ENCLOSURE

SAFETY EVALUATION REPORT N-1 LOOP OPERATION

COOPER NUCLEAR STATION (CNS)

1.0 INTRODUCTION

The current CNS Technical Specifications do not allow plant operation beyond 24 hours if an idle recirculation loop cannot 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 renders one loop inoperable.

By letter dated August 5, 1980, Nebraska Public Power District (the licensee) requested changes to the Technical Specification for Single Loop Operation of CNS. The licensee submitted additional information in letter dated April 24, 1981. The requested changes would permit CNS to operate at up to 72% 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 of 72% of rated power, the experience (reference letter from L. M. Mills, TVA dated March 17, 1980 to H. Denton, NRC) at Browns Berry 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, has shown to result in acceptable flow and power characteristics, we will permit the CNS to operate at power levels up to 50% of rated with one loop out of service during Cycle 7.

If requested, we will reconsider operation up to 72% of rated power for CNS 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 Planar Linear Heat Generation Rate (MAPLHGR) and Minimum Critical Power Ratio (MCPR) limits at the same maximum pump speed. Pump seizure was simulated by setting the single operating 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 voids increase which result in a negative reactivity insertion and a 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 of this analyzed event. These results are applicable to CNS.

2.1.2 Abnormal Transients

2.1.2.1 a. Idle Loop Startup

The idle loop startup transient was analyzed, in the CNS FSAR, with an initial power of 60%. 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 initial 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 the 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 the 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 demonstrate that, even if the operator ignores all instrument indications and the alarm which could occur during the course of the transients, 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 exist 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 CNS LOCA. The licensee states that evaluation of these calculations (that are performed according to the procedure outlined in NEDO-20566-2, Rev. 1) indicates that a multiplier of 0.84 (7x7 fuel), 0.86 (8x8 fuel), 0.77 (8x8R fuel) (Ref: - NEDE 24258 May 1980) and 0.77 (P8x8R) should be applied to the MAPLHGR

limits for single loop operation of the CNS.

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-24258, operating along with the minimum forced recirculation line with one pump running at minimum speed is more stable than operating with natural circulation flow only, but is less 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. 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 conclusions resulting from this study will be applied to CNS.

5. SUMMARY ON SINGLE LOOP OPERATION

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

Operating at 50% power with appropriate T-S changes was approved on a long term basis for the Duane Arnold Plant and Peach Bottom Units 2 and 3 (Safety Evaluation Reports (SER) dated November 19, 1981 and May 15, 1981 respectively). Authorization for single loop operation for extended periods was also given to Dresden Unit 2 and 3 and Quad Cities Units 1 and 2 (SER July 9, 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 IncoreProbe (TIP) readings. The licensee has reported that this increase in the MCPR Safety Limit was addressed in GE reports specifically for CNS for one loop operation. On the basis of previous staff reviews for Duane Arnold and Peach Bottom and on our review of plant comparisons we find this analysis acceptable for CNS.

3. Minimum Critical Power Ratio (MCPR) Limiting Condition for Operation (LCO) will be Increased by 0.01 to 1.24, 1.25, 1.25 and 1.25 for 7x7, 8x8, 8x8R, P8x8R Fuel Respectively

The staff require that the operating limit MCPR be increased by 0.01 and multiplied by the appropriate two loop K_f factors that are in the CNS T-S. 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 T-S MAPLHGR by 0.84 (7x7 fuel); 0.86 (8x8 fuel); 0.77 (8x8R) and 0.77 (P8x8R) for single loop operation. These reductions were based

on analyses by General Electric (GE) in report NEDE 24011-P-A-1 and NEDO 24258. 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 and RBM 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 CNS T-S. The above changes are similar to the Peach Bottom T-S 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 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.

8. 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%.

9. 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. 1.1A)
3. The MCPR Limiting Condition for Operation (LCO) will be increased by 0.01 to 1.24, 1.25, 1.25 and 1.25 for 7x7 and 8x8, 8x8R, P8x8R fuel respectively (T.S.)
4. The Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) limits will be reduced by multiplying 0.84, 0.86, 0.77, and 0.77 for 7x7, 8x8, 8x8R, P8x8R fuel respectively (T.S. reference 3-12-1)
5. The APRM Scram and Rod Block Setpoints and the RBM Setpoints, shall be reduced to read as follows:

T.S. 2.1.A.1	S _ (.66W + 54% -0.66 ΔW)
T.S. 2.1.A.1*	S _ (.66W + 54%- 0.66 ΔW) FRP/MFLPD
T.S. 2.1.A.3	S _ (.66W + 42%-.66 ΔW)
T.S. 2.1.A.3*	S _ (.66W + 42%- 0.66 ΔW) FRP/MFLPD
T.S. 3.2.C.	

APRM Upscale _(.66W +42%- 0.66 ΔW) FRP/MFLPD

RBM Upscale _ .66W + 41%

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-percent peak to peak.
8. The core plate delta 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 CNS we conclude that single-loop operation of CNS, up to a power level of 50% and in accordance with the proposed TSs, will not

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* In the event that MFLPD exceeds FRP.

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 7 only.

B. SIEGEL

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JAN 24 1982

MEMORANDUM FOR: Themis P. Speis, Assistant Director for Reactor Safety, DSI

FROM: Gerald Mazetis, Acting Chief, Reactor Systems Branch, DSI

SUBJECT: BWR SINGLE LOOP OPERATION - STATUS REPORT

Under multiplant action Item E-04, there are 11 plants which involve single loop operation (SLO) the status of each plant is given below.

Plant Name	SER Issued for 50% Operation	Licensing Amendment Issued
1. Dresden-2	July 9, 1981	Yes
171 2. Dresden-3	July 9, 1981	Yes
177 3. Quad Cities-1	July 9, 1981	Yes
177 4. Quad Cities-2	July 9, 1981	Yes
237 5. Peach Bottom-1	May 15, 1981	Yes
249 6. Peach Bottom-2	May 15, 1981	Yes
7. Duane Arnold	November 19, 1981	No
254 8. Cooper	December 10, 1981	No
265 9. Pilgrim-1	December 15, 1981	No
10. Brunswick-2	Waiting For Additional Information from the Licensee	
293 298		
11. Brunswick-1	Licensee Has Not Requested For SLO at 50%	
324		

325 Duane Arnold initially requested for 82% of rated power operation with SLO. Since we are allowing operation only up to 50% with SLO, Duane Arnold came 331 with a new request as suggested by PM for 50% on December 18, 1981. Licensing amendment is expected to be issued for Duane Arnold this month.

Pilgrim-1 and Cooper also requested for 72% of rated power operation with SLO.

Since we are permitting only 50% of rated power operation with SLO, project managers required the licensee to send new requests for 50% operation. Licensing amendments will be issued after the receipt of licensee's new requests.

Brunswick-2 SER can be issued only after we get the additional information we requested on October 9, 1981. We already contacted CP&L for the additional information. We expect to get the information soon. CP&L is expected to apply for Brunswick-1 SLO in 1982. We will act on the request as and when received.

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As a follow up to the Browns Ferry-1 meeting with GE on SLO, questions were forwarded to T. Novak by memo dated January 15, 1982 from T. Speis for sending to GE and the utility group.

Gerald Mazetis, Acting Chief
Reactor Systems Branch
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