UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

Report Nos.: 50-327/91-27 and 50-328/91-27

Licensee: Tennessee Valley Authority
6N 38A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Docket Nos.: 50-327 and 50-328 License Nos.: DPR-77 and DPR-79

Facility Name: Sequoyah 1 and 2

Inspection Conducted: November 18-22, 1991

Inspector: Paul J. Fillion 1/6/92
P. J. Fillion Date Signed

Approved by: Camille Julian 1/6/92
M. Shymlock, Chief Date Signed
Plant System Section
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope:

This routine, announced inspection was conducted in the areas of design problems in electrical systems and electrical emergency maintenance.

Results:

In the areas inspected, violations or deviations were not identified.

The design problem was basically a coordination problem resulting from a circuit built into a solid state trip device by the manufacturer. The licensee did a good job analyzing and correcting the coordination problem. Emergency maintenance was required to repair and restore 480V switchgear after a fault had occurred. This work was properly scoped and carried out.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*R. J. Beecken, Plant Manager
*J. R. Bynum, Vice President Nuclear Operations
*S. M. Childers, Operations Superintendent
*M. Cooper, Site Licensing Manager
*D. C. Craven, Supervisor, Instrumentation and Control and Electrical, Technical Support
F. Cuzzort, System Engineer
*J. Long, System Engineer
*D. L. Lundy, Sequoyah Nuclear Engineering
*R. J. Mages, Sequoyah Nuclear Engineering
R. Netherz, Sequoyah Nuclear Engineering
*J. W. Profitt, Compliance Licensing Engineer
*R. R. Thompson, Compliance Licensing Manager
*P. G. Trudel, Manager, Nuclear Engineering

Other licensee employees contacted during this inspection included craftsmen, engineers, operators, security force members, technicians, and administrative personnel.

NRC Resident Inspectors

*W. Holland, Senior Resident Inspector
*S. M. Shaeffer, Resident Inspector

*Attended exit interview

2. Coordination Problem and Short-Circuit at 480V Switchgear

The sequence of events described in this section is about a breaker coordination problem revealed by a revision to the breaker calibration procedure. A revised version of Surveillance Instructions SI 275.1, "Testing of Non-Class 1E Load Circuit Breakers Fed from Class 1E Buses" was issued on September 17, 1991. The surveillance instruction covers the calibration of solid state, "Amptector", trip devices used on 480V power circuit breakers. Germane to this discussion was the fact that the procedure step for testing the short time element time delay was revised. Previous revisions called for injecting ten times the sensor rating, then recording the response time. The September 17 revision of SI 275.1 called for injecting 1.5 times the short time pickup value which would in some cases call for injecting values of current higher than ten times the sensor rating.

The revised version of SI 275.1 was probably used for the first time on November 6, 1991. On that date, it was applied as a post-modification test on a breaker that had undergone a current transformer replacement (revised ratio) and a trip device set point change. The breaker being modified fed a motor control center and was equipped with a long time element and a short time element. Since the short time pickup was nine times the sensor rating, the short time element time delay test injected 1.5 times nine times the sensor rating or 13.5 times the sensor rating. Injecting 13.5 times the sensor rating caused an instantaneous trip rather than the expected time delayed trip. The immediate problem was that the modified breaker could not pass its post-modification test.

On November 6, 1991, Unit 1 was in MODE 6 and Unit 2 was at power. Engineers reviewed Westinghouse Electric Corporation publication I.B 33-790-1E (effective September 1979), "Instructions for Low-Voltage Power Circuit Breakers Types DS and DLS", in hope of shedding light on the failed post-modification test situation. They found the information being sought. Section 8.3 of the circuit breaker instruction manual is repeated below in its entirety.

8.3 Making Current Release (Discriminator)

> All Amptector trip units which do not have instantaneous trip elements (Amptector II model SE and Amptector I models LS and LSG) are provided with a "making current release" which is referred to as a "Discriminator." This is a circuit in the trip unit which determines at the time of a fault whether or not there has been any current flow in the primary circuit previous to the fault. If there has been no measurable current flow previous to the fault, indicating that the circuit breaker is just being closed (or possibly that a switching device ahead of the breaker has just been closed) and if the primary current flow exceeds approximately twelve times the sensor rating, the trip unit will function instantaneously. If the "Discriminator" circuit determines that there has been a measurable current flow prior to the fault, the instantaneous operation will not occur and the normal short time delay element will take over to delay tripping. The purpose of this unique tripping concept is that selectivity and continuity of service in un-faulted sections of the system can be maintained if there is any need, but if there is no previously operating load on the circuit, the instantaneous function takes over to limit extensive damage which might occur due to a delayed tripping operation.

The instantaneous tripping that was occurring during performance of SI 275.1 was a manifestation of the "Discriminator" circuit. Note that calibrations done according to older versions of SI 275.1 would not have detected the presence of the "Discriminator" circuit, because only 10 times the sensor rating was injected.

On November 7, 1991, at approximately 1400 HRS, Unit 2 tripped [LER 91-006]. At approximately 1800 HRS the licensee realized that the "Discriminator" circuit could cause coordination problems. Sequoyah utilizes motor control centers that serve both safety-related and non-safety-related loads. Some of these MCC's feed almost exclusively motor operated valves, and therefore may well have current low enough to enable the "Discriminator" circuit of the MCC feeder breaker even during normal operation or accident scenarios. "No measurable current" has been defined by Westinghouse Electric Corporation as 5-10 percent of the sensor rating. With the discriminator circuit enabled, a fault on a non-safety-related circuit could cause the safety-related circuits to become de-energized, a situation prohibited by NRC regulations. The coordination problem comes about when a fault occurs on an individual motor control center circuit. In such cases, the fault current would cause both the molded-case circuit breaker protecting the individual circuit and the MCC feeder breaker at the switchgear to open. The licensee entered the appropriate Technical Specification action statement, and made the requisite report to the NRC.

Working with Westinghouse Electric Corporation, the licensee developed an emergency design change notice, DCN-E-07731, on November 7, to disable the "Discriminator" circuit by placing a jumper across the DS and DN terminals at the Ampector. The DCN was implemented by work order 91-05590-00. The "Discriminator" circuit was disabled on 41 circuit breakers. Post-modification testing confirmed that the circuit was in fact disabled by the jumper.

Before re-energizing any circuit that had been de-energized for installation of the jumper, the licensee's procedure called for making an insulation resistance test of the cable and load. In order to safely perform the insulation resistance test, they wanted to confirm that the circuit about to be tested was in fact de-energized by using a voltage sensing stick. On November 8, at approximately 0923 HRS, when the technician attempted to confirm that the voltage sensing stick was functioning properly, he applied the stick to the vertical bus bars in switchgear 1B2-B, section 2, and inadvertently created a phase-to-phase fault.

This initial short-circuit created a cloud of ionized gases which rose to the top of section 2. Upon reaching the top of the switchgear the ionized gases spread to section 3 where the vertical bus was quite close to the top of switchgear. At section 3, the gases created a short-circuit between at least two phases and the switchgear top. Heat and smoke generated by the electric arcs caused damage to the bus, switchgear structure, wiring and devices in sections 2 and 3. Sections 1 and 4 sustained minor damage.

Relays and the main incoming breaker operated properly to interrupt the fault current and de-energize the bus. An Unusual Event was declared. Operational consequences of the de-energized equipment are discussed in NRC Inspection Report 91-26.

On November 11, work order 91-05625-00 was issued to control the work of repairing the switchgear. Work began immediately, and was completed on November 14. Work performed in repairing and returning to service the 1B2-B 480V switchgear included, but was not limited to:

a. Clean all parts and components as necessary.

b. Replace damaged internal wires as necessary at section 2 (right side as viewed from rear) and at section 3 (both sides).

c. Cut out damaged external wiring and splice new section of cables as necessary.

d. Replace approximately 19 twelve-point terminal blocks.

e. Make insulation resistance test on any new wiring after installation.

f. Make resistance measurement at all bus connections and power cable connections.

g. Inspect all meters and relays.

h. Remove and clean bus support insulators. Perform high potential test on selected bus support insulators using 2800V d-c.

i. Interconnecting wiring not replaced was inspected by a representative of Westinghouse Electric Corporation.

j. Verify control fuse continuity.

k. Replace 480V power fuses in section 3.

l. The main bus, though damaged, was not replaced because damage was in a non-current-carrying, nonstructural area. The NRC inspector looked at the bus damage and agreed that it was of no consequence to future operation.

m. Perform high potential test on bus.

n. Cut out and replace some metal wireway and ventilation grill at top of section 3.

o. Perform complete preventive maintenance on main breaker and other specified breakers.

p. Perform an inspection of selected breakers.

q. Perform a calibration of selected trip devices.

r. Replace cable and wire tags as necessary.

s. Perform a functional test on all circuits where any wires were replaced, spliced or determinated/reterminated.

The inspector's conclusions in relation to the sequence of events described in this section are as follows. With respect to the coordination problem caused by the "Discriminator" circuit the conclusions are:

a. The inspector agreed that defeating of the "Discriminator" circuit by jumpering terminals DS and DN was a proper solution to the coordination problem.

b. In a telephone conversation between the licensee and Westinghouse Electric Corporation during the inspection, Westinghouse stated the DS breakers received interrupting tests with long time and short time elements only (i.e. no instantaneous element) and that the "Discriminator" circuit was disabled during these tests. In other words, all interrupting ratings remain the same regardless of the "Discriminator" circuit operation. Westinghouse stated that a letter would be sent confirming this conclusion.

c. The original issue (January 1971) of the circuit breaker instructions book and its first revision (May 1971) did not mention the "Discriminator" circuit feature. Westinghouse told the licensee the feature existed from first production. Revision C (August 1976) and subsequent revisions (F was current at the time of this inspection) did mention the feature in section 8.3, although it was not mentioned on the time - current characteristic sheets. In none of these revisions were any changes to the manual highlighted. The inspector believes that the feature is very possibly unique to this particular model of switchgear. These circumstances caused the licensee to not be aware of the "Discriminator" circuit and the concomitant coordination problem. The licensee did a good job of analyzing the failed calibration test and implementing a necessary corrective action.

d. A portion of the inspection was devoted to a review of the licensee's vendor manual control program. This program calls for reviews of new vendor manuals for technical adequacy. This review focuses on whether or not the manual being reviewed is applicable, useful and complete. What may not be happening in the case of updated manuals is determination of differences between the old and new versions and subsequent evaluation of new information, especially engineering application type information. The licensee did not disagree with this statement, but did not make a commitment to take any action such as study their program, revise the program or issue an instructive memorandum on the subject.

With respect to the short-circuit at the 1B2-B switchgear the conclusions are:

a. Repair and restoration of the equipment was adequate. This conclusion is based on a review of the damage assessment report, the work order package and inspection of the finished work.

b. As part of the event analysis, the relay group noted that the phase B instantaneous relay at the 1B2-B main breaker had operated -- i.e. they noted that the instantaneous flag had dropped. The instantaneous relay was not wired to trip but its pickup setting could indicate the magnitude of fault current. It was confirmed by test that the relay was set at 80A or 48,000A primary current. The problem was that this information was not consistent with calculation results. The calculated maximum 3-phase-fault current that could be seen by the relay was 21,500A rms symmetrical. Since the initial fault was a phase-to-phase fault the maximum current that could be seen by the relay was 87 percent of the value or 18,700A rms symmetrical. Assuming the current wave was fully offset, the relay could have seen 32,400A rms asymmetrical. Even considering the transient overshoot phenomena associated with electromechanical instantaneous relays, a relay set at 48,000A should not have operated. The licensee is investigating to resolve this apparent discrepancy.

3. Exit Interview

The inspection scope and results were summarized on November 22, 1991, with those persons indicated in paragraph 1. The inspector described the areas inspected and discussed in detail the inspection results. Proprietary information is not contained in this report.