ENCLOSURE

SAFETY EVALUATION REPORT N-1 LOOP OPERATION

BRUNSWICK STEAM ELECTRIC PLANT (BSEP) UNIT NOS. 1 & 2

1.0 INTRODUCTION

The current BSEP Technical Specifications do not allow plant operation beyond 24 hours if an idle recirculation loop can not be returned to service. The ability to operate at reduced power with a single loop is highly desirable from availability/outage planning standpoint in the event that maintenance or component unavailability rendered one loop inoperable.

By letter dated June 3, 1982 Carolina Power & Light Company (CP&L) (the licensee) requested changes to the Technical Specification for Single Loop Operation of BSEP. The requested changes would permit BSEP to operate at up to 50% of rated power with one recirculation loop out of service for unlimited time. While analyses indicate that it may be safe to operate BWRs on a single loop in the range higher than 50% of rated power, the experience (reference letter from L. M. Mills, TVA dated March 17, 1980 to H. Denton, NRC) at Browns Ferry Unit 1 has caused concern about flow and power oscillations. However, because single loop operation at 50% rated power at several plants, including Browns Ferry Plant Unit 1, has shown acceptable flow and power characteristics, we will permit CP&L to operate at power levels up to 50% of rated with one loop out of service during Cycles 3 and 5 for Units 1 and 2 respectively.

If requested, we will reconsider operation at a higher power level for BSEP with one recirculation loop out of service after staff concerns stemming from Browns Ferry - Unit 1 single loop operation are satisfied.

2 EVALUATION

2.1 Accidents (Other than Loss of Coolant Accident (LOCA) and Transients Affected by One Recirculation Loop Out of Service

2.1.1 One Pump Seizure Accident

The licensee states that the one-pump seizure accident is a relatively mild event during two recirculation pump operation. Similar analyses were performed to determine the impact this accident would have on one recirculation pump operation. These analyses were performed using NRC approved models for a large core BWR/4 plant. The analyses were conducted from steady-state operation at the following initial conditions, with the added condition of one inactive recirculation loop. Two sets of initial conditions were assumed:

a. Thermal Power = 75% and core flow = 58% of rated

b. Thermal Power = 82% and core flow = 56% of rated

These conditions were chosen because they represent reasonable upper limits of single-loop operation within existing Maximum Average Linear Heat Generation Rate (MALHGR) and Minimum Critical Power Ratio (MCPR) limits at the same maximum pump speed.

Pump seizure was simulated by setting the single operation pump speed to zero instantaneously.

The anticipated sequence of events following a recirculation pump seizure which occurs during plant operation with the alternate recirculation loop out of service is as follows:

a. The recirculation loop flow in the loop in which the pump seizure occurs drops instantaneously to zero.

b. Core void increase which results in a negative reactivity insertion and sharp decrease in neutron flux.

c. Heat flux drops more slowly because of the fuel time constant.

d. Neutron flux, heat flux, reactor water level, steam flow, and feedwater flow all exhibit transient behaviors. However, it is not anticipated that the increase in water level will cause a turbine trip and result in scram.

It is expected that the transient will terminate at a condition of natural circulation and reactor operation will continue. There will also be a small decrease in system pressure.

The licensee concludes that the MCPR for the pump seizure accident for the large core BWR/4 plant was determined to be greater than the fuel cladding integrity safety limit; therefore, no fuel failures were postulated to occur as a result or this analyzed event. These results are applicable to BSEP.

2.1.2 Abnormal Transients

2.1.2.1 a. Idle Loop Startup

The idle loop startup transient was analyzed, in the BSEP FSAR, with an initial power of 65%. The licensee is to operate at no greater than 50% power with one loop out of service. Additionally, the Technical Specifications are being modified to require that, during single loop operation, the suction valve in the idle loop be shut and electrically disconnected. These measures are being taken to preclude startup of an idle loop.

b. Flow Increase

For single-loop operation, the rated condition steady-state MCPR limit is increased by 0.01 to account for increased uncertainties in the core total flow and Traversing In-core Probe (TIP) readings. The MCPR will vary depending on flow conditions. This leads to the possibility of a large inadvertent flow increase which could cause the MCPR to decrease below the Safety Limit for a low inital MCPR at reduced flow conditions. Therefore, the required MCPR must be increased at reduced core flow by a flow factor K_f. The K_f factors are derived assuming both recirculation loop pumps increase speed to the maximum permitted by the scoop tube position set screws. This condition maximizes the power increase and hence maximum ΔMCPR for transients initiated from less than rated conditions. When operating on one loop the flow and power increase will be less than associated with two pumps increasing speed, therefore, the K_f factors derived from two-pump assumption are conservative for single loop operation.

c. Rod Withdrawal Error

The rod withdrawal error at rated power is given in the FSAR for the initial core and in cycle dependent reload supplemental submittals. These analyses are performed to demonstate that, even if the operator ignores all instrument indications and the alarm which could occur during the course of the transient, the rod block system will stop rod withdrawal at a minimum critical power ratio which is higher than the fuel cladding integrity safety limit. Correction of the rod block equation and lower initial power for single-loop operation assures that the MCPR safety limit is not violated.

One-pump operation results in backflow through 10 of the 20 jet pumps while flow is being supplied to the lower plenum from the active jet pumps. Because of this backflow through the inactive jet pumps the present rod-block equation and APRM settings must be modified. The licensee has modified the two-pump rod block equation and APRM settings that exists in the Technical Specification for one-pump operation and the staff has found them acceptable.

The staff finds that one loop transients and accidents other than LOCA, which is discussed below, are bounded by the two loop operation analysis and are therefore acceptable.

2.2 Loss of Coolant Accident (LOCA)

The licensee has contracted General Electric Co. (GE) to perform single loop operation analysis for BSEP LOCA. The licensee states that evaluation of these calculations (that are performed according to the procedure outlined in NEDO-20556-2, Rev. 1) indicates that a multiplier of 0.85 (Unit-1-8x8 fuel, 8x8R Fuel, P8x8R Fuel) and 0.84 (Unit-2-7x7, 8x8R, P8x8R), 0.85 (Unit-2-8x8 Fuel) (Ref: - NEDE 24344 September 1981) should be applied to the MAPLHGR limits for single loop operation of BSEP Units 1 and 2. We find the use of these MAPLHGR multipliers to be acceptable.

3. THERMAL HYDRAULICS

The licensee has confirmed that analysis uncertainties are independent of whether flow is provided by two loops or single loop. The only exceptions to this are core total flow and TIP reading. The effect of these uncertainties is an increase in the MCPR by .01, which is more than offset by the K_f factor required at low flows. The steady state operating MCPR with single-loop operation will be conservatively established by multiplying the K_f factor to the rated flow MCPR limit.

4. STABILITY ANALYSIS

As indicated in the applicant's submittal NEDO-24344, operating along e minimum forced recirculation line with one pump running at minimum speed is more stable than operating with both pumps operating at minimum speed.

The licensee will be required to operate in master manual to reduce the effects of instabilities due to controller feedback. The staff has accepted previous stability analyses results as evidence that the core can be operated safely while our generic evaluation of BWR stability characteristics and analysis methods continues. The previous stability analysis results include natural circulation conditions and thus bound the single loop operation. In addition, the decay ratios (0.74, 0.73) predicted for Units 1 and 2 for Cycle 3 and 5 of BSEP Units 1 and 2 respectively shows margin relative to Browns Ferry #1 (.83) which had the flow noise oscillations during SLO. We conclude that with appropriate limitations to recognize and avoid operating instabilities, that the reactor can be operated safely in the single loop mode. Our evaluation of the flow/power oscillations evidenced in Browns Ferry will continue and any pertinent conclusions resulting from this study will be applied to BSEP.

5. SUMMARY ON SINGLE LOOP OPERATION

1. Steady State Thermal Power Level will not exceed 50%

Operating at 50% power with appropriate TS changes was approved on a cycle basis for Pilgrim 1, Cooper Nuclear Station and Monticello Nuclear Generating Station (Safety Evalution Reports (SER) dated December 15, 1981, December 10, 1981 and September 10, 1982 respectively). Authorization for single loop operation for extended periods was also given to

Dresden Unit 2 and 3, Quad Cities Units 1 and 2, Peach Bottom Units 2 and 3 and Duane Arnold (SER July 9, 1981, SER November 19, 1981). It was concluded that for operation at 50% power transient and accident bounds would not be exceeded for these plants.

2. Minimum Critical Power Ratio (MCPR) Safety Limit will be Increased by 0.01 to 1.08

The MCPR Safety Limit will be increased by 0.01 to account for increased uncertainties in core flow and Traversing Incore Probe (TIP) readings. The licensee has reported that this increase in the MCPR Safety Limit was addressed in GE reports specifically for BSEP for one loop operation. On the basis of previous staff reviews for Pilgrim 1, Cooper, Duane Arnold, Monticello and Peach Bottom and our review of plant comparisons we find this analysis acceptable for BSEP.

3. Minimum Critical Power Ratio (MCPR) Limiting Condition for Operation (LCO) will be Increased by 0.01

The staff requires that the operating limit MCPR be increased by 0.01 and multiplied by the appropriate two loop K_f factors that are in the BSEP TS. This will preclude an inadvertent flow increase from causing the MCPR to drop below the safety limit MCPR. This was also approved by the staff for Peach Bottom 2 and 3.

4. The Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Limits will be Reduced by Appropriate Multipliers

The licensee proposed reducing the TS MAPLHGR by 0.85 (Unit-1- 8x8 Fuel, 8x8R Fuel, Px8x8R Fuel) and 0.84 (Unit-2 -7x7, 8x8R, Px8x8R), 0.85 (Unit-2 8x8 Fuel) for Single Loop Operation. These reductions were based on analyses by General Electric (GE) in reports NEDE 24011-P-A-1 and NEDO 24344. The Peach Bottom units were allowed to operate with their MAPLHGR values reduced by factors of 0.71, 0.83, and 0.81 for an unlimited period of time for the first three types of fuel listed above.

5. The APRM Scram and Rod Block Setpoints will be Reduced

The licensee proposed to modify the two loop APRM Scram, Rod Block and Rod Block Monitor (RBM) setpoints to account for back flow through half the jet pumps. The changes were based on plant specific analyses by GE. These setpoints equations will be changed in the BSEP TS. The above changes are similar to the Peach Bottom TS changes and are acceptable to the staff.

6. The Suction Valve in the Idle Loop is Closed and Electrically Isolated

The licensee will close the recirculation pump suction valve and remove power from the valve. In the event of a loss of coolant accident this would preclude partial loss of LPCI flow through the recirculation loop degrading the intended LPCI performance.

The removal of power also helps to preclude a start up of an idle loop transient.

7. The Equalizer Line between the Loops will be Isolated

The licensee will close appropriate valves in the cross-tie (equalizer) line between the loops. The previously discussed analysis assumed the two loops were isolated. Therefore, it is required that the cross-tie valve be closed.

8. The Recirculation Control will be in Manual Control

The staff requires that the licensee operate the recirculation system in the manual mode to eliminate the need for control system analyses and to reduce the effects of potential flow instabilities. This was also required of Peach Bottom.

9. Surveillance Requirements

The staff requires that the licensee perform daily surveillance on the jet pumps to ensure that the pressure drop for one jet pump in a loop does not vary from the mean of all jet pumps in that loop by more than 5%.

10. Provisions to Allow Operation with One Recirculation Loop Out of Service

1. The steady-state thermal power level will not exceed 50% of rated

2. The Minimum Critical Power Ratio (MCPR) Safety Limit will be increased by .01 to 1.08 (T.S. 3.11C)

3. The MCPR Limiting Condition for Operation (LCO) will be increased by 0.01

4. The Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) limits will be reduced.

Unit-1 (Ref: TS 3/4.2.1)

Fuel Type	Reduction Factor
8x8	0.85
8x8R	0.85
P8x8R	0.85

Unit-2 (Ref: TS 3/4.2.1

Fuel Type	Reduction Factor
7x7	0.84
8x8	0.85
8x8R	0.84
P8x8R	0.84

5. The APRM Scram and Rod Block Setpoints and the RBM Setpoints, shall be reduced to read as follows:

T.S. 3/4.2.2 $S \leq (.66W + 54\% - 0.66\ \Delta W)$

T.S. 3/4.2.2* $S \leq (.66W + 54\% - 0.66\ \Delta W)$TPF(FRP)/MTPF(MFLPD)

T.S. 3/4.2.2 $S \leq (.66W + 42\% - .66\ \Delta W)$

T.S. 3/4.2.2* $S \leq (.65W + 42\% - 0.65\ \Delta W)$TPF(FRP)/MTPF(MFLPD)

APRM Upscale $(.66 + 42\% - 0.66\ \Delta W)$

RBM Upscale $(.66W + 41\% - 0.56\ \Delta W)$

*In the event that MFLPD exceeds FRP.

6. The suction valve in the idle loop is closed and electrically isolated until the idle loop is being prepared for return to service.
7. APRM flux noise will be measured once per shift and the recirculation pump speed will be reduced if the flux noise exceeds 5% peak to peak.
8. The core plate delta pressure noise be measured once per shift and the recirculation pump speed will be reduced if the noise exceeds 1 psi peak to peak.

Therefore, based upon the above evaluation and a history of successful operation of other BWRs of the same type as BSEP we conclude that single-loop operation of BSEP up to a power level of 50% and in accordance with the proposed TSs, will not exceed the accident and transient bounds previously found acceptable by the NRC staff and is therefore acceptable.

The approval for single loop operation up to a power level of 50% is authorized during cycle 3 for BSEP Unit #1 and Cycle 5 BSEP Unit #2.

We have concluded, based on the considerations discussed above, that: (1) because the amendment does not involve a significant increase in the probability or consequences of accidents previously considered or create the possibility of an accident of a type different from any evaluated previously, and does not involve a significant decrease in a safety margin, the amendment does not involve a significant hazards consideration, (2) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (3) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

400 Chestnut Street Tower II

April 14, 1983

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Denton:

In the Matter of the	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

At the request of your staff, we met with Oak Ridge National Laboratory (ORNL) on February 11, 1983 to discuss concerns regarding operation with a single recirculation loop at Browns Ferry Nuclear Plant. During that meeting we answered questions and provided ORNL with considerable data on past Browns Ferry experience in single loop. Enclosed is additional information and clarification regarding our previous submittals on single loop.

We are still very much interested in obtaining NRC approval of single loop operation at the highest power level attainable. However, we understanding that single loop operation at power levels up to 50 percent may be the only possible option available to us at this time. We want to avoid the need for emergency approval and are willing to work closely with NRC and contractors to resolve any remaining questions and concerns on this issue as expeditiously as possible.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Licensing

Subscribed and sworn to before
me this 14th day of April 1983.

Paulette H. White

Notary Public

My Commission Expires 9-5-84

A001

Enclosure
cc: See page 2

5pp.

Mr. Harold R. Denton April 14, 1983

cc (Enclosure):
U.S. Nuclear Regulatory Commission
Region II
ATTN: James P. O'Reilly, Regional Administrator
101 Marietta Street, Suite 2900
Atlanta, Georgia 30303

Mr. R. J. Clark
Browns Ferry Project Manager
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20814

ENCLOSURE

ADDITIONAL INFORMATION AND CLARIFICATION REGARDING
SINGLE RECIRCULATION LOOP OPERATION
BROWNS FERRY NUCLEAR PLANT
(Reference: TVA letter from L. M. Mills to
H. R. Denton dated January 6, 1983)

1. NRC requested that figure 3 of the referenced letter be clarified. Test data was recorded at various conditions as listed in the attached tables A-1 and A-2. The maximum peak to peak variation APRM signal was then determined from each recording and that point was plotted against the active loop flow for that condition. The figure also includes an operating map showing the region in which the tests were performed. It should be noted that active loop flow and total core flow are not directly proportional due to inactive loop backflow characteristics.

2. During the February 11, 1983 meeting between TVA and ORNL, it was pointed out to us that our response to question 1 of the referenced letter was incorrect.

   Paragraph 2 of that response states that "the individual jet pump flow variations show no relationships to the power-void characteristics signal (i.e., flux) and their signals show no common oscillation driving them from the discharge end . . . jet pump noise observed . . . is not driven by power-void feedback." TVA agrees that this is not correct and, in fact, there will always be a component of jet pump variation though it may be small which is characteristic of power-void feedback and which is common to all jet pumps. We contend that because the individual jet pump flow signals bear no resemblance to the flux and total flow signals, the power-void effect on the jet pump signals is a minor component compared to the others which add together to comprise the total signal, and that the major components are not common to all jet pumps and not related to power-void feedback.

TABLE A-1

Test A Signals Recorded

Pump Speed - Percent				49	54	60	66	70	75	80	85
Core Flow - Percent				42	44.9	48.7	48.7	49.7	49.7	50.7	52.6
Power - Percent				51.6	53.4	55.2	57.3	59.4	59.4	61.1	62.8
Condition				A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8
Signal				Initial value at test condition							
No.	Title	Units	Scale Units/In.								
2	B Recirc Pump ΔP	PSId	10	50	60	75	90	100	115	132	150
3	Jet Pump 1-10 Flow	Millions lbs/hr	4	42.0	46.0	52.0	56.0	60.0	64.0	68.0	72.0
4	B Recirc Pump Speed	Percent	10	49	54	60	66	70	75	80	85
5	Jet Pump 1 Flow	Millions lbs/hr	1	4.0	4.0	4.3	5.9	5.5	5.8	5.8	6.0
6	Jet Pump 6 Flow	Millions lbs/hr	1	4.0	4.2	4.6	5.2	5.5	6.0	6.0	6.2
7	B Recirc Drive Flow *	Thousands GPM.	7	26	29	34	35	37	40	42	45
8	Total Feedwater Flow	Millions lbs/hr	2	6.8	6.8	7	7.1	7.6	7.6	7.9	8.2
9	Rx Press (NR)	PSIG	5	954	954	945	945	952	953	953	953
10	Core Plate ΔP	PSId	1	1.8	2.4	2.4	2.7	3.0	3.3	3.9	5.1
11	Jet Pump 11-20 Flow	Millions lbs/hr	4	DNSCL	DNSCL	2.0	10.0	12.0	15.0	17.0	19.0
13	Jet Pump 11 Flow	Millions lbs/hr	1	0	.2	.4	.8	.95	1.1	1.2	1.5
14	Jet Pump 16 Flow	Millions lbs/hr	1	.1	.6	.9	1.2	1.3	1.5	1.7	1.8
15	NR Water Level	Inches	5	34.0	34.0	34.0	33.5	33.5	33.5	33.5	34.0
16	LPRM 48-33B	Percent	10	28	28	29	30	32	32	33	38
17	LPRM 48-33A	Percent	10	27	27	26	27	25	25	25	25
18	LPRM 48-33C	Percent	10	28 +	28 +	29 **	30	30 **	31	31	36
19	LPRM 48-33D	Percent	10	16	15	15	16	17	18	19	20
20	APRMD	Percent	10	52.6	53.0	55.0	57.5	58.0	59.0	62.0	70.0

* Signal polarity reversed for all conditions + signal missing for these conditions

** Signal polarity reversed for these conditions

Table A-1: Scale and initial conditions for first set of recordings

TABLE A-2

Test B Signals REcorded

Pump Speed - Percent				50	70	85
Core Flow - Percent						
Power - Percent						
Condition				B-1	B-2	B-3
Signals				Initial Value at test condition		
No.	Title	Units	Scale Units/in			
2	B Recirc Pump ΔP	PSIG	10	50	100	150
3	Jet Pump 1-10 Flow	Millions lbs/hr	4	44	60	72
10	Core Plate ΔP	PSI d	1	1.9	3.0	4.2
19	APRM	Percent	10	56	63	67
20	Jet Pump Head	PSId	1	0	1.5	3.5
21	Jet Pump 7 ΔP	PSId	3	7.5	15.0	21.5*
22	Jet Pump 8 ΔP	PSId	3	8.0	16.0	24 *
23	Jet Pump 9 ΔP	PSId	3	9.0	16.5	23 *
24	Jet Pump 10 ΔP	PSId	3	8.5	13.0	18 *

* Scale changed to 6 psid per inch for condition B-3

Table A-2: Scale and initial conditions for second set of recordings