ATTACHMENT 1 to NLS-90-074

Carolina Power and Light Co
Brunswick Steam Electric Plant
Unit Nos. 1 and 2

Compliance With General Design Criteria 17 Electric Power Systems

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INTRODUCTION

The NRC performed a Diagnostic Evaluation of the Brunswick Nuclear Project (BNP) and its supporting organizations over the period of April 10-21 and May 1-5, 1989. An NRC Diagnostic Evaluation Team (DET) Report was issued on August 2, 1989. CP&L responded to DET Report concerns via an Integrated Action Plan (IAP) transmitted on September 27, 1989. In response to one of the DET concerns, CP&L committed (IAP Item D1) to re-evaluate the Brunswick offsite to onsite electrical circuits design and procedures for compliance with 10CFR50, Appendix A, General Design Criteria 17, Electrical Power Systems.

As a result of this evaluation, CP&L has concluded that the BNP electrical distribution system, as designed, meets the requirements of GDC-17 as interpreted when the plant was licensed and presented in IEEE 308-1971.

Further, on November 1, 1989, NRC letter (NRC-89-731) acknowledged CP&L's commitment to re-evaluate the Brunswick electrical distribution system for compliance with GDC-17 by March 31, 1990. The letter also requested CP&L to respond to the following four questions:

1. Explain how Brunswick satisfies the requirements of GDC-17 (as stated in the current TS bases) by identifying the immediate and the delayed access circuits for each unit and describing how the backfeed capability can be established within the acceptable time limit to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded (i.e., one SAT and on-site diesels are not available -paragraph 3 of GDC-17).

2. Describe how Surveillance Requirement 4.8.1.1.1.b has been performed over the years for the delayed source (backfeeding through UAT). The discussion should also include your recent amendment change on Surveillance 4.8.1.1.1.b.

3. Describe specific use of bus ties between the units. Also describe the transfer methods (automatic and manual) as well as any transfer limitations (i.e., not enough capacity on the SAT's etc.) if the SAT's are shared between the two units.

4. Discuss the adequacy of your current TS with respect to the June 17, 1989 LOOP event.

This report documents the evaluation of the BNP electrical distribution system compliance with GDC-17 offsite to onsite electrical circuits requirements and provides responses to NRC letter NRC-89-731 questions 1 through 4.

EVALUATION OF LICENSING BASIS

The Brunswick offsite to onsite electrical circuits licensing basis is documented, as follows. This evaluation is based upon the current design of the BNP offsite to onsite electrical distribution system and upon a review of licensing documents and standards existing at the time BNP was licensed.

GDC-17 was originally issued on February 20, 1971 and stated, in part:

> Electrical power from the transmission network to the switchyard shall be supplied by two physically independent transmission lines (not necessarily on separate rights of way) designed and located so as to suitably minimize the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. (emphasis added)

On July 7, 1971, GDC-17 was revised to state the following:

> Electrical power from the transmission network to the on-site electrical distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. (emphasis added)

The Brunswick original FSAR and UFSAR state that the plant is in compliance with GDC-17. The original FSAR Appendix F, Page F-15 and UFSAR Chapter 3, Section 3.1.2.2.8, Page 3.1.2-5, address GDC-17 compliance as follows:

> The plant electrical distribution system has been designed in accordance with the guidelines as outlined in IEEE Standard 308-1971, Criteria for Class 1E Electrical Systems for Nuclear Power Generating Stations.

The following are some of the critical excerpts from IEEE 308-1971:

> 5.2.3 Preferred Power Supply
>
> (1) Description. The preferred power supply shall consist of one or more circuits from the transmission network or equivalent source of electric energy to the distribution system. (emphasis added)
>
> (4) Availability. A minimum of one circuit from the transmission network normally shall be available during operation. If only one circuit from the transmission network is normally available, the design shall include a provision for alternate access to the transmission network within eight hours of post-accident unit shutdown. (emphasis added)

5.2.4 Standby Power Supply

(2) Function. The standby power supply shall provide electric energy for the operation of emergency systems and engineered safety features during and following the shutdown of the reactor when the preferred power supply is not available.

(4) Availability. The standby power supply shall be available following the loss of the preferred power supply within a time consistent with the requirements of the engineered safety features and the shutdown systems under normal and accident conditions.

8.1 Preferred Power Supply

8.1.1 Capacity. A multi-unit station may share preferred power supply capacity between units. In such a case, as a minimum the total preferred capacity must be sufficient to operate the engineered safety features for a design basis accident on one unit and those systems required for concurrent safe shut-down on the remaining units. The type of accident and shut-down and the unit assumed to have had the accident, shall be those which give the largest total preferred capacity requirement.

9. Inter-Unit Ties

It is permissible to provide inter-unit ties between the Class 1E buses of the units in a multi-unit station, provided any single component failure does not degrade the Class 1E electrical systems of any unit below an acceptable level and provided that the independence of the redundant systems is maintained.

The original FSAR Chapter 8, Section 8.10.11, Page 8.10-6 and the UFSAR Chapter 8, Section 8.3.1.2, Page 8.3.1-22, make the following two statements:

In the event of a total loss of the preferred power source, power for the engineered safety features is supplied from the standby diesel generators located on the site.

If the unit generators are unavailable, there are two other independent sources of auxiliary power: the standby diesel generators and the 230 kV lines. Both sources may be connected to feed the Class 1E buses, and each has capacity for operation of all systems required to shut down the plant and maintain it in a safe shut down condition.

Based upon the wording in IEEE 308-1971, the February 20, 1971 edition of GDC-17 requirements, the BNP original FSAR, and the BNP UFSAR the following scenario demonstrates satisfactory compliance with GDC-17 for either unit at BNP.

1. If an accident occurs the Unit load is transferred from the Unit Auxiliary Transformer (Normal Power Source) to the Start-up Auxiliary Transformer (Preferred Power Source). Safe shutdown loads on the affected unit are supplied by the Start-up Auxiliary Transformer and the emergency diesel generators start in anticipation of a Start-up Auxiliary Transformer failure.

2. If the Start-up Auxiliary Transformer fails, the emergency diesel generators provide power to the emergency buses and thereby to the safe shutdown loads powered from the affected unit.

3. This situation will leave the affected unit emergency diesel generators as the only source of AC power remaining for the safe shutdown loads, therefore, it is desirable to establish an alternative means of providing AC power to the emergency buses.

4. The backfeeding of the UAT provides an additional means of supplying power to the affected unit emergency buses. The eight hour requirement for establishing the backfeed ensures that prompt action is taken to establish a second off-site power source for the affected unit emergency buses.

This scenario is a representation of how BNP, as licensed, meets the requirements of GDC-17.

EVALUATION OF GDC-17 COMPLIANCE

IEEE Standard 765-1983, IEEE Standard for Preferred Power Supply for Nuclear Generating Stations, was generated to provide detailed design criteria for the Preferred Power Supply (PPS) to ensure a design commensurate with its intended function and provide sufficient detail to interpret, clarify, and expand guidance given in GDC-17, GDC-18, and ANSI/IEEE Std 308-1980, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations. NRC Regulatory Guide 1.6 (Formerly Safety Guide 6) has not been revised to endorse IEEE 765-1983; however, it is assumed that the standard provides the current interpretation of requirements for compliance with 10CFR50, Appendix A, General Design Criteria 17, Electric Power Systems. The following are some excerpts from IEEE 765-1983 that are applicable to this evaluation:

4.1 General

The preferred power supply (PPS) shall consist of two or more circuits from the transmission system to the Class 1E distribution system. (emphasis added)

4.3 Capacity and Capability

Each circuit of the preferred power supply shall be designed to provide sufficient capacity and capability to power equipment required to ensure that:

(1) Specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of

anticipated operational occurrences.

(2) The core is cooled and containment integrity and other vital functions are maintained in the event of plant design basis accidents.

4.5 Availability

A minimum of two circuits from the transmission system to class 1E power system shall be designed to be available during start-up and normal operation to meet accident, post-accident, and safe shutdown requirements in accordance with the following guidelines.

(4) A minimum of one PPS shall be designed to be available automatically to provide power to the class 1E buses within a few seconds following a design basis accident.

(5) A second circuit shall be designed to be available within a time period demonstrated to be adequate by the safety analysis of the station.

7.1 Shared System Capability

Shared preferred power supply circuits shall be capable of simultaneously supplying all loads required for each designed mode of operation of both units.

A number of significant changes have been made in the interpretation of requirements for compliance with GDC-17 between the period when BNP was licensed and 1989. Some specific differences between the original interpretation and the current interpretation of GDC-17 are relevant to this documentation, and are presented as follows:

1. When BNP was licensed IEEE Standard 308-1971 required the preferred power source to consist of one or more circuits from the transmission network to the distribution system. Current interpretation per IEEE Standard 765-1983 and IEEE Standard 308-1980 requires the preferred power source to consist of two or more circuits from the transmission network to the class 1E distribution system.

2. When BNP was licensed IEEE Standard 308-1971 required the design to include a provision for alternate access to the transmission network within eight hours of post-accident unit shutdown. IEEE Standard 765-1983 requires that a second circuit (from the transmission network) shall be available within a time period demonstrated adequate by the safety analysis of the station. IEEE Standard 308-1980 requires that for non-accident conditions each of the circuits shall be designed to be available in sufficient time to assure that specified acceptable fuel design limits, and design conditions of the reactor coolant pressure boundary, are not exceeded, assuming that the other circuit and the standby power supplies are unavailable.

3. When BNP was licensed, IEEE Standard 308-1971 allowed a multi-unit station to share preferred power supply capacity between units. In such a case, the minimum total preferred capacity must be sufficient to operate the engineered safety features for a design basis accident on one unit and those systems required for concurrent safe shut-down on the remaining units. This requirement is the same for IEEE Standard 308-1980.

CONCLUSIONS

The BNP electrical distribution system, as designed, meets the requirements of GDC-17 interpreted when the plant was licensed and presented in IEEE 308-1971.

NRC QUESTION 1

Explain how Brunswick satisfies the requirements of GDC-17 (as stated in the current TS bases) by identifying the immediate and delayed access circuits for each unit and describing how the backfeed capability can be established within the acceptable time limit to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded (i.e., one SAT and on-site diesels are not available - paragraph 3 of GDC-17)

Question 1 - Response

GDC-17 was originally issued on February 20, 1971 and stated, in part:

> Electrical power from the transmission network to the switchyard shall be supplied by <u>two physically independent transmission lines</u> (not necessarily on separate rights of way) designed and located so as to suitably minimize the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. Two physically independent circuits from the switchyard to the on-site electrical distribution system shall be provided. (emphasis added)

On July 7, 1971, GDC-17 was revised to state the following:

> Electrical power from the transmission network to the <u>on-site electrical distribution system shall be supplied by two physically independent circuits</u> (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. <u>A switchyard common to both circuits is acceptable</u>. (emphasis added)

For the July 7, 1971 revision to GDC-17, the Federal Register Notice stated that the changes related "solely to correction and clarification" and were omitted from the notice of proposed rule making. The original reference to "two transmission lines" and the revisions inclusion of the sentence "A switchyard common to both circuits is acceptable" combined with the constant reference to "rights of way" are indicative of the emphasis placed on transmission lines and the switchyard.

BNP FSAR and UFSAR state that the plant is in compliance with GDC-17. The original FSAR Appendix F, Page F-15 and UFSAR Chapter 3, Section 3.1.2.2.8, Page 3.1.2-5, address GDC-17 compliance as follows:

> The plant electrical distribution system has been designed in accordance with the guidelines as outlined in IEEE Standard 308-1971, Criteria for Class 1E Electrical Systems for Nuclear Power Generating Stations.

IEEE Standard 308-1971 makes the following statements concerning the number and availability of circuits between the transmission network and the on-site distribution system:

> The preferred power supply shall consist of one or more circuits from the transmission network or equivalent source of electric energy to the distribution system. (emphasis added)
>
> A minimum of one circuit from the transmission network normally shall be available during operation. If only one circuit from the transmission network is normally available, the design shall include a provision for alternate access to the transmission network within eight hours of post-accident unit shutdown. (emphasis added)

The Original FSAR Chapter 8, Section 8.10.11, Page 8.10-6 and the UFSAR Chapter 8, Section 8.3.1.2, Page 8.3.1-22, make the following two statements:

> In the event of a total loss of the preferred power source, power for the engineered safety features is supplied from the standby diesel generators located on the site.
>
> If the unit generators are unavailable, there are two other independent sources of auxiliary power: the standby diesel generators and the 230 kV lines. Both sources may be connected to feed the Class 1E buses, and each has capacity for operation of all systems required to shut down the plant and maintain it in a safe shut down condition.

Based upon the wording in IEEE 308-1971, the February 20, 1971 edition of GDC-17 requirements, the FSAR, and the UFSAR the following interpretation for the availability of a second off-site power source was made:

1. If an accident occurs the Unit load is transferred from the Unit Auxiliary Transformer (Normal Power Source) to the Start-up Auxiliary Transformer (Preferred Power Source). Safe shutdown loads on the affected unit are supplied by the Start-up Auxiliary Transformer and the emergency diesel generators start in anticipation of a Start-up Auxiliary Transformer failure.

2. If the Start-up Auxiliary Transformer fails, the emergency diesel generators provide power to the emergency buses and thereby to the safe shutdown loads powered from the affected unit.

3. This situation will leave the affected unit emergency diesel generators as the only source of AC power remaining for the safe shutdown loads; therefore, it is desirable to establish an alternative means of providing AC power to the emergency buses.

4. The backfeeding of the UAT provides an additional means of supplying power to the affected unit emergency buses. The eight hour

requirement for establishing the backfeed ensures that prompt action is taken to establish a second off-site power source for the affected unit emergency buses.

This scenario is a representation of how BNP, as licensed, meets the requirements of GDC-17. The SAT is the immediately available off-site to on-site circuit and the UAT is the delayed access off-site to on-site circuit. The UAT is available within eight hours of post-accident unit shutdown via a backfeed from the transmission system through the main transformer (i.e., the emergency diesel generators are relied upon until the backfeed is completed). Voltage calculations and procedures exist for the backfeeding of the UAT.

Calculation B8517-E-01-F, Analysis For UAT Backfeed, was approved on September 25, 1985 as part of TAR B85-17. The calculation performed a voltage study for the backfeed of the UAT when the main generator and the SAT are unavailable. The calculation considered the following:

1. Low-voltage study on Unit 2 with Unit 1 at full power, Unit 2 in the scheduled SAT outage (backfeeding through the main transformer and UAT) and both common buses being fed from Unit 2.

2. Low-voltage study on Unit 2 with LOCA start on Unit 1 while Unit 2 is in the scheduled SAT outage and feeding both common buses (RHR-2C and RHR-2D starting).

3. Low-voltage study on Unit 2 with LOCA run on Unit 1 while Unit 2 is in the scheduled SAT outage and feeding both common buses (RHR-2C and RHR-2D running).

4. High-voltage study on Unit 2 with Unit 1 at full power, Unit 2 in the scheduled SAT outage and both common buses being fed from Unit 1.

Loading on both units is similar and the evaluation of Unit 2 was based on the results of the Unit 1 calculations, with the exception of a high voltage calculation. The calculation demonstrates the acceptability of supplying in-house loads via a UAT backfeed.

BNP developed revisions to Operating procedures 1(2)-OP-50 which allow the UAT backfeed to be established in an 8 hour period of time in the event of a loss of the SAT. Additionally, actions were taken after the June 17, 1989 loss of the SAT, to streamline the operating procedures and to provide training to Operations personnel.

Additional capability is available in the BNP design to support a GDC-17 event. Service water and one train of RHR are available at all times, powered from the unaffected unit. In addition, following completion of modifications to meet 10 CFR 50.63 for Station Blackout, a cross-tie capability will be available to power the affected unit's battery chargers from the unaffected unit. Once this modification is complete, BNP procedures will be revised to enhance the ability to cope with a loss of the preferred power supply coincident with unavailability of the unit's diesel generator(s) (GDC-17) event.

NRC QUESTION 2

Describe how Surveillance Requirement 4.8.1.1.1.b has been performed over the years for the delayed source (backfeeding through UAT). The discussion should also include your recent amendment change on Surveillance 4.8.1.1.1.b.

Question 2 - Response

Surveillance Requirement 4.8.1.1.1.b specifies that the unit power supply be transferred from the normal circuit to the alternate circuit at least once per 18 months during shutdown. As noted in a 1988 Brunswick request for a Technical Specification amendment of this surveillance, Brunswick considered that two transmission lines were used to satisfy the requirements of alternate and normal and; therefore, the surveillance was not applicable to Brunswick. Following discussions with the NRC Staff, the Company revised the Bases to Technical Specification 3/4.8 to state, in part:

> The requirement of Specification 4.8.1.1.1.b to demonstrate the operability of the independent circuits between the offsite transmission network and the onsite Class 1E distribution system may be satisfied by transferring unit loads from the unit auxiliary transformer (UAT) to the start-up auxiliary transformer (SAT). The requirement to perform this demonstration 'during shutdown' implies that this testing may be performed by the normal power switching evolutions during unit shutdown or while shutdown.

The NRC approved this bases change on May 25, 1989. Although a formal procedure to perform the surveillance as identified in the revised Bases was not established prior to the Bases amendment, Brunswick was conducting the required transfer of power using normal operating procedures since initial operation through normal operating procedures. These procedures reflected the current methodology.

NRC QUESTION 3

Describe specific use of bus ties between units. Also describe the transfer methods (automatic and manual) as well as any transfer limitations (i.e., not enough capacity on the SATs etc.) if the SAT's are shared between the two units.

Question 3 - Response

BNP does not use bus ties for compliance with GDC-17.

Emergency bus cross ties are used in conjunction with two Appendix R Alternate Safe Shutdown scenarios. In the event of a diesel generator No. 1 cell fire the cross tie breakers between 4.16 kV emergency buses E1, E2, and E3 are manually closed to provide Alternate Safe Shutdown Train A power to Train B. In the event of an E6 Unit Substation cubical fire the cross tie breakers between 4.16 kV emergency buses E1, E2, and E4 are manually closed to provide Alternate Safe Shutdown Train B power to Train A.

The emergency bus cross tie breakers are currently racked out with the control power fuses pulled, as required by the UFSAR section 8.3.1.1.6.3. This does not preclude plant operations from using the cross tie breakers if necessary.

The 4.16 kV Balance of Plant buses Common A and Common B are provided with an automatically initiated, delayed, dead bus transfer. The scheme is capable of energizing either bus and its loads from the other bus when the normal source of power (incoming feeder) is lost and the voltage on the bus has decayed to a point that is between 25 and 30 percent of nominal voltage. The transfer is initiated by automatically closing the bus tie breaker following loss of voltage on the bus to be transferred and after checking that the incoming feeder breaker on the bus to be transferred is open. The transfer is blocked if the incoming feeder breaker of the bus to be transferred fails to open. This is the only condition at BNP where the SAT is normally shared between the units. The UAT backfeed voltage analysis, mentioned earlier, considered the voltage conditions where 4.16 kV common buses are cross tied.

The 4.16 kV Balance of Plant bus 1B is equipped with a tie breaker to bus 2B. The tie breaker is racked out and cannot be closed without an engineering evaluation, as required by plant operating procedures 1(2)-OP-50, Plant Electric System Operating Procedure.

NRC QUESTION 4

Discuss the adequacy of your current TS with respect to the June 17 1989, LOOP event.

Question 4 - Response

The current Brunswick Technical Specification requirements are adequate for loss of off-site power events, including the LOOP event that occurred on June 17, 1989. Technical Specifications for the electrical system (AC) are established to assure that adequate electrical power is available under the most limiting accident conditions within the accident analysis. The most limiting accident condition for the Brunswick Plant includes the loss of all off-site power and the loss of one diesel generator. The LOOP event on June 17, 1989 did not place the plant outside this design basis analysis.

Technical Specifications are not uniquely established to provide controls for each design criteria and regulation applicable to the nuclear facilities. As such, Technical Specification 3.8.1.1 was not established to ensure compliance with GDC-17, but was derived from the analyses and evaluation included in the safety analysis report per 10 CFR 50.36. As noted, operation within these specifications assured the health and safety of the public were not threatened when off-site power was lost; therefore, the current technical specifications are considered adequate.

REFERENCES

1. BSEP Preliminary Safety Analysis Report, Chapter VIII, Section 3.0, Plant Auxiliary Power System.

2. BSEP Final Safety Analysis Report, Chapter 8 Appendix F, and Appendix M.

3. BSEP Updated Final Safety Analysis Report, Chapter 8.

4. BSEP Technical Specification 3/4.8 and B3/4.8, Electrical Power Systems.

5. NUREG-0800, Standard Review Plan, Section 8.2, Off-site Power System, Revision 2, July 1981. (BNP was not licensed using this SRP)

6. NUREG-0800, Standard Review Plan, Section 8.3.1, A-C Power Systems (On-site), Revision 2, July 1981. (BNP was not licensed using this SRP)

7. NUREG-0800, Standard Review Plan, Section 8.3.2, D-C Power Systems (On-site), Revision 2, July 1981. (BNP was not licensed using this SRP)

8. Safety Guide 6, Independence Between Redundant Standby (On-site) Power Sources and Between Their Distribution Systems.

9. Regulatory Guide 1.32 (Formerly Safety Guide 32), Use of IEEE Std 308-1971 "Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations", August 11, 1972. (BNP is not committed to this Safety Guide)

10. 10CFR50 Appendix A, General Design Criterion 17, Electric Power Systems, February 20, 1971.

11. 10CFR50 Appendix A, General Design Criterion 17, Electric Power Systems, July 7, 1971.

12. 10CFR50 Appendix A, General Design Criterion 17, Electric Power Systems, January 1, 1988.

13. License Event Report (LER) 2-89-009, Manual Reactor Scram In Accordance with IE Bulletin 88-07 Due to Loss of Both Reactor Recirculation Pumps Following a Unit 2 Loss of Off-site Power, July 17, 1989.

14. NRC Letter NRC-89-643, Summary of 8/18/89 Meeting Regarding The Unit 2 Loss of Off-site Power Event on 6/17/89, September 26, 1989.

15. Technical Specification Interpretation 87-02, Required Off-site Power Sources, March 10, 1987.

16. Letter, NLS-88-050, CP&L to NRC, Technical Specification change request alternate/normal power testing, February 28, 1988.

17. Letter, NLS-89-103, CP&L to NRC, Technical Specification change request withdrawal and bases change request, May 1, 1989.

18. NRC Letter NRC-89-371, Withdrawal of Application for Amendments, May 25, 1989.

19. NRC Letter NRC-89-731, Brunswick Integrated Action Plan Item D1: Re-evaluate the Brunswick Electrical Distribution System for Compliance with GDC-17, November 1, 1989.

20. 1-OP-50, Plant Electric System Operating Procedure, Unit 1, Revision 15.

21. 2-OP-50, Plant Electric System Operating Procedure, Unit 2, Revision 29.

22. IEEE Standard 308-1971, IEEE Standard Criteria for Class 1E Electrical Systems for Nuclear Power Generating Stations.

23. IEEE Standard 308-1974, IEEE Standard Criteria for Class 1E Electrical Systems for Nuclear Power Generating Stations.

24. IEEE Standard 308-1980, IEEE Standard Criteria for Class 1E Electrical Systems for Nuclear Power Generating Stations.

25. IEEE Standard 765-1983, IEEE Standard for Preferred Power Supply for Nuclear Generating Stations. (BNP is not committed to this IEEE Standard)

26. Calculation B8517-E-01-F, Analysis for UAT Backfeed for BSEP Units 1 and 2, Revision 0, September 25, 1985