MAINE YANKEE ATOMIC POWER COMPANY •

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August 6, 1982
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United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Office of Nuclear Reactor Regulation
Division of Licensing
Operating Reactors Branch #3
Mr. Robert A. Clark, Chief

Reference: (a) License No. DPR-36 (Docket No. 50-309)
(b) USNRC letter to MYAPCo dated July 26, 1982, Safety Evaluation Report

Subject: Maine Yankee Cycle 7 CEA Modifications

Dear Sir:

The purpose of this letter is to inform your staff of Control Element Assembly (CEA) bank modifications and changes to our analytical methods to be utilized in the design and analysis of the Cycle 7 reload core.

* 1. The Cycle 7 core performance analysis, which will incorporate the changes, is scheduled to be submitted for review in early September 1982. Cycle 7 startup is expected to occur on or about November 22, 1982.

The expanded examination of cooldown transient modes associated with a postulated steamline break (SLB) accident has resulted in the need for increased margin to criticality with cooldown. This has been accomplished by modification of CEA Bank 5, the lead regulating bank.

The original and new Bank 5 configurations are depicted in Figures 1 and 2 (Attachment I). The eight part-strength CEA's have been replaced by full-strength CEA's. Four of these eight part-strength CEA's have now been added to Bank 5 for better local power distribution control. These additional Bank 5 CEA locations formerly comprised one of the part-length CEA banks. The full length CEA's in these locations are nontrippable. Please note that the part-length CEA banks have not been employed in any previous cycle.

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The modification of the Bank 5 CEA's has affected the CEA ejection transient and will require some minor changes to the methodology to maintain appropriate margins. These changes are detailed in Attachment II.

We trust you find this information satisfactory. If you have any questions, please do not hesitate to contact us.

Very truly yours,

MAINE YANKEE ATOMIC POWER COMPANY

A. J. Cayia

for John H. Garrity, Senior Director
Nuclear Engineering and Licensing

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Attachment I (1 page)
Attachment II (9 pages)

* The numbered notation will be used internally by M.Y., to aid in commitment tracking

ATTACHMENT I

Figure 1

MAINE YANKEE CYCLES 1-6
CEA BANK 5 CONFIGURATION

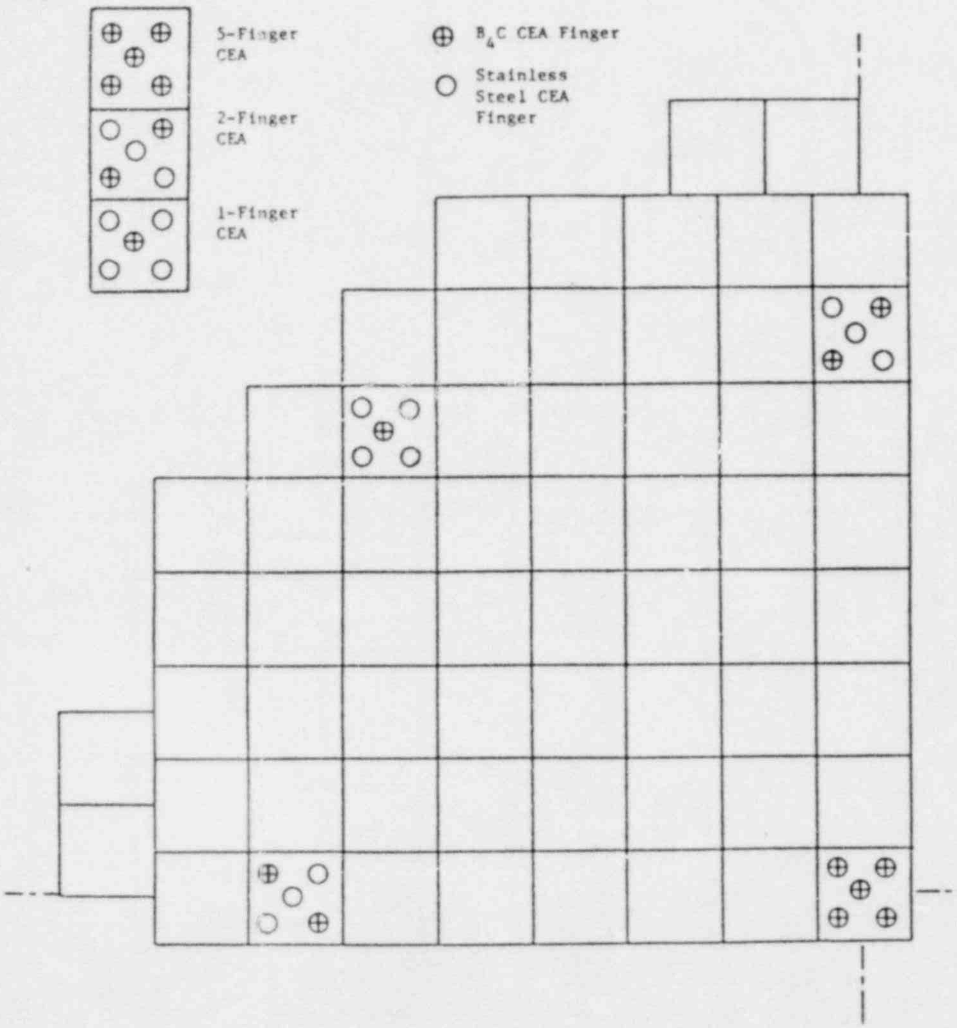
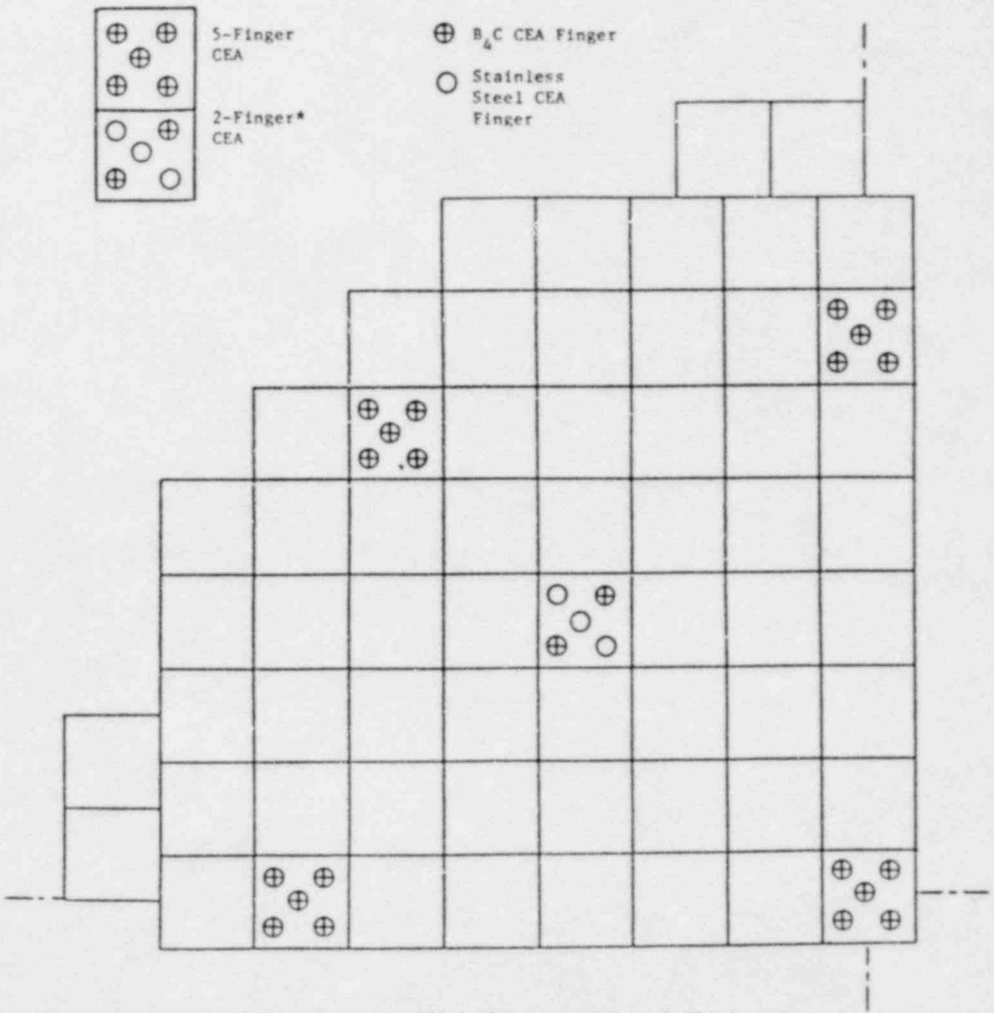


Figure 2

MAINE YANKEE CYCLE 7
CEA BANK 5 CONFIGURATION



* Non-scrammable CEA in former part-length CEA location

Attachment II

Changes in Analytical Methods
CEA Ejection Analysis Physics Input

1.0 BACKGROUND AND INTRODUCTION

The CEA ejection analysis method employed since Cycle 3 contains conservatisms based on both analytical model assumptions and selection of input parameters. This method has adequately addressed the worst CEA ejections witnessed in Cycles 3-6.

The available scram reactivity requirements for Cycle 7 have increased due to the recent emphasis on examination of cooldown transient modes. To achieve this, the part-strength Bank 5 CEA's have been replaced for Cycle 7 with full-strength CEA's. As a result, the CEA ejection physics parameters are more limiting for Cycle 7.

The nominal key physics parameters for the CEA ejection from Cycle 6, Cycle 7, and the FSAR analysis of Cycle 1 are given in Tables 1 and 2 for the worst ejections from full power and zero power, respectively. The key parameters of the worst cases, the FSAR EOC cases, bound those of Cycles 6 and 7. The FSAR analysis, however, used space-time analysis to remove conservatisms inherent in the point kinetics approach.

Changes are proposed in the physics input parameters to the CEA ejection analysis which are justified by the nature of the transient and supported by higher-order calculations.

1.1 Present Licensing Methodology

1.1.1 CHIC-KIN Computer Code

The CHIC-KIN program has been used in analysis of the CEA ejection and seized rotor transients. Application is described in Reference 1. Improvements for Cycle 6 were described in Reference 2. The code uses point kinetics reactivity assumptions in determining the core power response with time.

1.1.2 Physics Parameter Inputs

The referenced document for the physics parameter analysis is YAEC-1115 (Reference 3). This document describes the computer codes and their application in the calculation of these parameters. The following key physics parameter inputs are required for the CEA ejection analysis. Other physics input parameters are of lesser significance.

1. Determination of the worst static ejected CEA worth from HFP and HZP conditions at BOC and EOC. Sufficient scoping and judgment is applied to assure that these limiting ejections bound intermediate power level and cycle burnup conditions. Static calculated worths are conservative relative to higher order space-time calculated worths. A 15% uncertainty is applied to the static ejected CEA worths for conservatism.

2. Determination of the worst pin power peaking and pin power census from the post-ejected static condition from HFP and HZP conditions at BOC and EOC. These cases have historically been the worst static ejected CEA worth cases. The static pin power peaking and census are more limiting than the higher order space-time calculated values. A 10% uncertainty is applied to the pin power census for conservatism when comparing to the fuel failure limit.

3. A core average doppler defect curve is supplied for each time in core life analyzed. The defect curve is typically from an unrodded case, in which local power weighting effects are not significant. A 25% uncertainty is applied to the doppler defect for conservatism.

4. Delayed neutron parameters are supplied for each case analyzed. These parameters correspond to the pre-ejected condition. A 10% uncertainty is applied, for conservatism, to the delayed neutron parameters. The pre-ejection weighted delayed neutron parameters are typically conservative in comparison to post-ejection weighted parameters.

2.0 PROPOSED CHANGES TO LICENSING METHODOLOGY

There are two proposed changes to the licensing methodology, dealing with the physics parameter inputs. The following remain unchanged:

1. the CHIC-KIN program or its application
2. the static ejected worth, pin power peaking, pin power census and the stated uncertainties for each parameter.
3. the delayed neutron parameters and the stated uncertainties.

The proposed changes are described in the following sections.

2.1 Pre-Ejected Power Weighting for the Core Average Doppler Defect Calculation

The core average doppler defect curve is typically calculated for the unrodded condition. As such, the local power weighting effects are minimal. The uncertainties are conservatively applied to the defect curve in the direction of worsening the effects of the given transient.

It is proposed that a core average doppler defect curve with local power weighting based on the explicit pre-ejected power shape be applied for each of the ejected CEA cases. The core average doppler defect curve thus derived is more representative of the given conditions than the unrodded curve. Most significant is that it is a conservative curve in application to the ejected CEA case. This is because the pre-ejected power weighting is the least peaked, or flattest, shape witnessed during the transient.

This pre-ejected weighting results in typical increases in the core average doppler defect of approximately 10-15% relative to the nominal unrodded weighting over the core average fuel temperature ranges of interest (1,000-2,000^{0}F for HFP cases, 500-1,500^{0}F for HZP cases).

2.2 Core Average Doppler Defect Uncertainty

The core average doppler defect uncertainty typically included for transient analysis application is 25%. This uncertainty addresses items such as:

1. uncertainties in cross sections and their temperature dependencies
2. uncertainties in burnups which affect isotopic distributions
3. uncertainties in nominal power distributions which influence the local doppler reactivity weighting.
4. uncertainties in the local doppler reactivity weighting during the course of the transient due to changing conditions

For all transient cases, the uncertainties in items (1) - (3) are applicable. For CEA ejections, however, the local doppler reactivity weighting is a significant factor in limiting the transient. Thus, the component in item (4) results is an important benefit in limiting the consequences of CEA ejections.

A large number of studies of CEA ejections (References 4, 5 and 6) for typical PWR conditions have documented the magnitude of the local doppler reactivity weighting by comparison of space-time to point kinetics analysis results. These studies typically define a spatial doppler weighting factor. This factor may be defined as the multiplier to the doppler defect in the point kinetics calculation which yields the same total core energy response as the space-time (i.e, spatially weighted doppler) solution.

Such analysis was performed for the explicit Cycle 1 worst ejected CEA cases from HFP and HZP by Combustion Engineering and documented in the FSAR (Reference 4). Subsequent licensing methods used by CE have demonstrated that this FSAR analysis technique is conservative (Reference 5, Appendix B). The FSAR analysis developed a linear relationship between spatial doppler weighting factor and ejected CEA worth for the same Bank 5 ejection locations which have been the most limiting in all subsequent cycles. The results was a doppler weighting factor (with 20% reduction for conservatism included) of 72% per dollar of ejected CEA worth. Stated another way, a spatial doppler weighting factor of 1.72 would be applicable to an ejected CEA worth of 1 dollar.

A summary of the results of higher-order calculated spatial doppler weighting factors for control rod ejections are given in Table 3. The spatial doppler weighting factor for each case is expressed as percent increase per dollar of ejected reactivity for purposes of comparison.

It is recognized that the details of the ejected CEA case determine the specific amount of applicable spatial doppler weighting. Nevertheless, there is a sizeable spatial doppler reactivity component which is correlated to the magnitude of the CEA ejection.

Based on the supporting higher-order calculation results and the particular nature of the transient, a reduction in the uncertainty applied to the core average doppler defect from 25% to 15% is thus proposed, in application to CEA ejections only. Such a reduction recognizes the inherent conservatisms in the non-spatial point kinetics representation of the doppler defect for this particular transient.

Table 1

Maine Yankee
Comparison of Full Power CEA Ejection
Nominal Physics Parameters

	Time in Cycle Life					
	BOC			EOC		
Parameter	Cycle 6	Cycle 7	FSAR	Cycle 6	Cycle 7	FSAR
Delayed Neutron Fraction	0.0058	0.0061	0.0069	0.0052	0.0052	0.0052
Ejected CEA Worth (% Delta Rho)	0.09	0.23	0.36	0.19	0.36	0.39
Ejected CEA Reactivity in Dollars	0.16	0.38	0.52	0.37	0.69	0.75*
Maximum 1-Pin Radial Peak	2.19	3.11	3.85	3.28	4.04	4.58*

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* worst reactivity and peaking case from HFP

Table 2

Maine Yankee
Comparison of Zero Power CEA Ejection
Nominal Physics Parameters

	Time in Cycle Life					
	BOC			EOC		
Parameter	Cycle 6	Cycle 7	FSAR	Cycle 6	Cycle 7	FSAR
Delayed Neutron Fraction	0.0058	0.0064	0.0069	0.0052	0.0053	0.0052
Ejected CEA Worth (% Delta Rho)	0.21	0.51	0.55	0.34	0.69	1.07
Ejected CEA Reactivity in Dollars	0.36	0.80	0.80	0.65	1.30	2.06*
Maximum 1-Pin Radial Peak	4.55	6.67	5.85	6.25	7.83	7.93*

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* worst reactivity and peaking case from HZP

Table 3

Comparison of Doppler Weighting Factors
For Various Control Rod Ejection Analyses

Analysis (Reference)	Conditions	Ejected Worth (Dollars)	Doppler Weighting Factor (DWF)	% Increased Doppler per Dollar Ejected
MY FSAR (4)	HFP	0.58	1.43	72*
		0.83	1.60	72*
	HZP	0.87	1.62	72*
		2.27	2.64	72*
CE (5)	HZP	1.61	1.98	61**
B&W (6)	HFP	0.79	1.81	103
	HZP	1.31	2.85	141

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* 20% conservatism included

** conservatism included - unspecified

References

1. YAEC-1103, Maine Yankee Core Analysis Model Using CHIC-KIN, R. N. Gupta, September 1976.

2. YAEC-1259, Maine Yankee Cycle 6 Core Performance Analysis, attachment to Proposed Change No. 84, Docket 50-309, FMY 81-65, dated April 28, 1981.

3. YAEC-1115, Application of Yankee's Reactor Physics Methods to Maine Yankee, D. J. Denver, E. E. Pilat, R. J. Cacciapouti, October 1976.

4. Maine Yankee Final Safety Analysis Report, Docket 50-309.

5. CENPD-190, C-E Method for Control Element Assembly Ejection Analysis, Combustion Engineering, January 1976.

6. Bian, S., "Application of Reactivity Weighting to Rod Ejection Accident Analysis in a Pressurized Water Reactor," Nucl. Tech. Vol. 41, 401-407 (1978).