UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
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NRC REGULATORY ISSUE SUMMARY 2004-05
GRID RELIABILITY AND THE IMPACT ON PLANT RISK AND THE OPERABILITY OF OFFSITE POWER

ADDRESSEES

All holders of operating licenses for nuclear power reactors except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

INTENT

The U.S. Nuclear Regulatory Commission (NRC) is issuing this regulatory issue summary (RIS) to advise nuclear power plant (NPP) addressees of the requirements of Section 50.65 of Title 10 of the *Code of Federal Regulations* (10 CFR 50.65), "Requirements for monitoring the effectiveness of maintenance at nuclear power plants," 10 CFR 50.63, "Loss of all alternating current power," 10 CFR Part 50 Appendix A, General Design Criterion (GDC) 17, "Electric power systems," and plant technical specifications on operability of offsite power. The NRC plans to perform inspections to review these areas following the issuance of this RIS. A temporary instruction (TI) will be issued for these inspections and will be available in advance of the inspections. This RIS does not require any action or written response on the part of an addressee.

BACKGROUND

On August 14, 2003, the largest power outage in the history of the United States occurred in the Northeastern United States and parts of Canada. Nine U.S. NPPs tripped. Eight of these, along with one NPP that was already shut down, lost offsite power. Although the onsite emergency diesel generators (EDGs) functioned to maintain safe shutdown conditions, this event was significant in terms of the number of plants affected and the duration of the power outage.

The loss of all alternating current (AC) power at NPPs involves the loss of offsite power (LOOP) combined with the loss of the onsite emergency power supplies (typically EDGs). This is also referred to as a station blackout (SBO). Risk analyses performed for NPPs indicate that the loss of all AC power can be a large contributor to the core damage frequency, contributing up to 74 percent of the overall risk at some plants. Although NPPs are designed to cope with a LOOP event through the use of onsite power supplies, LOOP events are considered to be precursors to SBO. An increase in the frequency or duration of LOOP events increases the risk of core damage.

The NRC has been evaluating the reliability of offsite power for NPPs over the last several years as a result of the changing nature of the surrounding electrical grids. A switchyard degraded voltage condition that occurred at the Callaway nuclear plant on August 11, 1999, was attributed to high grid power flows. The NRC staff has been working with the nuclear power industry on concerns identified in NRC RIS 2000-24 regarding offsite power voltage inadequacies and grid reliability challenges due to the electric power industry deregulation. The August 14, 2003, U.S.-Canadian power outage gave rise to concerns regarding grid operation and its impact on NPPs and their compliance with certain NRC regulations applicable to the condition of offsite power. Some of the concerns involve NPP safety. Many of the matters below were discussed in RIS 2000-24. The regulations discussed will be the focus of the subject TI.

General Design Criterion 17 and Plant Technical Specifications (TSs)

For NPPs licensed to the GDC in Appendix A to 10 CFR Part 50, the design criteria for onsite and offsite electrical power systems are provided in GDC 17, “Electric power systems”. For NPPs not licensed to the GDC in Appendix A, these design criteria are provided in the plant updated final safety analysis report the plant was licensed under. These have criteria similar to GDC 17, which requires an offsite electric power system be provided to power safety equipment necessary to respond to anticipated operational occurrences and postulated accidents. The transmission network (grid) is the source of power to the offsite power system. The final paragraph in GDC 17 requires (along with other provisions) provisions to minimize the loss of power from the transmission network given a loss of power generated by the nuclear power unit. The loss of power generated by the nuclear power unit (trip) is an anticipated operational occurrence. It is therefore necessary that offsite power be designed to be available following a trip of the unit in order to power safety equipment necessary to respond to the event.

The trip of an NPP, however, can cause grid changes that could result in a LOOP. Foremost among the grid changes is a reduction in the plant’s switchyard voltage as a result of the loss of the reactive supply to the grid from the NPP’s generator. If the voltage is low enough, it could actuate the plant’s degraded voltage protection with subsequent separation of the plant safety buses from offsite power. A less likely event would be the trip of a nuclear plant causing grid instability and subsequent LOOP due to the loss of the real and/or reactive power support being supplied to the grid from the plant’s generator.

Plant TSs require the offsite power system to be operable as part of the limiting conditions for operation and specify what actions to take when it is not. Plant operators should therefore be cognizant of the capability of (1) the offsite power system to meet plant safety needs during operation and (2) situations that can result in a LOOP following a trip of the plant. If offsite power is not capable of supporting the NPP safety requirements in either situation, the system should be declared inoperable and pertinent plant TS provisions followed.

10 CFR 50.65

Section 50.65(a)(4) requires that licensees assess and manage the increase in risk that may result from maintenance activities before performing the proposed maintenance activities. These activities include, but are not limited to surveillances, post-maintenance testing, and

corrective and preventive maintenance. The scope of the assessment may be limited to structures, systems, and components (SSCs) that a risk-informed evaluation process has shown to be significant to public health and safety.

In NRC Regulatory Guide (RG) 1.182, the NRC endorsed the February 22, 2000, revision to Section 11 of NUMARC 93-01, Revision 2, as providing methods that are acceptable for meeting 10 CFR 50.65(a)(4). The revised Section 11 addressed grid stability and offsite power availability in several areas. For example:

> Section 11.3.2.8 states that "emergent conditions may result in the need for action prior to conduct of the assessment, or could change the conditions of a previously performed assessment. Examples include plant configuration or mode changes, additional SSCs out of service due to failures, or **significant changes in external conditions (weather, offsite power availability)."**
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> Additionally, Section 11.3.4 states, in part, that the assessment for removal from service of a single SSC for the planned amount of time may be limited to the consideration of **unusual external conditions that are present or imminent (e.g., severe weather, offsite power instability)**.

On this basis, grid reliability evaluations should be performed as part of the maintenance risk assessment required by 10 CFR 50.65 prior to taking a risk-significant piece of equipment (including but not limited to EDG, battery, steam driven pump, alternate AC power source, etc.) out of service for the purpose of performing proposed maintenance activities, including surveillances, post-maintenance testing, and corrective and preventive maintenance. This grid reliability evaluation should be considered, as should other external events, in the maintenance risk assessment, whether quantitatively or qualitatively. If any risk management actions are taken as a result of the maintenance risk assessment, the licensee should consider rescheduling maintenance activities that tend to increase the initiating event frequency for a LOOP or SBO and those that tend to reduce the capability to cope with those occurrences. If there is some overriding need to perform maintenance on risk-significant equipment under conditions of degraded grid stability, then risk management actions should include consideration of alternate equipment protection measures and compensatory actions.

With regard to conditions that emerge during a maintenance activity in progress, Section 11.3.2.8 in NUMARC 93-01, Revision 2, states that emergent conditions could change the conditions of a previously performed risk assessment. Offsite power availability is one of the examples provided of an emergent condition that could change the conditions of a previously performed risk assessment. Therefore, in consideration of the fact that worsening grid conditions could impact offsite power availability and change the conditions of a previously performed risk assessment, it is appropriate for a licensee to reassess the plant risk, taking the potential effects of a worsening grid condition into account. However, this reassessment of the risk should not interfere with or delay measures to place and maintain the plant in a safe condition in response to or preparation for those effects.

10 CFR 50.63

Pursuant to 10 CFR 50.63, "Loss of all alternating current power," the NRC requires each NPP licensed to operate be able to withstand an SBO for a specified duration and recover from the SBO. NRC Regulatory Guide (RG) 1.155 provides NRC guidance for licensees to use in developing their approach to compliance with 10 CFR 50.63. The RG has a series of tables that define a set of pertinent plant and plant site parameters that have been found to impact the likelihood of a plant experiencing an SBO event of a given duration. Use of the tables allows a licensee to determine a plant's relative vulnerability to SBO events of a given duration and identify a minimum SBO coping duration for the plant that is acceptable to the NRC.

With regard to grid-related losses of offsite power, Table 4 in RG 1.155 indicates that the following plant sites should be assigned to Offsite Power Design Characteristic Group P3:

> Sites that expect to experience a total loss of offsite power caused by grid failures at a frequency equal to or greater than once in 20 site-years, unless the site has procedures to recover ac power from reliable alternative (nonemergency) ac power sources within approximately one-half hour following a grid failure.

The majority of U.S. NPPs fall into the 4-hour minimum required coping capability category. Table 2 in RG 1.155, however, indicates that the typical plant with two redundant EDGs per nuclear unit would be required to have at least an 8-hour minimum coping duration if it fell into the P3 group. Therefore, plants that have experienced a grid-related LOOP since they were evaluated against the SBO guidance in RG 1.155 may no longer be consistent with RG 1.155.

Section 2 of RG 1.155 provides guidance on the procedures necessary to restore offsite power, including losses following "grid undervoltage and collapse." Section 2 states: "Procedures should include the actions necessary to restore offsite power and use nearby power sources when offsite power is unavailable." These procedures are a necessary element in minimizing LOOP durations following a LOOP or SBO event.

SUMMARY OF ISSUE

Licensees are required to comply with their plant TSs relative to inoperability of offsite power when the design requirements of GDC 17 (or criteria similar to GDC 17) cannot be met (e.g., when post-trip switchyard voltages will be inadequate or offsite power will unavailable post-trip).

Plant TSs contain limiting conditions for operation (LCOs) that require the plant offsite power system to be operable. Maintenance being performed on, and inoperability of, key elements of the plant switchyard and offsite power grid can impact the operability of the offsite power system, particularly during times of high grid load and grid stress. A communication interface with the plant's transmission system operator, together with other local means used to maintain an awareness of changes in the plant switchyard and offsite power grid, is appropriate to determine the impact of these changes on operability of the offsite power system.

Licensees should ensure that offsite power is operable during normal plant operation, as well as during anticipated operational occurrences and postulated accidents (e.g., licensees should be aware of the impact of a plant trip on the availability of offsite power and adequacy of post-trip switchyard voltages). Plant operators should therefore be aware of the offsite power needs of the plant, including minimum required switchyard voltages, and know when these needs cannot be met. (Note: The cooperation of the transmission system operator may have to be enlisted through an appropriate communication interface to ensure that offsite power will be available and switchyard voltages will be adequate following a trip of the plant.)

Transmission system operators typically use computer programs such as state estimators and contingency analyzers to periodically verify the condition of the transmission system. When these tools are unavailable to the transmission system operator, the availability and adequacy of offsite power to the nuclear plant, especially following a trip of the plant, may be unknown. Plant operators should be aware of situations, such as the above, that can result in unavailability of systems that could impact operability of offsite power.

Analyses for electrical supplies to the plant may take credit for nonsafety devices such as automatic tap changing transformers or reactive load compensation such as capacitor banks. If these devices are degraded or taken out of service, the effect on the operability of offsite power should be evaluated. If these devices are necessary for operability of offsite power, licensees can add information to the bases of the TSs regarding the technical parameters of the devices (e.g., automatic response, minimum rating required) necessary to ensure offsite power operability.

In taking any risk management actions as a result of the maintenance risk assessment, the licensee should consider rescheduling maintenance activities that tend to increase the initiating event frequency for a LOOP or SBO and those that tend to reduce the capability to cope with those occurrences. If there is some overriding need to perform maintenance on risk-significant equipment under conditions of degraded grid stability, then risk management actions should include consideration of alternate equipment protection measures and compensatory actions.

With regard to conditions that emerge during a maintenance activity in progress, worsening grid conditions could impact offsite power availability and change the conditions of a previously performed assessment. It is therefore appropriate for a licensee to reassess the plant risk taking the potential effects of a worsening grid condition into account. However, this reassessment of the risk should not interfere with or delay measures to place and maintain the plant in a safe condition in response to or preparation for those effects.

Pursuant to 10 CFR 50.63, “Loss of all alternating current power,” the NRC requires that each NPP licensed to operate must be able to withstand an SBO for a specified duration and recover from the SBO.

NPPs that have experienced a grid-related LOOP since they were evaluated against the SBO guidance in RG 1.155 may no longer be consistent with RG 1.155. Specifically, the statement in RG 1.155 under Group P3, (“Sites that expect to experience a total LOOP caused by grid failures at a frequency equal to or greater than once in 20 site years”) may now apply to NPPs

not originally included in group P3. NPPs should also have procedures available consistent with the guidance in Section 2 of RG 1.155 for restoration of offsite power following a LOOP or SBO event.

BACKFIT DISCUSSION

This RIS requires no action or written response and, therefore, is not a backfit under 10 CFR 50.109. Consequently, the staff has not performed a backfit analysis.

***FEDERAL REGISTER* NOTIFICATION**

A notice of opportunity for public comment on this RIS was not published in the *Federal Register* because it is informational.

CONGRESSIONAL REVIEW ACT

The NRC has determined that this RIS is not subject to the Congressional Review Act, 5.U.S.C 801-808, because the RIS does not state a new position.

PAPERWORK REDUCTION ACT STATEMENT

The information collections associated with this Regulatory Issue Summary are covered by the requirements of 10 CFR Part 50, which were approved by the Office of Management and Budget, approval number 3150-0011.

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB approval number.

If you have any questions about this matter, please contact one of the persons listed below or the appropriate Office of Nuclear Reactor Regulation project manager.

/RA/
William D. Beckner, Chief
Reactor Operations Branch
Division of Inspection Program Management
Office of Nuclear Reactor Regulation

Technical Contact: James J. Lazevnick
301-415-2782
E-mail: jjl@nrc.gov

Attachment: List of Recently Issued NRC Regulatory Issue Summaries

LIST OF RECENTLY ISSUED
NRC REGULATORY ISSUE SUMMARIES

Regulatory Issue Summary No.	Subject	Date of Issuance	Issued to
2004-04	Use of Code Cases N-588, N-640, and N-641 in Developing Pressure-Temperature Operating Limits	04/05/2004	All holders of construction permits or operating licenses for nuclear power reactors except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.
2004-03	Risk-informed Approach For Post-Fire Safe-Shutdown Associated Circuit Inspections	03/02/2004	All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.
2004-02	Deferral of Active Regulation of Ground-Water Protection at *in Situ* Leach Uranium Extraction Facilities	02/23/2004	All holders of materials licenses for uranium and thorium recovery facilities.
2004-01	Method for Estimating Effective Dose Equivalent from External Radiation Sources Using Two Dosimeters	02/17/2004	All U.S. Nuclear Regulatory Commission (NRC) licensees.
2003-18	Use of NEI 99-01," Methodology for Development of Emergency Action Levels," Revision 4, Dated January 2003	10/08/2003	All holders of operating licenses for nuclear power reactors and licensees that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

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