Single CEA Drop event at Waterford 3 and therefore the current AOR would not require changes in order to accommodate a PLCEA replacement.

Single CEA Withdrawal within Deadband Data

The Single CEA Withdrawal within Deadband (SCEAW) event considers the impact of an inadvertent withdrawal of a single CEA over the maximum change in position that could occur. This distance, referred to as the "deadband size", is [ ] for Waterford 3.

[ ] The most limiting combinations of overall bank insertion and initial and final CEA position are employed in the analysis.

For Task 2, the combinations of overall bank insertion and initial and final CEA position were expanded to account for the implementation of Pattern C (and the new Bank P PDIL shown in Figure 4) as part of a PLCEA replacement. This means that, generally, more and/or stronger CEAs will be present in the core prior to the single CEA withdrawal.

The maximum SCEAW reactivity insertion data obtained for Waterford 3 Cycle 12 are presented in the following Table, along with the [ ] SCEAW rod worth results obtained for Waterford 3 Cycle 11 [ ]:

		Calculated Rod Worths (%Δρ)				
	Power Level	Cycle 11 *		Cycle 12 *		[ ]
COLSS In Service	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CEACs Out of Service	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

* Indicates whether the calculated rod worth is [ ]

[ ] the rod worths [

] with the CEACs out-of-service condition[ ] are [ ] based only on withdrawals of a Bank 6 CEA along the deadband[
] not due to the PLCEA replacement but instead [ ] from the behavior of the fuel management pattern.

The SCEAW maximum ROPM data obtained for Cycle 12 with Pattern C are presented in the following Table, along with the [
] results obtained for Waterford 3 Cycle 11 [ ]:

	Power Level	Calculated ROPM (%) Cycle 11 *	Cycle 12 *	[ ]
COLSS In Service	[ ]	[ ] [ ]	[ ] [ ]	[ ]
	[ ]	[ ] [ ]	[ ] [ ]	[ ]
	[ ]	[ ] [ ]	[ ] [ ]	[ ]
	[ ]	[ ] [ ]	[ ] [ ]	[ ]
CEACs Out of Service	[ ]	[ ] [ ]	[ ] [ ]	[ ]
	[ ]	[ ] [ ]	[ ] [ ]	[ ]
	[ ]	[ ] [ ]	[ ] [ ]	[ ]
	[ ]	[ ] [ ]	[ ] [ ]	[ ]

* Indicates whether the calculated ROPM is [ ]

It is seen that the [

]
small variation in SCEAW ROPMs between Cycle 11 and Cycle 12 is typical of magnitude of variation associated with cycle-to-cycle changes in fuel management. These observations imply that the Cycle 12 ROPM results are more impacted by the nature of the fuel management pattern than by the PLCEA replacement.

Westinghouse concludes that current Waterford 3 SCEAW AOR should not require changes in order to accommodate a PLCEA replacement. Any cycle-specific SCEAW results [ ] can, as is the current practice, be resolved on a case-by-case basis. It should be noted that such cycle-specific resolutions may result in the need for COLR changes or setpoint changes.

Single CEA Ejection Data

The Single CEA Ejection event considers the impact of an inadvertent ejection (complete withdrawal) of a single CEA from the core. [

]

The following parameters are calculated[1]:

CEA Ejection Analysis Parameter	Parameter used in:	Physics Data Calculated at:
Minimum ejected (N-2) scram worths	Evaluating those CEA ejections which result in a VOPT trip.	[ ]
Maximum excore decalibration uncertainties	Representing the difference between the minimum excore power and the average excore power at the trip.	[ ]
Max. 3D peaking factor (F_Q) vs. reactivity worth of the ejected CEA	Computing the maximum energy deposited in a fuel rod for those CEA ejections that result in a VOPT trip.	[ ]

For Task 2, the combinations of overall bank insertion and initial and final CEA position were expanded to account for the implementation of Pattern C (and the new Bank P PDIL shown in Figure 4) as part of a PLCEA replacement. This means that, generally, more and/or stronger CEAs will be present in the core prior to the single CEA ejection. [
]

The ejected scram worth results obtained for Waterford 3 Cycle 12 with CEA Pattern C are [ ] very similar to the results obtained for Waterford 3 Cycle 11, as shown in the following table:

Case	Ejected Scram Worths (%Δρ)		
	Cycle 11 Current PLCEAs in Current Configuration	Cycle 12 PLCEA Replacement Pattern C Configuration	[ ]
[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]

1 Note that a determination of maximum total fuel failure, while also a part of the Waterford 3 CEA Ejection analysis, was not performed herein since the calculation of that parameter requires detailed transient analysis evaluations that were outside of the scope of this study.

The improvements in the ejected scram worth data for Cycle 12 are consistent with the expectation that the PLCEA replacement would increase ejected scram worths due to the additional reactivity hold down of the eight new FLCEAs.

The maximum excore decalibration uncertainty results obtained for Waterford 3 Cycle 12 with Pattern C [ ] very similar to the results obtained for Waterford 3 Cycle 11, as shown in the following Table:

Power Level	Maximum Excore Decalibration Uncertainty Cycle 11 * Current PLCEAs in Current Configuration		Cycle 12 * PLCEA Replacement Pattern C Configuration		[ ]
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

* Indicates whether the calculated Decalibration is [ ]

[ ]

For the [ ] maximum excore decalibration uncertainty data, the small increases for Cycle 12 relative to Cycle 11 are judged to be due to a combination of the fuel management differences between the two cycles and the effects of the PLCEA reconfiguration. For this parameter, the impact of the PLCEA replacement on the Single CEA Ejection AOR is judged to be small.

The F_Q versus ejected worth data obtained for Waterford 3 Cycle 12 with CEA Pattern C are presented in Figures 32 through 36 [ ]. For comparison purposes, the corresponding results obtained for Waterford 3 Cycle 11 are also presented on those Figures.

It is seen that Cycle 12 (with CEA Pattern C) exhibits higher F_Q versus ejected worth data than was obtained for Cycle 11. [ ] The most limiting results at [ ] are associated with the ejection of the outer Bank 4 CEA.

The above available data does not readily indicate whether these increases are due to differences between the Cycle 11 and Cycle 12 fuel management patterns or whether they are due to the impact of the PLCEA reconfiguration. Therefore, while outside of the scope of this analysis, additional F_Q versus ejected worth data was generated for Cycle 12 with the *current* CEA configuration (i.e., no PLCEA replacement). These results are shown in Figure 37 together with the Cycle 11 data and with the Cycle 12 results that reflect the PLCEA replacement.

Figure 37 shows that the F_Q versus ejected worth [ ] for Cycle 12 at [ ] *without* PLCEA replacement [ ] limiting data is also associated with the ejection of the outer Bank 4 CEA. It may therefore be concluded that the behavior of the Cycle 12 fuel management pattern has a strong influence on the F_Q versus ejected worth data. The PLCEA replacement of Pattern C is only a contributing factor to these overall results.

The above Single CEA Ejection data indicates that the Cycle 12 design evaluated in this study will be problematic at [ ] due to high F_Q versus ejected worth data resulting from the ejection of the outer Bank 4 CEA. Furthermore, since a fuel failure evaluation was not performed as part of this study, the impact (if any) of the PLCEA replacement on this parameter is not known.

[ ] the current AOR for Single CEA Ejection [ ] F_Q versus ejected worth [ ] preserve the current docketed results, it is unlikely that additional margin could be developed [ ]. Westinghouse has identified two approaches for addressing this issue: 1) revise the AOR, or 2) remove Bank 4 from the PDIL.

A revision to the fuel failure evaluation portion of the Single CEA Ejection AOR (to verify higher calculated fuel failures) would incorporate calculations based upon centerline melt criteria. With increased fuel failures the analysis would need to be submitted to the NRC for their review and approval. EOI would need to re-perform the associated dose calculations, ideally to provide back calculated fuel failure limits at the dose criteria. [ ]

In lieu of developing a detailed plan to improve the AOR for Single CEA Ejection, one potential remedy would be to remove Bank 4 from the PDIL for Cycle 12. This would eliminate the need to evaluate the most limiting single CEA ejection cases [ ]. Westinghouse understands that EOI might consider this approach to be relatively benign given the current usage of Bank 4 at Waterford 3. This approach would also allow for subsequent reevaluation of the presence of Bank 4 in the PDIL in later cycles.

Examinations of CPCS and COLSS

The Core Operating Limit Supervisory System (COLSS) is a digital computer based on-line monitoring system. As such, COLSS does not activate any safety equipment, initiate any automatic actions, or provide any direct input to safety systems. Instead, COLSS uses input from selected sensors to determine the plant condition, and provides information to aid the operator in complying with the Technical Specifications operating limits on total core power, peak Linear heat Rate, Departure from Nucleate Boiling Ratio (DNBR), and Axial Shape Index. COLSS also provides audible alarms and visual CRT messages are provided to alert the operator when an operating limit is exceeded.

The Core Protection Calculator System (CPCS) is an on-line digital computer system that is part of the Plant Protection System (PPS). As such, it not only provides indications of the various system inputs to the operator, it is designed to provide reactor trip signals to the PPS under certain criteria. The CPCS calculates the local power density (LPD) and DNBR based on core average power, reactor coolant system (RCS) pressure, RCS inlet temperature, RCS flow, and the core power distribution. The CPCS will provide a trip signal if the calculated DNBR falls below the safety limit or if the calculated LPD exceeds the safety limit for peak linear heat rate.

For Task 2, Westinghouse investigated whether there would be functional design impacts to the CPCS and COLSS due to the PLCEA replacement. In addition, the software-related database parameters of these systems were examined and required changes were identified. Finally, Westinghouse identified other Waterford 3 setpoint analysis and plant computer issues that should be addressed as part of a PLCEA replacement effort. These items are discussed below:

Functional Designs of the CPCS and COLSS

The following key characteristics are required to ensure that the current functional designs of CPCS and COLSS are preserved:

- [ ]
- [ ]
- [ ]
- [ ]

For Waterford 3, the replacement of PLCEAs by FLCEAs and the reconfiguration of the CEA groups into Pattern C will comply with these limits. The total number of CEA groups and subgroups will remain the same. With Pattern C, Subgroup [ ] (currently in Shutdown Bank A) will be reassigned to Bank P and Subgroups [ ] (which currently comprise to Part Length Groups) will be reassigned to be part of Shutdown Bank A. Therefore, Westinghouse expects that there will be no need to modify the CPCS or COLSS functional designs.

CPCS Database Constants

There are a number of CPCS database constants and arrays that need modification in whole or in part to accommodate the change in Bank P from an eight PLCEA group to a four FLCEA group (with the associated changes to other CEA groups to incorporate the released CEAs). The set of constants and arrays whose values may need to be modified is independent of the specific choice of which CEAs will be in Bank P (as well as the configuration of the other CEA groups). However, the values to be provided for these constants and arrays will be specific to the selected PLCEA Replacement pattern.

All of the constants and arrays affected by the PLR Replacement are part of the CPCS Reload Data Block (RDB). Note that modifications of RDB values are not considered to be a "software change" that would require at least partial phase I/II testing and (possibly) licensing submittals.

The following CPCS constants and arrays will require modification:

- The **KINDEX** array in POWER lists the CEA subgroup (target CEA) indices for transferring the CEA position signals to the correct subgroup within the CPCS. These values are ordered consistent with the CEA group structure defined in the NUMGRP array.

  In order to implement the PLCEA Replacement, the values within this array must be modified to be consistent with the revised CEA configuration.

- The **NUMGRP** array in POWER lists the number of subgroups in each of the Regulating groups, the Bank P group(s), and the Shutdown groups.

  In order to implement the PLCEA Replacement, the values within this array must be modified to be consistent with the revised CEA configuration (i.e., one additional subgroup for Bank A and one fewer subgroup for Bank P).

- The **PLROD** constant in POWER specifies the length of the active region of the PLCEAs.

  In order to implement the PLCEA Replacement, the value of this constant must be increased to 100% of core height. The CPCS will then treat the replacement Bank P CEAs as "full length PLCEAs" with position limits separate from the Regulating CEAs.

- The **B4C** constant in POWER specifies the length of the boron carbide filler in the current PLCEA design.

  In order to implement the PLCEA Replacement, the value of this constant must be reset to zero (since the new Bank P CEAs will not have a boron carbide "filler" section).

- The **PPLR** constant in POWER specifies the penalty multiplier on power to be applied when the boron carbide filler in the current PLCEA design.

  In order to implement the PLCEA Replacement, the value of this constant must be reset to one (signifying no penalty), since the new Bank P CEAs will not have a boron carbide "filler" section.

- The **PLRCMI** constant in POWER specifies the PLCEA position below which the CPCS will set the CEA Motion Inhibit (CMI) flag.

  In order to implement the PLCEA Replacement, the value of this constant must be modified to either reflect the newly-developed PDIL for Bank P or to disable setting the CMI based on Bank P position.

- The **CONTAB** array in CEAC lists the CEA indices for transferring the CEA position signals to the correct array locations within CEAC. These values are ordered so as to be consistent with the CEA group and subgroup structure defined in the POINT array.

  In order to implement the PLCEA Replacement, the values within this array must be modified to be consistent with the revised CEA configuration.

- The **POINT** array in CEAC lists the number of groups, the number of subgroups per group, and the number of CEAs per subgroup in a predefined order.

  In order to implement the PLCEA Replacement, the values within this array must be modified to be consistent with the revised CEA configuration (i.e., one additional subgroup for Bank A, one fewer subgroup for Bank P, and revised subgroup assignments for Banks A and P).

- The **SGTAB** array in CEAC relates lists the indices used to define subgroups within the CEA groups.

  In order to implement the PLCEA Replacement, the values within this array must be modified to be consistent with the revised CEA configuration.

In addition, some constants and arrays have values that depend on various aspects of core behavior and therefore may be impacted by the PLCEA Replacement. The parameters listed below represent the CPCS Database constants and arrays that Westinghouse recommends be evaluated as part of a PLCEA Replacement implementation effort:

- The **PFPRD** and **PFPRL** constants in UPDATE provide DNBR and LPD penalty factors when the CPCS is set to the CEAC Inoperable mode. It may be necessary to modify the values of these constants to accommodate changes in the severity of CEA related events due to the modified CEA configuration.

- The **SLOPEM**, **BINTER**, and **DEVMAX** arrays in POWER provide subgroup deviation penalty factors as a function of deviation sized for each of the subgroups. It may be necessary to modify the values within these arrays to accommodate changes in the sensitivity of the subgroup deviation penalty factors in the modified CEA configuration. Any CEA groups that are modified to have only a single subgroup (such as the new Bank P) will not require a subgroup deviation penalty and may have the penalty factors nullified by modifying the constant values.

- The **GL** array in POWER provides the fixed CEA positions to be used when the CPCS is set to the CEAC Inoperable mode. The effects of the modified CEA configuration need to be evaluated in order to decide whether the current values within this array are appropriate.

- The **FCS** and **FPR** arrays in POWER provide the basic CEA shadowing factor (FCS) and radial peaking factor (FPR) values for various combinations of Regulating group, Bank P, and Shutdown group insertion. Westinghouse has identified two possible approaches for addressing these arrays as part of the PLCEA Replacement implementation:

    - Selected array values could be replaced by analytical values more appropriate for the modified CEA configuration at the implementation of the PLCEA Replacement. For future cycles, the values of the ASM and ARM addressable constants would be adjusted on a cycle-specific basis to address the changes in asbuilt radial peaking and CEA shadowing factors; this approach is consistent with the current reload practice.

    - The current array values could be retained if appropriate cycle by cycle values of the ASM and ARM addressable constants are developed to represent not only the asbuilt radial peaking and CEA shadowing factors (as is the current reload practice) but also to account for the effects of the modified CEA configuration.

COLSS Database Constants

There are a number of COLSS database constants and arrays that need modification in whole or in part to accommodate the change in Bank P from an eight PLCEA group to a four FLCEA group (with the associated changes to other CEA groups to incorporate the released CEAs). The set of constants and arrays whose values may need to be modified is independent of the specific choice of which CEAs will be in Bank P (as well as the configuration of the other CEA groups). However, the values to be provided for these constants and arrays will be specific to the selected PLCEA Replacement pattern.

The following COLSS constants and arrays will require modification:

- The **HPLR** constant in Block K and the **N02** constant in Block L both specify the length of the active region of the PLCEAs.

  In order to implement the PLCEA Replacement, the value of these constants must be increased to the full core height value of 150 inches. COLSS will then treat the replacement Bank P CEAs as "full length PLCEAs" with position limits separate from the Regulating CEAs.

- The **AB1** and **INDEX** arrays in Block L provide radial peaking factor values (AB1) and indices (INDEX) to locate values for various combinations of Regulating group, Bank P, and Shutdown group insertion.

  In order to implement the PLCEA Replacement, the values within these arrays must be modified to be consistent with the revised CEA configuration.

In addition, the **CDEV0**, **CDEV1**, and **CDEV2** arrays in Block L (which provide deviation penalty factors as a function of deviation sized for each of the groups) may be impacted by the PLCEA Replacement. Since the values within these arrays are related to the sensitivity of the group deviation penalty factors, Westinghouse recommends that an evaluation of these COLSS Database parameters be included in a PLCEA Replacement implementation effort.

Other Analysis and Plant Computer Considerations

COLSS does not directly read CEA position sensor data to determine CEA group positions. Instead it receives group position and group deviation information from other software operating on the plant monitoring computer(s). This software must be modified so as to be consistent with the subgroup reassignments associated with the PLCEA replacement to assure that COLSS receives the correct CEA group data.

The Waterford 3 Master Setpoint Analysis (MSA) [

] evaluate various addressable constants and parameter limits. The following considerations are noted:

- [

]

- [

]

The Waterford 3 COLSS Out of Service (COOS) analysis [

] is expected to be cycle independent[

] Westinghouse recommends that these [ ] be reviewed with respect to the combined effect of CEA configuration changes and cycle-to-cycle changes as part of a PLCEA replacement implementation effort.

Examination of CEDMCS

The Control Element Drive Mechanism Control System (CEDMCS) controls the direction, rate, and duration of control rod motion in the reactor core. The CEDMCS is comprised of an operator's panel (from which the system is controlled) and cabinets (located remotely from the operator's panel) from which the control logic and power switching functions are performed.

An inherent design feature of the CEDMCS is that its control over the 91 CEAs in the Waterford core is based on *subgroups* of CEAs. The subgroups are symmetrical about the center of the reactor core, with the exception [ ]. The center CEA [ ] is capable of being assigned to any one of the subgroups and is currently assigned to subgroup [ ]. The CEDMCS CEA rod and subgroup assignments for Waterford 3 are shown in Figure 38.

The Waterford 3 CEDMCS has the flexibility to accommodate a maximum of [ ] control groups. These control groups may be comprised of a maximum of [ ] shutdown control groups, [ ] Regulating control groups and [ ] Part Length control groups. The maximum numbers of subgroups that may be assigned to each of the control group types are limited as follows:

- [ ]
- [ ]
- [ ]

For Waterford 3, the replacement of PLCEAs by FLCEAs and the reconfiguration of the CEA groups into Pattern C will comply with these limits. The total number of CEA groups and subgroups will remain the same. With Pattern C, Subgroup [ ] (currently in Shutdown Bank A) will be reassigned to Bank P and Subgroups [ ] (which currently comprise the Part Length Groups) will be reassigned to be part of Shutdown Bank A. These subgroups are highlighted in Figure 38.

The design of the Waterford 3 CEDMCS implements the various subgroup-to-group assignments via the system wiring. This allows many types of CEA-related changes to be made with a minimum impact on system availability. These changes include adding (or removing) subgroups from any particular control group, and subgroup-to-control group reassignments (i.e., interchanging subgroups between control groups). In general, such changes require rearrangements of jumper wires, connectors and identification labels within the system, as opposed to requiring any additional external or internal wiring.

Westinghouse has identified the following types of hardware and wiring changes as being required to implement the PLCEA replacement at Waterford 3:

- Modal Control Signals
- Timer Enable Signals
- Sub-group Raise/Lower Signals
- CEA Motion Interlocks
- Operator's Control Panel Indicators

These changes are discussed in more detail below:

Modal Control Signals

The CEDMCS provides for control of CEA/PLCEA motion in five distinct modes of control. These modes are Automatic Sequential, Manual Sequential, Manual Group, Manual Individual, and Off. The CEDMCS system logic requires that if subgroup reassignments are being made, the operational signals associated with each of the five modes of control must also be reassigned. In order to implement the PLCEA replacement, the signals associated with each mode of control must be reassigned to make the system wiring conform with new subgroup-to-group assignments. These reassignments involve moving / adding jumpers in cabinet [ ].

Timer Enable Signals

The CEDMCS uses Timer Enable signals in conjunction with Mode Control signals and CEA or Subgroup Selection commands to initiate motion of a single PLCEA/CEA in the Manual Individual mode, or to initiate motion of all CEAs in a subgroup in the Manual Group, Manual Sequential or Automatic Sequential modes. In order to implement the PLCEA replacement, the Timer Enable signals must be reassigned to make the system wiring conform with new subgroup-to-group assignments. These reassignments involve moving / adding jumpers in cabinet [ ].

Sub-group Raise/Lower Signals

In the CEDMCS, the CEA Group raise/lower signals are output from the Common Logic Housing and are converted to Subgroup Raise/Lower signals by virtue of the system wiring. The Raise/Lower signals are sent to the Control Panel to illuminate motion indicators and to provide the subgroup logic motion commands. In order to implement the PLCEA replacement, both of these types of Subgroup Raise/Lower signals must be reassigned to make the system wiring conform with new subgroup-to-group assignments. These reassignments involve moving / adding jumpers in cabinet [ ].

CEA Motion Interlocks

Most of the motion interlock functions of CEDMCS will be impacted by the subgroup-to-group reassignments associated with the PLCEA replacement. These interlock functions include:

- Automatic Withdrawal Prohibit (AWP)

  This interlock prohibits the withdrawal of all Regulating CEAs in Automatic Sequential mode.

- Automatic Motion Inhibit (AMI)

  This interlock prohibits both the withdrawal and insertion of all Regulating CEAs in Automatic Sequential mode.

- CEA Withdrawal Prohibit (CWP)

  This interlock prohibits the withdrawal of all Regulating and Shutdown CEAs in all modes of control except Manual Individual regardless of any demand for motion.

- Upper and Lower Group Stops (UGS and LGS)

  These interlocks prohibit the withdrawal/insertion of the affected group's CEAs in the Automatic Sequential, Manual Sequential and Manual Group modes of control.

- Upper and Lower CEA Limits (UCL and LCL)

  The Waterford 3 plant computer provides these motion interlock signals to the CEDMCS for each CEA in the Part Length Group(s). If the UCL and/or LCL signals indicate that any CEA in the Part Length Group(s) has reached those limits, the CEDMCS will inhibit Part Length motion as follows:

  - In the Manual Individual Mode of control, CEDMCS will prohibit the movement of only the affected PLCEA.
  - In the Manual Group and Automatic Sequential Modes of control, CEDMCS will prohibit movement of the entire subgroup containing the affected PLCEA.

The design of CEDMCS in processing these CEA Motion Interlock signals is flexible enough to allow any subgroup of CEAs to be assigned to the Part Length Group(s). In order to implement the PLCEA replacement, each of the above Interlock signals must be reassigned to make the system wiring conform with new subgroup-to-group assignments. These reassignments involve moving / adding jumpers in cabinets [ ].

Operator's Control Panel Indicators

As mentioned above, the CEDMCS includes an operator's panel from which the system is controlled. There are three categories of wiring in the operator's panel that will be impacted by the PLCEA replacement effort:

- Group indicator selection and column assignment, which provides adding to, or subtracting from, the total number of indicator columns assigned to each group.
- Indicator I/O signals, including (automatic) group selection, subgroup motion and electrical limit indication.
- Subgroup CEA indicator selection, which controls the status of the individual CEA indicators (CEA select section only) assigned to each subgroup.

Each of the above items will require appropriate wiring changes in the CEDMCS operator's panel to make the system wiring conform with new subgroup-to-group assignments.

In summary, Westinghouse believes that the impact on the Waterford 3 CEDMCS due to the PLCEA replacement will be limited to the wiring reassignments and hardware changes discussed above. As previously discussed, the selection of "Pattern C" for examination in this scoping study helps to minimize this impact because all CEAs remain in their current subgroups and subgroup-to-group reassignments are limited to Group A and Group P. No additional wiring or other changes in the CEDMCS internal or external wiring have been identified.

Summary of Task 2

The following observations of the Task 2 results are noted:

- The physics data for Single CEA Drop shows that there would be little impact due to the PLCEA replacement and that the current Waterford 3 Single CEA Drop AOR would not require changes.
- The physics data for Single CEA Withdrawal within Deadband shows that the impact of PLCEA replacement is typical to that associated with cycle-to-cycle changes in fuel management. The current Waterford 3 SCEAW AOR should therefore not require changes in order to accommodate a PLCEA replacement.
- The physics data for Single CEA Ejection shows improvements in the ejected scram worth, and small variations in the maximum excore decalibration uncertainty data. The F_Q versus ejected worth data [ ] become even more limiting when PLCEA replacement is considered. An evaluation of projected fuel failure levels was not performed.

  Since the current Waterford 3 Single CEA Ejection AOR was performed to the current docketed results, this analysis may need to be revisited in Cycle 12. One approach would be to revisit and improve the AOR for resubmittal to the NRC. Alternatively, consideration could be given to removing Bank 4 from the PDIL, at least for Cycle 12, thus eliminating the most limiting ejection cases.
- An examination of the CPCS software shows that only reload data block changes would be required to implement a PLCEA replacement; no hardware or programming changes were identified. Westinghouse identified the impacted CPCS parameters, as well as other system changes that may be required.
- An examination of the COLSS shows that no hardware or programming changes would be required to implement a PLCEA replacement. Westinghouse identified the impacted COLSS parameters and other changes that may be required, and recommended that the applicability of the current overall uncertainty analysis (OUA) case set be investigated.
- An examination of the CEDMCS shows that only system wiring changes would be required to implement a PLCEA replacement because all CEAs remain in their current subgroups and subgroup-to-group reassignments are limited. No additional wiring or other changes in the CEDMCS internal or external wiring should be required. Westinghouse also identified specific wiring changes for the various CEA subgroup-related interface signals of the CEDMCS.

Based on the information developed in Task 2, Westinghouse concludes that it would be feasible to adopt CEA Pattern C as part of a PLCEA implementation for Cycle 12 at Waterford 3.

Overall Assessment of PLCEA Replacement at Waterford 3

The evaluations of this scoping study provide an indication of some of the key tasks that should be part of a PLCEA replacement implementation effort. These tasks include:

- [ ]
    - [ ]
    - [ ]
    - [ ]
- Review the final core design selected for Cycle 12 to confirm the applicability of the conclusions of the scoping study.
- Review physics and transient analyses not included in the scoping study to assess the impact of the PLCEA replacement (e.g., Subcritical CEA Withdrawal, Axial Shape Analysis).
- Consider the feasibility of removing Bank 4 from the PDIL as a means of improving the Single CEA Ejection results obtained in the Scoping Study.
- Incorporate changes resulting from the removal of PLCEAs into the Waterford 3 Transient Analysis AORs and CCLs as appropriate.
- Develop and implement the CPCS and COLSS database parameter changes identified in the scoping study. Consider the other CPCS and COLSS evaluations (e.g., revisiting the MSA) identified in the scoping study.
- Develop (and prepare to put into operation) written procedures required to implement the CEDMCS wiring changes identified in the scoping study.

It is noted that if EOI still plans to complete such an effort in time for Cycle 12 (Spring, 2002), these tasks will need to be performed in parallel with the normal reload design processes.

Figure 1: Waterford 3 Full Core CEA Locations with Current PLCEAs Highlighted

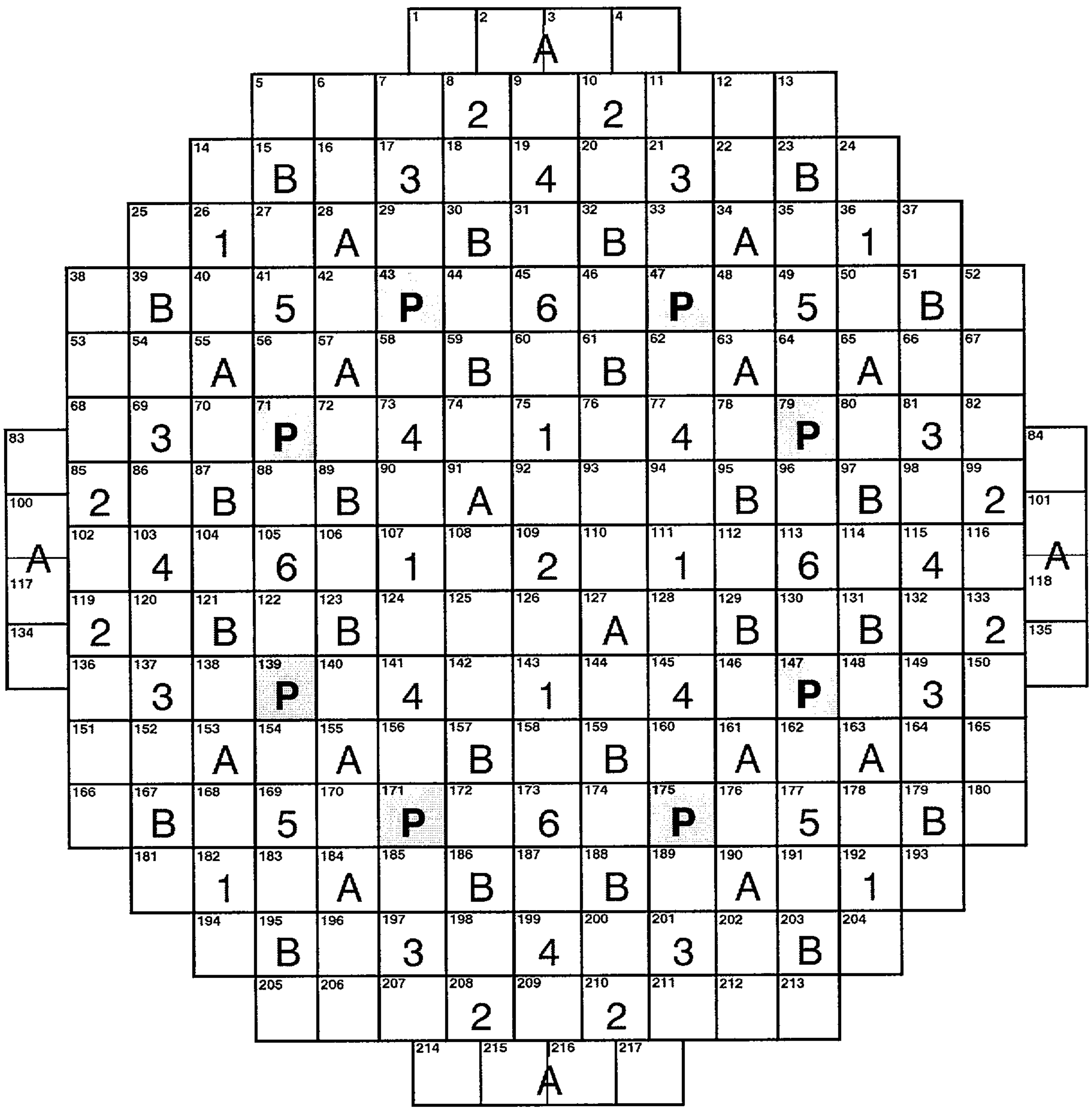


Figure 2: Potential CEA Bank Reconfiguration "Pattern A"

Bank P ... Comprised of the four FLCEAs currently in the outer subgroup of Bank 4.

Bank 4 ... Comprised of the eight CEAs of the current Bank P (replaced with FLCEAs).

Bank A ... Augmented with the four FLCEAs currently in the inner subgroup of Bank 4.

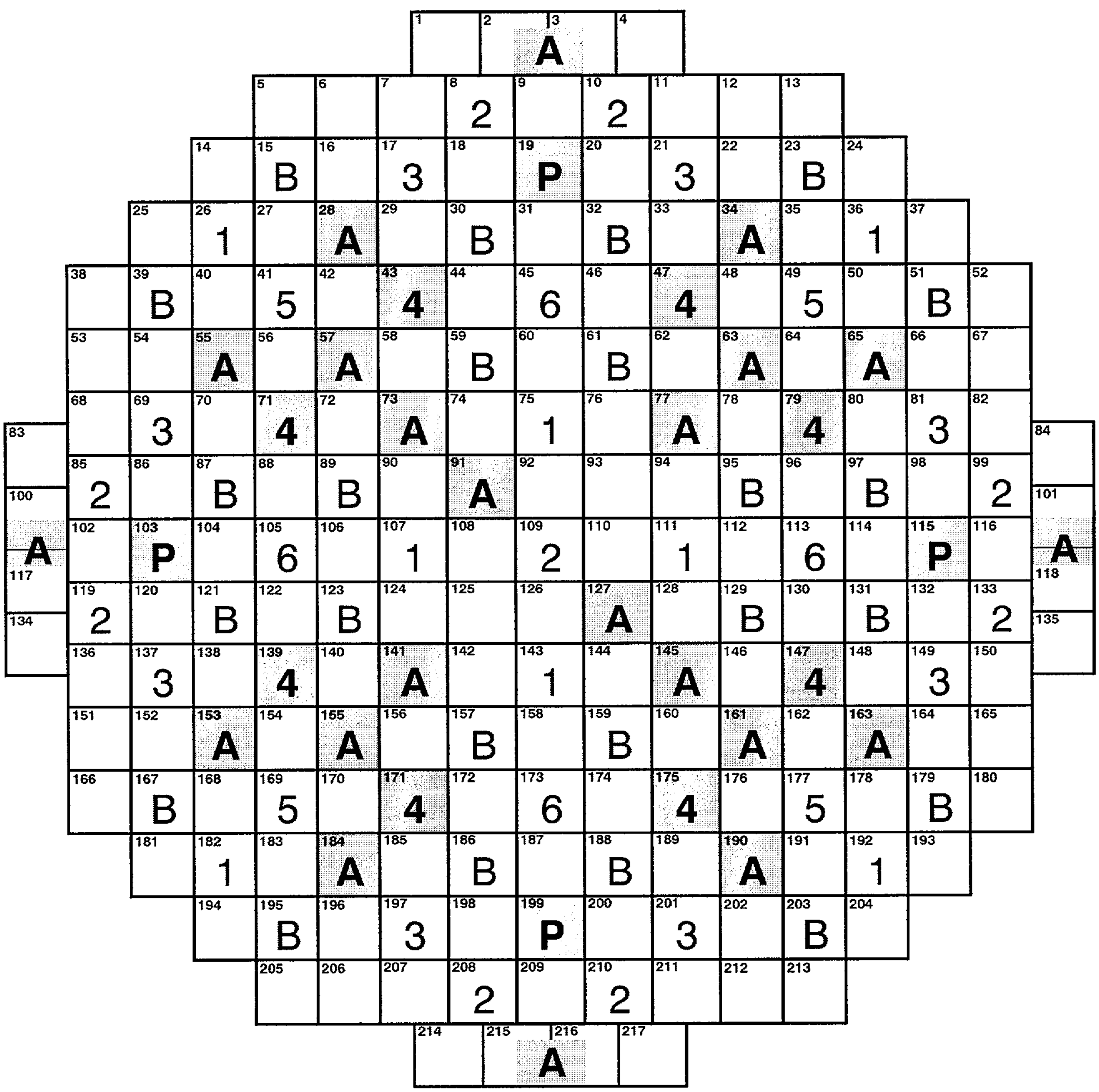


Figure 3: Potential CEA Bank Reconfiguration "Pattern B"

Bank P ... Comprised of the four FLCEAs currently in the inner subgroup of Bank 4.

Bank 4 ... Comprised of the four FLCEAs currently in the outer subgroup of Bank 4 plus the four FLCEAs currently in the main diagonal subgroup of Bank A.

Bank A ... Augmented with the eight CEAs currently in Bank P (replaced with FLCEAs), and with the four main diagonal FLCEAs mentioned above removed.

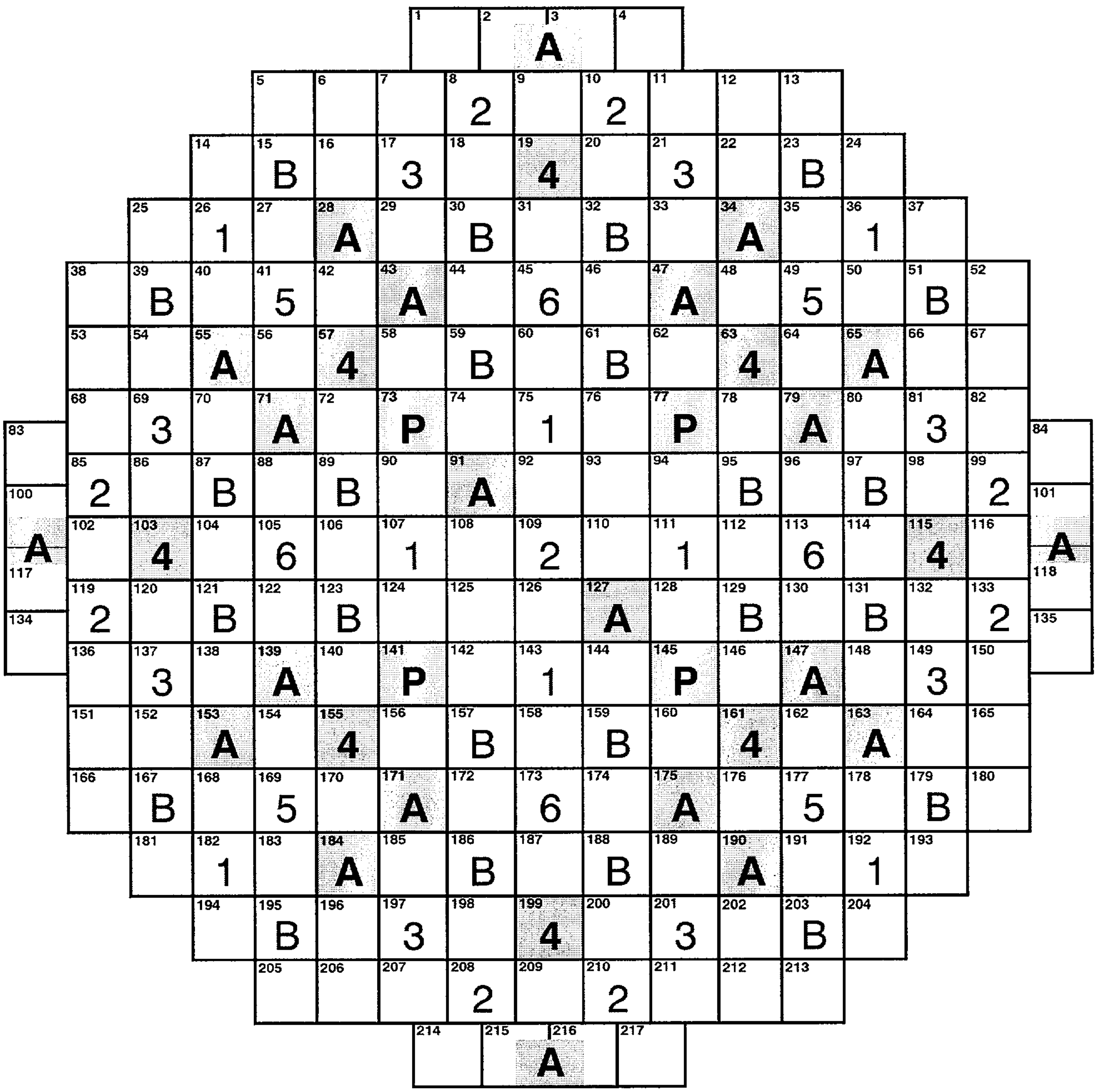


Figure 4: Potential CEA Bank Reconfiguration "Pattern C"

Bank P ... Comprised of the four FLCEAs currently in the main diagonal subgroup of Bank A.

Bank 4 ... Unchanged.

Bank A ... Augmented with the eight CEAs currently in Bank P (replaced with FLCEAs), and with the four main diagonal FLCEAs mentioned above removed.

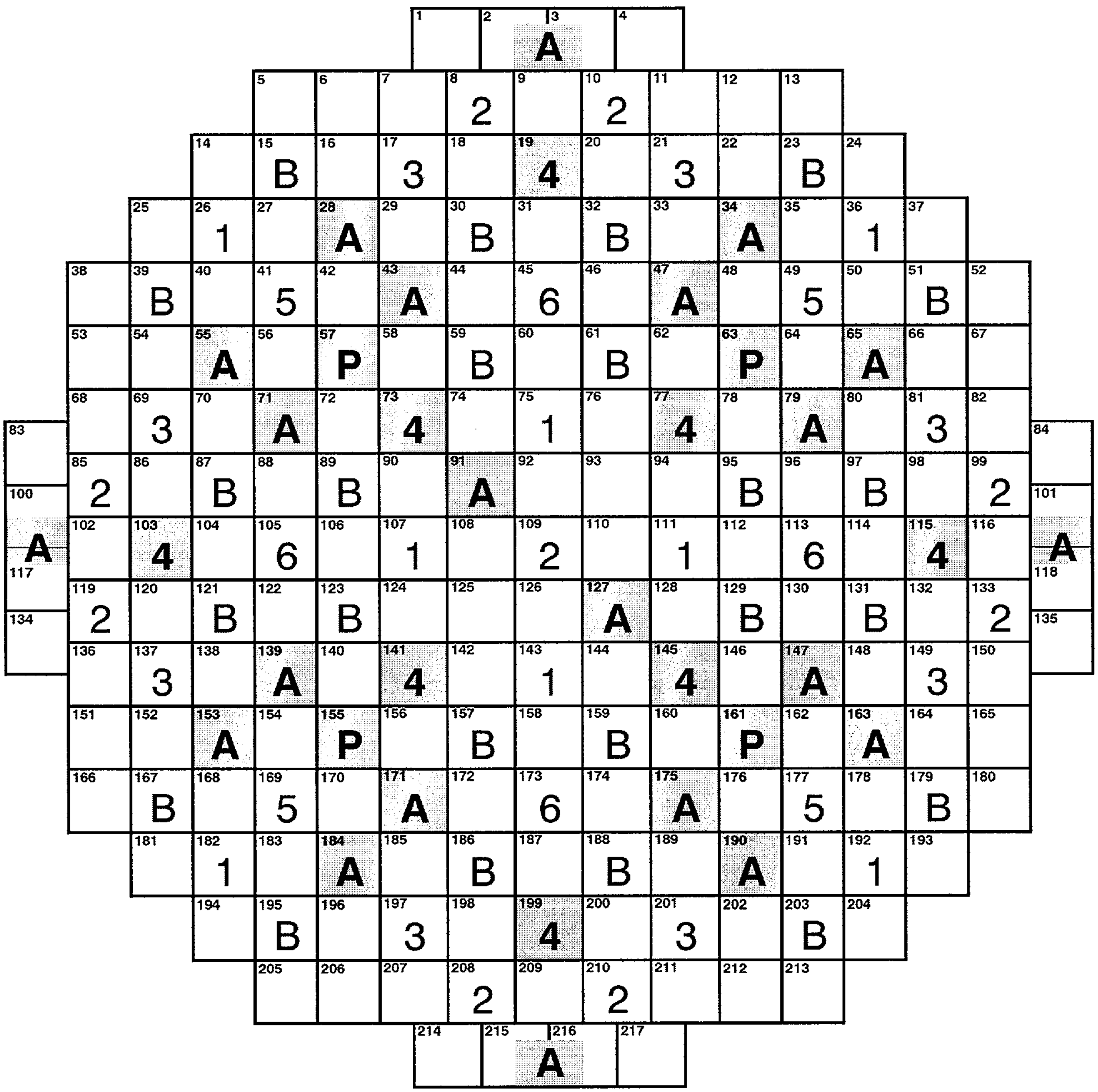
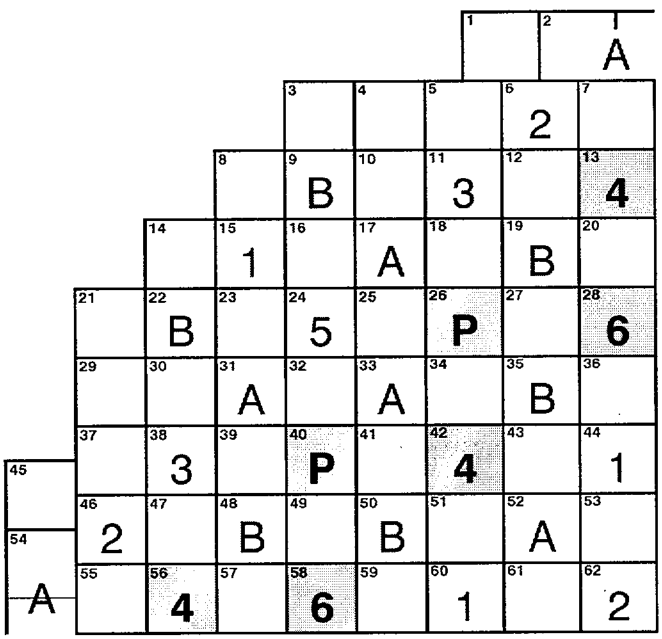
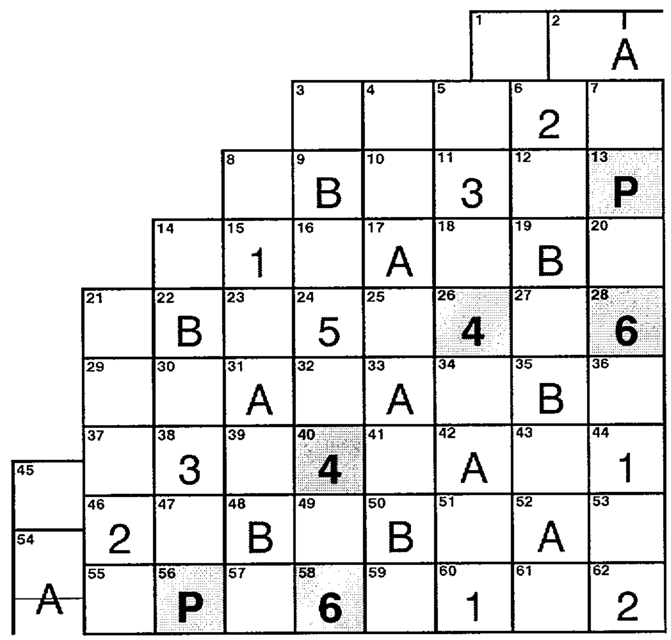


Figure 5: Quarter-Core CEA Bank Configurations Assessed for PLCEA Scoping Study

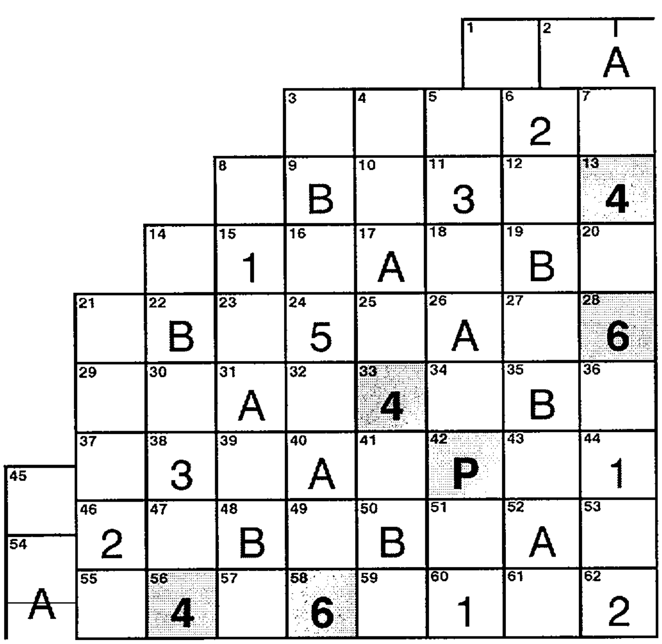
Original CEA Pattern



PLCEA Replacement Pattern "A"



PLCEA Replacement Pattern "B"



PLCEA Replacement Pattern "C"

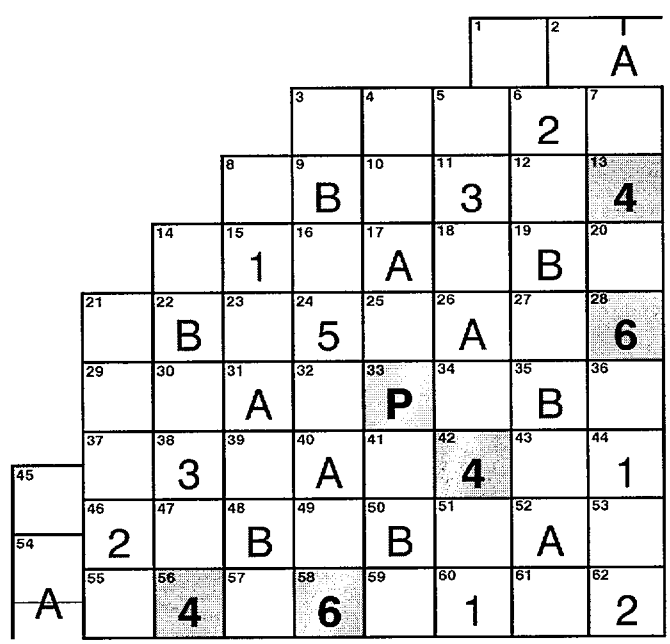


Figure 6: Quarter-Core Loading Map
Waterford 3 Cycle 10

Assy	Sub-Batch	Prev* Assy	Num Rot's

(*From Cy-9)

Batch S Summary

40	S4's	(48 Erb)
8	S3's	(32 Erb)
36	S2's	(24 Erb)
8	S1's	(0 Erb)

							1 P2 5 2	2 P0 28 0
				3 P2 22 2	4 P2 4 2	5 R3 49 2	6 S2	7 S2
			8 P0 31 2	9 S1	10 S2	11 S2	12 S4	13 R1 7 0
		14 P0 17 2	15 R3 34 2	16 S2	17 R1 10 2	18 R3 47 1	19 R3 43 3	20 S4
	21 P2 9 2	22 S1	23 S2	24 R3 53 2	25 S4	26 R3 32 1	27 S3	28 R3 20 2
	29 P2 29 2	30 S2	31 R1 30 2	32 S4	33 R1 16 0	34 S4	35 R2 11 2	36 S4
45 P2 37 2	37 R3 27 2	38 S2	39 R3 12 3	40 R3 25 3	41 S4	42 R3 41 2	43 S4	44 R1 6 2
54 P0 36 3	46 S2	47 S4	48 R3 51 1	49 S3	50 R2 38 2	51 S4	52 R1 23 2	53 R1 46 1
	55 S2	56 R1 55 0	57 S4	58 R3 57 2	59 S4	60 R1 6 1	61 R1 46 0	62 P0 24 0

Figure 7: Quarter-Core Loading Map
Waterford 3 Cycle 11

Assy
Sub-Batch
Prev Assy **Num Rot's**
(Prev. in Cy-10)

Batch T Summary

20	T5's	(88 Erb)
12	T4's	(80 Erb)
8	T3's	(72 Erb)
16	T2's	(60 Erb)
16	T1's	(32 Erb)
4	T0's	(0 Erb)

							1 R1 44 2	2 R1 17 2
				3 R3 18 2	4 R3 15 2	5 R3 37 2	6 S2 11 2	7 *T0*
			8 R1 52 2	9 S4 47 2	10 *T1*	11 *T2*	12 *T2*	13 S2 46 0
		14 R1 33 2	15 S4 36 2	16 *T1*	17 S2 10 3	18 S1 22 0	19 S2 23 0	20 *T5*
	21 R3 39 2	22 S4 12 2	23 *T1*	24 S2 6 0	25 *T4*	26 S4 51 3	27 *T5*	28 S4 20 0
	29 R1 53 2	30 *T1*	31 S2 30 1	32 *T4*	33 S4 25 3	34 *T5*	35 S4 34 0	36 *T4*
45 R1 13 2	37 R3 5 2	38 *T2*	39 S1 9 0	40 S4 43 1	41 *T5*	42 S4 32 3	43 *T3*	44 S3 27 0
54 R1 31 2	46 S2 38 2	47 *T2*	48 S2 16 0	49 *T5*	50 S4 41 0	51 *T3*	52 S2 7 3	53 S3 49 1
	55 *T0*	56 S2 46 3	57 *T5*	58 S4 20 3	59 *T4*	60 S3 27 3	61 S3 49 0	62 P0 24 1 *9*

Figure 8: Quarter-Core Loading Map
Waterford 3 Cycle 12

Legend:
Assy
Sub-Batch
Prev* Assy **Num Rot's**
*(*From Cy-11)*

Batch U Summary

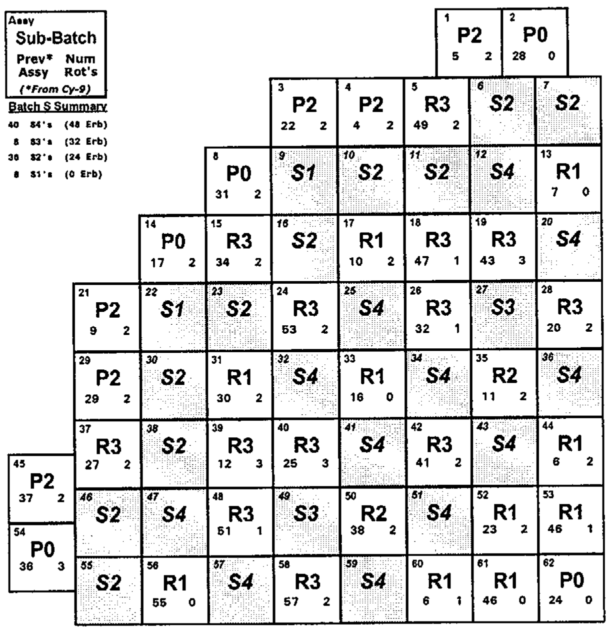
16 U8's (88 Erb)
24 U7's (80 Erb)
8 U6's (72 Erb)
8 U4's (48 Erb)
20 U3's (32 Erb)
8 U2's (24 Erb)

							1 **S3** 53 2	2 **S2** 31 2
				3 **S4** 40 2	4 **S2** 52 2	5 **S2** 46 3	6 ***U3***	7 ***U3***
			8 **S2** 19 2	9 **S1** 18 2	10 ***U2***	11 ***U4***	12 ***U8***	13 **T5** 20 0
		14 **S2** 48 2	15 **T5** 27 0	16 ***U3***	17 **T1** 10 3	18 **T2** 38 1	19 **T5** 34 0	20 ***U7***
	21 **S4** 26 2	22 **S1** 39 2	23 ***U3***	24 **T2** 47 0	25 ***U7***	26 **T1** 16 0	27 ***U7***	28 **T5** 49 1
	29 **S2** 13 2	30 ***U2***	31 **T1** 30 1	32 ***U7***	33 **T4** 32 3	34 ***U8***	35 **T3** 43 1	36 ***U7***
45 **S2** 24 2	37 **S2** 6 1	38 ***U4***	39 **T2** 11 3	40 **T1** 23 0	41 ***U8***	42 **T4** 25 3	43 ***U6***	44 **T4** 36 0
54 **S2** 17 2	46 ***U3***	47 ***U8***	48 **T5** 41 0	49 ***U7***	50 **T3** 51 3	51 ***U6***	52 **T 0** 7 3	53 **T2** 12 1
	55 ***U3***	56 **T5** 20 0	57 ***U7***	58 **T5** 49 1	59 ***U7***	60 **T4** 36 0	61 **T2** 12 1	62 **S4** 9 0

Figure 9: Waterford 3 Core Designs Assessed for PLCEA Scoping Study

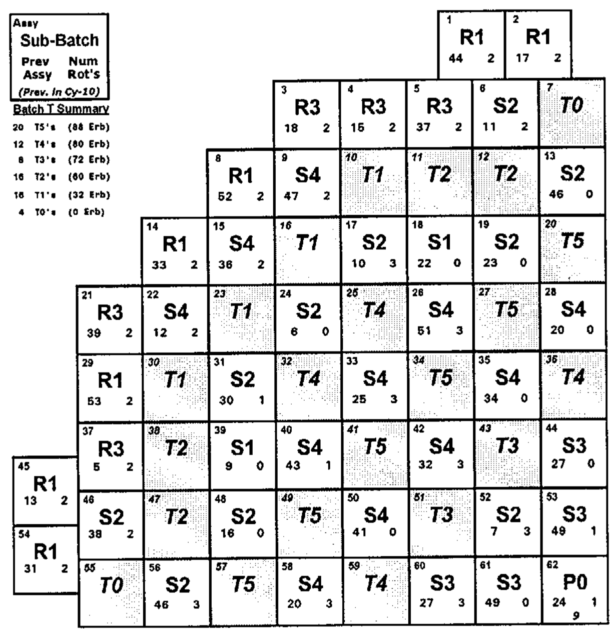
Cycle 10

92 Fresh Batch S Assemblies
530 EFPD Cycle Length



Cycle 11

76 Fresh Batch T Assemblies
524 EFPD Cycle Length



Cycle 12

84 Fresh Batch U Assemblies
505 EFPD Cycle Length

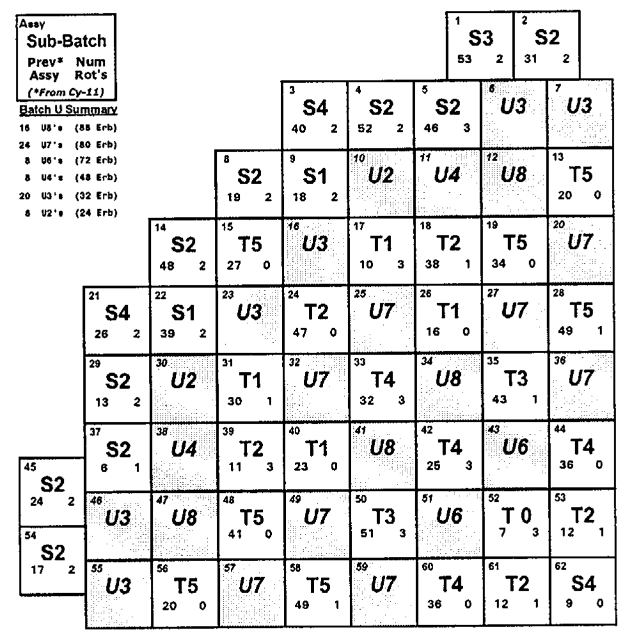


Figure 10: Maximum CEA Bank Insertions (PDIL) Current Waterford 3 Limits

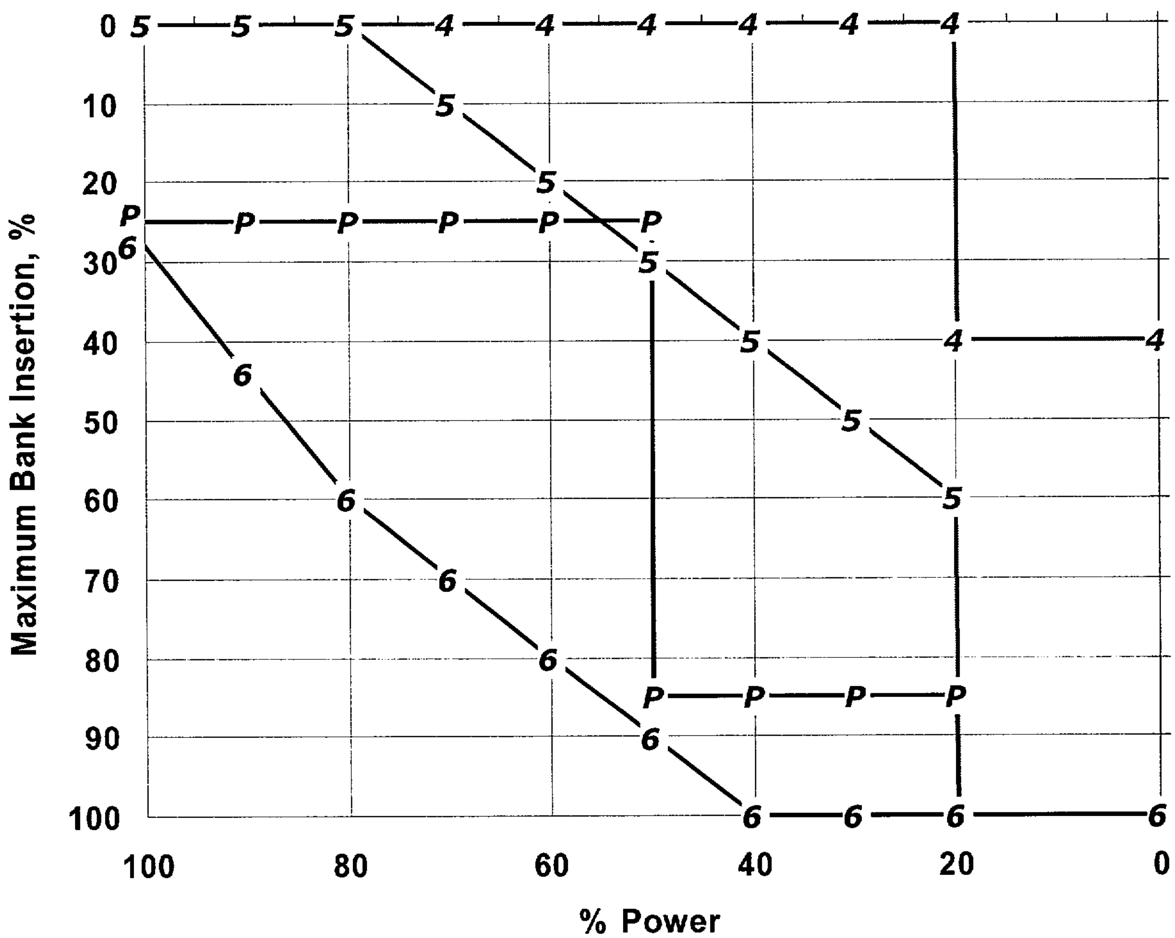


Figure 11: Maximum CEA Bank Insertions (PDIL) Developed for PLCEA Replacement Scoping Study

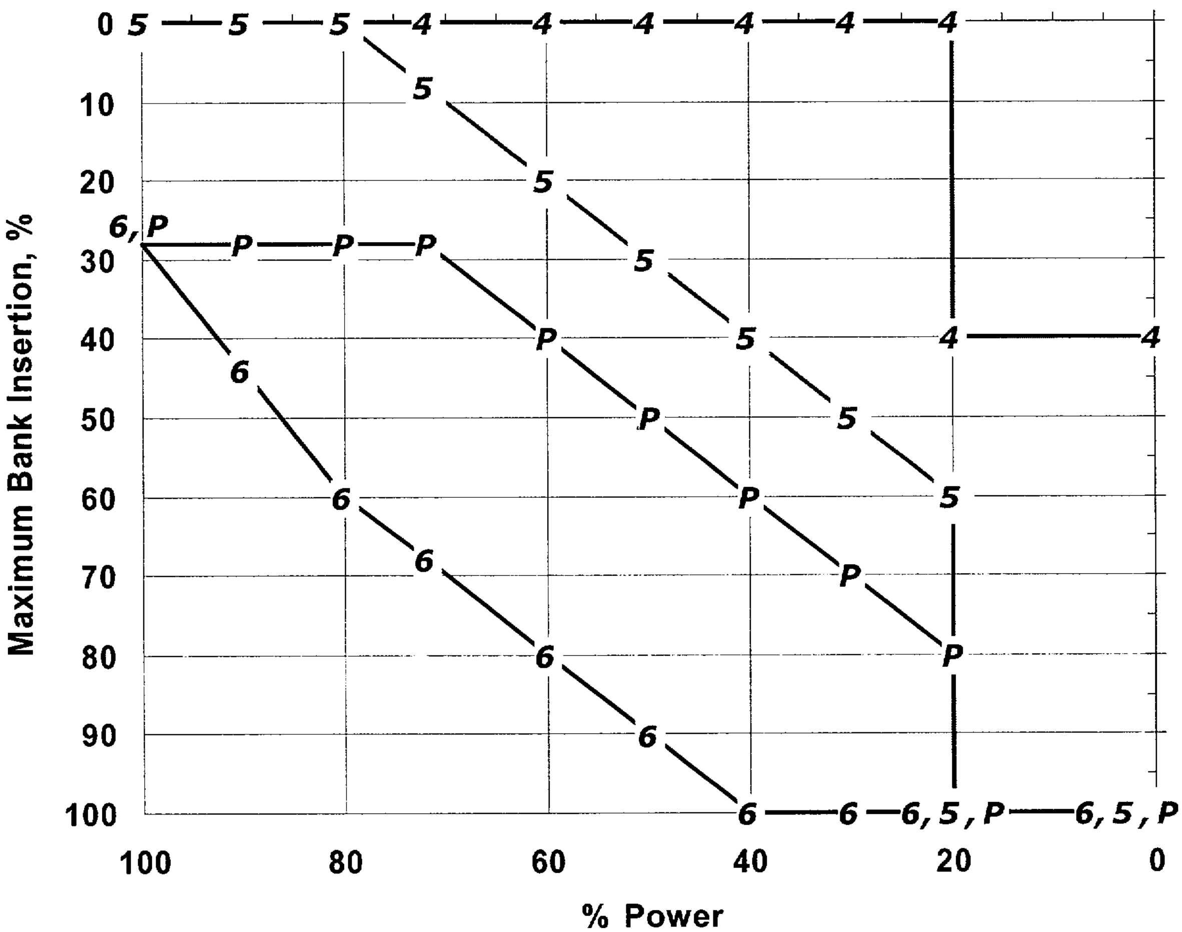


Figure 12: CEA Bank Insertion Reactivity Data

Cycle 10

Cycle 11

Cycle 12

Figure 13: CEA Bank Insertion F_{XY} Peaking Data

Cycle 10

Cycle 11

Cycle 12

Figure 14: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 10 Original CEA Pattern

Figure 15: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 11 Original CEA Pattern

Figure 16: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 12 Original CEA Pattern

Figure 17: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 10 CEA Pattern "A"

Figure 18: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 11 CEA Pattern "A"

Figure 19: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 12 CEA Pattern "A"

Figure 20: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 10 CEA Pattern "B"

Figure 21: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 11 CEA Pattern "B"

Figure 22: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 12 CEA Pattern "B"

Figure 23: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 10 CEA Pattern "C"

Figure 24: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 11 CEA Pattern "C"

Figure 25: F_{XY} Peaking Data and F_R Synthesis Calculation

Data From: Cycle 12 CEA Pattern "C"

Figure 26: HFP CEA Withdrawal Data

	BANK P INSERTION		CYCLE 10			CYCLE 11			CYCLE 12	
			RIR	FQ		RIR	FQ		RIR	FQ
A-BOC	28		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
	0		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
B-BOC	28		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
	0		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
C-BOC	28		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
	0		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
A-EOC	28		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
	0		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
B-EOC	28		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
	0		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
C-EOC	28		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]
	0		[ ]	[ ]		[ ]	[ ]		[ ]	[ ]

Figure 27: EOC HZP CEA Withdrawal - Reactivity Data

Cycle 10

Cycle 11

Cycle 12

Figure 28: EOC HZP CEA Withdrawal - Peaking (F_Q) Data

CEA Pattern	Cycle 10	Cycle 11	Cycle 12
Original	[ ]	[ ]	[ ]
Pattern A	[ ]	[ ]	[ ]
Pattern B	[ ]	[ ]	[ ]
Pattern C	[ ]	[ ]	[ ]

Figure 29: Cycle 10 Preliminary (2D) CEA Ejection Results

BOC HZP Ejected CEA Cases (from Banks 6+5+4+P Inserted)

CEA Pattern	Parameter	6+5+4+P Inserted	Ejected CEA from: Bank P	Bank 6	Bank 5	Bank 4

Figure 30: Cycle 11 Preliminary (2D) CEA Ejection Results

BOC HZP Ejected CEA Cases (from Banks 6+5+4+P Inserted)

CEA Pattern	Parameter	6+5+4+P Inserted	Ejected CEA from:			
			Bank P	Bank 6	Bank 5	Bank 4

Figure 31: Cycle 12 Preliminary (2D) CEA Ejection Results

BOC HZP Ejected CEA Cases (from Banks 6+5+4+P Inserted)

CEA Pattern	Parameter	6+5+4+P Inserted	Ejected CEA from: Bank P	Bank 6	Bank 5	Bank 4

Figure 32: Task 2 CEA Ejection Results at 0% Power

Cycle 11 - Current Design with PLCEAs

Cycle 12 - CEA Pattern C with PLCEAs replaced

Figure 33: Task 2 CEA Ejection Results at 20% Power

Cycle 11 - Current Design with PLCEAs

Cycle 12 - CEA Pattern C with PLCEAs replaced

Figure 34: Task 2 CEA Ejection Results at 50% Power

Cycle 11 - Current Design with PLCEAs

Cycle 12 - CEA Pattern C with PLCEAs replaced

Figure 35: Task 2 CEA Ejection Results at 80% Power

Cycle 11 - Current Design with PLCEAs

Cycle 12 - CEA Pattern C with PLCEAs replaced

Figure 36: Task 2 CEA Ejection Results at 100% Power

Cycle 11 - Current Design with PLCEAs

Cycle 12 - CEA Pattern C with PLCEAs replaced

Figure 37: Comparison of CEA Ejection Results at 20% Power

Figure 38: Control Rod and Subgroup Assignments within CEDMCS

Highlighted subgroups indicate the CEAs that would be impacted in a PLCEA replacement with Pattern C

Attachment 5

To

W3F1-2001-0102

Elimination of 4-Rod CEAs
From CE NSSS 217 Fuel Assembly Cores

(Non-Proprietary Version)

Non-PROPRIETARY

CEOG COMBUSTION ENGINEERING OWNERS GROUP

CE NPSD-1202-NP

ELIMINATION OF 4-ROD CEAs FROM CE NSSS 217 FUEL ASSEMBLY CORES

CEOG TASK 1168

Final Report

Prepared for the

COMBUSTION ENGINEERING OWNERS GROUP

By

WESTINGHOUSE ELECTRIC COMPANY
C-E Nuclear Power LLC

Windsor, CT

November 2000

LEGAL NOTICE

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Windsor, CT 06095-0500

Table of Contents

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1.0 EXECUTIVE SUMMARY

The 4-Rod Control Element Assembly (CEA) was originally included in the Combustion Engineering designed 3410 MWT core inventory in order to increase the shutdown margin during a steamline break accident. Four such CEAs are located at the periphery on the core axes of Waterford 3, SONGS 2 and 3, and St. Lucie Unit 2. The physical design is unique because the CEAs straddle two fuel assemblies. From a mechanical standpoint, the unique physical design requires keeping additional spare parts on hand. Adherence to more complex refueling and handling procedures is required, and there is an increased potential for damage of the CEA, its extension shaft, as well as the reactor internals.

For early core designs characterized by out-in type loadings, these CEAs provided a significant increase in the minimum net (N-1) CEA worth used in the safety analysis. However, the benefit is relatively small in the modern low-leakage core design.

This report evaluates the prospect of completely eliminating the 4-Rod CEAs from Waterford 3. A similar evaluation could be performed for SONGS and St. Lucie 2. It concludes that removal of the 4-Rod CEAs has a small but acceptable impact on the core design and safety analyses, given the current 18-month low leakage core designs at Waterford 3. Potentially costly physical modifications to the reactor internals are not required, although the removal process needs to be integrated into the schedule. Changes to the CPCS, CEDMCS and COLSS can be accomplished within the course of a normal refueling outage.

Finally, the financial benefit to Entergy was estimated using the EPRI PLEBE Cost Benefit Program. Costs include estimated contractor and internal utility costs associated with 4-Rod elimination. This evaluation shows a favorable Benefit to Cost Ratio of 3.6, not including costs of an unanticipated abnormal occurrence surrounding the continued use of 4-Rod CEAs which, if accounted for, would tip the scale even more in the favorable direction. A one day unscheduled delay in 2004, for example, quickly increases the benefit ratio to 4.6.

2.0 BACKGROUND

SONGS 2/3, Waterford 3, and St. Lucie Unit 2 are currently operating with four 4-Rod CEAs included in their complement of otherwise 5-Rod CEAs. The issue of eliminating the 4-Rod CEA was raised in the interest of saving refueling outage time. Waterford 3 estimates that 8 – 10 critical path hours are required to handle these components. The 4-Rod CEA was implemented initially to reduce the worth of an adjacent stuck CEA during a steam line break (SLB) accident. Due to the "offset box" design at the periphery of these units, the placement of a CEA on the core axes means that it must straddle two fuel assemblies (Figure 3.2-5). Unlike 5-Rod CEAs used in the rest of the core, the 4-Rod CEAs must therefore be removed from the core prior to core offload. This is accomplished by withdrawing the extension shaft with the CEA still coupled and suspending the shaft and CEA in a latching mechanism mounted on the Upper Guide Structure (UGS) Lift Rig. This operation takes place before the UGS is removed from the vessel. The CEA tip array is captured in a short tube sheet arrangement located at the bottom of the CEA Shroud. After the UGS is returned to the vessel, the CEA and shaft may be released from the latching mechanism and lowered to the full down position. Entry of the rod tips into the fuel assembly guide tubes is assured by the locating holes in the base of the CEA shroud.

The need to raise the shaft and CEA such that the CEA tips are not protruding from the bottom side of the UGS means that the CEA spider will pass through the top of the CEA shroud extension shaft guide area. This is never required for a 5-Rod CEA. Thus the extension shaft guides in the 4-Rod CEA shrouds are of a complex geometry (to allow passage of the CEA spider and assorted tools) and the guides are not as robust as in the 5-Rod CEA locations.

In light of this history, it is not surprising that the importance of the 4-Rod CEA is being questioned. Another factor prompting this investigation is the use of low leakage core designs. The worth of the peripheral 4-Rod CEAs is clearly reduced in this area of low reactivity fuel, but it has not been quantified until now.

3.0 TECHNICAL EVALUATION

3.1 MECHANICAL ISSUES

3.1.1 Bypass Leakage Flow

The reactor internals are designed to direct the coolant flow through the core. Bypass leakage flow is the flow that short circuits the core through gaps, through guide tubes, etc. For Waterford 3, the design bypass flow value is 2.6% of total loop flow. Bypass flow will increase through the 16 vacated corner guide tubes that result from 4-Rod CEA removal. Increase of the total bypass flow was evaluated

Most of the hydraulic information for the flow network is extracted from Reference 1, which is the analysis of record for Waterford 3. However, some changes from the initial analysis were included in this evaluation, along with removal of the 4-Rod CEAs. These changes are:

1. Alignment Key Gap Finding - Visual inspection of the CSB performed during the Cycle 7 refueling outage at Waterford 3 indicated that one of the four alignment keys had moved radially outward from its design position at the back of the key-way slot. This changes the bypass flow area slightly. It was documented in Reference 2.

2. Quickloc ICIs -The ICI sheath diameter has been reduced from the original size down to the smaller Quickloc ICI, somewhat reducing the resistance in the guide tubes containing ICIs. (Reference 3).

3. Fuel Assembly Spacer Grid Changes – The top grid was changed to include additional fuel rod support arches, somewhat increasing resistance in the main flow stream.

With the updated network, the hydraulic resistance of the 16 rodded corner guide tubes was recalculated with no CEA rods in place. There is no significant change of the corner guide tube resistance due to the rod removal since the single cooling hole

Removing

guide tube. However, the total best estimate bypass flow

[rate compared to the design bypass] flow rate of 2.6%.

Therefore, bypass flow leakage is not significantly impacted by the removal of the 4-Rod CEAs.

3.1.2 Fuel Rod Vibration Potential

Flow entering the cooling hole in the guide tube passes laterally across the fuel rods immediately adjacent to the guide tube cooling hole. The cross flow component introduces localized vortex shedding and possible excitation of the rod. The vortex shedding frequency of the fuel rods adjacent to the rodded corner guide tube is within (the

during the fuel cycle. Increasing the) bypass flow drives the fuel pin vortex shedding frequency away from its natural frequency, decreasing possibility of resonance. Based on this evaluation, removal of the 4-Rod CEA presents no increased potential of flow induced vibration of the fuel rods adjacent to the cooling holes.

3.1.3 UGS Shroud Operating Temperature

The maximum temperature difference between two adjacent CEA shrouds was (determined in the) design of the CEA Shroud attachments. A review of Reference 4 shows that core power distribution and the localized coolant temperature overwhelmingly determine the shroud temperature. Any minor change in bypass leakage will have a trivial effect on shroud temperature. Therefore, the metal temperature difference between the 4- (Rod CEA Shroud

.)

3.1.4 Core Flow Distribution

Flow exiting the core in the 4-Rod CEA location passes into the outlet plenum above the Fuel Alignment Plate (FAP) by two paths. The first is a series of holes in the FAP. The second path is through the center of the CEA Shroud. Flow passes upward into an elbow and is exhausted into the plenum through an opening in the side of the CEA shroud facing radially outward. Neither flow path is impacted in any way by removal of the rods.

3.1.5 Reactor Internals Changes

Sections 3.1.1 through 3.1.3 looked at the impact of increased bypass flow on key design parameters. Section 3.1.4 gives a basis for concluding there is no impact on core exit flow distribution. In the absence of any negative thermal-hydraulic finding, Westinghouse concludes that changes to the UGS to limit bypass flow are not needed. This is an important conclusion since the costs associated with a field modification of the reactor internals are avoided.

3.1.6 Removing CEAs and Extension Shafts From Containment

To date planned 4-Rod CEA removal from the internals has not occurred. The manner in which they are removed must be planned out in advance so as to have the minimum impact on the outage. The total combined length of the extension shaft and 4-Rod CEA approaches 40 feet. The CEA tips will be activated having resided at the core exit as part of their duty in a shut down bank. The remainder of the CEA and shaft will be contaminated. A hot spot can be expected at the CEA gripper, which has not been exercised for many years and which may have some crud accumulation. In order to keep the CEA tips a comfortable distance under water during removal, the 4-Rod CEA should be removed at a time when the UGS Lift Rig is not attached to the UGS. The removal operation could be done at the same time as the ICIs are pulled out for disposal, i.e., after flood-up but before UGS Lift Rig attachment.

The procedure outline is as follows. It involves some new, simple tooling.

a. Pre-stage a frame holding four transfer cans, each capable of holding a 4-Rod CEA, on the cavity floor. As an alternative to the frame, use the in-containment storage rack. Pre-stage two simple identical grapple tools, one on each side of the transfer canal, which are designed to pick up the can. (The 4-Rod CEA finger pattern is coincidentally almost dimensionally the same as the four corner rods on a 5-Rod CEA. So it could conceivably be somehow loaded into a fuel assembly for transfer if the tips could be inserted; however, the Spider is of a different configuration. In addition, the length of the 4-Rod CEA alone is about equal to the combined length of a 5-Rod CEA inserted into a fuel assembly. The 4-Rod CEA alone is 15'-9". A normal fuel assembly with a protruding 5-rod CEA, which normally goes through the transfer canal, is about 15'-8". The upender fuel carrier is about 15'-11" long. This length issue is the reason for the recommendation to use a transfer can. The transfer can would just envelope the 4-Rod CEA and the grapple tool would attach to the can through pick up points located in the space between the spider and the inside of the can.)

b. After flood-up but prior to UGS Lift Rig attachment, engage a 4-Rod CEA shaft and pull it and the CEA completely clear of the UGS. The Gripper Operating Tool can be used for this lift. The combined length of the shaft and CEA is about 40 feet. Transfer one at a time to the cavity area where the depth is about 45 feet, and insert the CEA into the transfer can. While supporting the shaft, remove the Gripper Operating Tool, install the short Gripper Operating Tool, and proceed to uncouple the shaft from the CEA. Remove the shaft to the operating deck (or hang it submerged until it needs to be removed and bagged later).

c. Using the special grapple tool, move the transfer can with 4-Rod CEA to the upender. Disengage the grapple and shuttle the can to the spent fuel pool. Pull the next 4-Rod CEA and shaft from the UGS.

d. On the spent fuel side, use the duplicate grapple to remove the can from the upender and transfer it to an empty fuel storage cell. With the can in the spent fuel rack, it should be no higher than a fuel assembly containing a 5-Rod CEA. And because the normal spent fuel pool grapple is not compatible with the 4-Rod CEA Spider, inadvertent lifting at some future time is not possible.

e. After the last 4-Rod removal from the UGS, the UGS Lift Rig can be put on the UGS and the ICI plate raised. The time normally associated with the 4-Rod CEA withdrawal into the latching mechanism is now saved.

f. Move the UGS to the laydown area.

g. Complete refueling.

h. Return the UGS to the vessel. Some time will be saved here because 4-Rod manipulations are no longer required.

The above scenario increases time in one place, but reduces it in two other windows; however, the net is probably a slight increase, on the order of 4 hours for this one outage in which the 4-Rod CEAs are removed.

The above approach is one possibility. The actual steps will need to be integrated into the detailed outage schedule to minimize any impact. For example, empty transfer cans could be loaded directly into the upender (instead of a frame rack), saving a step. Also, the Temporary Reactor Head (TRH) available at Waterford 3, may offer some scheduling flexibility. In an outage where the use of the TRH is scheduled, perhaps all of the transfers of the 4-Rod CEAs to the spent fuel pool could be deferred until the time the vessel is drained. This window would be after core off-load and therefore operation of the fuel transfer machine is not on critical path. Entergy would need to verify that the transfers can be made through an open gate with the TRH in place and the vessel drained down.

3.1.7 Control Element Drive Mechanism (CEDM) Abandonment

The CEDMs should be abandoned in place. By leaving them in place, the CEDM air cooling flow path within the head area cooling shroud is not altered in any way. The four abandoned CEDMs must be vented upon reactor reassembly as are all of the other CEDMs. The Versa Vent devices must be maintained in accordance with preventative maintenance instructions.

On selected 800MWT plants, the Part Length CEAs were eliminated several cycles after plant start-up, for nuclear design reasons. In those cases, the Part Length Control Element Assemblies (PLCEDMs) were abandoned in place, serving as a precedent for Waterford 3.

3.2 CORE DESIGN AND SAFETY ANALYSIS

The primary concern in the safety and physics areas related to removing the 4-Rod CEAs is the potential loss in scram worth, which could have an adverse impact on a number of Chapter 15 events, particularly the main steam line break (SLB). Indeed, it was this event that caused the 4-Rod CEAs to be incorporated in the original plant design.

Many things have changed since Cycle 1, and the design basis of the 4-Rod CEAs should be considered in today's environment. Chief among these changes has been the use of low-leakage fuel management techniques, in which highly burned, hence low reactivity, fuel is placed on the core periphery. Contrast this to the Cycle 1 design, which used an out-in style of fuel management, in which the highest reactivity fuel was placed on the core periphery. In general the reduction in peripheral-average k-infinity due to the burned fuel is greater than the reduction in k-infinity due to the 4-Rod CEAs. If this were the sole change since Cycle 1, the removal of the 4-Rod CEAs would be straightforward from the perspective of safety analyses.

However, there has been one significant adverse change since Cycle 1, that being the use of significantly increased average feed enrichment. The increased feed enrichment is needed to achieve 18-month cycles and to improve the fuel cycle economics by minimizing the size of the feed batch. This report evaluates the trade-offs among these changes, and determines the feasibility of removing the 4-Rod CEAs from a Chapter 15 perspective.

Fortunately, there have been significant advances in analysis techniques and vast increases in computer capabilities that permit using these techniques on a routine basis. In particular, the Cycle 1 SLB analysis avoided a condition known as a return-to-power (RTP), since it was difficult and expensive to adequately determine the core characteristics under such conditions. Today it is considered routine to perform a RTP analysis. In fact, the physics portion of this analysis has been automated for both [WSES-3 and ANO-2. The use of these modern methods

analysis. In some plants and cycles

.]

3.2.1 Assessment of SLB in Near-term and Future Cycles

3.2.1.1 Cycles Selected for Detailed Assessment

1. Cycle 11, which serves as a base or reference cycle, since there is an associated safety analysis that is successful. This cycle has 76 feed assemblies.

2. Cycle 12 of the Cycle 11 Final Energy Utilization Plan (FEUP), which is typical of all later cycles in that FEUP, and is slightly more adverse than Cycle 11. It is typical of the current thinking at Entergy with respect to energy requirements of future cycles. This cycle has 84 feed assemblies.

3. A 24-month cycle, similar to one actually operated in another 217-assembly plant. This was selected to cover cycles well beyond those currently envisioned for Waterford 3. This cycle has 108 feed assemblies.

The configuration of fresh, once burned, and twice burned fuel near the 4-Rod CEAs for these cycles is shown in Figures 3.2-1, 3.2-2, and 3.2-3.

3.2.1.2 Assessment Approach

The approach used in this assessment is to compute the key physics inputs to post-trip SLB on a consistent basis for a known acceptable cycle (with the 4-Rod CEAs), and for some potential future cycles with and without the 4-Rod CEAs. The focus is on the <u>changes</u> from cycle-to-cycle and with/without the 4-Rod CEAs, not on absolutes. Thus, biases and uncertainties are not included, since they would to first-order cancel among the cycles.

[In each cycle, the which is characteristic of the cold zero power (CZP) post-SLB temperature. The reactivity from is noted for each case.] The 3D fine-mesh power peaking factor, Fq, is also noted.

3.2.1.3 Data and Its Interpretation, HFP ARO to CZP N-1

[The reactivity from . The lead bank "bite" was] ignored in these cases, since it would largely cancel among cases. The case with the largest positive composite reactivity would be the worst case for a classic <u>non</u>-RTP analysis.

Table 3.2-1 summarizes the reactivity changes from HFP ARO to CZP N-1. This data is presented relative to Cycle 11, which is known to be acceptable for SLB with a near zero reactivity balance, and essentially no return to power. In Cycle 11, there is almost no impact when the 4-Rod CEAs are removed.

The reactivity for Cycle 12 with 4-Rod CEAs is somewhat more adverse than for Cycle 11 with 4-Rod CEAs. This is explained by the presence in Cycle 12 of fresh fuel in quarter core assembly 6 and its symmetric partners. Removing the 4-Rod CEAs in Cycle 12 increases the reactivity at zero power. The difference with and without the 4-Rod CEAs is smaller than the difference between Cycle 12 and Cycle 11.

The reactivity for the 24-month cycle <u>with</u> 4-Rod CEAs is only slightly adverse relative to Cycle 11 with 4-Rod CEAs.

However, in the becomes clear. There is fresh fuel placed in quarter-core assembly 2, and its symmetric partners, configuration, since the to the 4-Rod CEAs. (See Figure 3.2-5 for the location of CEAs near the 4-Rod CEAs.)

The data in However, it is beyond the scope of this assessment to generate a detailed fuel management for such a cycle and perform a quantitative assessment. Note that Figure 3.2-4 corresponds to about 92 feed assemblies, whereas Figure 3.2-3 corresponds to 108 feed assemblies. The pattern with 92 feed assemblies requires a higher enrichment, and has higher nominal radial peaking, but is overall more economic than the one with 108 feed assemblies.

Note that the above reactivity differences do not present a complete picture of the post-trip trip SLB for these cycles. One also needs to consider the reactivity changes during the return-to-power, and the associated 3D peaking.

3.2.1.4 Including Return to Power Reactivity

For each case the fission power was increased while maintaining the N-1 configuration. Reactivity and Fq were extracted. The negative reactivity inserted for finite fission power is a measure of the spatial reactivity feedbacks, and is taken as a credit in a RTP analysis. The associated reduction in Fq is also taken as a credit in the RTP analysis.

The sum of the composite reactivity (ARO HFP to CZP N-1) <u>and</u> the RTP reactivity is a measure of the total reactivity balance for the RTP analysis. A system simulation code, such as CESEC or CENTS, would respond most closely to this total reactivity. A summary of the total reactivity differences, <u>relative to those for Cycle 11</u> is shown in Table 3.2-2.

The interpretation that should be given to Table 3.2-2 is that a reactivity difference of zero means that cycle would have the same post-trip fission power as Cycle 11. A positive reactivity implies that a cycle would have a higher fission power. Exactly how much higher is difficult to estimate with precision. However, based on experience with other plants, a few tenths percent reactivity usually results in only a few percent higher fission power. Of course, a negative reactivity difference from Cycle 11 implies a lower fission power.

As power increases, both which is usually acceptable, if the peaking is moderate. Peaking is discussed below.

The 24-month cycle with the 4-Rod CEAs has a benign reactivity balance relative to Cycle 11, and would therefore be acceptable.

The relative to Cycle 11. However, as power rises the decreases. These cycles would probably which would probably , depending on the peaking.

Note: At sufficiently high fission powers (20%+) this cycle would have a reactivity balance no worse than does Cycle 11. Unfortunately, it is unlikely that one could achieve such high powers without . And, while is of Waterford.

3.2.1.5 Peaking During RTP

The best-estimate 3D peaking during the RTP phase of the SLB is shown in Table 3.2-3. These are absolute numbers, not differences relative to Cycle 11. The case of Cycle 11 without 4-Rod CEAs is not continued through the RTP phase, since it is almost identical to the 4-Rod CEA cases at CZP N-1, and is therefore known to also be acceptable.

The peaking for Cycle 12 with 4-Rod CEAs is somewhat more adverse than for Cycle 11 with 4-Rod CEAs. As with the reactivity discussed above, this is explained by the presence in Cycle 12 of fresh fuel in quarter core assembly 6 and its symmetric partners. Removing the 4-Rod CEAs in Cycle 12 increases the peaking at zero power, but less so as the fission power increases. Overall the Cycle 12 peaking is moderate (for SLB with RTP), and based on other plants should yield acceptable results, .

The the peaking as Cycle 11. By itself this would be very adverse. However, given the , this cycle is acceptable <u>with</u> the 4-Rod CEAs.

The . Coupled with the , this cycle would probably show . Therefore, this would not be to the current . However, it might be .

3.2.2 Licensing Changes

No changes to the physics and safety licensing bases would be required for low-leakage, 18-month cycles.

However, there would need to be an update to Chapter 4 of the UFSAR to show the new CEA pattern.

In the case of low-leakage 24-month cycles, it might be necessary to submit a small change to the licensing bases to include fuel failure during the post-trip phase of the SLB. This has already been done on other plants.

3.2.3 Summary

From the perspective of core design and safety analysis, the 4-Rod CEAs can be removed, with only a small and acceptable impact on the Steam Line Break (SLB) analysis.

This conclusion is contingent on the Waterford-3 fuel management remaining similar to any of the cycles shown in the final core design report for Waterford 3 Cycle 11 (WS-FE-0314, Rev.00). This conclusion also assumes there are no adverse plant changes or adverse operating space changes.

As described herein, Cycle 11 is relatively benign for SLB. However, all the scoping cycles (12 through 15) would also be acceptable. These cycles are similar to those examined for the (postponed) WSES-3 uprate, which would also be acceptable. 24-month cycles, with and/or revised licensing bases.

By "acceptable" it is meant that the current PAC methodology would still apply, except as required to specify that the 4-Rod CEAs be removed from all ROCS cases that model post-trip conditions. That methodology includes an analysis criterion of no fuel failure during the return-to-power (RTP) phase of the SLB.

Table 3.2-1, Reactivity Changes from HFP ARO to CZP N-1
(Data relative to Cycle 11 with 4-Rod CEAs)

	CY11	CY12	24MO
DELRHO HFP-->CZP			
WITH MINIDUAL			
NO MINIDUAL			

* Note the significant impact of

!

Table 3.2-2, Total Reactivity Changes
(Data relative to Cycle 11 with 4-Rod CEAs)

PCT	CY12	CY12	24MO	24MO
POWER	WITH	WITHOUT	WITH	WITHOUT
0				
5				
10				
15				
20				

Table 3.2-3, Fq during RTP SLB

PCT	CY11	CY12	CY12	24MO	24MO
POWER	WITH	WITH	WITHOUT	WITH	WITHOUT
0					
5					
10					
15					
20					

Figure 3.2-1, Fuel Placement Near 4-Rod CEA for Cycle 11

F = Fresh

1 = Once Burned

2 = Twice Burned

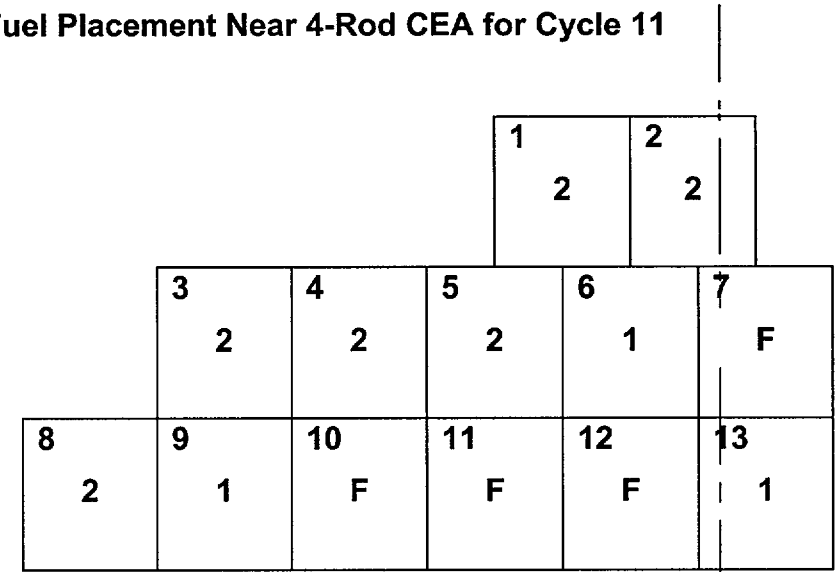


Figure 3.2-2, Fuel Placement 4-Rod CEA for Cycle 12

F = Fresh

1 = Once Burned

2 = Twice Burned

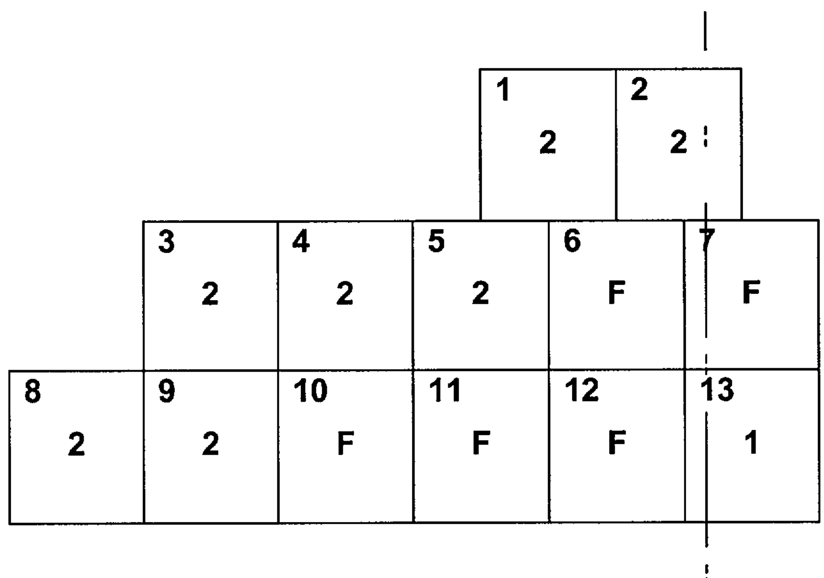


Figure 3.2-3, Fuel Placement 4-Rod CEA for 24-Month Cycle
(Very Adverse for SLB)

F = Fresh

1 = Once Burned

2 = Twice Burned

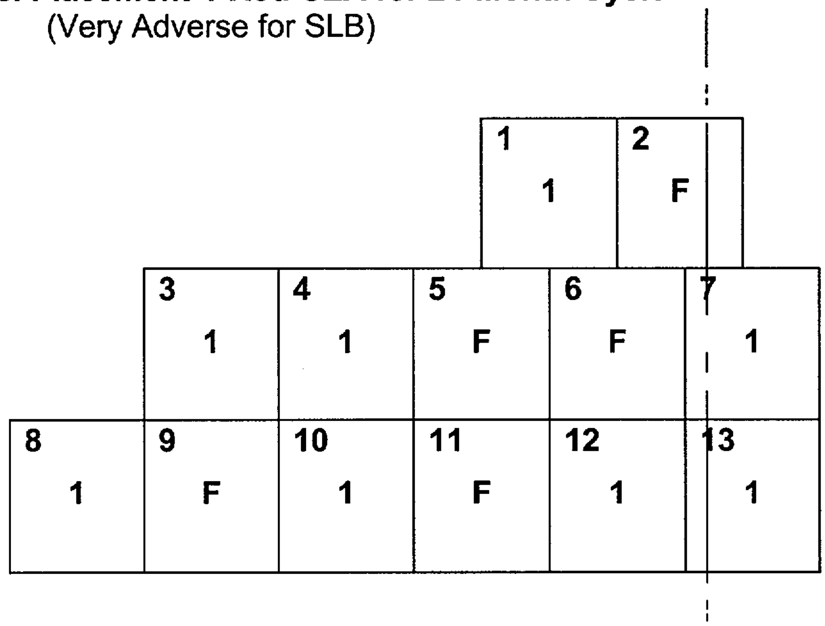


Figure 3.2-4, Alternative Fuel Placement Near 4-Rod CEA for 24-Month Cycle
(Less Adverse for SLB than Figure 3.2-3; Also, Better Fuel Economics)

F = Fresh

1 = Once Burned

2 = Twice Burned

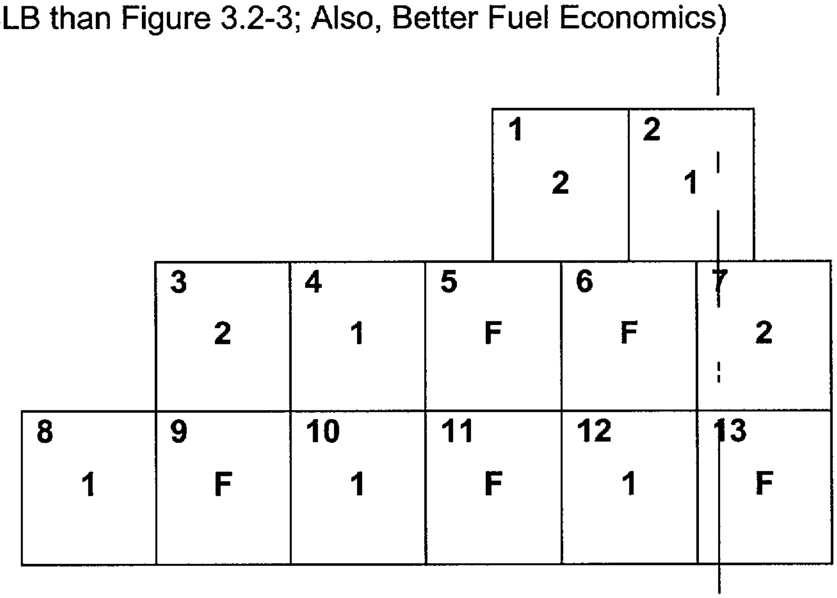
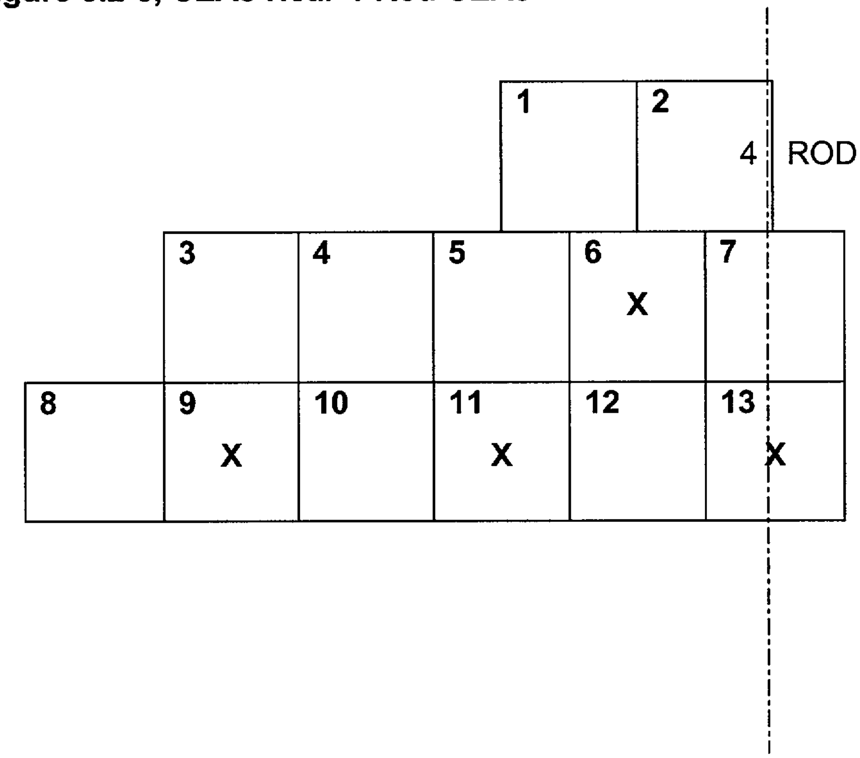


Figure 3.2-5, CEAs Near 4-Rod CEAs

X = CEA



3.3 REACTOR PROTECTION, CONTROL, AND MONITORING

3.3.1 Core Protection Calculator (CPCs)

The four 4-Rod CEAs to be removed are numbered 88, 89, 90 and 91. They are assigned to subgroup number 22, shutdown bank A. The CEA assignment and the number of CEA subgroups in a plant are part of the CPC database constants. The CPC calculates the CEA group position and the subgroup deviation penalty factor based on the input values of CEA 88, 89, 90 & 91 position. Removal of these four CEAs would require a change in the CPC software because the number of CEA subgroups was not included in the core reload data block constant list. Without the software change, the CPC would calculate an erroneous group position and generate a continuous subgroup deviation alarm and associated penalty factor. Any change in the CPC software would require significant testing effort to revalidate the affected portions of the 1985 vintage software.

For this reason, two other options for Entergy are suggested below:

Option 1, With CPC Software Change

Entergy is considering replacing the CPCS at Waterford 3 with the Common-Q Advant system. If the 4-Rod CEA removal were planned at the same time frame as the new CPCS, the additional cost in making the database change would be small. Proper co-ordination in advance is needed in order to minimize the scope in software testing.

Option 2, Without CPC Software Change

When the 4-Rod CEAs are removed, their respective CEA input signal can be strapped to an existing CEA in the same group that is a target CEA for the same CPC channel. For example, CEA position 91 will be connected to CEA 55, CEA position 90 will be connected to CEA 53, CEA position 88 will be connected to CEA 49, and CEA position 89 will be connected to CEA 51. All the CEA group position calculations and subgroup deviation calculations within CPC would remain valid. The single CEA drop (e.g. CEA# 55) would appear as two CEA drops (CEA #55 and #91). The consequence is still that same – channel trip. Entergy has replaced the CEA Display previously (without OEM). Accordingly, Entergy can choose to modify the CEA Display to delete the subgroup 22 or leave it as is. The CEA Display is not safety related.

3.3.2 Control Element Drive Mechanism Control System (CEDMCS)

The four CEAs to be eliminated are numbers 88, 89, 90, 91 comprising subgroup 22. The current CEDMCS designs being shipped to another customer are 73-rod systems capable of supporting 81 rods. They are factory tested with the additional two sub-groups. After testing, the power switches and sub-logic circuit cards are removed. The jumpers for the RSPT are removed and a special PC card, the "LED Test Driver", is installed in the sub-group logic housing, to emulate the proper operation of the now missing sub-groups and prevent alarms and annunciations.

A similar approach is suggested for Waterford 3 as the most expeditious way to accommodate 4-Rod CEA removal. A new card would be provided for Waterford 3 for the subgroup that is being disabled. It would be a modified design based on later plant designs, adapted for the 5-coil design. Also, the power switches can be removed and all assemblies refurbished and used as spares. The operator's module display would have to be modified (remove the subgroup indicators) and remove their wiring.

3.3.3 Core Operating Limit Supervisory System (COLSS)

COLSS resides on the plant computer. It receives the CEA positions and deviations from other rod position processing program located also on the plant computer. The processing programs receive pulse information from the ACTMs (Automatic CEA Timing Modules). However, the pulses coming from the ACTMs with the removed rods (no load) will not be the same shape. The ACTM would sense inadequate current and attempt to hold the rod on the upper gripper and motion of the group would be inhibited.

To accommodate 4-Rod removal, the same jumpering scheme suggested for the CPCs is recommended for the rod positioning programs. Under this plan after they are strapped together, 49 will drive the inputs for 49 and 88, 51 for 51 and 89, 53 for 53 and 90, and 55 for 55 and 91. The jumpering would take place in the plant computer.

Again, it is believed that this is a fairly easy task that can be accomplished in the course of a normal outage.

4.0 COST BENEFIT ANALYSIS

The Benefit Analysis is included as Attachment (A). Westinghouse estimated the following cost inputs for the analysis:

- Vendor cost (engineering and hardware) for special tooling associated with a one-time removal evolution
- Entergy licensing costs
- Entergy's internal engineering costs
- Vendor cost to verify and QA Thermal/Hydraulic findings
- CEDMCS changes
- CPC adjustments (excludes software change – it is not required)
- COLSS adjustments
- Future replacement 4-Rod CEA costs (shafts not considered)

A daily outage cost of $340,000 was assumed. A one-time 4-hour outage hit was applied for the initial removal of the 4-Rod CEAs in 2002, followed by an 8-hour time savings during future refueling outages, which occur every 18 months.

The benefit ratio under the above assumptions is about 3.6. However, if one single forced outage day occurs in the future due to the 4-Rod CEA, the scale is tipped even more in the favorable direction. For example, a single day lost due to a handling mishap associated with the continued use of the 4-Rod CEAs shifts the benefit ratio up to 4.6.

5.0 REFERENCES

1. Calculation A-WS-FE-0102 Rev. 00 “Core Bypass Flow and Thermal Hydraulic ECCS Data for Waterford – 3 Cycle 8”, Y. R. Chang, 8/10/95.

2. Calculation A-WS-FE-0196 Rev. 00 “Thermal Hydraulic Analysis for Waterford Uprate (Cycle 10)”, G. Kogan, 3/21/97.

3. Calculation A-WS-FD-0018 Rev. 00, “Waterford – 3 Core Exit Thermocouple Reading Impacted by ICI Design Change”, Y. R. Chang, 5/4/95.

4. Calculation 9270-NRE-013 Rev. 00, “Thermal Design Data for Several Reactor Vessel Internal Components for the 108% Power Uprate in Waterford Unit 3”, R. K. Kapoor, 3/14/97.

Attachment A

To

00000-NOME-ER-0142

Cost Benefit Analysis

4-Rod CEA Removal

Waterford 3

November 2000

Attachment 6

To

W3F1-2001-0102

Affidavit Supporting the Withholding of Proprietary Information

I, Philip W. Richardson, depose and say that I am the Licensing Project Manager of Westinghouse Electric Company LLC (WEC), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and described below.

I am submitting this affidavit in conjunction with the application by Entergy Operations Incorporated and in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations for withholding this information. I have personal knowledge of the criteria and procedures utilized by WEC in designating information as a trade secret, privileged, or as confidential commercial or financial information.

The information for which proprietary treatment is sought, and which documents have been appropriately designated as proprietary, is contained in the following:

- *CE NPSD-1102-P, "Elimination of 4-Rod CEAs from CE NSSS 217 Fuel Assembly Cores," dated November 2000.*
- *Proprietary Enclosure A to L-2001-002, "Scoping Study of PLCEA Replacement at Waterford 3," dated January 5, 2001.*

Pursuant to the provisions of Section 2.790(b)(4) of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information included in the documents listed above should be withheld from public disclosure.

i. The information sought to be withheld from public disclosure is owned and has been held in confidence by WEC. It consists of details of the analyses concerning the removal of 4-rod Control Element Assemblies from 217 fuel assembly CE NSSS designs and the replacement of part length CEAs at Waterford-3.

ii. The information consists of analyses or other similar data concerning a process, method or component, the application of which results in substantial competitive advantage to WEC.

iii. The information is of a type customarily held in confidence by WEC and not customarily disclosed to the public.

iv. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.

v. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.

vi. Public disclosure of the information is likely to cause substantial harm to the competitive position of WEC because:

   a. A similar product or service is provided by major competitors of Westinghouse.

   b. Development of this information by WEC required tens of thousands of dollars and hundreds of manhours of effort. A competitor would have to undergo similar expense in generating equivalent information.

c. The information consists of details of analyses and evaluation data concerning the elimination or replacement of part length control element assemblies at Waterford-3, the application of which provides a competitive economic advantage. The availability of such information to competitors would enable them to design their product or service to better compete with WEC, take marketing or other actions to improve their product's position or impair the position of WEC's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.

d. In pricing WEC's products and services, significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included. The ability of WEC's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.

e. Use of the information by competitors in the international marketplace would increase their ability to market comparable products or services by reducing the costs associated with their technology development. In addition, disclosure would have an adverse economic impact on WEC's potential for obtaining or maintaining foreign licenses.

Sworn to before me this
16th day of October 2001

Philip W. Richardson
Licensing Project Manager
Westinghouse Electric Company LLC

Joan C. Hastings
Notary Public

My commission expires: JOAN C. HASTINGS
NOTARY PUBLIC
MY COMMISSION EXPIRES SEP. 30, 2002

Attachment 7

To

W3F1-2001-0102

Summary of Commitments

The following table identifies those actions committed to by Entergy Operations, Inc. in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

REGULATORY COMMITMENTS	DUE DATE/EVENT
Entergy commits to implement the CEA replacement changes only after both NRC staff approval of the requested technical specification changes has been received and acceptable conclusions from the 10CFR50.59 evaluation of the reload analyses report have been determined.	prior to implementation of amendment (and modification)
The reload 10CFR50.59 evaluation will address the PLCEA and four-element changes as they relate to the accident analyses.	prior to implementation of amendment (and modification)
The RAR will evaluate the final configuration of the fuel and CEAs. It will ensure that, with the COLR-required insertion limits, the technical specification requirements for shutdown margin, rod worth, and axial flux shaping continue to be met and are adequate to protect the safety limits.	prior to implementation of amendment (and modification)