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December 18, 2013
U7-C-NINA-NRC-130063

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Response to Request for Additional Information

Reference: Letter, David Misenhimer to Scott Head, "Request for Additional Information Letter No. 438 Related to SRP Section 8.2 for Nuclear Innovation North America, LLC (NINA) Combined License Application" (ML13325A905)

Attached is the Nuclear Innovation North America, LLC (NINA) response to the NRC staff question in the reference. The attachment to this letter contains the response to the following RAI question:

08.02-26

The COLA change documented in this submittal will be implemented in the next routine revision of the COLA.

There are no commitments in this letter.

If you have any questions, please contact Scott Head at (979) 316-3011, or Bill Mookhoek at (979) 316-3014.

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

Executed on 12/18/13

Scott Head
Manager, Regulatory Affairs
NINA STP Units 3 & 4

Attachment:
RAI 08.02-26

DD91
NRD

STI 33801263

cc: w/o attachment except*
(paper copy)

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RAI 08.02-26:

In the revised response to Request for Additional Information 08.02-25 dated September 4, 2013, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13256A154), Nuclear Innovation North America, LLC (NINA), the applicant, discussed its response to NRC issued Bulletin 2012-01, "Design Vulnerability in Electric Power System," (ADAMS Accession No. ML12074A115) on the electric power system design, and recent operating experience that involved the loss of one of the three phases of the offsite power circuit (single-phase open circuit condition) at Byron Station.

1) The applicant states that in the scenario where a single-phase open circuit event on the grid side of the Main Transformer (MT), the feed from the MT and each of the associated UATs does not affect the safety-related or non-safety related loads since:

- The wye-delta configuration of the MT regenerates the lost phase (open-circuited phase), and
- The MT can carry the increased load on the remaining two phases because the MVA capacity of the MT is large relative to the combined safety-related and non-safety related loads on the UATs.

Based on the statements above, address the following:

a. Unbalanced operation is among the potential hazards to motor loads that result from abnormal conditions such as a system-induced loss of phase. The current produces flux in the motor air-gap rotating in the opposite direction to the actual motor direction which is essentially a double-frequency current in the rotor. The skin effect results in higher resistance which compounds with the already increased total current (resulting from both the positive and negative-sequence current components) creating a heating effect. In the case of a loss of phase where the lost phase is induced in the secondary side of the transformer, increasing currents will be observed on the secondary upstream of the loads:

i. Provide an analysis that shows that none of the safety-related or non-safety related loads will exceed their current ratings that would cause physical damage to motor windings, and other inductive elements.

ii. Clarify how the phase angle change, as well as the presence of negative sequence currents, will be detected to preclude damage on inductive loads.

iii. Provide your evaluation and analysis to show that sensitive instrumentation and control and protection circuits that are dependent on ac power quality are not adversely impacted by an unbalanced power system

iv. Provide supporting documentation from equipment vendors validating the capability of their equipment to function with current and voltage variations addressed in the above questions.

2) If the secondary side of the MT is regenerating the lost phase, there will be no change in voltage magnitude that would actuate the degraded voltage relays. However, there will be a change in the phase angle and the current on the secondary side of the transformer.

a. Provide a means of detecting a loss of phase given the assumptions stated above since the degraded voltage relays will be incapable of detecting the loss of phase as a function of phase angle.

b. Provide an ITAAC that demonstrates by testing that the selected means of protection will actuate and withstand the higher currents during the loss of phase condition.

c. Provide a Technical Specifications (TS) Surveillance Requirements (SRs) that will provide assurance that the protective measures for a loss of phase condition are reliable and functional and able to preclude damage to safety related equipment.

d. Provide details on any tests that will be performed on the plant electrical system to validate the analytical results for a loss of phase on high voltage side of transformers and successful operation of worst case plant loading for an extended duration without adverse effects.

3) If no plant design changes are planned to automatically detect and isolate the open phase condition (degraded offsite power sources) and transfer the important to safety buses to alternate power source(s), provide the applicant and/or the grid operator's evaluation to show that availability and reliability of offsite power system (capacity and capability) is maintained in accordance with transmission system protocols and in accordance with 10 CFR 50 Appendix A, GDC 17 requirements.

4) The applicant states the following in the RAI response:

This response provides the results of analyses of the design that is provided in COLA revision 9, and does not propose or rely upon any design features that are not included in COLA revision 9. The protection scheme for the onsite power system is described primarily in DCD Section 8.3, and is not changed significantly by the limited departures related to electric power system...
Loss of a single phase on a Class 1E bus is specifically addressed in the certified ABWR design. As a result of loss of a single phase, the undervoltage protective circuitry will separate the Class 1E Safety buses from a connected failed offsite source due to loss of voltage or sustained degraded grid voltage with or without concurrent design basis accidents...
Based on the above, the loss of voltage and degraded voltage relay schemes on each of the Class 1E Safety buses detect and respond to the postulated loss of phase scenarios on a Class 1E Safety bus that could prevent the Class 1E bus from performing its required safety function. The loss of voltage and degraded voltage functions start the EDGs, disconnect the affected Class 1E bus from the degraded offsite source and connect the EDG to the affected Class 1E bus...

For a single-phase open circuit event on the grid side of the MT, the feed from the MT and each of the associated UATs does not affect the safety-related or non-safety related loads since the wye-delta configuration of the MT regenerates the lost phase (open-circuited phase). Also, the

MT can carry the increased load on the remaining two phases because the MVA capacity of the MT is large relative to the combined safety-related and non-safety related loads on the UATs... For a single-phase open circuit event on the grid side of a RAT, the feeds from the RATs are affected because of the wye-wye configuration of the RATs...The loss of a single phase on the high side of the transformer will drop voltage low enough for the degraded undervoltage relays to detect and trip the feed...

If a ground fault were located on the high side of the UATs or RATs, the ground fault would be expected to either burn off and clear or rapidly propagate to a ground fault that would actuate the protective relaying and disconnect the transformer from offsite power. This would result in a Loss of Preferred Power (LOPP) for the affected Class 1E Safety bus(es) which would then automatically realign to the EDG(s)...

Licensing Strategy : As described in this response, NINA has demonstrated that loss of a single phase in an offsite circuit either has no effect on STP 3 & 4 Class 1E electrical bus safety functions or will be detected by existing Technical Specification undervoltage and/or degraded voltage functions which will disconnect the affected offsite circuit and power affected Class 1E buses from an EDG. This conclusion will be confirmed for the 'as-built' plant by the ITAAC proposed below... To ensure that the 'as-built' design of the STP 3 & 4 Electrical Power Distributions (EPD) System is appropriately protected for a lost phase, with or without a ground fault, on credited offsite power circuits supplying the MT and RATs, NINA will revise COLA, Part 9, Section 3.0, Site-Specific ITAAC.

Based on the above statements the staff notes the following:

a. The design features described in COLA revision 9, DCD Section 8.3, is for addressing loss of voltage and degraded voltage conditions for a balanced 3-phase offsite power system.

b. The certified ABWR design mentioned in the above documents is referring to a loss of a single phase at the 4.16 kV bus level and not the loss of a single phase condition with and without a high impedance ground condition, on the high voltage side of a transformer connecting a credited GDC-17 offsite power circuit to the transmission system.

c. A single-phase open phase event on the grid side of a RAT cannot be detected for all operating configurations and design basis loading conditions by the existing degraded voltage protection scheme because the voltage response is dependent on transformer loading conditions. Refer to the various Bulletin responses provided to the NRC by the operating fleets.

d. As stated earlier, the existing scheme (loss of voltage instrumentation) does not automatically detect the open phase condition (Unbalanced AC power system condition) and therefore cannot take protective actions to enable proper functioning of important-to safety structures, systems and components. The design vulnerability needs to be addressed to meet the ABWR certified design requirements specified in 10 CFR Part 52, Appendix A.

Therefore, the applicant is requested to provide sufficient analyses in the final safety analysis report (Sections 8.2 and 8.3 of Chapter 8) and ITAAC information (COLA, Part 9, Section 3.0, Site-Specific ITAAC) offsite power system) in accordance with § 52.79, "Contents of

applications; technical information," and § 52.80, "Contents of applications; additional technical information," and 10 CFR 50.55a(h)(3) for the staff to determine whether the NINA COLA meets the requirements of 10 CFR Part 50, Appendix A, GDC 17 "Electric power systems," regarding the offsite power circuit and onsite electrical power distribution system to provide adequate capacity and capability in view of the design vulnerability identified in NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System." The information should include, as a minimum, design and analyses and ITAAC information to automatically detect and take protective actions for a single phase open phase condition with and without a high impedance ground condition, on the high voltage side of a transformer connecting credited GDC-17 offsite power circuits to the transmission system (high voltage side MTs and RATs).

5) In the RAI revised response the applicant states that it will evaluate Nuclear Strategic Issues Advisory Committee (NSIAC) initiatives to ensure that STP 3 & 4 design and procedures remain consistent with industry accepted practices. The staff requests the applicant to provide a license condition to reflect this statement and also the proposed changes to the plant TS in terms of limiting conditions of operation and SRs.

6) Based on the Forsmark Operating Experience, address Questions 1 thru 5 for a loss of two phases condition with and without a high impedance ground condition on the high voltage side of a transformer connecting a credited GDC 17 offsite power circuits to the transmission high voltage side MTs and RATs.

RESPONSE TO RAI 08.02-26:

As stated in our revised response to RAI 08.02-25, our analyses of the ABWR certified design show that in an open phase condition (OPC), such as identified in NRC Bulletin 2012-01, the important to safety functions will remain available. Nevertheless, NINA is committed to full resolution of this issue through implementation of the associated design features and procedures being developed by the industry and agreed upon with the NRC. In order to proactively resolve this as a licensing issue now, rather than answering the detailed questions in this RAI NINA proposes a license condition which requires (1) automatic detection of open phase conditions on the high-voltage side of the Main Power Transformer (MPT) and Reserve Auxiliary Transformers (RAT) and an alarm in the Main Control Room, (2) development of an alarm response procedure, (3) training for the control room operators to respond to this alarm, (4) performance of a simulated loss-of-phase test of the detection and alarm capability prior to fuel load, and (5) evaluation of the Nuclear Strategic Issues Advisory Committee (NSIAC) Open Phase Condition initiative to ensure that the STP 3 & 4 design and procedures remain consistent with industry accepted practices.

Detection capability will monitor all three phases of the MPT and both RATs for differential over current, open phase, and ground faults using the specific transformer protective relay. When an open phase is detected in one or more phases of a MPT or RAT protective relay, the protective relay will generate an alarm in the Main Control Room. The alarm response procedure will require prompt operator response including verification that the systems operated as designed, validation of the open phase alarm, and verification that the individual phase voltages on the low-voltage side of the transformers are uniform. Operator responses to this alarm would include transfer or trip of the affected transformer or alarm

reset if it is determined that the alarm was not valid. Operator training will ensure that the operators are familiar with the actions needed to be taken in accordance with this procedure. Instrumentation to detect an open phase condition is not fundamentally different from the instrumentation to detect a differential over current condition or ground fault and NINA believes the proposed additional detection capability, main control room alarm, alarm response procedure, and operator training will ensure that appropriate actions are promptly taken in the event of an open phase condition. Automatic actuation is not needed because the alarm response procedure will verify that all systems functioned as designed and that any required corrective action is implemented within the requirements of the Technical Specifications for the loss of an offsite AC source.

The following license condition language is proposed:

NINA shall:

1. Add the capability to monitor each phase of the power feeds on the high voltage side of the Main Power and the Reserve Auxiliary Transformers to detect an open phase condition and generate an alarm in the Main Control Room.

2. Develop an alarm response procedure defining the actions to be taken in the event of an open phase condition on the Main Power and Reserve Auxiliary Transformers. The alarm response procedure will be developed as part of the implementation of the operational programs as described in COLA FSAR Section 13.5.

3. Perform training of the control room operators on the alarm response procedure prior to fuel load. This training will be developed and performed in accordance with COLA FSAR Sections 13.2 and 13.4S.

4. Perform a simulated test of the open phase condition detection and alarm capability prior to fuel load.

5. Evaluate the Nuclear Strategic Issues Advisory Committee Open Phase Condition initiative to ensure that the STP 3 & 4 design and procedures remain consistent with industry accepted practices. A report documenting this assessment will be prepared 2 years prior to fuel load.

A COLA markup is provided below showing the proposed changes to Combined License Application (COLA) FSAR Section 8.2, Offsite Power Systems. The changes involve the addition of a new subsection and an additional reference. These changes are similar to those adopted by the Economic Simplified Boiling Water Reactor (ESBWR) to address this issue for that design center's electrical design which is similar to the ABWR electrical design. These markups will be included in the next revision of the COLA. As a result of this revised approach, the ITAAC proposed in the revised response to RAI 08.02-25 is no longer necessary, and will be removed from the COLA in next revision.

8.2.1.2.4 Monitoring of Main Power and Reserve Auxiliary Transformers

All three phases of the MPT and RATs are monitored for differential over current, open phase and ground faults using the specific transformer protective relay. When a differential over current, open phase or ground fault is detected in any combination of one, two or three phases by the designated MPT or RAT protective relay, the protective relay generates an alarm in the Main Control Room.

Since an open phase condition could result in a degraded condition in the onsite power system (see Reference 8.2-7), all three phases on the high side of the MPT and RATs are monitored for one or more open phases, with or without ground fault, using the specific transformer protective relay. To detect one or more open phases, dual level current transformer sensors and digital protective relays are used to monitor the power feeds on the high voltage side of the MPT and RATs. When an open phase is detected in any combination of one, two or three phases by the designated MPT or RAT protective relay, the protective relay generates an alarm in the Main Control Room. Operator actions are addressed in procedures, as described in Section 13.5. Testing of the monitoring system is performed per Section 8.2.4.1 of this chapter to verify proper functionality.

8.2.6 References:

8.2-7 NRC Bulletin 2012-01, "Design Vulnerability in Electric Power System," July 27, 2012.