



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

NOV 10 1976

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MEMORANDUM FOR: A. Schwencer, Chief, Operating Reactors Branch-1, DOR
D. Ziemann, Chief, Operating Reactors Branch-2, DOR

FROM: R. Baer, Chief, Reactor Safety Branch, DOR

SUBJECT: REVIEW OF SINGLE LOOP OPERATION IN BWR'S

There are four current technical assistance requests dealing with the review of the acceptability of operation of BWR's with a recirculation loop. The requests and the plants are:

<u>TACS Number</u>	<u>Plant</u>
None	Pilgrim-1 293
6170	Brunswick-2 324
6190	Monticello 263
6184	Dresden 2/3 and 237, 249
	Quad Cities 1/2 254, 265

This memorandum is being written to discuss the status of these reviews.

Each of these reviews consists of several major aspects; namely, ECCS performance, normal operation, and transients. The Analysis Branch (AB) of DSS is reviewing the ECCS model and the Reactor Safety Branch (RS) of DOR is reviewing the plant specific aspects for both normal operation and ECCS performance.

The approach agreed upon by the General Electric Company, AB and RS was as follows:

- (1) General Electric would submit a topical report documenting the ECCS model used for single loop BWR operation.
- (2) The Reactor Safety Branch would review the information submitted on Pilgrim 1 and request any additional information required regarding methods of calculations for normal operation and transients.
- (3) General Electric would update the Pilgrim 1 docket to reflect item (2).
- (4) The Pilgrim 1 docket would be referenced for future submittals, and responses to questions on non-ECCS calculational methods for plants under current review would also reference the Pilgrim 1 docket.

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UNITED STATES
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2-10

NOV 14 1979

MEMORANDUM FOR: T. Ippolito, Chief, Operating Reactors Branch #3, DOR
FROM: G. Lainas, Chief, Plant Systems Branch, DOR
SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNIT 2 - SAFETY
EVALUATION FOR N-1 LOOP OPERATION

In response to technical assistance request, TAC 6171, enclosed is the Plant Systems Branch Safety Evaluation Report for single loop operation of Brunswick Unit 2. We find the proposed modifications to the plant for single loop operation as described in Carolina Power and Light Company's submittal to be acceptable.

G. Lainas, Chief
Plant Systems Branch
Division of Operating Reactors

Enclosure:
Safety Evaluation
Report

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SAFETY EVALUATION REPORT
N-1 LOOP OPERATION
BRUNSWICK STEAM ELECTRIC PLANT
UNIT 2

I. INTRODUCTION

By Letter to the U.S. Nuclear Regulatory Commission (NRC) dated September 3, 1976, the Carolina Power and Light Company (CP&L) submitted information to support its proposed license amendment to operate the Brunswick Steam Electric Plant, Unit 2, with one recirculation loop out of service (i.e., single-loop operation). This information represented the licensee's analysis of significant events, based on a review of accidents and abnormal operational transients associated with power operations in the single-loop mode and provided by the nuclear steam supply steam designer (General Electric Company, Nuclear Energy Division (GE-NED)). Conservative assumptions were employed in the GE-NED Report NEDO-21281, dated May 1976, to ensure that its generic analyses for boiling water reactors (BWR) 3/4 were applicable to the Brunswick Steam Electric Plant, Unit 2. GE-NED submitted an additional report (NEDO-20566-2, dated July 1978) of an analytical model for a Loss-of-Coolant Accident (LOCA) with one recirculation loop out-of-service which is presently under review by the NRC Reactor Safety Branch (RSB).

The purpose of this report is to evaluate the Electrical, Instrumentation, and Control (EI&C) design aspects of the proposed license amendment as presented in NEDO-21281 using the following criteria: IEEE Std-279-1979; the Code of Federal Regulations Title 10, Part 50.46; and Title 10, Part 50, Appendix A and Appendix K.

II. EVALUATION

The enclosed technical evaluation was prepared for us by Lawrence Livermore Laboratory/EG&G as part of our technical assistance program.

III. CONCLUSION

The consultant has reviewed Carolina Power and Light Company's submittal for license amendment for single-loop operation of the Brunswick Steam Electric Plant, Unit 2, and concluded that the modifications satisfy the IEEE Std-279-1971 criteria and are acceptable. The submittal was based on the analysis in NEDO-21281 performed by the nuclear steam supply system manufacturer (GE-NED). The manufacturer had, however, not analyzed the performance of the Emergency Core Cooling System (ECCS) during single-loop operating conditions.

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A new analysis has been performed by GE-NED for a LOCA with one recirculation loop out-of-service. This analysis, reported in NEDO 20566-2, includes the ECCS single-loop analysis and was provided to satisfy the Code of Federal Regulations, Title 10, Part 50, Appendix K.

The consultant also concluded that if an additional review of the EI&C design aspects is required as part of the staff's review of NEDO-20566-2, the licensee will be required to update its submittal based on that new analysis. Such a review, if required, will be presented as a supplement to the consultant's technical evaluation.

Based on our review of consultant's technical evaluation, we conclude that conceptual design as presented in the licensee submittal and reviewed in the consultant's technical evaluation is acceptable. However, the licensee's submittal did not include a design of hard-wire modifications (see Section 2.2 of attached technical evaluation) to the reactor protection system that will enable the operator to make setpoint changes from the front of the nuclear instrument cabinet. It is, therefore, concluded that before operation in the single-loop mode can be implemented at Brunswick, Unit 2, the licensee must accomplish the aforementioned modifications to the reactor protection system in a manner that satisfies IEEE Stds. 279-1971, 323-1971, and 344-1975.

TECHNICAL EVALUATION OF THE
ELECTRICAL, INSTRUMENTATION, AND CONTROL DESIGN ASPECTS
OF
THE PROPOSED LICENSE AMENDMENT FOR SINGLE-LOOP OPERATION
OF
THE BRUNSWICK STEAM ELECTRIC PLANT, UNIT 2

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TECHNICAL EVALUATION OF THE
ELECTRICAL, INSTRUMENTATION, AND CONTROL DESIGN ASPECTS
OF
THE PROPOSED LICENSE AMENDMENT FOR SINGLE-LOOP OPERATION
OF
THE BRUNSWICK STEAM ELECTRIC PLANT, UNIT 2

(Docket No. 50-324)

James H. Cooper
EG&G, Inc., Energy Measurements Group, San Ramon Operations

1. INTRODUCTION

By letter¹ to the U. S. Nuclear Regulatory Commission (NRC) dated September 3, 1976, the Carolina Power & Light Company (CP&L) submitted information to support its proposed license amendment to operate the Brunswick steam electric plant, Unit 2, with one recirculation loop out of service (i. e., single-loop operation). This information represented the licensee's analysis of significant events, based on a review of accidents and abnormal operational transients associated with power operations in the single-loop mode and provided by the nuclear steam supply system designer (General Electric Company, Nuclear Energy Division (GE-NED)). Conservative assumptions were employed in the GE-NED Report NEDO-21281,² dated May 1976, to ensure that its generic analyses for boiling water reactors (BWR) 3/4 were applicable to the Brunswick steam electric plant, Unit 2. GE-NED submitted an additional report (NEDO-20566-2,³ dated July 1978) of an analytical model for a loss-of-coolant accident (LOCA) with one recirculation loop out-of-service which is presently under review by the NRC Reactor Safety Branch (RSB).

The purpose of this report is to evaluate the electrical, instrumentation, and control (EI&C) design aspects of the proposed license amendment as presented in NEDO-21281² and using IEEE Std-279-1971⁴ criteria and the Code of Federal Regulations, Title 10, Part 50.46,⁵ and Title 10, Part 50, Appendix A⁶ and Appendix K⁷ criteria.

2. DESCRIPTION AND EVALUATION OF THE PROPOSED LICENSE
AMENDMENT FOR SINGLE-LOOP OPERATION

2.1 DESCRIPTION OF THE PROPOSED CHANGES

The licensee states that from its analysis of NEDO-21281² the only changes necessary to the reactor protection system (RPS) for single-loop operation, are:

- (1) Modifications to the rod-block setpoints of the rod-block monitor (RBM) system.
- (2) Modifications to the SCRAM trip settings of the average power range monitor (APRM) system.
- (3) Reduction of 0.82 in the maximum average planar linear heat generation rate (MAPHLGR) limit for the fuel.

Because of the different flow quantity and different flow path during single-loop operation, the APRM SCRAM trip settings, which are flow-biased according to the equation in the technical specifications, require re-setting to protect the reactor from overpower. The rod-block setpoint equation is flow-biased in the same way and with the same flow signal as the APRM setpoint, and must also be modified to provide adequate local core protection for the postulated rod withdrawal error.

The revised technical specifications propose single-loop operation at reduced safety settings for unlimited periods of time. The revised technical specifications also propose a limit of 24 hours in which to reduce the safety settings. Use of Section 3.4.1.1.a of the standard BWR technical specifications⁸ will be required. Section 3.4.1.1.a states that

"With one recirculation loop not in operation, (reactor) operation may continue; restore both loops to operation within 12 hours or be in at least hot shutdown within the next 12 hours."

The numerical values of the new settings are delineated in the revised technical specifications which accompany the licensee's submittal.¹

2.2 EVALUATION OF THE PROPOSED CHANGES

The temporary changes in the settings of the trip points for the APRM and RBM must be made in the power-range cabinets in the control room and so must be done with the reactor shut down (i. e., with the mode switch in shutdown or refuel, condition 3, 4, 5) as required by the NRC Branch Technical Position ICSB 12.⁹ These adjustments include readjusting the power and flow potentiometers in each of the six APRM channels and the two RBM channels. One channel of the multichannel systems will be adjusted at a time and then returned to service. Before all of the channels are returned to service, the new trip setpoints will be verified by the instrument engineer following the readjustment and testing of the setpoints by the instrument technician. Two operators will perform functional tests to double check the new setpoints and to check the instrument's return to an operable condition.

The sequence outlined above shall be written into the plant technical specifications. A permanent installation of the setpoint-change capability must be made in order for the system to satisfy the requirements of Section 4.15 of IEEE Std-279-1971.⁴ Hard-wire modifications will be required to enable making setpoint changes from the front panel of the power range cabinet by way of control switches. The licensee's proposed modifications must be submitted to the NRC staff for review prior to this installation.

The recirculation-loop equalizer valves must be verified closed and tagged for single-loop power operation, as is the case for two-loop power operation. The safety analysis in NEDO-21281² assumes that these valves remain closed as their effect on a LOCA has not been analyzed.

Recirculation flow must be manually controlled by the operator, as opposed to automatic control, whenever the system is operating in the single-loop mode, since control stability is improved in the manual mode. Manual control is assumed in NEDO-21281.² The technical specifications will be changed to include this restriction.

Due to the different flow pattern during single-loop operation as described by the licensee, a number of indications in the control room will change, such as individual jet-pump flow and total summed core flow. Some indications will be only slightly less accurate, but some others will be erroneous. The control room indications must be corrected prior to single-loop power operation or they must be tagged out-of-service, as appropriate. This is a requirement of Section 4.20 of IEEE Std-279-1971.⁴

The normal plant configuration as described in the final safety analysis report (FSAR)¹⁰ includes recirculation-pump start interlocks to prevent an inadvertent cold-water injection into the reactor. Any recirculation loop that is out-of-service and whose water has cooled must be run in the bypass mode to preheat the water to within 100⁰F of the reactor cooling water before the water may be valved back to the reactor pressure vessel. The recirculation pump start is interlocked to permit start-up only if the pump discharge valve is closed, the bypass valve is open, and the suction valve is open. This configuration will limit the amount of cold water which can be transported through the reactor vessel from a cold-loop startup, thereby limiting the effect of a cold-water slug event. Although interlocks are provided, no credit is taken for their safety function in NEDO-21281² for single-loop operation since this is not the limiting transient.

The instrument setpoints can be set down to enable operation in the single-loop mode for unrestricted periods. This mode of operation is desired by the licensee to facilitate more extensive unscheduled maintenance without the requirement of keeping the reactor shut down. It is stipulated that single-loop operation will not be a planned mode of operation.

The new rod-block and trip setpoints vary linearly as a function of recirculation flow rate. For power increases by rod withdrawal, the RBM rod block must be set to the next higher trip level by manual operator action. The APRM, flow-biased, SCRAM trip follows the new trip curve automatically for both power increases and decreases.

3. CONCLUSIONS

We conclude that the Carolina Power & Light Company's license amendment submittal for single-loop operation of the Brunswick steam electric plant, Unit 2, satisfies the IEEE Std-279-1971 criteria and is acceptable. The submittal was based on the analysis in NEDO-21281² performed by the nuclear steam supply system manufacturer (GE-NED). The manufacturer had, however, not analyzed the performance of the emergency core cooling system (ECCS) during single-loop operating conditions.

A new analysis has been performed by GE-NED for a LOCA with one recirculation loop out-of-service. This analysis, reported in NEDO 20566-2,³ includes the ECCS single-loop analysis and is in accordance with the Code of Federal Regulations, Title 10, Part 50, Appendix K.⁷

If an additional review of the EI&C design aspects is required as a result of NEDO-20566-2,³ the licensee will be required to update its submittal based on that new analysis. The review will then be presented as a supplement to this technical evaluation.

REFERENCES

1. CP&L Letter to NRC (B. Rusch), dated September 3, 1976.
2. General Electric Company, Nuclear Energy Division, Brunswick Steam Electric Plant Unit 2 License Amendment Submittal For Single-Loop Operation With the Bypass Flow Holes Plugged and With LPSI Modification, NEDO-21281 (May 1976).
3. General Electric Company, Nuclear Energy Division, An Analytical Model For Loss-of-Coolant Accident (LOCA) With One Recirculation Loop Out-Of-Service, NEDO-20566-2 (July 1978).
4. IEEE Std-279-1971: Criteria For Protection Systems For Nuclear Power Generating Stations (n. d.).
5. Code of Federal Regulations, Title 10, Part 50.46: Acceptance Criteria For Emergency Core Cooling Systems For Light Water Nuclear Power Reactors (January 1976).
6. Code of Federal Regulations, Title 10, Part 50, Appendix A: General Design Criteria For Nuclear Power Plants (January 1978).
7. Code of Federal Regulations, Title 10, Part 50, Appendix K: ECCS Evaluation Models (January 1, 1978).
8. General Electric Company, Standard Boiling Water Reactor Technical Specifications (n. d.).
9. NRC/RSB, Protection System Trip Point changes for Operation With Reactor Coolant Pump Out of Service, Branch Technical Position ICSB 12 (n. d.).
10. CP&L, Final Safety Analysis Report For Brunswick Steam Electric Plant (FSAR) (n. d.).