Preliminary Evaluation of OPC Voluntary Industry Initiative (VII) Initial Inspection Results

1. OPC Detection and Alarm

NEI VII criteria:
"Detection, Alarms and General Criteria

An open phase condition must be detected and alarmed in the control room unless it can be shown that the open phase condition does not prevent functioning of important-to-safety structures, systems and components. For example, some licensees believe they can show no impact due to transformers that are oversized for their loading conditions. Sufficient "robust" calculational bases or tests must be provided to show that the open phase condition will not adversely affect important-to- safety equipment performance. Testing is preferred if this is possible without challenging on line or shutdown risk profiles.

If the licensee can demonstrate that the open phase condition does not prevent the functioning of important-to-safety structures, systems and components, then detection of the open phase condition should occur within a reasonably short period of time (e.g., 24 hours). The licensee must document how detection and correction of the open phase condition will occur.

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

> **Note**: It is recognized that some transformers have very low or no loading when in the 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. Additionally, if automatic detection is not possible, shiftily surveillance requirements must be established to look for evidence of an open phase.

If open phase condition actuation circuits are required, the design should minimize misoperation or spurious action that could cause separation from an operable off-site GDC 17 source. Additionally, the protective scheme should not separate the operable off-site GDC 17 source in the range of voltage unbalance normally expected in the transmission system. Licensees must demonstrate that the additional actuation circuit design does not result in lower overall plant operation reliability. These devices must 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 actuation circuits may be non-Class-1E. While it is recognized that a Class-1E solution is preferable, a non-Class-1E solution may be more effective. A non-Class-1E solution will enable timely implementation and will provide reasonable levels of reliable functionality

given the low likelihood of adverse impacts from open phase events. Additionally, there is regulatory precedent in using non-Class-1E circuits in newly identified nuclear plant vulnerabilities (e.g., anticipated transient without scram (ATWS) circuits). New non-Class-1E circuits will not be allowed to replace existing Class-1E circuits."

Observations:
The proposed OPC detection and alarm design schemes appear technically adequate to detect, and alarm in the main control room in the event of an unbalanced voltage from an OPC.

Questions for the Industry:

None

2. OPC Protective Action

NEI VII criteria:

"Protective Actions
If an open phase condition occurs,[1] 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 important-to-safety 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). This provision applies to TS equipment affected by the open phase condition (i.e., not just the specifications related to the off-site power source); and
   1.3. Important-to-safety equipment is not damaged by the open phase condition; and
   1.4. Shutdown safety is not compromised.

Notes:

- Provision 1.1 or provisions 1.2, 1.3 and 1.4 must be maintained.
- For operating modes where power is supplied from the main generator through unit auxiliary transformers, the licensee must evaluate provisions 1.1, 1.2 and 1.3 assuming that the main generator is lost and loads must be transferred to the alternate source(s). Load transfer cases will include reactor trips with and without accident conditions present. The accident transfer cases are used for assessment of Criterion 2 below.

[1] For plants that have evaluated their specific designs and installations and have determined that there is no single credible failure that could cause an open phase condition, a full engineering evaluation must be developed and issued to document the basis for an open phase condition as a non-credible event. The Bruce Power and Forsmark operating experience must be considered as part of this analysis.

- Operator action may be credited in the evaluation of provisions 1.3 and 1.4 if existing regulations and guidelines are met for the use of manual actions in the place of automatic actions.
- Item 1.4 is intended to ensure that an open phase event will not challenge fuel cooling during hot shutdown, cold shutdown and refueling modes of operation. Power supplied to spent fuel pool cooling systems must also be considered. The limiting conditions will be those where power is supplied from a single source or an alternate source is used that does not have open phase protection (like a main power transformer back-feed source).
- Provision 1.2 must consider situations where alternate sources are removed from service if allowed by the Technical Specifications.
- If provision 1.1 or provisions 1.2, 1.3 and 1.4 cannot be met with the existing plant design features, modifications will be required to provide automatic features to ensure the provisions can be met.

2. With an accident condition signal present, the licensee must demonstrate:
   2.1 Automatic detection and actuation will transfer loads required to mitigate postulated accidents to an alternate source and ensure that safety functions are preserved, as required by the current licensing bases.
   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.

Note:

- It is not expected that accident analyses are updated when licensees add additional detection and mitigation circuitry. Actuation times needed to maintain equipment safety functions should be short enough to provide reasonable assurance that accident mitigation functions are maintained."

Observations:

Three of the designs incorporated defense-in-depth features such as redundant channels and coincidence trip logic which will minimize spurious trip of the offsite power system. One licensee used a single channel detection and protection scheme to mitigate the effects of OPCs. In general, all four protection aspects of the design are capable of mitigating an OPC with and without an accident if no failures are assumed in the OPIS system.

The staff is interested in understanding how the OPIS designs consider potential failures, and how the VII criteria will be met during potential failures.

Questions for the Industry:

a. What actions are being taken to mitigate the potential consequences resulting from a potential OPIS failure? How do these actions meet the OPC VII criteria?
b. If there was a failure of the OPIS, how would the plant meet the provisions for single failure of the onsite power system to mitigate against DBAs? If so, describe how.

3. UFSAR update

VII criteria:

"The Updated Final Safety Analysis Report (UFSAR) must be updated to discuss the design features and analyses related to the effects of, and protection for, any open phase condition design vulnerability. This update would typically be to chapter 8."

Observations:

Three of the four licensees reviewed during the initial inspections were evaluating the need to update their UFSARs because the modification process had not been completed at the time of the inspections. One licensee updated their UFSAR with very limited details of the design features and analyses related to the effects of, and protection for, any OPC design vulnerability.

The staff is interested in understanding what technical content will be included in the UFSAR updates to be consistent with the VII.

Questions for the Industry:

What is NEI's expectations for updates to UFSAR with regard to the level of technical content detail and schedule for implementation? What is sufficient detail to reflect the licensing basis for protection against OPCs? Could you provide examples?

4. Surveillance and LCO Requirements in Plant TS

VII criteria:

"Periodic tests, calibrations, setpoint verifications or inspections (as applicable) must be established for any new protective features. The surveillance requirements must be added to the plant Technical Specifications, if necessary to meet the provisions of 10 CFR 50.36. Further industry guidance will be provided for the development of Technical Specifications as the design features are identified."

Observations:

Three licensees were currently evaluating the need to: (a) update LCOs and Surveillance Requirements in plant Technical Specification; and (b) establish procedures for periodic inspections, tests, calibrations, and setpoint verifications. One licensee determined no changes are required to the TS, but established procedures for periodic inspections, tests, calibrations, and setpoint verifications.

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It is unclear to the staff what tests, calibrations, setpoint verifications or inspections are likely to be established, and how licensees will update their Technical Specifications to be consistent with the VII.

Questions for the Industry:

What type of periodic tests, calibrations, setpoint verifications or inspections are anticipated to be established, consistent with the VII? What is NEI's expectations for having licensee's update their TSs in order to meet the VII criteria? Could you provide examples?

References:

1. NEI VII to address the OPC (ADAMS Accession No. ML15075A454).

2. Functional criteria established in the November 25, 2014, NRC letter to NEI (ADAMS Accession No. ML15075A454)

3. NRC Inspection Reports:

i. 05000458/2018010 (ADAMS Accession No. ML18085B197);

ii.05000528/2018010,05000529/2018010, AND 05000530/2018010 (ADAMS Accession No. ML18103A157);

iii. 05000454/2018011; 05000455/2018011 (ADAMS Accession No. ML18138A136); and

iv. 05000335/2018002; 05000389/2018002(ADAMS Accession No. ML18208A328).