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SUBJECT: Forwards application for Proposed Amend 75 to License NPF-22 to incorporate requirements of Bulletin 88-007,Suppl 1.

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JUN 23 1989

Director of Nuclear Reactor Regulation
Attention: Dr. W. R. Butler, Project Director
Project Directorate I-2
Division of Reactor Projects
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
PROPOSED AMENDMENT 75 TO LICENSE
NO. NPF-22: UNIT 2 STABILITY
PLA-3217 FILES A17-2/R41-2

Docket No. 50-388

Dear Dr. Butler:

The purpose of this letter is to propose changes to the Susquehanna SES Unit 2 Technical Specifications which incorporate the interim requirements of NRC Bulletin 88-07, Supplement 1 "Power Oscillations in Boiling Water Reactors (BWRs)" in place of the existing "detect and suppress" requirements. This letter also proposes changes which clarify Actions and Surveillance Requirements.

DESCRIPTION OF CHANGES

The following changes, which are illustrated on the attached marked-up pages, are proposed for Unit 2:

o Specification 3.4.4.1.1: Rewrite the LCO statement to read as follows:

"3.4.1.1.1 Two reactor coolant system recirculation loops shall be in operation with the reactor at a THERMAL POWER/core flow condition outside of Regions I and II of Figure 3.4.1.1.1-1."

Add Footnote "+" to OPERATIONAL CONDITION 2 in the APPLICABILITY.

Replace ACTIONS a, b, and c with the following new actions:

"a. In OPERATIONAL CONDITION 1:

1. With:

a) No reactor coolant system recirculation loops in operation, or

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b) Region I of Figure 3.4.1.1.1-1 entered, or

c) Region II of Figure 3.4.1.1.1-1 entered and core thermal hydraulic instability occurring as evidenced by:

1) Two or more APRM readings oscillating with at least one oscillating greater than or equal to 10% of RATED THERMAL POWER peak-to-peak, or

2) Two or more LPRM upscale alarms activating and deactivating with a 1 to 5 second period, or

3) Observation of a sustained LPRM oscillation of greater than 10w/cm^2 peak-to-peak with a 1 to 5 second period, or

d) Region II of Figure 3.4.1.1.1-1 entered and less than 50% of the required LPRM upscale alarms OPERABLE,

immediately place the reactor mode switch in the shutdown position.

2. If Region II of Figure 3.4.1.1.1-1 is entered and greater than or equal to 50% of the required LPRM upscale alarms OPERABLE, immediately exit the region by:

a) inserting a predetermined set of high worth control rods, or

b) increasing core flow.

3. With less than 50% of the required LPRM upscale alarms OPERABLE, follow ACTION a.1.d upon entry into Region II of Figure 3.4.1.1.1-1.

b. In OPERATIONAL CONDITION 2 with no reactor coolant system recirculation loops in operation, return at least one reactor coolant system recirculation loop to operation, or be in HOT SHUTDOWN within the next 6 hours.

c. With any pump discharge valve not OPERABLE, remove the associated loop from operation, close the valve and comply with the requirements of Specification 3.4.1.1.2.

d. With any pump discharge bypass valve not OPERABLE, close the valve and verify closed at least once per 31 days."

o Footnote "***": Delete.

- Footnote "+": Add new footnote to read as follows:

  "The LPRM upscale alarms are not required to be OPERABLE to meet this specification in OPERATIONAL CONDITION 2."

- Specification 4.4.1.1.1.2: Delete the requirement.

- Specification 4.4.1.1.1.3: Redesignate this Specification as 4.4.1.1.1.2.

- Specification 4.4.1.1.1.4: Replace the existing requirement with the following:

  "4.4.1.1.1.3 At least 50% of the required LPRM upscale alarms shall be determined OPERABLE by performance of the following on each LPRM upscale alarm:

  1) CHANNEL FUNCTIONAL TEST at least once per 92 days, and

  2) CHANNEL CALIBRATION at least once per 184 days."

- Figure 3.4.1.1.1-1: Replace with new figure entitled "Thermal Power Restrictions."

- Specification 3.4.1.1.2: Revise the introductory part of the LCO statement to read as follows:

  "3.4.1.1.2 One reactor coolant recirculation loop shall be in operation with the pump speed $\leq$80% of the rated pump speed, and the reactor at a THERMAL POWER/core flow condition outside of Regions I and II of Figure 3.4.1.1.1-1, and . . ."

  Also, delete 3.4.1.1.2 b and c. (Other changes to page 3/4 4-1c are provided for information only; they were previously provided in the referenced proposed amendment.)

  Add Footnote "+" to OPERATIONAL CONDITION 2 in the APPLICABILITY.

  Delete ACTIONS a, c, and e and add the following new actions:

  "a. In OPERATIONAL CONDITION 1:

  1. With:

  a) No reactor coolant system recirculation loops in operation, or

  b) Region I of Figure 3.4.1.1.1-1 entered, or

c) Region II of Figure 3.4.1.1.1-1 entered and core thermal hydraulic instability occurring as evidenced by:

1) Two or more APRM readings oscillating with at least one oscillating greater than or equal to 10% of RATED THERMAL POWER peak-to-peak, or

2) Two or more LPRM upscale alarms activating and deactivating with a 1 to 5 second period, or

3) Observation of a sustained LPRM oscillation of greater than 10 w/cm^2 peak-to-peak with a 1 to 5 second period, or

d) Region II of Figure 3.4.1.1.1-1 entered and less than 50% of the required LPRM upscale alarms OPERABLE,

immediately place the reactor mode switch in the shutdown position.

2. If Region II of Figure 3.4.1.1.1-1 is entered and greater than or equal to 50% of the required LPRM upscale alarms OPERABLE, immediately exit the region by:

a) inserting a predetermined set of high worth control rods, or

b) increasing core flow by increasing the speed of the operating recirculation pump.

3. With less than 50% of the required LPRM upscale alarms OPERABLE, follow ACTION a.1.d upon entry into Region II of Figure 3.4.1.1.1-1.

b. In OPERATIONAL CONDITION 2 with no reactor coolant system recirculation loops in operation, return at least one reactor coolant system recirculation loop to operation, or be in HOT SHUTDOWN within the next 6 hours.

e. With any pump discharge valve not OPERABLE, remove the associated loop from operation, close the valve and verify closed at least once per 31 days.

f. With any pump discharge bypass valve not OPERABLE, close the valve and verify closed at least once per 31 days."

Redesignate current ACTION b as c.

- Specification 4.4.1.1.2.2: Replace the existing requirement with the following:

  "4.4.1.1.2.2 At least 50% of the required LPRM upscale alarms shall be determined OPERABLE by performance of the following on each LPRM upscale alarm:

  1) CHANNEL FUNCTIONAL TEST at least once per 92 days, and

  2) CHANNEL CALIBRATION at least once per 184 days."

- Specification 4.4.1.1.2.4: Delete and renumber accordingly.

- Specification 4.4.1.1.2.6: Delete and renumber accordingly.

- Specification 4.4.1.1.2.8: Delete and renumber accordingly.

- Footnote "***": Delete.

- Footnote "+": Add new Footnote to read as follows:

  "The LPRM upscale alarms are not required to be OPERABLE to meet this specification in OPERATIONAL CONDITION 2."

- Figure 3.4.1.1.2-1: Delete.

- Specification 3.4.1.4b: Revise to read as follows:

  "When only one loop has been idle, unless the temperature differential between the reactor coolant within the idle and operating recirculation loops is less than or equal to 50°F, the operating loop flow rate is less than or equal to 50% of rated loop flow, and the reactor is operating at a THERMAL POWER/core flow condition below the 80% Rod Line shown in Figure 3.4.1.1.1-1."

The Index and Bases sections have been updated on the marked-up pages consistent with the above described changes.

SAFETY ANALYSIS

The proposed Technical Specification changes incorporate the interim requirements provided in NRC Bulletin 88-07, Supplement 1 (Reference 1) for preventing and mitigating reactor core instability events. The main features of this Technical Specification change include:

1) The addition of a Power/Flow region where immediate manual scram is required,

2) Natural circulation operation requires an immediate manual scram when operating in the run mode,

3) Indication of a reactor core instability requires an immediate manual scram,

4) Three times baseline noise is replaced by 10% of Rated Thermal Power peak-to-peak for the APRMS and 10 w/cm^2 peak-to-peak for the LPRMs to indicate that a reactor core instability is in progress,

5) LPRM upscale alarms are also used to indicate that a reactor core instability is in progress,

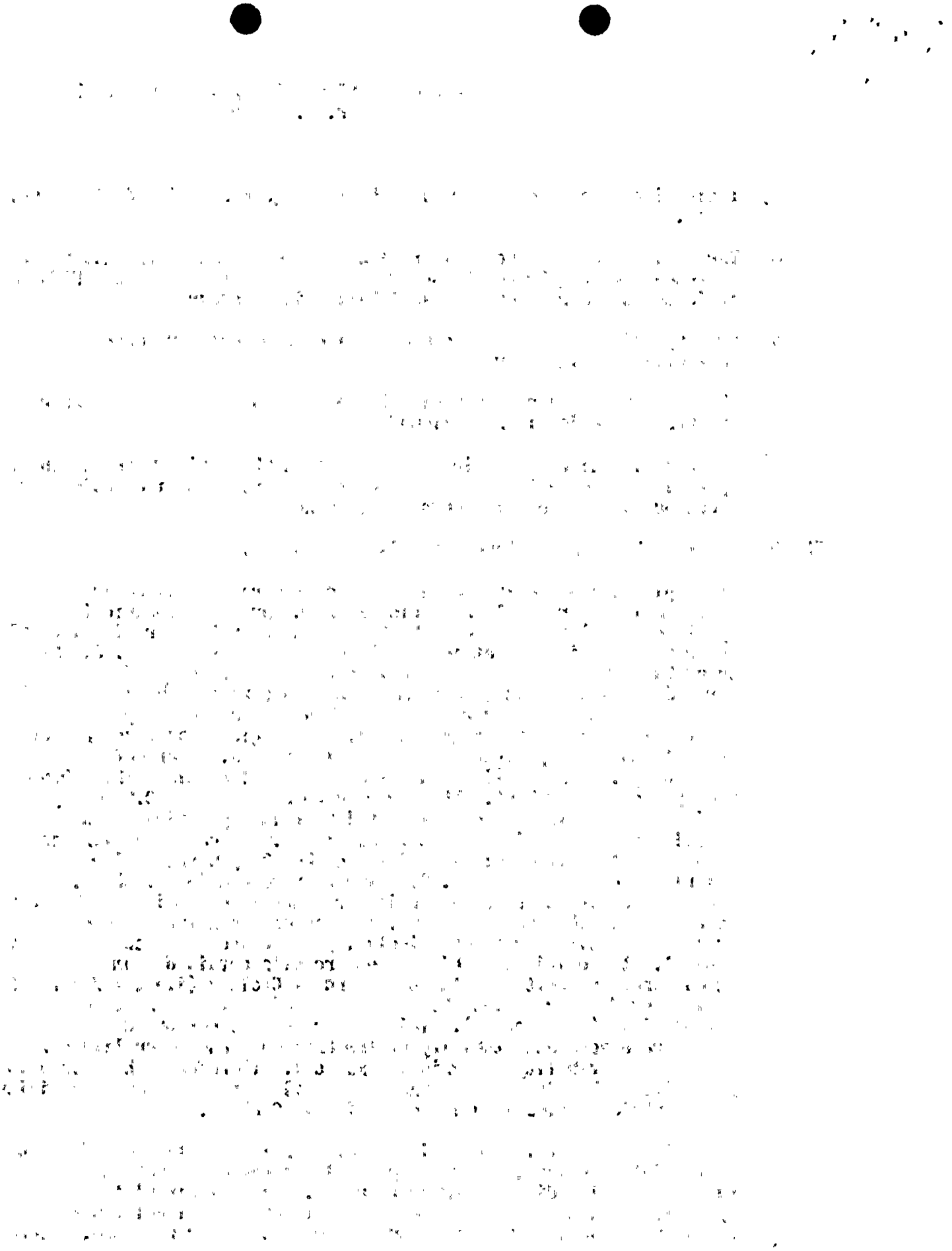
6) The "detect and suppress" region has been changed to a region where extended operation is not allowed, and

7) If operating with single loop conditions in the region where extended operation is not allowed, the region can be exited by increasing core flow, but a recirculation pump start is not allowed.

The basis for each of these changes is discussed below.

1) The region which requires a manual reactor scram (i.e., designated Region A in Reference 1 and Region I in the proposed Technical Specifications) is defined such that the decay ratio for all allowable power/flow conditions outside of the region is less than 0.90. Since Susquehanna SES Unit 2 has a complete core of ANF fuel, ANF has performed calculations to determine the boundaries of Region I. ANF has shown that the decay ratio at the boundary of the proposed Technical Specification Figure 3.4.1.1.1-1 Region I is less than or equal to the NRC approved decay ratio limit of 0.90 for ANF methodology. Table 1 lists the decay ratio calculations which have been performed for U2C4. The power corresponding to a 0.90 decay ratio was determined at 42% flow by linear interpolation of the two calculated decay ratios at 42% flow. The 0.90 decay ratio line is defined by this interpolated point and the 63% power/40% flow calculated decay ratio of 0.90. Linear extrapolation of the 0.90 decay ratio line to rated power is performed to determine the boundary of Region I. The linear extrapolation is conservative based on available sensitivity studies including the calculated decay ratios in Table 1. In addition, stability test results obtained from Susquehanna SES Unit 2 at the beginning of Cycle 2 (i.e., 42% ANF 9x9 fuel) showed decay ratios which were very close to COTRAN code calculations (Reference 2). This comparison was performed to demonstrate adequate stability of the U2C2 core and to qualify ANF methods for stability analysis of 9x9 fuel. Therefore, there is a low probability that Susquehanna SES Unit 2 will experience an instability event outside Region I during operation in Cycle 4.

2) Operation in natural circulation conditions is not allowed and if the recirculation pumps trip at any power level during operating in the run mode, an immediate scram is required. Natural circulation operation is not a stability concern at lower power levels, but considering human factors to ensure a quick operator response, a scram



is required whenever operating in the run mode with natural circulation conditions.

3) During the LaSalle Unit 2 March 9, 1988 instability event, the amplitude of the oscillations increased and decreased very rapidly. Therefore, if an instability event is observed, the operators must immediately scram the reactor.

4) To respond quickly to an instability event, an oscillation amplitude that is constant, easy to remember, and adequately indicates the onset of instability must be specified. The three times baseline criteria changes slightly each cycle and the cycle specific value is difficult to remember. An amplitude of 10% peak-to-peak for APRMs and 10 w/cm^2 peak-to-peak for the LPRMs are constant, easy to remember, and provide a large margin to core-wide (i.e., APRMs and LPRMs) and regional (i.e., LPRM) oscillations which potentially could exceed a thermal limit. An immediate manual scram is required if the oscillation reaches these amplitudes.

5) Since LPRM signals are only indicated in the control room when a control rod is selected and when a control rod is selected only the 4 LPRM strings surrounding the selected control rod are indicated, the LPRM upscale alarms are used to indicate an instability event. Surveillance requirements are added to assure that the number and location of the operable LPRM alarms are sufficient to detect core wide and regional oscillations. Operating plant instability data is used to determine the specific LPRM strings assigned to a core zone. The core zones and required LPRM upscale alarms in each zone are specified in appropriate procedures. LPRM downscale alarms are not included in the proposed Technical Specifications but will be used as a trigger to monitor the LPRM meters to determine if they are oscillating greater than 10 w/cm^2 peak-to-peak.

The LPRM upscale alarm trip circuitry is essentially the same as the APRM upscale neutron flux trip channels; each device's principle of operation and their means of calibration are essentially the same. Therefore, they share the same potential failure modes, failure rates, and operating characteristics upon which the APRM Technical Specification surveillances are based.

With the exception of the channel check surveillance, the proposed Technical Specification surveillances are derived from Technical Specification Section 4.3.1.1, as revised by proposed amendments to the existing APRM Technical Specification (Reference 3). Based on engineering judgement, exclusion of the channel check is acceptable for the LPRM upscale alarms because of the large number of instruments performing the stability monitoring function. This redundancy ensures that 6 to 8 LPRM upscale alarms are operable in every designated core zone if the proposed 50% criterion is met. (In actuality, since all LPRM upscale alarms will be surveilled, as many as 12 to 15 in each zone may be available to monitor for instability). Given the low

probability of 6 instruments failing in the same zone over a 92 day period, the exclusion of the channel check is acceptable.

This engineering judgment is supported by INPO report 88-011, "The Operational Performance of Reactor Protection Systems in U.S. Boiling Water Reactor 1981-1985." This report provides an estimate of the average failure rate for an LPRM assembly of 4×10^{-6} per hour. The LPRM assembly includes detectors, cable connections and power supplies. The report shows that SSES performance exceeds the average; therefore, this reported failure rate should bound our case. Using this data the chance of failure during a 92 day period is nine in one thousand. This low failure rate, combined with the probability of at least 3 LPRMs failing in the same core zone (for a local event; many more LPRM failures would be required for a core-wide event to go undetected) and the probability of a coincident instability event results in an insignificant effect on our ability to detect instabilities due to not performing the channel check.

In addition to the above, the indicator lights for the LPRM upscale alarms have a preventive maintenance procedure performed on them weekly. The LPRM readings are currently obtained once every 24 hours from a core monitoring system (POWERPLEX) edit. An indication of LPRM performance is also available once per 12 hours by the performance of the APRM channel check.

6) Region B and C of Reference 1 have been combined into a single region (i.e., Region II) in the proposed Technical Specifications. This region has a calculated decay ratio of less than or equal to 0.75 at the worst point on the outside boundary using ANF's stability analysis methodology. The NRC has approved this approach for specifying the detect and suppress region for previous Susquehanna SES Unit 1 and Unit 2 reload cores. The Region II outside boundary is equivalent to the Reference 1 Region B and C boundary below and to the left of the 66% power/45% flow point. Above and to the right of this point the Region II boundary is parallel to the Region I boundary. This encompasses all 0.75 decay ratio points calculated by ANF and results in a conservative extrapolation to rated power. For Unit 2 Cycle 4, Region II must be immediately exited if it is inadvertently entered.

7) Starting a recirculation pump to exit Region II is not allowed in order to reduce the probability of starting a recirculation pump during an instability event. A recirculation pump start during an instability event is not a design basis event and must be precluded.

The proposed Technical Specifications provide a more effective means of preventing, detecting, and mitigating the consequences of core thermal hydraulic instability events. Therefore, the margin of safety is not reduced as a result of the proposed Technical Specification changes.

In addition the proposed Technical Specification changes transfer certain Surveillance Requirements on the recirculation pump discharge and bypass valves which are really actions to the "ACTION" part of the Limiting Condition for Operation. This will ensure that Specification 3.0.3 is not unnecessarily entered if these valves should fail.

These changes are administrative in nature and do not change the intent of the existing Technical Specifications. Adding an action for when the discharge and bypass valves fail allows for continued operation without putting the unit through an unnecessary shutdown. Requiring the pump discharge and bypass valves to be closed is consistent with the ECCS analysis which assumes that these valves are closed during a recirculation line break. If these valves are not capable of being closed then Specification 3.0.3 would be entered.

The removal of actions from Surveillance Requirements provides the operator with clearer guidance on the actions required when the discharge and bypass valves are inoperable. This removes hidden requirements which could be missed.

SAFETY ANALYSIS REFERENCES

1) NRC Bulletin No. 88-08, Supplement 1, "Power Oscillations in Boiling Water Rectors (BWRs)," December 30, 1988.

2) Letter (PLA-2795) from H.W. Keiser (PP&L) to E. Adensam (NRC), "Unit 2 Stability Test Program Results," February 3, 1987.

3) Letter (PLA-3102) from H. W. Keiser (PP&L) to W. R. Butler (NRC), "Proposed Amendments 116 to License Number NPF-14 and 66 to License Number NPF-22: Revision to RPS AOTs and STIs," October 27, 1988.

NO SIGNIFICANT HAZARDS CONSIDERATIONS

The following three questions are addressed below for each of the proposed Technical Specification changes:

I. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

II. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

III. Does the proposed change involve a significant reduction in a margin of safety?

o Specification 3/4.4.1.1.1, Recirculation Loops - Two Loop Operation

This specification has been revised to replace the existing stability controls on the recirculation system with (at a minimum) those recommended in NRC Bulletin 88-07, Supplement 1.

I. No. The changes to the LCO provide the appropriate limits to ensure that proper actions are taken if SSES Unit 2 is operating in a region of the power/flow map where an instability is more likely to occur. The boundaries of these regions are based upon NRC approved limits for ANF methodology.

Action a is deleted as an editorial change; its purpose as a cross reference is adequately covered by the Applicability sections for the two-loop and single-loop specifications.

New Action a.1 requires when operating in Operational Condition 1 an immediate manual scram if operation in natural circulation occurs, if Region I of the new Figure "Thermal Power Restrictions" is entered, if power range monitoring instrumentation exhibits evidence of instability or if Region II of the Figure is entered and inadequate instability monitoring capability is available. These actions will ensure that the MCPR Safety Limit is not violated, so that an increase in the consequences of an accident previously evaluated will not occur.

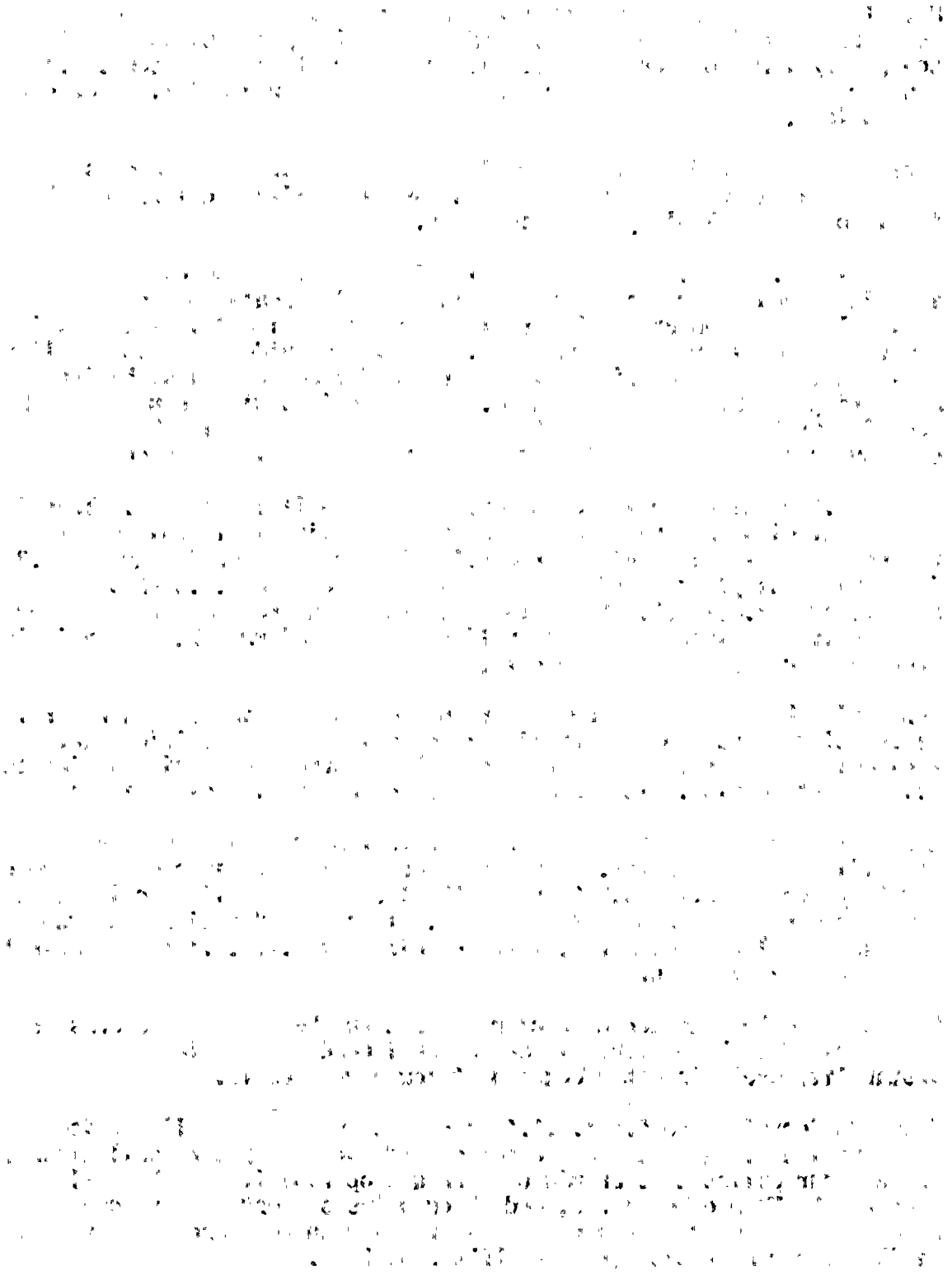
Action a.2 requires an immediate exit of Region II if entered. This is consistent with the Bulletin, and does not require an immediate scram because no indications of power oscillation have occurred. Action a.3 is provided simply to avoid entry into Specification 3.0.3 should new Surveillance 4.4.1.1.1.4 be failed. It is not appropriate for any more restrictive requirements to be applied to these alarms when the unit is operating outside Regions I and II.

New Action b reflects the current requirements associated with natural circulation operation in Operational Condition 2 and clarifies that a recirculation loop may be attempted to be returned to service during the allowed outage time. This change is an administrative clarification.

New Actions c and d incorporate actions that previously appeared as Surveillance Requirements. This transfer is proposed in order to avoid invoking Specification 3.0.3 due to the lack of a specific action if the pump discharge or bypass valves failed. These "new" actions and the associated deletion of Surveillance Requirement 4.4.1.1.1.1 are entirely administrative in nature.

New Footnote "+" was added to clarify that the LPRM upscale alarms are not required to be operable in Operational Condition 2 since an instability event is not a concern at low power levels.

Existing Surveillance 4.4.1.1.1.4 is deleted since a baseline noise level will no longer be used to detect and suppress power oscillations. The new surveillance is provided to ensure operability of the newly required LRPM upscale alarms, and frequencies of testing were chosen based on NRC approved methods for determining surveillance intervals for similar instrumentation (ref. GE NEDC 30851P-A).



Based on the above, none of the proposed changes involve a significant increase in the probability or consequences of an accident previously evaluated. The stability related changes are consistent with current NRC guidance and approved analytical methods where applicable, and the transferring of certain surveillances to actions will preclude unnecessary shutdowns due to Specification 3.0.3.

II. No. The proposed changes relating to stability use the current guidance contained in NRC Bulletin 88-07 Supplement 1, which will ensure that a new or different kind of event will not occur. They accomplish this by requiring reactor scrams in unstable regions and additional instability detection capability.

The editorial changes shifting Surveillance Requirements to Actions cannot create a new event.

III. No. See I above. The stability changes are designed to protect the margin of safety to the MCPR Safety Limit. The editorial changes improve safety margin by precluding unnecessary plant shutdowns.

o Specification 3/4.4.1.1.2, Recirculation Loops - Single Loop Operation

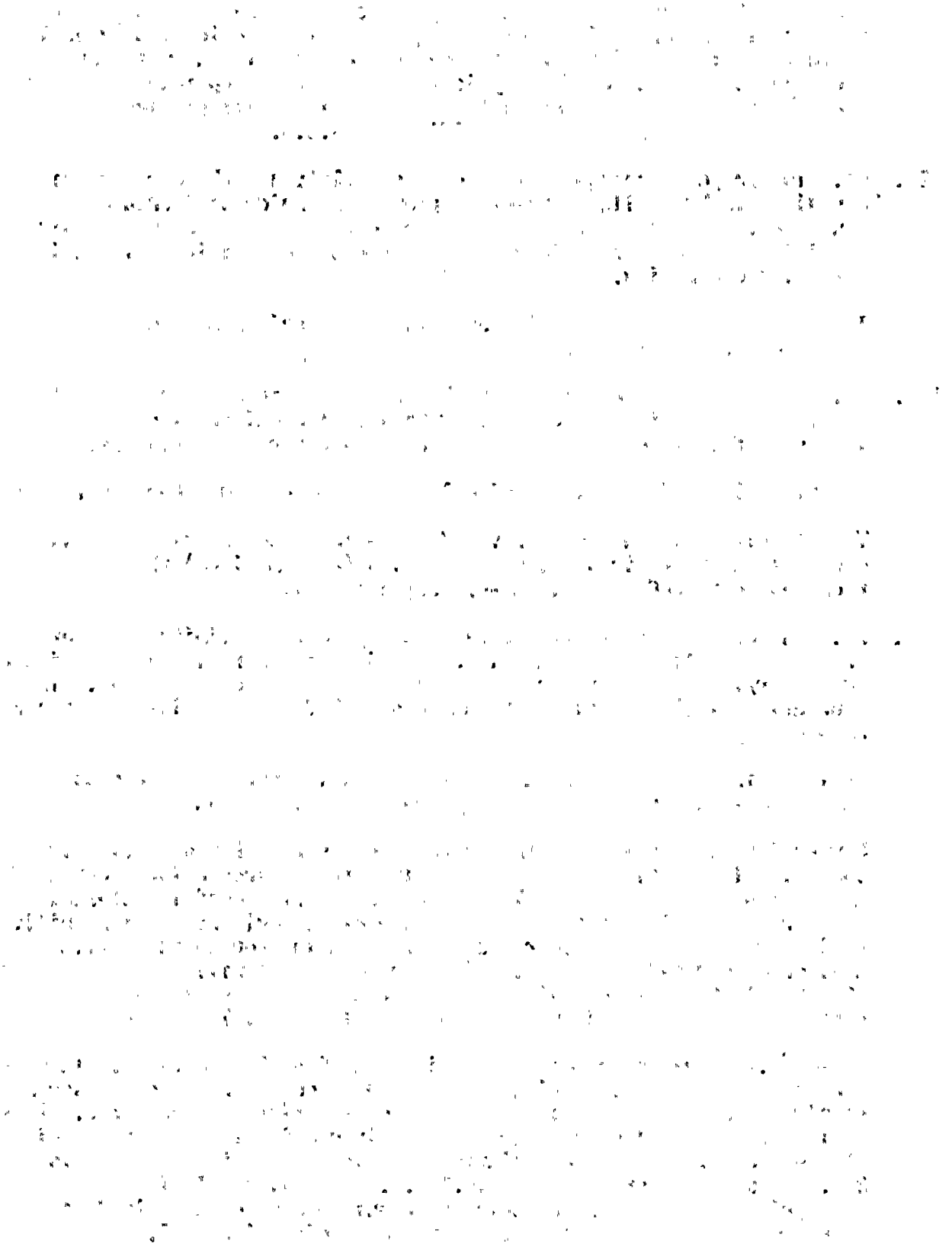
This specification has been revised to replace the existing stability controls on the recirculation system with (at a minimum) those recommended in NRC Bulletin 88-07, Supplement 1.

I. No. the changes to the LCO provide the appropriate limits to ensure that proper actions are taken if SSES Unit 2 is operating in a region of the power/flow map where an instability is more likely to occur. The boundaries of these regions are based upon NRC approved limits for ANF methodology.

Action a is deleted as an editorial change; its purpose as a cross reference is adequately covered by the new Actions a and b.

New Action a.1 requires an immediate manual scram when operating in Operational Condition 1 if operation in natural circulation occurs, if Region I of the new Figure "Thermal Power Restrictions" is entered, if power range monitoring instrumentation exhibits evidence of instability, or if Region II of the Figure is entered and inadequate instability monitoring capability is available. These actions will ensure that the MCPR Safety Limit is not violated, so that an increase in the consequences of an accident previously evaluated will not occur.

Action a.2 requires an immediate exit of Region II if entered. This is consistent with the Bulletin, and does not require an immediate scram simply because no indications of power oscillation have occurred. This action does not allow the start of a recirculation loop to exit Region II. Action a.3 is provided simply to avoid entry into Specification 3.0.3 should new Surveillance 4.4.1.1.2.2 be failed. It is not appropriate for any more restrictive requirements to be applied to these alarms when the unit is operating outside Regions I and II.



New Action b reflects the current requirements associated with natural circulation operation in Operational Condition 2.

New Actions e and f incorporate actions that previously appeared as Surveillance Requirements. This transfer is proposed in order to avoid invoking Specification 3.0.3 due to the lack of a specific action if the pump discharge or bypass valves failed. These "new" actions and the associated deletion of Surveillance Requirements 4.4.1.1.2.6 and 4.4.1.1.2.8 are entirely administrative in nature.

New Footnote "+" was added to clarify that the LPRM upscale alarms are not required to be operable in Operational Condition 2 since an instability event is not a concern at low power levels.

The revision to existing Action b is purely editorial in nature.

Existing Actions c and e and Surveillance 4.4.1.1.2.2 are deleted since a baseline noise level will no longer be used to detect and suppress power oscillations. The new actions and surveillance are provided to ensure operability of the newly required LPRM upscale alarms, and frequencies of testing were chosen based on NRC approved methods for determining surveillance intervals for similar instrumentation (ref. GE NEDC 30851P-A).

Based on the above, none of the proposed changes involve a significant increase in the probability or consequences of an accident previously evaluated. The stability related changes are consistent with current NRC guidance and approved analytical methods where applicable, and the transferring of certain surveillances to actions will preclude unnecessary shutdowns due to Specification 3.0.3.

II. No. The proposed changes relating to stability use the current guidance contained in NRC Bulletin 88-07 Supplement 1 to ensure that an unanalyzed event will not occur. They accomplish this by requiring reactor scrams in unstable regions, additional instability detection capability, and precluding a recirculation pump start during single loop operation in a potentially unstable region of the power/flow map.

The editorial changes shifting Surveillance Requirements to Actions cannot create a new event.

III. No. See I above. The stability changes are designed to protect the margin of safety to the MCPR Safety Limit. The editorial changes improve safety margin by precluding unnecessary plant shutdowns.

o Specification 3.4.1.4, Idle Recirculation Loop Startup

Action a has been revised to clarify the thermal power/core flow condition where an idle recirculation loop can be started.

I. No. This requirement is consistent with new Action a.2 of Specification 3.4.1.1.2, Single Loop Operation, which was reviewed above. The requirement to preclude a recirculation pump start in a potentially unstable region of the power/flow map will ensure that a new or different kind of event will not occur, and is consistent with the guidance in NRC Bulletin 88-07 Supplement 1.

II. No. See I above.

III. No. See I above.

IMPLEMENTATION

PP&L has implemented administrative controls to ensure the guidance provided in NRC Bulletin 88-07 Supplement 1 is followed. (Reference: PLA-3162, H.W. Keiser to W.T. Russell, "Response to NRC Bulletin 88-07, Supplement 1," dated March 7, 1989.) We believe that the administrative controls are adequate, but not optimal, given that they are inconsistent with the Technical Specifications. Furthermore, the current Tech Specs require "detect and suppress" neutron flux noise baselining surveillances to be performed during startup after each refueling and inspection outage, and this should no longer be required since the detect and suppress method of mitigating potential instabilities has been superseded.

PP&L requests that this proposed amendment be approved and conditioned to become effective prior to startup following the Unit 2 third refueling and inspection outage. Startup from this outage is currently scheduled to begin as early as November 10, 1989.

Any questions on this submittal should be directed to Mr. R. R. Sgarro at (215) 770-7916.

Very truly yours,

H. W. Keiser

cc: NRC Document Control Desk (original)
NRC Region I
Mr. G. S. Barber, NRC Sr. Resident Inspector
Mr. M. C. Thadani, NRC Project Manager
Mr. T. M. Gerusky, PA DER

Table 1

COTRAN DECAY RATIO CALCULATIONS FOR U2C4

Core Thermal Power (% Rated)	Total Core Flow (% Rated)	Calculated Decay Ratio
48.5	30	0.87
63	40	0.90
64	42	0.83
68	42	0.98
62	45	0.63
66	45	0.75
68	45	0.79
72	46	0.87
70	47	0.75
73	50	0.69
75	50	0.73