CATAWBA

ENCLOSURE 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION EVALUATION OF ELECTRICAL CIRCUIT BREAKER COORDINATION DEFICIENCY AT CATAWBA NUCLEAR STATION DOCKET NOS. 50-413 AND 50-414

BACKGROUND

The electrical distribution system functional inspection (EDSFI) at Catawba Nuclear Station Units 1 and 2 (CNS), from January 13 to February 14, 1992, identified a safety significant deviation from the following FSAR commitment:

"NUREG-0800, Standard Review Plan, states on page 8.3.2-5 that acceptance [of a design] is based on meeting the specific guidelines in Regulatory Guide 1.32, which endorses the Institute of Electrical and Electronics Engineers (IEEE) Standard 308."

IEEE Standard 308 section 5.3.1, states that, "protective devices shall be provided to limit the degradation of Class 1E power systems." The licensee's Final Safety Analysis Report (FSAR) states on page 8-75 that the system meets the requirements of this standard. FSAR Section 8.3.1.1.2.2 states that protective devices on the 600-V ac essential power system (EPS) are set to achieve a selective tripping scheme so that a minimal amount of equipment is isolated by an adverse condition such as a fault.

Contrary to the above, the licensee deviated from the commitment because the protective devices may not limit the degradation of the 125-V dc vital instrumentation and control power system (EPL) distribution center and other main feeder circuit breakers for some faults, at some locations, and will not limit degradation for some faults, at other locations. The licensee's analysis showed that coordination did not exist for fault currents above

3500 Amperes (A) to the maximum fault current of 9,500 A, on the battery charger output cables (Fault BC).

In an attempt to determine, more accurately than was possible on the basis of the licensee's original submittal of May 12, 1993, the impact on the plant risk of those breakers which both the staff and the licensee agreed were miscoordinated, and to obtain assurance that the consequences were not significant, the staff on December 6, 1993 sent a request for additional information (RAI) to the licensee. In that RAI, the staff asked for the locations of faults of any kind which could lead to miscoordinated breakers, the identity of the breakers, the loads served, and the consequences of losing the safety loads affected.

The licensee responded by meeting with the staff on February 7, 1994 and submitting on March 2, 1994, copies of breaker coordination curves and system one-lines drawings showing locations for worst case faults and the breakers which would not coordinate for those faults. The calculations on which the fault currents were based, as well as a list of loads which would be dropped if breakers were not coordinated, were included.

The licensee postulated faults only at load input terminals because the cable impedance between the load and its breaker limits the current, in many cases, in such a way as to leave the breakers coordinated, as they would not be for faults closer to the breaker.

The argument for considering only load end cable faults is that the 2-kV armored cable, used for both the 125-V dc and for the 600-V ac circuits, is reliable and the licensee has never had a fault in any of their plants, on such cables. The most probable site, therefore, for a 3-phase fault on the 600-V ac system, or a double conductor fault (dcf) on the ungrounded 125-V dc system, would be at the load termination for each branch circuit.

The licensee's arguments in its response to the staff's RAI are the same for both the 125-V dc and 600-V ac systems:

1. The armored cable is reliable.

2. Faults unlikely are unlikely anywhere, but are most probable only at the load ends of branch circuits.

3. The 125-V dc system is ungrounded; therefore, two simultaneous faults are required to trip a vital I&C breaker. In short, the probability of an initiating event is low.

4. Fully redundant safety divisions limit consequences.

5. A search of the Nuclear Plant Reliability Data System and inquiries at other utilities, who showed no dcfs on dc system cables of all kinds, not just the more reliable than average, armored 2-kV cable used by the licensee.

6. Worst-case faults were postulated, at the fault locations postulated.

EVALUATION

The licensee's responses to the EDSFI finding that were forwarded in Enclosures 1 and 2 to the letter of May 12, 1993, from the Region II Office to G. Lainas and the staff's comments follow:

Licensee Response 1:

"The EPL system for each unit...[comprises] two completely redundant and separate trains each consisting of two load channels.... Therefore, a postulated fault would, at worst, disable two load channels of the same train,

yet the redundant train would remain unaffected."

Staff Comment on Licensee Response 1:

Review of the licensee's FSAR and one-line electrical drawings shows that there is substantial reason to find that the safety functions required of the vital power supply would all be performed after a 3-phase fault in one safety division, as required by the licensing basis.

Licensee Response 2:

"Selected loads such as the Diesel Load Sequencer, Essential Switchgear and Load Center Controls, and Auxiliary Feedwater Pump Turbine Controls are not only fed by the EPL system, but are auctioneered with the 125-V dc Diesel Auxiliary Power (EPQ) system. Consequently, should the EPL System become unable to feed these loads, the EPQ System will supply them without interruption. A fault on the EPL System will not affect the EPQ System and vice versa."

Staff Comment on Licensee Response 2:

Although not sufficient by themselves to safely shut down the plant, important safety functions of the 125-V dc vital I&C system are protected against the loss of the battery or battery charger for whatever reason, and not only as a result of what must be the much less frequent trip of a miscoordinated breaker in one division of the EPL system.

Licensee Response 3:

MCC incoming breakers were provided although only switches were needed because switches that would fit the available MCC enclosures were not available with high enough peak current ratings.

Staff Comment on Licensee Response 3:

The reason for putting a device of any kind in a safety system is not relevant to the consideration of the safety consequences its failure has; if the device does not significantly degrade system reliability, its presence is acceptable, even if it is only a convenience or even a design error. No rule compels a licensee to operate with an optimum system; it need only be acceptable under its license.

Licensee Response 4:

"The probability that a three phase bolted fault will occur on the 600-Volt essential system,...is low since it would have to occur in a motor control center compartment or be the result of a failure of an armored cable. Each compartment circuit and cable was inspected and tested before initial operation, and post-modification/maintenance testing verifies that no detrimental conditions have been induced before returning the equipment to operation."

Staff Comment on Licensee Response 4:

This licensee position is further supported by the licensee's supplementary submittal of March 2, 1994, wherein it describes the search for armored cable failures.

The reason for the staff conclusions, in this safety evaluation,

is not entirely the reliability of the armored cables or that of electrical equipment in MCCs, but is, in part, the presence of redundant operable safety equipment.

However, the staff agrees with the licensee that the probability of a 3-phase fault in an MCC, or within a few feet of the downstream member of an uncoordinated pair of breakers, is so low that no significant risk should attend such faults.

Licensee Response 5i

Three-phase bolted faults, at many locations in the EPL, would not result in upstream breakers tripping, before the branch circuit breakers, if the battery and main circuit breakers were replaced with Westinghouse MA 800A or NB 1200A magnetic-only breakers. But replacement would require extensive modifications to main EPL distribution centers. And the substantial engineering and design time and material costs associated with the modifications are not justified by the increased freedom from improper circuit breaker trips.

Staff Comment on Licensee Response 5i

The staff agrees with the licensee that the probability of a dcf that would cause a 125-V dc distribution center breaker to trip before it should, because of a lack of coordination with a downstream breaker, is sufficiently low that the considerable cost of modifying the breakers is not justifi

Licensee Response 6:

A fault on the auctioneered distribution center bus will not cause the battery or main circuit breakers in the EPL to trip before the branch circuit breakers. The conclusion that the battery or main circuit breakers would trip first was based on an erroneous worst-case fault current calculation.

Staff Comment on Licensee Response 6:

On the basis of its analysis of the RAI response (RAIR), the staff agrees that a fault on an EPQ auctioneered bus will not cause a trip of the associated main or battery breaker.

The staff evaluation to here was of the licensee's first submittal. The following evaluation is of the licensee's supplementary submittal in response to the RAI.

The miscoordinated Catawba circuit breakers are found in two systems: the 125-V dc vital instrumentation and control power system and the 600-V ac essential auxiliary power system. In Part 1 of its supplementary response the licensee analyzes the former, and in Part 2, the latter.

Staff Evaluation of RAIR Part 1:

As a result of its exhaustive analysis of 125-V dc breaker coordination, the licensee found four locations at which double conductor faults (dcfs) would cause miscoordinated breakers.

These miscoordinated breakers, by compartment number, are the

following:

1. F02A and F03A are miscoordinated, for a dcf at location BC on the cable from the 125-V dc vital battery charger to breaker compartment F03A.

2. F02A, F02B, and F03C are miscoordinated for a dcf at location VI on the cable from the 120-V ac vital inverter to breaker F03C.

3. F01C, F02A, and F02B are miscoordinated for dcfs on the EPA bus.

4. Power panelboard breaker #4 (PPB#4), F01C, F02B, and F02A would all be miscoordinated in case of a dcf on the output terminals of PPB #4.

Faults at the next four locations would only trip the immediately adjacent breakers in case of dcfs at the prescribed locations; that is, the involved breakers are either coordinated or partially coordinated.

1. F01A, F01C, and F01D would be miscoordinated for a dcf on the output cable from F01C, anywhere on the cable. Breakers F02A, F02B, and F02A would be coordinated so that the 125-V dc distribution center bus would not be lost. DPC described this site, EDE1, as resulting in partially coordinated breakers, as are the next three cases.

2. F01D, F01E, and F01A would be miscoordinated for a dcf at EDE2, on the load side of breaker F01E, anywhere on the cable. However, breakers F02A, F02B, and F03A would not trip therefore the auctioned 125-V dc bus would not be lost.

3. F01A, F01D, and F01F would trip for a dcf anywhere on the load side cable from breaker F01F to the diesel generator load sequencer, i.e. site EDE3. However, breakers F02A, F02B,

and F03A would not trip; therefore, the 125-V dc bus would not be lost.

4. 125-V dc PPB#4 and F01C would trip in case of a dcf at the first termination of the cable from PPB#4 to a component cooling system solenoid valve. F02A, F02B, and F03A would not trip; therefore, the 125-V dc distribution center bus → would not be lost.

For the remaining locations in the EPL system, a dcf on the input to the auction diode assembly, i.e., location AD would trip F01D without tripping F02A, F02B, or F03A; and a dcf on the auctioned distribution center bus, i.e., location EDE would trip F01D or F01A without tripping F02A, F02b, or F03A. Thus, the breakers are coordinated for faults at these locations.

Whenever F02A or F02B are tripped, the associated 125-V dc distribution load center (DLC) is lost. Its loads must be picked up by the DLC of the redundant safety division. The loss of a DLC is a design-basis event. The frequency of loss of a DLC because of a dcf must be less than the frequency of losses of DLCs from all causes and is, therefore, acceptable to the staff.

EVALUATION OF RAIR PART 2:

The incoming breakers for the following 600-V ac MCCs are coordinated for 3-phase faults at the first cable termination outside the MCC:

1. 1EMXA,-B,-C,-D,-E,-F,-I,-J,-K, and -L.

2. 1EMXG is powered from load center 1ELXA in Catawba Unit 1 and can also be powered from load center 2ELXA in Catawba Unit 2. The two MC800 incoming breakers are not coordinated for

3-phase faults on the control room area air handling unit cable load end from breaker LB225; they are coordinated for the other loads on 1EMXG. Since the two incoming breakers are interlocked, a fault tripping one MC800 would result only in the temporary loss of the 1EMXG loads, until the alternative MC800 could be closed.

If 1EMXG were to be deenergized under accident conditions, the transfer to the alternative MC800 breaker would be automatic, without interruption. The miscoordination leading to the undesired tripping of an MC800 breaker will also always trip the LB225 branch circuit breaker. Otherwise, a fault on the control room area air handling unit would lead to the blackout of the 1EMXG when the automatic transfer closed the second MCC 800 breaker on a preexisting fault.

CONCLUSION

The staff accepts the licensee's proposal to update the FSAR in lieu of modifying 600-V ac breakers and MCCs or 125-V dc breakers and MCCs that might be uncoordinated in the event of improbable initiating events, namely, a 3-phase fault or a dcf, respectively, at a limited number of locations.

FACILITY NAME: Catawba Nuclear Station Units 1 and 2

SUMMARY OF REVIEW:

The licensee for Catawba Nuclear Station, Units 1 and 2, in response to an electrical distribution system functional inspection (EDSFI) finding and notice of deviation of March 18, 1992, proposed to the NRC that nothing be done to correct admitted deficiencies in circuit breaker coordination in two safety systems. The basis of the licensee's position is that the initiating events are rare and the consequences of the deficiencies are small. Further, the costs of correcting the circuit breaker deficiencies are substantial and the benefits of the required modifications could not justify them.

The staff's position is that for the reasons just given, the licensee may, as it requested, change the FSAR so that coordination of the subject breakers is not a requirement.

NARRATIVE DISCUSSION OF LICENSEE PERFORMANCE
FUNCTIONAL AREA: ENGINEERING/FUNCTIONAL SUPPORT:

The licensee's first submittal, although clear with respect to the reasons why the FSAR should be changed rather than the uncoordinated breakers, was not clear enough with respect to the details about the sites of the faults, their magnitudes, and their consequences.

This defect was corrected by the licensee's responses to a staff RAI. The responses and the presentation that preceded them were

complete and accurate and sufficient for the staff to fully appreciate the breaker coordination defects.

Author: C. Morris
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