Attachment 3 to 2.04.074

Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Plant

Proposed Amendment to the Technical Specifications

General Electric Report GE-NE-0000-0027-5301
Pilgrim Nuclear Power Station
Single Loop Operation
(Non-proprietary)

GE Nuclear Energy

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ACRONYMS

Term	Definition
AOO	Anticipated Operational Occurrence
APRM	Average Power Range Monitor
ARTS	APRM/RBM/Technical Specification
ATWS	Anticipated Transient Without Scram
BWR	Boiling Water Reactor
CPR	Critical Power Ratio
DBA	Design Basis Accident
ECCS	Emergency Core Cooling System
ELLLA	Extended Line Load Limit Analysis
EOOS	Equipment Out-Of-Service
FFWTR	Final Feedwater Temperature Reduction
FIV	Flow-Induced Vibration
FSAR	Final Safety Analysis Report
FWCF	Feedwater Controller Failure
FWHOOS	Feedwater Heater Out-of-Service
GE	General Electric
ICGT	In-Core Guide Tube
ICF	Increased Core Flow
LHGR	Linear Heat Generation Rate
LOCA	Loss-Of-Coolant Accident
LRNBP	Load Rejection with No Bypass
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCPR	Minimum Critical Power Ratio
MELLLA	Maximum Extended Load Line Limit Analysis
MOP	Mechanical Over-Power
MSIV	Main Steamline Isolation Valve

ACRONYMS
(Continued)

Term	Definition
OLMCPR	Operating Limit Minimum Critical Power Ratio
OOS	Out-of-Service
PCT	Peak Clad Temperature
PNPS	Pilgrim Nuclear Power Station
RBM	Rod-Block Monitor
RWE	Rod Withdrawal Error
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single Loop Operation
SRLR	Supplemental Reload Licensing Report
SRV	Safety/Relief Valve
TIP	Traversing In-Core Probe
TLO	Two Loop Operation
TOP	Thermal Over-Power
TTNBP	Turbine Trip with No Bypass
USNRC	US Nuclear Regulatory Commission

1. INTRODUCTION AND SUMMARY

1.1 Introduction

The capability to operate in the single-loop operation (SLO) mode is useful if a recirculation pump or other component malfunction renders one recirculation loop inoperative for longer time than allowed by standard plant technical specifications. To support the use of long term SLO for Pilgrim Nuclear Power Station (PNPS), the accidents, abnormal operational transients and other events associated with power operation were reviewed for the case with only one recirculation pump in operation. The results of this evaluation are presented in this report.

1.2 Summary

In this report, SLO operation for PNPS is justified based on the results of the evaluations documented here. The major conclusions of this report are summarized as follows:

- Increased uncertainties in the total core flow and Traversing In-Core Probe (TIP) readings are conservatively accounted for by an incremental increase of ~0.01 to 0.02 in the Safety Limit Minimum Critical Power Ratio (SLMCPR) during single-loop operation. The two loop and single loop SLMCPR are calculated each cycle, so the exact incremental increase may vary. This increase in SLMCPR must be included in the determination of the Operating Limit MCPR (OLMCPR) for SLO (Sections 3 and 4).

- The reduced core flow coastdown for recirculation line breaks requires a Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) and Linear Heat Generation Rate (LHGR) SLO multiplier of 0.80 (Section 6).

- The flow-biased Average Power Range Monitor (APRM) rod block and scram setpoints are adjusted for SLO condition (Sections 4 and 8).

- The maximum rod line allowed for SLO operation is the rod line with a maximum power of 65% and a core flow of 52% of rated (Reference 1) due to SLO vessel internal vibration evaluation (Section 7).

Based on the evaluations presented herein, it is concluded that SLO for PNPS is acceptable within the region shown on Figure 1-1. The low power interlock is shown to be adequate to protect against jet pump cavitation for SLO (Reference 1). The PNPS recirculation flow control system should be operated in the manual flow control mode during SLO to prevent potential control oscillations from occurring in the recirculation flow control system. A summary of the plant Technical Specifications changes is shown in Section 8.

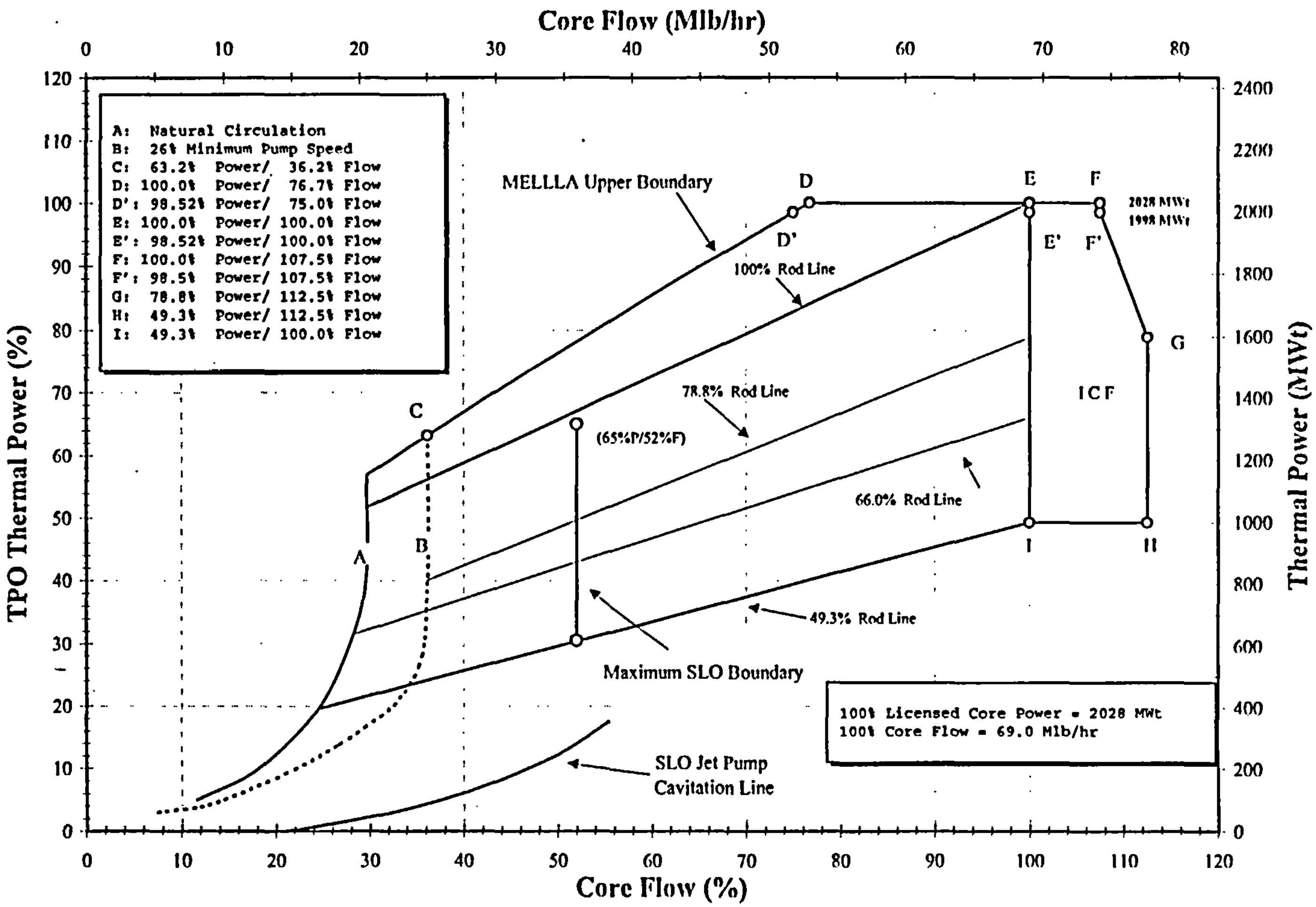

Figure 1-1 PNPS SLO POWER/FLOW MAP

2. OVERALL ANALYSIS APPROACH

The Reference 1 report documents a previous SLO evaluation performed for the PNPS. This section describes the various analyses that are being updated for the PNPS for SLO.

The following safety and regulatory concerns are identified as potentially being affected as a result of SLO:

- Fuel Cladding Integrity Safety Limit Minimum Critical Power Ratio (SLMCPR).
- Thermal limits during abnormal operational occurrences.
- Thermal-hydraulic stability performance.
- ECCS/loss of coolant accident (LOCA) performance.
- Reactor vessel internals vibration responses.
- Effects on plant Technical Specifications.

Each applicable safety and regulatory concern implied in the above listed items was reviewed to determine the acceptability of plant operation in the single loop mode. Other analyses, such as Containment Response and Anticipated Transients Without Scram are not addressed specifically here or in previous SLO for PNPS (Reference 1). The analyses not addressed here are assumed to be both: (a) not sensitive to the SLO plant state, and (b) valid in the power to flow operating map for SLO. Additionally, the reactor vessel internals vibration response to SLO from Reference 1 is applied to this evaluation and is summarized in Section 7. Discussions are presented in the sections indicated in Table 2-1.

The SLO analysis may be combined with other PNPS non-standard plant operating conditions and equipment out-of-service (EOOS), such as final feedwater temperature reduction (FFWTR), Feedwater Heater out-of-service (FWHOOS) or Main Steam Isolation Valve (MSIV) out-of-service (OOS), because the analyses for SLO that also affect these options conclude that the analysis for two loop is applicable to SLO. However, SLO is not compatible with the Maximum Extended Load Line Limit Analysis (MELLLA) or Increased Core Flow (ICF) options as these operating regions are excluded in SLO.

Table 2-1
EVALUATIONS PRESENTED IN THIS REPORT

Item	Section	Result
Fuel Cladding Integrity Safety Limit MCPR	3.0	Acceptable with correction
Fuel Transient Thermal Limits and Over-Pressure Limit	4.0	Acceptable with correction and setpoint adjustment
Thermal-Hydraulic Stability	5.0	Acceptable with setpoint adjustment for Option 1D
ECCS/LOCA Performance	6.0	Acceptable with multiplier
Reactor Vessel Internals Vibration	7.0	Previous analysis and conclusions applied
Effects on Technical Specifications	8.0	Acceptable Changes required

3. FUEL CLADDING INTEGRITY SAFETY LIMIT MCPR

Except for the total core flow and TIP reading, the uncertainties used in the statistical analysis to determine the SLMCPR are not dependent on whether coolant flow is provided by one or two recirculation pumps. Uncertainties used in the two-loop operation analysis are documented in Reference 2. A 6% core flow measurement uncertainty has been established for SLO (compared to 2.5% for two-loop operation). As shown in Subsection 3.1, this value conservatively reflects the one standard deviation (one sigma) accuracy of the core flow measurement system. The random noise component of the TIP reading uncertainty was revised for single recirculation loop operation to reflect the operating plant test results discussed in Subsection 3.2. This revision results in a 3DMonicore effective TIP uncertainty of 9.1% for reload cores. The comparable two-loop 3DMonicore uncertainty value is 8.7%. The net effect of revised core flow and TIP uncertainties is an increase in the required SLMCPR of approximately 0.01 to 0.02. The actual increase may vary from cycle to cycle, since the two loop and single loop SLMCPR values are calculated each fuel cycle.

3.1 Core Flow Uncertainty

3.1.1 Core Flow Measurement During Single-Loop Operation

The jet pump core flow measurement system is calibrated to measure core flow when both sets of jet pumps are in forward flow, the total core flow being the sum of the indicated loop flows. For SLO, however, the inactive jet pumps will be operating in reverse flow at active pump flows above approximately 40%. Therefore, the measured flow in the inactive jet pumps must be subtracted from the measured flow in the active loop to obtain the total core flow. The jet pump flow coefficient is different for reverse flow than for forward flow, and the measurement of reverse flow must be modified to account for this difference.

In SLO, the total core flow is derived from the following formula:

$$\begin{pmatrix}\text{total}\\\text{core}\\\text{flow}\end{pmatrix} = \begin{pmatrix}\text{active}\\\text{loop}\\\text{indicated}\\\text{flow}\end{pmatrix} - C\cdot\begin{pmatrix}\text{inactive loop}\\\text{indicated flow}\end{pmatrix} \tag{3-1}$$

The coefficient "C" is a correction factor and "loop indicated flow" means the flow indicated by the jet pump "single-tap" loop flow summers and indicators, which are set up to indicate forward flow correctly. A value of 0.95 is used for the "C" coefficient, as the result of a conservative evaluation. [[

]] If more exact, less conservative core flow is required, special in-reactor calibration tests could be made. Such calibration tests would involve (1) calibrating core support plate ΔP versus core flow during one-pump and two-pump operation along a constant flow control line and (2) calculating the correct value of "C" based on the core support plate ΔP and the loop flow indicator readings. Until such tests are made, the 0.95 correction factor should be used for the core flow calculations during single-loop operation.

3.1.2 Core Flow Uncertainty Analysis

The uncertainty analysis procedure used to establish the core flow uncertainty for SLO is essentially the same as for two-pump operation. For SLO, the total core flow can be expressed as follows (Figure 3-1):

$$W_C = W_A - W_I \tag{3-2}$$

where:

W_C = total core flow

W_A = active loop flow

W_I = inactive loop true flow

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3.2 TIP Reading Uncertainty

Tests were performed at an operating BWR to establish the TIP noise uncertainty for single recirculation loop operation. The test was performed at a power level of 59.3% of rated with a single recirculation pump in operation (core flow of 46.3% of rated). A rotationally symmetric control rod pattern existed during the test. Results of the test are directly applicable to PNPS because the data collected are typical of random neutron, electronic and boiling noise during SLO for a BWR.

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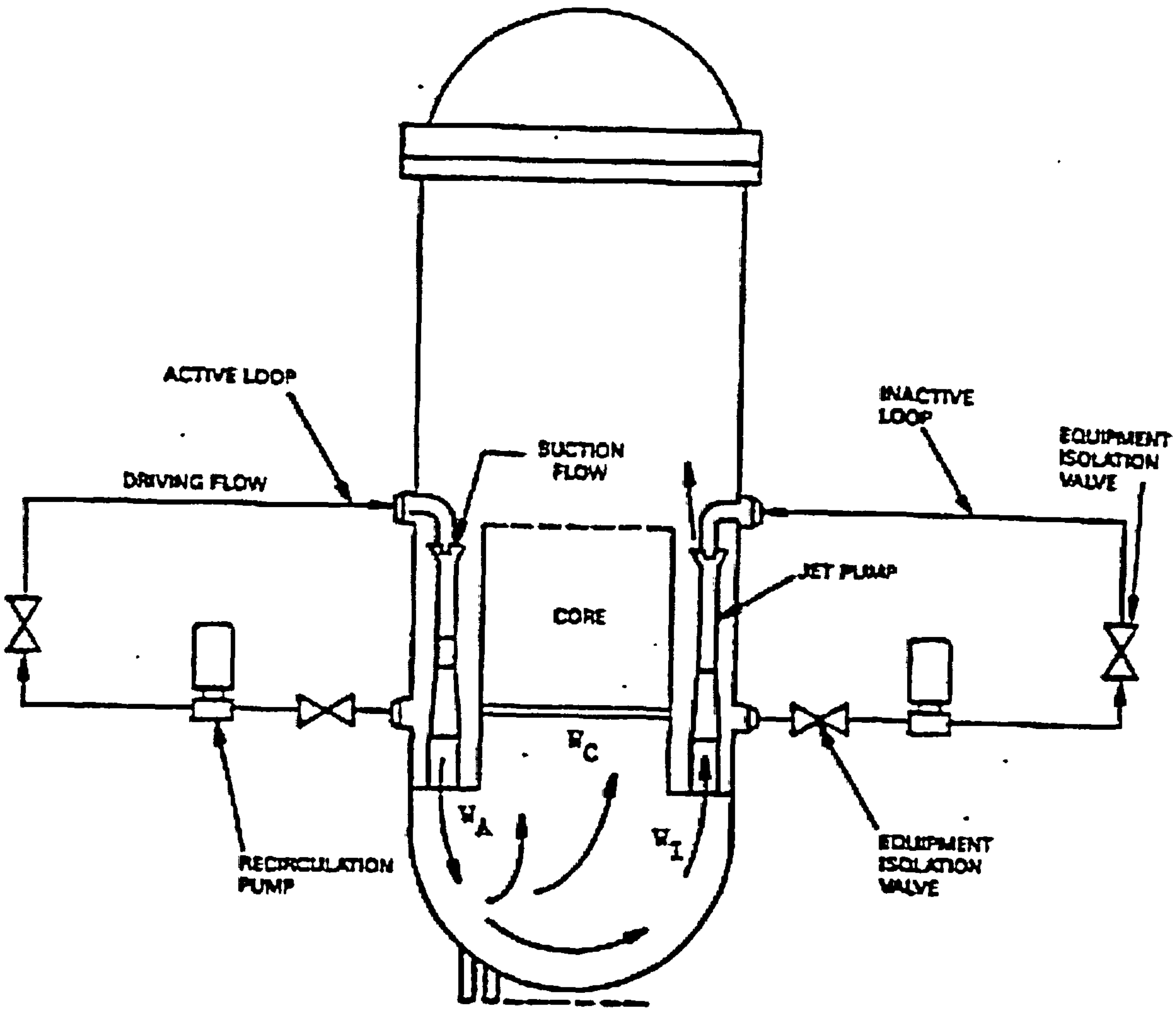
3.3 Calculational Options for SLMCPR

All SLMCPR evaluations for both TLO and SLO are based on the original GETAB model for licensing applications that use absolute adaption regardless of what adaptive (or non-adaptive) methods are used for core monitoring. For core monitoring systems that utilize shape adaptive option, the original GETAB uncertainties and models related to the power distribution have been shown to yield conservative SLMCPR values. However, core monitoring systems that utilize shape adaptive option may credit *REVISED* plant uncertainties and *REDUCED* power distribution uncertainties for both TLO and SLO. PNPS uses 3DMonicore (shape adaptive option) with *REVISED* plant uncertainties and *REDUCED* power distribution uncertainties. For 3DMonicore (shape adaptive option) the *REVISED* power distribution model (Reference 3) and *REVISED* plant uncertainties and *REDUCED* power distribution uncertainties (References 3 and 4) using the shape adaptive option have been reviewed and approved by the NRC (Reference 5).



W_C = Total Core Flow, W_A = Active Loop Flow, W_I = Inactive Loop Flow

Figure 3-1 ILLUSTRATION of SINGLE RECIRCULATION LOOP OPERATION FLOWS

4. TRANSIENT EVALUATIONS

4.1 Anticipated Operational Occurrences

The reactor response to abnormal operational transients (AOOs) is for the most part independent of the source of core flow (i.e. whether the flow is provided in one or both recirculation loops). Thus, the consequences of an event initiated from SLO will be the same as the consequences of an event initiated from two-loop operation given the same initial power/flow conditions. The highest allowable core flow, with one active pump, is 52%. For AOOs, the maximum power that can be justified is 78.1% power corresponding to the MELLLA boundary, however, power is restricted to a maximum of 65% because of vibration limitations discussed in Section 7. [[

]] The results of the full power analyses in the cycle specific Supplemental Reload Licensing Report (SRLR) for Pilgrim bound the thermal and over-pressure consequences of these events during SLO. Cycle specific analysis verifies or establishes reactor operating limits as reported in the SRLR (Reference 10) that cover ICF, MELLLA, and Final Feedwater Temperature Reduction (FFWTR) operating domains, both FWH-OOS and end-of-cycle (EOC) FFWTR extension, in combination with one MSIV out-of-service (MSIV-OOS). Cycle specific analysis verifies or establishes ARTS curves as reported in the SRLR and are used in the determination of off-rated (power and flow dependent MCPR and LHGR) limits for equipment in-service and for supported EOOS options. However, because the OLMCPR and the Thermal and Mechanical Over-Power (TOP/MOP) are influenced by relative change (compared to initial values), to justify SLO, safety analyses must be reviewed for one pump operation. The fuel cladding integrity safety limit MCPR, flow decrease, flow increase, cold water injection, and pressurization transients are evaluated.

Increased uncertainties in the total core flow and traversing in-core probe tip readings result in a small increase in the fuel cladding integrity SLMCPR for SLO. Therefore, when operating in SLO the plant SLMCPR is typically higher than when operating in TLO.

4.1.1 Core Flow Decrease Events

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4.1.2 Core Flow Increase Events

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4.1.3 Cold Water Injection Events

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4.1.4 Pressurization Events

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]] This is because at high core flows the transport time required for the feedwater to make its way to the core inlet is reduced, thereby increasing the core inlet subcooling more rapidly. The more rapid reactivity increase produced by the more rapid core inlet subcooling increase makes the transient more severe. In SLO, the maximum allowable core flow is 52.0% of rated core flow. [[

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4.1.5 Recirculation Pump Seizure Accident

When operating with only one recirculation pump in operation, this active pump provides drive flow for the jet pumps in that loop. This bank of jet pumps is referred to as the active jet pumps. The other recirculation pump is out of service and the jet pumps in that loop are referred to as the inactive jet pumps. The inactive jet pumps have reverse flow. In this condition of forward flow in the active loop and reverse flow in the inactive loop, the maximum core flow is limited to 52% of rated for Pilgrim. This reduced flow capability limits the maximum achievable core power to 78.1% as governed by the MELLLA boundary line.

The Recirculation Pump Seizure is characterized by a near instantaneous stoppage of the pump and associated pump flow. With this sudden stagnation of the drive flow, the active loop flow rapidly decreases. The resultant core flow decrease causes the core void fraction to increase which in turn causes a rapid decrease in core power. Because of the extremely low probability of occurrence for this event, a pump seizure is classified as an accident rather than an AOO. The purpose of evaluating a Pump Seizure event is to assure that the radiological consequences of the event are acceptable. The analysis was performed using the reload licensing methodology documented in References 2 and 6 and is based on the PNPS Cycle 14 core configuration..

Although the Cycle 14 core configuration was used, the analysis is considered cycle independent. The cycle-independent OLMCPR calculated for a recirculation pump seizure event when operating in Single Loop Operation (SLO) is 1.46. When adjusted for the off-rated power/flow conditions for SLO, (i.e., Kp of 1.082), this limit corresponds to a rated power/flow OLMCPR of 1.35, assuming a SLO SLMCPR ≤ 1.12.

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4.1.6 Rod Withdrawal Error

The implementation of the ARTS Program eliminated the flow-biased rod block monitor (RBM) trips and replaced them with power-dependent trips (Reference 7). The Rod Withdrawal Error (RWE) evaluations are independent of the source of the core flow (i.e., one recirculation loop versus two). Consequently, these evaluations are valid for both two-loop and single-loop operation.

The Flow Biased APRM rod block and scram system provides additional alarms, rod blocks and scram when power levels are grossly exceeded. Modification of the Flow Biased APRM function is therefore required to maintain the TLO rod block and scram versus power relationship when in SLO.

SLO results in backflow through 10 of the 20 jet pumps while flow is being supplied into the lower plenum from the 10 active jet pumps. The present rod block equation must be modified for use during SLO because of the backflow. Without correction the relationship between drive flow and core flow measurements may be non-conservative with respect to two-loop operation above approximately 35% core flow.

A procedure has been established for correcting the Flow Biased APRM rod block and scram equations to account for the discrepancy between actual flow and indicated flow in the active loop.

For normal TLO, the Flow Biased APRM Rod Block function is defined as:

$$RB = mW_d + c$$

For SLO, the above equation is revised to include the flow correction term:

$$RB = mW_d + c - m\,\Delta W_d$$

Or equal to

$$RB = mW_d + c'$$

For example, a nominal trip setpoint of the TLO rod block equation given by:

$$RB = mW_d + c = 0.66 * W_d + 58.5\% \text{ (may include several similar flow segments)}$$

Following the process described above, using a value of 10% to represent the SLO to TLO flow correction ΔW_d, the SLO equation becomes:

$$RB = mW_d + c - m\,\Delta W_d = 0.66 * W_d + 51.9\%$$

Where:

RB = Power at rod block in % of rated

m = Flow reference slope, assumed 0.66 in example

ΔW_d = Difference in drive flow between single and two loop operation at the same core flow. A value of 10% is verified to be bounding for PNPS based on plant specific recirculation system calculations. A more direct value can be derived using the procedure described in section 3.1.1.

W_d = Drive flow in % of rated

c = Constant in flow-biased rod block equation, assumed 58.5 in example

The Flow Biased APRM scram trip settings are corrected in the same manner as the Flow Biased APRM rod block setting. Therefore, the Flow Biased APRM flux scram settings are subject to the same procedural changes as the rod block setting discussed above.

4.2 Plant Operating Limit MCPR

The uncertainties used in the statistical analysis to determine the fuel cladding integrity SLMCPR are independent of whether coolant flow is provided by one or two recirculation pumps. However, the SLMCPR is impacted by uncertainties in core total flow and TIP readings. The effects of the increase in core flow and TIP uncertainties would be bounded by a 0.02 incremental increase in the required SLMCPR as shown in Reference 10. This increment will be confirmed or revised on a plant/cycle specific basis. For SLO the OLMCPR is corrected by this increment and the adjustment is described in References 7 and 10.

With the implementation of ARTS, power- and flow-dependent MCPR limits are determined from the rated power and flow OLMCPR through the use of MCPR adjustment factors. The power and flow dependencies are based on different transient events. For any given power and flow condition, both the power- and flow-dependent MCPRs must be determined. The OLMCPR is, then, the more restrictive of these two MCPRs, as follows:

OLMCPR = Maximum[MCPR(P), MCPR(F)]

The PNPS power-dependent MCPR adjustment factors discussed in Reference 7 are based on analyses of the limiting pressurization transients [[
]] initiated from various rated and off-rated initial power conditions. The power-dependent MCPR multiplier, K_p, was established based on plant specific analyses. The applicability of these multipliers was then confirmed by performing the PNPS Cycle 15 specific calculations. MCPR(P) is calculated as follows:

$$MCPR(P) = K_p * OLMCPR \text{ at } 100P/100F$$

However, prior to application of SLO operation the OLMCPR should be adjusted as described in 4.1.5 and in References 7 and 10.

PNPS flow dependent MCPR curves are based on generic recirculation slow flow run-out evaluations (Reference 7). This flow dependent limit, MCPR(F), assures that the SLMCPR will not be violated during a slow flow run-out event which does not terminate in a scram. As discussed in Section 4.1.2 these limits, as established for two-loop operation are conservatively applicable for SLO even with the SLMCPR increase of 0.02 (Reference 10) because of the significantly reduced recirculation run-out capability with only one recirculation pump in operation.

Also, part of the ARTS improvement program is the power and flow dependent MAPLHGR/LHGR limits. These limits are developed to maintain the fuel thermal and mechanical design criteria under postulated transient events at off rated power/flow conditions. From this transient overpower protection viewpoint, the power and flow dependent MAPLHGR/LHGR limits are not impacted by SLO because their evaluations are independent of the source of the core flow.

The power and flow dependent ARTS Limits for Pilgrim Cycle 15 are provided in Figures 4.2-1 through 4.2-7. The power dependent limits below P-bypass are based on Cycle 15 specific analyses with a two-loop safety limit of 1.06. The flow dependent ARTS limits are based on Figure 3-4 and Figure 3-5 of Reference 7.

4.3 Overpressurization Protection

The limiting event, the MSIV closure with flux scram in SLO, will yield peak pressures well below those calculated for rated power operation due to the reduced initial core power/flow condition during SLO.

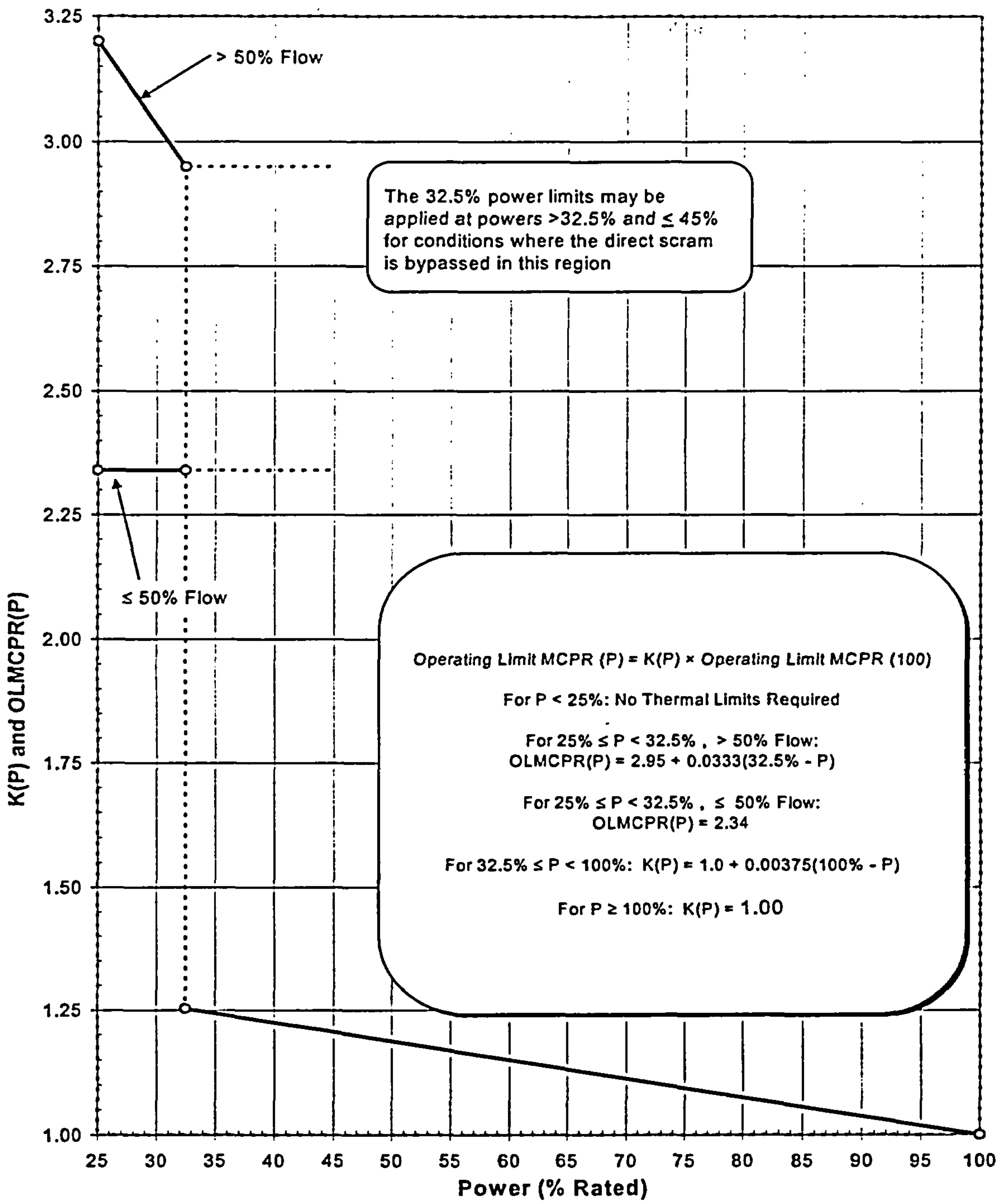

Figure 4.2-1 Power Dependent MCPR Limits (Turbine Bypass in Service)
(FFWTR included in limits)

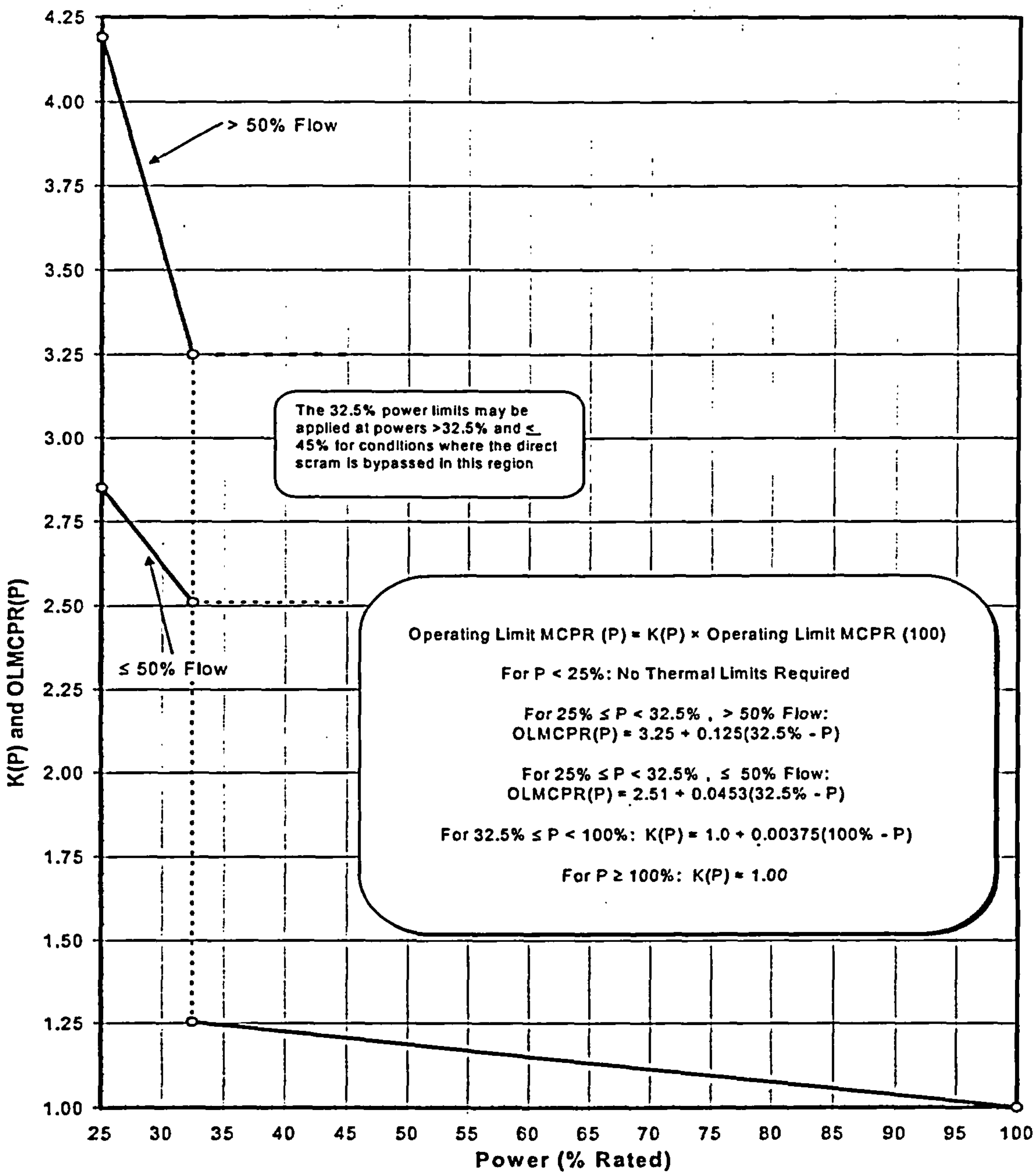

Figure 4.2-2. Power Dependent MCPR Limits (Turbine Bypass Out-of-Service)
(FFWTR included in limits)

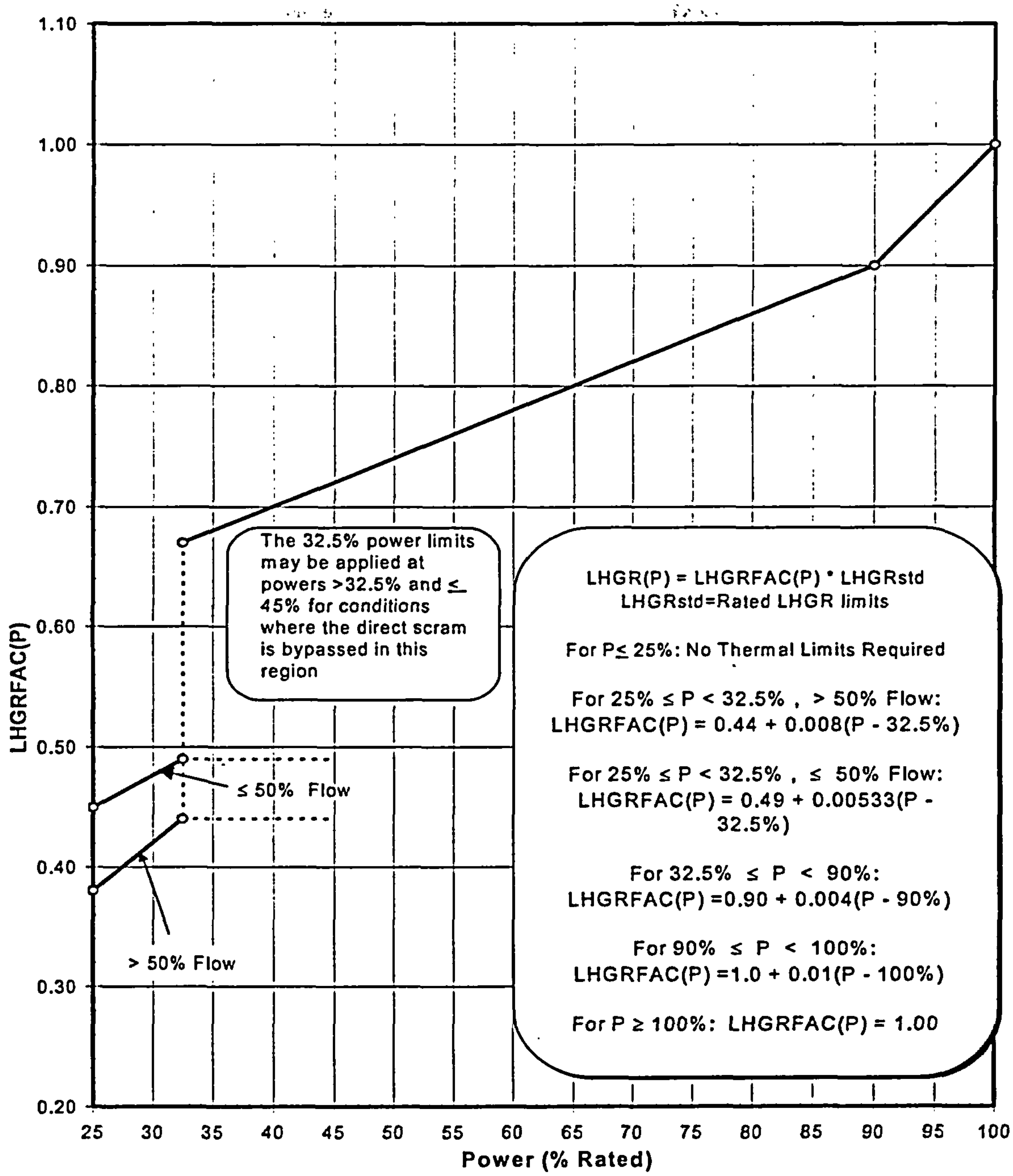

Figure 4.2-3. Power Dependent LHGR Factors with Turbine Bypass In Service or Out of Service (FFWTR included in limits)

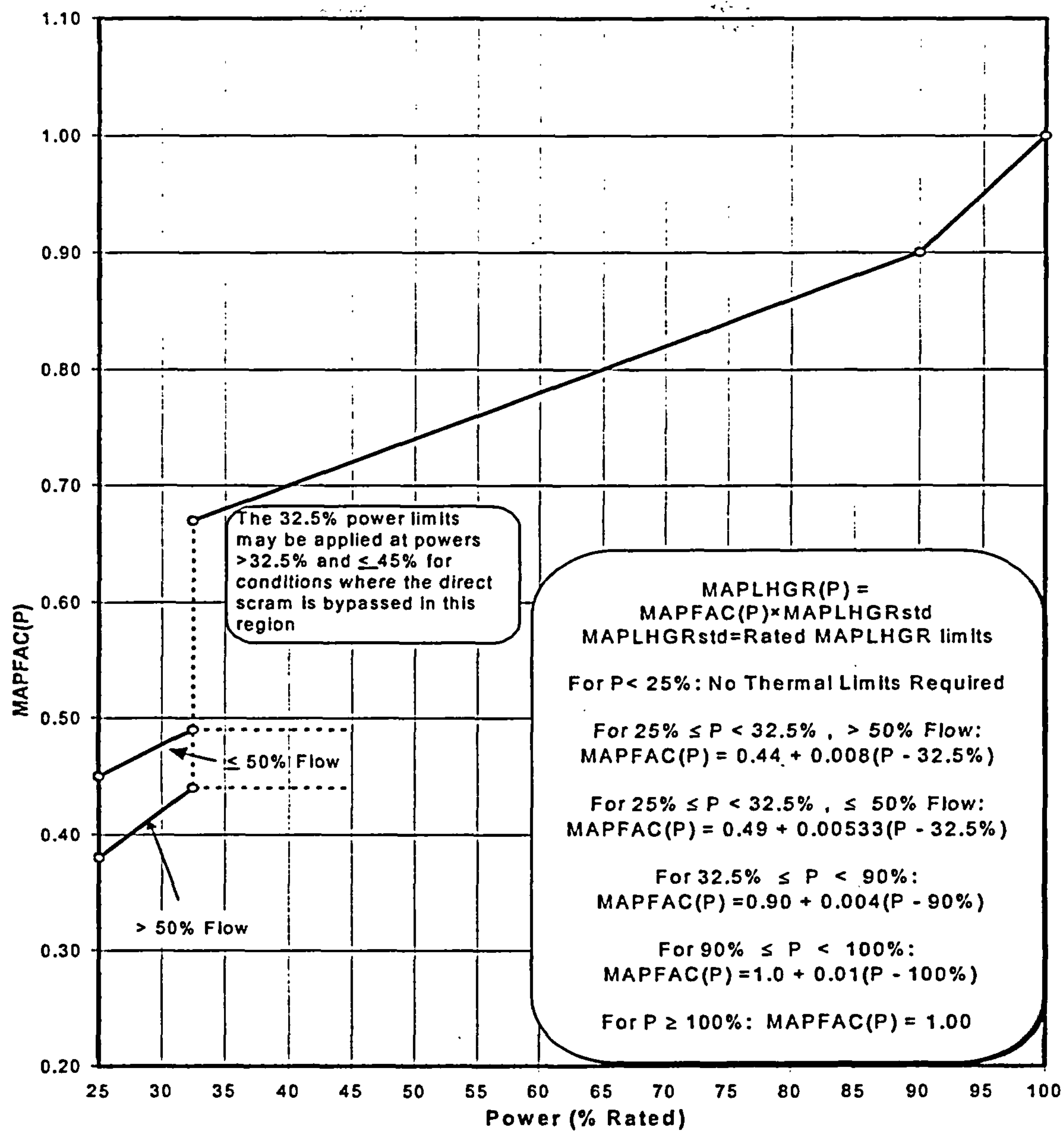

Figure 4.2-4. Power Dependent MAPLHGR Factors with Turbine Bypass In Service or Out-Of-Service (FFWTR included in limits)

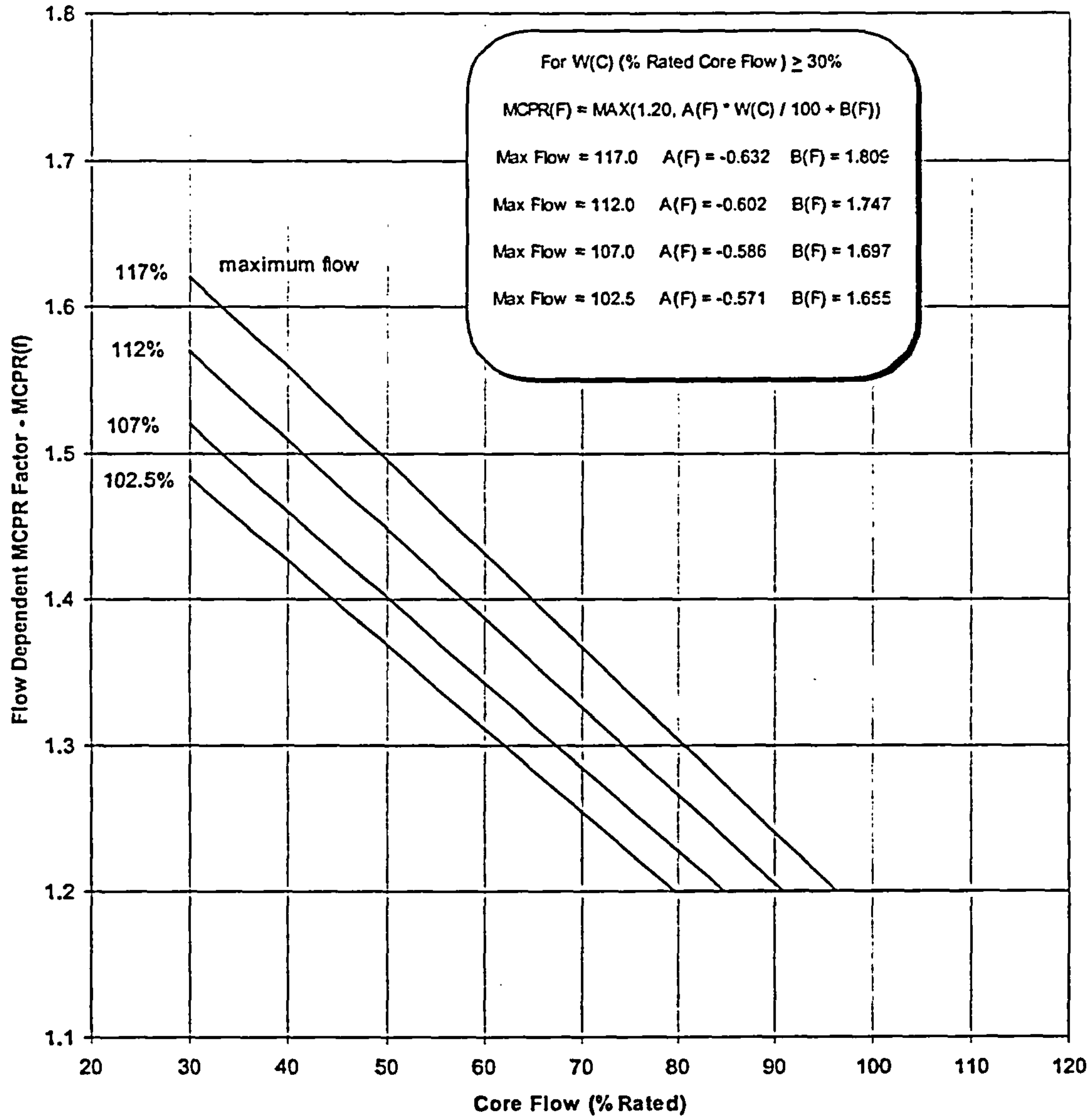

Figure 4.2-5. Flow Dependent MCPR Limits (All Operating Flexibility Options)

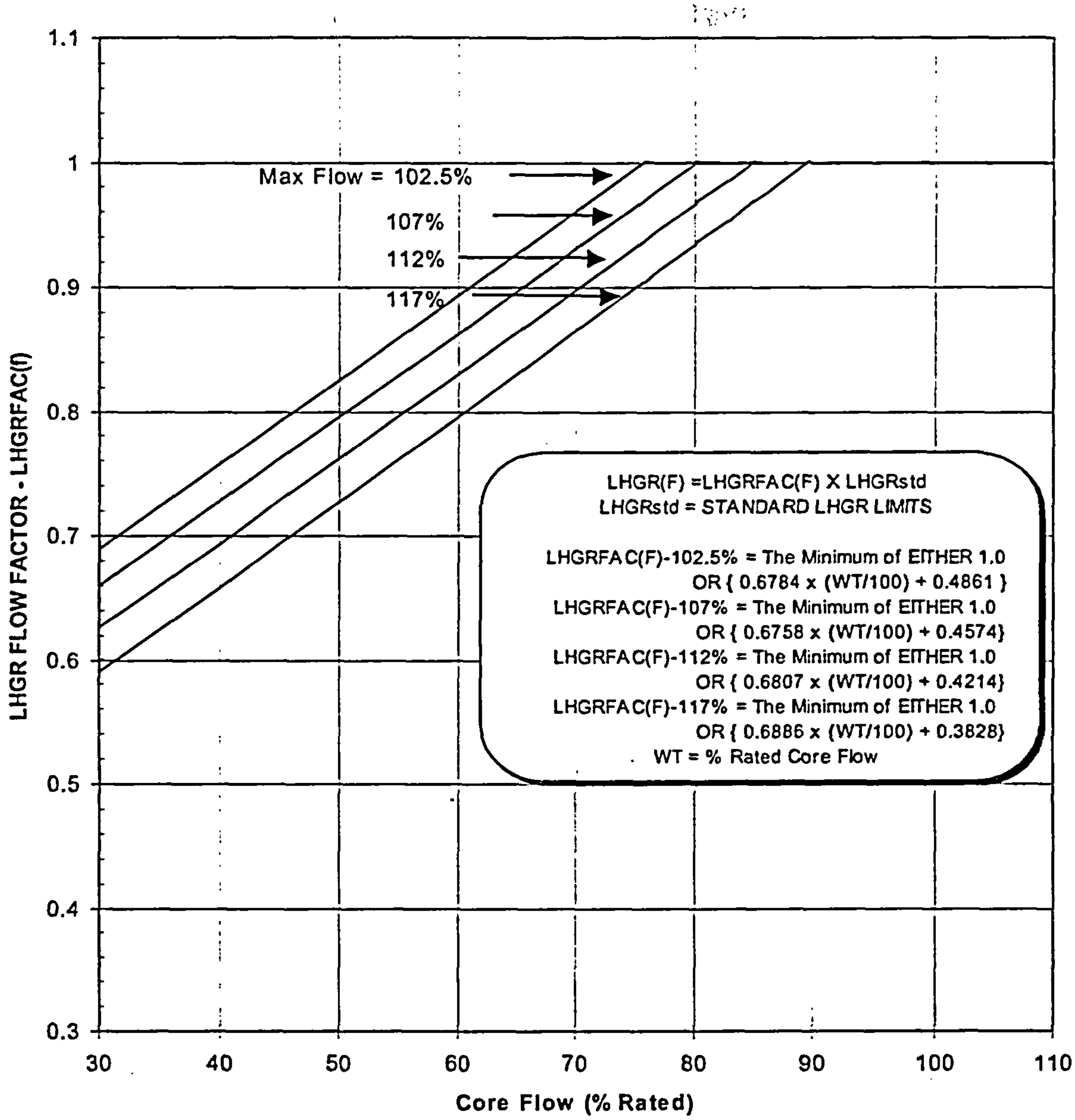

Figure 4.2-6. Flow Dependent LHGR Factors (All Operating Flexibility Options)

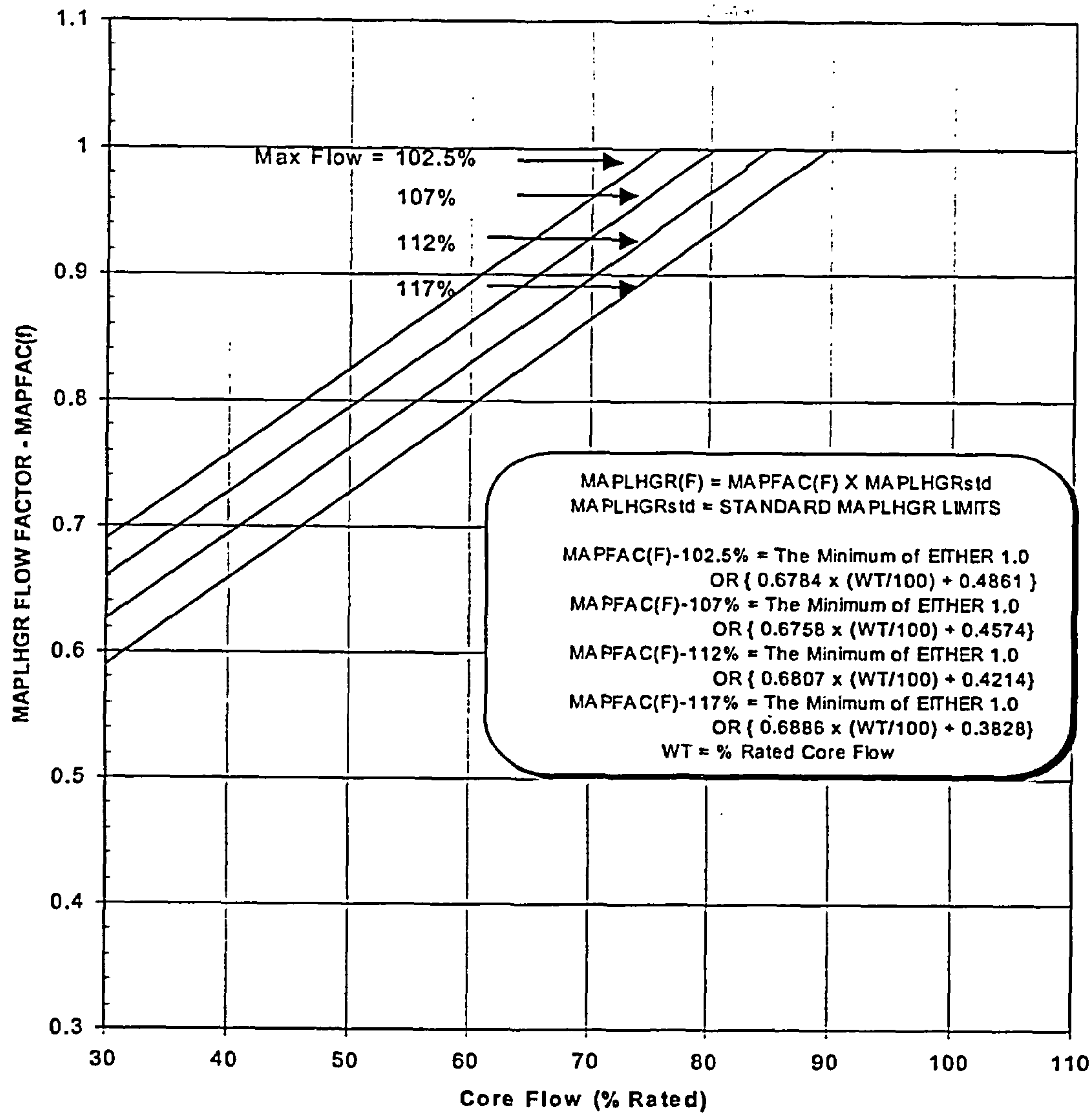

Figure 4.2-7. Flow Dependent MAPLHGR Factors

5. STABILITY ANALYSIS

5.1 Phenomena

The primary contributing factors to the stability performance with one recirculation loop not in service are the power-flow ratio and the recirculation loop characteristics. At forced circulation with only one recirculation loop in operation, the reactor core stability is influenced by the inactive recirculation loop characteristics. For low core flows occurring at minimum pump speed, the jet pumps on both recirculation loops will exhibit forward flow. At higher pump speeds the core flow is increased in SLO and the inactive jet pump forward flow decreases because the driving head across the inactive jet pumps decreases with increasing core flow. The reduced flow in the inactive loop reduces the resistance that the recirculation loops impose on reactor core flow perturbations, thereby adding a destabilizing effect. At the same time, the increased core flow results in a lower power-flow ratio, which is a stabilizing effect. These two countering effects result in slightly decreased stability margin (higher decay ratio) initially as core flow is increased (from minimum) in SLO, and then an increase in stability margin (lower decay ratio) as core flow is increased further and reverse flow in the inactive loop is established.

As core flow is increased beyond 40% of rated during SLO, substantial reverse flow is established in the inactive loop, an increase in jet pump flow, core flow and neutron noise is observed. A cross flow is established in the annular downcomer region near the jet pump suction entrance caused by reverse flow of the inactive recirculation loop. This cross flow interacts with the jet pump suction flow of the active recirculation loop and increases the jet pump flow noise. This effect increases the total core flow noise, which tends to increase the neutron flux noise.

To determine if the increased noise condition represents reduced stability margin as SLO core flow was increased, an evaluation was performed which phenomenologically accounts for SLO effects on stability (Reference 11). The model predictions were initially compared with test data and showed very good agreement for both two-loop and single-loop test conditions. An evaluation was performed to determine the effect of reverse flow on stability during SLO. With increasing reverse flow, SLO exhibited similar decay ratios as two-loop operation. However, at core flow conditions with no reverse flow, SLO was slightly less stable. This is consistent with observed behavior in stability tests at operating BWRs (Reference 11).

In addition to the above analyses, the cross flow established during reverse flow conditions was simulated analytically and shown to cause an increase in the individual and total jet pump flow noise, which is consistent with test data (Reference 11). The results of these analyses and tests indicate that the stability characteristics are not significantly different from two-loop operation. At low core flow, SLO may be slightly less stable than two-loop operation, but as core flow is increased and reverse flow is established, the stability performance is similar. At higher core flow, with substantial reverse flow in the inactive recirculation loop, the effect of cross flow on the flow noise results in an increase in system noise (jet pump, core flow and neutron flux noise).

5.2 Compliance to Stability Criteria

The stability compliance of GE fuel designs is documented in Reference 2.

The USNRC acceptance of thermal-hydraulic stability includes the condition that the plant has systems and procedures in place, supported by Technical Specifications, as appropriate, which provide adequate instability protection. The USNRC has accepted stability Option E1A (Reference 12), which is consistent with the operating practices at PNPS, and has accepted stability long-term solution Option 1D (Reference 13), which may replace Option E1A at PNPS in the future.

Stability Option E1A

Stability Option E1A provides Safety Limit MCPR protection by defining regions in the power-flow map where instabilities are credible (Reference 12). To prevent the violation of specified acceptable fuel design limits, the plant protection system provides an automatic scram upon entry into a defined exclusion region and a rod block upon entry into a defined restricted region, as well as additional Option E1A protection features. Since the stability performance for SLO is comparable to two-loop operation in the E1A regions, and only slightly decreased for the short duration that the inactive loop flow is low, the reactor scram and rod block stability setpoints are applicable to SLO without pump flow to core flow alignment (Reference 12, Appendix G).

Stability Option 1D

Stability Option 1D provides MCPR Safety Limit protection by using the NRC approved methodology (References 13 and 14). To achieve this purpose the analysis demonstrates 1) an Exclusion Region on the power flow map where instabilities are expected to occur and 2) Detection and Suppression of power oscillations using the Flow-Biases APRM Neutron Flux scram. A core decay ratio < 0.80 at the Exclusion Region Boundary and assurance that core wide is the predominant mode of reactor instability are required for the Option 1-D solution to be applicable (Reference 13). Since the stability performance for SLO is comparable to two-loop operation, and only slightly decreased for the short duration that the inactive loop flow is low, the Exclusion Region Boundary and Flow-Biased APRM scram setpoints are applicable to SLO with pump flow to core flow adjustment.

6. ECCS PERFORMANCE ANALYSIS

The Emergency Core Cooling System (ECCS) performance for single-loop operation (SLO) has been evaluated for PNPS in Reference 17, using the SAFER/GESTR-LOCA methodology. SLO analysis is performed for Design Basis Accident (DBA), since SLO will affect the DBA results more than the smaller breaks. With breaks smaller than the DBA, there is a longer period of nucleate and/or film boiling prior to fuel uncovery to remove the fuel stored energy. [[

]] These assumptions are conservative and provide bounding results for the Design Basis Accident (DBA) under SLO.

[[

]] Using the 0.8 PLHGR/MAPLHGR multipliers with the Appendix K assumptions yields PCT values well below the 10CFR50.46 PCT limit of 2200 °F. Therefore, the calculated SLO PLHGR/MAPLHGR multipliers are conservative and assure that the SLO results satisfy the acceptance criteria of 10CFR50.46 and the NRC SER requirements for the SAFER application methodology. The ECCS LOCA analysis in Reference 17 for SLO is based on an initial power level of 77.6% of rated for nominal cases and 79% of rated for Appendix K cases. The initial core flow was 52% of rated. These initial conditions are consistent with limits established for SLO in this report.]]

7. REACTOR INTERNAL VIBRATIONS

The Reference 1 report documents the conclusions of the SLO internals vibration review for PNPS based on plant start-up data. The conclusion of that review was that the maximum core flow should be limited to 52% of rated core flow on the rated rod line at 65% core power, which corresponds approximately to 94% of rated pump speed. This pump speed and flow correspond approximately to the rated core power and flow for two pump operation conditions.

The limitation in core power and flow does not change with newer fuel designs as the thermal hydraulic environment of the internal components remain unchanged with new fuels.

The 65% core power limit is scaled to reflect the subsequent change in the Pilgrim licensing bases due to the increase in thermal power from the thermal power uncertainty reduction.

8. PROPOSED DOCUMENTATION CHANGES

The implementation of the SLO will require the changes to specific items in the PNPS technical specifications, core operating limits report and associated bases. The APRM flow biased rod block and scram values must be modified to reflect the difference in core flow to power relationship for SLO. The recommended changes to these items are shown below.

Table 8-1
RECOMMENDED DOCUMENTATION CHANGES

Tech Specs Item	Description of Change
Safety Limit MCPR	Modify any LCO and Action statements regarding the Safety Limit MCPR to include SLO values. Furthermore, the basis for the SLMCPR may need revision and the cycle specific values may be included in the Core Operating Limits Report.
Operating Limit MCPR	Modify any LCO and Action statements regarding specific values of the Operating Limit MCPR to include the SLO values. Furthermore, the basis for the OLMCPR may need revision and the cycle specific OLMCPR for SLO may be included in the COLR.
MAPLHGR	Modify specific values of the MAPLHGR to include the SLO multiplier. Furthermore, the basis for the MAPLHGR may need revision and the cycle specific MAPLHGR values for SLO may be included in the COLR.
LHGR	Modify specific values of the LHGR to include the SLO multiplier. Furthermore, the basis for the LHGR may need revision and the cycle specific LHGR values for SLO may be included in the COLR.
Flow Biased APRM Scram	Modify any scram trip equation to include SLO values.
Flow Biased APRM Rod Block	Modify any rod block trip equation to include SLO values.
SLO Condition	Modify any reference to operation in SLO to include the applicable power and flow restrictions. Furthermore, incorporate the SLO operating map in applicable plant documents and procedures.

9. CONCLUSIONS

The following paragraphs summarize the conclusions resulting from the SLO safety evaluation for PNPS.

The transient safety evaluation shows that the transient consequences for SLO are bounded by the full power TLO analyses results.

Increased uncertainties in the core total flow and TIP readings results in increased fuel cladding integrity SLMCPR value during SLO. An increase in rated and off-rated OLMCPR is required to account for the SLMCPR increase. The flow-biased APRM rod block and flux scram setpoints are adjusted for SLO.

Thermal-hydraulic stability was evaluated for adequacy with respect to General Design Criterion 12 (10CFR50, Appendix A). It is shown that this stability criterion is satisfied during SLO. It is further shown that the increase in neutron noise associated with SLO is independent of system stability margin. The flow-biased APRM rod block and flux scram setpoints are adjusted for SLO.

To prevent potential control oscillations from occurring in the recirculation flow control system, the flow control should be in master manual for the duration of SLO.

The limiting MAPLHGR and LHGR reduction factor for SLO is calculated to be 0.80.

A limit on the maximum core thermal power and flow is imposed for SLO based on consideration of the reactor internals vibration.

Based on the above, it is concluded that the PNPS can operate in single loop mode without undue risk to the public health and safety.

10. REFERENCES

1. GE-NE-187-10-0591, General Electric Company, "Pilgrim Nuclear Power Station Single Loop Operation", October 1991.

2. NEDE-24011-P-A-14, General Electric Company, "GESTAR II General Electric Standard Application for Reactor Fuel", June 2000.

3. NEDC-32601P-A, Methodology and Uncertainties for Safety Limit MCPR Evaluations, August 1999.

4. NEDC-32694P-A, Power Distribution Uncertainties for Safety Limit MCPR Evaluations, August 1999.

5. Letter F. Akstulewicz (NCR) to G. A. Watford (GE), Acceptance for Referencing of Licensing Topical Reports NEDC-32601P, "Methodology and Uncertainties for Safety Limit MCPR Evaluations"; NEDC-32694P, "Power Distribution Uncertainties for Safety Limit MCPR Evaluation"; and Amendment 25 to NEDE-24011-P-A on Cycle-Specific Safety Limit MCPR (TAC NOS. M97490, M99069 and M97491), March 11, 1999.

6. NEDC-24154P-A, "Qualification of the One-Dimensional Core Transient Model (ODYN) for Boiling water Reactors", Volume 1 through 3 and Supplement 1, Revision 1 to Volume 4, February 2000.

7. NEDC-31312P, General Electric Company, "*ARTS Improvement Program Analysis for Pilgrim Nuclear Power Station (PNPS)*" September 1987.

8. Not Used

9. NEDC-32306P, General Electric Company, "*Maximum Extended Load Line Limit for Pilgrim Nuclear Power Station Reload 9 Cycle 10,*" March 1994.

10. General Electric Company, Supplemental Reload Licensing Report for *Pilgrim Nuclear Power Station Reload 14 Cycle15,* 0000-0008-6613SRLR, Revision 1, March 2003.

11. Letter, H. C. Pfefferlen (GE) to C.O. Thomas (NRC), "Submittal of Response to Stability Action Item from NRC Concerning Single-Loop Operation," September 1983.

12. NEDO-32339-A, "Reactor Stability Long-Term Solution: Enhanced Option I-A," April 1998.

13. NEDO-32465-A, General Electric Company, "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," August 1996.

14. NEDO-31960-A and NEDO-31960-A Supplement 1, "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology," November 1995.

15. Not used

16. Not used

17. "SAFER/GESTR-LOCA Loss of Coolant Accident Analysis for Pilgrim Nuclear Power Station," NEDC-31852-P, Rev. 2, Jan. 2003.

Attachment 4 to 2.04.074

Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Plant

Proposed Amendment to the Technical Specifications

List of Regulatory Commitments:

The following table identified those actions committed to by Pilgrim in this document. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments.

REGULATORY COMMITMENT	DUE DATE
Implement change to the Core Operating Limits Report (COLR).	Prior to implementation of approved TS.