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Dominion®

May 12, 2011

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

Serial No. NA3-11-003RA
Docket No. 52-017
COL/MWH

DOMINION VIRGINIA POWER
NORTH ANNA UNIT 3 COMBINED LICENSE APPLICATION
SRP 08.02: RESPONSE TO RAI LETTER 54

On February 3, 2011, the NRC requested additional information to support the review of certain portions of the North Anna Unit 3 Combined License Application (COLA). The responses to the following seven Request for Additional Information (RAI) Questions are provided in Enclosures 1 through 7:

- RAI 5181 Question 08.02-42 — GDC 5 Compliance
- RAI 5181 Question 08.02-43 — Switchyard Equipment Ratings (parts d and e)
- RAI 5181 Question 08.02-45 — Switchyard Grounding and Lightning Protection
- RAI 5181 Question 08.02-50 — Adequate Power to RCPs After Trip
- RAI 5181 Question 08.02-52 — Grid Reliability and Stability Analysis
- RAI 5181 Question 08.02-54 — Switchyard Voltage Limits
- RAI 5181 Question 08.02-55 — Switchyard Frequency Variations

This information will be incorporated into a future submission of the North Anna Unit 3 COLA, as described in the enclosures.

Please contact Regina Borsh at (804) 273-2247 (regina.borsh@dom.com) if you have questions.

Very truly yours,

Eugene S. Grecheck

D089
NRO

COMMONWEALTH OF VIRGINIA

COUNTY OF HENRICO

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Eugene S. Grecheck, who is Vice President-Nuclear Development of Virginia Electric and Power Company (Dominion Virginia Power). He has affirmed before me that he is duly authorized to execute and file the foregoing document on behalf of the Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 12th day of May, 2011
My registration number is 7173057 and my
Commission expires: August 31, 2012

Wanda K. Marshall
Notary Public

WANDA K. MARSHALL
Notary Public
Commonwealth of Virginia
7173057
My Commission Expires Aug 31, 2012

cc: U. S. Nuclear Regulatory Commission, Region II
C. P. Patel, NRC
T. S. Dozier, NRC
J. T. Reece, NRC

Enclosures:

1. Response to NRC RAI Letter Number 54, RAI 5181 Question 08.02-42
2. Response to NRC RAI Letter Number 54, RAI 5181 Question 08.02-43 (parts d and e)
3. Response to NRC RAI Letter Number 54, RAI 5181 Question 08.02-45
4. Response to NRC RAI Letter Number 54, RAI 5181 Question 08.02-50
5. Response to NRC RAI Letter Number 54, RAI 5181 Question 08.02-52
6. Response to NRC RAI Letter Number 54, RAI 5181 Question 08.02-54
7. Response to NRC RAI Letter Number 54, RAI 5181 Question 08.02-55

Commitments made by this letter:

1. Incorporate proposed changes in a future COLA submission.

ENCLOSURE 1

Response to NRC RAI Letter 54

RAI 5181 Question 08.02-42

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5181 (RAI Letter 54)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 02/03/2011

QUESTION NO.: 08.02-42

The North Anna 3 switchyard is shared among North Anna Units 1, 2 and 3. Accordingly, GDC 5 appears applicable. Revision 3 of the application incorporates the US APWR design where offsite power is important to safety. GDC 5 requires that component parts of the offsite power system not be shared among units without sufficient justification, thereby ensuring that an accident in one unit of a multi-unit facility can be mitigated using an available complement of mitigative features, including required ac power, irrespective of conditions in the other units and without giving rise to conditions unduly adverse to safety in another unit. RG 1.32 provides acceptable guidance related to the sharing of structures, systems, and components of the preferred offsite power system. Discuss in the FSAR how GDC 5 is met specifically the capacity of transmission lines to adequately support auxiliary loads of one unit during an accident where the other two units are in a safe shutdown condition.

Dominion Response

As described in FSAR Section 8.2.1.2.1, the preferred power system has two physically and electrically independent lines beginning at the switchyard and providing offsite power to North Anna Unit 3: an overhead 500 kV circuit for the alternate preferred power supply; and an underground 230 kV circuit for the normal preferred power supply. These lines are not shared with any other unit.

GDC 5 applies to SSCs that are "important to safety." The introduction to 10 CFR 50, Appendix A, *General Design Criteria for Nuclear Power Plants*, defines important to safety as "...structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public."

In December 2008, NEI submitted a position paper [Email from Russ Bell (NEI) to Tom Bergman (NRC), *NRO Directors Issue Resolution Process*, dated December 19, 2008 {ML090060684}] regarding the applicability of GDC 2, 4, and 5 to the offsite power system. The central theme of that paper was that the offsite power system is not important to safety, and that GDC 2, 4, and 5 are not applicable to the offsite power system. In response to this paper [Email from Tom Bergman (NRC) to Russ Bell (NEI), *NRC response to GDC 2, 4 and 5 one-pager*, dated January 23, 2009 {ML090260039}], the NRC staff stated that GDC 2 and 4 are not applicable to the offsite power system, but stated that "...GDC 5 would only apply where systems are shared among units." It is unclear in the email what the scope of the term "systems" means. Nevertheless, because GDC 2, 4, and 5 only apply to SSCs that are important to safety, the basis for concluding that GDC 2 and 4 are not applicable to offsite power system also supports a conclusion that GDC 5 is not applicable to the offsite power system.

NRC has not required the operating nuclear plants to comply with GDC 5 for the offsite portion of the preferred power system. North Anna Units 1 and 2 share portions of the switchyard with Unit 3, and with each other. The North Anna Unit 1/Unit 2 UFSAR, Section 3.1.5.2 describes compliance with GDC 5 and does not list this criterion as being applicable to the switchyard. The North Anna Unit 1/Unit 2 UFSAR, Section 8.2.2 states that the offsite power system meets GDC 17 but does not reference GDC 5. The NRC Final Safety Evaluation Report (FSER) for North Anna Units 1 and 2 (NUREG-0053), Chapter 8, evaluated the offsite power system including the common switchyard and states in Section 8.1 that GDC 17 and 18 (in addition to applicable standards and regulatory guides) were used as the bases for the staff's evaluation of the safety related electrical power systems. The staff FSER does not reference GDC 5. In FSER Section 8.2, *Offsite Power*, the NRC staff concluded that the facility offsite power system meets the requirements of Criteria 17 and 18 of the GDC and is, therefore, acceptable.

The offsite power system for Unit 3 conforms to GDC 17. GDC 17 specifies requirements for the offsite power system regarding independence, capacity, and capability. GDC 17 does not specify that it is applicable only to systems important to safety, as does GDC 5. Although Dominion concludes that compliance with GDC 5 is not required, the updated system impact study, *PJM Generator Interconnection Q65 North Anna 500 kV (1594 MW Capacity) Revised System Impact Study and Facilities Study Report Resulting from Necessary Studies Agreement*, dated April 2011, demonstrates the capacity and capability of the offsite electric power system as required by GDC 17. The results of the study shows, in Case NP 4, that adequate capacity exists to support the auxiliary loads of one unit connected to the North Anna switchyard during an accident while providing for an orderly shutdown and cooldown of the remaining units.

Therefore, the offsite power system has been shown to have adequate capacity to support auxiliary loads of one unit during an accident when the other two units are in a safe shutdown condition. This system impact study analysis case will be included in FSAR Section 8.2.2.2.

Proposed COLA Revision

FSAR Section 8.2.2.2 mark-up is provided with the response to RAI 5181, Question 08.02-52.

ENCLOSURE 2

Response to NRC RAI Letter 54

RAI 5181 Question 08.02-43 (parts d and e)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5181 (RAI Letter 54)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 02/03/2011

QUESTION NO.: 08.02-43

FSAR Subsection 8.2.1.2.1 provides ratings of transformers, breakers, transmission lines and bus work. Please provide the following in the FSAR: (a) The ratings of disconnect switches, (b) identifiers for transformers in the text of FSAR Subsection 8.2.1.2.1, (c) the switchyard bus bracing values, (d) the maximum available fault current from the system and confirm that the breaker interrupting ratings, both symmetrical and asymmetrical, are consistent with the available fault, and (e) statements of assumptions and results of short circuit analysis.

Dominion Response

The responses to parts (a), (b), and (c) of this question were provided in Dominion letter NA3-11-003R dated March 17, 2011. The following supplements the response provided in that letter by providing responses to Parts (d) and (e) of the question.

Part (d)

FSAR Section 8.2.2.2 describes the system impact study that was performed as part of the grid reliability and stability analysis. The study has been updated by the regional transmission organization (PJM Interconnection) to incorporate the US-APWR specific generation data. The new report, *PJM Generator Interconnection Q65 North Anna 500 kV (1594 MW Capacity) Revised System Impact Study and Facilities Study Report Resulting from Necessary Studies Agreement*, dated April 2011, is a publicly available document.

The Short Circuit Analysis Results section of the report includes a table that shows the symmetrical and asymmetrical fault currents available at each circuit breaker in the North Anna switchyard. Following completion of system reinforcements required for interconnection of Unit 3 and as identified in the Facilities Study Results section of the report, all circuit breakers in the North Anna 500 kV switchyard will have an interrupting rating of 50 kA, which exceeds the maximum calculated symmetrical and asymmetrical fault currents. Also, the short circuit analysis verified that symmetrical and asymmetrical fault currents available in the 230 kV switchyard do not exceed the 230 kV breaker ratings (40 kA). FSAR Section 8.2.2.2 will be revised to include maximum system fault current and breaker interrupt rating.

Part (e)

Assumptions and results of the short circuit analysis are provided in the Short Circuit section of the *PJM Generator Interconnection Q65 North Anna 500 kV (1594 MW Capacity) Revised System Impact Study and Facilities Study Report Resulting from Necessary Studies Agreement* report.

Proposed COLA Revision

FSAR Section 8.2.2.2 mark-up provided with the response to RAI 5181, Question 08.02-52.

ENCLOSURE 3

Response to NRC RAI Letter 54

RAI 5181 Question 08.02-45

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5181 (RAI Letter 54)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 02/03/2011

QUESTION NO.: 08.02-45

US-APWR DCD, Rev.2, Subsection 8.3.1.1.11 states that the design of the grounding system follows the procedures and recommended practices stated in IEEE Std. 80, 81,142, 524a and 665. Additionally, the US-APWR DCD states that the design of the lightning protection is in accordance with NFPA-780. The US-APWR DCD also states that the lightning protection system is designed in accordance with IEEE Std. 665, 666, 1050 and C62.23 as endorsed by RG 1.204. Additionally, FSAR Table 1.9-202 indicates that North Anna 3 conforms to RG 1.204. Confirm that the grounding system and lightning protection system design is consistent with the guidance of RG 1.204. Please include those standards in North Anna 3 FSAR or provide justification for not including them.

Dominion Response

The descriptions of the grounding and lighting protection systems in DCD Section 8.3.1.1.11 are for the standard plant portions of the US-APWR facility. This section of the DCD is incorporated into the North Anna FSAR without exception. The North Anna switchyard grounding and lighting protection systems are site-specific and are not designed to meet the same standards as listed in DCD Section 8.3.1.1.11.

Regulatory Guide 1.204, *Guidelines for Lightning Protection of Nuclear Power Plants*, provides guidance for the design and installation of lightning protection systems for power plants and the switchyards. Regulatory Guide 1.204 endorses the following four standards issued by the Institute of Electrical and Electronics Engineers (IEEE) for providing comprehensive lightning protection system guidance for nuclear power plants:

- IEEE Std. 665-1995 (R2001), *IEEE Guide for Generating Station Grounding*
- IEEE Std. 666-1991 (R1996), *IEEE Design Guide for Electrical Power Service Systems for Generating Stations*
- IEEE Std. 1050-1996, *IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations*

- IEEE Std. C62.23-1995 (R2001), *IEEE Application Guide for Surge Protection of Electric Generating Plants*

IEEE Stds. 665, 666, and 1050 provide design and installation practices relevant to the standard plant. IEEE Std. 665 also provides recommended practices for connecting the power plant grounding grid to the switchyard grounding grid. The North Anna switchyard grounding grid connection to the plant grid is consistent with IEEE Std. 665.

IEEE Std. C62.23 provides lightning protection system recommended practices for switchyard and transmission systems as well as the power plant. The North Anna switchyard is an existing facility and is described in FSAR Section 8.2.1.2.1. The switchyard design and construction was performed in the 1970's in accordance with Dominion substation engineering design practices, and predates the issuance of IEEE Std. C62.23. As a result, the North Anna switchyard lightning protection system design is not fully compliant with IEEE Std. C62.23.

DCD Section 8.2.2.1 states that the US-APWR offsite power supply design fully conforms to the requirements of the IEEE standards endorsed by Regulatory Guide 1.204 that pertain to the lightning protection of nuclear power plants. The site-specific portion of the offsite power supply meets alternative standards for lightning protection system design as described below.

The North Anna switchyard grounding system, which overlays an older grounding system, was designed and installed in accordance with the Dominion Substation Engineering Manual and IEEE Std. 80, *IEEE Guide for Safety in AC Substation Grounding.* In accordance with IEEE Std. 80, the switchyard ground grid resistance is less than 1 ohm. The switchyard grounding grid is connected to the station grounding grid which is described in DCD Section 8.3.1.1.11. The connection utilizes conductors installed directly under the tie lines to the MT in accordance with the recommendations of IEEE Std. 665.

As described in FSAR Section 8.2.1.2.1, the North Anna switchyard lighting protection system uses surge suppressors on the high and low sides of Transformers 1, 2, 3, 5, and 6. The insulation coordination and surge protective devices are applied in compliance with IEEE Std. 1313.2, *IEEE Guide for the Application of Insulation Coordination* and IEEE Std. C62.22, *IEEE Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems.* The surge protective devices are maintained according to NEMA requirements and manufacturer's recommendations.

A shield wire arrangement is designed for lightning abatement in the switchyard in accordance with IEEE C62.22, IEEE 998, *IEEE Guide for Direct Lightning Stroke Shielding of Substations*, and reference book entitled *Insulation Coordination for Power Systems.*

Induced signals are minimized by using shielded cable with parallel, grounded messenger cables continuously from field equipment into the switchyard control houses. Grounded messenger cables are bonded to the control house cable tray. Open racks are bonded to the same ground. Microprocessor circuits are routed separately from power and control circuits within the control houses. Telecommunications cables and communications/data circuits are gathered at the telephone backboard in the control house and grounded to a single isolated ground bar that is connected to the substation ground. Fiber optic cabling is used to transmit information from data collectors in the control house to offsite locations.

FSAR Table 1.9-202 will be revised to indicate an exception to Regulatory Guide 1.204 regarding compliance with IEEE Std. C62.23 for the switchyard lightning protection system design.

FSAR Sections 8.2.1.2.1 and 8.2.2.1 will be revised to provide additional description of the grounding and lightning protection systems.

Proposed COLA Revision

FSAR Table 1.9-202, and Sections 8.2.1.2.1 and 8.2.2.1, will be revised as indicated on the attached markup.

Markup of North Anna COLA

The attached markup represents Dominion's good faith effort to show how the COLA will be revised in a future COLA submittal in response to the subject RAI. However, the same COLA content may be impacted by revisions to the DCD, responses to other COLA RAIs, other COLA changes, plant design changes, editorial or typographical corrections, etc. As a result, the final COLA content that appears in a future submittal may be somewhat different than as presented herein.

NAPS COL 1.9(1)

Table 1.9-202 Conformance with Regulatory Guides

RAI 08.02-45

RG Number	Title	Revision	Date	RG Position	Evaluation
1.204	Guidelines for Lightning Protection of Nuclear Power Plants	Rev. 0	Nov-05	General	Conforms, with the following exception to regulatory position 1: NAPS switchyard is not designed in accordance with IEEE Std C62.23. Switchyard lightning protection is described in Section 8.2.1.2.1.
1.205	Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants	Rev. 1	Dec-09	General	Not applicable. Risk-informed, performance-based fire protection is not used.
1.206	Combined License Applications for Nuclear Power Plants (LWR Edition)	Rev. 0	Jun-07	General	Conforms with exceptions. See exception to RG 1.8, RG 1.33 and SRP 13.1.1.
1.207	Guidelines for Evaluating Fatigue Analyses Incorporating the Life Reduction of Metal Components Due to the Effects of the Light-Water Reactor Environment for New Reactors	Rev. 0	Mar-07	General	Conforms

NAPS COL 8.2(4)
NAPS COL 8.2(5)

Add the following information after the last sentence of the second paragraph in DCD Subsection 8.2.1.2.

Neither the grid stability analysis in Subsection 8.2.2.2 nor the failure modes and effects analysis (FMEA) in Subsection 8.2.2.3 identified the non-safety related offsite power system as risk-significant during any mode of plant operation.

STD* COL 8.2(10)

Replace the last sentence of the fifteenth paragraph in DCD Subsection 8.2.1.2 with the following.

In case of a sudden pressure relay operation, the transformer is isolated.

NAPS COL 8.2(4)
NAPS COL 8.2(5)

Replace the second sentence of the eighteenth paragraph in DCD Subsection 8.2.1.2 with the following

Minimum one-hour fire barriers are provided between all transformers. Cables associated with the normal and alternate PPS between the switchyard and the electrical room in the T/B are routed in separate underground duct bank. Normal and alternate PPS cables are physically separated which minimizes the chance of simultaneous failure. The underground duct bank for these circuits is sealed to prevent degradation in wetted or submerged condition.

8.2.1.2.1 Switchyard

NAPS COL 8.2(3)

Replace the content of DCD Subsection 8.2.1.2.1 with the following.

The NAPS switchyard, is a 500/230 kV, air-insulated, breaker-and-a-half bus arrangement. Unit 3 is connected to this switchyard by an overhead 500 kV circuit for the alternate preferred power supply and an underground 230 kV circuit for the normal preferred power supply. The two circuits are physically and electrically independent.

The physical location and electrical interconnection of the switchyard is shown on Figure 8.2-201 and Figure 8.2-202.

RAI 08.02-49 **NAPS COL 8.2(8)**
NAPS COL 8.2(9)

~~Control and relay protection systems are provided. Support systems, such as grounding, raceway, lighting, AC/DC station service, and switchyard lightning protection, are also provided.~~

AC Power is fed to the 500 kV and 230 kV switchyard control houses from switchyard service transformers. Each switchyard service transformer is a 19.9 kV/120-240V transformer and is aligned using manual throw switches. Multiple switchyard service transformers can be aligned to both the 500 kV and 230 kV control houses.

DC power for the 500 kV switchyard controls is provided by two systems from separate and completely independent batteries and chargers. Each DC system in the 500 kV house consists of a single lead-acid storage battery maintained by two chargers (one as normal and one as backup). The batteries are located in separate, ventilated rooms of the control house. The chargers are located in the same room in the central part of the control house and are separated to minimize interaction. The 500 kV control house battery chargers can be fed from any of the AC power sources supplying the 500 kV control house, but are typically powered from separate sources.

DC power for the 230 kV switchyard controls is provided by a separate system located in the 230 kV switchyard control house. This system consists of a single lead-acid storage battery maintained by two chargers (one as normal and one as backup). The 230 kV control house battery chargers are fed from the AC power source supplying the 230 kV control house.

The batteries are sized in accordance with Dominion substation engineering standards and the sizing is verified using the manufacturer's sizing program that adheres to battery sizing methodologies found in IEEE 485 (Reference 8.2-210). Battery charger sizing is verified in accordance with Dominion substation engineering standards.

The switchyard grounding system, which overlays an older grounding system, was designed and installed in accordance with the Dominion Substation Engineering Manual and IEEE 80 (Reference 8.2-211). In accordance with IEEE 80, the switchyard ground grid resistance is less than 1 ohm.

RAI 08.02-45 The switchyard grounding grid is connected to the station grounding grid. The connection utilizes conductors installed directly under the tie lines to the MT in accordance with the recommendations of IEEE Std 665 (Reference 8.2-214).

The North Anna switchyard uses surge suppressors on the high and low
RAI 08.02-45 sides of Transformers 1, 2, 3, 5, and 6 to protect equipment from voltage surges, including lightning events. The insulation coordination and surge protective devices are applied in compliance with IEEE 1313.2

(Reference 8.2-203) and IEEE C62.22 (Reference 8.2-204). The surge protective devices are maintained according to NEMA requirements and manufacturer's recommendations.

A shield wire arrangement is designed for lightning abatement in the switchyard in accordance with IEEE C62.22 (Reference 8.2-204), IEEE 998 (Reference 8.2-205), and reference book entitled "Insulation Coordination for Power Systems"(Reference 8.2-206).

Induced signals are minimized by using shielded cable with parallel, grounded messenger cables continuously from field equipment into the switchyard control houses. Grounded messenger cables are bonded to the control house cable tray. Open racks are bonded to the same ground. Microprocessor circuits are routed separately from power and control circuits within the control houses. Telecommunications cables and communications/data circuits are gathered at the telephone backboard in the control house and grounded to a single isolated ground bar that is connected to the substation ground. Fiber optic cabling is used to transmit information from data collectors in the control house to offsite locations.

RAI 08.02-43

The capacity and electrical characteristics for switchyard equipment are as follows:

Transformers	**Voltage Rating**	**MVA Rating**
~~Transformer~~ 1 and 2	500/~~230~~ 36.5 kV	~~67.2/89.6/112~~ 60/80/100/112
3	230/36.5 kV	67.2/89.6/112
~~Transformer~~ 5 and 6	500/230 kV	~~112/145~~ 67.2/89.6/112

Breakers	**Max Design ~~(kV)~~ Voltage**	**Rated Current ~~(A)~~**	**Interrupting Current at Max kV**
500 kV	550 kV	3000A	50 kAIC
230 kV	242 kV	2000A	40 kAIC

Disconnect Switch	**Maximum Voltage**	**Basic Impulse Insulation Level**	**Continuous Current Rating**
500 kV	550 kV	1550 kV	3000A

The operations shift manager has the responsibility for the safe operation of North Anna Unit 3, including authorizing the operation and maintenance of switchyard equipment.

RAI 08.02-40

~~Normal operating and abnormal~~ Operating procedures exist to maintain the switchyard voltage within the limits of the normal voltage schedule ~~and address challenges to the maximum and minimum limits~~. Upon ~~approaching or exceeding a limit~~ deviation from the normal voltage schedule, these procedures verify the availability of required and contingency equipment and materials, and direct notifications to outside agencies, until the normal voltage schedule can be ~~maintained~~ restored.

The TSO provides analysis capabilities for both Long Term Planning and Real Time Operations. System conditions are evaluated to ensure a bounding analysis and model parameters are selected that are influential in determining the system's ability to provide offsite power adequacy. Elements included in the analysis are system load forecasts (including sufficient margin to ensure a bounding analysis over the life of the study), system generator dispatch (including outages of generators known to be particularly influential in offsite power adequacy of affected nuclear units), outage schedules for transmission elements that have significant influence on offsite power adequacy, cross-system power transfers and power imports/exports, and system modification plans and schedules. A Real Time State Estimator is used to assist in the evaluation of actual system conditions. These capabilities are described in the System Analysis Protocol of the Switchyard Interface Agreement.

8.2.2.1 Applicable Criteria

NAPS DEP 8.2(1)

Delete the first bullet line and following paragraph and the second bullet line and following paragraph in this section.

RAI 08.02-45 **NAPS COL 8.2(3)**

Add the following sentence at the end of the paragraph following the twelfth bullet line in this section.

The site-specific portion of the offsite power supply design meets alternate standards for the North Anna switchyard lightning protection system design as described in Section 8.2.1.2.1.

RAI 08.02-46 8.2-208 NERC Standard PRC-008-0, "Implementation and Documentation of Underfrequency Load Shedding Equipment Maintenance Program," April 1, 2005

RAI 08.02-46 8.2-209 NERC Standard PRC-017-0, "Special Protection System Maintenance and Testing," April 1, 2005

RAI 08.02-49 8.2-210 IEEE Std 485-1997, "IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications"

RAI 08.02-49 8.2-211 IEEE Std 80-2000, "IEEE Guide for Safety in AC Substation Grounding"

RAI 08.02-41 8.2-212 INPO Significant Operating Experience Report (SOER) 99-1, "Loss of Grid," dated December 27, 1999 and SOER 99-1 "Loss of Grid – Addendum," dated December 9, 2004

RAI 08.02-41 8.2-213 NERC Standard NUC-001, Revision 1, "Nuclear Plant Interface Coordination"

RAI 08.02-45 8.2-214 IEEE Std 665-1995 (R2001), "IEEE Guide for Generating Station Grounding"

ENCLOSURE 4

Response to NRC RAI Letter 54

RAI 5181 Question 08.02-50

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5181 (RAI Letter 54)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 02/03/2011

QUESTION NO.: 08.02-50

FSAR Subsection 8.2.2.2 states that stability of the grid will be studied to confirm that after a turbine trip, adequate power to the RCPs is maintained for at least three seconds as required in the transient and accident analysis in Chapter 15. Provide the results of an analysis that demonstrates that after a turbine trip, adequate power to the RCPs is maintained for at least three seconds.

Dominion Response

FSAR Section 8.2.2.2 describes the system impact study that was performed as part of the grid reliability and stability analysis. The study has been updated by the regional transmission organization (PJM Interconnection) to incorporate the US-APWR specific generation data. The new report, *PJM Generator Interconnection Q65 North Anna 500 kV (1594 MW Capacity) Revised System Impact Study and Facilities Study Report Resulting from Necessary Studies Agreement,* dated April 2011, is a publicly available document.

Attachment A of the report includes case 4.4.a that evaluates the stability of the transmission system resulting from a trip of Unit 3. Table 1a shows the results of this contingency as case NP 1 and shows that the transmission system remains stable and capable of powering the reactor coolant pumps for at least 3 seconds following unit trip. During the 3 seconds, voltage and frequency do not exceed the interface requirements given in DCD Section 8.2.3. FSAR Section 8.2.2.2 will be revised to identify the results of the system impact study related to maintaining power to the reactor coolant pumps for at least 3 seconds following unit trip.

Proposed COLA Revision

FSAR Section 8.2.2.2 mark-up provided with the response to RAI 5181, Question 08.02-52.

ENCLOSURE 5

Response to NRC RAI Letter 54

RAI 5181 Question 08.02-52

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5181 (RAI Letter 54)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 02/03/2011

QUESTION NO.: 08.02-52

FSAR Subsection 8.2.2.2 states that "The system will be studied under conditions including loss of the largest generating unit, loss of the most critical transmission line, and multiple facility contingencies." Provide assumptions and results of the study.

Dominion Response

FSAR Section 8.2.2.2 describes the system impact study that was performed as part of the grid reliability and stability analysis. The study has been updated by the regional transmission organization (PJM Interconnection) to incorporate the US-APWR specific generation data. The new report, *PJM Generator Interconnection Q65 North Anna 500 kV (1594 MW Capacity) Revised System Impact Study and Facilities Study Report Resulting from Necessary Studies Agreement,* dated April 2011, is a publicly available document. PJM evaluated cases representing loss of the largest generating unit, loss of the most critical transmission line, and multiple facility contingencies to determine which were most limiting. Assumptions and results are described in the report under sections titled System Impact Study Analyses, Facilities Study Results, and Attachment A – Q65 Stability Study Report.

FSAR Section 8.2.2.2 will be revised to include the results of the updated system impact study.

Proposed COLA Revision

FSAR Sections 8.2.2.2 and 8.2.5 will be revised as indicated on the attached markup.

Markup of North Anna COLA

The attached markup represents Dominion's good faith effort to show how the COLA will be revised in a future COLA submittal in response to the subject RAI. However, the same COLA content may be impacted by revisions to the DCD, responses to other COLA RAIs, other COLA changes, plant design changes, editorial or typographical corrections, etc. As a result, the final COLA content that appears in a future submittal may be somewhat different than as presented herein.

NAPS COL 8.2(11) Add the following new subsections after DCD Subsection 8.2.2.1.

8.2.2.2 Grid Reliability and Stability Analysis

RAI 08.02-52

~~A system impact study was performed for the interconnection of an ESBWR of similar size and machine characteristics as the US-APWR to analyze load flow, import/export capability, short circuit analysis, and system stability. (Reference 8.2-201) The study was prepared using 2011 summer light load and 2014 summer base case projections.~~

~~The analysis was performed using Power Technology International Software PSS/E. The system was studied under single and double contingency conditions.~~

~~The equipment considered is from the point of interconnection of Unit 3 to the switchyard out to the 500 kV transmission system. This included the 230 kV buses and interconnections. The 34.5 kV portion of the North Anna switchyard is not modeled separately, but the 34.5 kV loads are considered at the 500 kV level. Maximum and minimum switchyard voltage limits have been established for the 500 kV switchyard at 534 kV and 505 kV, respectively.~~

~~The study concluded that with the additional generating capacity of Unit 3, the transmission system remains stable under the analyzed conditions, preserving the grid connection and supporting the normal and shutdown power requirements of Unit 3.~~

~~Because the machine size (MWe injected into the grid) and dynamic data for the US-APWR is similar to the size of, and bounded by, the ESBWR generator previously studied, it is reasonable to assume that the impact on system load flow and import/export capability is not adversely affected by the change in reactor technology. However, to verify system capabilities, Dominion will request a new study from PJM using the US-APWR specific data. The new study analyzes the system for impacts on load flow, import/export capabilities, short circuit capability, and system stability resulting from interconnection of the USAPWR.~~

~~The system will be studied under conditions including loss of the largest generating unit, loss of the most critical transmission line, and multiple facility contingencies. Stability of the grid will be studied to confirm that after a turbine trip, adequate power to the RCPs is maintained for at least three seconds as required in the transient and accident analysis in Chapter 15.~~

The FSAR will be revised to reflect the results of the study as part of a subsequent FSAR update.

A system impact study was performed to assess the effects of interconnection of the 1900 MVA US-APWR on the transmission system in the areas of load flow, import/export capability, short circuit analysis, system stability, and voltage sensitivity. (Reference 8.2-201) The study was prepared using the 2013 light load base case and the 2014 summer peak case projections. The analysis was performed using Power Technology International Software PSS/E for load flow, import/export capability and stability evaluation, and ASPEN One-liner for short circuit evaluation.

The equipment considered is from the point of interconnection of Unit 3 at the switchyard out to the 500 kV transmission system. This includes the 230 kV buses and interconnections. The 34.5 kV portion of the North Anna switchyard is not modeled separately, but the 34.5 kV loads are considered at the 500 kV level. Maximum and minimum voltage limits have been established for the 500 kV switchyard at 534 kV and 505 kV, respectively.

The system was studied for stability and voltage sensitivity based on the following scenarios:

- Close in 3 phase faults cleared in primary time
- Close in 3 phase faults cleared in primary time with prior outage of selected transmission lines
- Close in breaker failure faults with delayed clearing
- Loss of largest generating unit
- Loss of most limiting transmission line
- Sequential loss of all generating units at North Anna
- Loss of North Anna Unit 3 with Units 1 and 2 in refueling
- Accident on North Anna Unit 3 with normal shutdown of Units 1 and 2
- Sudden simultaneous loss of Units 1 and 2 with Unit 3 operating

A separate case was studied and confirmed that after a turbine trip, adequate power to the RCPs is maintained for at least three seconds as required in the transient and accident analysis in Chapter 15.

The study concluded in all cases analyzed that the generator rotor angles and system voltage recover to acceptable operating points, with no unstable frequency deviations during the transients. Although in certain cases the maximum frequency decay rate exceeds 5 Hz/sec, the maximum low frequency variation for the most severe case is –0.585 Hz (minimum frequency of 59.415 Hz) prior to recovery to nominal frequency. Since all cases are stable, and worst case minimum frequency does not approach the minimum RCP speed setpoint of 95 percent (57 Hz), none of the cases result in either a reactor trip or reactor coolant pump trip due to frequency variation. Therefore, grid frequency stability is consistent with the requirements of Chapter 15.

Short circuit analyses were performed to verify the interrupting capability of the 500 kV breakers. The study results show that symmetrical short circuit current does not exceed 40 kA and asymmetrical short circuit current does not exceed 46 kA. The 500 kV breakers are rated to interrupt at 50 kA and are, therefore, adequately sized. Results of the study also showed that symmetrical and asymmetrical short circuit currents did not exceed the 40 kA rating of the 230 kV circuit breakers.

The reliability of the overall system design is indicated by the fact that there have been no widespread system interruptions. Failure rates of individual facilities are low. Transmission lines are designed to have less than one lightning flashover per 100 miles per year, and the record shows much better performance, indicating conservative designs. Most lightning-caused outages are momentary, with few instances of line damage. Other facilities do fail occasionally, but these are random occurrences, and experience has shown that equipment specifications are adequate.

Grid availability in the region over the past 20 years was also examined and it was confirmed that the system has been highly reliable with minimal outages due to equipment failures.

Site-specific designs with the potential to affect PRA results are described in Table 1.8-1R. The offsite power transmission system is addressed in that table as a system interface for the US-APWR electrical power system. As described in Section 19.1.1.2.1, the offsite power transmission system is considered to have no potential influence on the results of the PRA.

Grid stability is evaluated on an ongoing basis based on load growth, the addition of new transmission lines, or new generation capacity.

8.2(6) ***Deleted from the DCD.***

NAPS COL 8.2(7) — *8.2(7)* ***Protective relaying***

This COL Item is addressed in Subsection 8.2.1.2.1.

NAPS COL 8.2(8) — *8.2(8)* ***Switchyard dc power***

This COL Item is addressed in Subsection 8.2.1.2.1.

NAPS COL 8.2(9) — *8.2(9)* ***Switchyard ac power***

This COL Item is addressed in Subsection 8.2.1.2.1.

STD* COL 8.2(10) — *8.2(10)* ***Transformer protection***

This COL Item is addressed in Subsection 8.2.1.2.

STD* COL 8.2(11)
NAPS COL 8.2(11) — *8.2(11)* ***Stability and Reliability of the Offsite Transmission Power Systems***

This COL Item is addressed in Subsections 8.2.2.2, 8.2.2.3, 8.2.3.

8.2(12) ***Deleted from the DCD.***

8.2.5 References

RAI 08.02-52

8.2-201 PJM Generator Interconnection Q65 North Anna 500 kV (1594 MW Capacity) Revised System Impact Study and Facilities Study Report Resulting from Necessary Studies Agreement, ~~June 2007~~ April 2011

8.2-202 VA PJM Design and Application of Overhead Transmission Lines 69kV and above, May 20, 2002

8.2-203 IEEE Std 1313.2-1999 (R2005), "IEEE Guide for the Application of Insulation Coordination"

8.2-204 IEEE Std C62.22-2009, "IEEE Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems"

8.2-205 IEEE Std 998-1996 (R2002), "IEEE Guide for Direct Lightning Stroke Shielding of Substations"

8.2-206 Hileman, A. R.: Insulation Coordination for Power Systems; Taylor & Francis, Inc., Boca Raton, FL, 1999

RAI 08.02-46

8.2-207 NERC Standard PRC-005-1, "Transmission and Generation Protection System Maintenance and Testing," May 1, 2006

ENCLOSURE 6

Response to NRC RAI Letter 54

RAI 5181 Question 08.02-54

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5181 (RAI Letter 54)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 02/03/2011

QUESTION NO.: 08.02-54

FSAR Subsection 8.2.2.2 states that maximum and minimum switchyard voltage limits have been established for the 500 kV switchyard at 534 kV and 505 kV respectively. Please confirm that these voltage limits have been established based on the loss of the largest generating units or loss of the most critical transmission line and multiple contingencies. Also, specify the maximum and minimum voltage limits for the 230 kV switchyard in the FSAR.

Dominion Response

FSAR Section 8.2.2.2 describes the system impact study that was performed as part of the grid reliability and stability analysis. The study has been updated by the regional transmission organization (PJM Interconnection) to incorporate the US-APWR specific generation data. The new report, *PJM Generator Interconnection Q65 North Anna 500 kV (1594 MW Capacity) Revised System Impact Study and Facilities Study Report Resulting from Necessary Studies Agreement,* dated April 2011, is a publicly available document.

The system was studied under cases including loss of the largest generating units, loss of the most critical transmission line, and multiple contingencies. Results of the study show that the most limiting maximum and minimum voltage variation for all cases studied is +2.68% (maximum deviation from nominal) to –1.67% (minimum deviation from nominal). This confirms that the voltage limits of 534 kV and 505 kV meet the interface requirements of DCD Section 8.2.3 which require transmission system operating voltage be maintained + 10%.

The voltage schedule for the North Anna switchyard is maintained at the 500 kV level. The 230 kV switchyard is connected to the 500 kV switchyard by two 500/230 kV transformers with fixed taps currently set at -2.5%. This establishes the 230 kV switchyard per unit voltage at 97.5% of the 500 kV switchyard per unit voltage. Therefore, the 230 kV switchyard does not have maximum and minimum voltage limits independent from the 500 kV switchyard. Considering the 500/230 kV transformer tap setting of -2.5%, voltages in the 230 kV switchyard also meet the interface requirements of DCD Section 8.2.3 when the 500 kV switchyard voltage limits of 534 kV and 505 kV are maintained.

Proposed COLA Revision

None

ENCLOSURE 7

Response to NRC RAI Letter 54

RAI 5181 Question 08.02-55

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 5181 (RAI Letter 54)

SRP SECTION: 08.02 – OFFSITE POWER SYSTEM

QUESTIONS for Electrical Engineering Branch (EEB)

DATE OF RAI ISSUE: 02/03/2011

QUESTION NO.: 08.02-55

FSAR Subsection 8.2.2.2 discusses grid reliability and stability analysis. However, the NRC staff did not find any discussion of frequency variation at the switchyard. Provide in the FSAR the frequency variation and the maximum frequency decay rate expected at the switchyard under the most limiting conditions. Confirm that the frequency variations and the maximum frequency decay rate are consistent with requirements specified in Chapter 8 and Chapter 15 of DCD.

Dominion Response

FSAR Section 8.2.2.2 describes the system impact study that was performed as part of the grid reliability and stability analysis. The study has been updated by the regional transmission organization (PJM Interconnection) to incorporate the US-APWR specific generation data. The new report, *PJM Generator Interconnection Q65 North Anna 500 kV (1594 MW Capacity) Revised System Impact Study and Facilities Study Report Resulting from Necessary Studies Agreement,* dated April 2011, is a publicly available document.

DCD Section 8.2.3 requires the COL applicant to perform a grid stability analysis to confirm the assumptions for offsite power supply in DCD Chapter 15. The offsite power supply frequency assumptions are frequency variation of +/- 5% and maximum frequency decay rate (in association with the RCP low-speed trip setpoint of 95%) of 5 Hz/sec. The updated study concluded in all cases analyzed that the generator rotor angles and system voltage recover to acceptable operating points, with no unstable frequency deviations during the transients. Although in certain cases the maximum frequency decay rate exceeds 5 Hz/sec, the maximum low frequency variation for the most severe case is -0.585 Hz (minimum frequency of 59.415 Hz) prior to recovery to nominal frequency. Since all cases are stable, and worst case minimum frequency does not approach the minimum RCP speed setpoint of 95% (57 Hz), none of the cases result in either a reactor trip or reactor coolant pump trip due to frequency variation. Therefore, grid frequency stability is consistent with the requirements of DCD Chapter 8 and Chapter 15.

FSAR Section 8.2.2.2 will be revised to identify that the stability of the offsite power supply frequency is consistent with DCD Chapter 15.

Proposed COLA Revision

FSAR Section 8.2.2.2 mark-up provided with the response to RAI 5181, Question 08.02-52.