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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Subject: Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Renewed Operating License Nos. DPR-71 and DPR-62
Docket Nos. 50-325 and 50-324
Response to Request for Additional Information Regarding
Generic Letter 2008-01 (NRC TAC Nos. MD7802 and MD7803)

References:

1. Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," dated January 11, 2008 (ADAMS Accession Number ML072910759)
2. Letter from Benjamin C. Waldrep to the U. S. Nuclear Regulatory Commission (Serial: BSEP 08-0137), "Nine-month Response to Generic Letter 2008-01," dated October 10, 2008 (ADAMS Accession Number ML082950466)
3. Letter from Benjamin C. Waldrep to the U. S. Nuclear Regulatory Commission (Serial: BSEP 09-0079), "Post-Outage Supplemental Response to Generic Letter 2008-01," dated July 27, 2009 (ADAMS Accession Number ML092160595)
4. Letter from Farideh E. Saba, U. S. Nuclear Regulatory Commission, to Mr. Benjamin Waldrep, Vice President Brunswick Steam Electric Plant, "Request for Additional Information Regarding the Response to Generic Letter 2008-01," dated November 10, 2009 (ADAMS Accession Number ML093080444)

Ladies and Gentlemen:

On January 11, 2008, the NRC issued Generic Letter (GL) 2008-01 requesting that each licensee evaluate the licensing basis, design, testing, and corrective action programs for the Emergency Core Cooling Systems (ECCS), Decay Heat Removal (RHR) system, and Containment Spray system, to ensure that gas accumulation is maintained less than the amount that challenges operability of these systems, and that appropriate action will be taken when conditions adverse to quality are identified.

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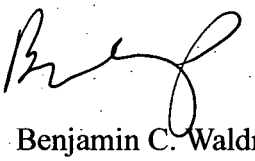
NRR

In a letter dated November 10, 2009, the NRC requested additional information concerning Carolina Power & Light Company's (CP&L), now doing business as Progress Energy Carolinas, Inc., response to GL 2008-01 for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. The enclosure to this letter provides the requested information.

No regulatory commitments are contained in this submittal. Please refer any questions regarding this submittal to Ms. Annette Pope, Supervisor - Licensing/Regulatory Programs, at (910) 457-2184.

I declare, under penalty of perjury, that the foregoing is true and correct. Executed on December 21, 2009.

Sincerely,



Benjamin C. Waldrep

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Enclosure:
Response to Request for Additional Information (RAI) Regarding Generic Letter 2008-01

Response to Request for Additional Information (RAI) Regarding Generic Letter 2008-01

Background

On January 11, 2008, the NRC issued Generic Letter (GL) 2008-01 requesting that each licensee evaluate the licensing basis, design, testing, and corrective action programs for the Emergency Core Cooling Systems (ECCS), Decay Heat Removal (RHR) system, and Containment Spray system, to ensure that gas accumulation is maintained less than the amount that challenges operability of these systems, and that appropriate action will be taken when conditions adverse to quality are identified.

In a letter dated November 10, 2009, the NRC requested additional information concerning Carolina Power & Light Company's (CP&L), now doing business as Progress Energy Carolinas, Inc., response to GL 2008-01 for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. The response to this RAI follows.

NRC Question 1

In References 1 and 2, the licensee states that a calculation has been developed to provide an analytical basis for void acceptance criteria. Please describe the criteria used to develop the calculation, and discuss how it differs from the criteria set forth in Reference 6. Justify the differences.

BSEP Response to Question 1 with regards to discharge piping

For voids in discharge piping, the void acceptance criteria was that the pressure change generated by a non-condensable gas due to a water-hammer event is not of sufficient magnitude to cause relief valves to lift or to exceed the piping design pressure. No criterion is set forth in Reference 6 regarding voids found in discharge piping. Piping axial imbalance loads and corresponding impact on support loads, delay in the time to injection, and impact of voids on core cooling also need to be considered for discharge piping voids. If an actual void is found in discharge piping at BSEP which cannot be removed by static venting, an evaluation is performed and documented in the Corrective Action Program (CAP) process regarding acceptability of the void.

BSEP Response to Question 1 with regards to suction piping

Introduction

The purpose of the gas void evaluations and associated acceptance criteria developed by CP&L for BSEP to date was to make a best effort to satisfy the desire to have the assessment of gas movement in suction lines and to fully evaluate pump response due to entrained gas, even though BSEP has a good operating history. During original plant design, BSEP ECCS pumps were selected based on standby service applications, and the systems were not designed to operate

close to best efficiency point (BEP). CP&L established the acceptance criteria at BSEP prior to the NRC publication of Reference 6.

Suction Void Acceptance Criteria

Two criteria were used to develop the calculation, a "steady-state" criterion and a transient criterion, as follows:

(1) Steady-state criterion – Void size limited such that the continuous void fraction does not exceed 2% at the pump suction under design basis flow rates. No limitations on BEP are imposed. However, as will be shown below, the transients used to establish these criteria are bounded by Criterion 4 from Table 2 of Reference 6, which is applicable to all pump flow rates.

(2) Transient criterion – Void size limited such that the peak (i.e., instantaneous) void fraction does not exceed 10% at the pump suction under design basis flow rates over a 5-second duration. For the model, the transient duration is defined as the time from when the theoretical void fraction at the pump increases above 2% to the time when the void fraction has decreased to a value below 2%. Consistent with the BWROG ECCS Pumps Suction Void Fraction Study (i.e., the relevant industry guidance available at the time BSEP acceptance criteria were developed), no limitations on BEP were imposed on the transient criteria.

These criteria differ from the criteria set forth in Reference 6, as follows:

(1) "Steady-state" criterion – To allow use of a 2% continuous void fraction criterion, Reference 6 limits pump flow to within a prescribed band of BEP flow. Reference 6 also prescribes a 1% continuous void fraction when pump flow is outside of the best efficiency band.

(2) Transient criterion – To allow use of a 10% void fraction criterion for all 0.5 second time steps, Reference 6 limits pump flow to within a prescribed band of BEP flow for a transient of less than 20 seconds. Reference 6 also prescribes a 5% void fraction for all 0.5 second time spans when pump flow is outside of the best efficiency band.

(3) General – Reference 6 provides an equation for increasing the required Net Positive Suction Head (NPSH) for void fractions greater than zero but less than or equal to 2%. Additionally, Criterion 5 in Table 2 of Reference 6 provides a continuous 2% void fraction limit, below which head reduction is negligible if pump flow is within the prescribed range of BEP flow.

General Discussion of Modeling

In modeling of void transport, key assumptions were made to ensure conservative results that would yield the maximum void fraction at the pump suction for a given gas void volume located in the upstream piping. First, system flow rates were assumed to be at the design values. Second, system flow was assumed to be at the design value before gas was introduced into the system by the model. These assumptions result in a conservatively high void fraction at the

pump suction during the transient. In reality, all systems analyzed will experience a transient in which the pump starts and flow is ramped from zero up to the required flow rate. During this process, shearing of the gas void will occur as part of the entrainment process, which will reduce the void fraction at the pump suction. Finally, the model places the gas void in a compact configuration which also adds conservatism to the void fraction at the pump suction. Ultrasonic Testing (UT) inspection results performed to date at BSEP have shown that voids tend to be distributed as an elongated volume along the top of horizontal piping, which would typically yield a lower void fraction at the pump suction. Further justification for the BSEP criteria is as follows:

(1) Steady-state criterion

For Residual Heat Removal (RHR), Core Spray (CS), and High Pressure Coolant Injection (HPCI), BSEP does not have any anticipated case of continuous steady-state gas intrusion. In fact, there are no cases where voids will pass through a pump while the pump is being relied on to provide a specific level of performance. Short-lived, transient voids at the pump may be incurred either during system test starts following post-maintenance initial fill activities or RHR shutdown cooling system starts following initial fill/loop warming activities. In the following discussions of pump suction, the "steady-state" criterion is actually being applied to transient cases involving discrete voids.

Even though no BSEP case has been identified where continuous operation with a significant void fraction is expected, a bounding evaluation was performed. A continuous 2% void fraction was specified to develop void size acceptance criteria. However, in applying this "steady-state" criterion, voids of discrete volume were postulated at various locations in the pump suction piping that are potentially susceptible to gas accumulation. Postulated void volumes were varied until the pump suction instantaneous void fraction predicted by the model approached but did not exceed 2%. For the BSEP "steady-state" cases analyzed, the corresponding transients were less than 20 seconds in duration, although this was not an acceptance criterion. Therefore, they are bounded by Criterion 4 in Table 2 of Reference 6, which is applicable to all pump flow rates.

If a case of expected operation with continuous void fraction is identified in the future, the actual parameters of the identified case would need to be evaluated. Limitations associated with actual flow versus BEP flow would be addressed.

(2) Transient criterion

ECCS Function

For ECCS functions, pumps may experience transient void(s) following maintenance and initial fill of the system. For these cases, the pump has not been restored to operable at this time. The pump will have completed all Technical Specification testing and in-service testing (IST) prior to declaring the pump operable. The aforementioned voids will have been removed by dynamic venting prior to the pump being relied upon to fulfill its ECCS function.

This sequence of events reflects the way pumps have been operated since they were installed (i.e., approximately 30 years of service to date). In-service testing has detected no degradation associated with these transient system restarts.

Shutdown Cooling Function

BSEP has a typical BWR-4 shutdown cooling suction flow path for RHR. Significant industry operating experience on RHR voiding exists when placing shutdown cooling in service. BSEP has recently installed shutdown cooling suction line vent valves on Unit 2 RHR. These valves have provided significantly improved void removal capabilities. Unit 1 shutdown cooling suction line vent valves will be installed during the next refueling outage (i.e., spring 2010). During placement of shutdown cooling into service for normal use, RHR pump suction void fraction will be well below 2% for no more than 20 seconds based on gas transport analysis results.

Given the lack of good suction vents prior to 2009, past starts were more likely to approach or exceed the 2% void fraction that was evaluated. Thirty years of routine use of shutdown cooling with the original as-built piping configuration has resulted in no significant pump degradation. No RHR pump has required major maintenance due to loss of performance as monitored by in-service testing. Some pump seal maintenance has been required, but this has been very infrequent and is not a symptom of damage due to gas ingestion.

Analysis

The duration for a 10% void fraction transient in the BSEP criteria is limited to 5 seconds, which is more conservative than the 20-second duration provided for Criterion 3 in Table 2 of Reference 6. As stated in the Suction Void Acceptance Criteria section, the transient duration for BSEP was defined as the time from when the theoretical void fraction at the pump increases above 2% to the time when the void fraction has decreased to a value below 2%. However, the void fraction for the transient cases used in establishing limiting gas volumes was well below 1% within 20 seconds. The gas transport analysis was performed using system design basis flow rates for each pump. No limitation with respect to BEP was specified as a criterion to develop the computation. This is considered acceptable based on conservatisms built into the gas transport model as discussed above. This is substantiated by operability testing, which demonstrates satisfactory system performance by meeting the required acceptance criteria for Technical Specifications operability and IST testing. For all voids identified on suction piping to date, associated locations have been UT-inspected following system operation. In all cases, the locations were found to be filled with water.

(3) General criterion – NPSH required criteria can only be assessed at steady-state conditions. Vendor NPSH required criteria are determined by head degradation testing at stabilized conditions and are not applicable during transients. As stated previously, any gas voids present would be transported through the pump during pump start for either routine testing or when going into shutdown cooling (for RHR). For all of these starts, NPSH available margins are quite large. Even though a continuous 2% void fraction was specified (with a maximum of 10% for 5 seconds) as a basis to develop the criteria, the corresponding gas transport durations have been calculated to be less than 20 seconds. Consistent with the BWROG ECCS Pumps Suction Void Fraction Study, a 2% continuous suction gas void fraction and an average void fraction less than 10% for no more than 5 seconds is considered acceptable and can be tolerated by the pump and system. Whether short or long term degradation modes are under consideration, the duration of pump operation necessary for such damage is substantially longer than the time necessary for the void volumes of interest to be transported through the pump.

It is understood that during the transient in which entrained gas is transported through the system, a momentary degradation of developed head proportional in duration to the transport time of the void through the pump may be incurred. However, this is considered acceptable because the voids will pass through the pump prior to the system being relied upon to fulfill its ECCS or decay heat removal function.

NRC Question 2

Consistent with Section 3.7 of Reference 4, briefly discuss your plans for training at BSEP that is "considered to be a necessary part of applying procedures and other activities when addressing the issue identified in the GL."

BSEP Response to Question 2

The NRC Generic Letter did not require discussion of training to satisfy the 10 CFR 50.54(f) request and, therefore, none was provided in the BSEP response. However, when any plant procedure is modified, an assessment for training needs is required in accordance with BSEP procedure PRO-NGGC-0204, "Procedure Review and Approval." The determination and development of training is consistent with the systematic approach to training. If required, this training is accomplished prior to, or in parallel with, the issuance of the procedure. For fill and vent procedure revisions, the changes have generally been minor and have been considered enhancements. Procedures or work orders which direct the periodic examination of selected piping for the presence of gas were created or modified to draw upon pre-existing corporate nuclear oversight nondestructive examination procedures, which provide detailed instruction for the ultrasonic inspection of piping to verify that it is full of water.

CP&L is an active participant in the Nuclear Energy Institute (NEI) Gas Accumulation Team, which is currently coordinating with the Institute of Nuclear Power Operations (INPO) in the

development of generic training modules for gas accumulation and management. These training modules target the Engineering, Operations, and Maintenance disciplines. When these training modules are completed and become available to the industry, CP&L will evaluate them for applicability to BSEP, and may implement a version tailored to meet station needs.