Public Service Company of Colorado
P.O. Box 361, Platteville, Colorado 80651

August 20, 1979
Fort St. Vrain
Unit No. 1
P-79181

Mr. George Kuzmycz
U. S. Nuclear Regulatory Commission
Division Project Management
Special Projects
Washington, D.C. 20555

Docket No. 50-267

Subject: Fluctuation Testing
Reference: P-79094
P-79131

Dear Mr. Kuzmycz:

Pursuant to the site meeting held on August 16, 1979, with Mr. Larry Phillips of your staff, we have revised RT-500E to incorporate comments discussed during the site meeting as well as comments presented in the ten (10) informal questions submitted by your office on August 13, 1979.

Please find enclosed three copies of RT-500F. The areas revised in Revision F have been designated as such.

The following represents our comments and/or the action taken with respect to the ten (10) informal questions mentioned above. Response has been keyed to the question numbers as presented.

Question 1

Reference 2 revises item 2 on page 4 of Reference 1 (under Corrective Action). However, the "Limits During Fluctuation Testing" given in RT-500E (Sheet 7) also appear to need revision for consistency with Reference 2. Please clarify.

Response

Revision F of RT-500 contains all test limits and corrective action and reporting requirements consistent with P-79094 and P-79131 (see pages 6 and 7, RT-500F).

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Question 2

On Sheet 4 of RT-500E, it is estimated that the Part I testing is expected to be no more than 10 hours in the fluctuating mode for a total of about 15 fluctuations.

However, item (4B) on Sheet 9 of RT-500 (Ref. 1) requires data acquisition for one hour at each core flow resistance. Is the 1/2 hour testing in item (4C) on Sheet 10 part of the one hour in item 4B, or is the total test time to be 1 1/2 hours? Is the testing to commence at 30% power or 40% power? If not at 30%, why not? Clarify and detail the basis for your estimated time in Fluctuations?

What are your plans for evaluation and maintenance of records and cumulative fatigue damage effects of the fluctuation tests on system components which are affected? What assurance can you provide that the fatigue design life of affected components will not be exceeded due to the unplanned thermal cycling?

Response

Concerning the time spent in the fluctuating mode versus the cycles we would agree that RT-500E was not very cleary written. Revision F attempts to clarify this matter. It was pointed out in our meeting on August 17 that tests would be conducted as follows:

Test	Total Tests	Duration Each Test	Total Test Hours
1. One test at four different power levels (core resistance values) for the purpose of obtaining fluctuation test data.	4	1 hour	4
2. A repeat of the test at each power level with fluctuations initiated by power changes only to verify repeatability.	4	1/2 hour	2
3. A repeat of the test at each power level with fluctuations initiated by pulsing the circulators.	4	1/2 hour	2
4. A repeat test of item 3 to verify repeatability.	4	1/2 hour	2

Test	Total Tests	Duration Each Test	Total Test Hours
5. One test at only one power level of the tests in Item 1 with the regulating rod in manual.	1	1/2 hour	1/2 hour
	Total Test Time		10 1/2 hours

Concerning the test power levels and the question of beginning at 40% rather than 30%, it was pointed out in the meeting that the tests are to begin at a nominal 40% power level. Based on cycle 1 information, none of the fluctuations experienced at 28 - 30% power exceeded a 1% change in the nuclear channels. Fluctuations at these low power levels, therefore, are no longer classified as fluctuations per the current definition of fluctuations. In addition, the core configuration must be drastically changed to obtain conditions conducive to fluctuations which represents conditions which are never approached during normal operation. Tests at 30% power, therefore, do not serve any useful purpose in establishing the operating threshold line.

Concerning the question of maintaining records for cumulative fatigue damage it was agreed that large system swings that may result from fluctuation tests would be logged along with the information that we maintain for plant life cycles to ensure that such swings would be considered along with other plant cycles. As pointed out in our meeting of August 16, 1979, fatigue damage resulting from fluctuations within the proposed test limits represents negligible damage to the steam generators design life. Larger swings beyond the test limits were only observed once during cycle 1 (November 4, 1978) for a brief period of time, and we have established adequate precaution to terminate fluctuation tests if limits are exceeded for Cycle 2 testing. Although we believe that any thermal cycling resulting from fluctuation tests will have negligible effect on the steam generators we will ensure that large swings beyond the test limits are properly logged for future consideration of overall plant cycles.

Question 3

On Sheet 5 of RT-500E, why is emphasis now placed on core ΔP rather than core resistance for evaluation of the fluctuation threshold.

Response

As far as test control is concerned our emphasis has always been on ΔP rather than core resistance, as ΔP is the only parameter that can be readily monitored in the control room. We still

believe that there is some definite relationship between core ΔP and core resistance, and that there is some definite relationship between core resistance and the fluctuation threshold line. We have elected, however, to control on the basis of core ΔP, but will continue to develop relationships and correlations of these parameters in the fluctuation test program.

Question 4

Under Operating Considerations (Sheets 5 and 6 of RT-500), it is not likely that the changes in region outlet temperature experienced during cycle 1 provide a good basis for the Figure 1 limits on cycle 2. Your note indicates that Figure 1 will be administratively revised based on cycle 2 experience. The staff should be consulted on changes to Figure 1 or a more general limitation should be defined in RT-500.

Response

It was pointed out in the meeting of August 16, that Figure 1 represented our best estimate of temperature margins. These margins were necessarily based on cycle 1 as there is no other basis for the estimate. In addition the margins established, while they only represent a starting point, are necessary in order to obtain a core temperature outlet configuration that will keep us within Technical Specification limits.

It was agreed that PSC would keep the staff informed of changes to Figure 1, as well as other significant test procedure changes. PSC would intend to notify the staff of significant procedural changes or the intent to revise procedures when the summary test data is furnished (see attachment to P-79131). The summary test data will be submitted to the staff within one (1) week of completion of testing for each power level.

Question 5

Reference 2 limits the module main steam temperature to 1075F for NRC review. What is the technical specification limit on this parameter?

Response

There is no Technical Specification limit for a main steam temperature of 1075°F. It was pointed out, however, that there is a Technical Specification limit of 1075° for hot reheat steam. Since hot reheat steam and main steam are basically at the same temperature, and hot reheat steam is much more sensitive to power and flow changes it can be inferred that main steam is essentially limited to 1075°F.

Question 6

How do the testing procedures of RT-500 (Sheets 8 and 9) assure that adequate power/flow ratios are maintained?

Response

The tests are conducted with the plant control systems in automatic. Therefore any changes in power will result in automatic changes in flow and vice-versa. Power to flow ratios will therefore be maintained automatically. There is one test where the regulating rod is placed in manual control. The remaining control systems remain in automatic during this test.

We have added, in addition, a precaution that the power/flow ratio as dictated by SL 3.1 and associated Figure 3.1.2 is not to be exceeded (see paragraph 10 sheet 12 of 17 RT-500F).

Question 7

In RT-500E Procedure, explain the deletion of waiting periods to allow thermal conditions to stabilize.

Response

Waiting periods were not deleted. See Note 3 page 9 of 17 of RT-500F.

Question 8

Steps 5 and 6 of RT-500E (Sheet 10) appear to increase the number of fluctuation cycles to more than the estimated total of 16. Explain.

Response

Discussed above as part of the response to Question 1.

Question 9

Step 10 of RT-500E (Sheet 11) indicates that the lowest power level for testing should be 40 percent. Why not 30 percent?

Response

Discussed above as a part of the response to Question 1.

Question 10

What are the consequences of operating with a lower core flow resistance than was planned (FSAR)?

Response

Operations postulated in the FSAR were for an equilibrium core with high region peaking factors up to the Technical Specification limits. Accident re-analyses were submitted by P-77221 bounding conditions for other core configurations. Current plant operations are well within these limits and therefore are enveloped by the above re-analyses. This is further demonstrated by the example of results for the less demanding expected conditions for accident cooldowns as submitted by P-78178.

We trust that the revisions to RT-500 adequately address your comments and we request your approval to resume the fluctuation test program as soon as possible. As discussed during our recent telecon the outage for Fort St. Vrain Unit No. 1 for installation of the Region Constraint Devices is presently scheduled to begin on October 20. It is essential that we receive your release to resume the fluctuation test program as soon as possible to permit analysis of the test results prior to our scheduled shutdown.

Very truly yours,

PUBLIC SERVICE COMPANY OF COLORADO

Don Warembourg by MLS

Don Warembourg
Manager Nuclear Production

DWW:dkm

Attachment

Mathie -- need rush PORC on Monday

RT-500F
Sheet 1 of 17

GA RT -500 Revision F

POT REF

REE REF

DATE 8/17/79

ISSUED

PORC 822 AUG 20 1979

REQUEST FOR TEST

REQUESTOR R. Kapernick/W. Simon SYSTEM 12

D PURPOSE/OBJECTIVE - There are two main objectives of this test:

D D 1. To determine the fluctuation threshold in terms of core pressure drop vs flow (power) for cycle 2 operation.

D D 2. To obtain FM data during fluctuations with the revised instrumentation systems for comparison with cycle 1 data.

C C D D D D D D D D D C D E F DESCRIPTION OF TEST - With the plant in normal operation, core orifices will be adjusted to achieve a specified core pressure drop. Load increases in ~3% steps and pulse changes in circulator speed of ~3% will be used as trigger mechanisms to induce fluctuations and to determine the fluctuation threshold in terms of core pressure drop as a function of core flow rate (power level). When a fluctuation occurs, the step causing the fluctuation will be repeated to demonstrate repeatability. Fluctuations will be initiated first at ~40% power and then at ~10% intervals so as to provide a good definition of the stability threshold line. Part 1 of the test encompases testing at <70% power while Part 2 refers to testing at >70% power. For at least one fluctuation, FM data will be obtained with the reg-rod held in a constant position.

Revision E incorporates PSC comments on Revision D.

F Revision F incorporates NRC comments on Revision E.

DATA REQUIRED - See attached.

D D D ANTICIPATED RESULTS/ACCEPTANCE CRITERIA - The test will provide data to aid in predicting conditions for stable operation. Additionally, data will be obtained which will aid in understanding the fluctuation phenomenon and for comparison with cycle 1 observations. There are no specific anticipated results or acceptance criteria.

REF SOP OR ABNORMAL CONDITIONS - SOP 12-04

SCHEDULE REQUIREMENTS -

SAR & APPROVAL SHEET ATTACHED

WORK ASSIGNED BY L D Scott 8-17-79 TO PSC OPERATIONS/GAC
Name/Date

EVALUATION COMPLETED _____
Name/Date

REVIEWED BY _____
Name/Date

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This SAR is in Support of RT-500E and is enclosed as Page 2 of 17
of that RT even though the SAR is a separate Uncontrolled Document.

(CHECK WITH DOCUMENT CENTER FOR LATEST ISSUE)

GENERAL ATOMIC COMPANY
FORT ST. VRAIN NUCLEAR GENERATING STATION
SAFETY ANALYSIS REPORT

1. INITIATING DOCUMENT: RT-500 Revision F

	YES	NO
2. CATEGORY: PLANT CHANGE	[ ]	[X]
CLASS I	[ ]	[X]
SAFE SHUTDOWN COOLING	[ ]	[X]
3. FAILURE MODES AFFECTED	[ ]	[X]
4. SAFETY RELATED COMPONENT, SYSTEM OR STRUCTURE CHANGE	[ ]	[X]
5. SAFETY SIGNIFICANT CHANGE	[ ]	[X]
6. UNREVIEWED SAFETY QUESTION	[ ]	[X]
7. TECH SPECIFICATION CHANGE	[ ]	[X]
8. FSAR CHANGE	[ ]	[X]

DOCUMENT CHANGE ONLY [ ]
MAINTENANCE [ ]
TEST [X]

STATE IN ITEM 10 THE BASIS FOR THE BOXES CHECKED

9. APPLICABLE FSAR OR TECH SPEC SECTIONS REVIEWED: T.S. LOC 4.1.4 AND LCO 4.1.7

10. BASIS FOR SAFETY EVALUATION: (Add additional Sheets if Required):
During this test, operation will be within Tech Spec and design limits. The test is performed to investigate the threshold for fluctuations, and although they might be encountered, the time at fluctuation would be minimal. Consequently, any fatigue damage to the core and/or steam generators would be negligible. Main steam temperature fluctuation limits have been set accordingly. In addition, throughout the test, sufficient margin will be maintained between the Tech Spec limit and the region exit temperatures so that even during the most severe fluctuation observed to date the Tech Spec limits will not be violated. (See Figure 1.) Although there will be a period of time that the reg-rod is disabled and not responding to the auto flux (continued on attached sheet)

11. IS SAN DIEGO SAFETY ANALYSIS/LICENSING REVIEW REQUIRED? YES [ ] NO [X]

12. HAS SAN DIEGO SAFETY ANALYSIS/LICENSING REVIEW BEEN PERFORMED? YES [X] NO [ ]

13. Michael Mapelsnik 8/17/79
INITIATOR/DATE

LICENSING/DATE

14. GAC ENGR. REVIEW/DISPOSITION: I CONCUR WITH THE ABOVE SAFETY ANALYSIS

ENG'R/DATE L O Scott 8-17-79

FORM: SAR 1/77

This SAR is in support of [illegible] and is enclosed as Part [illegible] of this RT even though the S/ is a separate Uncontrolled Document.

RT-500 Rev. F
Sheet 2 of 17

(CHECK WITH DOCUMENT CENTER FOR LATEST ISSUE)

TO: HANCHNICK/SCOTT
GTE-11679

GENERAL ATOMIC COMPANY
FORT ST. VRAIN NUCLEAR GENERATING STATION
SAFETY ANALYSIS REPORT

1. INITIATING DOCUMENT: RT-500 Revision F

2. CATEGORY:

PLANT CHANGE		1
CLASS 1		A
SAFE SHUTDOWN COOLING		X
3. FAILURE MODES AFFECTED		F
4. SAFETY RELATED COMPONENT, SYSTEM OR STRUCTURE CHANGE		S
5. SAFETY SIGNIFICANT CHANGE		A
6. UNREVIEWED SAFETY QUESTION		U
7. TECH SPECIFICATION CHANGE		T
8. FSAR CHANGE		F

DOCUMENT CHANGE ONLY [ ]
MAINTENANCE [ ]
TEST [X]

STATE IN ITEM 10 THE BASIS FOR THE BOXES CHECKED

9. APPLICABLE FSAR OR TECH SPEC SECTIONS REVISED: T.S. LCO 4.1.4 AND LCO 4.1.7

10. BASIS FOR SAFETY EVALUATION: (Add additional Sheets if Required):
During this test, operation will be within Tech Spec and design limits. The test is performed to investigate the threshold for fluctuations, and although they might be encountered, the rate of fluctuation would be minimal. Consequently, any fatigue damage to the core and/or steam generators would be negligible. [illegible] steam temperature fluctuation limits have been set appropriately to maintain throughout the test, sufficient margin will be maintained between the Tech Spec limit and the region exit temperatures so that even during the most severe fluctuation observed to date the Tech Spec limits will not be violated. (See Figure 1.) Although there will be a period of time that the rod-pos is disabled and not responding to the auto "lo" (continued on attached sheet)

11. IS SAN DIEGO SAFETY ANALYSIS/LICENSING REVIEW REQUIRED? YES [ ] NO [X]

12. WAS SAN DIEGO SAFETY ANALYSIS/LICENSING REVIEW PERFORMED? YES [X] NO [ ]

13. [signature] 8/17/79
INITIATOR/DATE

[signature] 8/17/79
LICENSING/DATE

14. QAC ENGR. REVIEW/DISPOSITION: I CONCUR WITH THE ABOVE SAFETY ANALYSIS

[signature] 8-17-79
DIG'N/DATE

10. BASIS FOR SAFETY EVALUATION (continued)

control system, test procedures will assure any required rod runbacks will take place and will produce the subsequent desired reactor power control. Therefore, this test will not adversely affect the integrity of the core or steam generator and will not affect public safety.

Since first being encountered on October 31, 1977, fluctuations have been initiated several times in a continuing effort to understand their cause. The power levels at which fluctuations were initiated have ranged
D from 30% to 68%. A total of about 65 hours has been spent in a fluctuating
D mode, which is equivalent to 390 cycles with a period of ten minutes.

Although the cause of the fluctuations is not known, there are several reasons for concluding that continued testing is safe. The total core
C power, flow, and average temperatures are relatively stable. An inspection of the top plenum in December 1977 after fluctuation testing at power levels between 53% and 68% showed it was in good condition. An inspection at that time of the control rods in region 34 (which were inserted throughout the entire period of fluctuation testing) also showed no signs of excessive
D temperature or impact. During the first refueling outage, eleven blocks
D from region 35 were carefully inspected in the PSC hot service facility
D and there was no evidence of damage. An in-core inspection of region 35
D and its surroundings with the fuel handling machine T.V. camera revealed
D no damage or excessive wear to any component. The upper plenum area
D looked fine; the gaps in the regions and side reflector surrounding the
D cavity left when region 35 was unloaded were very regular with no evidence
D of wear or damage. An inspection of the core support blocks in regions 13 &
D 35 havelikewise revealed no damage.

E
D Every element removed from the core during the refueling of six
D regions has been photographed as has each block in five additional regions
D which were unloaded to permit installation of test assemblies. Examinations
D of these photographs have revealed no damage.

D Testing Above 70% Power (Part 2)

D Since fluctuations were first encountered, tests have been con-
D ducted under various core conditions. In large part, these tests were
D designed to gather specific information on what key parameter or combina-
D tion of parameters leads to the fluctuations, since this knowledge could
D be instrumental in understanding their cause. These tests have shown
D fairly conclusively that power level is not by itself a parameter of primary
D importance to the fluctuation threshold, and they have established core
D pressure drop as a key parameter, probably closely related to the cause of
D the fluctuations. Another result from these tests is that it appears that
D the core pressure drop at which fluctuations are produced is higher at
D higher core power levels.

D Differences in fluctuation magnitudes and character have been observed
D in the ~65 fluctuations that were initiated during cycle 1 operation.
D These differences have been carefully studied and reported extensively.
D No apparent correlation with power level has been noted, nor has a change

D been observed with time that would indicate increasing fluctuation magni-
D tudes or significant differences in character. All of the fluctuation
D testing limits and operating considerations as well as normal plant tech-
D nical specification limits and SOPs are in effect both below 70% power
D and above 70% power. One exception is the limit on nuclear detector
D fluctuations. This limit is increased from 10% at <70% power to 20% for
D >70% power. This increase is justified because nuclear channel fluctua-
D tions are believed to be due primarily to a streaming effect and are thus
D expected to be nearly proportional to the power (neutron flux) level.
D In this test, fluctuations will be initiated at successively higher power
D levels. The magnitude and character of the fluctuations at each power
D level will be carefully observed for differences in addition to monitoring
D the Technical Specification and fluctuation testing limits. Consequently,
D testing above 70% power will not affect public safety.

D Time Spent Fluctuating

D It is anticipated that a total of about 16 fluctuations will be
D initiated during Part 1 of this test (testing ≤70% power). Total time
D in the fluctuating mode during Part 1 is expected to be no more than
F ~10 1/2 hours. For each of the four power levels at which the fluctuation
F threshold limit will be defined, a first fluctuation will be initiated and
F sustained for a 1-hour period (Step 4B of the Procedure). To verify repeat-
F ability, three additional fluctuations will then be initiated and immediately
F halted at each of these power levels (Steps 5, 6 and 7 of the Procedure).
F One-half (1/2) hour in the fluctuating mode has been allotted for each of the
F latter three fluctuations. In addition, for one fluctuation during the
F conduct of this RT, the fluctuation will be sustained for one-half (1/2) hour
F with the reg-rod disabled and all rods held in a constant position (Part 1,
F Step 4C of the Procedure).

D During Part 2 of this test (testing at >70% power), fluctuations may be
D initiated about 8 times, with a total time in the fluctuation mode of
D ~4 hours.

PREFACE

Revision A accomplished the following changes: (1) The Operating Limits Section was redefined to incorporate limits required by the NRC. (2) The remainder of the previous limits were redesignated as Operating Considerations. (3) The equation for core resistance was redefined to better fit observed operating data. (4) Addendum I was added to determine the fluctuation threshold at 28% power.

Revision B accomplished the following changes: (1) The 10% limit on a nuclear channel fluctuation was extended to cover all six channels. (2) The required instrumentation was increased to have brush recorders for all twelve steam generator module outlet temperatures and all six nuclear channels; the steam generator temperatures will be monitored both by wide range brush recorders (700°F - 1100°F) and by either narrow range brush recorders (100°F range, zero suppressed) or digital display of fluctuation magnitudes from the steam generator data acquisition system. (3) The limit on module main steam temperature at which testing is suspended until authorized by PSC management is increased from ±30°F to 150°F. (4) In Figure 1, the region temperature mismatch margin for region 12 is increased to 100°F. (5) The instruments to be monitored by the trend recorders are not specified: any four thought to be of most use may be trended. (6) A two hour waiting period between fluctuation tests is specified.

Revision C accomplished the following changes: (1) Corrective action is to be taken to stop the fluctuation if a module main steam temperature reaches 1025°F. (2) Editorial changes were made to the other limits on module main steam temperature. (3) The test team members responsible for conducting the test are specified. (4) The physical location of the data systems to be monitored are specified, as are the respective team members responsible for monitoring them. (5) Figure 2 of Addendum I has been "cleaned up" and updated to reflect the current actual locations for thermocouples 3, 4, 5, 7, 19, 23, and 25. (6) In Figure 1, the region temperature mismatch margin on regions 17, 18, 26, and 27 have been increased.

Revision D accomplished the following changes: (1) The detailed test procedure has been rewritten. The number of anticipated fluctuations and the total time spent in the fluctuation mode has been reduced. However, the basic test philosophy and the limits during fluctuations remain unchanged. (2) RT-502 (Threshold Testing >70% Power) has been incorporated as Part 2 of this RT. (3) The objectives of the test have been modified to reflect testing during cycle 2 (for comparison with cycle 1) with the emphasis on gathering data to aid in predicting conditions for stable operation. (4) Addendum I of RT-500 Revision C has not been repeated here because it was successfully completed during cycle 1 testing. (5) A definition of a fluctuation has been included. (6) There have been numerous editorial changes (changes are denoted by a D in the margin).

Revision E incorporates comments from PSC to delete the detailed orifice adjustment procedure, update Data Sheet 1 to include all limits and other minor comments as noted in the left margin.

Revision F incorporates comments from NRC as noted.

INTRODUCTION

The collection of data from all cycle 1 core fluctuations indicates a distinct influence of core ΔP on the threshold for fluctuations. However, the cycle 1 data shows a lot of scatter and fresh fuel has been loaded into six regions of the core; therefore, fluctuation threshold testing at the beginning of cycle 2 is necessary.

This RT will determine the fluctuation threshold as a function of core pressure drop for cycle 2 (with a procedure aimed at minimizing the amount of scatter in the data). The FM Data System now includes 24 traversable thermocouples, PCRV displacement probes and magnetometers for attempting to monitor core barrel motion, and two instrumented control and orificing assemblies having in-core instrument packages. These data will be collected during fluctuations to aid in predicting conditions for stable operation and in understanding the fluctuation phenomenon.

The expected methods for triggering a fluctuation will be a 3% load increase at 3% per minute and a pulse change in circulator speed sufficient to produce ~3% increase in flow. When a fluctuation develops, the steps preceding and resulting in the fluctuation will be repeated to demonstrate repeatability and to provide a reasonably accurate determination of the threshold power.

The test scope includes the determination of the fluctuation threshold for at least three values of core flow resistance.

Testing will be conducted by the coordinated efforts of a test team consisting of, but not limited to, the following members:

1. PSC Shift Supervisor
2. PSC Reactor Operator(s)
3. Test Coordinator
4. Core Performance Engineer
5. Data Systems Engineer

The NRC will be provided, within one week, with a summary of test results for each power level. Included with these results will be notification of any change to the procedure as a result of the test results.

OPERATING CONSIDERATIONS

In addition to the normal plant operating procedures and limitations, the following should be observed:

1. The HRH and MS temperature imbalance between each SG module and the average for the loop should not exceed 30°F (in steady state) or the limits given in SOP 12-04 whichever are more restrictive. In addition, the maximum individual module MS steady state temperature should be limited to 995°F. The purpose of the 995°F limit is to provide margin on MS temperature when fluctuations occur.

2. Steady state module helium inlet temperature shall be limited to ±45°F about the mean or the limits given in SOP 12-04 whichever are more restrictive.

D 3. In order to minimize the chance of getting into a degraded performance condition during fluctuations, the maximum region outlet gas temperature during steady state conditions shall be limited as follows: From previous fluctuation data, it was noted that the following core regions exhibited the most severe temperature changes during the C fluctuation: Regions 1, 2, 3, 4, 5, 6, 7, 9, 12, 20, 33, 34, 35, B 36, and 37. All of these regions must be kept at least 60°F, 80°F, B or 100°F below the allowable temperature limit of LCO 4.1.7 as shown in Figure 1. All other regions must be kept at least 35°F below the allowable limit.

E NOTE: The margins per Figure 1 are based on cycle 1 experience. When fluctuations are observed in cycle 2, the regions that exhibit the largest temperature variations may be different. As differences, if any, are observed, Figure 1 will be administratively revised accordingly.

F 4. The plant is defined to be in a fluctuation operating mode when a D single nuclear channel exhibits offset deviation from the average D equal to or greater than 1% of full power reading on a cyclic basis not D exceeding a 30 minute period.

F 5. Operation and/or testing at power levels >70% should be in accordance D with the B-0 startup test program.

F 6. Throughout the duration of this RT, all plant control systems are to be F in automatic (except for the one test with the reg-rod in manual, see F Step 4C of the Procedure), and with MS and HRH temperature controls set F to a maximum of 980°F.

F Note: The reason for selecting the temperature setpoint at 980°F vs F 1000°F is to allow margin for the temperature swings that F occur when fluctuations develop.

LIMITS DURING FLUCTUATION TESTING

Test Limits

F 1. Proposed testing will be conducted within the Technical Specification F limits.

F 2. Throughout the test, the intent will be to minimize the time spent F in fluctuation except when necessary to record FM data. When fluctu- F ations are present, the following should be observed:

F A temperature fluctuation of module main steam temperature F about its mean of $\pm 10^{\circ}$ (20°F total amplitude) is acceptable F with no specific time considerations.

F A temperature fluctuation of module main steam temperature F about its mean greater than $\pm 10^{\circ}$F (20°F total amplitude) but F less than $\pm 30^{\circ}$F (60°F total amplitude) should not exceed one F hour in duration per event.

A temperature fluctuation of module main steam temperature about its mean of $\pm 30^{\circ}F$ ($60^{\circ}F$ total amplitude) is cause to take immediate corrective action by reducing power to stop the fluctuations.

A uni-directional module main steam temperature change of $60^{\circ}F$ (excluding the average component of intentional steam temperature changes) is cause to take immediate corrective action by reducing power to stop the fluctuations.

A module main steam temperature of $1025^{\circ}F$ is cause to take immediate corrective action by reducing power to stop the fluctuation.

A primary coolant activity increase greater than a factor of 25% but less than a factor of 5 over the prior equilibrium value for that power level is cause to take immediate corrective action by reducing power to stop the fluctuations.

3. A limit of $\pm 10\%$ of full power range on any nuclear channel will be maintained.

4. The helium purification system will be in service during all testing.

5. An increase in primary coolant activity levels greater than a factor of five (5) over prior equilibrium values for that power level during any fluctuation test will be cause for terminating the testing and proceeding with an orderly plant shutdown.

Corrective Action

1. If any of the established limits or conditions outlined in items 2 through 4 above are exceeded during a fluctuation test, the test will be terminated, and further plant testing in the fluctuating mode will be suspended until specifically authorized by PSC management.

2. If any of the following conditions are exceeded, immediate action will be taken to terminate the fluctuation test and further testing in fluctuation mode will be suspended until authorization to proceed is obtained from the Commission:

   a) Technical Specification limits are exceeded

   b) An increase in primary coolant activity levels greater than a factor of five (5) over prior equilibrium values for that power level.

   c) A temperature change of module main steam temperature of $150^{\circ}F$ relative to the initial steady state temperature and exclusive of temperature change due to load changes

   d) A module main steam temperature which exceeds $1075^{\circ}F$.

3. If inadvertent fluctuations are observed (see page 6 for the definition of a fluctuation) in normal operation, corrective action will be taken

F to terminate the fluctuation, and PSC management authorization will
F be required prior to returning to a power level that would approach
F that level that the inadvertent fluctuations were observed.

INSTRUMENTATION/DATA SYSTEMS

Through the duration of this test, the following data systems shall
D be operating and personnel should be present for monitoring:

C 1. Brush recorders (located in the auxiliary control room) with all
D steam generator module main steam outlet temperatures and nuclear
C channels. A data system engineer will be present to monitor the
recorders. Both wide range brush recorders (700°F - 1100°F) and
either narrow range brush recorders (100°F, zero suppressed) or
digital display by the steam generator data acquisition system will be
D available to monitor the steam generator module main steam outlet
temperatures.

C 2. Data logger (located in the control room). The core performance
engineer will be present to monitor the core temperature limiting
conditions for operation.

C 3. The primary coolant activity monitor (located in the control room).

D 4. FM data acquisition system.

If any of the above systems becomes inoperable, testing shall be
halted until the system is reinstated. If fluctuations are encountered
when any of these systems is inoperable, core power should be reduced
until the fluctuations cease.

D During power increases or pulsed circulator speed changes and for a
D period of 2 hours (power increase) or 1 hour (circulator speed pulse)
D following either of these system changes, the following data system
and data taking frequencies are desired:

1. Data logger on a fast sample rate (15 seconds or less)

2. Steam generator Fox II computer on a fast sample rate (~5 seconds)

3. Model verification computer

4. FM data acquisition system

D 5. Brush recorders

At periods during the test when the initial conditions for a fluc-
tuation test are being established (orifice adjustments, flow/power changes),
the following data systems and data taking frequencies are desired.

1. Data logger on a sample rate of 2 minutes or faster

2. Steam generator Fox II computer on a sample rate of 15 seconds or
faster

3. Model verification computer

D 4. FM data acquisition system

D 5. Brush recorders

D The traversable thermocouples are to be positioned per RT-524.

PART 1: TESTING AT ≤70% POWER

Initial Conditions

F 1. Plant at approximately 40% power.

2. The orifices are to be adjusted such that the region exit temperatures and steam generator inlet temperatures are reasonably balanced
D per normal procedures and per the Operating Considerations section
D of this RT.

Procedure

D 1. The objective of this test is to develop a core pressure drop vs
D core flow rate (or power) stability threshold line. Thus it is
D desired to initiate fluctuations at three or more values of core
D flow rate. This will be done by orificing the core to different
D flow resistances. Depending on the core flow rate at which fluc-
D tuations are initiated in the first test, higher or lower values
D of core resistance may be selected. To generate a reasonably good
D stability threshold line it is desired to initiate fluctuations at
D a lowest power level of about 40% to 50% and at about every 10%
D increase in power thereafter.

D NOTES: 1. Each time fluctuations are initiated, Data Sheet 1 must
D be completed.
D 2. The most effective means of halting fluctuations is by
D power reduction. Experience has shown that to halt a
D fluctuation the power may have to be reduced by 5% to 10%
D below the power level which produced the fluctuation.
D 3. Wait at least 1/2 hour to reach thermal equilibrium
D prior to performing any fluctuation test, wait 2 hours
D after attempting to initiate a fluctuation by a load
D increase before continuing, wait 1 hour after attempting
D to initiate a fluctuation by a pulse change in circulator
D speed before continuing.

D 2. For the first test configuration, adjust the core orifices in a series
E of steps using the procedure supplied by the test coordinator as a guide
D to obtain an average core pressure drop of 2.3 psi. Core resistance corres-
D ponding to this core pressure drop and core flow rate may be calculated by:

$$\text{Resistance} = 2.0 \cdot 10^{13} \frac{\Delta P \text{ Measured} \cdot \text{Pressure}}{\text{Flow}^{1.85} \cdot (T_{in} + 460)}$$

where ΔP measured is the measured core pressure drop in psi (item 71 in DF 76)

Pressure is the circulator inlet helium pressure in psi (item 9 in DF 76)

Flow is the total circulator flow in lbm/hr (item 72 in DF 76)

T_{in} is the circulator inlet temperature in degrees Fahrenheit (average of items 1 and 2 in DF 76)

Verify that the region outlet gas temperatures have adequate margin from LCO 4.1.7 per Figure 1 and that the S/G module temperatures are within the Operating Limits Section of this RT before preceeding.

D 3. Begin a series of power rises by increasing turbine load at 3% per
D minute in incremental load changes of 3% (~9 MWe). Continue the
D incremental load increases until fluctuations develop or a plant
D limit is reached. Prior to each incremental load increase, adjust orifices as necessary to balance region outlet gas temperatures and module inlet gas temperatures. In addition, adjust the reg-rod position according to normal operations practice.

D 4. When fluctuations develop, there are three basic sets of data to obtain:

A. It is desirable to obtain FM data during the onset of all fluctuations.

B. For one fluctuation with each core flow resistance, obtain FM data for one hour during the fluctuations. The operating limits stated in this RT must be adhered to during the one-hour period.

F C. For one of the fluctuations described in Step 4B, it is desirable
F to obtain FM data for an additional 1/2 hour, with the reg-rod
E disabled and all rods held in a constant position. Attachment I defines the procedure for disabling the reg-rod. The operating limits stated in this RT must be adhered to during fluctuations.

C The Core Performance Engineer will coordinate which particular fluctuations will be monitored per items B and C above.

D F D D F D 5. For each fluctuation encountered, repeat the step preceding the fluctuation and, if fluctuations are not encountered, that step which caused the fluctuation. For example, if fluctuations are encountered during a power rise from 50% to 53% power, return to 47% power and repeat the 47% to 50% power rise. If no fluctuations occur, then repeat the 50% to 53% power rise.

D D D D D D D D D D 6. When a fluctuation threshold has been defined per steps 2 - 4, return to the highest power level for which a fluctuation was not initiated (47% in the above example). Perform Part II of RT-499, the circulator speed pulse test, where the primary coolant flow is increased by ~3%, held at the higher value for a short duration (~10 seconds) and returned to its initial level. If fluctuations are not initiated, increase power by 3% at 1/2%/minute and repeat Part II of RT-499, the circulator speed pulse test. Continue until fluctuations are encountered or until a power level 9% above the maximum from step 4 is achieved (until 62% in the above example).

D F F 7. Repeat the circulator speed pulse test (Part II of RT-499) for the step preceding the fluctuation and, if fluctuations are not encountered, that step which caused the fluctuation.

F F F F D D 8. The next test power level depends on the power level at which fluctuations were encountered in Step 5 above. The objective is to initiate fluctuations at power levels approximately 10% apart; that is, at about 40%, 50%, 60% and 70% power. For the selected new power level the next value of core resistance can be calculated from the conditions which initiated the preceding fluctuation as follows:

D $$R_{NEW} = R_{OLD}\left(\frac{F_{OLD}}{F_{NEW}}\right)^2$$

D where R_{OLD} is the resistance from the preceding test

F F_{OLD} is the core flow rate from the preceding test (step 5)

F F F_{NEW} is the flow rate corresponding to the power level where the next fluctuation is desired.

D F D D D D 9. The starting point for the next test is with the core orificed to achieve the new core resistance, R_{NEW}, per the equation given in step 2, and with a core pressure drop 10% - 20% below that at which the preceding fluctuation was initiated. In getting to the new starting point, it is desired to keep the core pressure drop at or below the value at which the fluctuation test will be started to prevent inadvertent fluctuations. To do this it is suggested that:

D A. If $R_{NEW} > R_{OLD}$, reduce flow before closing orifices.

D B. If $R_{NEW} < R_{OLD}$, open orifices before increasing flow

10. Repeat steps 3 - 7 to obtain data for at least 3 values of core resistance. To generate a reasonably accurate stability threshold, fluctuations should be initiated at a lowest power level of about 40 - 50% and at increments of ~10% power above this initial level.

Depending upon the effect of refueling on the fluctuation threshold, it may be necessary to vary attemperation flow (core P/F), region outlet temperature mismatches, or partially insert control rods (power flattening) in order to demonstrate the threshold at high power levels. Any or all of these operations may be used as permitted by SOPs and Technical Specifications. Caution should be exercised to maintain the region temperature margins for L.C.O. 4.1.7 given in Figure 1 and to not violate the core thermal safety limit on core power/flow ratio (S.L. 3.1, Figure 3.1-2).

If the pulse change in circulator speed test fails as a "trigger" for fluctuations for two values of core resistance, then it is not necessary to continue attempting to initiate fluctuations via this mechanism.

Part 2: Testing at >70% Power

From an initial steady-state condition of ~70% power, the core power will be increased slowly (1/2% per minute) to ~73% and stabilized. If no fluctuations occur, power will be reduced to 70%, stable operation achieved, and a pulse change in circulator speed will be employed to attempt to initiate fluctuations. If fluctuations do not develop, a 3% load increase at 3% per minute will be effected to attempt to trigger fluctuations. This process of slow power increases, circulator speed pulses, and then rapid power increases of 3% will be continued until fluctuations are encountered or until 100% power or a plant limit is encountered. If fluctuations occur, data will be recorded for a short period of time and the step which initiated the fluctuation will be repeated to establish reproducibility of the onset of fluctuations.

Initial Conditions

1. Plant at approximately 70% power.

2. The orifices are to be adjusted such that the region exit temperatures and steam generator inlet temperatures are reasonably balanced per normal procedures and per the Operating Considerations section of this RT.

Procedure

1. The objective of this test is to extend the core pressure drop vs core flow rate (or power) stability threshold line developed in Part 1.

NOTES: 1. Prior to each incremental load increase, adjust orifices as necessary to balance region outlet gas temperatures and module gas temperatures. In addition, adjust the reg-rod position according to normal operations practice.

2. The most effective means of halting a fluctuation is by power reduction. Experience has shown that to halt a fluctuation the power may have to be reduced to 5% to 10% below the power level which produced the fluctuation.
3. Each time a fluctuation is initiated, Data Sheet 1 must be completed.
4. Wait at least 1/2 hour to reach thermal equilibrium prior to performing any fluctuation test, wait 2 hours after attempting to initiate a fluctuation by a load increase before continuing, wait 1 hour after attempting to initiate a fluctuation by a pulse change in circulator speed before continuing.

2. For the first test configuration, adjust the core orifices in a series of steps using the procedure supplied by the test coordinator as a guide to obtain an average core pressure drop at least 10% below the threshold ΔP determined in Part 1 for 70% power. The core resistance corresponding to this core pressure drop and core flow rate may be calculated by the equation given in Part 1 procedure step 2.

   If the core orifices are opened as much as possible, the main steam temperature may be reduced to 40°F below the reheat temperature setpoint, core control rods may be partially inserted (to flatten the power distribution and thereby permit further opening of orifices), or attemperation flow may be increased within the limits of SOPs and Technical Specifications to further reduce the core pressure drop.

   Verify that the region outlet gas temperatures have adequate margin from LCO 4.1.7 per Figure 1 and that the S/G module temperatures are within the Operating Limits Section of this RT before proceeding to the next orifice changes.

3. Increase power by ~3% (~9 MWe) at 1/2% per minute. If fluctuations do develop, go to step 6. If fluctuations are not initiated, decrease power by ~3% to achieve initial conditions once again.

4. Perform Part II of RT-499, the circulator speed pulse test, where the primary coolant flow is increased by ~3%, held at the higher value for a short duration (~10 seconds) and returned to its initial level. If fluctuations develop, go to step 6.

5. If fluctuations are not initiated by step 4, increase power by 3% at 3% per minute. If fluctuations develop, go to step 6. If fluctuations do not develop, repeat steps 3 through 5 starting at the new power level (~3% above the preceding power level). Continue with successively higher power levels until fluctuations do develop or until 100% power or a plant limit is encountered.

6. When fluctuations develop, there are two basic sets of data to obtain:

   A. It is desirable to obtain FM data during the onset of all fluctuations.

   B. For one fluctuation with each core flow resistance, obtain FM data for one hour during the fluctuations. The operating limits stated in this RT must be adhered to during the one-hour period.

The Core Performance Engineer will coordinate which particular fluctuations will be monitored per item B above.

7. For each fluctuation encountered, repeat the step (load increase or circulator speed pulse change) preceding the fluctuation and if no fluctuations occur, that step which caused the fluctuation. For example, if fluctuations are encountered during a power rise from 73% to 76% power, return to 70% power and repeat the 70% to 73% power rise, then if no fluctuations occur, repeat the 73% to 76% power rise.

Similarly, if the circulator speed pulse changes initiated fluctuations, then repeat the circulator speed pulse test (Part II of RT-499) for the step preceding the fluctuation and that step which caused the fluctuation.

8. After demonstrating repeatability, reduce power and re-establish a stable plant configuration. If fluctuations were first initiated by the 1/2% per minute load increase (step 3), then establish the initial conditions preceding initiation of fluctuations and perform the circulator speed pulse test, step 4. If fluctuations were first initiated by the pulse change in circulator speed (step 4), then establish initial conditions preceding initiation of fluctuations and effect a 3% load increase at 3% per minute, i.e., step 5. If fluctuations were first initiated by the 3% per minute load increase (step 5), proceed to step 9.

9. The next starting point is with a primary flow rate (power level) 5% - 10% above that of the preceding starting point but with the same core pressure drop. This may be achieved as before, by opening the orifices to a new value of core resistance.

Partial rod insertion may be employed to permit further opening of orifices and/or the main steam temperature set point may be reduced to 40°F below the reheat temperature setpoint to reduce core pressure drop.

To guard against inadvertent fluctuations, the orifices should be opened before increasing flow.

10. Repeat steps 3 - 5, at successively higher power levels, until 100% power is reached or until a plant limit is encountered.

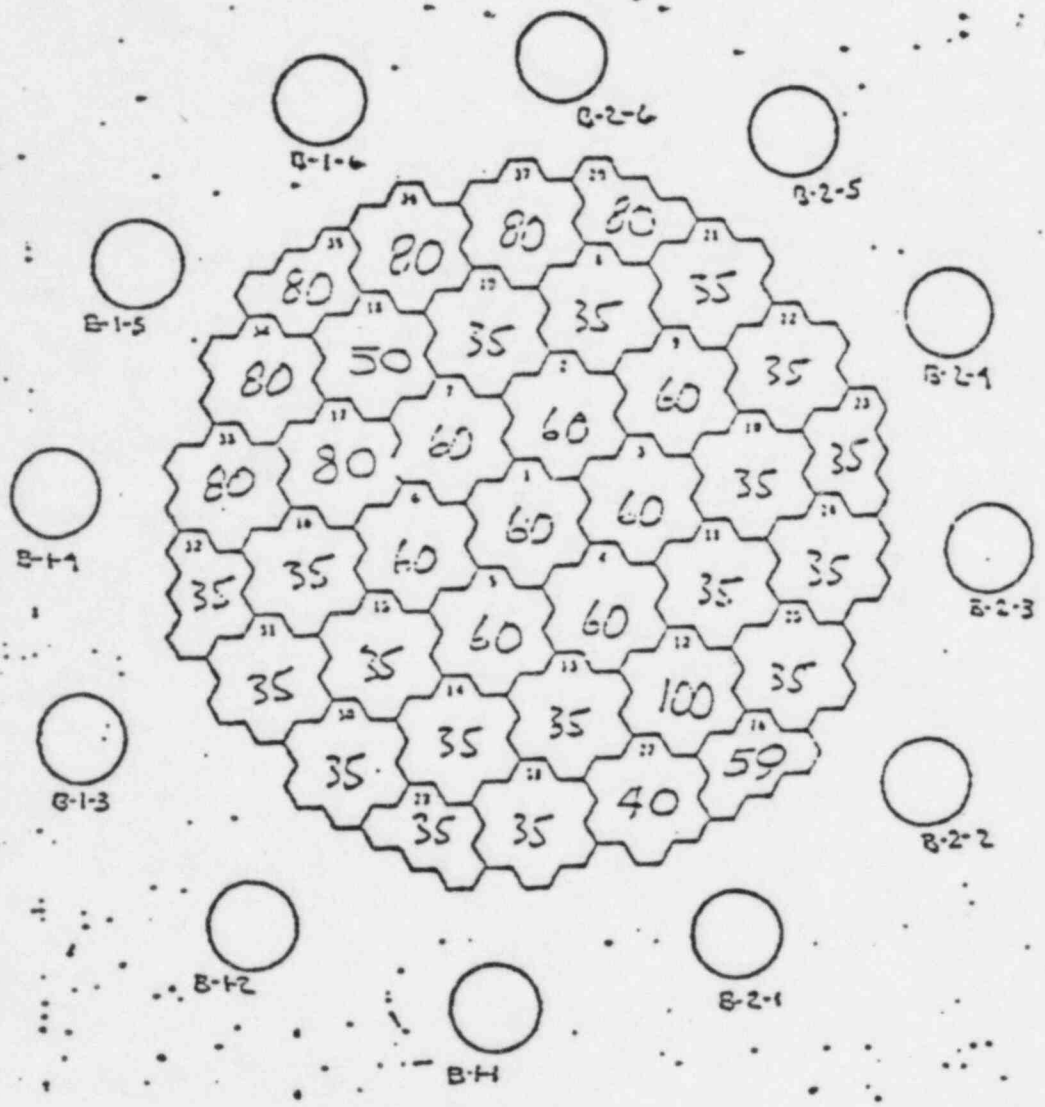

FIG. 1. REQUIRED MARGIN ON ALLOWABLE MISMATCH (L.C.O. 4.1.7 LIMIT - TOLT)

(new figure in Revision B)

ATTACHMENT I

REG-ROD INFLUENCE TEST

D D D D D The purpose of this test is to determine if taking the reg-rod out of auto will reduce the amplitude of the fluctuations and to obtain data from the out-of-core and in-core nuclear channels which are responding to the influence of the fluctuation phenomenon alone, without the complicating effect of reg rod motion influencing the signals. The procedure is as follows:

1. After a fluctuation has developed, monitor the amplitude of the module MS temperature fluctuation to verify that the Operating Limits of this RT are met. Previous experience with fluctuations indicates that the amplitude may be reduced by slowly reducing power and thus allow a longer time in fluctuations.

2. Disable the ability of the flux controller to move the reg-rod by placing the reheat temperature controller in manual and then rotating the regulating rod selector switch (HS-1218) to the OFF position. This permits the automatic flux control to initiate a rod runback if needed as a result of any transient during this test. If necessary, manually position the reg-rod to the average position that existed prior to disabling the automatic control feature. This step is desirable in order to maintain a constant value for total reactor power and average core temperature.

   CAUTION: If a runback occurs, the reheat temperature controller should be nulled out and returned to automatic and HS-1218 returned to the #1 position as soon as possible.

D 3. Wait a period of approximately 30 minutes to determine the effect on fluctuations. Control room trend recorders and brush recorders are to be used for this purpose. Return the reg-rod to auto by returning HS-1218 to the #1 position, null out reheat temperature controller, and return it to automatic.

DATA SHEET I

Complete this data sheet if fluctuations were encountered. This data sheet is to certify that test limits were not exceeded.

A. If any of the following limits are exceeded, testing must be stopped until further authorized by PSC Management.

	Limit
1. Were OPERATING CONSIDERATIONS 1,2&3 met? YES___/NO___	N/A
2. Time/Date fluctuation started _____	N/A
3. Power Level at start of fluctuation _____	N/A
4. Time/Date power reduced _____	1 hour
5. Time/Date fluctuation stopped _____	N/A
6. Power Level when fluctuation stopped _____	N/A
7. Maximum fluctuation on Nuclear Channel # _____	N/A
Peak Magnitude _____	±10% (< 70%) ±20% (>70%)
8. Maximum fluctuation of Loop I MS Temp Module #_____	N/A
Fluctuation Magnitude _____	60°F P-P
Hottest Module # _____ _____°F	1025°F
9. Maximum Fluctuation of Loop II MS Temp Module # _____	N/A
Fluctuation Magnitude _____	60°F P-P
Hottest Module # _____ _____°F	1025°F
10. Equilibrium Value of Primary Coolant Activity for power level of test _____	N/A
11. Maximum Value of Primary Coolant Activity During test _____	25% increase Required for Testing
12. Were Data Systems in service? YES____/NO_____	
13. Was a purification train in service? YES___/NO__	Required for Testing

B. For any of the following, testing must be stopped and reported to the NRC:

1. Any Technical Specification exceeded? YES____/ NO_____
2. Any MS Temperature Fluctuation > 150°? YES____/ NO_____
3. Primary Coolant Activity >5 times normal? YES____/ NO_____
   This requires an immediate orderly shutdown.

PSC SHIFT SUPERVISOR _____
Signature/Date

TEST COORDINATOR _____
Signature/Date