Tennessee Valley Authority, 1101 Market Street, LP 5A, Chattanooga, Tennessee 37402-2801

July 09, 2008

10 CFR 52.79

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

In the Matter of) Docket No. 52-014 and 52-015
Tennessee Valley Authority)

BELLEFONTE COMBINED LICENSE APPLICATION – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION – ELECTRICAL POWER

Reference: Letter from Tanya Simms (NRC) to Andrea L. Sterdis (TVA), Request for Additional Information Letter No. 026 Related to SRP Section 08.02 for the Bellefonte Units 3 and 4 Combined License Application, dated May 23, 2008.

This letter provides the Tennessee Valley Authority's (TVA) response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) items included in the reference letter.

A response to each NRC request in the subject letter is addressed in the enclosure which also identifies any associated changes that will be made in a future revision of the BLN application.

If you should have any questions, please contact Phillip Ray at 1101 Market Street, LP5A, Chattanooga, Tennessee 37402-2801, by telephone at (423) 751-7030, or via email at pmray@tva.gov.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 9th day of July, 2008.

Andrea L. Sterdis
Manager, New Nuclear Licensing and Industry Affairs
Nuclear Generation Development & Construction

Enclosure
cc: See Page 2

D085
NRO

cc: (Enclosures)
E. Cummins, Westinghouse
S. P. Frantz, Morgan Lewis
M.W Gettler, FP&L
R. C. Grumbir, NuStart
P. S. Hastings, NuStart
P. Hinnenkamp, Entergy
M.C. Kray, NuStart
D. Lindgren, Westinghouse
G. D. Miller, PG&N
M.C. Nolan, Duke Energy
N. T. Simms, Duke Energy
T. Simms, NRC/HQ
G. A. Zinke, NuStart

cc: (w/o Enclosure)
B. Anderson, NRC/HQ
M.M.Comar, NRC/HQ
B. Hughes ,NRC/HQ
R. G. Joshi, NRC/HQ
R. H. Kitchen, PGN
M. C. Kray, NuStart
A. M. Monroe, SCE&G
C. R. Pierce, SNC
R. Register, DOE/PM
L. Reyes, NRC/RII
J. M.Sebrosky, NRC/HQ

Enclosure
TVA letter dated July 09, 2008
RAI Responses

Responses to NRC Request for Additional Information letter No. 026 dated May 23, 2008

(14 pages, including this list)

Subject: Electrical Power in the Final Safety Analysis Report

RAI Number	Date of Response
08.02-01	This letter – see following pages
08.02-02	This letter – see following pages
08.02-03	This letter – see following pages
08.02-04	This letter – see following pages
08.02-05	This letter – see following pages
08.02-06	This letter – see following pages
08.02-07	This letter – see following pages
08.02-08	This letter – see following pages

Attachments / Enclosures	Pages Included
None	

Enclosure
TVA letter dated July 09, 2008
RAI Responses

NRC Letter Dated: May 23, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08.02-01

SRP 8.2-01 Section 8.2.2 of the FSAR states that in order to maintain reactor coolant pump operation for 3 seconds following a turbine trip, the grid voltage on the high side of the main step-up transformer (GSU) and reserve auxiliary transformers (RATs) cannot drop more than 15 percent from the pre-trip steady-state voltage. In this regard, provide the following information: a. What is this pre-trip steady-state voltage? Is it based on worst expected switchyard voltage? b. Is the 15% voltage drop criteria consistent with North American Electric Reliability Corporation (NERC) criteria (or those of a local reliability council)? c. Clarify how the isophase bus steady-state voltage would be maintained within 0.95 – 1.05 per unit if the switchyard voltage is allowed to drop 15%. d. Describe the effect of voltage drop of 15% on the operation of the onsite auxiliary power system equipment including the Class 1E battery chargers and uninterruptible power supplies.

BLN RAI ID: 393

BLN RESPONSE:

a. The pre-trip steady state voltage is between 0.95 and 1.05 per unit (pu) (95-105% of nominal). This is based on steady state requirements prior to the assumed transient. The AP1000 DCD Subsection 8.2, states "The AP1000 safety analyses assume that the reactor coolant pumps can receive power from either the main generator or the grid for a minimum of 3 seconds following a turbine trip." The AP1000 DCD Subsection 8.2, also states "A grid stability analysis to show that, with no electrical system failures, the grid will remain stable and the reactor coolant pump will remain above the voltage required to maintain the flow assumed in the Chapter 15 analyses for a minimum of 3 seconds following a turbine trip is as addressed in subsection 8.2.5."

The Westinghouse acceptance criteria is to maintain the voltage at the Reactor Coolant Pumps to $\geq$ 80% of 6900V (or 5520V) for at least 3 seconds following a turbine trip of the unit, to maintain the reactor coolant flow assumed in the Chapter 15 analyses.

The acceptance criteria defining the maximum voltage drop (0.15 pu) allowed during the 3 second period from the minimum steady state value (0.95 pu) was also provided. This transient voltage drop from minimum steady state defines the maximum allowable voltage drop at the high side of the transformer being used for bus supply in order for Westinghouse design analyses to demonstrate the reactor coolant pump will remain above the 80% voltage required to maintain the flow assumed in the Chapter 15 (Subsection 15.2.3) analyses for a minimum of three seconds following a turbine trip.

In the BLN evaluation, switchyard equipment, including the transformers, was modeled to confirm the required voltage would be available at the generator bus (or high side of the transformer being used for bus supply). As indicated in the FSAR Subsection 8.2.1.1, "The TSP/TSO also maintains switchyard voltage such that steady state voltage on the 26 kV isophase bus is within 0.95 – 1.05 pu of its nominal value." There were several different pre-trip steady-state voltages considered in the grid study. The all-ties-closed area switchyard voltage for Bellefonte is 515 kV or 1.03 pu (27.02 kV at the generator terminals). This voltage was used for the base case with all lines and generators in service. Many scenarios were then studied to

simulate different possible grid contingencies. A series of different pre-trip voltages was studied (corresponding to each different pre-contingency grid configuration).

The worst case pre-trip steady-state voltage (26.24 kV at the generator terminals) occurred when only one BLN unit was operating and the BLN-Madison 500-kV Transmission Line was out of service. This corresponds to the worst expected switchyard voltage for the contingencies studied. The contingency list used in the grid study is considered to be sufficiently extensive and at an appropriate severity level to bound the reasonably expected voltages. Because BLN is close to the TVA area boundary, the list of "outaged" transmission lines included both TVA and other nearby facilities. The list of "outaged" generators also included units in both TVA and other nearby facilities.

b. The TVA Bulk Electric System is designed to meet NERC reliability standards. The NERC standards do not give specific voltage or voltage drop criteria, but require that the system remain stable and consistent with the voltage requirements of the control area. However, maintaining "switchyard voltage such that steady state voltage on the 26 kV isophase bus is within 0.95 – 1.05 pu of its nominal value" would be considered to be consistent with the NERC criteria. Additionally, the 0.15 pu voltage drop criteria for Bellefonte Nuclear Plant is consistent with TVA's practices for nuclear plants, and their applicable grid studies which are designed to meet NERC criteria.

c. The "0.95 to 1.05 per unit" is the steady state condition. A 0.15 pu drop from the lowest point of that range (0.95-0.15 = 0.8) for 3 seconds is the requirement to allow for flow before the RCP begins coast down. This is a methodology (95%-15% =80%) of verifying that that 80% is available at the RCPs. The 0.95-1.05 and the 0.15 pu drop from that point is a deterministic evaluation of RCP voltage. The 0.95 pu is the base from which 0.15 pu is allocated for voltage drop in order to verify adequate RCP voltage. The grid stability analyses indicate that the expected voltage drop is much less than 0.15pu.

d. A transient of 0.15 pu from the steady state condition of 0.95 to 1.05 pu has no adverse affect on plant auxiliary equipment. This transient is less severe than the motor starting transient described in NEMA MG1 for which the plant equipment is designed. As the NEMA MG1 transient bounds the turbine trip 3 second transient, the undervoltage relay scheme settings are designed not to trip during the turbine trip 3 second voltage transient. In specific reference to the uninterruptible power supplies (UPS), the UPS is isolated from the grid voltage by the battery charger and the batteries, and therefore is unaffected by this voltage transient.

In specific reference to the class 1E battery chargers, the battery chargers are a qualified class 1E isolation device. The battery charger function is to provide isolation between input ac and the safety-related dc system and to provide dc source power when ac power is available. Safe shutdown of the plant does not require the support of the battery chargers. The battery charger is designed to allow the battery to support the dc loads during times of ac input undervoltage. This could occur during the 3 second turbine trip transient discussed above during which the RCP must remain above 80% stall voltage. The battery charger supply breaker at the ac motor control center is not designed to trip on this undervoltage condition. Additionally, there is no design requirement in the AP1000 to lock out the battery charger on an ac input undervoltage condition.

This response is PLANT-SPECIFIC.

Enclosure
TVA letter dated July 09, 2008
RAI Responses

ASSOCIATED BLN COL APPLICATION REVISIONS:

No COLA revisions have been identified associated with this response.

ATTACHMENTS/ENCLOSURES:

None

Enclosure
TVA letter dated July 09, 2008
RAI Responses

NRC Letter Dated: May 23, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08.02-02

SRP 8.2-03 RG 1.206, C.III.1, Position C.I.8.2.1 states that a COL applicant for passive design should provide a discussion in the FSAR of how the single designated offsite power circuit from the transmission network conforms with the requirements of GDCs 2, 4, 5, 17 and 18 (also see guidance in Standard Review Plan Section 8.2.II). Discuss how the FSAR addresses this consideration, as well as how TVA intends to meet the requirements of 10 CFR 50.65.

BLN RAI ID: 0394

BLN RESPONSE:

There is no portion of the single required offsite circuit required to conform with GDC's 2, 4, 5, and 18. These GDC's are for structures, systems and components important to safety. For the AP1000, the single offsite circuit does not perform a safety-related function as stated in DCD section 8.1.4. The required offsite circuit interface with the safety related batteries is through the class 1E battery chargers. These battery charges are located within the Nuclear Island which is designed in accordance with GDC's 2, and 4.

Environmental effects are considered in the design of the offsite power circuit. For example, conductors are designed to withstand a particular high temperature (normally 120 degrees C) before violating sag clearances, and transmission lines are designed for high winds, typically 110 mph, and for appropriate levels of snow and ice. Additionally, transmission lines include overhead ground wires and, in an area with a history of lightning strikes or an area of high ground resistivity, have lightning arrestors installed.

The transmission lines and switchyard are designed so the full output of the plants can be carried out to the network, and the capacity is more than sufficient for any incoming power requirements.

Maintenance and testing of the offsite power circuits is discussed in the response to question 08.02-08.

With regard to GDC 17, Regulatory Guide 1.206, Section C.III.1, Position C.I.8.2.1 states that for passive designs "the applicant should provide information on the single offsite power source with sufficient capacity and capability from the transmission network designed to power the safety-related systems and other auxiliary systems under normal, abnormal, and accident conditions. The design of this offsite power source should minimize to the extent practical the likelihood of its failure under normal, abnormal, and accident conditions."

The results of the grid stability analysis demonstrate the offsite source capacity and capability to power plant components during normal, shutdown, startup, and turbine trip conditions.

The results of the failure modes and effects analysis demonstrate the reliability of the offsite source which minimizes the likelihood of its failure under normal, abnormal and accident conditions.

FSAR Section 17.6 describes implementation of the requirements of 10 CFR 50.65. As indicated therein, implementation of the NEI 07-02 program description will determine the applicability of the maintenance requirements for the offsite power circuit.

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

No COLA revisions have been identified associated with this response.

ATTACHMENTS/ENCLOSURES:

None

Enclosure
TVA letter dated July 09, 2008
RAI Responses

NRC Letter Dated: May 23, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08.02-03

SRP 8.2-04 In order for the staff to confirm that the single offsite power circuit provided from the transmission network satisfies the requirements of GDC 17, provide the voltage and frequency variations expected at the 500 kV switchyard. Confirm that these voltage and frequency limits are acceptable for auxiliary power system equipment operation during different operating conditions. The confirmation should include the following calculations: load flow analysis (bus and load terminal voltages of the station auxiliary system); short circuit analysis; equipment sizing studies; protective relay setting and coordination; motor starting with minimum and maximum grid voltage conditions. A separate set of calculations should be performed for each available connection to offsite power supply. In addition, discuss how the results of the calculations will be verified before fuel load.

BLN RAI ID: 0395

BLN RESPONSE:

It is recognized extensively throughout the FSER (NUREG-1793) that there is no requirement for functionality of the offsite power to accomplish safe shutdown of the AP1000. Section 8.2.3.2 of the NRC FSER for the AP1000 addresses the AP1000 partial exemption from GDC 17 and states "The AP1000 design does not rely on power from the offsite system to accomplish safety functions, and therefore, the underlying purpose of the rule is met without the need for two independent offsite circuits." Additionally the Regulatory Guide 1.206 position describes the requested information for a single offsite source for passive plants and that information was addressed in the preceding question, NRC RAI No. 08.02-02.

For the BLN grid voltage evaluation, the 500-kV voltage was set to 515-kV (1.03 pu). This is the anticipated voltage schedule to be set by TVA Operations, and is consistent with standard practice for grid studies at TVA. For an AP1000 turbine trip event, adequate grid voltage is required for 3 seconds. The unit's electric generator will motor immediately following a turbine trip, providing MVAR's to support this voltage, and therefore, the generator bus voltage remains relatively stable. The grid stability analyses are not particularly sensitive to the starting voltage; thus, if the voltage change is minimal at 515 kV it would also be minimal at a lower or higher voltage. When TVA performs grid studies, if the voltage is close to violating a limit, then the grid would be stressed abnormally to see if there was a minimum or maximum voltage limit or a MVAR limit. Since the resulting voltage was not close to its limit, the Bellefonte study did not include these additional variations.

Confirmation that the switchyard voltage and frequency variations are acceptable for auxiliary power system equipment operation during different operating conditions is also addressed by NRC RAI No. 08.02-07.

The above grid voltage evaluation results are verified during the preoperational testing identified in DCD Subsection 14.2.10 which includes the following tests.

- 100 Percent Load Rejection (DCD Subsection 14.2.10.4.21)
- Plant Trip from 100% Power (DCD Subsection 14.2.10.4.24)
- Loss of Offsite Power (DCD Subsection 14.2.10.4.26)

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

No COLA revisions have been identified associated with this response.

ATTACHMENTS/ENCLOSURES:

None

Enclosure
TVA letter dated July 09, 2008
RAI Responses

NRC Letter Dated: May 23, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08.02-04

SRP 8.2-05 Section 8.2.2 of the BNL FSAR discusses grid stability studies and the assumptions made for load flow, transient stability, and fault analysis. The staff notes that the stability study analyzed used the summer off-peak base case while the load flow studies analyzed used summer peak base case. In this regard provide the following information: a. Explain why the stability studies used a summer off-peak base case while the load flow study used the summer peak base case. b. Provide TVA's basis for choosing the grid voltage of 515 kV in lieu of minimum expected grid voltage in TVA's analysis. c. Explain whether this analysis includes worst-case disturbances for which the grid has been analyzed to remain stable.

BLN RAI ID: 0396

BLN RESPONSE:

a) Both the stability and load flow were analyzed with summer peak cases. The FSAR will be revised as indicated in the Application Revisions section below.

b) This item is addressed in the response to NRC RAI No. 08.02-01.

c) This item is addressed in the response to NRC RAI No. 08.02-01.

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

COLA Part 2, FSAR, Chapter 8, Subsection 8.2.2 will be revised from:

- A summer off-peak base case is used for stability studies.

To read:

- A summer peak base case is used for stability studies.

ATTACHMENTS/ENCLOSURES:

None

NRC Letter Dated: May 23, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08.02-05

SRP 8.2-06 Section 8.2-1of the FSAR states that "The secondary windings (500 kV side) of the GSU are connected in wye configuration and connected to the 500 kV switchyard." Clarify whether this statement should refer to the primary winding of the transformer connected to the switchyard.

BLN RAI ID: 0397

BLN RESPONSE:

The FSAR will be revised to provide the requested clarification as shown in the Application Revisions section below.

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

COLA Part 2, FSAR, Chapter 8, Subsection 8.2.1.2 will be revised from:

The secondary windings (500 kV side) of the GSU are connected in wye configuration and connected to the 500 kV switchyard.

To read:

The high side (500 kV) winding of the GSUs is connected in wye configuration to the 500 kV switchyard.

ATTACHMENTS/ENCLOSURES:

None

Enclosure
TVA letter dated July 09, 2008
RAI Responses

NRC Letter Dated: May 23, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08.02-06

SRP 8.2-07 The final paragraph of GDC 17 requires, in part, provisions to minimize the probability of the loss of power from the transmission network given a loss of the power generated by the nuclear power unit(s). Describe any limits on the main generator MVAR output such that loss of the main generator will not result in an unacceptable voltage in the switchyard. Describe any auxiliary transmission system equipment, such as capacitor banks, static VAR compensators that may be necessary to offset loss of MVAR support on loss of the main generator.

BLN RAI ID: 0398

BLN RESPONSE:

The grid stability analysis did not identify a need to limit the generator MVAR output due to impacts on the switchyard voltage. A range of unit/plant MVAR output levels (within the vendor supplied capabilities) were simulated for various grid configurations. In each instance, the switchyard voltage remained acceptable for the simulated loss of a Bellefonte unit(s). The Bellefonte 500 kV switchyard simulation considered a transmission network with five generation resources (dynamic VAR sources) interconnected within 1-2 buses of the Bellefonte switchyard. No capacitor banks or static VAR compensators are currently planned for the Bellefonte switchyard.

This response is PLANT SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

No COLA revisions have been identified associated with this response.

ATTACHMENTS/ENCLOSURES:

None

Enclosure
TVA letter dated July 09, 2008
RAI Responses

NRC Letter Dated: May 23, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08.02-07

SRP 8.2-08 Section 8.2.2 of the FSAR states that "the grid stability analysis has confirmed that the interface requirements for steady state load, inrush kVA for motors, nominal voltage, allowable voltage regulation, nominal frequency, allowable frequency fluctuation, maximum frequency decay rate, and limiting under frequency values for RCP have been met." Provide the summary of the grid stability analysis results, the assumptions made, and the acceptance criteria used for the each case analyzed. In addition, provide the nominal frequency, allowable frequency fluctuation, maximum frequency decay rate and limiting under frequency values used for the RCPs in the analysis.

BLN RAI ID: 0399

BLN RESPONSE:

The requested summary of the grid stability analysis results is provided below, including the nominal frequency, allowable frequency fluctuation, maximum frequency decay rate and limiting under frequency values used for the RCPs in the analysis.

DCD Table 1.8-1 item 8.2 Parameter	**WEC AC requirements**	**BLN value assumed**
Steady-state load	"normal running values provided as input to grid stability"	"normal running values provided as input to grid stability"
Inrush kVA for motors	56,712 KVA*	88,969 KVA
Nominal voltage	Not provided	1.03 pu (515 KV)
Allowable voltage regulation	0.95-1.05 pu steady state ±20% total for transient	0.95-1.05 pu steady state ±20% total for transient
Nominal frequency	60 Hz assumed	60 Hz
Allowable frequency fluctuation	±½ Hz indefinite	±½ Hz indefinite
Maximum frequency decay rate	5 Hz/sec	5 Hz/sec

* - Based on the inrush of a single 10,000 HP feedwater pump assuming efficiency = 0.95, pf= 0.9, and inrush = 6.5X FLA.

DCD Table 1.8-1 item 8.2 Parameter	**WEC acceptance criteria**	**BLN value calculated**
Limiting under frequency value for RCP	≥57.7 Hz	>59 Hz

For the DBE simulation and the unit tripped simulation, the voltages remained above 0.95 pu. For the 3-phase normally cleared fault the 26-kV voltage recovered to 0.85 pu immediately after the fault cleared in 5 cycles.

For the DBE, it is assumed that the unit experiencing the DBE remains connected to the grid for at least 15 seconds. Loads for normal shutdown or shutdown in the event of a DBE are the same as normal running loads.

The acceptance criteria were obtained from Westinghouse. For a transient, the 26-kV voltage must remain between 0.95 and 1.05 pu or drop no more than 0.15 pu.

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

No COLA revisions have been identified associated with this response.

ATTACHMENTS/ENCLOSURES:

None

Enclosure
TVA letter dated July 09, 2008
RAI Responses

NRC Letter Dated: May 23, 2008

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 08.02-08

SRP 8.2-09 Section 8.2.1.4 of the FSAR discusses maintenance, testing, and calibration practices that Power Systems Operations (PSO) follows. It states that PSO also observes Federal Energy Regulatory Commission (FERC) requirements and NERC reliability standards. Explain whether this statement is intended to indicate that TVA will follow the FERC and NERC standards for switchyard maintenance and testing.

BLN RAI ID: 0400

BLN RESPONSE:

The statement was intended to indicate that TVA follows the applicable NERC Reliability Standards associated with switchyard maintenance and testing. The confusing paragraph will be revised as identified in the Application Revisions section below.

This response is PLANT-SPECIFIC.

ASSOCIATED BLN COL APPLICATION REVISIONS:

COLA Part 2, FSAR, Chapter 8, Subsection 8.2.1.4 will be revised from:

For performance of maintenance, testing, calibration and inspection, PSO follows its own field test manuals, vendor manuals and drawings, industry's maintenance practices and observes Federal Energy Regulatory Commission (FERC) requirements and the following NERC Reliability Standards.

- PRC-005-1 Transmission and Generation Protection System Maintenance and Testing.
- PRC-008-0 Under Frequency Load Shedding Equipment Maintenance Program.
- PRC-011-0 Under Voltage Load Shedding System Maintenance and Testing, and Field Test Procedure.

To read:

For performance of maintenance, testing, calibration and inspection, PSO follows its own field test manuals, vendor manuals and drawings, and industry maintenance practices to comply with applicable NERC Reliability Standards.

ATTACHMENTS/ENCLOSURES:

None