JUN 17 1976

DISTRIBUTION

Local PDR	JRBuchanan
NRC PDR	DRoss
Docket	OPA (CMiles)
ORB #2 Reaidng	JMcGough
KRGoller	DEisenhut
BCRusche	BScharf (10)
EGCase	BJones (4)
VStello	BRood
TJcarter	WGMcDonald, MIPC
EAReeves	
DLZiemann	
RMdiggs	
EOLD	
OI&E (3)	
ACRS (16)	
TBAbenrathy	

* Sent cys of Combustion Engrg ltr. 6/15/76 and NRC ltrs. to CE 12/9/75 * 6/13/75. RD

Docket No. 50-317

Baltimore Gas and Electric Company
ATTN: Mr. A. E. Lundvall, Jr.
Vice President - Supply
Gas & Electric Building
Charles Center
Baltimore, Maryland 21203

Gentlemen:

Enclosed is a signed original of an Order for Modification of License dated June 17, 1976, issued by the Commission for the Calvert Cliffs Nuclear Power Plant, Unit No. 1. This Order amends Facility Operating License DPR-53 by adding the provision that the reactor shall not be operated with a peak linear heat generation rate in excess of 13.9 kW/ft for all fuel assemblies. This Order also requires submittal of a corrected ECCS analysis as soon as possible.

A copy of this Order is being filed with the Office of the Federal Register for publication.

Information was transmitted to BG&E (Lawrence & Douglas) by telecon 2:40PM 6-17-76. EAR

Sincerely,

Original signed by
Dennis L. Ziemann

Dennis L. Ziemann, Chief
Operating Reactors Branch #2
Division of Operating Reactors

Enclosure:
Order for Modification
of License

cc w/enclosure:
See next page

SEE PREVIOUS YELLOW FOR CONCURRENCE
DOR:ORB #2
RMDiggs
6/ /76

NRR:DIR
BCRusche
6/ /76

OFFICE	DOR:ORB #2	DOR:ORB #2	EOLD	DOR:AD/ORs	DOR:DIR	NRR:D/DIR
SURNAME	EAReeves:ah	DLZiemann		KRGoller	VStello	EGCase
DATE	6/17/76	6/17/76	6/ /76	6/ /76	6/ /76	6/ /76

DISTRIBUTION:

Local PDR	TBAbernathy
Docket	JRBuchanan
ORB#2 Rdg	DRoss
BCRusche	OPA (Clare Miles)
EGCase	JMcGough
VStello	DEisenhut
KRGoller	BScharf (10)
TJCarter	BJones (4)
DZiemann	EAReeves
RMDiggs	WGMcDonald, MIPC
OELD	
OI&E (3)	
ACRS (16)	

Docket No. 50-317

Baltimore Gas and Electric Company
ATTN: Mr. A. E. Lundvall, Jr.
Vice President - Supply
Gas & Electric Building
Charles Center
Baltimore, Maryland 21203

Gentlemen:

Enclosed is a signed original of ~~the~~ an Order for Modification of License dated June 17, 1976 issued by the Commission for the Calvert Cliffs Nuclear Power Plant, Unit No. 1. The Order amends Facility Operating License DPR-53 by adding the provision that the reactor shall not be operated with a peak linear heat generation rate in excess of 13.9 kW/ft for all fuel assemblies. This Order also requires submittal of a corrected ECCS analysis as soon as possible.

A copy of the Order is being filed with the Office of the Federal Register for publication.

Changes as marked per Rusche - EAR 6/17/76

Sincerely,

Dennis L. Ziemann, Chief
Operating Reactors Branch #2
Division of Operating Reactors

Enclosure:
Order for Modification
of License

cc: See next page

OFFICE ➤	DOR:ORB #2	DOR:ORB #2	OELD	DOR:AD/ORs	DOR:DIR	NRR:D/DIR	NRR:DIR
SURNAME ➤	EAReeves:ah	RMDiggs: DLZiemann	Shapar	KRGoller	VStello	EGCase	BCRusche
DATE ➤	6/16/76	6/16/76	6/16/76	6/17/76	6/17/76	6/17/76	6/ /76

Form AEC-318 (Rev. 9-53) AECM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1974-526-166

cc w/enclosure:
James A. Biddison, Jr.
General Counsel
Gas and Electric Building
Charles Center
Baltimore, Maryland 21203

James C. Cawood, Jr., Esquire
Vice President
Chesapeake Environmental
Protection Association
4700 Auth Place
Camp Springs, Maryland 20023

George F. Trowbridge, Esquire
Shaw, Pittman, Potts and
Trowbridge
1800 M Street, N. W.
Washington, D. C. 20036

Bechtel Power Corporation
ATTN: Mr. R. L. Ashley
Chief Nuclear Engineer
P. O. Box 607
Gaithersburg, Maryland 20760

Combustion Engineering, Inc.
ATTN: Mr. J. A. Honey
Project Manager
P. O. Box 500
Windsor, Connecticut 06095

Calvert County Library
Prince Frederick, Maryland 20678

Mr. Bernard Fowler, President
Board of County Commissioners
Prince Frederick, Maryland 20678

cc w/enclosure and cy of BG&E
filing dtd. 6/14/76:
Mr. Warren D. Hodges, Director *
Department of State Planning
30 West Preston Street
Baltimore, Maryland 21201

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of)
)
BALTIMORE GAS AND ELECTRIC COMPANY) Docket No. 50-317
)
(Calvert Cliffs Nuclear Power Plant,)
Unit No. 1))

ORDER FOR MODIFICATION OF LICENSE

I.

Baltimore Gas and Electric Company, Gas & Electric Building, Charles Center, Baltimore, Maryland 21203 (the Licensee), is the holder of Facility Operating License No. DPR-53 which authorizes the operation of a nuclear power reactor known as Calvert Cliffs Nuclear Power Plant, Unit No. 1 (the facility) at steady state reactor power levels not in excess of 2560 thermal megawatts (rated power). The facility is a pressurized water reactor (PWR) located at the Licensee's site in Calvert County, Maryland.

II.

In conformance with evaluations of the performance of the Emergency Core Cooling System (ECCS) of the facility submitted by the Licensee on September 12, 1974, and with the Order for Modification of License dated December 27, 1974, the reactor core peak linear heat rate is limited to 15.2 kW/ft in all fuel assemblies. To further comply with the Order of December 27, 1974, the Licensee submitted on July 9, 1975, a re-evaluation of ECCS cooling performance to verify the operating limitations proposed in the Licensee's submittal of September 12, 1974. The ECCS performance evaluation submittal by the Licensee on July 9, 1975, was based upon a subsequently approved

ECCS evaluation model developed by Combustion Engineering, Inc. (CE), the designer of the facility, to conform to the requirements of the Commission's ECCS Acceptance Criteria, 10 CFR Part 50, §50.46 and Appendix K. The evaluation indicated that with peak linear heat generation rate limited to 15.8 kW/ft, and with the other limits set forth in the facility's Technical Specifications, the ECCS cooling performance for the facility would conform to the criteria contained in 10 CFR §50.46(b) which govern calculated peak clad temperature, maximum cladding oxidation, maximum hydrogen generation, coolable geometry and long term cooling. The NRC staff review of the Licensee's submittal of July 9, 1975, is continuing. In the meanwhile, the Technical Specifications have been limited to 15.2 kW/ft based on the earlier evaluation.

On June 8, 1976, the NRC staff was informed by CE that several errors had been discovered in STRIKIN-2, the computer code used to calculate peak clad temperature and the clad oxidation percentage in both CE ECCS models. These errors were discovered by CE during an internal Quality Assurance audit of their LOCA evaluation model codes. While some of these errors have either no significant effect or a conservative effect on the evaluation results, some lead to non-conservative values. Based on a preliminary assessment, including information and supportive calculations by CE, the staff has determined that the following two code errors, when corrected, could produce ECCS evaluation results which would require a reduction in operating limits for Combustion Engineering plants:

(1) Guide Tube Model - The code treated the control rod guide tube as a solid rod rather than a hollow tube. This resulted in an

excess heat storage capacity in the guide tube which then led to excessive thermal radiation cooling from the hot rod to the guide tube.

(2) View Factors for Radiation Cooling Model - The code did not conservatively treat the view factors in the thermal radiation model to account for the possible effect of rupture and ballooning of adjacent fuel rods which contact the hot rod and reduce the surface area available for radiation cooling.

For this reason the staff instructed CE and the Licensee to provide a revised calculation of peak clad temperature for the worst break area identified in previous calculations with the errors properly corrected. Using the more recent CE evaluation model, with the code corrected for the two items discussed above, and with an additional correction of a sign error in the source term of the conduction equations (this latter error produced a conservative effect), the revised calculations demonstrate that for peak linear heat generation rates of 14.9 kW/ft in all fuel assemblies, the peak clad temperature and amount of cladding oxidation remain below the criteria set forth in 10 CFR §50.46(b). The staff expects that when final revised calculations for the facility are submitted using the revised and corrected model they will demonstrate that operation with these peak linear heat generation rates would conform to the criteria of 10 CFR §50.46(b). Such revised calculations fully conforming to the requirements of 10 CFR §50.46 are to be provided for the facility as soon as possible.

However, since a revised evaluation for the entire break spectrum for the facility using the new evaluation model properly corrected cannot be completed for several weeks, the staff believes that it is prudent to impose an interim penalty on allowable peak linear heat generation rate to account for uncertainties that may result from the fact that calculations thus far have been made only for the worst case break previously identified. The staff concludes that an additional limitation of 1 kW/ft will eliminate uncertainties resulting from the preliminary limited break spectrum calculations thus far performed, and will assure that ECCS performance at the facility will conform to all the criteria set forth in 10 CFR §50.46(b). These additional limitations will provide reasonable assurance that the public health and safety will not be endangered.

Upon notification by the NRC staff on June 11, 1976, the Licensee promptly modified plant setpoints to reduce peak linear heat generation rate by 1 kW/ft to 13.9 kW/ft in all fuel assemblies. The NRC staff believes that the Licensee's action, under the circumstances, is appropriate and that this action should be confirmed by NRC Order.

Copies of the following documents are available for public inspection in the Commission's Public Document Room, 1717 H Street, N. W., Washington, D. C., 20555 and are being placed in the Commission's Local Public Document Room, the Calvert County Library, Prince Frederick, Maryland: (1) Letters dated June 13, 1975 and December 9, 1975, from the NRC staff to Combustion Engineering; (2) Letter dated June 14, 1976 from Baltimore Gas and Electric Company to the Director of Nuclear Reactor Regulation; (3) Letter dated June 15, 1976, from Combustion Engineering to the NRC staff; and (4) This Order for Modification of License, In the Matter of Baltimore Gas and Electric Company (Calvert Cliffs Nuclear Power Plant, Unit No. 1), Docket No. 50-317.

III.

Accordingly, pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's Rules and Regulations in 10 CFR Parts 2 and 50, IT IS ORDERED THAT Facility Operating License No. DPR-53 is hereby amended by adding the following new provisions:

(1) As soon as possible, the Licensee shall submit a re-evaluation of ECCS cooling performance calculated in accordance with Combustion Engineering Company's Evaluation Model approved by the NRC staff on June 13, 1975 and December 9, 1975 and corrected for the errors described herein.

(2) Until further authorization by the Commission, the reactor shall not be operated with a peak linear heat generation rate in excess of 13.9 kW/ft for all fuel assemblies.

FOR THE NUCLEAR REGULATORY COMMISSION

Ben C. Rusche, Director
Office of Nuclear Reactor Regulation

Dated in Bethesda, Maryland
this 17th day of June, 1976.

For. Docket file
50-317

C-E Power Systems
Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Tel 203/688-1911
Telex 9-9297

POWER
SYSTEMS

June 15, 1976
LD-76-068

Dr. Denwood F. Ross
Assistant Director for Reactor Safety
Division of Systems Safety
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Dr. Ross:

Following up on information which was informally presented to your staff earlier this week, Attachment 1 is being telecopied to formally make this information available.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Licensing Manager

AES/ARA:cs

Attachment 1: STRIKIN-II Changes -- Summary of Effect on Operating Plants

STRIKIN-II Changes

Summary of Effect on Operating Plants

Plant	STRIKIN Version	Supp. No.	Limiting Break	PLHGR (kw/ft)	PCT °F	FLCD (%)	Rupture Node
. Calhoun	Old	1	1.0 DES	13.4	2151 (LR)	9.3	15 (BD)
	Old	1	1.0 DES	14.0	2122 (LR)	8.9	15 (Refill
	New	2	1.0 DES	13.4	1879 (ER)	6.2	15 (BD)
	New	2	0.8 DEG	13.4	1914 (ER)	5.8	13 (BD)
ine Yankee	Old	2	0.6 DEG	13.3	1856 (LR)	6.9	14 (Reflo
	New	2	0.6 DEG	13.3	1962 (LR)	9.7	14 (Reflo
lvert Cliffs	Old	1	0.8 DEG	14.9	2198 (LR)	10.5	15 (BD)
	New	2	0.8 DEG	14.9	2130 (ER)	8.6	15 (BD)
llstone	Old	1	1.0 DEG	15.3	2186 (LR)	12.3	15 (BD)
	New	2	1.0 DEG	15.1	2034 (LR)	11.6	15 (Refill
Lucie 1**	Old	2	0.8 DEG	14.2	1966 ([illegible])	5.3	15 (BD)
	New	2	0.8 DEG	13.7	2056 (LR)	15.1	15 (BD)

** Flow Reduced Throughout Transient

Blowdown

fill Refill

Early Reflood

Late Reflood

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

December 9, 1976

For Docket File 50-317

Mr. A. E. Scherer
Licensing Manager (460-4)
Nuclear Power Systems Division
Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Dear Mr. Scherer:

In a letter dated June 13, 1975, the Nuclear Regulatory Commission (NRC) staff accepted an Emergency Core Cooling System evaluation model proposed by Combustion Engineering. However, this accepted model did not include modifications proposed in submittals dated April 14, and August 26, 1975.

The staff has completed its review of the proposed changes to the Combustion Engineering Emergency Core Cooling System evaluation model. The proposed model changes are defined in Supplement 2-P to topical report CENPD-132-P. We conclude that the model changes regarding the containment wall noding and the resistance across the Emergency Core Cooling System injection section are acceptable and may be incorporated into Emergency Core Cooling System performance evaluations for the plant classifications noted in the enclosed summary.

A third model change proposed in CENPD-132-P, Supplement 2-P, is a modification to the 0.8 multiplier presently required by the staff for FLECHT reflood heat transfer coefficients for 16X16 fuel assemblies. The staff concludes that insufficient experimental data have been reported by Combustion Engineering in support of the proposed FLECHT multiplier and that therefore, the third model change is not acceptable at this time.

It should be noted that the previous models regarding containment noding and injection section resistance are still acceptable, and remain a part of the Combustion Engineering evaluation model approved by letter dated June 13, 1975.

Our acceptance of the two model changes applies only to the use of CENPD-132-P, Supplement 2-P as part of the Combustion Engineering Emergency Core Cooling System evaluation model and does not constitute acceptance of the supplement for any other purpose than for Emergency Core Cooling System analyses. The non-proprietary version of CENPD-132-P, Supplement 2-P, which is also approved, exists as CENPD-132, Supplement 2.

Sincerely,

Original Signed by
O. D. Parr

Olan D. Parr, Chief
Light Water Reactors
Project Branch 1-3
Division of Reactor Licensing

Enclosure:
Staff Review Summary

NRC Staff Review of the Proposed
Combustion Engineering ECCS Evaluation Model Changes

1.0 Introduction

On April 16, 1975, Combustion Engineering submitted reference 1 requesting modifications to its previously approved ECCS evaluation model (referred to as the December 27, 1974 model). This model is documented by Combustion Engineering in references 3-15 and the staff's review and subsequent approval in references 16-18.

The requested model changes described in reference 1 involve the following three areas:

a) Containment wall noding used in the calculation of containment back pressure,

b) Resistance across the ECCS injection section during pumped injection, and

c) FLECHT reflood heat transfer coefficient multiplier for 16x16 fuel assemblies.

The Containment Systems Branch has reviewed the material submitted by Combustion Engineering[(1)] in support of the containment wall noding, and the Reactor Systems Branch has similarly reviewed that part of the submittal involving injection section resistance and the FLECHT heat transfer coefficient multiplier. During the course of the review, the staff requested that Combustion Engineering supply additional information in support of the change in injection section multiplier and to show what effect each of the proposed model changes has on predicted containment pressure and peak clad temperature during a LOCA. Combustion Engineering resubmitted to the NRC the material of reference 1 combined with the additional information requested by the staff as an additional supplement to their evaluation model[2]. Further detail regarding the three requested changes, and the staff's review and conclusions are presented below.

2.0 Containment Wall Noding

The presently approved Combustion Engineering evaluation model utilizes a fixed number of evenly spaced nodes to represent each containment wall material (paint-concrete and/or paint-steel). Combustion Engineering has performed a passive heat sink noding study to determine the adequacy of the present noding scheme. The study was performed using Calvert Cliffs I containment data and a computer code, CONTRANS[19], which is the basis for the presently approved Combustion Engineering ECCS containment pressure calculations.[8,9]

The noding study indicated that the scheme utilized in the present model is too coarse resulting in a nonconverged, very conservative solution for the containment pressure. The use of the overly-coarse noding results in a relatively large heat capacitance at the wall surface region which in turn causes relatively high heat transfer rates to the containment walls, low containment pressure and reflood rates with subsequent predicted peak clad temperature which is then relatively high compared to the case where a finer containment wall noding scheme is used.

Based on their noding study, Combustion Engineering proposed a modified noding scheme for future ECCS evaluations. This modified sheme is presented in Table 1 of references 1 and 2 and represents a finer mesh than that used in the presently approved model. The modified noding is shown to represent the converged solution by the noding study results. The proposed (modifed) containment wall noding scheme is compatible with the present noding input capability for the COMPERC-II code[8,9] used to calculate containment pressure, and therefore, no code modifications are required to utilize the modified noding scheme.

Although no code changes are required to incorporate the proposed new noding scheme, the model sensitivity studies performed by Combustion Engineering[2] and discussed in Section 5.0 of this evaluation indicate that the difference in predicted peak clad temperature for calculations performed using the proposed model rather than the present one exceeds 20°F. Therefore, the noding effect is significant and should be documented.

Based on our review, we conclude that Combustion Engineering has adequately justified its proposed containment wall noding modification, that it is in compliance with the criteria of Appendix K of 10 CFR 50.46, and is therefore acceptable.

3.0 Resistance Across the ECCS Injection Section During Pumped Injection

The presently approved Combustion Engineering evaluation model utilizes a + 0.4 psid differential pressure across the injection section during safety injection tank injection for plants having a 60° injection angle and + 1.5 psid for 75° injection. During pumped injection, the present model includes prediction of injection section differential pressure by a momentum balance assuming zero steam condensation and an assumed slip ratio of 1.0.

Subsequent to its present model development and approval, Combustion Engineering discovered that two data points which were considered during the development of the model for pumped injection had been incorrectly plotted showing a pressure drop which was too high by a factor of 10.

Combustion Engineering reconsidered the available data, and in references 1 and 2 requested approval to modify its model for injection section resistance during pumped injection. Included in the submittals was a semiempirical model for partial condensation with slip ratio greater than one, however, due to the complexity of this model, Combustion Engineering proposed the use of a constant (positive) upper limit value of differential pressure.

The staff has reviewed the partial condensation model proposed by Combustion Engineering and concludes that additional experimental data is needed to justify the model in the region of low water momentum flux (between zero and 2.0 lb/ft^2).

In support of its proposed constant upper limit value for injection section pressure drop during pumped injection, Combustion Engineering submitted data including corrected plots with the two data points discussed above. The cited data was taken from the one-third scale steam relief tests which were performed at Combustion Engineering[3] and from the EPRI/Westinghouse one-fourteenth scale mixing tests.[20] None of the above data falling within the ranges of steam momentum flux and ECC injection water momentum flux applicable to the Combustion Engineering plants exceeded the upper limit value proposed by Combustion Engineering. The EPRI/Westinghouse data which were considered also included 90° injection data, which generally indicated larger pressure drops than the 45° and 60° data. The staff has reviewed the data cited by Combustion Engineering and in addition has considered data from the Combustion Engineering one-fifth scale steam relief tests.[21,22] Within the range of applicable momentum fluxes, the one-fifth scale data included two tests for 75° injection having injection section pressure drops which slightly exceeded the upper limit value proposed by Combustion Engineering, however the proposed upper limit value is well above the mean of all of the applicable data reported in references 3, 20, 21 and 22. Combustion Engineering has stated that it does not consider the two data values which exceeded the proposed upper limit value to be completely applicable for two reasons:

1) Combustion Engineering has compared data from the one-fifth scale tests with data of about the same steam and injection water momentum flux values from the one-third scale tests. These comparisons indicate that the one-fifth scale data are generally more positive in value suggesting that there is a scaling effect. The cause of the apparent scaling effect is thought to be the difference in relative magnitude of the piping frictional pressure drop. If this were true, one would expect the full scale injection system to experience smaller pressure drops than those measured in either the one-third or one-fifth scale tests.
2) Combustion Engineering has stated that the 75°, one-fifth scale tests cited above were characterized by oscillatory flow which resulted in larger pressure drops than would be experienced for more steady flow as is expected to occur during pumped injection. (In the EPRI/Westinghouse test report[20] it is stated that in the one-fourteenth scale tests

simulating safety injection flow regimes, the test section effluent was always a two phase mixture with no oscillations.)

It is the staff's conclusion that effects due to scaling and oscillation are not sufficiently well understood at this time to allow elimination of the cited 75°, one-fifth scale data. However, considering the large margin which exists between the proposed upper limit pressure drop value and the mean value of all of the data considered, we conclude that the proposed limit is acceptable for both 60° and 75° injection plants.

4.0 Proposed Reflood Heat Transfer Coefficient Model

The reflood heat transfer characteristics of the 16x16 fuel assembly design are expected to differ from those of the 14x14 design for which supporting test data are available. Refill/reflood heat transfer coefficients used for 16x16 design may be based on extrapolation from 15x15 PWR FLECHT data and/or BWR FLECHT or any other similar data provided the extrapolation technique is shown to be theoretically or experimentally justified.

In a letter to Victor Stello from F. M. Stern, dated March 27, 1975 Mr. Stern states "... C-E plans to provide appropriate rod bundle heat transfer coefficient data prior to the start-up of any of our 16x16 fuel assembly plants employing coefficients greater than 0.8 FLECHT." Additionally, Combustion Engineering (CE) is working toward a physical model for reflood heat transfer. In the interim, CE proposed a model developed from extrapolation of BWR FLECHT and PWR 15x15 FLECHT data.

The extrapolation technique used by CE is essentially the same as that used by the staff in arriving at the 0.8 multiplier except that the multiplier derived by CE varies with time. One BWR run (13x) and one PWR run (4027) were used; data from all three instrumented rods in the BWR run were used. CE calculated the extrapolated heat transfer coefficient every 10 seconds for each instrumented BWR rod and drew a lower bound to the extrapolated points. This lower bound constitutes the CE interim model.

The staff finds that, while conservative methods have been applied to the available PWR and BWR FLECHT data, the referenced data base is not sufficient to support a time dependent FLECHT type correlation for the 16x16 geometry. In the absence of 16x16 data, the applicant should provide further justification of the extrapolation technique used, and a larger number of data points must be considered in order to provide an acceptable confidence level for the correlation. Combustion Engineering is obtaining single tube data and is developing an analytical approach which combines correlations for several well documented physical processes (film boiling, nucleate boiling, dispersed flow). However, the data base and the model are still in the development stage. Until more information is available, CE must continue to use the 0.8 multiplier on the 14 x 14 FLECHT correlation for 16 x 16 applications.

5.0 LOCA Analysis Sensitivity to Proposed Changes in ECCS Evaluation Model

Combustion Engineering has performed parameter studies in order to demonstrate the effect of the three proposed evaluation model changes described above on the ECCS performance evaluation results.

The effect of the containment wall noding and injection section resistance changes were evaluated using the Calvert Cliffs 1 reactor. Results were presented in the form of plots of containment pressure, mass added to core during reflood, and peak clad temperature. The plots showed the successive effect of adding one modification at a time to a base case (presently approved ECCS evaluation model of December, 1974).

All three proposed modifications were similarly evaluated for the Standard System 80 Design (CESSAR) having a 16x16 fuel design. The staff has reviewed the sensitivity evaluations and found them to be acceptable. The results indicate that each of the changes are significant, generally resulting in peak clad temperature differences greater than 20°F compared to calculations without the model changes.

6.0 Conclusions

The staff has concluded that the model changes regarding the containment wall noding and the resistance across the ECCS injection section are acceptable, but that insufficient experimental data has been presented by Combustion Engineering in support of the proposed FLECHT reflood heat transfer coefficient multiplier.

We conclude that the tw changes cited above are acceptable to be used for ECCS performance evaluations for all plants satisfying the following plant classifications:

(1) Typical current Combustion Engineering three and four-loop plants

(2) Dry containments (including subatmospheric)

(3) Power ratings up to 3800 MWt

(4) Plant utilizing only bottom flooding emergency core cooling systems,

Subject to the restrictions cited in this report, Supplement 2-P of CENPD-132-P is acceptable for reference in licensing applications as a part of the approved Combustion Engineering ECCS evaluation model. CENPD-132, Supplement 2 contains a similarly approved non-proprietary version of this document. The previous approved models regarding containment noding and injection section resistance are still acceptable and remain a part of an approved Combustion Engineering evaluation model.

Our acceptance applies only to the use of the referenced topical reports as part of the Combustion Engineering ECCS evaluation model and does not constitute acceptance of the reports for any purpose other than for ECCS analyses.

REFERENCES

1. Proposed Modification to CE ECCS Model, letter with enclosure from F. Stern (CE) to V. Stello (NRC), DP-606, April 14, 1975.

2. CENPD-132P, Supplement 2-P,"Calculational Methods for the C-E Large Break LOCA Evaluation Model," July, 1975.

3. CENPD-132P, "Calculational Methods for the CE Large Break LOCA Evaluation Model," August 1974.

4. CENPD-132P, Supplement 1, "Calculational Methods for the CE Large Break LOCA Evaluation Model," February, 1975.

5. CENPD-133P, CEFLASH-4A, A FORTRAN-IV Digital Computer Program for Reactor Blowdown Analysis," August, 1974.

6. CENPD-133P, Supplement 1, "CEFLASH-4AS, A Computer Program for the Reactor Blowdown Analysis of the Small Break Loss of Coolant Accident," August, 1974.

7. CENPD-133P, Supplement 2, "CEFLASH4A, A FORTRAN-IV Digital Computer Program for Reactor Blowdown Analysis (Modifications)," February, 1975.

8. CENPD-134P, "COMPERC-II, A Program for Emergency Refill-Reflood of the Core," August, 1974.

9. CENPD-134P, Supplement 1, "COMPERC-II, A Program for Emergency Refill-Reflood of the Core, (Modifications)," February, 1975.

10. CENPD-135P, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program," August, 1974.

11. CENPD-135P, Supplement 2, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program (Modifications)," February, 1975.

12. CENPD-136P, "High Temperature Properties of Zircaloy and UO_2 For Use In LOCA Evaluation Models," August, 1974.

13. CENPD-137P, "Calculative Methods for the CE Small Break LOCA Evaluation Model," August, 1974.

14. CENPD-138P, "PARCH - A FORTRAN-IV Digital Computer Program for Evaluating Pool-Boiling Axial Rod and Coolant Heatup," August, 1974.

15. CENPD-138P, Supplement 1, "PARCH- FORTRAN IV Digital Computer Program to Evaluate Pool-Boiling Axial Rod and Coolant Heatup, (Modifications)", February, 1975.

16. Status Report by the Directorate of Licensing in the Matter of Combustion Engineering, Inc., ECCS Evaluation Model Conformance to 10 CFR 50, Appendix K, October, 1974.

17. Supplement to the Status Report by the Directorate of Licensing in the Matter of Combustion Engineering, Inc., ECCS Evaluation Model Conformance to 10 CFR 50, Appendix K, November 13, 1974.

18. NRC Staff Review of the Combustion Engineering ECCS Evaluation Model, NRC letter from O. D. Parr (NRC) to F. M. Stern (CE), June 13, 1975.

19. CENPD-140, "Description of the CONTRANS Digital Computer Code for Containment Pressure and Temperature Transient Analysis," April, 1974.

20. EPRI 294-2, "Mixing of Emergency Core Cooling Water With Steam: 1/14-Scale Testing Phase," (WCAP-8307), January, 1975.

21. J. R. Brodrick, W. E. Burchill, P. A. Lowe, 1/5 Scale Intact Loop Post-LOCA Steam Relief Tests, CENPD-63, Revision 1, March, 1973.

22. P. A. Lowe, J. A. Brodrick, W. E. Burchill, Steam-Water Mixing Test Program Task D: Formal Report for Task A 1/5 Scale Broken Loop, AEC-COO-2244-1, CENPD-65, Revision 1, March, 1973.

For Docket File 50-317

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

JUN 1 3 1975

Mr. F. M. Stern
Vice President, Projects
Combustion Engineering, Inc.
Combustion Division
1000 Prospect Hill Road
Windsor, Connecticut 06095

Dear Mr. Stern:

The Nuclear Regulatory Commission (NRC) staff has completed its review of the Combustion Engineering ECCS evaluation model as defined by certain Topical Reports (References 1 through 13 of the enclosed staff review summary). We conclude that the model is acceptable to be used for ECCS performance evaluations for all plants satisfying the following plant classifications:

(1) Typical current Combustion Engineering three and four-loop plants,

(2) Dry containments (including subatmospheric),

(3) Power ratings up to 3800 MWt,

(4) Plants utilizing only bottom flooding emergency core cooling systems.

Our acceptance applies only to the use of the Topical Reports as part of the Combustion Engineering ECCS evaluation model and does not constitute acceptance of the individual reports for any purpose other than for ECCS analyses. All of the reports, References 1 through 13, are proprietary. Non-proprietary versions of each report and its supplements, which are also approved, exist as Revision 01 to each document. It should be noted that in CENPD-132P, Supplement 1, additional information is presented which has not been evaluated, and therefore, is not part of the approved model.

Sincerely,

Original Signed by
O. D. Parr

Olan D. Parr, Chief
Light Water Reactors
Project Branch 1-3
Division of Reactor Licensing

Enclosure: Staff Review Summary

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

NRC Staff Review of the Combustion Engineering ECCS Evaluation Model

Background Information

Combustion Engineering submitted a description of the Combustion Engineering ECCS evaluation model by August 5, 1974 in several topical reports (references 1, 3, 4, 6, 8, 10, 11 and 12). The NRC staff reviewed the August submittal for conformity with the requirements of 10 CFR Part 50, Appendix K, "ECCS Evaluation Models," and published its evaluation in the October 15, 1974 "Status Report by the Directorate of Licensing in the Matter of the Combustion Engineering ECCS Evaluation Model Conformance to 10 CFR Part 50, Appendix K" (reference 14). This report addressed each requirement of Appendix K, discussed conformance by Combustion Engineering, indicated the acceptability of the analytical methods employed in the Combustion Engineering model, and, assessed the impact of specific open items which were either unresolved or unacceptable.

Additional documentation was subsequently submitted by Combustion Engineering addressing these open items and the NRC staff review was published on November 13, 1974 in a "Supplement to the Status Report by the Directorate of Licensing in the Matter of Combustion Engineering ECCS Evaluation Model Conformance to 10 CFR 50, Appendix K" (reference 15). The NRC staff concluded that certain modifications which were described in the above-mentioned documents, were required to achieve conformity with 10 CFR 50, Appendix K.

On October 26 and November 14, 1974 the staff presented its assessment of the Combustion Engineering evaluation model to the Advisory Committee on Reactor Safeguards. In its report to the Chairman of the AEC, dated November 20, 1974, the Advisory Committee concluded that "the four light-water reactor vendors have developed evaluation models which, with additional modifications required by the (NRC) staff, will conform to Appendix K to Part 50."

The required model changes which were subsequently implemented by Combustion Engineering into their evaluation model, included the following:

1. Additional justification for assumed initial stored energy.
2. Inclusion of clad plastic deformation prior to rupture, and use of best estimate for swelling.
3. Use of a single assembly in hot region of core.
4. Consideration of dissolved nitrogen during reflood.
5. Modification of assumed injection section pressure drop during safety injection tank injection.

6. Modification of hot wall delay time calculation.
7. Modification of steaming rate calculation.
8. Inclusion of diversion crossflow due to blockage during reflood rate less than 1 inch/sec.
9. Use of 0.8 X h_{FLECHT} for 16x16 plants.
10. Inclusion of a conservative assumption for the surroundings during rod-rod radiation.

On December 27, 1974, the Commission, in response to submittals from operating Combustion Engineering plants; pursuant to Section 50.46 and Appendix K of 10 CFR 50, issued a Safety Evaluation Report and Orders for Modification of Licenses pertaining to the latest proposed Technical Specifications. In addition, the Commission requested that the modifications to the Combustion Engineering evaluation model be made and that a reanalysis be submitted within six months based upon the approved evaluation model.

On March 14, 1975, Combustion Engineering formally submitted proprietary and non-proprietary versions of supplements to five of its topical reports (references 2, 5, 7, 9 and 13) which documented all of the modifications required by the NRC staff in October and November, 1974 (references 14 and 15). In addition to the modifications required by the staff, Combustion Engineering submitted supplemental information to complete the documentation requirements of Appendix K, including responses to questions raised by the NRC staff in the course of reviewing the Combustion Engineering ECCS evaluation model, and documentation of minor modifications which had no significant effect on computational results. In Sections SIII.D.5.a.1 and SIII.D.5.b of Supplement 1 to CENPD-132P, Combustion Engineering included additional material which has not been approved by the staff and which is not a part of the approved model. Combustion Engineering has included in its topical reports, descriptions of the various code options which are available, some of which are not acceptable to the staff as part of the approved model. Combustion Engineering will submit an additional report delineating between those options which are a part of the approved model and those which are not. In lieu of having formal documentation at this time, the following code options are not allowable for use in ECCS analysis:

a. The pseudo viscosity pressure drop term described in Appendix E of CENPD-133P, Supplement 2.[5]

b. The use of a loss coefficient for determination of the injection section pressure drop described in Section II.D of CENPD-134P,[9] Supplement 1. (7)

In addition, it is the staff's understanding that the options used for the unpressurized fuel analysis described in Appendix C of CENPD-135P, Supplement 2, are equivalent to the staff approved FATES model.[17] The staff evaluation of these reports is documented in reference 16.

Conclusions

The NRC staff has completed its review of the Combustion Engineering ECCS evaluation model, which is comprised of references 1 through 13. The NRC staff closely followed the development of the Combustion Engineering ECCS evaluation model and utilized the referenced topical reports to determine the compliance of the Combustion Engineering evaluation model to 10 CFR 50, Appendix K. The details of the NRC staff review are summarized in references 14, 15 and 16. The staff concluded:

1) That the Combustion Engineering evaluation model is an acceptable model to be used for ECCS performance evaluation for all plants satisfying the following plant classifications:

   a) Typical current Combustion Engineering three- and four-loop plants.

   b) Dry containments (including subatmospheric).

   c) Power ratings up to 3800 Mwt.

   d) Plants utilizing only bottom flooding ECC Systems.

2) that References 1 through 13 which constitute the consolidated description of the Combustion Engineering ECCS evaluation model, may be used by reference in licensing applications, as an approved ECCS evaluation model. This approval applies to the entire ECCS model package with the exception of Sections S III D.5.a.1 and S III D.5.b of CENPD-132P, Supplement 1, and the code options noted above, and does not constitute approval of the individual topical reports for any purpose other than ECCS analyses.

REFERENCES

1. CENPD-132P, "Calculational Methods for the CE Large Break LOCA Evaluation Model," August 1974.

2. CENPD-132P, Supplement 1, "Calculational Methods for the CE Large Break LOCA Evaluation Model," February 1975.

3. CENPD-133P, "CEFLASH-4A, A FORTRAN-IV Digital Computer Program for Reactor Blowdown Analysis," August 1974.

4. CENPD-133P, Supplement 1, "CEFLASH-4AS, A Computer Program for the Reactor Blowdown Analysis of the Small Break Loss of Coolant Accident," August 1974.

5. CENPD-133P, Supplement 2, "CEFLASH-4A, A FORTRAN-IV Digital Computer Program for Reactor Blowdown Analysis (Modifications)," February 1975.

6. CENPD-134P, "COMPERC-II, A Program for Emergency Refill-Reflood of the Core," August 1974.

7. CENPD-134P, Supplement 1, "COMPERC-II, A Program for Emergency Refill-Reflood of the Core (Modifications)," February 1975.

8. CENPD-135P, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program," August 1974.

9. CENPD-135P, Supplement 2, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program (Modifications)," February 1975.

10. CENPD-136P, "High Temperature Properties of Zircaloy and UO_2 for Use in LOCA Evaluation Models," July 1974.

11. CENPD-137P, "Calculative Methods for the CE Small Break LOCA Evaluation Model," August 1974.

12. CENPD-138P, "PARCH - A FORTRAN IV Digital Computer Program to Evaluate Pool-Boiling Axial Rod and Coolant Heatup," August 1974.

13. CENPD-138P, Supplement 1, "PARCH - A FORTRAN IV Digital Computer Program to Evaluate Pool-Boiling Axial Rod and Coolant Heatup (Modifications)," February 1975.

14. Status Report by the Directorate of Licensing in the Matter of Combustion Engineering, Inc. ECCS Evaluation Model Conformance to 10 CFR 50, Appendix K, October 1974.

15. Supplement to the Status Report by the Directorate of Licensing in the Matter of Combustion Engineering, Inc. ECCS Evaluation Model Conformance to 10 CFR 50, Appendix K, November 13, 1974.

16. Response to TAR Nos. 1147, 1148, 1150, 1151, 1153, 1154, and 1155 - NRC staff Review of Combustion Engineering ECCS Evaluation Model Topical Reports, NRC letter from V. Stello to R. C. DeYoung, May 1975.

17. Response to TAR No. 1152 - AEC staff review of CENPD-139 and Supplement 1, AEC letter from V. Stello to R. C. DeYoung, November 12, 1974.