

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

December 21, 2000

**NRC REGULATORY ISSUE SUMMARY 2000-24
CONCERNS ABOUT OFFSITE POWER VOLTAGE
INADEQUACIES AND GRID RELIABILITY CHALLENGES
DUE TO INDUSTRY DEREGULATION**

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those that 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 inform addressees of concerns about grid reliability challenges which industry deregulation might pose and potential voltage inadequacies of offsite power sources, and of actions the industry has committed to take to address this issue. The NRC is continuing to work with the nuclear power industry to address this matter; this RIS presents the current status of the NRC/industry effort. This RIS does not transmit any new requirements or staff positions. No specific action or written response is required.

BACKGROUND INFORMATION

On August 11, 1999, the Callaway plant experienced a rupture of a reheater drain tank line. As a result, the plant operators initiated a manual reactor trip. Once the plant was shut down, offsite power was required to supply the plant equipment loads. During this period, the grid conditions were such that a substantial power flow was observed to occur from north to south through the local Callaway grid. The licensee has stated that the deregulated wholesale market has contributed to conditions in which higher grid power flows are likely to occur. This power flow, coupled with a high local demand and the loss of the Callaway generator, resulted in switchyard voltage at the site dropping below the minimum requirements for greater than 12 hours. Although offsite power remained available during the reactor trip transient, the post-trip analysis indicated that if there had been additional onsite loads at the time of the event, 4.16 kV distribution voltage would have dropped below the setpoint of the second-level undervoltage relays separating the loads from offsite power. The NRC conducted a special inspection at Callaway from November 29 to December 3, 1999, on the circumstances surrounding the event.

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The inspectors found that similar conditions prevailed in 1995 that went undetected by the licensee (Licensee Event Report 50-483/99-005 (Accession No. 9909200074); NRC Inspection Report (IR) 50-483/99-15 (Accession No. ML003684343), dated February 15, 2000). NRC Information Notice (IN) 2000-06 (attached) documents several events in which additional combinations of main generator unavailability, line outages, transformer unavailability, high system demand, unavailability of other local voltage support, and high plant load could have resulted in inadequate voltages. Common among all events is the inability to predict the inadequate voltages through direct readings of plant switchyard or safety bus voltages, without also considering grid and plant conditions and their associated analyses.

NRC IN 98-07 discussed the possibility that the deregulation of the electric utility industry could affect the reliability of the offsite power systems in nuclear power plants. NRC IN 95-37 alerted licensees to circumstances that could result in inadequate offsite power system voltages during design basis events. NRC IN 93-17 identified the potential for the loss of plant generation following a loss-of-coolant-accident causing degraded switchyard voltage and leading to a delayed loss of offsite power condition.

SUMMARY OF ISSUE

Under the process described in SECY 99-143, "Revisions to Generic Communications Program," the NRC held a meeting with representatives from the nuclear power industry on May 18, 2000, to discuss what assistance industry could provide in addressing the voltage adequacy issue. A summary of this meeting is in the public record under ADAMS Accession No. ML003722320. At this meeting, the staff proposed that the Nuclear Energy Institute (NEI) take the following steps as an industry initiative:

- (1) Provide guidance to utilities on the need for and acceptable techniques available to ensure adequate post-trip voltages;
- (2) Establish provisions to log and evaluate unplanned post-trip switchyard voltages to help verify and validate that the intent stated in Item (1) is met;
- (3) Determine plant-specific risks of degraded voltage/double sequencing scenarios.

Item 1 is based on the Callaway inspection finding in IR 50-483/99-15 that the licensee did not have adequate provisions in place to ensure the functionality of the offsite power system following a trip of the reactor and main generator. The inspection report concluded that this condition was caused, in part, by a failure to consider potential changes in the reliability and electrical characteristics (e.g., voltage levels) of the electrical grid caused by power market deregulation. Reduction in the reliability of the electrical grid from that assumed in the design of plant power systems could result in a failure of the offsite power sources to be able to meet their design capacity and capability, thereby resulting in a failure to meet General Design Criterion (GDC) 17 of Appendix A to 10 CFR Part 50. Licensees must continue to comply with GDC 17 despite any reductions in grid reliability and electrical characteristics.

Item 2 is based on a concern similar to that stemming from the Callaway event, i.e., inadequate voltage to safety loads. This concern was articulated in two NRC generic letters, one dated

June 2, 1977 ("Millstone Nuclear Power Station Degraded Grid Voltage") and the other dated August 8, 1979 (Generic Letter 79-36, "Adequacy of Station Electric Distribution Systems Voltages"). These generic letters were followed by Branch Technical Position (BTP) PSB-1 in the NRC standard review plan, which provided the original basis for analyses and commitments on the degraded voltage issue. In addressing this issue, licensees were to establish an anticipated range of normal offsite grid voltages over which they were to demonstrate that adequate voltages would be provided to the terminals of all safety-related equipment for all design-basis events. Typical plant technical specifications (TS) require that written procedures be established, implemented and maintained covering the activities specified in Appendix A of Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operations)," dated February 1978. Appendix A, Section 8.b of Regulatory Guide 1.33, sets forth acceptable positions for implementing procedures for each surveillance test, inspection, or calibration listed in the TS. IR 50-483/99-15 found that the Callaway licensee committed to satisfy the positions of Regulatory Guide 1.33; however, the licensee did not provide adequate instructions to assure reliable indication of switchyard voltages or establish adequate procedures for the evaluation of potentially inoperable offsite power supplies.

Item 3 relates to staff commitments documented in a letter from the Executive Director for Operations to the Advisory Committee on Reactor Safeguards, dated December 28, 1998 (Accession No. 9902120319), which are that the staff will (1) pursue concerns relating to the functional capability of the emergency core cooling system under degraded voltage conditions and (2) determine the regulatory process to be used to ensure that no plant has an electrical configuration that would result in an unacceptable core damage frequency.

The staff also discussed the need for NEI to move expeditiously to develop a schedule for the resolution of this issue and to establish milestones.

NEI informed the NRC in a letter dated June 26, 2000 (ADAMS Accession No. ML003727547), that it had committed to take the following actions:

- Communicate to licensee chief nuclear officers the issues associated with degraded grid voltage.
- Monitor industry progress in addressing the industry action plan for addressing grid voltage adequacy concerns.
- Obtain insights from recently initiated industry efforts to assess the risk significance of potential grid voltage sequences.
- Conduct an industry workshop early next year on degraded grid voltage to facilitate a broader sharing of licensee practices, insights and activities.

On October 27, 2000, the NRC held a follow-up meeting with representatives from NEI, the Institute of Nuclear Power Operations (INPO), North American Electric Reliability Council (NERC) and Electric Power Research Institute (EPRI) to discuss further the related grid voltage adequacy issues and to provide the status of industry efforts in this area. A summary of this meeting is in the public record under ADAMS Accession No. ML003770544.

NEI discussed plans for an industry workshop on nuclear power plant grid reliability to be held in April 2001. Representatives from INPO and EPRI presented discussions on their initiatives and experience related to ensuring adequate grid voltage to nuclear plants. INPO reported partial results from the nuclear power plant owners implementing Significant Operating Experience Report (SOER) 99-01, "Loss of Grid." INPO reported that 14 stations (27 nuclear units) have been evaluated for implementation of the SOER recommendations. SOER 99-01 contains five recommendations for ensuring that barriers to protect nuclear power plants from grid loss or degradation are in place. INPO will complete its review of SOER 99-01 at all nuclear power plants by June 2002. EPRI provided an overview of the Power Delivery Reliability Initiative, a 5 million dollar program with a goal of reducing the North American Grid vulnerability to disruption of service.

The industry provided information during the October 27, 2000, meeting with the NRC that showed there are initiatives in several areas. These initiatives, combined with the low probability of the initiating event, provide reasonable confidence that nuclear power plants will be protected from the detrimental effects of potential degraded grid voltage situations. The staff will continue to monitor plant events and/or industry trends as described in SECY-99-129, "Effects of Electric Power Industry Deregulation on Electric Grid Reliability and Reactor Safety," dated May 11, 1999.

BACKFIT DISCUSSION

This RIS requests no action or written response. Consequently, the staff did not perform a backfit analysis.

FEDERAL REGISTER NOTIFICATION

A notice of opportunity for public comment was not published in the *Federal Register* because this RIS is informational, and the public was afforded opportunities to comment on this issue at the meetings held on May 18, 2000 and October 27, 2000. The NRC intends to work with NEI, industry representatives, members of the public, and other stakeholders to resolve this issue.

PAPERWORK REDUCTION ACT STATEMENT

This RIS does not request any information collection.

If there are any questions concerning this RIS, please contact the person listed below.

/RA/

David B. Matthews, Director
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

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301-415-2985
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Attachments:

1. NRC Information Notice 2000-06, "Offsite Power Voltage Inadequacies"
2. List of Recently Issued Regulatory Issue Summaries

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

March 27, 2000

NRC INFORMATION NOTICE 2000-06: OFFSITE POWER VOLTAGE INADEQUACIES

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.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to inform addressees of experience related to a possible concern regarding the voltage adequacy of offsite power sources, that is, power from the transmission system grid to nuclear power plants. It is expected that recipients will review the information for applicability to their facilities and consider actions as appropriate to avoid similar problems. No specific action or written response is required by this notice.

Description of Circumstances

On August 11, 1999, the Callaway plant experienced a rupture of a reheater drain tank line. As a result, the plant operators initiated a manual reactor trip. Since the plant was shutdown, offsite power was required to supply the plant equipment loads. During this period, the grid conditions were such that a substantial power flow was occurring from north to south through the local Callaway grid. The licensee stated that the deregulated wholesale market contributed to conditions in which higher grid power flows are likely to occur. The licensee stated that these large flows were observed at this time. This power flow, coupled with a high local demand and the loss of the Callaway generator, resulted in switchyard voltage at the site dropping below the minimum requirements for 12 hours. Although offsite power remained available during the reactor trip transient, the post-trip analysis indicated that in the event that additional onsite loads would have been in operation at the time of the event, 4-16 kV distribution voltage may have decreased below the setpoint of the second-level undervoltage relays separating the loads from offsite power. The NRC conducted a special inspection at Callaway from November 29 to December 3, 1999, on the circumstances surrounding the event. The inspectors found that similar conditions existed in 1995 that were undetected by the licensee (Licensee Event Report (LER) 50-483/99-005 (Accession No. 9909200074); NRC Inspection Report 50-483/99-15 (Accession No. ML003684343), dated February 15, 2000).

The following events identify additional combinations of main generator unavailability, line outages, transformer unavailability, high system demand, unavailability of other local voltage support, and high plant load that could result in inadequate voltages. Common among all the

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events is the inability to predict the inadequate voltages through direct readings of plant switchyard or safety bus voltages, without also considering grid and plant conditions and their associated analyses.

On July 11, 1989, safety systems at Virgil C. Summer Nuclear Station experienced a sustained degraded voltage condition and, as a result, the safety buses were automatically transferred from the offsite power system to onsite standby diesel generators. The degraded condition was caused by a turbine trip and deficiencies in the offsite power system's transmission network equipment. The transfer of power supplies was initiated by operation of degraded voltage protective relays, as designed. Nonsafety system loads remained operable while being powered for approximately 1 hour from the degraded offsite power source (LER 50-395/89-012 (Accession No. 8908140351)).

On November 5, 1991, the licensee for Arkansas Nuclear One, Units 1 and 2, reported that had its 500-kV auto-transformer been lost during summer peak conditions, the 161-kV system might not have been able to maintain adequate voltages to support the operation of the safety system loads of both units (LER 50-313/91-010 (Accession No. 9111150021)).

On December 30, 1993, Northeast Nuclear Energy Company concluded that with the switchyard at the worst case minimum voltage, Millstone Nuclear Power Station, Unit 1, loss-of-coolant accident (LOCA) mitigation loads could combine with normal loads that are not shed upon receipt of an accident signal to produce a voltage drop that would actuate degraded voltage relays resulting in separation from offsite power. The utility determined that this worst case minimum switchyard voltage could occur after the loss of Millstone Unit 1 generation when both Millstone Units 2 and 3 are off-line (LER 50-245/94-01 (Accession No. 950920001)).

On February 6, 1995, the licensee for Palo Verde Nuclear Generating Station, Units 1, 2, and 3, reported shortcomings in the plant site voltage regulation. Specifically, if a LOCA occurred with the switchyard voltage in the lower two-thirds of its operating range, the engineered safety feature (ESF) loads would begin sequencing onto the preferred offsite power source, and the house loads would fast transfer to the startup transformer following the main generator or turbine trip that would accompany the LOCA. The resulting voltage drops at the safety buses would cause the bus degraded voltage relays to drop out during the ESF load sequencing and subsequently resequence the loads onto the diesel generators. The licensee identified this scenario as "double sequencing" (LER 50-528/93-011-01 (Accession No. 9502160195)).

On August 8, 1995, Pacific Gas & Electric Company (PG&E) reported that during peak system loading, all transmission lines and a local fossil power plant (Morro Bay) needed to be in service to meet Diablo Canyon Nuclear Power Plant voltage requirements. A review of the available data by PG&E on the offsite power supplies identified 47 instances in which the system configuration could have resulted in a degraded voltage condition between 1990 and 1995. PG&E identified a potential "double sequencing" scenario at Diablo Canyon if a LOCA occurred during these degraded voltage conditions (LER 50-275/95-007-01 (Accession No. 9608140037)).

On July 22, 1997, the licensee for Clinton Power Station sought an exemption from offsite power regulatory requirements because of its analysis that offsite power would become inadequate under certain summer peak conditions following the loss of the nuclear unit. The exemption request was eventually withdrawn by the licensee.

NRC inspection findings and licensee event reports have indicated instances in which grid stability analyses had not been updated by the licensees to reflect changes in the grid power system. An Office of Nuclear Regulatory Research report, "The Effects of Deregulation of the Electric Power Industry on the Nuclear Plant Offsite Power System: An Evaluation," dated June 30, 1999 (Accession No. 9907120008), recommended that the staff take certain followup actions to ensure that licensees will continue to maintain their licensing bases in this area.

Discussion

NRC Information Notice (IN) 98-07 discussed the possibility that the changes occurring as a result of deregulation of the electric utility industry could affect the reliability of the offsite power systems in nuclear power plants. Offsite power problems highlighted in licensee event reports were identified as potential sources of concern if not properly managed following the restructuring that occurs as a result of deregulation. NRC IN 95-37 alerted licensees to circumstances that could result in inadequate offsite power system voltages during design basis events.

The most recent problem, which was reported by the licensee for Callaway Unit 1, potentially tied the inadequate offsite system voltage problem to industry deregulation. The licensee stated in LER 50-483/99-005 (Accession No. 9909200074) that the magnitude of the power being transported across the grid during the period had not been previously observed and was far in excess of typical levels. LER 50-483/99-005 (Accession No. 9909200074) also stated that the deregulated wholesale power market contributes to conditions in which higher grid power flows are likely to occur, and these large flows were observed at this time.

Because the Callaway generator was supporting the grid voltage in the vicinity of the plant, the low grid voltage had not been observed until the Callaway generator voltage support was no longer available. However, if a design basis event had occurred during the period of high system demand, the consequential loss of the Callaway generator, combined with the plant electrical requirements associated with the event, could have actuated the plant's degraded voltage protection and separated safety loads from offsite power, which is the preferred power supply under these circumstances.

The reports referenced in this notice also identify additional combinations of circumstances than those seen at Callaway that could result in inadequate offsite voltages. These circumstances include main generator unavailability, line outages, transformer unavailability, high system demand, unavailability of other local voltage support, and high plant load. The common characteristic of these problems is that the true capability of the offsite source cannot necessarily be verified through direct readings of plant switchyard or safety bus voltages.

Instead, analyses of grid and plant conditions must be relied upon to determine this capability, considering the postulated occurrence of an event. If these analyses are not accurate and up to date, licensees could inadvertently operate their plants in regions of inadequate voltages for some periods of time.

As demonstrated by the Callaway event, industry deregulation can heighten the need to update the analyses on a more frequent basis. Some utilities have utilized on-line contingency analysis techniques in their grid control centers and implemented arrangements to be notified when the offsite system to their plant is in jeopardy of not providing its required capability. When the on-line capability is not available, other utilities have provided for updating of the analyses on a more frequent basis and have implemented procedures to identify when the plant and grid conditions are outside the bounds of the assumptions of the analyses, thereby providing the information to take compensatory actions as necessary.

Maintaining plant operation in a region of adequate offsite voltage is especially important for licensees that may not have evaluated their plant safety systems for the double-sequencing scenario identified in the Palo Verde and Diablo Canyon LERs. The safety consequences that would result if an event occurred during a period of inadequate voltage can, therefore, be difficult to assess.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

/RA/

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Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
 NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
2000-05	Recent Medical Misadministrations Resulting from Inattention to Detail	3/06/2000	All medical licensees
2000-04	1999 Enforcement Sanctions for Deliberate Violations of NRC Employee Protection Requirements	2/25/2000	All NRC licensees
2000-03	High-Efficiency Particulate Air Filter Exceeds Mass Limit Before Reaching Expected Differential Pressure	2/22/2000	All NRC licensed fuel-cycled conversion, enrichment, and fabrication facilities
2000-02	Failure of Criticality Safety Control to Prevent Uranium Dioxide (UO ₂) Powder Accumulation	2/22/2000	All NRC licensed fuel-cycled conversion, enrichment, and fabrication facilities
2000-01	Operational Issues Identified in Boiling Water Reactor Trip and Transient	2/11/2000	All holders of licenses for nuclear power reactors
99-34	Potential Fire Hazard in the use of Polyalphaolefin in Testing of Air Filters	12/28/99	All holders of licenses for nuclear reactors and fuel cycle facilities
99-33	Management of Wastes Contaminated With Radioactive Materials	12/28/99	All medical licensees
99-32	The Effect of the Year 2000 Issues on Medical Licensees	12/17/99	All NRC medical licensees
99-31	Operational Controls to Guard Against Inadvertent Nuclear Criticality	11/17/99	All NRC licensed fuel cycle conversion, enrichment and fabrication facilities

LIST OF RECENTLY ISSUED
NRC REGULATORY ISSUE SUMMARIES

Regulatory Issue Summary No.	Subject	Date of Issuance	Issued to
2000-23	Recent Changes to Uranium Recovery Policy	11/30/00	All holders of materials licenses for uranium and thorium recovery facilities
2000-22	Issues Stemming from NRC Staff Review of Recent Difficulties Experienced in Maintaining Steam Generator Tube Integrity	11/03/00	All holders of OIs for pressurized-water reactors (PWRs), except those who have permanently ceased operations and have certified that fuel have been permanently removed from the reactor vessel
2000-21	Changes to the Unplanned Scram and Unplanned Scram With Loss of Normal Heat Removal Performance Indicators	10/31/00	All holders of OIs for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel
2000-20	Advance Notice of Intent to Pursue License Renewal	11/14/2000	All holders of OIs for nuclear power reactors, except those licensees who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel