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Protecting People and the Environment

FOLLOW-UP MEETING
NRC BULLETIN 2012-01: DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM

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Overview

- Bulletin 2012-01
- Staff's Review of Responses
- Regulatory Requirements
- Staff's Conclusions and Recommendations

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Bulletin 2012-01

- **Bulletin Issued - July 27, 2012**
- **Requested Information from all holders of operating licenses and combined licenses for nuclear power reactors**
- **Responses Received - October 25, 2012**
- **Staff's review of responses completed - February 15, 2013**
- **Staff issued a Summary Report - February 26, 2013**
  (Ref. ADAMS Accession Number: ML13052A711)

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Information Requested

- **Bulletin requested details on:**
  - ❖ **Protection scheme(s) to detect and automatically respond to a single-phase open circuit condition with and without high impedance ground fault condition**
  - ❖ **Operating configuration of engineered safety features (ESF) buses during normal power operation for existing plants and non-safety buses for passive plants**
  - ❖ **Transformer winding configurations associated with offsite power system**

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Overview - Licensee Reponses

- **Operating Reactors:**
  - **Class 1E bus protective schemes not designed to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition**
  - **Detection of a single-phase open circuit condition is beyond the approved design and licensing basis of the plant**
  - **A high impedance fault by itself (independent of the open-phase circuit condition) is not a concern, not credible, or the existing protection is adequate**

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Overview - Licensee Responses (cont.)

Operating Reactors (cont.)

- One licensee stated that this is not a credible event at its facility because of the unique design of the switchyard (Sulphur Hexafluoride gas-insulated switchyard)
- Most licensees reviewed their plant design using the generic guidance from published literature
- Majority of the licensees stated that without formalized engineering calculations or engineering evaluations, the electrical consequences of such an open-phase event, including plant response cannot be evaluated

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Overview - Licensee Responses (cont.)

- **AP 1000 Reactors – Passive Design**

- The AC power system is non safety related and is not required to mitigate design-basis accidents or to bring the plant to a safe shutdown
- AC electrical system has not been designed to detect single-phase open circuit or high impedance ground fault conditions
- AC electrical design is in the finalization stage, and relay settings, detailed coordination studies, etc., are not yet available
- Operating configuration is consistent with the AP1000 Certified Design plus applicable AP1000 Certified Design exemptions
- If the single-phase open circuit or high impedance ground fault conditions is not detected, AP1000 safety functions would continue to be supported by its passive systems and the onsite DC safety-related power system

Overview - Licensee Responses (cont.)

➢ Analyses of requested information (operating plants)

- ✓ Offsite power transformer winding configuration
  - 43 reactor units - Byron Station configuration (Wye-Wye-Wye with solidly grounded primary and resistance grounded secondary)
  - 61 reactor units - various configurations

- ✓ Operating configuration of ESF buses
  - 40 reactor units - redundant offsite power sources feeding the redundant ESF buses during normal plant operation.
  - 19 reactor units – one offsite source feeds redundant ESF buses Byron Station configuration

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Overview - Licensee Responses (cont.)

➢ Analyses of requested information (operating plants)

✓ Operating configuration of ESF buses (Cont.)

- 27 reactor units - ESF buses normally aligned to the unit auxiliary transformers (UATs) during power operation. Upon unit trip, the ESF buses are transferred (using a bus transfer scheme) to the offsite power transformer
- 9 reactor units - generator output breaker (i.e., generator step up transformer and the UATs as the immediate access power source from the grid after the turbine or generator trip)
- 9 reactor units - operate with the normal feeds to ESF buses split between UATs and SAT

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Overview Licensee Responses (cont.)

Analyses of requested information (AP1000)

- All units have generator output breakers
- The credited GDC 17 circuit is the connection from the Main Step Up transformer (MSU) to the switchyard (only one circuit is required)
- Transformer configuration – three single phase MSUs with wye-delta configuration (solidly grounded neutral) and UATs with delta-wye configuration (wye) winding is low resistance grounded) (Not the same configuration as Byron Station)
- Medium voltage buses are normally aligned to the main generator during normal operations – no bus transfer required upon plant trip – operating configuration is the same as Byron station (one offsite circuit feeds redundant trains)
- Protection and transfer scheme between the offsite power system and onsite power system (standby diesel generators) - based on undervoltage conditions in nonsafety-related ac medium voltage buses

Regulatory Requirements

- 10CFR50 Appendix A GDC 17: 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 ……. 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.

- 10 CFR 50.55a(h)(2) requires protective actions to be completely automatic
  - IEEE 279 and IEEE 603 provide additional details.

- Criterion XVI, "Corrective Action," of 10 CFR Part 50, Appendix B, requires, in part, that conditions adverse to quality be promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective actions taken to preclude repetition.

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Staff's Conclusions and Recommendations

- **The design vulnerability exists for all plants including AP 1000**
  - ✓ The existing electric protection schemes do not detect and automatically respond to a single-phase open circuit condition
  - ✓ Most licensees have not completed detailed analysis to validate the plant-specific capability to address the design vulnerability
  - ✓ Not all licensees have established operating procedures and surveillances to monitor the operability of offsite power supplies (i.e., all three phases) at the ESF buses, at least once every shift during normal plant operation
  - ✓ All licensees should implement corrective actions in accordance with 10 CFR 50, Appendix B, Criterion XVI "Corrective Actions
  - ✓ Staff recommends the NRC take further regulatory actions to require current operating licensees to provide design features to address the design vulnerability
  - ✓ Staff recommends the NRC take further regulatory actions to require passive plants to provide design features to address the design vulnerability prior to the fuel load and NRC verification via applicable ITAACs