

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.

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 ACCESSION #: ML003695551 TEMPLATE #: NRR-052

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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