UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DEGRADED GRID VOLTAGE RELAY SETPOINTS

GEORGIA POWER COMPANY, ET AL.

EDWIN I. HATCH NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-321 AND 50-366

I. INTRODUCTION

Georgia Power Company, et al. (GPC or the licensee) is proposing to deviate from the current NRC staff guidance provided in Generic Letters (GLs) dated 1977 and 1979 with respect to sustained degraded voltage conditions of the offsite power source and the adequacy of the station electric distribution system voltages (Reference 1). The GLs provided supplemental guidance to help ensure that all plants' electrical systems meet a staff interpretation of General Design Criterion (GDC) 17 regarding degraded voltages.

The staff had concluded in 1982 that Hatch met the positions in the GLs (Reference 2). As part of the design approach, Hatch included a second level of degraded undervoltage protection with a nominal trip setpoint of 78.8% of bus voltage with a time delay of 21.5 seconds. CV-7 relays were used which have inverse time characteristics. Subsequently, an Electrical Distribution System Functional Inspection (EDSFI) determined that the voltage calculations done to support the setpoints were not adequate. Hatch was required to update the voltage calculations and the results indicated that the setpoint for the degraded grid protection should be raised to assure at least 91% voltage at the 4160 volt safety buses (Reference 3). Hatch investigated the feasibility of raising the setpoints at which automatic action would occur and concluded that the changes would involve new equipment and would be very costly. Furthermore, they believed that raising the setpoint would not significantly improve safety and could lead to unwanted plant trips. As a result, they proposed an interim approach, which relied on maintaining the 230 kV switchyard voltage between 101.3% and 104.9% and included alarm relays set at a higher voltage level (about 92%) and associated manual actions. The staff approved the interim approach but requested that the licensee continue to investigate the matter. The licensee is now proposing the interim approach as the final resolution to meet the GLs.

Specifically, the licensee is proposing to maintain the existing setpoints for their automatic degraded voltage protection scheme and to rely on anticipatory alarms set at 92% and operator actions to provide protection. They believe that this approach provides the necessary protection and that the cost of changing equipment is not justified based on their conclusion that such changes would not improve safety.

By maintaining their interim approach and not raising the setpoint for automatic action, it is recognized that there is a potential range of degraded voltages for certain postulated events where automatic protection would not occur. This is considered a deviation from the GL positions, and therefore, the licensee has specifically requested that the staff approve the deviation.

In support of the deviation there have been a number of meetings and letters as listed below:

1. Meeting summary dated August 16, 1991, for the August 6, 1991, meeting.

2. Meeting summary dated December 21, 1992, for the November 16, 1992, meeting.

3. Letter from Georgia Power to NRC dated November 22, 1993.

4. Letter from Georgia Power to NRC dated July 1, 1994.

5. Meeting summary dated January 10, 1995, for the December 7, 1994, meeting.

II. EVALUATION

The licensee's approach is based on their understanding of the events which led to issuance of the GLs and potential events which might challenge the Hatch facility. The GLs were prompted by events at Millstone One and Arkansas Nuclear One which heightened concerns for potential sustained degraded grid voltages and in plant voltage problems due to potential severe loading conditions during accidents.

The specific sequence of events which would require that the voltage setpoints be raised involves the simultaneous existence of a degraded offsite power source and a loss-of-coolant accident (LOCA). A LOCA puts the heaviest demand on the safety buses and if it would occur during degraded grid voltage conditions, some safety equipment might not receive sufficient voltage to perform their function. Among other requirements, the GLs required that the occurrence of a degraded offsite voltage should be sensed, and then an automatic transfer to the emergency diesel generators (EDGs) should take place. For the sequence of events of a degraded grid voltage and a LOCA, the licensee has concluded that the likelihood of such simultaneous events is extremely low. This is based on their existing grid operation coupled with the low likelihood of a LOCA.

Plant Hatch is part of the Southern electric grid system which is a member of the Southeastern Electric Reliability Council. The Southern electric system employs state-of-the-art monitoring and contingency analysis systems for the electric grid on a real time basis. System operators of the Southern electric grid ensure that adequate voltage is provided and the contingency analysis feature allows system operation to predict adverse effects from postulated grid system failures. Based on the contingency analysis results, system operators configure the offsite power system such that a worst-case postulated failure can occur without adversely affecting the minimum required voltage.

If the 230 kV system at Hatch were to fall below the current minimum expected value of 101.3%, the switchyard design and offsite power system design allows system operators to quickly mitigate such a dynamic voltage excursion. The following actions would be performed by system operators:

- System operators receive low voltage alarm.
- System operators notify the control room at Plant Hatch.
- The 162 MVAR capacitor bank on the 230 kV line is switched on (if off).
- The 150 MVAR shunt reactors on the 500 kV line are turned off (if on).
- Capacitor banks in the surrounding area are turned on (if off).
- Combustion turbines at Plant McManus are placed in service.

These actions are normally capable of improving the 230 kV voltage by approximately 2 to 4 percent. If these actions are not sufficient, system operators would take the following actions:

- Out of service elements are brought back on line.
- System load (external or internal) is reduced.

Therefore, because of the above outlined offsite system monitoring capabilities and design, a sustained degraded grid does not represent the most probable event. Rather, a dynamic voltage excursion is more likely. For a dynamic voltage excursion, GPC believes that disconnecting both units from the offsite power supply and introducing dual unit scrams and reactor isolation transients through automatic undervoltage relays would be adverse to safety.

Even if the system operators of Southern electric grid fail to improve the 230 kV grid voltage, GPC has issued an Operating Order at Plant Hatch which identifies specific actions to be taken if the grid system operators are in jeopardy of not maintaining the Hatch voltages within the required operating range. The actions consist of restoring any inoperable EDGs, limiting maintenance or surveillance of important onsite electrical equipment, closely monitoring voltage levels on the six 4160 volt safety-related buses, and informing plant management. The Operating Order also specifies action to be performed if the 4160 volt essential buses fall below the minimum acceptable voltage. These actions include initiation of a one hour Limiting Condition of Operation (LCO) to restore safety-related bus voltages, notification of management, and an orderly plant shutdown if voltage is not restored. The actions specified in the Operating Order have been incorporated into abnormal operating procedure 34AB-S11-001-OS, "Operation With Degraded System Voltage." This procedure would also be entered on receiving the low voltage alarms on the 4160 volt buses. Operators receive training relative to the actions specified in the procedure through the normal operator training and operator requalification training on abnormal operating procedures.

Therefore, the licensee concludes that, because of the elements in place on the Southern electric grid and at Plant Hatch, it would be a very rare event for the offsite voltage at Hatch to be below 101.3% during a postulated independent LOCA (from their IPE the estimated occurrence of a LOCA is 2.61 x 10^{-4} for Hatch).

In response to NRC staff concerns, the licensee also investigated other potentially more likely events, and has concluded that the alarms and procedures along with the plant's inherent response capabilities provide sufficient protection.

1. Sustained degraded grid conditions (no LOCA or plant trip)

   If the voltages on the offsite system were to degrade to unacceptable levels for a sustained period of time, the plant would be notified by the Southern System load dispatcher and in addition the plant alarms would alert the operators to the condition. Procedures would be implemented to restore voltages in one hour or start an orderly shutdown. By not raising the setpoint at which automatic action would occur, some potential for unnecessary automatic unit trips could be avoided.

2. Dynamic voltage excursion (no LOCA or plant trip)

   If the voltages on the offsite system were to degrade to the unacceptable level for a short period of time (on the order of minutes), the plant would be notified by the Southern System load dispatcher. Procedures would be implemented to restore the voltages. By not raising the setpoint at which automatic action would occur, unnecessary unit trips might be avoided. As noted by the licensee, an event of this nature occurred on Sunday, March 14, 1993. The licensee's post-event analysis concluded that this event supported its integrated approach to evaluating degraded grid protection which considers electrical design requirements, plant operation, and grid system operation. Details of the event and the licensee's analysis are provided in the appendix to this evaluation.

3. Sustained degraded grid conditions or a dynamic voltage excursion with Hatch units tripping (no LOCA)

   If a plant trip occurred during a grid problem (which could reasonably be expected to occur due to problems related to the equipment exposed to the degraded voltages, or because the tripping of the Hatch units was part of the problem leading to the degraded grid voltage) operator response to correct the voltages might not be quick enough, and therefore, damage to some ac equipment could occur. In this situation, the licensee has analyzed their facility and concluded that equipment not exposed to the ac voltage problems (because it is operating on dc-backed sources or is not operating and, therefore, free from potential damage),

such as reactor core isolation cooling (RCIC) and high pressure coolant injection (HPCI) would be available to safely shut the plant down. This same kind of analysis was done as part of their Station Blackout analysis.

4. Sustained degraded grid conditions or dynamic voltage excursion with Hatch units tripping and then a stuck open relief valve (LOCA)

This event could be the most probable sequence involving a degraded grid and LOCA. Because the plant response would be the same (e.g., RCIC, HPCI) the same conclusions as the above event sequence would also apply.

The staff has evaluated the licensee's proposal and agrees with the approach with the following additional conditions:

1. The degraded voltage alarm relays should be included in the plant Technical Specifications along with the degraded voltage relays which initiate automatic actions.

2. The offsite system operating voltage levels and their significance with respect to the Hatch approach to meeting the degraded voltage requirements should be documented in the Final Safety Analysis Report so the impact of possible future changes will receive appropriate consideration.

The licensee has agreed to these added conditions.

With the alternate approach, the staff concludes that both an offsite and onsite power system is available, each with the capability of providing power for the required safety components in accordance with GDC 17 of 10 CFR Part 50, Appendix A.

III. CONCLUSION

Based on its review, the staff finds that the requested deviation from the Generic Letters is acceptable because of the added design features and the compensatory measures at Hatch as discussed in the above Safety Evaluation.

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Date: February 23, 1995

REFERENCES

1. a. June 2, 1977, NRC Generic Letter (Staff Positions) regarding the onsite emergency power systems.

   b. August 8, 1979, NRC Generic Letter regarding the "Adequacy of Station Electric Distribution Systems Voltages."

2. a. April 5, 1982, NRC Staff Safety Evaluation regarding the adequacy of electric distribution system voltages at Hatch Units 1 and 2.

   b. May 6, 1982, NRC Staff Safety Evaluation regarding degraded grid Technical Specifications.

3. August 22, 1991, Electrical Distribution System Functional Inspection at Hatch, NRC Inspection Report No. 91-202.

APPENDIX

TEMPORARY VOLTAGE EXCURSION EVENT AT PLANT HATCH

A temporary voltage excursion event occurred at Plant Hatch on Sunday, March 14, 1993. During that weekend, record snow accumulations, along with high winds were occurring within the Southern Electric System. This was resulting in significant outages due to failures of local distribution networks. During this time, specifically on March 14, 1993, at 10:04 a.m., Florida Power Corporation's Crystal River Unit 2 tripped. The loss of generation within the Florida grid caused a dynamic voltage excursion within the Southern Electric grid. The Hatch switchyard voltage dropped to 215 kV (93 percent) in one second and stabilized at 223 kV (97 percent) in approximately 6 seconds. At 10:05 a.m., with the Hatch switchyard voltage at 223 kV and recovering, Crystal River Unit 4 tripped. The second loss of generation resulted in a voltage drop to 218 kV (95 percent). At 10:06 a.m., the Southern Company Power Control Center contacted the Florida Power Control Center to assess the conditions causing the voltage excursion and the condition of the Florida grid. Southern Company was informed of the situation and confirmed that the Florida System was bringing up generation to stabilize the power flow from the Southern System to Florida's grid. Approximately 1.5 minutes after Crystal River Unit 4 tripped, the Hatch capacitors were manually closed and the voltage began a steady recovery. The combined voltage excursion from both the Crystal River Unit 2 and Unit 4 trips lasted approximately 6.5 minutes.

Georgia Power's review of the event concluded that the system performed as expected given the transmission system failures caused by the snow storm and nearly simultaneous unit trips at Florida Power. The loss of generation within the Florida System caused a voltage depression throughout the south Georgia area as the power flow from the Southern System to the Florida System increased to replace the lost generation. The actual effect or drop in voltage on the 4160 volt buses at Plant Hatch was not available, but no adverse effects were noted at the plant.

However, as part of the review, GPC identified a discrepancy relative to communication between the system operators and the Hatch control room. Specifically, system operators did not notify the Hatch control room that the 230 kV voltage had dropped below the minimum value until after the voltage had been restored. Technically, both units should have been in a one hour LCO. The notification did not occur as system operations had concluded that the system was not in jeopardy; the voltage excursion was quickly being restored. Corrective actions were taken to clarify this requirement and assure proper communications.

The licensee concluded that this event demonstrated that the degraded grid protection for Plant Hatch is consistent with GPC's objectives.

- The plant was adequately protected from an undervoltage condition as no adverse effects were evident.

- The offsite power source was preserved as the preferred source. While a short term dip in voltage occurred, the integrity of the system was not in jeopardy and a disconnect was not warranted.

- The situation was not further exacerbated by the unnecessary removal from the grid of Unit 1's approximately 800 megawatts. (Unit 2 was in a fuel reconstitution outage). Accordingly, the Southern Electric System was able to provide support to the Florida Power System as needed.

- If the setpoint for the degraded grid relays had been raised, a trip of Unit 1 probably would not have occurred for this specific event. However, the possibility of an unnecessary disconnect would have been increased due to possible setpoint drift. Consequently, GPC's objective of avoiding an unnecessary reactor isolation transient was met.

This led the licensee to conclude that the actual event supported GPC's integrated approach to evaluating degraded grid protection which considers electrical design requirements, plant operation, and grid system operation. In the event, the plant's electrical equipment was not adversely impacted by the voltage excursion, the plant continued to support the grid, the Southern Electric grid was able to support a neighbor utility and its public, and the plant was able to remain on offsite power. However, the application of automatic controls or prescriptive actions, in this event, could have been adverse to safety as the possibility of unnecessarily disconnecting the plant from the offsite power supply would have been increased, the possibility of unnecessary reactor isolation transients would have been increased, and the possibility of unnecessary load reductions/blackouts within the Southern Electric and Florida Power service areas would have been increased.