CEN-310-NP-A

CPC AND METHODOLOGY CHANGES FOR THE CPC IMPROVEMENT PROGRAM

COMBUSTION ENGINEERING

LEGAL NOTICE

CEN-310-NP-A

CPC AND METHODOLOGY CHANGES FOR THE CPC IMPROVEMENT PROGRAM

APRIL, 1986

COMBUSTION ENGINEERING

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

March 12, 1986

Mr. A. E. Scherer, Director
Nuclear Licensing
Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Dear Mr. Scherer:

SUBJECT: ACCEPTANCE FOR REFERENCING OF LICENSING TOPICAL REPORT CEN-308-P AND CEN-310-P, "CPC/CEAC SOFTWARE MODIFICATIONS FOR THE CPC IMPROVEMENT PROGRAM" AND "CPC AND METHODOLOGY CHANGES FOR THE CPC IMPROVEMENT PROGRAM"

We have completed our review of the subject topical report submitted by Combustion Engineering, Inc. (CE) by letters dated August 30, 1985 and October 18, 1985. We find the reports to be acceptable for referencing in license applications to the extent specified and under the limitations delineated in the report and the associated NRC evaluation, which is enclosed. The evaluation defines the basis for acceptance of the reports.

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

In accordance with procedures established in NUREG-0390, it is requested that CE publish accepted versions of the reports, proprietary and non-proprietary, within three months of receipt of this letter. The accepted versions shall incorporate this letter and the enclosed evaluation between the title page and the abstract. The accepted versions shall include an -A (designating accepted) following the report identification symbol.

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

Sincerely,

Herbert N. Berkow

Herbert N. Berkow, Director
Standardization and Special
Projects Directorate
Division of PWR Licensing-B

Enclosure:
As stated

ENCLOSURE

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

SAFETY EVALUATION OF CE TOPICAL REPORTS
CEN-308-P, "CPC/CEAC SOFTWARE MODIFICATIONS FOR THE CPC IMPROVEMENT PROGRAM"
CEN-310-P, "CPC AND METHODOLOGY CHANGES FOR THE CPC IMPROVEMENT PROGRAM"

1.0 INTRODUCTION

Combustion Engineering, Incorporated (CE), by letter from A. E. Scherer (CE) to G. Knighton (NRC) dated August 30, 1985, submitted topical report CEN-308-P, Revision 00-P, entitled, "CPC/CEAC Software Modifications for the CPC Improvement Program." This report describes the changes made to the Core Protection Calculator (CPC) and Control Element Assembly Calculator (CEAC) functional design requirements as part of the program of CPC modifications and methodology improvements. This CPC improvement program has been implemented by the CPC Oversight Committee, consisting of Arizona Nuclear Power Project, Arkansas Power and Light Company, Louisiana Power and Light Company and Southern California Edison, with CE as its technical consultant. In addition, topical report CEN-310-P, "CPC and Methodology Changes for the CPC Improvement Program," was submitted on October 18, 1985, by letter from A. E. Scherer to G. Knighton. This report provides a brief overview of each functional change and the associated changes in analysis methodology and was used to assist the NRC's review of CEN-308-P.

The CPC system is designed to provide the low departure from nucleate boiling ratio (DNBR) and high local power density (LPD) reactor trips to ensure that the specified acceptable fuel design limits (SAFDLs) on departure from nucleate boiling (DNB) and centerline fuel melt are not exceeded during anticipated operational occurrences (AOOs). In addition, these trips assist the engineered safety features system in limiting the consequences of certain postulated accidents.

The CPC improvement program was developed with several goals in mind. One goal is to presently implement appropriate modifications and methodology improvements so as to reduce future reload efforts and, possibly, the

need for NRC reload reviews by attempting to avoid future CPC software changes. Another goal is to reduce unnecessary plant trips. The CPC improvement program is also designed so as to maintain safety margins. Technical questions that arose during review of these two documents were addressed at a meeting between Southern California Edison, Louisiana Power and Light Company, Oak Ridge National Laboratory, NRC, and Combustion Engineering at the vendor's headquarters in Windsor, Connecticut on December 3 and 4, 1985.

2.0 SAFETY EVALUATION

Changes to the CPC system software include the addition of certain new features and the deletion or substantial simplification of others. Specifically, the following modifications were reviewed:

A. FLOW Program

1. Simplification of flow calculations.
2. Removal of the DNBR flow projection modules.

B. UPDATE Program

1. Addition of variable overpower trip.
2. Removal of redundant thermal power compensation filters.
3. Enhancement of ASGT delta-T compensation filter.
4. Changes for CEAC desensitization.
5. Removal of pressure projection.
6. Combination of PFMLTD and PFMLTL addressable constants into a single penalty factor multiplier.

C. POWER Program

1. Base low power ASI calculation on actual axial shape.
2. Revision of power synthesis calculations.
3. Removal of flow projection calculations and DNBR operating limit.

4. Incorporation of an ASI dependent power peaking adjustment.
5. Changes for CEAC desensitization-CEA withdrawal prohibit flag for misoperation.

D. TRIPSEQ Program

1. Removal of comparison to flow projected DNBR and pressure projected DNBR.
2. Redefinition of auxiliary trip flag (J_{trip}).
3. Changes for CEAC desensitization.
4. Addition of DNBR trip setpoint to addressable constants.

E. CEAC Program

1. Changes for CEAC desensitization - set flag to initiate CEA withdrawal prohibit.

Certain CPC constants are addressable so that they can be changed as required during operation. As a result of the CPC system software modifications, changes have also been made to the list of addressable constants. The power synthesis algorithm changes in the POWER program to allow the addressable constants ARM6, ARM7, EOL, ASM6 and ASM7 to be deleted. The combination of the penalty factor multipliers for DNBR and LPD into a single multiplier results in the deletion of addressable constant PFMLTL. Also, as a result of the simplification of the flow calculations, the core coolant mass flow rate calibration constant FC2 has been deleted. These addressable locations will now contain the following new addressable constants:

A. ARM6 will contain the maximum value of Variable Over Power Trip (VOPT) setpoint.
B. ARM7 will contain the offset between VOPT setpoint and FOLLOW.
C. EOL will contain the DNBR trip setpoint.
D. ASM6 will contain the ASGT delta-T trip setpoint.

E. ASM7 will remain vacant.

F. PFMLTL will contain the CEAC penalty factor time delay as a result of the CEAC desensitization changes.

G. FC2 will contain the pump speed trip setpoint.

We have reviewed these modifications within the guidelines provided by the NRC Standard Review Plan (NUREG-0800), namely, Sections 4 and 15. Included in this effort was the review of the San Onofre Nuclear Generating Station (SONGS) Units 2 and 3 Reload Analysis Report for Cycle 3 operation. The safety analyses confirm that the CPC modifications perform as intended and that the design limits on DNBR and LPD are met under all operating conditions.

As mentioned previously, one objective of these CPC modifications is to reduce spurious trips in an attempt to enhance both safety and operability. This implies that certain tolerance windows must be enlarged. A key consideration is whether the revised system is as conservative as the original. The modifications involve trade-offs: plant operation and reliability is improved to the extent that the incidence of spurious trips is reduced, but there results reduced sensitivity to disturbances such as control element assembly calculator (CEAC) malfunctions for which time delays are introduced. Considering all gains and losses, there appears conceptually to be little net change in system safety. On the basis of the available information, the system remains as conservative as it previously was for the most limiting conditions.

The reports did not contain results of Phase I and Phase II testing. Phase I design qualification testing is performed on the DNBR/LPD calculator system to verify that CPC/CEAC system software modifications have been properly implemented. Phase II testing is performed on the CPC/CEAC system to verify that the CPC and CEAC software modifications have been properly integrated with the CPC and CEAC software and system hardware and to provide confirmation that the static and dynamic operation of the integrated system as modified is consistent with that predicted by design analyses. The CPC Oversight Committee has indicated that the verification and validation procedures for changes to CPC system software which have been previously reviewed and approved by the NRC will be followed to assure that the new algorithms have been correctly incorporated into the CPC system software. We find this to be acceptable.

The NRC has been assisted by our consultants at Oak Ridge National Laboratory under Technical Assistance contract FIN No. A9472 in the review of CEN-308-P and CEN-310-P.

CONCLUSIONS

We have reviewed the CPC system software modifications as described in CEN-308-P and CEN-310-P. From a safety point of view, positive features include the intended reduction of spurious trips and the simplifications of the system design and operation, which should improve reliability.

We have not reviewed the results of Phase I and Phase II testing to verify that the modifications have been properly implemented but have been assured by the CPC Oversight Committee that previously approved testing procedures will be followed.

Based on our review, we find the proposed modifications to be conceptually desirable and acceptable.

GLOSSARY

ANO	Arkansas Nuclear One
ANPP	Arizona Nuclear Power Project
AOO	Anticipated Operational Occurrence
AP&L	Arkansas Power and Light Company
ASGT	Asymmetric Steam Generator Transient
ASI	Axial Shape Index
BCEAW	Bank CEA Withdrawal
CEA	Control Element Assembly
CEAC	CEA Calculator
CEAD	CEA Drop
CEDMCS	Control Element Drive Mechanism Control System
CMI	CEA Motion Inhibit
COLSS	Core Operating Limit Supervisory System
CPC	Core Protection Calculator
CPCS	Core Protection Calculator System
CWP	CEA Withdrawal Prohibit
DBE	Design Basis Event
DNB	Departure from Nucleate Boiling
DNBR	DNB Ratio
EPRI	Electric Power Research Institute
LCO	Limiting Condition for Operation
LOF	Loss of Flow
LPD	Linear Power Density
LP&L	Louisiana Power and Light Company
MTC	Moderator Temperature Coefficient

PLCEA Part Length CEA

ROPM Required Overpower Margin

RTD Resistance Temperature Detector

SAFDL Specified Acceptable Fuel Design Limit

SCE Southern California Edison

SONGS San Onofre Nuclear Generating Station

[ ]

VOPT Variable Overpower Trip

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1.0 SUMMARY

The COLSS/CPC Oversight Committee, consisting of Arizona Nuclear Power Project (ANPP), Arkansas Power and Light Company (AP&L), Louisiana Power and Light Company (LP&L) and Southern California Edison (SCE), with Combustion Engineering as its technical consultant, has developed the CPC Improvement Program, a program of CPC modifications and methodology improvements scheduled to be implemented in 1986 and 1987. An initial presentation of concepts was presented to the NRC on November 8, 1984 and the schedule for implementation of the program was provided to the NRC on March 8, 1985. A detailed presentation of the portions of the program scheduled for implementation in early 1986 was provided in a meeting on April 18, 1985. Copies of the slides presented at that meeting have been provided to the NRC in Reference 1.

The CPC Improvement Program consists of three major areas:

Part A	-	Optimization of CPC/CEAC Software for Reloads
Part B	-	CEAC Desensitization to Spurious Signals
Part C	-	Reload Data Block Constants

Parts A and B of the program will first be implemented in Cycle 3 of SCE's SONGS Unit 2 which is scheduled for start up in early 1986. Following this implementation, the same algorithms will be implemented in Cycle 5 of AP&L's ANO Unit 2 and Cycle 3 of SCE's SONGS

Unit 3 later in 1986. Functionally identical algorithms incorporating additional modifications for Part C of the program are planned for implementation in Cycle 2 of LP&L's Waterford Unit 3 and in Cycle 2 of ANPP's Palo Verde Units 1, 2, and 3 as these plants are refueled. Table 1-1 summarizes the implementation schedule.

This document provides a brief review of each functional change to the CPCS associated with Parts A and B of the CPC Improvement Program and the basis for those changes. Part C of the program will be addressed in a future submittal. In addition, a brief overview is provided of changes in analysis methodology associated with the functional changes. Detailed algorithm modifications, in the form of functional specifications, were provided in the CPC/CEAC Software Modification document (Reference 2). The modifications were described as changes relative to the CPC/CEAC algorithms currently in place at SONGS Unit 2 and ANO Unit 2 (References 3 & 4).

Table 1-1

CPC Improvement Program Implementation Schedule

Utility	Plant	Cycle	Program Components*	Date
SCE	SONGS-2	3	A,B	Early 1986
AP&L	ANO-2	Mid-5	A,B	Early 1986
SCE	SONGS-3	3	A,B	Late 1986
LP&L	Waterford-3	2	A,B,C	Early 1987
ANPP	PVNGS-1	2	A,B,C	Early 1987
ANPP	PVNGS-2	2	A,B,C	Early 1988
ANPP	PVNGS-3	2	A,B,C	Early 1989

*Part A - Optimization of software for reloads

Part B - CEAC desensitization to spurious signals

Part C - Reload Data Block Constants

2.0 CPCS AND METHODLOGY CHANGES

2.1 Variable Overpower Trip

A Variable Overpower Trip (VOPT) algorithm has been added to the UPDATE program to improve the CPC response to transients with rapid power increases such as low power CEA withdrawals and large excess load events. Previously, [ ] [ ] was required to correct for the maximum non-conservative power error that could occur during design basis transients. The addition of the VOPT algorithm will reduce the size of this adjustment.

The VOPT algorithm [ ]

The new algorithm is functionally similar to the hardware VOPT system that is presently installed in the Palo Verde units except

The addition of the VOPT algorithm permits reanalysis of the CEA bank withdrawal and excess load events to credit the improved response of the CPCS to such transients.

2.1.1 Impact on Sequential CEA Bank Withdrawal Analysis

Protection against exceeding the DNBR SAFDL during a sequential CEA bank withdrawal (BCEAW) event at power was provided by the CPC Low DNBR trip. The CPC sensed the power rise and related changes in other parameters and determined if a Low DNBR trip was required.

The addition of the Variable Overpower Trip adds another level of plant protection for this event. The VOPT will initiate a reactor trip for events with rapidly increasing core power. Thus, the addition of the VOPT will affect those BCEAW events with large reactivity insertion rates. For such events, the VOPT will respond more rapidly than would the CPC Low DNBR trip. Due to the faster response of the VOPT, the dynamic response of the CPC DNBR algorithm was relaxed and [ ] was not required to assure a timely CPC trip for these rapid events. For example, during a typical BCEAW event from zero power the SONGS Unit 2 CPC will now initiate a trip via the VOPT algorithm when the power reaches approximately 30% of rated power. For the same event, a Low DNBR trip would not have been initiated until the power exceeded approximately 70% of rated power. This faster response to rapid BCEAW events simplifies the event analysis and improves the safety of the plant.

The CPC Low DNBR trip remains the primary protection for BCEAW events with lower reactivity insertion rates. However, for these slower events, [ ] implies a smaller impact on the plant operating flexibility and a reduced possibility of an unnecessary reactor trip. A re-evaluation of the spectrum of BCEAW events using current methodology but crediting the new trip will be performed to confirm that the events meet the SAFDLs on both DNBR and LHR as well as the criterion on peak system pressure.

2.1.2 Impact on Excess Load Event Analysis

The increased main steam flow event is the limiting excess load event and results in a power increase whenever the MTC is negative. Previous analyses credited either the CPC Low DNBR trip or the Linear High Power trip to demonstrate that the DNB and LPD SAFDLs were met for the event. Both of these trips can possibly be delayed by the rapid decrease in cold leg temperature: the DNBR trip due to beneficial impact of reduced temperature on calculated DNBR and the linear high power trip due to the increased shielding of the excore detectors by the colder (i.e., more dense) water. The VOPT algorithm will provide a reactor trip sooner than either the Low DNBR trip or the Linear High Power trip for some rapid power increasing excess load events.

A large excess load event causes the core inlet temperature to decrease rapidly which results in a significant core power rise for typical values of negative MTCs. The use of [ ] [ ] Using the current methodology, the response of the CPCS with the VOPT to the increased main steam flow events will be re-evaluated to confirm that the events meet the SAFDLs on DNBR and LHR.

2.2 Asymmetric Steam Generator Transient Algorithm

The UPDATE program in CPC includes an algorithm which provides automatic protection in the event of certain Asymmetric Steam Generator Transients (ASGT). In the previous version of this algorithm, a sufficiently large difference in cold leg temperatures caused [ ]

Several modifications have been made to the ASGT algorithm to improve its response to asymmetric temperature transients. The use of [ ]

[ ]

The trip times obtained in the ASGT analysis based on the previous algorithm were adversely impacted by [

] This has the effect of reducing the sensitivity of the algorithm to short term perturbations of the temperature

signals. In addition, the algorithm is less sensitive to changes in the RTD characteristics so that margin penalties are less likely.

As an additional benefit, the improved ASGT algorithm allows for the calculation of cycle independent [ ] This leaves only the trip setpoint, which is an addressable constant, that needs to be verified or recalculated on a cycle specific basis.

2.3 Incipient CEA Misoperation Detection

The CPCS provides protection against violation of a SAFDL due to CEA misoperations such as single CEA deviation, CEA subgroup deviation, out-of-sequence CEA group insertion, and excessive insertion of the PLCEAs. Modifications have been made to several of the CPC programs to initiate the CEA withdrawal prohibit (CWP) prior to exceeding the deadband for CPCS response to any of these misoperations.

The CPCS uses two CEA calculators (CEACs) to determine if any CEA has deviated from the remainder of its subgroup by an excessive amount. When either CEAC detects a small deviation, an alarm is initiated and, if the deviation exceeds an allowable deadband, each CEAC sends a penalty factor to each of the four CPCs to increase the radial power peaking. When operating margin is small, even a small penalty could result in a reactor trip.

The CEAC program has been modified to provide a flag bit to indicate when one or more CEAs have deviated from their subgroup by an amount greater than the alarm limit even if the deviation is not large enough to send a penalty factor. If this flag bit has been set by either CEAC, the UPDATE program will forward the flag to TRIPSEQ which will initiate a CEA Withdrawal Prohibit (CWP).

The POWER program determines if larger scale CEA misoperations have occurred. Penalty factors are applied to the radial power peaking whenever [ ] the core, the regulating CEAs are moved out-of-sequence, or there is a significant deviation between the subgroups within the same group. The penalty factor for these conditions may be large (e.g., an 8.0 multiplier) and may cause a CPC channel trip when applied in the calculation. The algorithm has been modified to set a flag when the plant is approaching one of the above situations but prior to application of a penalty factor. This flag is also sent to TRIPSEQ which will initiate a CEA Withdrawal Prohibit (CWP).

By warning the operator about the incipient application of a penalty factor and simultaneously preventing the CEA movement in the direction that would increase core power, the CWP provides time for the operator to take corrective action. This will sometimes prevent the plant from reaching a condition that might have required a trip and thus reduces the possibility that an unnecessary plant trip will occur.

2.4 CEAC Desensitization to Spurious Signals

The previous UPDATE program selected the larger of the penalty factors transmitted by the two CEACs for immediate application to the core power used in the DNBR and LPD calculations. As a result,

2.4.1 CEAC Fail Flag Interpretation

The penalty factor word that is transmitted by each CEAC includes a [ ]

The logic in UPDATE has been revised to [ ] Thus, the modification can not have any adverse effect on plant safety unless the CEAC failure should occur during a single CEA misoperation event while the other CEAC has been taken out of service for periodic testing or maintenance. [ ] However, the consequences of

the event would only be slightly more adverse and will be considered in the safety analysis to confirm acceptable results.

2.4.2 CEAC Penalty Factor Delay

The algorithm in UPDATE which interprets CEAC deviation penalty factors has been modified [

]

[ ] for the initial implementation of this algorithm modification for SONGS Unit 2 Cycle 3.

2.5 [ ]

[ ]

2.6 Other Modifications

The remaining changes to the CPC algorithm have smaller impact on the performance of the system than do those already described. The changes include the incorporation into the algorithms of effects that had been previously obtained via selection of data base constants, removal of unused algorithms, the response to a new licensing position, the simplification of methods, and the provision of additional information to the plant operator.

2.6.1 Simplified Flow Calculation

The algorithm used to calculate coolant mass flow rate in the FLOW program has been simplified [ ]

[ ] The flow calculated by the revised algorithm does not differ significantly from that calculated by the current algorithm. The minor residual differences will be accommodated in the CPC uncertainty analysis. Simplifying the prior calculation, [ ] [ ] reduces the time required to calculate flow and thus reduces the loading on the CPC central processor unit.

2.6.2 Removal of Projected DNBR Algorithms

The previous FLOW program included a projection of the calculated DNBR for perceived changes in core mass flow. This projected DNBR was used to prevent violation of the DNBR SAFDL during the Loss of Flow (LOF) event. This event analysis now uses the CPC trip that occurs when the speed of one or more of the reactor coolant pumps drops below the new addressable trip setpoint on pump speed. The flow projected DNBR is no longer required and has thus been removed. The addressable pump speed trip setpoint will be determined from the LOF analysis for each plant. This change was first implemented (without the addressable constant) in the SONGS Unit 2 Cycle 2 analysis by modifications to data base constants.

Also, the previous UPDATE program included the calculation of a projected DNBR which accounted for dynamic pressure changes. Safety analyses have determined that such a projection is not required and data base constants have always nullified the calculation.

Therefore, this algorithm is being eliminated to reduce the calculational time and hence the loading on the CPC central processor unit.

Complementary modifications were made to the TRIPSEQ and FLOW programs to compare a single DNBR [ ] [ ] to the DNBR trip setpoint. In addition, the calculation of several parameters previously used in the flow projection algorithm has been removed from the POWER program.

2.6.3 Elimination of [ ]

The previous UPDATE program included [ ] [ ]

[ ]

2.6.4 Deviation Penalty Factor Simplification

The data base constants previously used in the CEAC program provided unique penalty factors for both DNBR and LPD for many combinations of deviation direction, deviated CEA, and general CEA configuration. A reduced set of penalty factor data will be used in the future to simplify the analysis that generates the CEAC data base. [ ] In either case, analysis required to support these deviation penalty factors for future cycles will be reduced. [ ] was first approved in mid Cycle 1 of SONGS Unit 2.

The previous UPDATE program included [ ]

[ ]

2.6.5 ASI Dependent Parameters

[ ]

2.6.6 Low Power ASI Display

At low power levels where excore signals are less reliable due to noise, [ ]

[

]

2.6.7 Elimination of the Augmentation Factor Array

The previous POWER program included adjustment of the 3-D power peaking factor for the effects of fuel densification via an axially dependent augmentation factor. A recently completed analysis performed by C-E for EPRI (Reference 5), demonstrated that the increased power peaking associated with the small interpellet gaps found in C-E's modern fuel rods (non-densifying fuel in pre-pressurized tubes) is insignificant and that the augmentation factors are no longer required. This analysis was presented to the NRC for Calvert Cliffs Units 1 & 2 (Reference 6) and was approved in Reference 7. Thus, the augmentation factors are no longer required in CPC and this calculation has been deleted from the POWER routine.

2.7. COLSS Modifications

The total Loss of Reactor Coolant Flow (LOF), the single full length CEA Drop (CEAD) and the Asymmetric Steam Generator Transient (ASGT) have typically been the most limiting transients with respect to determining DNBR margin related LCO's. As described in Reference 9, the thermal margin maintained by the LCO's has been monitored in COLSS [ ] [ ] and potential margin loss due to the need to use conservative conversion factors.

Recent analyses using HERMITE space-time methods (Reference 8) have reduced the margin requirements for LOF and ASGT on some plants. In contrast, the desire to avoid unnecessary plant trips [ ] [ ]

FIGURE 2.1
VOPT ALGORITHM RESPONSE

FIGURE 2.2
ASGT ALGORITHM SCHEMATIC

3.0 REFERENCES

1) "CPC Improvement Program - Detailed Presentation to NRC", CEN-302(S)-NP, April 1985

2) "CPC/CEAC Software Modifications for the CPC Improvement Program," CEN-308-NP Rev. 00-NP, August 1985

3) "Functional Design Requirements for a Core Protection Calculator," CEN-305-NP, July 1985

4) "Functional Design Requirement for a Control Element Assembly Calculator," CEN-304-NP, July 1985

5) "CEPAN Method of Analyzing Creep Collapse of Oval Cladding, Volume 5: Evaluation of Interpellet Gap Formation and Clad Collapse in Modern PWR Fuel Rods," EPRI NP-3966-CCM, Volume 5, Project 2061-6, Computer Code Manual, April 1985

6) "Calvert Cliffs Nuclear Power Plant Unit Nos. 1 & 2 Docket Nos. 50-317 & 50-318, Request for Amendment", Letter, A. E. Luduall, Jr. to J. R. Miller (Chief Operating Reactors Branch #3) 12/31/80

7) "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 104 to Facility Operating License No.

DPR-53, Baltimore Gas & Electric Company Calvert Cliffs Nuclear Power Plant Unit No. 1 Docket 50-317

8) "HERMITE - A Multi-dimensional Space Time Kinetics Code for PWR Transients", CENPD-188, March 1976

9) "Overview Description of the Core Operating Limit Supervisory System (COLSS)", CEN-312-NP, Rev. 0-NP, September, 1986