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

September 7, 1995

NRC INFORMATION NOTICE 95-37: INADEQUATE OFFSITE POWER SYSTEM VOLTAGES DURING DESIGN-BASIS EVENTS

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to circumstances that could result in inadequate offsite power system voltages during design-basis events. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

In response to a deficiency identified at Palo Verde Nuclear Generating Station by an electrical distribution system functional inspection (EDSFI) team, the licensee undertook an electrical design-basis reconstitution effort to upgrade and reverify the voltage regulation calculations at the plant. Subsequently, Licensee Event Report (LER) 93-011, dated December 25, 1993, reported on shortcomings in the plant site voltage regulation. Specifically, with the switchyard voltage in the lower two-thirds of its expected operating range and the startup transformer heavily loaded, the Class 1E loads might separate from the transformer and load onto the diesel generators; or the Class 1E bus undervoltage relays may not actuate even though sustained, substandard voltages might occur at the terminals of Class 1E loads. The heavy loading of the startup transformer would occur following a main generator or turbine trip with successful fast bus transfer of house loads to the transformer, or following manual transfer of house loads to the transformer.

In a recent supplement to LER 93-011, dated February 6, 1995, the Palo Verde licensee identified a different series of events that could occur as a result of the same problem. If a loss of coolant accident (LOCA) should occur 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 to fail to reset before timing out. This circumstance would result in the ESF loads separating from offsite power, load shedding of the safety buses, closing of the diesel generator breaker, and resequencing of the ESF loads onto the diesel generators. The licensee is administratively maintaining the switchyard voltage in the upper one-third of its operating range until a long-term solution to the problem is in place.

On August 8, 1995, the licensee for Diablo Canyon reported the same voltage vulnerability when one of the offsite power sources are unavailable.

In LER 91-010, Supplement 1, dated March 27, 1993, the licensee for Arkansas Nuclear One, (ANO), Units 1 and 2, reported that had a 500-kV autotransformer been lost during summer peak conditions in the past, the 161-kV system might not have been able to maintain adequate voltage to the safety loads of both units unless local hydro generation was available and dispatcher actions were taken to shed some of the 161-kV system load. The 500-kV autotransformer is a common link between the Unit 1 and Unit 2 startup transformers. Upon a unit trip the loads of each unit are automatically transferred to their respective startup transformer. If the 500-kV autotransformer that feeds both startup transformers is lost or unavailable, the loads of both units are transferred to a third common startup transformer fed from the 161-kV system. The long-term resolution of this problem was to install a voltage regulator from the 161-kV offsite power source.

Discussion

In the case of Palo Verde and ANO, the licensees determined through their analyses, which utilized updated computer-aided computational capabilities, that offsite power system voltages that could occur over the course of a year may not be adequate to support all design-basis events. At Palo Verde the weakness exists in the plant's electrical distribution system, and at ANO, the problem existed in the offsite power switchyard and transmission system.

In the case of Palo Verde, the licensee determined that the normal anticipated switchyard voltage variance is greater than the electrical system design could accommodate and still provide acceptable onsite distribution system voltage spread characteristics. The licensee has indicated that the minimum and maximum loading conditions used in previous analyses were respectively greater than and less than those that actual plant operating experience could support, the configuration control of transformer tap settings was not auditable, and a fast bus transfer undervoltage blocking feature was not fully understood and documented. This situation occurred and went undetected because of weaknesses in the original design and previous analyses of the plant's electrical distribution system, and because of a less than full understanding of the original design basis.

At ANO, the licensee indicated that the 161-kV inadequate voltage problem occurred because of an increase in the 161-kV grid loading with time. The problem went undetected because the ANO staff failed to periodically review the grid network voltage capability relative to the ANO voltage requirements or to consider how many years the required minimum offsite voltage levels could be maintained following the initial analysis.

NRC Generic Letters dated June 3, 1977 ("Millstone Nuclear Power Station Degraded Grid Voltage"), and August 8, 1979 ("Adequacy of Station Electric Distribution Systems Voltages"), which were subsequently replaced by Branch Technical Position (BTP) PSB-1 in the NRC standard review plan, provide the basis for original analyses and commitments on the degraded voltage issue. As part of this issue, licensees were asked to establish an anticipated range of normal offsite grid voltages over which they were then required to demonstrate that adequate voltages would be provided to the terminals of all safety-related equipment for all design-basis events. As identified by the ANO and Palo Verde licensees, operating the plant outside a range of offsite grid voltages that would provide adequate voltage to safety equipment, or that would result in separation from the offsite power system because of operation of degraded voltage protection relays may constitute a failure to meet plant technical specifications relative to adequate capability and capacity of the offsite power system circuits.

As demonstrated by the above described-events, failure to periodically update the original voltage analyses as the result of changing offsite grid or plant conditions could result in unintentional operation outside regulatory requirements. In addition, many licensees recently have identified a need to increase the setpoints of their undervoltage protection relays to ensure adequate voltages at the terminals of all safety-related equipment as a result of NRC EDSFIs or their own in-house electrical inspection or design reconstitution efforts. Although this measure ensures that inadequate voltages will not exist at the terminals of the equipment for any unacceptable length of time, increasing the setpoints increases the potential for separation from the offsite system during design-basis events over the range of normally anticipated offsite system grid voltages. An additional concern in this area is plants with no upper limit on degraded voltage protection relay setpoints. If these setpoints are allowed to drift in the upward direction, this trend could also lead to the same increased potential for separation from the offsite power system during design-basis events.

An unanticipated voltage drop during emergency load sequencing process could lead to sequencer lockup or circuit breaker operation that may require remote manual reset action. This problem was experienced at Vogtle Unit 1 and is documented in NUREG 1410, "Loss of Vital AC Power and RHR During Mid-Loop Operations at Vogtle Unit 1 on March 20, 1990." Accident mitigation could be delayed if procedures and training do not address restarting the sequencer and other compensatory actions.

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Dennis M. Crutchfield, Director
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OL = Operating License
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