May 4, 1988

Docket Nos.: 50-369/370

Mr. H. B. Tucker, Vice President
Nuclear Production Department
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28242

Dear Mr. Tucker:

SUBJECT: CIRCUIT BREAKER COORDINATION - MCGUIRE NUCLEAR STATION, UNITS 1 AND 2 (TACS 66899 and 66900)

The NRR staff has reviewed the operating event of September 6, 1987 in which the McGuire Unit 2 reactor tripped due to overcurrent faults in an instrument air compressor motor and caused loss of power to a main turbine control system relay. The event is described in your Licensing Event Report 87-16 dated September 6, 1987. Enclosed is a report of the results of this NRC staff review, in which we conclude that a problem of relay and breaker coordination exists at the McGuire Station. We request that you reevaluate criteria and associated calculations for breaker and relay coordination for both safety related and non-safety related electrical systems' protective devices to assure proper functioning (i.e., isolation of only that portion of the system in which the abnormality occurs).

During the course of this NRR review, the September 6, 1987 event was also examined by the NRC's Diagnostic Evaluation Team and discussed in paragraph 3.5.6.2 of their report forwarded to you April 8, 1988. NRR's request for reevaluation has been derived with the benefit of the Diagnostic Evaluation Team's recent report and is not altered by it.

Please advise me of your intentions and schedule for the reevaluation within 30 days of receipt of this letter. Your calculations and coordination curves, once completed, should be maintained in a form available for staff audit.

Sincerely,

Original signed by:

Darl S. Hood, Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II

Enclosure:
As stated

cc:
See next page

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McGuire Nuclear Station

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ENCLOSURE 1

NRR EVALUATION OF CIRCUIT BREAKER COORDINATION DUKE POWER COMPANY MCGUIRE 1&2 DOCKET NOS. 50-369/370

1.0 INTRODUCTION

Auxiliary power panelboard KXB requires an uninterruptible power supply which normally receives power from a 125V dc auxiliary control battery through a static inverter. An alternate power supply to panelboard KXB is provided from a regulated 120 VAC power supply which receives its power from the 600V shared MCC. Instrument air compressor 'A' also receives its power from the same shared MCC.

On September 4, 1987, the static inverter was taken out for maintenance and the panelboard was being powered from the regulated alternate power supply. On September 6, 1987, the operator started compressor 'A' to verify proper operation after maintenance work on the compressor. A fault on the compressor motor tripped the compressor motor feeder breaker and the incoming feeder breaker to the 600V MCC. On the loss of power to panelboard KXB, DEH turbine control system closed the main turbine throttle, governor and intercept valves. The reactor tripped on high pressurizer pressure signal which caused an immediate turbine trip.

2.0 EVALUATION

The licensee investigated and determined that the insulating tape on the connecting lug of one of the motor leads in the motor junction box had worn through and the connecting lug grounded out on the metal frame of the motor. This short to ground caused the 600V motor feeder breaker and the incoming feeder breaker for 600V MCC to trip.

The frame size of the circuit breaker supplying power to the compressor is 400 amps with long time trip setting at 225 amps. The instantaneous trip setting shown on the coordination curve was 1400 amps while the "as found" trip setting on the breaker was 2000 amps. The long line element of the incoming feeder breaker for the 600V MCC was set at 700 amps with the instantaneous trip setting at 3000 amps. The full load current of the compressor is 134.8 amps. A size 5 starter was used which has a thermal overload trip setting of 205 amps.

In its review of the calculations and the coordination curves provided by the licensee, the staff has evaluated the following:

In order to assure proper sequential isolation of electrical equipment from overload and short circuit conditions, it is necessary to set protective devices such that proper selectivity is provided with protective devices upstream. Selective tripping is the application of protective devices in series so that, of the protective devices carrying fault current, only the one nearest the fault opens and isolates the faulted circuit from the system. It is obvious that such selectivity becomes more important with the devices that are closest to the power source, as the portion of the system affected becomes greater. Therefore, it is especially desirable to provide selectivity between incoming breaker and motor feeder breakers.

Integral-horsepower motors up to 200 horsepower manufactured in accordance with NEMA standards will have a service factor of 1.15. The thermal overload (TOL) relay element is usually set at 1.33 x full load current (FLC) when the service factor is 1.15 for a combination starter. Because a TOL relay operates considerably slower than a direct-trip long time element, the TOL relay can be set for a lower pickup and will not operate unnecessarily for overcurrents created by brief periods of undervoltage. The instantaneous trip setting is theoretically 1.6 times the locked rotor current but is set at twice the locked rotor current. In the event that the MCCB instantaneous element fails to trip, the TOL relay should back up the protection, and should provide a trip. In the event of performance failure by either primary protective device, the backup action of the incoming feeder breaker long time and instantaneous trips should operate.

In the light of the above mentioned criteria, the trip settings of the devices should have been as follows:

1) TOL of the combination starter = 1.33 x FLC
with a Service Factor of 1.15 = 1.33 x 134.5 = 178 amps

TOL of the starter should have been set at 175 amps but was erroneously set at 205 amps. In order to provide adequate protection for the motor, it should be set above the motor accelerating curve but below the motor thermal capability curve.

2) Instantaneous trip setting of the = 2 x LRC of the compressor motor
breaker feeding to the compressor = 2 x 773 = 1540 amps

Instantaneous trip setting of the breaker feeding to the compressor should have been set at 1540 amps instead of "as found" trip setting of 2000 amps.

3) Long time element of the breaker feeding to the compressor should have been set below the motor thermal capability curve but was erroneously set at 225 amps which is above the thermal capability curve.

4) Long time element of the incoming breaker feeding to the 600V motor control center should be set above the locked rotor current of the largest motor on the bus plus the total load on the bus minus the full load current of the largest motor on the bus = 773 + 264.5 - 134.5 = 903 amps.

Long time element of the incoming breaker should have been set at 903 amps but was erroneously set at 680 amps.

5) The licensee had not shown the motor accelerating curve and the motor thermal capability curve without which it would be impossible to draw the rest of the curves and coordinate them. Since the compressor motor is non-Class 1E, the motor accelerating curve should be plotted at 80% voltages as well as 100%.

3.0 CONCLUSION

We have reviewed the licensee's event report and the submittal and have concluded that the problem of the relay and breaker coordination exists at McGuire 1&2. We recommend that the licensee should reevaluate criteria and the calculations for breaker and relay coordination for safety related Class 1E as well as non-safety related electrical systems protective devices so as to isolate only that portion of the system where the abnormality occurs. The calculations and the coordination curves should be available at site for staff's audit.