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Mathis

Revision No. 8

ATTACHMENT 10.9
Sheet 1 of 7
TEST CONTROL RECORD

Fort St. Vrain #1
ADM-27
Page 42 of 48

Test Ref. No. RT-500 Rev. 4 (GA Issue H)

System Ref. No. 12

FORT ST. VRAIN NUCLEAR GENERATING STATION

Page 1 of 23

REQUEST FOR TEST

Prepared By: _____ Date 10-14-78

Reviewed By: _____ Date 10-14-78

Original Issue Reviewed, PORC # PORC 278 8610 Date _____

Approved & Issued: s/ _____ Date 10/16/78

Safety Significant: Yes ____ No X NFSC Review: _____

RECORD AND CONTROL OF REVISIONS

Rev. No.	Prepared By	PORC Approval	Approved & Issued Effective Date of Revision
1	L. Liggy jr	PORC 30 MAY 10 1979	5/10/79
2	[illegible]	PORC 322 AUG 20 1979	8/20/79
3	R J Hirsch jr	PORC 330 OCT 15 1979	10/15/79
4	R J Hirsch jr	PORC 342 JAN 8 1980	1/8/80
5			
6			
7			

Completed Test Reviewed: _____ 8002150 292
Superintendent, Operations (or designee)

CONCUR WITH SAR _____ 8/22/79 Rathelle 10-15-79

PROCEDURE CHANGES: ☐ Permanent ☐ Temporary

PAGE NO.	DESCRIPTION AND REASON FOR CHANGE OR DEVIATION	SAFETY EVALUATION

APPROVALS:

Plant Management Staff (Senior License) — Date

Plant Management Staff — Date

NOTICE TO TEST CONDUCTOR

IT IS MANDATORY THAT THIS DEVIATION BE REVIEWED BY PORC NO LATER THAN 14 DAYS FROM THE DATE OF SIGNATURE. YOU ARE RESPONSIBLE FOR HAVING THIS DONE.

Test Ref. No. RT-500 Rev 4 (GA Issue H)

System Ref. No. 12

Request for Test - Sheet 5

10) TEST EQUIPMENT (If required)

Name	Identification Number	Last Calibration Date

11) TEST CONDUCTOR
(Include all assistants)

Permission to initiate test _____
Shift Supervisor Date

12) PROCEDURE (See attached pages):

Test Ref. No. RT-500 Rev 4 (GA Issue H)

System Ref. No. 12

Request for Test - Sheet 6

13) VERIFY THAT THE SYSTEM HAS BEEN RETURNED TO NORMAL:

_____
s/Shift Supervisor Date

14) TECHNICAL SERVICES ACTION:

10 CFR 50.59 Report Required: Yes____ No____

Tech Spec Report Required: Yes____ No____

Reviewed by_____
Signature Date

REQUEST FOR TEST

REQUESTOR K. Asmussen/W. Simon SYSTEM 12

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

D H 1. To determine the fluctuation threshold in terms of core pressure drop vs flow (power) for cycle 2 operation after installation of region constraint devices.

D H 2. To obtain FM data during fluctuations with the revised instrumentation systems for comparison with cycle 2 data without region constraint devices.

C D D D D D D D C C 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). If a fluctuation occurs, the step causing the fluctuation will be repeated to demonstrate repeatability. Attempts to initiate fluctuations will be performed 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, if fluctuations occur, FM data will be obtained with the reg-rod held in a constant position.

E Revision E incorporates PSC comments on Revision D.

F Revision F incorporates NRC comments on Revision E.

G Revision G incorporates a revised definition of a fluctuation and increases the estimated time spent in a fluctuating mode. These revisions are based on experience gained from RT-500F testing at 40% and 50% power.

H H Revision H provides for fluctuation testing with the Region Constraint Devices (RCD's) installed.

D H D D ANTICIPATED RESULTS/ACCEPTANCE CRITERIA - The test will provide data to aid in predicting conditions for stable operation. Additionally, the test will demonstrate the effect of RCD's on fluctuations, and data will be obtained which will aid in understanding the fluctuation phenomenon and for comparison with previous cycle 2 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 R. Mirschl 12,20,79 TO PSC Operations Personnel
Name/Date

EVALUATION COMPLETED _____
Name/Date

REVIEWED BY _____
Name/Date

Distribution: K. Asmussen, W. Bushnell, E. Hill, A. Kennedy, F. Mathie, R. Phelps, Requestor, G. Bramblett, W. Franek, J. Lopez, R. Mirschl, W. Tersini, GA-SD Ref. Library

This SAR is in Support of RT-500H and is enclosed as Page 2 of 19 of that RT even though the SAR is a separate Uncontrolled Document.

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

1. INITIATING DOCUMENT: RT-500 Revision H

		YES	NO		
2.	CATEGORY: PLANT CHANGE	☐	☒	DOCUMENT CHANGE ONLY	☐
	CLASS I	☐	☒	MAINTENANCE	☐
	SAFE SHUTDOWN COOLING	☐	☒		
3.	FAILURE MODES AFFECTED	☐	☒	TEST	☒
4.	SAFETY RELATED COMPONENT, SYSTEM OR STRUCTURE CHANGE	☐	☒	STATE IN ITEM 10 THE BASIS FOR THE BOXES CHECKED	
5.	SAFETY SIGNIFICANT CHANGE	☐	☒		
6.	UNREVIEWED SAFETY QUESTION	☐	☒		
7.	TECH SPECIFICATION CHANGE	☐	☒		
8.	FSAR CHANGE	☐	☒		

9. APPLICABLE FSAR OR TECH SPEC SECTIONS REVIEWED: 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 influence of Region Constraint Devices on 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 ☒

12. HAS SAN DIEGO SAFETY ANALYSIS/LICENSING REVIEW BEEN PERFORMED? YES ☒ NO ☐

13. Keith Asmussen 12/17/79 — INITIATOR/DATE
A. J. Lennoy 12/17/79 — LICENSING/DATE

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

ENG'R/DATE R. J. Brickl 12,18,79

FORM: SAR 4/77

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 H from 30% to 68%. A total of 65 hours was spent in a fluctuating mode in H Cycle 1 and another 41 hours in Cycle 2. This is equivalent to about 640 H Cycles with an average period of about 10 minutes.

Although the cause of the fluctuations is not known, there are several reasons for concluding that continued testing is safe. The total core power, C 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 and D there was no evidence of damage. An in-core inspection of region 35 and its D surroundings with the fuel handling machine T.V. camera revealed no damage D or excessive wear to any component. The upper plenum area looked fine; the D gaps in the regions and side reflector surrounding the cavity left when D region 35 was unloaded were very regular with no evidence of wear or damage. D An inspection of the core support blocks in regions 13 & 35 have likewise D revealed no damage.

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

H Fluctuations have been initiated and observed on seven (7) occasions H during Cycle 2 at power levels between 38% and 63%. Four (4) of these were H initiated by power increases and three (3) commenced during orifice valve H adjustments. The data from the in pile test program has demonstrated that H while the fluctuations encountered during Cycle 2 appear to be somewhat more H regular and widespread throughout the core, it is basically the same phenom- H enon experienced during Cycle 1.

H Eighty-four Region Constraint Devices were added to the top layer of H hexagonal elements (keyed plenum elements) during the October and November H outage. These mechanical links are placed at locations in the core where H 3 regions intersect and will provide inter-region keying and preclude the H accumulation of large sized gaps which might result if several regions are H displaced in the same direction. These have been installed to provide a H permanent solution to the core temperature fluctuations that have previously H occurred.

H The installation of the Region Constraint devices is expected to have no
H impact on the nuclear design or projected nuclear performance of the core.

D Testing Above 70% Power (Part 2)

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

D Differences in fluctuation magnitudes and character have been observed
D in the fluctuations that were initiated during Cycle 1 and Cycle 2 operation.
D These differences have been carefully studied and reported extensively. No
D apparent correlation with power level has been noted, nor has a change been
D observed with time that would indicate increasing fluctuation magnitudes or
D significant differences in character. All of the fluctuation testing limits
D and operating considerations as well as normal plant technical specification
D limits and SOPs are in effect both below 70% power and above 70% power. One
D exception is the limit on nuclear detector fluctuations. This limit is in-
D creased from 10% at <70% power to 20% for >70% power. This increase is just-
D ified because nuclear channel fluctuations are believed to be due primarily
D to a streaming effect and are thus expected to be nearly proportional to the
D power (neutron flux) level. In this test, fluctuations will be initiated at
D successively higher power levels. The magnitude and character of the fluc-
D tuations at each power level will be carefully observed for differences in
D addition to monitoring the Technical Specification and fluctuation testing
D limits. Consequently, testing above 70% power will not affect public safety.

Time Spent Fluctuating

H It is anticipated that no additional temperature fluctuations will be
H encountered with the RCD's installed. The purpose of this test is to demon-
H strate that fact or to determine what impact their installation has on the
H fluctuation threshold. In the event that fluctuations are again observed,
H it is anticipated that operation in the fluctuating mode would be limited to
H about 15 hours for completion of part 1 (< 70% power) and another 10 hours
H for part 2 (70% to 100% power). This is based on previous test operating
H experience. It assumes that fluctuations are initiated from 2 to 4 times at
H 3 power levels or core configurations during part 1 and another 2 power levels
H or core configurations during part 2.

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.

Revision G incorporates a revised definition of a flucutation and increases the estimated time spent in a fluctuation mode. These revisions are based on experience gained from RT-500F testing at 40% and 50% power. The increased time is the result of approximately 15 hours spent in a fluctuation mode during completion of the first half of RT-500F.

Revision H provides procedures for fluctuation threshold testing up to 100% reactor power after installation of the RCDs. In essence the test is a continuation of that previously performed in Cycle 2. After establishing the core configuration for which fluctuations were initiated at the lowest power level during previous Cycle 2 operation, an attempt will be made to initiate fluctuations by a power level increase. The power level will be increased incrementally up to 70% and if no fluctuations are encountered, the power level will be reduced to 40%, and the core Δp increased by adjusting the orifice valve opening. This will be repeated until a stable power operation at a power level of 70% with a core Δp of about 4.5 is achieved or a fluctuation threshold established. Part 2 would be a continuation of this operation up to 100% power. Other than the method for determining system operating lines, the conditions and controls of this test are the same as those for the previous RT-500G. Test prerequisites, administrative controls, system and operating limits, and reporting requirements are all unchanged.

INTRODUCTION

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

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

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

The test scope includes attempts to induce fluctuations for at least three D valves 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)
D 3. Test Coordinator
D 4. Core Performance Engineer
D 5. Data Systems Engineer

F The NRC will be provided, within one week, with a summary of test results for F each power level. Included with these results will be notification of any change F 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. C The HRH and MS temperature imbalance between each SG module and the average for the loop should not exceed 30°F (in steady state) C 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.

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 fluctuation: Regions 1, 2, 3, 4, 5, 6, 7, 9, 12, 17, 20, 33, 34, 35, 36, and 37. All of these regions must be kept at least 60°F, 80°F, 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.

NOTE: The margins per Figure 1 are based on Cycle 1 experience and have proven to be adequate for previous Cycle 2 testing.

4. The plant is defined to be in a fluctuation operating mode when individual nuclear channels exhibit cyclic deviations from the average power equal to or greater than 0.5% peak-to-peak of full power not exceeding a 30-minute period.

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

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

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

LIMITS DURING FLUCTUATION TESTING

Test Limits

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

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

   A temperature fluctuation of module main steam temperature about its mean of ±10° (20°F total amplitude) is acceptable with no specific time considerations.

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

A temperature fluctuation of module main steam temperature about its mean of ±30°F (60°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°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°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 ±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°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°F.

3. If inadvertent fluctuations are observed (see page 8 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

F 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 per normal
D procedures and per the Operating Considerations section of this RT.

Procedure

D 1. The objective of this test is to demonstrate that no fluctuations occur
H with RCD's installed or to develop a core pressure drop vs core flow rate
D (or power) stability threshold line. Thus it is desired to attempt to
D initiate fluctuations at three or more values of core flow rate. This
D will be done by orificing the core to different flow resistances. Depending
D on the core flow rate at which fluctuations are initiated in the first test,
D higher or lower values of core resistance may be selected. To generate a
D reasonably good stability threshold line it is desired to initiate fluctu-
D ations at 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 be completed.

D 2. The most effective means of halting fluctuations is by power reduction. Experience has shown that to halt a fluctuation the power may have to be reduced by 5% to 10% below the power level which produced the fluctuation.

D 3. Wait at least 1/2 hour to reach thermal equilibrium prior
D to performing any fluctuation test, wait 2 hours after
D attempting to initiate a fluctuation by a load increase
D before continuing, wait 1 hour after attempting to initiate
D a fluctuation by a pulse change in circulator speed before
D continuing.

H 2. For the first test configuration, adjust the core orifices in a series of
H steps to obtain an average core pressure drop of about 1.7 psi with a core
H resistance of about 46. Core resistance corresponding to this core pressure
D 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 proceeding.

D 3. Begin a series of power rises by increasing turbine load at 3% per minute
D in incremental load changes of 3% (~9 MWe). Continue the incremental load
D increases until fluctuations develop or a plant limit is reached. Prior to
D each incremental load increase, adjust orifices as necessary to balance
D region outlet gas temperatures and module inlet gas temperatures. In
D addition, adjust the reg-rod position according to normal operations practice.
H If 70% power is reached and no fluctuations have been encountered, reduce
H the power to 40% and begin a series of orifice adjustments to increase the
H core Δp to about 2.2 psi. The orifices will be closed incrementally so that
H approximately the same regional core flow distribution is maintained. Verify
H that the region outlet gas temperatures have adequate margin from LCO4.1.7
H per Figure 1 and that the steam generator module temperatures are within the
H operating limits. Begin another series of power increases by increasing the
H turbine load at 3% per minute in increments of about 3%. Continue these
H power increases until a power level of 70% is achieved or fluctuations are
H encountered.
H Repeat the above procedure until a stable operation at 70% power is
H achieved with a core Δp of about 4.5 psi.

D 4. If 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 to
F obtain FM data for an additional 1/2 hour, with the reg-rod dis-
E abled 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.

G For one of the fluctuations described in Step 4B, it is desirable to
G obtain FM data for an additional 1/2 hour with the steam generator module
G trim valves in manual control -- (in a fixed position). During this
G fluctuation period, the operating limits stated in this RT must be ad-
G hered to. At the end of this 1/2 hour the trim valves will be returned
G to automatic control.

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

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.

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).

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.

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:

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

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

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

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

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:

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

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 RCD's 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.

D 2. The most effective means of halting a fluctuation is by
D power reduction. Experience has shown that to halt a
D fluctuation the power may have to be reduced to 5% to 10%
D below the power level which produced the fluctuation.
D 3. Each time a fluctuation is initiated, Data Sheet 1 must
D be completed.
D 4. 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 at least 10% below the threshold
D ΔP determined in Part 1 for 70% power. The core resistance corresponding
D to this core pressure drop and core flow rate may be calculated by the
D equation given in Part 1 procedure step 2.

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

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

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

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

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

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

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

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

D The Core Performance Engineer will coordinate which particular fluc-
D tuations will be monitored per item 8 above.

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

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

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

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

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

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

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

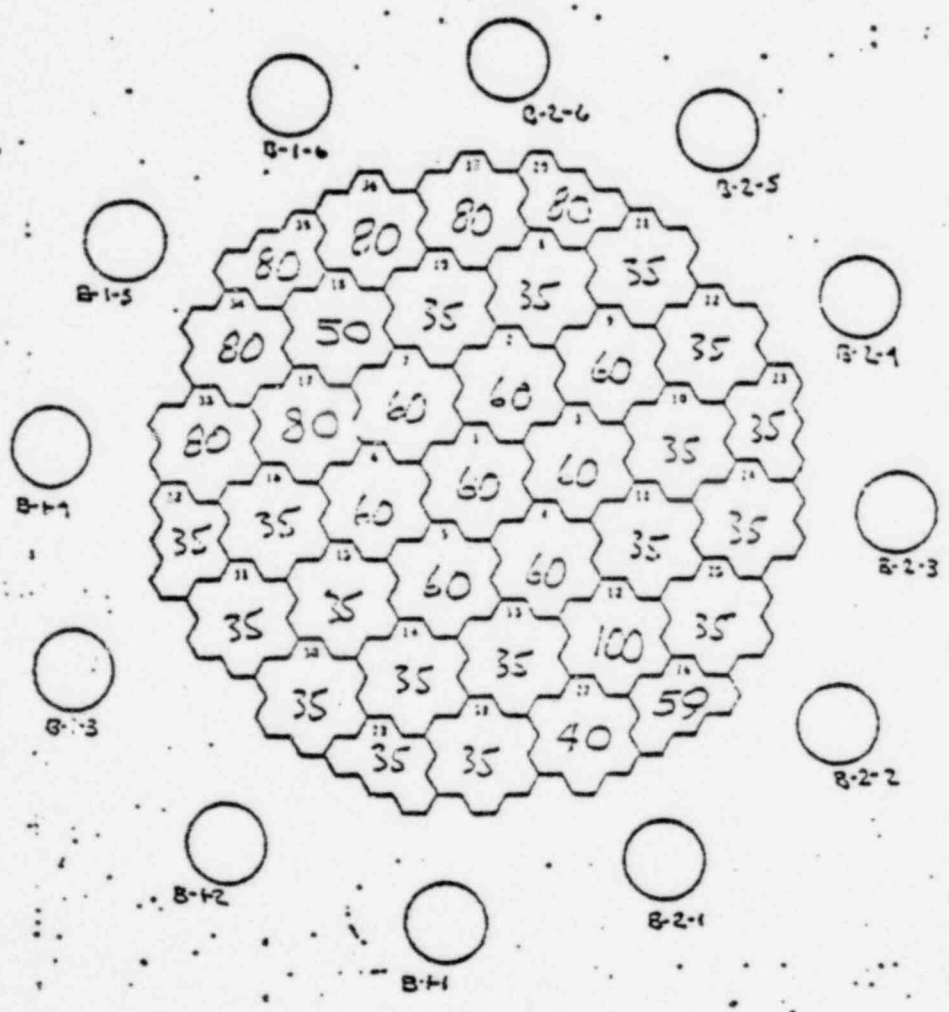

FIG. 1. REQUIRED MARGIN ON ALLOWABLE MISMATCH (LCO. 4.1.7 LIMIT - TOLT)

(new figure in Revision B)

ATTACHMENT I

REG-ROD INFLUENCE TEST

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