U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR NuScale SMR DESIGN

BRANCH TECHNICAL POSITION DSRS 8-6

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES (FOR PASSIVE DESIGN)

REVIEW RESPONSIBILITIES

Primary - Organization responsible for electrical engineering

Secondary - None

A. BACKGROUND

Events at the Millstone station have shown that adverse effects on the Class 1E loads can be caused by sustained low grid voltage conditions when the Class 1E buses are connected to offsite power. Loss-of-voltage relays, which generally have a low-voltage pickup setting in the range of 0.7 per unit voltage or less, will not detect these low-voltage conditions. See Reference 2 for further background information regarding these events.

The Millstone events also demonstrated that improper voltage protection logic can itself cause adverse effects on the Class 1E systems and equipment, such as spurious load shedding of Class 1E loads from the standby diesel generators and spurious separation of Class 1E systems from offsite power resulting from normal motor starting transients.

An event at the Arkansas Nuclear One station and the subsequent analysis performed disclosed the possibility of degraded voltage conditions existing on the Class 1E buses, even those with normal grid voltages, as a result of deficiencies in equipment between the grid and the Class 1E buses or by the starting transients experienced during certain accident events not originally considered in the sizing of these circuits. See Reference 3 for further background information regarding this event.

Regulatory Issue Summary (RIS) 2000-24 summarizes the staff's concerns about grid reliability challenges that industry deregulation might impose and potential voltage inadequacies of offsite power sources.

RIS 2011-12 was issued to clarify the NRC staff's technical position on existing regulatory requirements. Specifically, this RIS clarifies voltage studies necessary for Degraded Voltage Relay (second level undervoltage protection) setting bases and Transmission Network/Offsite/Station electric power system design bases for meeting the regulatory requirements specified in General Design Criteria (GDC) 17 to 10 CFR Part 50, Appendix A.

NUREG-1793 discusses the interfaces of the AP1000 passive plant design with the offsite

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alternating current (ac) power system. This report also presents assumptions on the performance of the offsite power system following loss of offsite power required for supporting Chapter 15 analyses.

Information Notice (IN) 2000-06 informed licensees of possible concerns regarding the voltage adequacy of offsite power sources (i.e., power from the transmission system to nuclear power plants). This notice documents specific examples from plant operating experience.

B. BRANCH TECHNICAL POSITION – PASSIVE DESIGNS

The advantages of a passive design over an active design with respect to degraded grid conditions is that in a passive design, the important-to-safety (i.e., safety related plus regulatory treatment of non-safety-related system (RTNSS)) loads may be isolated from the degraded grid conditions and if so, are not subject to common cause failure. A design is considered passive for this design-specific review standard, branch technical position (BTP) if the above conditions hold true. Otherwise, the design is considered active with respect to this BTP and Standard Review Plan BTP 8-6 (Active Plants) should be applied.

For a passive plant design, the review should address the following:

1. The reviewer should assure that the Class 1E battery chargers are qualified isolation devices in accordance with IEEE Std. 384 and Regulatory Guide (RG) 1.75 and that they are capable of isolating grid transients from the Class 1E direct current (dc) power system, as well as preventing degraded voltage conditions from being impressed upon the dc system. For degraded voltage conditions, the battery chargers should be in a back-biased state which would allow the batteries to supply the dc loads without any additional draw down of the batteries. Acceptable isolation of any ac-powered RTNSS loads may be demonstrated, for example, by such features as normally open circuit breakers.

2. Monitoring of degraded grid conditions should be provided as part of the design. The applicant must justify the extent of the monitoring and the placement thereof within the ac distribution system to assure that the entire ac system is covered.

3. The applicant should provide a description of the actions to be taken upon the detection of a degraded grid condition such as communications with the grid operations staff as well as any site-specific actions.

C. REFERENCES

1. RG 1.153, “Criteria for Power, Instrumentation, and Control Portions of Safety Systems.”

2. Millstone Unit No. 2, Safety Evaluation Supporting Amendment No. 16 to License No. DPR-65.

3. NRC Summary of Meeting for Arkansas Nuclear One Incident of September 16, 1978, February 9, 1979.

4. IEEE Std. 279-1971, “Criteria for Protection Systems for Nuclear Power Stations.”

5. IEEE Std. 603-1991, “Criteria for Safety Systems for Nuclear Power Generating Stations.”

6. NRC IN 2000-06, “Offsite Power Voltage Inadequacies,” March 27, 2000.

7. NRC RIS 2000-24, “Concerns About Offsite Power Voltage Inadequacies and Grid Reliability Challenges due to Industry Deregulation,” December 21, 2000.

8. NUREG-1793, “Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design,” September 2004.

9. NRC RIS 2011-12, “Adequacy of Station Electric Distribution System Voltages”, December, 2011

10. Economic Simplified Boiling-Water Reactor Final Safety Evaluation Report, March 10, 2011, ADAMS Accession No. ML103470210.