November 25, 2014

Mr. Anthony R. Pietrangelo
Senior Vice President and Chief Nuclear Officer
Nuclear Energy Institute
1201 F Street, NW, Suite 1100
Washington, DC 20004

Dear Mr. Pietrangelo:

On behalf of the U.S. Nuclear Regulatory Commission (NRC), I am responding to the Nuclear Energy Institute's (NEI) letters dated March 21, 2014, and August 14, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML14087A253, ML14087A254, and ML14226A804). The letters explained the industry perspective that the protection system requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(h)(2), "Protection Systems," do not apply to the industry's proposed generic solution that resolves the recently identified open phase condition (OPC) vulnerability and the regulatory issues related to it.

In your letter dated October 9, 2013 (ADAMS Accession No. ML13333A147) and acknowledged in NRC letter dated December 19, 2013 (ADAMS Accession No. ML13340A329), the industry's Chief Nuclear Officers approved a formal initiative to address OPCs, and the initiative is a formal commitment among the companies that operate nuclear power plants (i.e., licensees) to follow the policy or plan of action. Your letter further indicated that this approved initiative commits each licensee to develop a proactive plan and schedule for addressing the potential design vulnerabilities associated with open phase conditions. The NRC appreciates the demonstrated industry attention and leadership commitment to support resolution of the open phase issue described in NRC Bulletin 2012-01 (BL 2012-01), "Design Vulnerability in Electric Power System."

Over the years, OPCs have occurred throughout the electric power industry on three-phase power systems and the safety significance and design vulnerability of OPCs were not well understood. The January 30, 2012, operating event at Byron Station, Unit 2, revealed a significant design vulnerability which resulted in loss of safety functions of electric power systems. In addition, although existing NRC regulations have requirements for the onsite and offsite power systems to permit functioning of structures, systems, and components important to safety for any failures in the offsite power system including a single failure in the onsite power system, OPCs were not specifically identified as an issue during the licensing reviews of the current operating nuclear power plants. For this reason, the staff recommended granting enforcement discretion and refraining from issuing an enforcement action for certain noncompliances which would require a reactor shutdown while addressing the open phase conditions of the design vulnerability within their electrical power system.

At Byron Unit 2, both offsite and onsite electric power systems were unable to perform their intended safety functions (i.e., to provide electric power to the engineered safety buses with sufficient capacity and capability to permit functioning of structures, systems, and components important to safety). The staff determined that a design-basis event concurrent with an OPC would likely have resulted in the plant exceeding criteria specified in 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors." NRC's Accident Sequence Precursor analysis for the Byron event indicated the risk, Conditional Core Damage Probability (CCDP), as 1×10^{-4}. Based on the Byron event and additional operating experience at other nuclear power plants to-date, the staff determined that OPC is a credible event of safety significance and must be considered in the electric power system design for nuclear power plants.

Specifically, the electric power system design requirements for nuclear power plants are provided in 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 17, or the principal design criteria specified in the updated final safety analysis report for the specific nuclear power plant, 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3), and plant Technical Specifications (TS).

In its most recent proposal, the industry addressed the OPC vulnerability with a new open phase isolation system (OPIS). The new OPIS will generally consist of a non-Class 1E sensor located on the non-Class 1E transmission circuit that connects a transformer to the transmission system and a non-Class relay that utilizes custom protection logic. When an OPC is detected the OPIS will annunciate an alarm in the Main Control Room and isolate the faulted power circuit consistent with the performance criteria contained in the Industry OPC Initiative. For a design basis event coupled with an OPC, the staff notes that the capability of the onsite power system to permit functioning of structures, systems, and components (SSCs) may depend on successful operation of OPIS.

The proposed Industry OPIS solution must fully address GDC 17 or the principal design criteria specified in the updated final safety analysis report for the specific nuclear power plant. GDC 17 states, in part:

> 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…….
>
> 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.

> 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 off-site 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 on-site electric power supplies.

As currently proposed, the staff notes that any failure of the OPIS to detect and isolate an OPC would preclude the remaining power sources from being available and may impede the proper operation of engineered safety features (ESF). The industry states that the OPIS typically needs to be installed on the non-Class 1E because the OPC cannot be reliably detected on the Class 1E buses. As a result of designing the OPIS for the non-Class1E buses, the industry asserts that the OPIS should not be considered part of the protection system described in 10 CFR 50.55a(h)(2), Institute of Electrical and Electronics Engineers (IEEE) Std. 279-1971, or IEEE Std. 603-1991. The industry conclusion is based on its analysis that the proposed OPIS system:

- does not sense and command features of the reactor trip system.
- does not generate signals or actuate ESF.
- does not provide power to any of the engineered safety features system actuation devices.
- is separate from the Class 1E degraded and loss of voltage protection systems.
- is located on connections to the station switchyard, switchyard transmission lines, or the transmission network which, as discussed in IEEE Std. 308-1974, are excluded from the Class 1E power systems.

The industry's analysis, however, focuses mainly on the regulatory requirements that apply to the limited functions of the proposed OPIS without fully addressing GDC 17. As a comparison, the function of OPIS is similar to the loss of voltage relays and degraded voltage relays installed on the Class 1E buses at all operating power plants. The safety function of these relays is to isolate a degraded GDC 17 power source in order to permit the remaining power source(s) to perform their safety function(s).

In addition, as stated in IEEE Std. 308-2001, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations," (Regulatory Guide 1.32), Section 4.5, "Power Quality," the variations of voltage, frequency, and waveform (including the effects of harmonic distortion) in the Class 1E power systems during any mode of plant operation shall not

degrade the performance of any safety system load below an acceptable level. The staff position is that power quality issues caused by any event or condition that could affect redundant ESF buses and loads must have features such as physical separation, electrical isolation, independence, redundancy, and meet qualification requirements. These features shall be included in the design to aid in preventing a mechanism by which a single design basis event could cause redundant equipment within the stations Class 1E power system to be inoperable.

Based on its review of the NEI correspondence, presentations and discussions held during approximately eleven public meetings, and other relevant information on this topic, the staff believes that compliance aspects that may not meet GDC 17 or the principal design criteria specified in the updated final safety analysis report may be resolved if each licensee addresses the design issue based on the plant-specific electric power system design; design basis loading conditions; and electrical system operating configuration for normal, abnormal, and accident conditions.

It is the staff's position, that any licensee solution (Class 1E or non-Class 1E) to address OPCs, should meet the following functional requirements:

1. The design should address single failure criteria as outlined in the GDCs or the principal design criteria specified in the updated final safety analysis report for the specific nuclear power plant (i.e., for an OPC, a non-Class 1E circuit should not preclude the onsite electrical power system from being able to perform its safety function given a single failure in the onsite power system).
2. The OPC should be automatically detected and alarmed in the main control room under all operating electrical system configurations and loading conditions
3. If offsite power circuits are degraded due to OPC, the power source should be transferred automatically to the onsite power system within the time assumed in the accident analysis and without actuating any protective devices, given a concurrent design basis event.
4. TS Surveillance Requirement and Limiting Condition of Operation for equipment used for mitigation of OPC should be consistent with the operability requirements specified in the existing plant TSs.

Therefore, until each licensee has addressed OPCs and informed the NRC that it is in full compliance with GDC 17, or the principal design criteria specified in the updated final safety analysis report for the specific plant regarding OPC, the staff will be recommending an interim enforcement policy (IEP) for OPC. If approved by the Commission, the IEP would authorize the NRC staff to exercise enforcement discretion and refrain from issuing an enforcement action for certain non-compliances with the requirements specified in TS for "Electrical Power Systems" (typically Section 3.8) and action statement(s) associated with "AC Sources-Operating" which would require a reactor shutdown if a licensee could not come into compliance within the plant-specific TS action statement timeframe.

The IEP would only be applicable to operating power reactor licensees resolving OPC design vulnerabilities within an electrical power system which has been identified as not

conforming to the requirements of the current GDC 17, “Electric Power Systems,” or the applicable principal design criteria in the updated final safety analysis report. The staff shared the draft IEP with the industry during a public meeting dated June 4, 2014.
The staff published a draft Branch Technical Position (BTP 8-9) in the Federal Register to formally obtain public comments. The purpose of this BTP is to provide guidance to the staff in reviewing future licensing actions related to OPC in electric power systems. Comments received from the FR notice are currently under staff review and being appropriately evaluated and considered before the BTP is finalized.

To continue the NRC and industry’s efforts to resolve and close-out Bulletin 2012-01, each licensee should do the following:

1. Provide a Commitment letter to the NRC stating that the OPC issue will be resolved in accordance with the schedule established in the industry initiative and how the solution addresses GDC 17 or the principal design criteria specified in the updated final safety analysis report for their specific nuclear power plant.
2. Develop and maintain a detailed plant-specific analysis and documentation which established the resolution of the OPC design vulnerability, including failure mode analysis that is available for NRC staff’s audits or inspections.
3. Provide a close-out letter to the NRC when full compliance is achieved.

Should you or your staff have any questions, please contact my staff MaryJane Ross-Lee at (301) 415-3281 or Jacob Zimmerman at (301) 415-1220.

Sincerely,

/RA/

William M. Dean, Director
Office of Nuclear Reactor Regulation

cc: G. Clefton, NEI
M. Satorius
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William M. Dean, Director
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cc: G. Clefton, NEI
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