ENCLOSURE

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

NINE MILE POINT RESTART ISSUES

NIAGRA MOHAWK POWER CORPORATION

NINE M' E POINT, UNIT 2

DOCKET NO. 50-410

1.0 INTRODUCTION

On August 13, 1991, five Uninterruptible Power Supplies (UPSs) tripped simultaneously, as a result of an electric fault on B phase of the main step up transformer causing a plant transient and loss of the control room annunciators. An NRC Incident Investigation Team (ITT) was established to determine the facts relevant to this event.

These UPSs supply power to non-Class 1E loads and thus do not need to be designed, maintained and monitored in accordance with requirements for Class 1E equipment and systems. By design each UPS is to a large degree internally redundant. However, certain failures of the UPS or equipment supplied by the UPSs make loss of UPS loads subject to single failures. Furthermore, the operators have emergency procedures and training and can rely on safety-related equipment to safely shutdown the reactor. This safety evaluation only focuses on those hardware and procedural corrective actions proposed by the licensee which are relevant to restart of the plant.

The licensee, at a public meeting on September 4, 1991, informed the staff that they have identified the root cause of the event, have performed appropriate corrective actions and are ready for restart of the unit. The agency responsibility for root cause determination for this event lies with the Incident Investigation Team (IIT) which is continuing its review. The Off' e of NRR staff has been briefed by the IIT on their investigation to date ...cluding their review of root cause for this event. Following the September 4, 1991, public meeting, and after meeting with the IIT, the licensee was requested to provide the following information for review:

(a) Root Cause Analysis and Short Term Corrective Actions

(b) Plans to provide a list of UPS loads to the operators in the control room

(c) Procedures and training pertaining to the mitigation of a ~ ent caused by loss of UPS 1A

(d) UPS Breaker Reliability and Coordination

2.0 EVALUATION

The licensee by letters dated September 10 and 11, 1991, submitted information to address all issues identified in the staff's request of September 5, 1991. Our evaluation of their submittal, with consideration of the root cause assessment provided by the IIT, is included herein.

2.1 Root Cause Analysis and Shor Term Corrective Actions

On August 13, 1991, five UPSs (2VBB-UPS 1A, B, C, D and G) tripped as a result of a fault on the B phase of the main transformer causing a plant transient. The licensee's post-trip review has concluded that the UPS shutdown was caused by low voltage created by the transformer fault that was sensed by the control logic power supply of each UPS. The logic trip was confirmed by the position of the power supply breakers and the presence of a modular trip indication on four of the five units. However, none of the ten Light Emitting Diodes which should have indicated the cause of the modular trip were lit. The alarm indications on two of the five units were identical. Alarm indications on the remaining three units were not consistent and for one of these units may have been reset during early recovery attempts. It was further determined that the preferred power supply for the control logic of the affected UPS is the B phase of the maintenance supply with the inverter output supply as a backup. Internal batteries are also provided in parallel with the preferred supply to the logic units. These batteries were found to be discharged and incapable of being recharged following the event. For the duration of the transformer fault and until loads were transferred to offsite power sources (i.e. approximately 200 m sec), the B phase voltage to the station normal AC distribution system decreased to about 50% of its normal value.

The licensee has evaluated the following three potential causes for the simultaneous tripping of the five UPS:

a. Propagation of high frequency noise from the main transformer fault

b. Voltage transient on the station ground system

c. Voltage transient on the B phase of the normal AC distribution system.

The licensee concluded that high frequency noise could not have tripped all five UPSs because preoperational testing has demonstrated that these units are not sensitive to radio frequency unless panel doors are open and an RF source is in close proximity. It is also very unlikely that high frequency noise from the fault could have been transmitted through the system's normal AC distribution system because multiple intervening transformers would have filtered away such a signal.

With regard to the station ground system, the transformer fault to ground caused currents to be delivered to the plant ground that have the potential to cause damage to grounded instrumentation components throughout the plant. Review of the strip chart recordings available for the 345 KV side of the transformer show a ground current contribution to the fault of 1,300 amperes coming from the 345 KV side of the transformer. No recordings are available for the low side of the transformer which is connected to the main generator and, therefore, the generator contribution to the fault could not readily be determined. However, since the fault is believed to have been developed on the high side of the transformer (345 KV), we have concluded that the generator contribution to the fault was nearly zero because of the delta low side transformer connections. With these transformer connections the zero sequence network configuration for the transformer would result in an open circuit for the low side and, therefore, would restrict the zero sequence (fault) current to ground.

The licensee has reported that the plant ground mat is designed to accept 30,000 amperes of fault currents without significantly raising the ground potential whereby electrical component failures can occur. Therefore, based on this analysis, and since no other instrumentation (including other UPSs) was affected by the event, the licensee concluded that ground potential was not the cause for the UPS trip.

The licensee, in order to confirm that the UPS trip was initiated by the degraded voltage supply to the control logic, conducted various tests simulating the voltage condition believed to have occurred during the transformer fault. These tests determined that:

1) The trip point for the control logic is about 17 VDC and, when the voltage was reduced below that value, the logic tripped the UPS supply breakers.

2) The K-5 relay drop-out voltage is about 45 VAC and pick up voltage is about 52 VAC. The K-5 relay is used to transfer power to the alternate source and it was determined that, since the voltage did not degrade below 50% to reach the 45 VAC, the relay did not drop-out and the alternate source (the inverter supply) was not picked-up.

3) The internal logic batteries on all five units were dead and were not capable of supplying proper logic voltage when all other sources were disconnected.

4) Voltage transient (degraded voltage condition) on the maintenance power supply in combination with degraded batteries tripped the control logic. The voltage transient was not low enough to cause the K-5 relay to change state. The licensee has demonstrated this on UPS 1C and UPS 1D. An induced voltage transient during testing with good batteries did not result in tripping the logic.

5) A sudden loss of the maintenance power supply with either new or degraded batteries did not result in tripping the control logic and the power supply properly transferred to the inverter output. Internal capacitance of the logic power supplies was sufficient to maintain control logic voltage during the transfer time of relay K-5.

The above tests have demonstrated that with dead internal UPS batteries, and all UPSs using maintenance power for the control logic, the initiating condition for the loss of the five UPSs was the degraded voltage caused by the transformer fault. Based on our evaluation of the submitted information and in particular the cause analysis discussion with IIT, and these tests, the staff agrees that the most likely initiating condition of the UPSs loss was the degraded control logic voltage due to a design deficiency, in combination with the dead internal UPS batteries.

The licensee has proposed the following short term corrective actions prior to plant restart:

a) The power supply to the control logic for all five UPSs will be normally fed from the inverter output with the maintenance supply as a backup.

b) Replace all control logic backup batteries.

c) Make appropriate changes to the UPS vendor manual to address the identified deficiencies.

d) Review other plant hardware where backup batteries are utilized and verify that the replacement schedule and control function of the batteries has been properly identified.

The licensee has also committed to the following corrective actions post restart:

a. Evaluate possible future modifications to change the K-5 relay drop-out characteristics.

b. Develop a replacement schedule for the logic batteries based on supplier recommendations, actual service condition and purpose of the batteries and provide easy access to these batteries for testing and replacement.

c. Continue laboratory testing to further investigate inconsistent alarm light indications.

We agree with the licensee's proposed pre-restart commitments for the UPS. Although investigation to resolve loss of LED indication continues, it is our judgement that these corrective actions will substantially reduce the likelihood of UPS loss from low voltage transients.

2.2 UPS Load Lists

During the August 13, 1991 events, the power to many essential non 1E components was lost. Control room annunciators, rod position indication and essential lighting was lost, which added to the complexity of the event. Therefore, the licensee has committed to have UPS load lists available, prior to restart, to the operators that provide circuit numbers, the device fed by each respective UPS and panel, the device location in the plant and a brief description of the plant impact upon loss of power to the device. These lists will also provide references to the applicable design documents of the specific circuits for further information, if desired.

The staff finds that the proposed load lists will significantly help the plant operators during UPS outage maintenance activities and in the implementation of event based operator response actions.

2.3 Procedures and Training

Niagara Mohawk Power Corporation in a letter to Steven A. Varga, NRC from B. Ralph Silvia, Niagara Mohawk Power Corporation dated September 10, 1991, indicated that the operators were properly trained and correctly followed the Emergency Operating Procedures (EOP's) during the event of August 13, 1991. They also concluded that no changes are needed to be made to the EOPs or operator training. The licensee stated they will develop and evaluate an alternate method to determine control rod position and when finalized, it will be added to the existing procedures.

However, the staff wanted further assurance that additional means are available to the operators to determine if a reactor scram has occurred when control rod position indication is lost and that the operators are properly trained to respond to such a situation. The licensee provided this assurance in a letter to S. Varga, NRC from J. Firlit, Nine Mile Point Nuclear Station, Niagara Mohawk Power Corporation, dated September 11, 1991, and a telephone conversation with the Operations Manager of Nine Mile Point No. 2 (Michael Colomb) on September 13, 1991.

The steps available to the operator listed in order of availability and accessibility of the information are:

1) Check nuclear instrumentation response including
   a. APRM's indicate less than 4% power and lowering (EOP entry condition)

   b. IRM's (after driven into the core) indicate on-scale less than or equal to range 6 to 7 and lowering

   c. SRM's (after driven into the core) indicate on-scale

2) Check scram pilot valve solenoid lights are extinguished on panel 2CEC*PNL603

3) Check indications that steam production is at post shutdown decay heat levels (less than or equal to one turbine bypass valve or safety relief valve open).

4) Check main steam line radiation monitors indicate downscale (ie. normal shutdown levels on panels 2CEC*PNL606 and 2CEC*PNL633)

5) Check scram discharge volume level indication on panels 2CEC*PNL609 and 2CEC*PNL611 (Rosemount indicating trip units) for upscale level

6) Check both air operated scram inlet and outlet valves at each Hydraulic Control Unit (locally) for open indication

7) Check 2RPS-PI133 locally at instrument rack 2CGS-RAK102 to verify that the scram air header has been depressurized as shown by a downscale or zero psig indication on the gauge

Based on our receiving confirmation from the licensee that the operators are trained to consider the above steps to verify reactor scram in the event of loss of instrumentation caused by UPS failure, the staff believes this to be adequate for restart. Further the licensee has committed to develop an alternate method to verify control rod position after restart and to verify that sufficient other instrumentation is available to implement the EOPs. In their response to NRC Bulletin 79-27 Niagara Mohawk provided an analysis to show that the plant can be shutdown with the loss of any electrical bus. This analysis will also be reconsidered as part of this effort. In addition, an assessment of the licensee's training incorporating the lessons learned from this event was conducted by an NRC Special Restart Assessment Team. This inspection team determined that the enhanced training on UPS operation was good. In addition, the licensee has developed a procedure for reenergizing a UPS following its trip.

2.4 UPS Breaker Reliability and Coordination Problem

During the event of August 13, 1991 and during subsequent troubleshooting activities some circuit breaker problems were experienced. These problems and corrective actions taken by the licensee are discussed below.

1) The feeder breaker on UPS1A tripped twice during trouble shooting. The licensee determined the cause of this failure to be a lower trip setting than appropriate to accommodate the higher expected inrush currents. The licensee has changed the setpoint on UPS1A, UPS1B and UPS1G. UPS1C and UPS1D were properly coordinated.

2) CB-3 on UPS1B would not close. This switch had been previously identified as worn. The licensee has replaced the switch.

3) CB-2 on UPS1D would not close after fifteen cycles during trouble shooting. This switch has been replaced by the licensee.

4) CB-3 on UPS1D binds on closure. The licensee has replaced this switch.

The licensee has committed to perform a root cause analysis for the breaker failures after restart. We believe that the licensee's plan to investigate the root cause in the longer term is acceptable.

3.0 CONCLUSION

Based on the above evaluation, we conclude that the licensee corrective actions based on their root cause analysis are appropriate for the restart of the plant. These corrective actions implemented before restart will minimize the likelihood of future loss of UPSs from similar electrical transients. We have also concluded that sufficient instrumentation and training are available for plant restart that will provide adequate information for plant operators to assure safe shutdown of the plant should the UPSs be lost.

Moreover, on September 12, 1991, NRR and Region I met with the IIT to review the results of NRR's findings regarding the UPSs and the licensee's associated corrective actions related to the restart of the plant. The IIT had no objections with the NRR technical findings and determinations concerning those issues related to restart of the plant.

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