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

SAFETY EVALUATION

SAN ONOFRE UNIT 1

ELECTRICAL SYSTEM DESIGN DEFICIENCIES

1.0 INTRODUCTION

By Licensee Event Report (LER) 88-019 dated January 12, 1989, the licensee for San Onofre Nuclear Generating Station Unit 1 (SONGS-1) reported design deficiencies in the Safeguard Load Sequencing System (SLSS) control of the plant's electrical power distribution system (4160/480 Vac) with additional complications due to the potential for harsh environmental effects on MCC-3 (see LER 88-001). By an event notification dated January 30, 1989, the licensee also described a design deficiency involving the potential overloading of 480 Vac switchgear during main steam line break (MSLB) or loss-of-coolant accident (LOCA) conditions. The NRC staff has reviewed the events and corrective actions as discussed in the LER, the event notification and supporting documentation and finds the corrective action acceptable as dis-cussed and conditioned below.

2.0 DISCUSSION/EVALUATION

SONGS-1 4160/480 Vac electrical distribution system is comprised of two trains (A and B) of 4160 Vac power each feeding its corresponding 480 Vac switchgear. Train A 4160 Vac Bus 1C feeds 480 Vac Switchgear #1 via Station Service Transformer #1 through normally-closed breakers 11C10 and 1102. Train B 4160 Vac Bus 2C feeds 480 Vac Switchgear #2 via Station Service Transformer #2 through normally-closed breakers 12C10 and 1202. In addition, a third 480 Vac switchgear/bus for safety related and non-safety related loads is provided which is powered by Train A 4160 Vac Bus 1C via normally closed breaker 11C11, Station Service Transformer #3 and normally closed breaker 1303. This bus, 480 Vac Switchgear #3, can also be energized from either 480 Vac Switchgear #1 or Switchgear #2 via normally open breakers 1103 or 1203. In an event requiring automatic actuation of safeguards equipment, SLSS-1 and SLSS-2 control 4160/480 Vac breakers to ensure that power is available to safety related/safeguards loads and that unnecessary/unqualified loads are isolated. The SLSS's initiate safeguards components on a Safety Injection Signal (SIS) or trip electrical loads that are not required and start required safeguards loads in a timed sequence on a Safety Injection Signal coincident with Loss of Offsite Power (SIS/LOP). Prior to Mid-Cycle IX, an SLSS-2 SIS/LOP signal would automatically transfer Switchgear #3 to 480 Vac Switchgear #2 by tripping breaker 1303 and closing breaker 1203.

2.1 LER 88-019:

A single failure analysis, performed for SONGS-1 in 1987, determined that a failure of Train B SLSS-2 could leave Switchgear #3 connected to its normal feed (Train A 4160 Vac Bus 1C) for SIS/LOP conditions and that electrical system load calculations had not considered Switchgear #3 as a continued load on Bus 1C following a SIS or SIS/LOP. Another review revealed (see LER 88-001) that a MSLB outside containment could cause spurious equipment actuation due to an unqualified motor control center, MCC-3, leading to unpredicted loads on Switchgear #3 and

Train A 4160 Vac Bus 1C or, with automatic transfer, Train B 4160 Vac Bus 2C further leading to possible failure of Train B 4160 Vac power. In Mid-Cycle IX outage, automatic transfer of Switchgear #3 to Switchgear #2 on SIS/LOP was eliminated. The licensee stated in LER 88-019 that on December 13, 1988, a design review determined that the MCC-3 spurious actuation coupled with the loads on Switchgear #3 could lead to possible failure of the Train A electrical distribution system and increased loads approaching the maximum capacity of the Train A diesel generator. The root cause of these design deficiencies was reported to be poor engineering.

In LER 88-019, the licensee stated that a design change was being made during the current refueling outage to correct the above design deficiencies. Specifically, Switchgear #3 will be completely isolated from all its sources of 480 Vac by SLSS-1 or SLSS-2 SIS and SIS/LOP open signals to corresponding normally-closed breakers 11C11 and 1303 and breakers 1103 and 1203, which are used only to energize Switchgear #3 for maintenance/post-accident recovery. Additional information was provided by the licensee's letters dated March 11, 1989, and March 17, 1989, which summarized the design deficiencies and corrective actions. A March 20, 1989, letter from the licensee provided a revision to the simplified power distribution system diagram originally included in LER 88-019.

During NRC's review of the LER and corrective actions, several concerns developed which were discussed with the licensee and were addressed during our discussions or in some of the above-listed correspondence. Specifically, the staff was concerned about the performance requirements for safety-related loads tied to Switchgear #3 which is completely isolated by SIS and SIS/LOP signals. In a February 25, 1989, letter the licensee stated that safety-related loads on Switchgear #3 are either not credited for accidents/post-accident re-covery, not required for 30 minutes which is adequate time for local operator action, or are powered by an Uninterruptible Power Supply (UPS) supplied by a battery with a 30-minute capacity. The staff finds this response acceptable and our concern resolved.

Also the staff was concerned about the lack of series breakers between 480 Vac Switchgear #1 and #3 and between 480 Vac Switchgear #2 and #3 required to provide adequate separation between redundant electrical divisions. In response the licensee discussed the electrical interlocks provided for breakers 1303, 1103, and 1203 which require all three breakers to be open before one can be closed. We find this concern resolved subject to the licensee proposing a technical specification for surveillance of these interlocks at a refueling outage periodicity. Also the licensee must provide specific steps within breaker 1103, 1203 and 1303 operating procedures which require verification that all three breakers are open prior to manual closure. These procedures should be supported by information tags affixed to the breaker cabinets to call the operator's attention to the specific verification requirements.

2.2 JANUARY 30, 1989, EVENT NOTIFICATION

In an event notification dated January 30, 1989, the licensee informed the staff that an evaluation of the auxiliary electrical system determined that 480 Vac Switchgear #1 and Switchgear #2 main feeder breakers 1102 and 1202 could be

overloaded during an accident requiring safety injection with offsite power available because nonessential loads are not shed from the buses/switchgear. The overload condition from essential plus nonessential loads would exceed the ampacity rating of the breakers and could lead to loss of redundant 480 Vac safeguards equipment during MSLB or LOCA conditions. Specifically, Breakers 1102 and 1202 rated for 1600 A, could be loaded to 1934A and 1833A, respectively. In a February 21, 1989 letter the licensee revised the overloads to be 1950A and 1650A for breakers 1102 and 1202, respectively, and that all previous load estimates did not consider all possible combinations of safeguards and nonessential loads. The February 21, 1989, letter also discussed possible corrective actions of either rerating the breakers, shedding nonessential loads from the buses, or replacing the breakers with breakers of higher rating and com-mitted to implement a viable solution prior to SONGS-1 restart.

In a letter dated March 15, 1989, the licensee described the results of an analysis and test of a Westinghouse DB-50 breaker which evaluated the effect of the overload condition (now stated to be 1896A for Switchgear #1 and 1640A for Switchgear #2) of the breakers. The test was based upon guidelines of ANSI C37.50, "Test Procedures for Low-Voltage AC Power Circuit Breakers Used in Enclosures," and was conducted at an ambient temperature of 40°C with a switchyard voltage of 230kV. The licensee stated that the test results were used to predict temperatures of critical breaker components (contacts, insulation, and connections) for the worst overload condition using graphical and analytical techniques. Predicted temperatures were plotted as a function of time and compared to ANSI recommended maximum values. It was determined that certain maximum continuous temperatures for normal operation would be exceeded but the additional temperature rise allowed for the four-hour emergency overload condition would not. An inspection of the breaker following the test revealed that the contacts and insulation were not degraded. The licensee's letter stated that since the peak overload currents were above the continuous ratings of the breakers, a gradual overheating of the breakers would occur over several hours which would cause accelerated aging but not breaker failure. The licensee also subjected the test breaker to 3 hour temperatures greater than 15°C above breaker rated temperature and to a peak temperature as high as 90°C above rated breaker temperature with no indication of impending failure.

The March 15, 1989, letter stated that an analysis of the auxiliary electrical system revealed that the main power cables feeding 480 Vac Switchgear #1 should be derated due to thermal effects caused by the overload current coupled with cables passing through a 34" fire barrier and being randomly laid in a section of covered cable tray. Although the resulting ampacity of the cables due to the derating falls below the overload current value, the licensee stated that these cables, located outside the containment, are environmentally qualified to survive high LOCA temperatures which exceed the temperatures expected to occur due to the overload condition and will therefore continue to perform their safety functions during high current overload conditions.

Although the licensee stated in the March 15, 1989, letter that no safety concerns exist and no modifications to eliminate the 480 Vac overload condition would be made for Cycle 10 operation, several actions would be taken prior to SONGS-1 restart from Cycle 10 outage. Specifically, the following actions as

clarified during subsequent discussions with the licensee will be taken:

1. Breakers 1102 and 1202 will have preventative maintenance performed on them to ensure that they will be in the same condition as the breaker that was tested.

2. Operating procedures will be revised to require operator load shedding of the 480 Vac Switchgear #1 and #2 to reduce the load to an acceptable continuous value within 4 hours of a safety injection actuation.

3. The 34" barrier will be reduced to 10" to improve cable ampacity.

4. The section of covered cable tray will have the covers removed or raised to improve ampacity.

Additionally, the licensee reiterated the possible long-term corrective actions discussed in the February 21, 1989 letter and has now committed to implementing a viable solution prior to Cycle 11.

In a March 17, 1989 letter the licensee again summarized the overload conditions, breaker test results, and corrective action. In addition, in response to a staff request, the licensee informed the staff that the rating of Station Service Transformer #1 would also be exceeded. The overload condition (133% of 1400 KVA OA rating at 65°C rise) was analyzed based on the four-hour limits prescribed in ANSI C57.92, "IEEE Guide for Loading Mineral-Oil-Immersed Power Transformers Up to and Including 100 MVA with 55°C or 65°C Average Winding Rise," and it was concluded that a negligible loss of transformer life would occur even without taking credit for the transformer's forced air cooling fans.

The staff has reviewed the licensee's corrective action intended to address the breaker, cable and transformer overload conditions. We find the four actions discussed above which the licensee will take prior to restart from Cycle 10 refueling outage acceptable as interim measures but condition our acceptance on the basis of the licensee's commitment to implement a viable solution prior to Cycle 11 which must address breakers, cables, and transformer.

If loads are not shed or breakers and transformer are not replaced as the viable solution to overload problem, the licensee's option to rerate breakers and not replace the existing transformer must be supported by the manufacturers' certifications that those components will perform satisfactorily under the overload conditions. Additionally, if an overload condition should occur before a long-term fix is implemented, the licensee must perform adequate testing and inspection of the overloaded components following the overload condition to ensure that those components have not degraded to an unacceptable level.

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