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June 17, 2013

Mr. Roy Mathew
Branch Chief, Electrical
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Submittal of draft Industry Open Phase Condition White Paper

Project Number: 689

Dear Roy:

The purpose of this letter is to transmit the draft Industry Open Phase Condition White Paper that we intend to use as meeting material at the NRC public meeting on Thursday June 27, 2013. We look forward to lively discussions between the NRC Staff and Industry participants.

If there are any questions on this matter, please contact me at 202-739-8086 or gac@nei.org.

Sincerely,

A handwritten signature in black ink, appearing to read "Gordon A. Clefton", with a long horizontal flourish extending to the right.

Gordon A. Clefton

Attachment

Goal

An open phase condition should not prevent functioning of safety-related structures, systems, and components. An open phase condition is defined as a single open phase, with or without a ground, which is located on the high voltage side of a transformer connecting a General Design Criterion (GDC) 17 offsite power circuit to the transmission system.

Objectives

- Operating nuclear power plant licensees demonstrate that safety functions remain available given an open phase condition or install plant modifications to detect and automatically separate from the open phase condition. If the open phase condition prevents the functioning of safety-related structures, systems, and components, the engineered safeguard buses should be transferred to an alternate GDC 17 offsite power source or to the onsite power source.
- New reactor licensees, Combined License (COL) applicants, and design centers for *active safety features plant designs* demonstrate that safety functions remain available given an open phase condition or install plant modifications to detect and automatically separate from the open phase condition. If the open phase condition prevents the functioning of safety-related structures, systems, and components, the engineered safeguard buses should be transferred to an alternate GDC 17 offsite power source or to the onsite power source.
- New reactor licensees, COL applicants, and design centers for *passive safety features plant designs* demonstrate that safety functions remain available given an open phase condition or provide design features to detect the condition.

Criteria

Note: Neither the equipment acceptance criteria nor protection design has been developed to protect against an adverse open phase condition for all plant designs and configurations. This section will address the criteria for dealing with an adverse open phase condition.

Detection, Alarms, and General Criteria (Active Plant Designs)

An open phase condition should be detected and alarmed in the control room unless it can be shown that the open phase condition does not prevent functioning of safety-related structures, systems, and components. For example, demonstration of no adverse impact may be possible in cases where transformers are oversized for loading conditions. Sufficient calculational basis should be provided to show that the open phase condition will not adversely affect safety-related equipment performance.

If the licensee can demonstrate that the open phase condition does not prevent the function of safety-related structures, systems, and components, then detection of the open phase condition

Open Phase Condition Strategy

should occur within a reasonably short period of time (e.g., 72 hours). The licensee must document how detection and correction will occur.

Detection circuits, for the open phase condition which prevents the functioning of safety-related structures, systems, and components, should be sensitive enough to identify an open phase condition for all credited loading conditions (i.e., high and low loading).

Note: It is recognized that some transformers have very low or no loading when in standby mode. Automatic detection may not be possible in this condition; however, automatic detection must happen as soon as loads are transferred to this standby source.

If open phase condition protection circuits are required, the design should minimize misoperation or spurious action that could cause separation from an operable offsite GDC 17 source. Additionally, the protective scheme should not separate the operable offsite GDC 17 source in the range of voltage unbalance normally expected in the transmission system. These devices should be coordinated with other protective devices in both the transmission system and the plant's electrical system (e.g., fault protection, overcurrent, etc.).

Detection and protection circuits may be non-Class-1E. While it is recognized that a Class-1E solution is preferable from a regulatory perspective, a non-Class-1E solution should be more effective. A non-Class-1E solution will enable more timely implementation and will provide reasonable levels of reliable protection given the low likelihood of adverse impacts from single phase events.

The UFSAR (typically Chapter 8) should be updated to discuss the design features and analyses related to the effects of, and protection for, any open phase condition design vulnerability.

Detection and Alarms (Passive Plant Designs)

The open phase condition should be detected and alarmed in the control room unless it can be shown that the open phase condition does not prevent functioning of safety related structures, systems, and components. If the licensee/applicant can demonstrate that the open phase can be detected and does not prevent functioning of safety related structures, systems, and components, no further action is required.

If the passive design cannot prevent degradation of safety related structures, systems and components due to a loss of phase event then the detection and alarm requirements specified for active designs are required.

Protective Actions (*Active Plant Designs*)

If an open phase condition occurs¹, the following design requirements are to be satisfied:

1. With no accident condition signal present, the licensee must demonstrate that:
 - 1.1. The open phase condition does not adversely affect the function of safety-related structures, systems, and components; or
 - 1.2. Technical Specification (TS) Limiting Conditions for Operation (LCOs) are maintained or the associated TS Actions are met without entry into TS LCO 3.0.3 (or the equivalent for plants that do not conform to the latest version of NUREG 0800, Chapter 16). This provision applies to all TS equipment affected by the open phase condition (i.e., not just the specifications related to the offsite power source); and
 - 1.3. Class-1E equipment is not damaged by the open phase condition event.

Notes:

- Provision 1.1 or both 1.2 and 1.3 must be maintained assuming that loads are transferred to the source with an open phase condition.
 - Operator action may be credited in the evaluation in provision 1.3.
 - If provisions 1.1 or both 1.2 and 1.3 cannot be met with the existing plant design features, modifications will be required to provide protective features to ensure the provisions can be met.
2. With an accident condition signal present, the licensee must demonstrate:
 - 2.1. Automatic detection and protection will transfer loads required to mitigate postulated accidents to the EDG(s) or alternate GDC 17 source and ensure that safety functions are preserved, as required by the current licensing bases. A time delay of a few seconds may be considered to preclude spurious trips.
 - 2.2. Alternatively, a licensee may show that all design basis accident acceptance criteria are met with the open phase condition given other plant design features. Accident assumptions must still include licensing provisions associated with single failures. Typically, licensing bases will not permit consideration of the open phase condition as the single failure since this failure is in a non-safety system.

Surveillance requirements should be established for any new protective features, including calibrations and setpoint verifications. The surveillance requirements should be added to the plant Technical Specifications.

¹ For plants that have evaluated their specific designs and installations and have determined that there is no single credible failure that could likely cause an open phase condition, a full engineering evaluation may be developed and issued to document basis for an open phase condition as a non-credible event.

Protective Actions (*Passive Safety Features Plant Designs*)

Following detection of an open phase condition, plant procedures will specify operator actions to restore the offsite power source to a functional condition.

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Regulatory Requirements:

GDC 17 establishes requirements for the electric design of nuclear power plants for which a construction permit application was submitted after the Commission promulgated the GDC.

GDC 17 states:

An onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure 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 and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

The onsite electric power supplies, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure.

Electric power from the transmission network to the onsite electric 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. A switchyard common to both circuits is acceptable. Each of these circuits shall be designed to be available in sufficient time following a loss of all onsite alternating current power supplies and the other offsite electric power circuit, to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded. One of these circuits shall be designed to be available within a few seconds following a loss-of-coolant accident to assure that core cooling, containment integrity, and other vital safety functions are maintained.

Provisions shall be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies.

Pre-GDC plants have their principal design criteria specified in their UFSAR.

Schedule for Operating Plants (assumes License Amendments are not required to install any design changes)

May 15, 2013

NSIAC endorsement of the industry direction to resolve the open phase condition issue.

June 30, 2013

Draft NEI Initiative (what is required; industry criteria to address the open phase condition issue).

July 31, 2013

NSIAC approval of the NEI Initiative.

August 31, 2013

Draft NEI guidance document (how to meet industry criteria; containing industry research, developments, pilots, technology, etc. to address the open phase condition issue).

December 31, 2014

Demonstration of compliance with the open phase condition criteria through analysis or identify appropriate actions required to demonstrate compliance.

December 31, 2016

Implementation of design changes, if necessary, to comply with the open phase condition criteria. The "active" protection features of new technology designs may be installed in a monitoring mode, with adequate justification, to demonstrate reliability.

December 31, 2017

If a monitoring period was deemed necessary, completion of any design adjustments identified during the monitoring period and enabling all "active" protection features needed to demonstrate compliance with the open phase condition criteria.

UFSAR Updates – Completion in conjunction with the timelines noted above, but no later than December 31, 2017.

Technical Specification Updates – Submitted by December 31, 2017. If a TSTF Traveler is available, submitted within six months of issuance of an NRC approved TSTF Traveler.

Note: If Technical Specification updates are required for modification implementation, the schedule is expected to change based on NRC required review times; however, the station schedule should be maintained as closely as possible with the timelines noted above.

Schedule for New Reactors

COL Licensees

Complete design changes and plant modifications, as needed, prior to fuel load.

COL Applicants

Describe design features in the FSAR, if change to certified design is required.

Design Centers

Provide design features in the Design Control Document / FSAR.

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