CP&L

Carolina Power & Light Company

Brunswick Nuclear Project
P. O. Box 10429
Southport, NC 28461-0429

November 14, 1989

FILE: B09-13510C
SERIAL: BSEP/89-1009

10CFR50.73

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT UNIT 1
DOCKET NO. 50-325
LICENSE NO. DPR-71
SUPPLEMENT TO LICENSEE EVENT REPORT 1-89-019

Gentlemen:

In accordance with Title 10 to the Code of Federal Regulations, the enclosed Supplemental Licensee Event Report is submitted. The original report, issued October 13, 1989, fulfilled the requirement for a written report within thirty (30) days of a reportable occurrence and was submitted in accordance with the format set forth in NUREG-1022, September 1983.

Very truly yours,

J. L. Harness

J. L. Harness, General Manager
Brunswick Nuclear Project

TH/mcg

Enclosure

cc: Mr. S. D. Ebneter
Mr. E. G. Tourigny
BSEP NRC Resident Office

IE28
1/1

NRC Form 366 (9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO 3150-0104
EXPIRES 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Brunswick Steam Electric Plant Unit 1	0 5 0 0 0 3 2 5	1 OF 1 0

TITLE (4) Failure of the Service Water System to Meet Design Requirements

EVENT DATE (5) Month	Day	Year	LER NUMBER (6) Year	Sequential Number	Revision Number	REPORT DATE (7) Month	Day	Year	OTHER FACILITIES INVOLVED (8) Facility Names	Docket Number(s)
0 9	1 4	8 9	8 9	— 0 1 9 —	0 1	1 1	1 4	8 9	BSEP Unit 2	0 5 0 0 0 3 2 4
										0 5 0 0 0

OPERATING MODE (9): 1

POWER LEVEL (10): 1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	X OTHER (Specify in Abstract below and in Text, NRC Form 366A)
20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	10CFR Part 21
20.405(a)(1)(iv)	X 50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER Area Code	
Tony Harris, Regulatory Compliance Specialist	9 1 9	4 5 7 - 2 0 3 8

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
B	B I	M O	G 0 8 0	YES					

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE) | X NO

EXPECTED SUBMISSION DATE (15): MONTH | DAY | YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

As a result of Service Water (SW) System design concerns raised by the NRC DET inspection conducted April 10 through May 5, 1989, it was determined on 9/14/89 that, since initial operation of the plant, the SW System may not have met its design requirements under certain worst-case conditions. The concerns fell into three major categories and applied to both Unit 1 and Unit 2. Root cause of the event was determined to be primarily a result of inadequate initial system and component design.

Engineering evaluations, system and component testing, interim operating restrictions and system modifications were performed to ensure continued operability of the system. As a result of modifications, testing and interim operating restrictions, the SW System is currently operable and capable of performing its intended design function. Continuing corrective modifications, assessments, and evaluations will be completed by the end of the upcoming Unit 1 1990 refuel outage.

Subsequent evaluations have determined this item to be reportable per 10CFR21.

This event is considered to have possibly had a major safety impact.

Event

Failure of the Service Water (SW) System (EIIS/BI) to meet design requirements.

Initial Conditions

Unit 1 was at 100% power and Unit 2 was shut down in Mode 5 (Refueling) for the Recirculation Pipe Replacement/Refuel Outage. Elements of these reported conditions have existed since the date of initial operation for both units.

Event Description

The NRC Diagnostic Evaluation Team (DET) inspection conducted April 10 through May 5 identified concerns relative to the Service Water System design adequacy. As a result of these concerns, CP&L initiated a team of corporate and site engineering personnel to evaluate the SW System design adequacy, as supplied by United Engineers and Constructors (UE&C). The concerns fell into three major categories and applied to both Unit 1 and Unit 2.

1. System Hydraulic Capability

2. Cross-tie Valve Leakage

3. Service Water Pump Motor Reliability

Engineering evaluations, system and component testing, interim operating restrictions, and system modifications (PMs) were performed to ensure continued operability of the system.

As a result of modifications, testing, and interim operating restrictions, the Service Water System is currently operable and capable of performing its intended design function.

Performed evaluations have not proven prior operability of the system. Additional analyses and testing necessary to demonstrate that the system could have performed its design function under the worst-case scenerio are not considered prudent at this time due to cost and available work resources. The system is thus considered to have not met its design requirements since initial operation of both Unit 1 and Unit 2 under certain worst-case scenerios.

This item was determined to be reportable on 9/14/89.

Event Investigation

The CP&L Team determined that the DET concerns were valid and that operation at the design maximum inlet temperature of 90 degrees Fahrenheit could not be justified based on available information. This conclusion was reached based upon the development of a computer based hydraulic model (KYPIPE) of the Service Water System, which was calibrated utilizing system flow testing. The model then predicted system performance under worst-case assumptions. A Justification for Continued Operation (JCO), Engineering Evaluation Report (EER) 89-0135, was issued to establish operational limits which ensured design conditions could be met. A parallel effort to develop a detailed design basis and correct known problems was initiated. Modifications and analyses are continuing. Presently, the system is capable of operation up to the design temperature of 90 degrees Fahrenheit. As modifications have been installed and more accurate engineering information has become available, EERs have been issued to document and establish less restrictive interim operational limits. A listing of EERs and completed plant modifications (PMs) is included in Table 1 of this report.

Subsequent evaluations have determined this item to be reportable per 10CFR21.

Event Cause

The causes for each of the three major areas of deficiencies are discussed below.

System Hydraulic Capability

The root cause for the inability of the SW system to meet flow requirements under all scenerios is primarily the result of inadequate original design. A contributing factor was the failure of startup testing to detect the inadequacies.

The automatic isolation valves (1/2SW-V106) (EIIS/BI/ISV) between the safety-related portion of the nuclear SW header and the non-safety related Reactor Building Closed Cooling Water (RBCCW) (EIIS/CC) supply were not single failure proof. This provided a diversion flow path which, coupled with flow diversion created by leaking valves, resulted in a potential for inadequate flow to safety-related components under worst-case assumptions. Not providing single failure-proof isolation valves is considered an original design inadequacy.

Startup testing did not detect the inadequacy of the original valve design. The testing conducted did not attempt to duplicate worst-case hydraulic conditions and was limited based on the availability of installed flow instrumentation. The startup testing program did not perform a system flow balance under worst-case conditions, but focused on system operation under normal operational lineups.

Cross-Tie Valve Leakage

Cross-tie valve leakage (EIIS/BI/ISV) between the nuclear SW header (EIIS/BI) and the conventional SW header (EIIS/KG) and certain loads was determined to be the major source of valve leakage diversion. These valves provide the isolation of the conventional and nuclear SW headers and certain system header loads. The root cause of the cross-tie valve leakage problem has been assessed by Technical Support personnel and is believed to have resulted from inadequate closing torque necessary to fully seat the valves. A valve action plan has been established. Final causal factor determination is planned to be completed by the end of the current Unit 2 outage. Valves with lower torque requirements have been or are currently being installed for key cross-tie valve locations, as identified below, during the current Unit 2 outage and will be similarly installed during the upcoming Unit 1 refueling outage. Modifications to replace the cross-tie valves are:

Unit 2	Unit 1	Action
82-218R	82-219R	Replacement of 1/2SW-V13 and V14
82-218S	82-219S	Replacement of 1/2SW-V15 and V16
82-218T	82-219T*	Replacement of 1/2SW-V17 and V18
87-208*	87-240*	Replacement of 1/2SW-V102
82-220B	82-221B*	Replacement of 1/2SW-V117
82-220A*	82-219W*	Replacement of 1/2SW-V118
82-220A*	82-221A	Replacement of 1/2SW-V111

*Completed

Service Water Motor Reliability

A failure analysis concluded that the motor failure of the 2B Nuclear SW Pump (EIIS/BI/P) on 4/27/89 was caused by inadequate air flow through the motor windings which, over a period of time, resulted in thermally aged insulation. The thermally aged insulation was then susceptible to failure from operational stresses imposed on the motor.

Corrective Actions Completed

Table 1 provides a list of modifications and EERs which have been completed to ensure that the system is capable of performing its design function requirements.

In addition, Technical Specification Interpretation (TSI) 84-06, of Technical Specification 3.7.1.2, has been revised (Revision 6) to reflect the current SW pump operating guidelines, as defined in EERs 89-0135, 89-0220 and 89-0253.

Actions taken to date for each of the categories of inadequacies are listed below.

Hydraulic Capability

a. System testing has been completed, including cross-tie valve leakage testing and validation of hydraulic models for both units.

b. Modifications have been developed and installed on both units to restore the system capability to its original design.

c. An analysis has been performed to evaluate the adequacy of the SW pump Intake Structure Bay sump levels under varying conditions.

d. Johnston Pump Company has performed factory pump testing on one of the existing SW pumps to develop a pump unique $NPSH_R$ curve, a pump thrust curve, and a head flow curve representative of BSEP installed SW pumps.

e. A preliminary evaluation of the potential for water hammer in the RHR SW has been completed. Evaluated risk was low; however, recommendations for addressing this risk are under development and the results will be included in the final SW System Project Report.

System Valve Leakage

a. Leakage has been quantified and evaluated for each unit and has been included in system hydraulic modeling and evaluations

b. A preliminary cause assessment of valve leakage has been completed. Final determination will be dependent on Unit 2 outage inspection results.

c. Modification packages replacing key cross-tie valves are in progress and are expected to be installed during the 1989 refueling outage for Unit 2 and the 1990 refueling outage for Unit 1.

d. EER 89-0153 provided the basis for revising the valve actuator setpoints listed in Engineering Procedure (ENP)-43 for existing valves to minimize cross-tie valve leakage.

Service Water Pump Motor Reliability

a. Failure analysis has been completed for the GE Model 5K6328XC279A 2B Nuclear SW pump motor, serial number AHJ126013 (EIIS/BI/P/MO). Motor failure was determined to be associated with a turn-to-turn failure caused by aging of the insulation.

As a result of the pump motor failure analysis, a redesign of the the SW pump motors was completed. The upgrading of the motors included upgrading the insulation to F class, installation of higher efficiency fans and reduction of internal air flow resistance.

b. A review of motor maintenance history has been completed and testing performed to establish present condition and predicted life of the SW motors (EER 89-169). The evaluation identified four motors for immediate rewind and established a basis for continued operation. The four SW pump motors have been rewound and motor modifications implemented. The modified motors run approximately 60 degrees cooler and well below the insulation design temperature.

Corrective Actions To Be Taken To Prevent Recurrence

The potential for similar generic design problems has been recognized. CP&L has committed, in its Integrated Action Plan (DET response letter NLS-89-265, dated 9/27/89), to complete a Service Water System Safety System Functional Inspection (SSFI) in 1989. The results of the assessment will be reviewed against the results of previously performed High Pressure Cooling Injection (HPCI) (EIIS/BJ) and Standby Liquid Control (SLC) (EIIS/BJ) SSFIs and the results of a Service Water Modification Review. The results will be evaluated for trends, patterns and significance. A determination by June 29, 1990 of additional actions and priorities is committed to per Action Item 7 of the Integrated Action Plan.

In addition to completion of the SW SSFI in 1989, the following activities are still in progress relative to this event:

1) Issuance of a final hydraulic report documenting hydraulic bases for the SW system and system compliance with the bases.

2) Completion of a review of previous SW modifications to ensure that these modifications are encompassed by design analyses and test activities.

3) Completion of installation of upgraded cross-tie valves to reduce cross-tie valve leakage.

4) Establishment of a motor temperature monitoring program to track remaining life for SW pump motors. Three additional SW pump motors have been scheduled for replacement by the end of 1990. Remaining motors have life expectancies of greater than 150,000 hours and are to be tracked as part of the temperature monitoring program.

5) Issuance of a final project report addressing the results of the project and providing further recommendations for system enhancement.

With the exception of the Unit 1 cross-tie valve modifications, which are scheduled for the 1990 refuel outage, remaining activities are expected to be completed during 1989.

Event Assessment

Two major operability concerns existed with the SW system prior to CP&L actions to correct the design inadequacies:

1. Whether the system could have provided required flows under worst-case conditions.

2. Whether the SW pumps and motors would have operated in an acceptable range above minimum system flow requirements and below pump runout condition.

Mitigating factors for each of the above concerns are listed below, with CP&L positions for dispositioning each of the possible alternatives. Assessment of the safety impact of these issues has been prioritized in terms of the cost/benefit of required analyses in terms of mitigating the consequences of each of the operability concerns. The extensive analyses and testing required for assessing operability using less conservative assumptions would divert project management resources from the completion of ongoing service water work. The work resources for the SW system at this time are being focused on current operability concerns and the redevelopment of the overall system design basis.

In assessing the impact of the inadequate flow concern, it may be possible to:

1. Take credit for additional operator intervention in terms of increasing flow rates to loads. This would require development of a realistic model to predict earliest accessibility time for entry to the Reactor Building. The cost/benefit of this analysis/modeling is not considered prudent.

2. Lower vital header component flow requirements by developing evaluations supporting lower heat load requirements. This evaluation would identify conservatism between current nameplate design and actual worst-case design requirements. In addition to the effort, it has been determined that higher efficiency room coolers have been previously installed, providing additional margin.

3) Perform a transient containment calculation using varying RHR SW flow rates to take credit for increased flow from operator action.

4) Perform additional pump testing to evaluate worst-case conditions which could have been encountered prior to implementation of operational restrictions and modifications.

In terms of assessing the concerns associated with operating range:

1) Additional motor thrust bearing testing is being performed on the 2A nuclear SW pump motor to evaluate the most accurate load capability for the motor. This testing is to be completed by the end of the Unit 2 outage.

2) Pump operation above current specification has been analyzed through factory pump testing and vendor assessment to certify short-term operation of worst-case potential runout conditions which may currently exist.

Due to the overall scope of the design inadequacies that have been involved with the SW system, exact assessment of the consequences of the system design deficiencies is not a prudent option. Historically, the SW system has provided required cooling loads. Had worst-case accident conditions occurred at some time in the past, however, sufficient cooling to all safety related components may not have occurred. For this case, therefore, this event is considered to potentially have had a major safety impact under certain worst-case conditions. Limits have been established and are being maintained to ensure operation within the design requirements of the SW system.

NRC Form 366A (9-83)

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES 8/31/88

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
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TEXT (If more space is required, use additional NRC Form 366A's) (17)

TABLE 1

COMPLETED SW SYSTEM EERs AND MODIFICATIONS

COMPLETED EERs

DATE	NUMBER	DESCRIPTION
5/4/89	89-0135	JCO for adequacy of SW system to meet design basis flow requirements
5/2/89	89-0147	Determination of correct setpoints for SW-PS-129/271/3213/3214, SW PUMP AUTO START Pressure Switches
5/5/89	89-0153	Evaluation of Unit 1 Cross-tie valve leakage
5/14/89	89-0163	Revised operating line-up for SW system--Assessment of alternate line-up for extended operation
5/17/89	89-0164	Ventilation enhancement of a SW pump motor
6/9/89	89-0166	Verification of acceptable SW flow to RHR for worst-case expected LOCA containment cooling
5/31/89	89-0169	Evaluation of reliability of SW system pump motors
6/22/89	89-0204	2A and 2B Nuclear SW pump low flow operation evaluation
7/6/89	89-0213	Electrical evaluation of modification of SW pump motors
6/30/89	89-0212	Structural evaluation of modifications to SW pump motors
7/11/89	89-0220	Follow-up to EER 89-0315, revising hydraulic anaysis for SW system nuclear header following completion of PMs 89-048 and 89-049
9/8/89	89-0253	Providing design basis and evaluation of SW system requirements in Modes 4 and 5, Unit 2
9/26/89	89-0263	Evaluation of Outage operation of Unit 2 nuclear SW header with SW vital header available.

NRC Form 366A (9-83)

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
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TEXT (If more space is required, use additional NRC Form 366A's) (17)

PLANT MODIFICATIONS COMPLETED TO DATE

UNIT	NUMBER	DESCRIPTION
1	89-048	SW-V103/106 Actuator and Logic Changes
2	89-049	SW-V103/106 Actuator and Logic Changes
2	89-050	RHR SW pump supply header pressure switch setpoint changes
1	89-051	RHR SW pump supply header pressure switch setpoint changes
1	89-074	Replacement of SW-FO-1188 flow orifice to restore design flow rate
2	89-075	Replacement of SW-FO-1187 flow orifice to restore design flow rate