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APPLICATION OF THE "REGIONAL EXCLUSION WITH FLOW-BIASED APRM NEUTRON FLUX SCRAM" STABILITY SOLUTION (OPTION I-D) TO THE DUANE ARNOLD ENERGY CENTER

Licensing Topical Report

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ABSTRACT

This report demonstrates the application of the "Regional Exclusion with Flow-Biased APRM Neutron Flux Scram" Stability Solution (Option I-D) of the "BWR Owners' Group Stability Long-term Solutions Licensing Methodology" to the Cycle 14 as-loaded-core of the Duane Arnold Energy Center, in compliance with General Design Criterion 12. An Exclusion Region is presented for the plant which identifies plant conditions that may lead to an instability. The Exclusion Region analysis shows that the large single-phase pressure drops induced by the relatively small inlet orifices of DAEC creates a preference for core-wide mode oscillations should the plant maneuver into the conditions susceptible to a reactor instability. The Exclusion Region analysis concludes that regional mode oscillations are not anticipated to occur for DAEC. In addition, a statistically based Detect and Suppress analysis is performed to demonstrate protection of the fuel Minimum Critical Power Ratio (MCPR) Safety Limit from the flow-biased APRM neutron flux trip. The Detect and Suppress analysis is performed for core-wide mode oscillations only, consistent with the Detect and Suppress licensing methodology documented to the NRC in NEDO-32465, May 1995.

1 INTRODUCTION

This report demonstrates the application of the "Regional Exclusion with Flow-Biased APRM Neutron Flux Scram" Stability Solution (Option I-D) to the Duane Arnold Energy Center (DAEC) as prescribed by the BWR Owners' Group Long-term Stability Solutions Licensing Methodology[1,2]. This solution creates an "Exclusion Region" in the plant operating map wherein oscillatory power behavior is conservatively predicted to be possible and which is avoided during plant operations. The Exclusion Region analysis also confirms that core-wide reactor instability is the predominate mode and regional mode oscillations are not expected to occur for DAEC. The protection of the Safety Limit Minimum Critical Power Ratio (SLMCPR) afforded by the flow-biased Average Power Range Monitor (APRM) neutron flux trip is demonstrated for the preferred core-wide mode of coupled thermal-hydraulic/neutronic oscillations for DAEC.

1.1 Historical Perspective

Protection against power oscillations that might lead to fuel damage has been required by General Design Criterion 12[3], which requires that such oscillations either not be possible or be reliably detected and suppressed. In the past, this requirement was met by showing that oscillations are not possible by calculating core and channel decay ratios as a part of reload licensing analyses. Such results notwithstanding, guidance was provided to BWR operators as early as 1982 in the form of a GE Service Information Letter[4] on the detection and suppression of hypothetical power oscillations at low-flow and high-power conditions.

With the advent of 8X8 fuel designs and more aggressive operating strategies to improve operational flexibility and fuel utilization (e.g., extended load lines, feedwater heaters out-of-service, etc.), stability margins decreased such that instabilities could no longer be demonstrated to be impossible; therefore, in 1982 and after, protection against power oscillations was ensured by providing plant operators with guidance on detecting and suppressing such oscillations[4,5]. In addition, analysis was performed to demonstrate that the occurrence of such oscillations did not challenge fuel thermal-mechanical limits[6,7].

Additional concerns about BWR stability were raised by the March 9, 1988, oscillation event at the LaSalle-2 plant, when investigations revealed that power oscillations could occur more rapidly than had been thought probable. Furthermore, new analyses predicted less margin to the SLMCPR than was previously shown[8]. This event led NRC to issue Bulletin 88-07[9], which requires BWR owners to indicate how they would guard against such events in the future.

1.2 BWR Owners' Group Response

In response to NRC Bulletin 88-07, the BWR Owners' Group, in conjunction with GE, implemented a program to develop a long-term solution to the stability issue. The BWROG approach, as well as interim protective guidelines, was accepted by the NRC in Supplement 1 to the aforementioned Bulletin[10]. The BWROG efforts led to generation of the "BWR Owners' Group Long-term Stability Solutions Licensing Methodology,"[1] which outlines several solution options. Some of these involve the introduction of a new Reactor Protection System (RPS) trip function and may be applied to all BWR's, while others demonstrate the adequacy of existing hardware but are applicable to only a limited set of plants.

1.3 Option I-D Solution

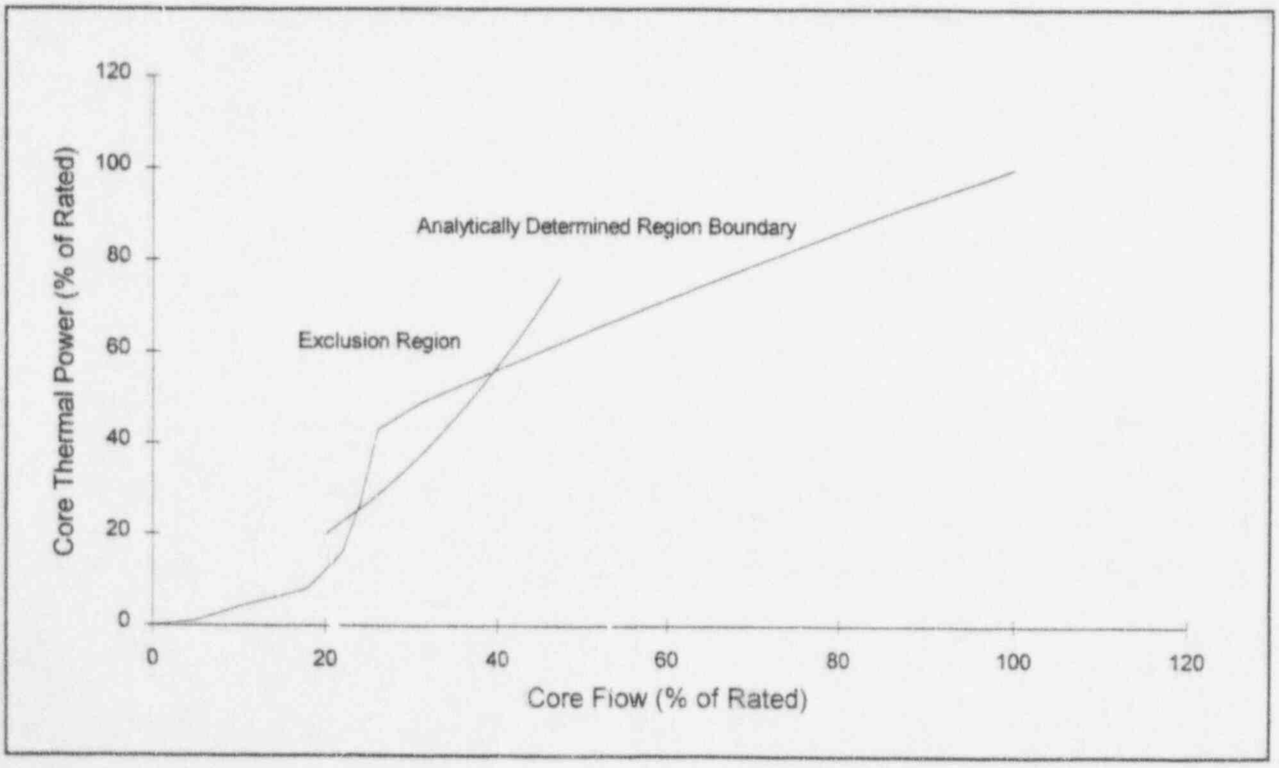
One of the solutions which demonstrates the adequacy of existing hardware is Option I-D, entitled, "Regional Exclusion with Flow-Biased APRM Neutron Flux Scram." This solution consists of two parts. The first is the creation of an Exclusion Region in the operating map for the plant (Figure 1-1). This is a region where conservative decay ratio calculations indicate that power oscillations are possible. If the plant should enter this region due to a flow reduction event, such as a recirculation pump trip or runback, or due to a power increase at low flow, the operators are instructed to promptly exit the region and initiate a manual scram if oscillations occur. As a part of the generation of the Exclusion Region, the margin to regional mode oscillations is quantified using the methodology identified in Supplement 1 to NEDO-31960[1]. As described therein (Section 5.0), there are unrealized conservatisms in the prediction of the already low likelihood of regional mode oscillations by neglecting the higher eigenvalue separation for the small core size of DAEC.

The second part of this solution is a demonstration that, even in the unlikely event of a power oscillation, an APRM flow-biased flux trip will detect and suppress the most probable mode power oscillations (core-wide mode) before the SLMCPR is reached. This demonstration uses the statistical methodology described in NEDO-32465[2]. It is conservatively applied for core-wide mode oscillations both in terms of the inputs and confidence levels used in the statistical methodology.

While the Exclusion Region and MCPR analysis are the components of the Option I-D solution which are analytically demonstrated, they are not, in and of themselves, the complete solution. Recognizing that highly skewed axial power shapes reduce margin to the onset reactor instability, an on-line stability predictor and administrative controls are being added to DAEC by the licensee. Therefore, the analytical demonstrations are part of a hierarchy of barriers that provide a high degree of assurance that fuel thermal limits cannot be approached. The barriers that must be scaled before fuel limits can be approached may be summarized as:

- Occurrence of a transient that brings the plant into the Exclusion Region (e.g., recirculation pump trip, recirculation pump runback, inadvertent control rod withdrawal or loss of feedwater heating during startup).
- Failure to leave the Exclusion Region either by increasing flow or decreasing power (It has been observed that an appreciable time lapse occurs before the system stabilizes at the new operating point and that oscillations require some time to evolve: there is adequate time for the operators to maneuver the plant out of the Exclusion Region or to scram the plant upon recognition of an oscillation.).
- Development of oscillatory power behavior outside of the expected statistical occurrence for which a RPS trip does not occur before fuel thermal limits are exceeded.

Figure 1-1. Typical Exclusion Region in Operating Map



1.4 Applicability of Option I-D to Duane Arnold

Integral to the Option I-D approach is the assertion that regional mode oscillations have a low probability of occurrence. One feature of DAEC that assists in protecting against the occurrence of regional mode oscillations is that there are large single-phase channel pressure losses when compared to other BWR's. Such losses, in the absence of other changes in core hydraulic characteristics, are known to be stabilizing. When comparing various plant designs, differences in single-phase pressure losses are mostly attributable to the fuel inlet orifices; thus, plants, such as DAEC, which have relatively small inlet orifice diameters, are expected to be more stable than those with larger inlet orifice diameters (the inlet orifice diameter for DAEC is 2.09 inches as compared to 2.43 inches for most other BWR 4's and 5's) and less likely to excite higher harmonic modes of reactor instability.

A second feature is that the core is relatively "small." Since the phenomenon underlying the neutronic portion of regional mode oscillations is the excitation of the higher harmonic modes of the fundamental (i.e., critical) flux shape, the occurrence of region mode oscillations requires the insertion of sufficient reactivity to overcome the inherent sub-critical multiplication of those modes (i.e., "eigenvalue separation"). The eigenvalue separation has been found to be strongly dependent on the size of the core, with smaller cores (e.g., 368 bundles) having markedly greater separation than larger cores (e.g., 764 bundles). Nevertheless, the current analysis conservatively neglects eigenvalue separation and relies wholly on the larger hydraulic losses of the inlet orifices to demonstrate a preference for the core-wide mode of oscillation.

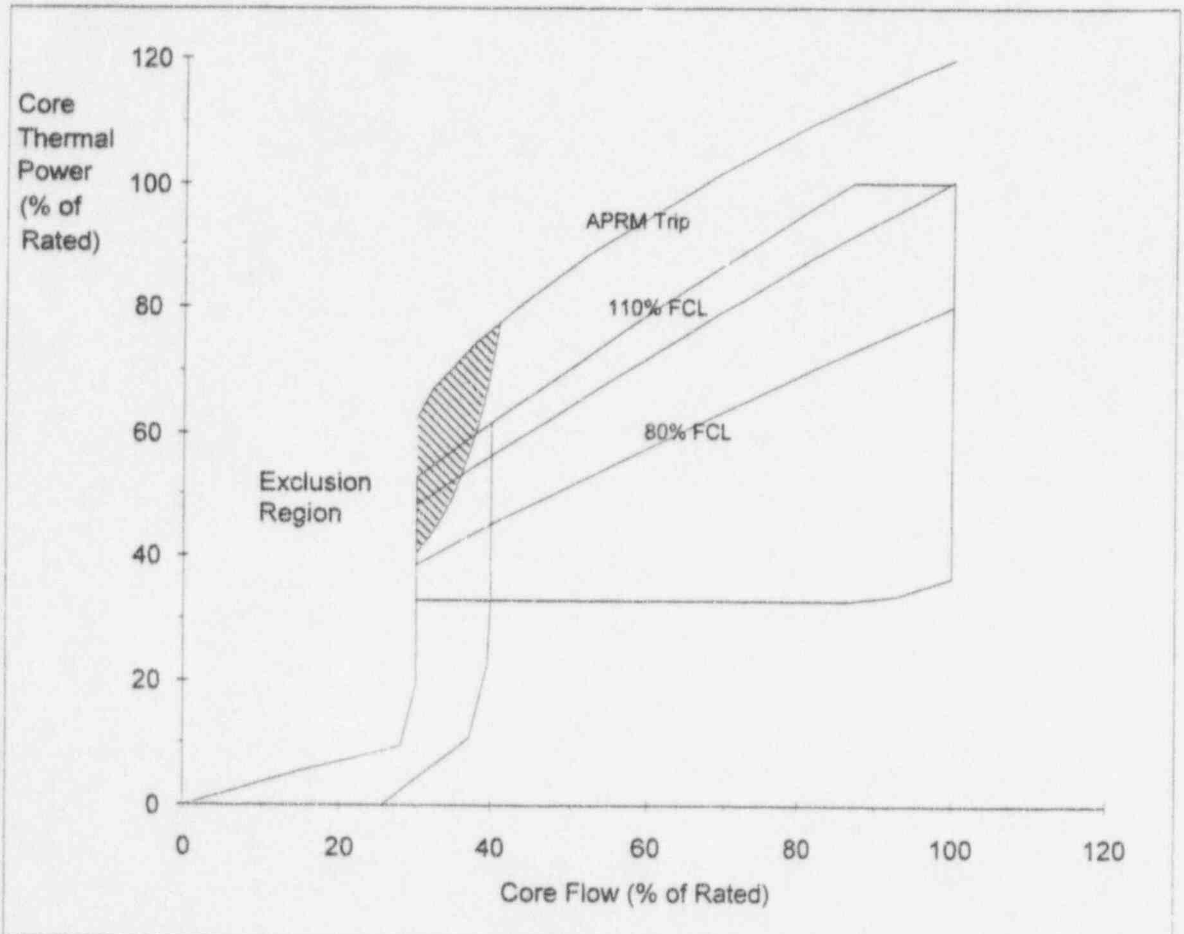
A third feature in the application of Option I-D is that DAEC has an unfiltered APRM flow-biased flux trip instead of a Simulated Thermal Power Monitor (STPM). The APRM neutron flux signal provides an instantaneous response to a neutron flux change rather than the slower fuel thermal response associated with a STPM. The assertion for a small core such as DAEC is that (1) a core-wide mode oscillation will be excited long before an azimuthal (regional mode) oscillation, and (2) the APRM flow-biased flux trip will suppress the oscillations before a thermal limit is reached (the MCPR limit is the most sensitive thermal limit for oscillations).

2 SUMMARY AND CONCLUSIONS

Compliance with General Design Criterion 12 is demonstrated with the Regional Exclusion with Flow-biased APRM Neutron Flux Scram Stability Solution (Option I-D) for the Cycle 14 as-loaded-core of the Duane Arnold Energy Center.

The Exclusion Region for the Cycle 14 as-loaded-core of DAEC is shown in Figure 2-1. The analysis confirms that core-wide mode oscillations are the preferred mode for DAEC primarily due to the relatively small fuel inlet orifice size.

Figure 2-1. Duane Arnold Exclusion Region (Cycle 14)



Protection of the Safety Limit Minimum Critical Power Ratio (SLMCPR) is demonstrated for core-wide mode oscillations on the rated flow-control line in accordance with the statistical methodology defined in NEDO-32465[2]. Therefore, the flow-biased APRM neutron flux trip provides protection of the fuel SLMCPR against the preferred mode of oscillation with high statistical confidence for Cycle 14.

Results of this demonstration for Cycle 14 are expected to be applicable to future reload cycles due to the use of conservative inputs and assumptions. However, it is appropriate to confirm applicability of the specific inputs and conditions identified in Section 7 for subsequent reload designs on a cycle-by-cycle basis.

3 APPLICATION OF BWROG STABILITY LONG-TERM SOLUTION REGIONAL EXCLUSION METHODOLOGY

Section 3 describes the application of the BWROG Regional Exclusion Methodology for DAEC. This application is intended to define the power flow conditions to be avoided during normal operation. Also, the results of this analysis conservatively verify that the core-wide mode of reactor instability is the preferred mode for DAEC. The analysis inputs described below for the demonstration application were developed for the Cycle 14 as-loaded-core. Future operating cycle reload analysis will confirm the applicability of the power flow map Exclusion Region and preference for core-wide mode oscillations to the particular characteristics of the new fuel cycle.

The algorithm used to define the Exclusion Region is based on the FABLE/BYPSS methodology and the inputs to it are as described in Section 5.2 of the BWROG methodology report[1]. Input parameters that are dependent upon cycle specific parameters, such as fuel loading, are from Cycle 14 for DAEC. As such, the Exclusion Region is specific to Cycle 14 and its validity must be confirmed for each subsequent fuel reload.

3.1 Void Coefficient

Void-feedback parameters (nuclear void coefficient and delayed neutron data) are chosen from the exposure point in Cycle 14 for which void coefficient is most negative. Other inputs to the methodology (e.g., axial power distribution) are not from the same exposure point, but use of the most limiting void-feedback parameter values is conservative.

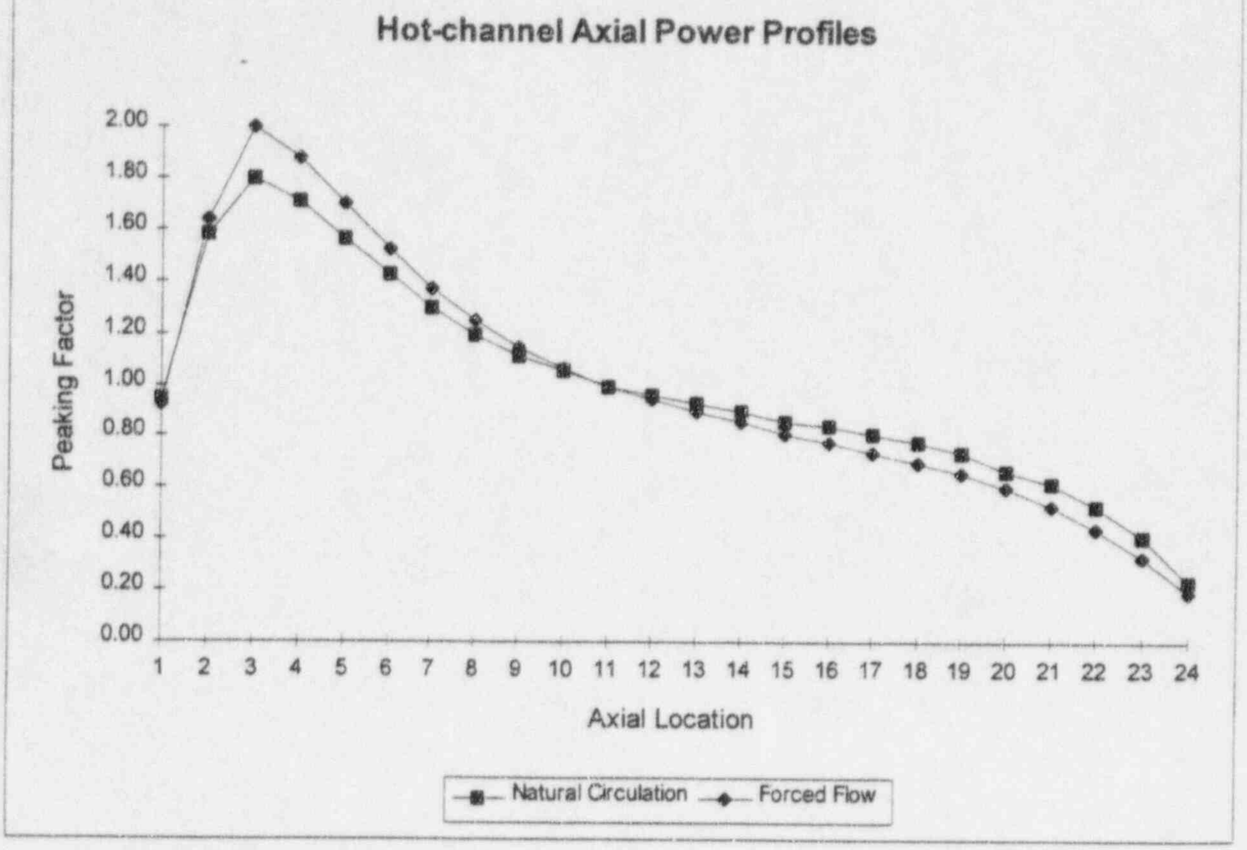
3.2 Thermal-hydraulic Data

Standard design values for DAEC, consistent with the FABLE/BYPSS qualification bases, are used in the analysis.

3.3 Hot-Channel Axial Power Distribution

Channel hydraulic stability is known to be strongly affected by the channel's axial power distribution. For the hot channels, the axial power distribution is fixed by the procedure to be peaked near the bottom of the channel, a distribution that is known to be less stable. These axial power distributions for both forced flow and natural circulation are shown in Figure 3-1. These axial profiles are consistent with those shown in Figure 5-5 of the BWROG Methodology report[1]. Hot channels are identified for each hydraulic channel design in the DAEC core.

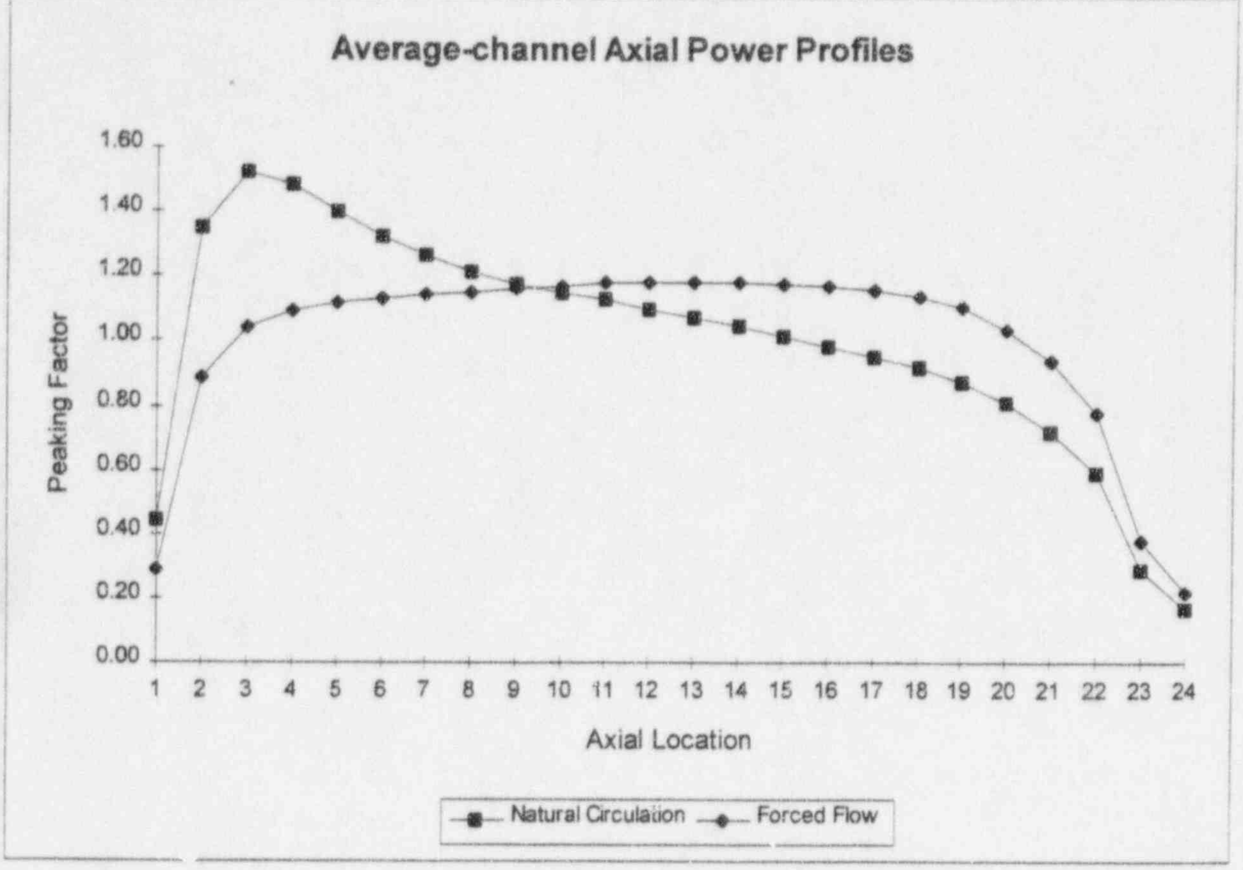
Figure 3-1



3.4 Average-Channel Axial Power Distribution

Core stability is known to be affected by the axial power distribution of the bulk of the channels in the core (all those other than the "hot channels"). In the absence of other changes, a relatively "flat" axial power distribution will be less stable than top-peaked or bottom-peaked distributions; therefore, for forced circulation conditions, the Haling End-of-Cycle 14 (EOC-14) full power and flow core-average axial power distribution is used (see Figure 3-2). For natural circulation conditions, the power distribution moves strongly to the bottom of the core and use of a Haling profile characteristic of full power and flow would be too conservative; therefore, a core-average axial power distribution characteristic of natural circulation flow at the Haling EOC-14 exposure point is used. The axial power profile at the intersection of the rated flow-control line (FCL) and the natural circulation flow line is shown in Figure 3-2.

Figure 3-2



3.5 Radial Power Distribution

The radial peaking factors for the channel grouping used in the FABLE/BYPSS analyses are based on those obtained from the GE 3D BWR Simulator Code[11]. The values chosen are from the EOC-14 Haling exposure point.

3.6 Pellet-Clad Gap Conductance

Core average pellet-clad gap conductances were determined for each fuel design using the approved fuel licensing model consistent with the FABLE/BYPSS qualification bases.

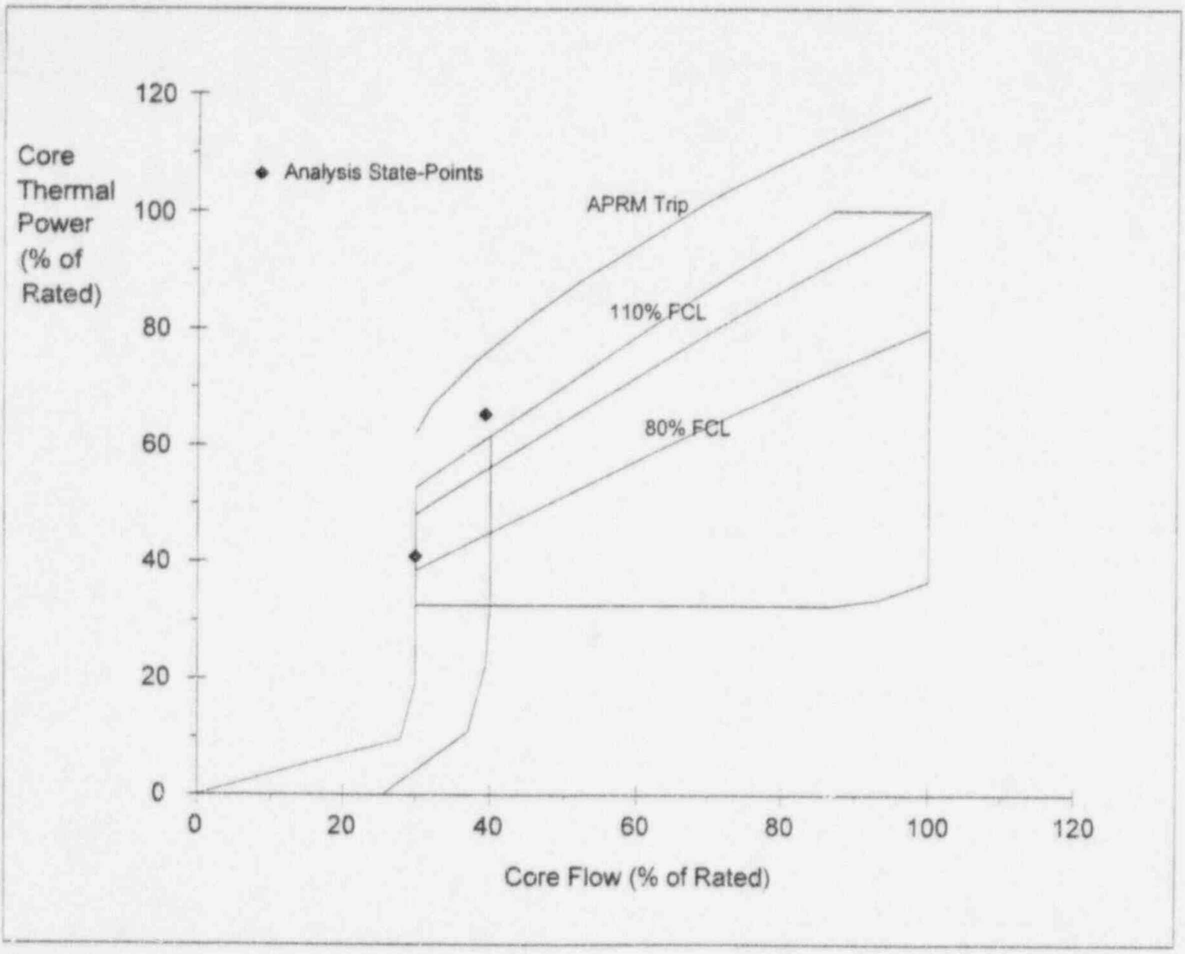
3.7 Miscellaneous Input Values

Other input values to the FABLE/BYPSS analyses, such as heat balance data, recirculation loop resistance, fuel physical parameters and material properties are standard design values for DAEC. It is assumed that the nominal heat balance assumptions, such as the operation of all feedwater heaters, are valid for this model.

4 REGIONAL EXCLUSION RESULTS

Core and channel decay ratios were calculated for two power flow combinations on the operating map (see Figure 4-1) using the inputs described in Section 3. The purpose of this analysis is to verify the location of the Exclusion Region boundary on the power flow map for the Cycle 14 as-loaded-core and verify that core-wide is the preferred mode of oscillation for DAEC. The boundary definition and margin to regional mode instability are established using the generic BWROG Stability Criterion Map.

Figure 4-1. Analysis State Points on Operating Map



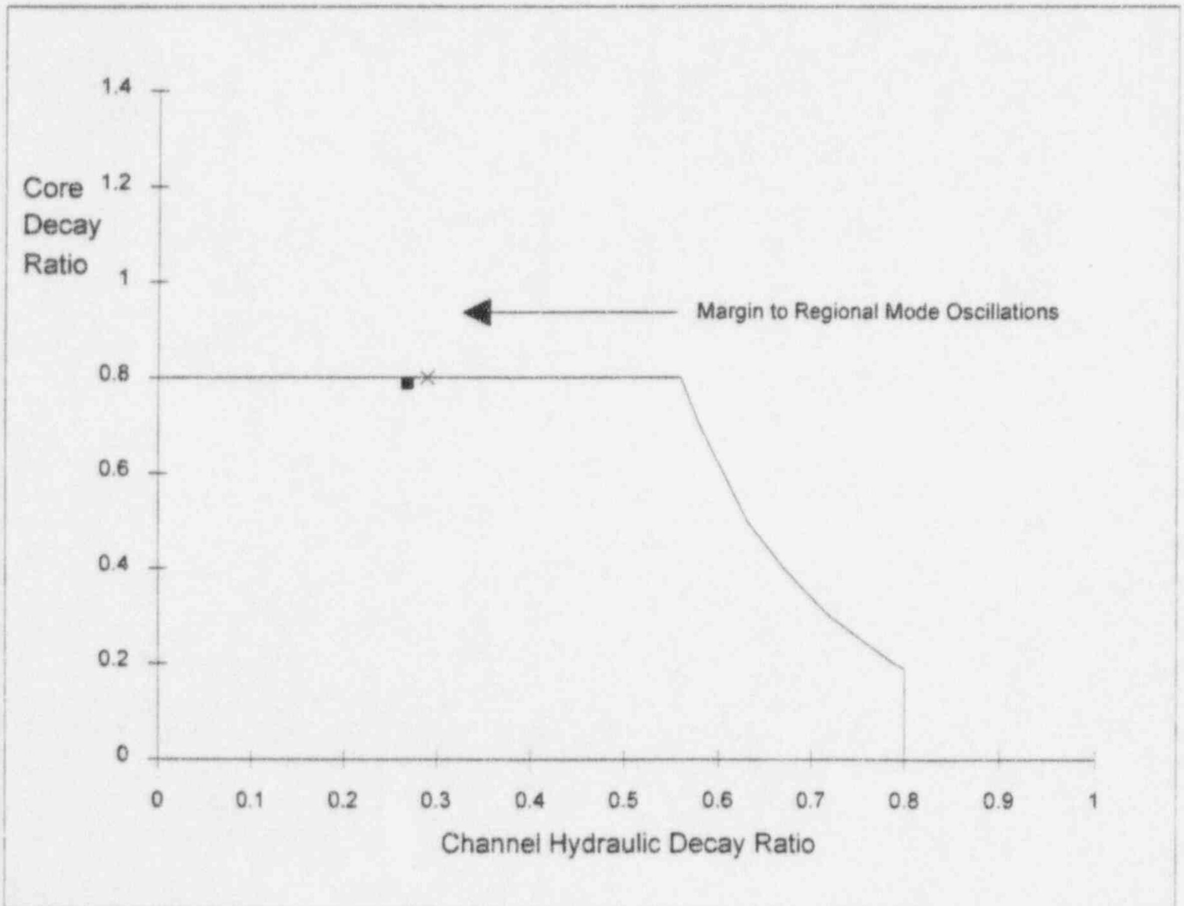
The points calculated are provided in Table 4-1. Point A is along the 120% flow-control line and Point B is along the natural circulation line. The core and channel decay ratio results of the analyzed points are tabulated in Table 4-1.

Table 4-1. Analysis State Points on Operating Map

State Point	Power (%)	Flow (%)	Channel Hydraulic Decay Ratio	Core Decay Ratio	Symbol on Figure 4-2
A	66.2	39.3	0.27	0.79	■
B	40.4	30.0	0.29	0.80	×

The points shown in Figure 4-1 and provided in Table 4-1 are plotted on the generic BWROG Stability Criterion Map in Figure 4-2. The plotting symbols have been provided in Table 4-1 for clarification. The power and flow conditions of the state points were chosen such that the stability map criterion are met. These power and flow conditions provide the coordinates of the endpoints of the exclusion region boundary.

Figure 4-2. Coordinates of Analysis State Points on Stability Criterion Map



The coordinates of the analysis state points on the generic BWROG Stability Criterion Map, Figure 4-2, provide further evidence that regional mode oscillations are not probable for DAEC. It was shown in the stability solutions licensing methodology report[1] that the probability of regional mode oscillations becomes progressively smaller as channel hydraulic decay ratio is decreased, and regional mode oscillations have not been observed for channel hydraulic decay ratios less than 0.6. The largest channel hydraulic decay ratio conservatively predicted by the methodology for DAEC is 0.29 and occurs at the intersection of the natural circulation flow line and the Exclusion Region boundary. Regional mode oscillations are not anticipated anywhere on the operating map for DAEC because of this large margin.

The points identified in Table 4-1 are then used to determine the location of the Exclusion Region boundary, which is shown in Figure 4-3. The Exclusion Region boundary for DAEC is specified by the boundary shape function equation which has been validated against previous Option I-D plant-specific region boundary calculations. The equation for the boundary is as follows:

$$P = P_B\left(\frac{P_A}{P_B}\right)^{\frac{1}{2}\left[\frac{W-W_B}{W_A-W_B}+\left(\frac{W-W_B}{W_A-W_B}\right)^2\right]}.$$

where,

P = a core thermal power value on the Exclusion Region boundary (% of rated),

W = the core flow rate corresponding to power, P, on the Exclusion Region boundary (% of rated),

P_A = core thermal power at State Point A (% of rated),

P_B = core thermal power at State Point B (% of rated),

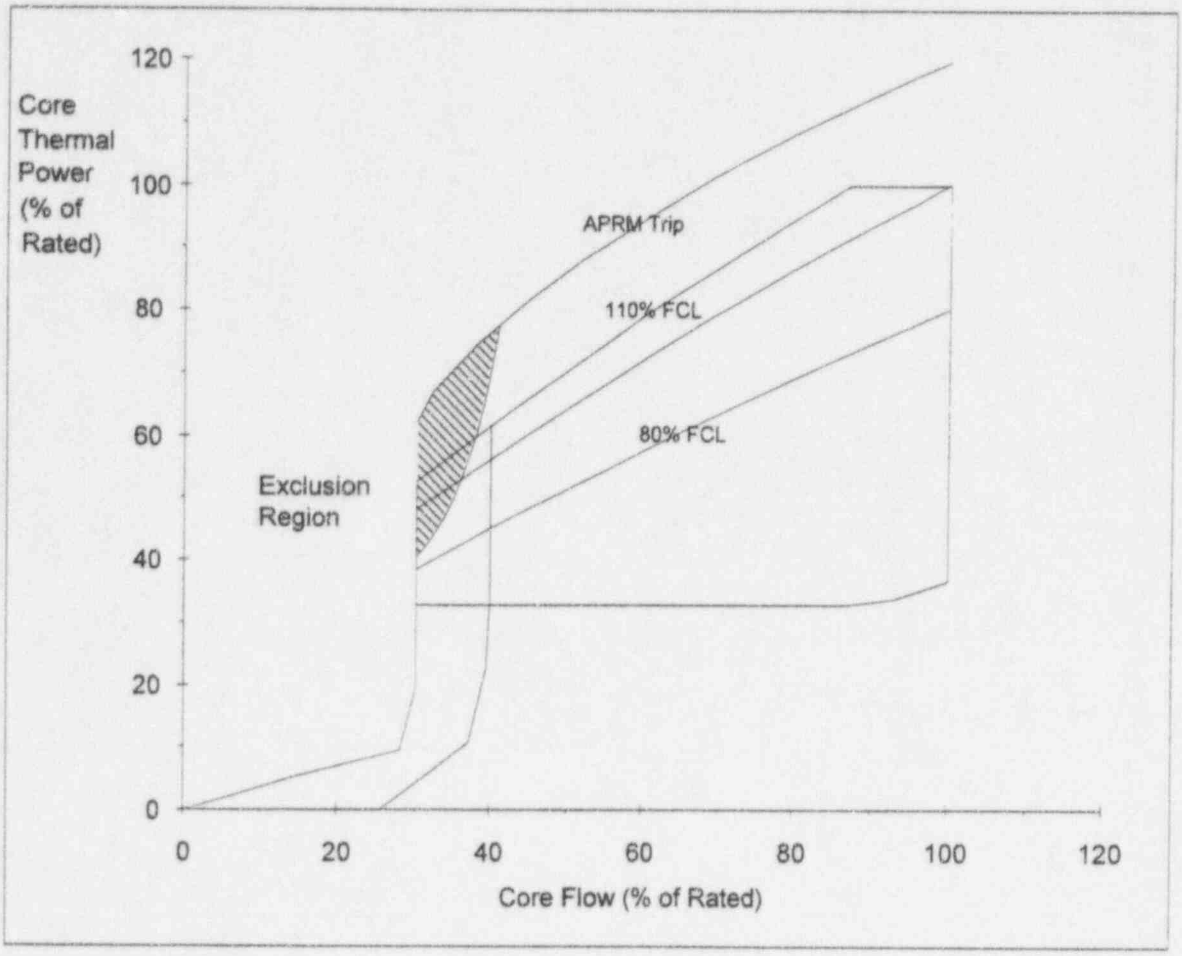
W_A = core flow rate at State Point A (% of rated),

W_B = core flow rate at State Point B (% of rated),

The range of validity of the fit is:

$30.0 < W < 39.3$.

Figure 4-3. Duane Arnold Exclusion Region (Cycle 14)



5 APPLICATION OF BWROG STABILITY LONG-TERM SOLUTION DETECT AND SUPPRESS METHODOLOGY

5.1 LICENSING COMPLIANCE

Section 5 describes the application to DAEC Cycle 14 of the Detect and Suppress portion of stability long-term solution Option 1-D. This application demonstrates protection of the SLMCPR provided by the flow-biased APRM neutron flux trip for core-wide mode oscillations. The Detect and Suppress licensing methodology for application to Option 1-D is documented in BWROG Licensing Topical Report NEDO-32465[2]. Consistent with DAEC qualification as an Option I-D solution plant, the Regional Exclusion methodology demonstrates that core-wide is the predominate oscillation mode and, therefore, the Detect and Suppress calculation must only be performed for core-wide mode oscillations.

The Detect and Suppress methodology[2] assumes that a core-wide mode oscillation occurs, and is terminated by automatic reactor scram when the APRM oscillation magnitude reaches the flow-biased APRM flux trip. The methodology applies a statistical method, using a combination of statistical and deterministic inputs, to determine the final MCPR (FMCPR) with a high statistical confidence when control rod insertion disrupts the oscillation. The flow-biased APRM flux trip provides adequate protection as long as the FMCPR is greater than the SLMCPR.

5.2 METHODOLOGY OVERVIEW

The Detect and Suppress methodology is used to determine the FMCPR resulting from core-wide mode oscillations which are terminated by the APRM flow-biased scram. The rated flow-control line is used to define the plant conditions for application of the methodology. The methodology consists of three major components:

a. Calculation of the Pre-Oscillation MCPR: A DAEC Cycle 14-specific determination of the MCPR on the rated flow-control line captures the margin to the SLMCPR prior to the oscillation. This is known as the initial MCPR (IMCPR). The IMCPR is calculated conservatively assuming the plant is initially operating at the MCPR operating limit (OLMCPR).

b. Statistical Calculation of Peak Oscillation Magnitude: A statistical evaluation of the normalized peak oscillation magnitude, Δh (defined as oscillation (peak-minimum)/average), due to an oscillation initiating on the rated flow-control line captures the effect of plant characteristics, trip system definition, and setpoint values on the peak fuel bundle power oscillation magnitude. The statistical methodology considers power distributions, oscillation contours, oscillation growth rates, oscillation frequencies, trip overshoot, LPRM failures, and APRM failures. The result of the evaluation is a statistically conservative value of the peak hot bundle oscillation magnitude, $\Delta h_{95/95}$, at a 95% probability and 95% confidence level for anticipated reactor instability.

c. MCPR Performance of the Hot Bundle: A relationship between the fractional change in CPR and the hot bundle oscillation magnitude for core-wide mode oscillations captures the effect of fuel design. The relationship has been derived from 3-D TRACG analyses performed over a range of conditions and conservatively represents current DAEC loaded fuel designs.

The IMCPR and oscillation magnitude calculations are both evaluated at the rated flow-control line. Additional conservatisms have been added to the methodology to streamline the reload review process. A relatively simple confirmation of the applicability of each portion of the DAEC Cycle 14 Detect and Suppress calculation is all that will be required for subsequent fuel cycles to assure with a high confidence that the RPS trip setpoints continue to provide protection of the SLMCPR for anticipated reactor instability. If the applicability of a portion of the calculation cannot be assured, then specific portions of the calculation would need to be re-performed.

Further information on application of each of the three portions of the methodology to DAEC Cycle 14 is provided in the following.

5.2.1 PRE-OSCILLATION MCPR

The IMCPR is the more limiting (lower) of the MCPR from two scenarios on the rated flow-control line. The two scenarios evaluated are (1) a two recirculation pump trip from rated flow with the MCPR at the OLMCPR, and (2) steady-state operation at 45% core flow at the applicable flow-dependent OLMCPR.

5.2.1.1 Two Recirculation Pump Trip

For DAEC Cycle 14, the lowest OLMCPR is 1.20[13]. Flow runback analysis completed on the rated flow-control line with the 3D core simulator determined that the CPR increase due to the flow runback from rated flow to natural circulation is 0.373. Therefore, the IMCPR for Condition 1 is:

$$\mathrm{IMCPR}_1 = 1.20 + 0.373 = 1.573$$

5.2.1.2 Steady-State Operation at 45% Core Flow

For DAEC Cycle 14, The OLMCPR on the rated flow-control line at 45% flow is computed from the flow-dependent MCPR limits for DAEC Cycle 14[13], resulting in:

$IMCPR_2 = 1.40$

5.2.1.3 Limiting IMCPR

The IMCPR is the more limiting (lower) of $IMCPR_1$ and $IMCPR_2$:

$IMCPR = Min[IMCPR_1, IMCPR_2] = 1.40$

5.2.2 STATISTICAL CALCULATION OF HOT BUNDLE OSCILLATION MAGNITUDE

The statistical model is described in BWROG Licensing Topical Report NEDO-32465[2]. The model calculates hot bundle oscillation magnitude, Δh, dependent on a combination of statistical inputs and deterministic plant-specific factors. The statistical model results in selection of a conservative value of the hot bundle oscillation magnitude, $\Delta h_{95/95}$, at the 95% probability with a 95% confidence level.

5.2.2.1 Statistical Inputs

Growth Rate: A review of actual instability events indicates that most BWR oscillations would be expected to have a growth rate only slightly above 1.00. For DAEC application, the growth rate is randomly selected from the probability density function with a χ^2 distribution shown in Ref. 2.

Overshoot: The trip setpoint overshoot is a measure of how much an oscillation exceeds the trip setpoint. The overshoot is the fraction of the peak-to-peak difference between two consecutive cycles which is above the setpoint, when a trip occurs. Thus, $0.0 \leq \delta \leq 1.0$; and the value of δ can be considered to be essentially random. For DAEC application, the overshoot is randomly selected from the uniform distribution shown in Ref. 2.

Oscillation Period: The statistical methodology considers a range of oscillation periods. Studies of actual instability events indicate that the expected value for the period is approximately 1.8 to 2.0 seconds. However, it is desirable to consider an oscillation frequency range between 0.7 Hz and 0.3 Hz. This corresponds to a desired period range of $1.4 \text{ sec} \leq T \leq 3.3 \text{ sec}$. For DAEC application, the oscillation period is randomly selected from the probability density function with a χ^2 distribution shown in Ref. 2.

LPRM Failures: The statistical model provides options for considering an input LPRM failure probability distribution, a fixed failure percentage, or no LPRM failures in the calculation of hot bundle oscillation magnitude. For DAEC application, a random number of LPRM failures are selected from the distribution specified in Ref. 2 which is representative of plant data on LPRM failure rates. The specific LPRMs which are defined to fail for a given trial are then randomly selected from the total DAEC LPRM population.

Oscillation Contours: The statistical model randomly selects from the specified set of oscillation contours. DAEC application uses plant-specific contours developed for core-wide mode oscillations.

5.2.2.2 Deterministic Inputs

LPRM Assignments: Option 1-D relies on the APRM flow-biased trip. LPRMs are assigned to their respective APRM channels according to the plant configuration. All non-failed LPRM signals in an APRM are used to produce an averaged power signal for comparison to the trip setpoint. DAEC was designed with 80 LPRMs, in 6 APRM channels. However, the "D" level detectors in LPRM strings 40-25 and 24-09 have been removed[14] (both were in APRM Channel E). Therefore, there are 78 remaining LPRMs in the DAEC core. In the DAEC design, the LPRMs assigned to Channel A are also assigned to Channel B, and the LPRMs assigned to Channel C are also assigned to Channel D, as illustrated in Table 5-1. The LPRMs in Channels E and F are not assigned to any other channels[14]. Since there are channel pairs with identical LPRMs, DAEC normally operates with either Channels A & D bypassed, or with Channels B & C bypassed as illustrated in Table 5-1. For stability trip applications, there is no difference between the two operational configurations.

Table 5-1. LPRM-to-APRM Assignment Logic

Division	APRM	LPRM	Operational (Not Bypassed)	
I	A	group 1	yes	
	C	group 2		yes
	E	group 3	yes	yes
II	B	group 1		yes
	D	group 2	yes	
	F	group 4	yes	yes

Trip Setpoint: The nominal APRM trip setpoint is input as a percentage of rated power. At natural circulation, the flow-biased APRM trip is at 62% reactor power[14].

Radial Peaking Factor: Since only the fundamental mode from the 3-D BWR simulator is used to calculate the relative LPRM signal averages, A, there is only one hot bundle in the core-wide mode oscillation. This bundle is also the "true" hot bundle with the highest radial peaking factor. Its normalized oscillation magnitude, Δh, is the same as any other location in the core. The radial peaking factor used for DAEC is 1.44[14].

RPS Trip Logic: DAEC has a one-out-of-two, taken twice trip logic. Therefore, at least one channel from Division I ***and*** at least one channel from Division II must reach the APRM trip setpoint for the trip signal to be generated.

APRM Channel Failure: In addition to the failure of individual LPRMs, the failure of one APRM channel is considered. The model provides several options: no APRM channel failure, failure of a specified channel, failure of a randomly selected channel, and failure of the most responsive channel. For conservatism, the failure of the most responsive channel (i.e., the first channel to reach the trip setpoint) is used for Option 1-D analysis.

Delay Time: The delay time for control rod insertion to terminate oscillation growth is input to the model. The time at which the reactor trip criterion is reached plus the delay time sets the time window in which the peak hot bundle oscillation magnitude can occur. The delay time is a plant-specific input consisting of the APRM response time (20 msec), the RPS processing time (50 msec), the control rod drive delay time before rod motion begins (200 msec), and the time for control rods to insert two (2) feet into the core assuming control rods insert at the minimum scram speed allowed by the plant Technical Specifications (615 msec). Even though control rod insertion two feet into the core will not shut the reactor down, it is judged to be adequate to prevent further growth of the hot bundle oscillation. Therefore, the total delay time for DAEC Cycle 14 is 885 msec.

5.2.3 MCPR PERFORMANCE OF THE HOT BUNDLE

The relationship of change in CPR as a function of oscillation magnitude has been designated as the DIVOM curve (**D**elta CPR over **I**nitial CPR **V**s. **O**scillation **M**agnitude). Application to Option I-D uses the generic DIVOM curve for core-wide mode oscillations[2], which is the same as the fixed DIVOM curve previously specified for Option 1-D application. The equation of the fixed curve is [ΔCPR/IMCPR = 0.175 * $\Delta h_{95/95}$ + 0.05]. The specified fixed curve is shown in Figure 5-1.

The generic DIVOM curve for core-wide mode oscillations is reasonably conservative (but not necessarily bounding in all cases) when compared to the TRACG CPR performance data[2]. It is very conservative for application in the licensing methodology since using a nominal value for the slope of the generic DIVOM curve with the $\Delta h_{95/95}$ hot bundle oscillation magnitude would produce a FMCPR at approximately the 95/95 level.

5.3 FINAL MCPR CALCULATION

The three-parts of the Detect and Suppress methodology provides for a conservative calculation of the minimum MCPR for an anticipated stability-related oscillation. First, the initial MCPR (IMCPR) is determined by a cycle-specific evaluation at the rated flow-control line. Next, the hot bundle oscillation magnitude ($\Delta h_{95/95}$) is calculated at the rated flow-control line. Finally, the

MCPR change (ΔCPR/IMCPR) corresponding to $\Delta h_{95/95}$ is determined. From these three elements, the final MCPR (FMCPR) can be determined:

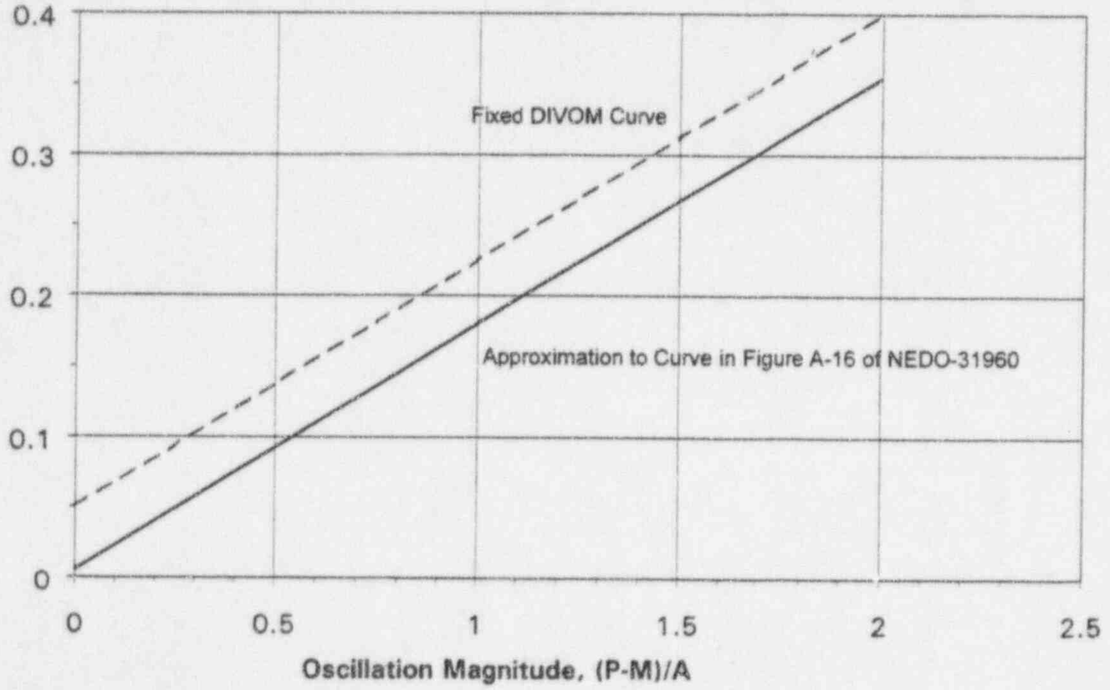
$$\text{FMCPR} = \text{IMCPR} - \text{IMCPR} * \{\Delta\text{CPR/IMCPR}\}$$

where:

$\{\Delta$CPR/IMCPR$\}$ = determined from generic DIVOM curve at the specified (P-M)/A $_{95/95}$ oscillation magnitude.

The licensing criterion is met when the FMCPR is greater than the SLMCPR. For DAEC Cycle 14, the SLMCPR is 1.07[13].

Figure 5-1. Fixed DIVOM Curve for Core Wide Mode Oscillations



6 DETECT AND SUPPRESS RESULTS

6.1 STATISTICAL MODEL CALCULATION

The statistical methodology consists of a 1000-trial Monte Carlo analysis. Based on non-parametric tolerance limits, the methodology rank orders the 1000 trials and selects the 39th trial from the end as the 95/95 value[2]. A 1000-trial statistical analysis has been calculated for DAEC Cycle 14. Table 6-1 lists the key inputs. Table 6-2 provides the highest 50 calculated values of hot bundle oscillation magnitude (Δh) and the 95/95 value ($\Delta h_{95/95} = 0.708$).

Table 6-1: DAEC Cycle 14 Inputs for Hot Bundle Oscillation Magnitude Calculation

Core Size:	368-bundle core
Trip System:	Flow-biased APRM
Trip Logic:	One-out-of two, taken twice
Oscillation Mode:	Core-wide
APRM Channel Failure:	Most Responsive APRM Channel (applied to 100.0% of all trials)
LPRM Failures:	Random (χ^2 Distribution)
Oscillation Period, T:	Random (χ^2 Distribution)
Growth Rate, Gr:	Random (χ^2 Distribution)
Overshoot, δ:	Random (Uniform Distribution)
Average Reactor Power:	48.0 % rated (100% rod line at natural circulation)
Radial Peaking Factor:	1.440
APRM Trip Level (nominal):	62.0 % rated (at natural circulation)
Total Delay Time:	885 msec. (measured from time of full trip)
Total Number of LPRMs:	78
Oscillation Contour Selection:	Random from contours: KE1B10AH1, KE1B10AH3, KE1M10AH1, KE1M10AH3, KE1E10AH1, KE1E10AH3, KE1H10AH1, KE1H10AH3

Table 6-2: Highest 50 Trials for DAEC Cycle 14 Hot Bundle Oscillation Magnitude Calculation

Trial #	Contour ID	Period, T (sec)	GR	Overshoot	APRM Failure	# LPRM Failures	% LPRM Failures	Hot Bundle OM	Peak Power (% rated)
812	KEIM10AH3	2.49	1.22	0.64	F	7	9.0	0.702	97.15
377	KEIM10AH3	2.69	1.13	0.06	F	4	5.1	0.702	97.19
930	KEIH10AH3	1.70	1.13	0.97	F	10	12.8	0.703	97.23
698	KEIH10AH3	1.49	1.16	0.84	F	5	6.4	0.704	97.26
483	KEIH10AH1	2.57	1.14	0.93	F	5	6.4	0.704	97.29
733	KEIB10AH1	1.94	1.22	0.72	F	2	2.6	0.705	97.28
924	KEIE10AH3	2.20	1.12	0.10	F	12	15.4	0.705	97.31
624	KEIH10AH3	2.68	1.17	0.78	F	7	9.0	0.705	97.34
548	KEIH10AH1	1.73	1.14	0.94	F	7	9.0	0.706	97.34
618	KEIB10AH3	1.47	1.24	0.67	F	6	7.7	0.706	97.34
678	KEIH10AH3	2.65	1.33	0.47	F	18	23.1	0.708	97.42
25	KEIB10AH1	1.96	1.19	0.86	F	4	5.1	0.708	97.44
	39th triai from end: Hot Bundle (P-M)/A 95/95, Δh95/95 = 0.708								
200	KEIM10AH3	1.91	1.18	0.83	F	3	3.8	0.708	97.44
501	KEIE10AH3	2.20	1.19	0.74	F	2	2.6	0.709	97.49
978	KEIB10AH1	1.50	1.21	0.82	F	10	12.8	0.711	97.57
356	KEIE10AH1	1.45	1.16	0.91	A	4	5.1	0.713	97.66
105	KEIM10AH1	2.02	1.19	0.85	D	9	11.5	0.713	97.65
556	KEIB10AH1	2.52	1.18	0.96	F	7	9.0	0.713	97.67
93	KEIH10AH1	2.40	1.15	0.95	F	4	5.1	0.714	97.7
482	KEIE10AH1	2.13	1.16	0.92	F	6	7.7	0.714	97.71
242	KEIE10AH1	2.15	1.17	0.91	D	7	9.0	0.715	97.75
456	KEIB10AH1	2.02	1.17	0.04	F	6	7.7	0.715	97.75
116	KEIH10AH1	1.97	1.26	0.60	F	6	7.7	0.715	97.74
983	KEIB10AH3	2.34	1.22	0.83	F	8	10.3	0.717	97.81
925	KEIE10AH1	1.52	1.18	0.86	F	9	11.5	0.718	97.88
648	KEIH10AH1	1.71	1.17	0.93	F	2	2.6	0.718	97.9
967	KEIE10AH3	1.71	1.15	0.08	A	15	19.2	0.719	97.95
457	KEIH10AH3	1.72	1.17	0.91	F	8	10.3	0.720	97.97
506	KEIB10AH1	1.34	1.18	0.00	F	8	10.3	0.720	97.95
681	KEIH10AH3	1.47	1.37	0.46	F	6	7.7	0.720	97.97

Table 6-2 (Continued)

Trial #	Contour ID	Period, T (sec)	GR	Overshoot	APRM Failure	# LPRM Failures	% LPRM Failures	Hot Bundle OM	Peak Power (% rated)
629	KEIH10AH1	1.74	1.17	0.97	F	5	6.4	0.723	98.12
605	KEIE10AH1	2.40	1.24	0.68	F	4	5.1	0.723	98.13
398	KEIH10AH1	2.03	1.21	0.79	F	8	10.3	0.726	98.25
785	KEIH10AH3	3.50	1.21	0.81	F	8	10.3	0.727	98.28
819	KEIH10AH1	1.91	1.22	0.80	E	14	17.9	0.731	98.49
892	KEIE10AH3	1.36	1.19	0.94	E	3	3.8	0.731	98.5
516	KEIM10AH1	2.21	1.18	0.07	F	8	10.3	0.733	98.56
256	KEIB10AH1	2.08	1.29	0.73	F	3	3.8	0.734	98.6
864	KEIM10AH1	2.20	1.27	0.73	F	10	12.8	0.736	98.68
64	KEIE10AH3	2.50	1.19	0.98	E	7	9.0	0.736	98.7
293	KEIH10AH3	2.09	1.20	0.98	F	6	7.7	0.746	99.15
773	KEIE10AH1	1.88	1.22	0.89	F	14	17.9	0.746	99.15
262	KEIE10AH3	2.45	1.21	0.96	A	7	9.0	0.748	99.25
866	KEIH10AH1	2.55	1.18	0.11	F	10	12.8	0.751	99.36
748	KEIB10AH3	1.91	1.27	0.90	F	8	10.3	0.758	99.69
440	KEIH10AH1	2.00	1.30	0.75	F	3	3.8	0.759	99.73
68	KEIH10AH1	2.08	1.44	0.62	F	14	17.9	0.784	100.84
402	KEIH10AH3	2.35	1.29	0.96	A	8	10.3	0.800	101.63
936	KEIH10AH3	1.69	1.36	0.88	F	8	10.3	0.824	102.7
551	KEIE10AH1	1.91	1.41	0.80	F	3	3.8	0.831	103.01
	MINIMUM	1.27	1.00	0.00			1.3	0.582	91.9
	MAXIMUM	3.67	1.44	1.00			28.2	0.831	103.01
	AVERAGE	2.04	1.10	0.49			8.6	0.648	94.79

6.2 FINAL MCPR CALCULATION

First, the initial MCPR (IMCPR) is determined by a cycle-specific evaluation at the rated flow-control line.

$$\text{IMCPR} = 1.40$$

Next, the hot bundle oscillation magnitude ($\Delta h_{95/95}$) is calculated using the statistical methodology at the rated flow-control line.

$$\Delta h_{95/95} = 0.708$$

Finally, the MCPR change (ΔCPR/IMCPR) corresponding to $\Delta h_{95/95}$ is determined from the generic DIVOM curve for core-wide mode oscillations.

$$\Delta \text{CPR/IMCPR} = 0.175 * \Delta h_{95/95} + 0.05$$
$$\Delta \text{CPR/IMCPR} = 0.175 * (0.708) + 0.05 = 0.174$$

From these three elements, the final MCPR (FMCPR) can be determined:

$$\text{FMCPR} = \text{IMCPR} - \text{IMCPR} * \{\Delta \text{CPR/IMCPR}\}$$
$$\text{FMCPR} = 1.40 - 1.40 * 0.174 = 1.16$$

The licensing criterion is met when the FMCPR is greater than the SLMCPR.

$$\text{FMCPR} > \text{SLMCPR}$$
$$1.16 > 1.07$$

Since the FMCPR is greater than the SLMCPR, the APRM flow-biased trip system shows protection for core-wide mode oscillations.

7 RELOAD APPLICATION

The purpose of the reload review is to determine the applicability of previous plant-specific calculations to the current fuel cycle. The analysis documented in this report constitutes the baseline for future fuel cycle reload reviews. Table 7-1 tabulates the key parameters which must be evaluated to determine the applicability of the analysis documented herein. If some key parameters do not meet the specified criteria, the applicable portions of the analysis must be re-performed.

Table 7-1. Parameters for Reload Review Evaluation

Regional Exclusion Methodology

Description	Criteria	Base Value
There are no reactor design changes which would affect the thermal-hydraulic stability of the reactor (e.g., recirculation loop performance)	No reactor changes	--
There are no new plant operating modes (e.g., power uprated, increased load lines) which would affect the operating region of the reactor	No operating region change	--
The reload fuel design has similar stability performance as the Cycle 14 fuel design	Similar to GE10	GE10
Haling radial peaking factor increases over Cycle 14 by no more than 5%	≤ 105% of base value	1.41
Reload batch size changes by no more than 18 bundles (5% of core size) from the Cycle 14 batch size	Within ±18 bundles from base value	128 bundles
The Haling cycle exposure changes by no more than 1080 MWD/ST (10% of base value) from the Cycle 14 Haling cycle exposure	Within ±1080 MWD/ST from base value	10,775 MWD/ST
The actual cycle exposure of the previous cycle changes by no more than 1050 MWD/ST (10% of base value) from the Cycle 13 actual cycle exposure	Within ±1050 MWD/ST from base value	10,468 MWD/ST

Table 7-1. Parameters for Reload Review Evaluation (continued)

Detect and Suppress Methodology

Parameter	Description	Value
OLMCPR (100/100)	MCPR Operating Limit at rated flow on the rated flow-control line	≥ 1.20
ΔMCPR(2RPT)	MCPR increase due to flow runback from a 2RPT	≥ 0.373
OLMCPR (100/45)	MCPR Operating Limit at 45% of rated flow on the rated flow-control line	≥ 1.40
#LPRMs	Number of installed LPRMs	≥ 78
APRM assignment	LPRM assignment to APRMs in 6 channels, etc.	No APRM design change
APRM trip @ NC	Flow-biased APRM trip power level (nominal value) at natural circulation	≤ 62% rated power
A @ NC	Average power level on the rated flow-control line at natural circulation	≥ 48% rated power
T_{delay}	Total delay time (20 msec APRM response time, 50 msec RPS processing time, 200 msec delay before start of control rod motion, 615 msec for 2 feet of control rod insertion)	≤ 885 msec
Fuel Design	Fuel Design which is covered by the Generic DIVOM Curve for Core-Wide Mode Oscillations	GE7, GE8, GE9, GE10, GE11, or GE12

8 REFERENCES

1. "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology," NEDO-31960, June 199[illegible] and NEDO-31960 Supplement 1, March 1992.

2. "BWR Owners' Group Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology and Reload Applications," NEDO-32465, May 1995.

3. 10 CFR 50, Appendix A.

4. GE Service Information Letter, SIL-380, Revision 0, August 11, 1982.

5. GE Service Information Letter, SIL-380, Revision 1, February 10, 1984.

6. NEDE-22277-P, "Compliance of the General Electric Boiling Water Reactor Fuel Designs to Stability Licensing Criteria," December, 1982.

7. NEDE-22277-P-1, "Compliance of the General Electric Boiling Water Reactor Fuel Designs to Stability Licensing Criteria," October, 1984.

8. NEDO-31708, "Fuel Thermal Margin during Core Thermal Hydraulic Oscillations in a Boiling Water Reactor," June, 1989.

9. NRC Bulletin No. 88-07, "Power Oscillations in Boiling Water Reactors," June 15, 1988.

10. NRC Bulletin No. 88-07, Supplement 1, "Power Oscillations in Boiling Water Reactors," December 30, 1988.

11. NEDO-30130-A, "Steady State Nuclear Methods," April, 1985.

12. NEDE-31917P, "GE11 Compliance with Amendment 22 of NEDE-24011-P-A (GESTAR II)," April, 1991.

13. 24A5171, Rev 1, "Supplemental Reload Licensing Report for Duane Arnold Energy Center Reload 13 Cycle 14," August 1995.

14. NG-95-2500, Letter RA Browning (IES Utilities) to DW Newkirk (GE), "DAEC Input Data for Detect and Suppress Calculations for Thermal-Hydraulic Stability," August 2, 1995.

RTS-287
Attachment 2 to
NG-95-3121

General Electric Company

AFFIDAVIT

I, George B. Stramback, being duly sworn, depose and state as follows:

(1) I am Project Manager, Licensing Services, General Electric Company ("GE") and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in the GE proprietary report GE-NE-523-A038-0495, *ODYSY Description and Qualification,* Class 3 (GE Proprietary Information), dated August 1995. The proprietary information is delineated by bars marked in the margin adjacent to the specific material.

(3) In making this application for withholding of proprietary information of which it is the owner, GE relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), 2.790(a)(4), and 2.790(d)(1) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 4). The material for which exemption from disclosure is here sought is all "confidential commercial information", and some portions also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by General Electric's competitors without license from General Electric constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals cost or price information, production capacities, budget levels, or commercial strategies of General Electric, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future General Electric customer-funded development plans and programs, of potential commercial value to General Electric;

e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in both paragraphs (4)a. and (4)b., above.

(5) The information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GE, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GE, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within GE is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed results of analytical models, methods and processes, including computer codes, which GE has developed, obtained NRC approval of, and applied to perform evaluations of BWR core and channel thermal-hydraulic stability conditions.

The development and approval of the BWR thermal-hydraulic stability methods used in this analysis was achieved at a significant cost, on the order of several million dollars, to GE.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GE asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GE.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GE would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

STATE OF CALIFORNIA)
) ss:
COUNTY OF SANTA CLARA)

George B. Stramback, being duly sworn, deposes and says:

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of his knowledge, information, and belief.

Executed at San Jose, California, this 20th day of November 1995.

George B. Strambac
George B. Stramback
General Electric Company

Subscribed and sworn before me this 20th day of November 1995.

Notary Public, State of California

JULIE A. CURTS
COMM. # 974657
Notary Public — California
SANTA CLARA COUNTY
My Comm. Expires SEP 30, 1996
NNA1

EVALUATION OF CHANGE PURSUANT TO 10 CFR SECTION 50.92

Background:

10 CFR 50 Appendix A, General Design Criterion 12 requires that the reactor and associated systems be designed to assure that power oscillations that could cause fuel design limits to be exceeded are not possible or can be reliably and readily detected and suppressed. The advent of 8X8 fuel designs and aggressive operating strategies in the 1980's resulted in conditions where instabilities could no longer be demonstrated to be impossible for Boiling Water Reactors (BWRs). Consequently, General Electric (GE) issued guidance to BWR operators, SIL-380 Rev. 1, to aid in detecting and suppressing such hypothetical oscillations which the DAEC incorporated into its plant Technical Specifications (TS), Amendment #119, dated May 28, 1985. In response to an instability event in 1988, the NRC issued Bulletin 88-07, "Power Oscillations in Boiling Water Reactors", which required BWR owners to indicate how they intended to guard against further events. In addition, the BWR Owner's Group (BWROG) formed a committee to develop long term solutions. In 1994, the NRC issued Generic Letter (GL) 94-02, "Long-Term Solutions and Upgrade of Interim Operating Recommendations for Thermal-Hydraulic Instabilities in Boiling Water Reactors". In response to GL 94-02, the DAEC committed to implement the BWROG Option I-D long term solution which would supersede the recommendations of SIL-380 Rev. 1 and the interim actions taken in response to GL 88-07. The DAEC also committed to request a change to the plant TS to require that a reactor scram be initiated in the event the plant enters natural circulation conditions.

Option I-D, Regional Exclusion with Flow-Biased Average Power Range Monitor (APRM) Neutron Flux Scram, calls for the creation of an exclusion region in the power-flow operating map which bounds the area where calculations indicate power oscillations are possible. The operators will be instructed to immediately take action to exit this region if the plant should inadvertently operate there. The second part of the solution involves an analysis which demonstrates that the flow-biased APRM neutron flux scram will detect and suppress core-wide power oscillations should they occur. Regional mode core oscillations are not predicted to occur at the DAEC because of its small core size and tight core inlet orifices.

In the course of preparing this TS change request, it was determined that certain specifications related to single recirculation pump operation (SLO) could be deleted. Currently, when the plant is operating in SLO, the operators are required to verify that the core plate differential pressure noise level does not exceed certain levels. This specification was included in TS Amendment #119 due to NRC concerns at the time that high core plate noise observed during SLO at Brown's Ferry in 1985 could be an indication of thermal hydraulic instability. It has since been determined that core plate differential pressure noise is not a cause of thermal hydraulic instability and that the noise does not pose a safety concern (Technical Resolution of Generic Issue No. B-59-(N-1)

Loop Operation in BWRs and PWRs (Generic Letter No. 86-09), dated March 31, 1986). Therefore, the DAEC proposes to remove the current core plate noise surveillance requirements from TS.

IES Utilities Inc., Docket No. 50-331,
Duane Arnold Energy Center, Linn County, Iowa
Date of Amendment Request: November 30, 1995

Description of Amendment Request:

The proposed Technical Specifications changes would implement the Option I-D long-term stability solution and remove the existing SIL-380 Rev. 1-based specifications. In addition, this proposed change would require a plant scram be initiated should the plant enter natural circulation conditions and prohibit restarting a recirculation pump while in natural circulation as well as define natural circulation. Finally, this change would delete TS actions and surveillance requirements related to core plate differential pressure noise while in SLO.

Basis for proposed No Significant Hazards Consideration:

The Commission has provided standards (10 CFR Section 50.92(c)) for determining whether a significant hazards consideration exists. A proposed amendment to an operating license for a facility involves no significant hazards consideration if operation of the facility in accordance with the proposed amendment would not (1) involve a significant increase in the probability or consequences of an accident previously evaluated; (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in a margin of safety.

After reviewing this proposed amendment, we have concluded:

1) The proposed license amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated. The implementation of the BWR Owner's Group long term solution Option I-D does not modify the assumptions in the existing accident analysis. The use of an exclusion region and the operator actions required to avoid and minimize operation inside the region do not increase the possibility of an accident. Licensing Topical Report, 'Evaluation of the "Regional Exclusion with Flow-Biased APRM Neutron Flux Scram" Stability Solution', GENE-A000-04021-01 (attachment 1) demonstrates that the APRM flow-biased scram function provides a high degree of assurance that the fuel safety limit will not be exceeded should power oscillations occur during plant operation within the restricted region. Regional mode core oscillations are not predicted to occur at the DAEC because of its small core size and tight core inlet orifices. Conditions for operation outside of the exclusion region are

within the assumptions of the existing accident analysis. The operator action requirement to exit the exclusion region upon entry minimizes the probability of an instability event occurring. Inserting control rods or increasing recirculation flow, the evolutions to be used to exit the region, are normal plant maneuvers.

The proposed clarifications to explicitly direct the operator to initiate a reactor scram in the event of operation in natural circulation are conservative and consistent with current plant operating practices. Likewise, the proposed prohibition from starting a recirculation pump as a means of exiting the natural circulation mode of operation is also conservative. Therefore, the proposed license amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

The core plate differential pressure noise surveillances that are performed while in single recirculation pump operation were included in TS Amendment #119 due to NRC concerns at the time that high core plate noise observed during SLO at Brown's Ferry in 1985 could be an indication of thermal hydraulic instability. GE has since determined that core plate differential pressure noise is not a cause of thermal hydraulic instability and that the noise does not pose a safety concern. Therefore, the proposed license amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2) The proposed license amendment does not create the possibility of a new or different kind of accident from any previously evaluated. As stated above, the proposed changes either mandate operation within the envelope of previously analyzed plant operating conditions or direct the operator to immediately return the plant to within these analyzed conditions using normal plant maneuvers. In addition, analysis has demonstrated that the APRM flow-biased scram function provides a high degree of assurance that the fuel safety limit will not be exceeded should power oscillations occur during plant operation within the restricted region. Therefore, the potential for a new or different type of accident from those previously evaluated is not created.

The proposed clarifications to explicitly direct the operator to initiate a reactor scram in the event of operation in natural circulation are conservative and consistent with current plant operating practices. Likewise, the proposed prohibition from starting a recirculation pump as a means of exiting the natural circulation mode of operation is also conservative. Therefore, the potential for a new or different type of accident from those previously evaluated is not created.

The core plate differential pressure noise surveillances that are performed while in single recirculation pump operation were included in TS Amendment #119 due to NRC concerns at the time that high core plate noise observed during SLO at Brown's Ferry in 1985 could be an indication of thermal hydraulic instability. GE has since determined that core plate differential pressure noise is not a cause of thermal hydraulic instability and that the noise does not pose a safety concern. Therefore, the potential for a new or different type of accident from those previously evaluated is not created.

3) The proposed amendment will not reduce the margin of safety. The combination of the proposed requirements to avoid possible unstable conditions and the automatic flow biased high reactor flux scram provide defense in depth to provide fuel protection. Therefore the individual or combination of means to detect and suppress thermal hydraulic instability supplements the margin of safety.

The proposed specification related to initiating a reactor scram while in natural circulation is conservative. Likewise, the proposed prohibition from starting a recirculation pump as a means of exiting the natural circulation mode of operation is also conservative and therefore does not constitute a reduction in the margin of safety.

The core plate differential pressure noise surveillances that are performed while in single recirculation pump operation were included in TS Amendment #119 due to NRC concerns at the time that high core plate noise observed during SLO at Brown's Ferry in 1985 could be an indication of thermal hydraulic instability. GE has since determined that core plate differential pressure noise is not a cause of thermal hydraulic instability and that the noise does not pose a safety concern. Therefore, the elimination of these surveillance tests does not constitute a reduction in the margin of safety.

Based upon the above, we have determined that the proposed amendment will not involve a significant hazards consideration.

Local Public Document Room Location: Cedar Rapids Public Library, 500 First Street SE, Cedar Rapids, Iowa 52401

Attorney for Licensee: Jack Newman, Kathleen H. Shea; Morgan, Lewis & Bockius, 1800 M Street NW, Washington, D.C. 20036-5869