UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 25 1980

Docket No.: 50-267

Mr. Don Warembourg
Nuclear Production Manager
Public Service Company
of Colorado
16805 Weld County Road 19 1/2
Platteville, Colorado 80651

Dear Mr. Warembourg:

An event at the Arkansas Nuclear One (ANO) station on September 16, 1978 brought into question the conformance of the station electric distribution system to GDC-17, in two separate regards. Each of two units at the ANO station has a dedicated startup transformer powered through a single shared autotransformer (common source of offsite power) from the station switchyard. Operation of an autotransformer overcurrent relay caused the loss of the two dedicated startup transformers. The station electrical distribution system thus automatically transferred the full auxiliary loads of both units to the backup startup transformer exceeding its rated capacity and degrading the voltage level at the safety buses. Secondly, during our review of the electrical system at the ANO station, the licensee's analysis indicated that the "immediate access offsite power circuit" (dedicated startup transformer) lacked "sufficient capacity and capability" to accommodate the simultaneous starting demands of the emergency loads concurrent with the full house loads, in the event of a loss of coolant accident (LOCA). The condition would result in all safety loads remaining on the dedicated startup transformer with unacceptably degraded voltage. A voltage degradation during the electrical starting condition becomes a safety concern either if the degradation causes the starting condition to be prolonged so as to become a sustained under-voltage or if the voltage degradation causes frequent spurious shedding of the ESF loads from the preferred power source, the offsite electric grid. This event was described in NRC's IE Information Notice No. 79-04. Additional background information is provided in Enclosure 1.

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The IE Information Notice No. 79-04 stated that NRC would follow with specific actions to be taken by licensees. This letter identifies those actions.

Based on the ANO event, the NRC has expanded its generic review of the adequacy of the electric power systems for all operating nuclear power facilities. Specifically, we must now confirm the acceptability of the voltage conditions on the station electric distribution systems with regard to both (1) potential overloading due to transfers of either safety or non-safety loads, and (2) potential starting transient problems in addition to the concerns expressed in our June 2, 1977 correspondence with regard to degraded voltage conditions due to conditions originating on the grid.

Based on the experience at ANO, the NRC is requiring all licensees to review the electric power systems at each of their nuclear power plants to determine analytically if, assuming all onsite sources of AC power are not available, the offsite power system and the onsite distribution system is of sufficient capacity and capability to automatically start as well as operate all required safety loads within their required voltage ratings in the event of (1) an anticipated transient (such as unit trip) or (2) an accident (such as a LOCA) regardless of other actions the electric power system is designed to automatically initiate and without the need for manual shedding of any electric loads. Protection of safety loads from undervoltage conditions must be designed to provide the required protection without causing voltages in excess of maximum voltage ratings of safety loads and without causing spurious separations of safety buses from offsite power. NRC should be informed of any required sequential loading of any portion of the offsite power system or the onsite distribution system which is needed to assure that power provided to all safety loads is within required voltage limits for these safety loads. Guidance on evaluating the performance of electric power systems with regard to voltage drops is provided in Enclosure 2.

The adequacy of the onsite distribution of power from the offsite circuits shall be verified by test to assure that analysis results are valid. Please provide: (1) a description of the method for performing this verification, and (2) the test results. If previous tests verify the results of the analysis, then test results should be submitted and additional tests need not be performed.

In addition, you are requested to review the electric power systems of your nuclear station to determine if there are any events or conditions which could result in the simultaneous or consequential loss of both required circuits to the offsite network to determine if any potential exists for violation of GDC-17 in this regard. These reviews should be completed, and a copy of the analyses provided to NRC within 60 days of the date of this letter.

In the event that any violations or potential violations of GDC-17 or voltage requirements of safety loads are discovered remedial action should be taken immediately. You should provide the Commission with prompt notification with written followup pursuant to the reporting requirements of your Technical Specifications.

Sincerely,

Robert L. Tedesco

Robert L. Tedesco, Assistant Director
for Licensing
Division of Licensing

Enclosures:
1. Background information on ANO event
2. Guidelines for voltage drop calculations

ENCLOSURE 1

BACKGROUND INFORMATION ON ANO EVENT

The event that occurred at the Arkansas Nuclear One station on September 16, 1978, brought into question the conformance of the station electric distribution system design to GDC-17 with regard to the capacity and the capability of the onsite systems.

Each of two units at the ANO station has a dedicated startup transformer connected to a single shared autotransformer (common source of offsite power) from the station switchyard. The incident was initiated by Unit 1 reactor trip concurrent with trip of the unit's turbine-generator. The Unit 1 auxiliary loads were automatically transferred to Startup Transformer 1. The power being supplied to Startup Transformer 3 (Unit 2 dedicated startup transformer), which was feeding Unit 2, and being supplied to Startup Transformer 1 resulted in operation of an autotransformer overcurrent relay and consequent tripping of the incoming circuit breaker of the autotransformer. The autotransformer has the capacity to provide power for both units, but due to an error, the overcurrent relay was still set for the operation of Unit 1 only. Loss of input power to the two Startup transformers automatically transferred the auxiliary loads for both units to the backup Startup Transformer, ST 2. However, this transformer is designed as an alternate supply for one unit and is not designed to carry full auxiliary loads for both units. This overload caused a voltage degradation at the safety buses. The event to this point demonstrated that the design of the offsite power system to the ANO station Units 1 and 2 did not fully meet GDC-17. In the circumstances experienced at ANO the failure of one of the two offsite electric power circuits resulted in failure of the other electric power circuit. GDC-17 requires, in part, that (1) electric power from the transmission network to the onsite distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and environmental conditions and (2) provision shall be included to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear unit, or the loss of power from the transmission network. The ANO did not fully meet these requirements.

Initially, the sequence of events on September 16, 1978 did not indicate any problem with the electrical distribution system of Unit 1. However, subsequent analysis by the licensee indicated that in the event of a LOCA at Unit 1 during which time Startup Transformer No. 1 would be required to provide power to both the non-safety auxiliary electrical loads and start the safety loads a voltage degradation would result. The safety loads might not transfer to the Unit 1 diesel-generators but could remain on the startup transformer with unacceptably degraded voltage. Although there is margin in the thermal capability of equipment such a situation could result in thermal damage in the safety equipment and/or blown fuses in control circuits for these safety loads. Either event could result in disabling these loads during a LOCA. GDC-17 requires, in part, that electric power supplies for nuclear power plants provide sufficient capacity and capability to assure that certain limits are not exceeded in the event of anticipated operational occurrences and that the core is cooled and containment integrity and other vital functions are maintained in the event of postulated failures. The ANO design was not capable of providing the electric power of "sufficient capacity and capability."

GUIDELINES FOR VOLTAGE DROP CALCULATIONS

1. Separate analyses should be performed assuming the power source to safety buses is (a) the unit auxiliary transformer; (b) the startup transformer; and (c) other available connections to the offsite network one by one assuming the need for electric power is initiated by (1) an anticipated transient (e.g., unit trip) or (2) an accident, whichever presents the largest load demand situation.

2. For multi-unit stations a separate analysis should be performed for each unit assuming (1) an accident in the unit being anlayzed and simultaneous shutdown of all other units at that station; or (2) an anticipated transient in the unit being analyzed (e.g., unit trip) and simultaneous shutdown of all other units at that station, whichever presents the largest load demand situation.

3. All actions the electric power system is designed to automatically initiate should be assumed to occur as designed (e.g., automatic bulk or sequential loading or automatic transfers of bulk loads from one transformer to another). Included should be consideration of starting of large non-safety loads (e.g., condensate pumps).

4. Manual load shedding should not be assumed.

5. For each event analyzed, the maximum load necessitated by the event and the mode of operation of the plant at the time of the event should be assumed in addition to all loads caused by expected automatic actions and manual actions permitted by administrative procedures.

6. The voltage at the terminals of each safety load should be calculated based on the above listed considerations and assumptions and based on the assumption that the grid voltage is at the "minimum expected value". The "minimum expected value" should be selected based on the least of the following:

   a. The minimum steady-state voltage experienced at the connection to the offsite circuit.

   b. The minimum voltage expected at the connection to the offsite circuit due to contingency plans which may result in reduced voltage from this grid.

   c. The minimum predicted grid voltage from grid stability analysis. (e.g., load flow studies).

In the report to NRC on this matter the licensee should state planned actions, including any proposed "Limiting Conditions for Operation" for Technical Specifications, in response to experiencing voltage at the connection to the offsite circuit which is less than the "minimum expected value." A copy of the plant procedure in this regard should be provided.

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7. The voltage analysis should include documentation for each condition analyzed, of the voltage at the input and output of each transformer and at each intermediate bus between the connection to the offsite circuit and the terminals of each safety load.

8. The analysis should document the voltage setpoint and any inherent or adjustable (with nominal setting) time delay for relays which (1) initiate or execute automatic transfer of loads from one source to another; (2) initiate or execute automatic load shedding; or (3) initiate or execute automatic load sequencing.

9. The calculated voltages at the terminals of each safety load should be compared with the required voltage range for normal operation and starting of that load. Any identified inadequacies of calculated voltage require immediate remedial action and notification of NRC.

10. For each case evaluated the calculated voltages on each safety bus should be compared with the voltage-time settings for the undervoltage relays on these safety buses. Any identified inadequacies in undervoltage relay settings require immediate remedial action and notification of NRC.

11. To provide assurance that actions taken to assure adequate voltage levels for safety loads do not result in excessive voltage, assuming the maximum expected value of voltage at the connection to the offsite circuit, a determination should be made of the maximum voltage expected at the terminals of each safety load and its starting circuit. If this voltage exceeds the maximum voltage rating of any item of safety equipment immediate remedial action is required and NRC shall be notified.

12. Voltage-time settings for undervoltage relays shall be selected so as to avoid spurious separation of safety buses from offsite power during plant startup, normal operation and shutdown due to startup and/or operation of electric loads.

13. Analysis documentation should include a statement of the assumptions for each case analyzed.