LOSS OF POWER TO VITAL BUSSES

Description of Incident

During a full load test run on Emergency Diesel Generator "A" on August 5, 1973, the Engineered Safeguard Bus feeder breaker tripped at 6:00 a.m., due to a malfunction. When the fault occurred, the diesel generator was at 100% rated load. When the feeder breaker tripped, Diesel Generator "A" became isolated to the 4160 volt Engineered Safeguard Bus, the 480 volt load center bus, and the connected loads on the two 480 volt motor control centers. When the operator tripped Diesel Generator "A" breaker, trouble alarms noted the loss of the two inverters that feed the Channel 1 and Channel 3 Reactor Protection and Engineered Safeguard Systems.

Subsequent investigation revealed the voltage regulator malfunctioned due to the failure of an isolation potential transformer located in the diesel generator excitation control cubicle. Failure of this transformer was apparently caused because the thermal tolerance of the insulating material was exceeded.

Safety Implications

It should be noted that the incident described above occurred during the pre-operational testing phase of the diesel generator. It is the function of these tests to bring to light any abnormal performance of systems or equipment, to allow for diagnosis of the apparent problems and to implement any required modification prior to subsequent fuel loading and plant operation. It has been identified that the "triggering factor" of the described incident was the overheating of the potential transformer. This overheating has not been predicted on an analytical basis because of the complex interaction of heat outputs from all of the surrounding equipment, and in particular, the less than favorable location of the potential transformer in respect to temperature variation within the cubicle. Since these facts were revealed during the pre-operation testing, the incident being reported thereby had no effect on the safety of the plant or the public.

The diesel generator malfunction caused a temporary loss of one engineered safeguard bus and its associated inverters. This resulted in a loss of one train of the non-nuclear instrumentation (NNI) of the reactor protection system. At no time during this incident was the integrity of the redundant diesel generator or that of its associated safeguard bus, inverters, or NNI compromised. Consequently, even if this event had occurred during power operation, sufficient capability would have been available to bring the plant to a safe shutdown condition in a timely manner without hazard to public health and safety.

Corrective Action Taken

In order to correct the thermal problem of the potential isolation transformer (which has definitely been identified as the cause of the incident), additional ventilation openings have been provided in the lower and upper part of the excitation cubicle. The transformer (originally rated 1 KVA) has been replaced with a 2 KVA rated transformer and relocated in the lower and relatively cooler region of this cubicle. Subsequent tests conducted at full load under high ambient temperature have proven that these modifications restored the safe operating condition of the voltage regulator. In addition, a circuitry change has been made in the trip circuit of the diesel generator circuit breaker such that it trips in the event of any similar occurrence which results in loss of voltage to the voltage regulator. However, this is only allowable during the testing and parallel operation of the diesel generator. The interlocks will prevent such an operation during emergency conditions.

We have conducted a complete review of the inverter circuitry and, as a result, we are now making several modifications to prevent its malfunction in the event that it experiences voltage or frequency surges similar to those which occurred during the incident. These modifications include the following:

1. Inverter 3 phase 480V AC power source shunt trip is being installed to give over-voltage protection when voltage surge is sensed.

2. An internal frequency sensing board is being incorporated for the purpose of cutting out rapid frequency oscillations to the inverters through the 480V AC single phase alternate source.

3. The inverter alternate source static switch input fuse is being changed to solid fused. The fuse will not be blown if the inverter fails and the static switch transfers out of phase. The actual inverter load protection will be supplied by the motor control center 480V AC single phase breaker and the inverter internal alternate source breaker.

4. We are replacing the 125V DC load center inverter feed breaker. The new breaker is a 2 pole, 225 amps frame size, magnetic trip only adjustable from 875 to 1750 amp. This new breaker will withstand higher inrush current which occurs when the inverters are turned on in the normal manner.

With the modifications already implemented and the circuitry changes that are being made, the voltage surge experienced during the incident by the 120V AC regulated inverters will not be likely to occur again.