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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIABILITY OF MANUAL BUS TRANSFERS

BETWEEN OFFSITE AND ONSITE POWER SUPPLIES AND

RESOLUTION OF 4.16KV SWITCHGEAR DEFICIENCY

POWER AUTHORITY OF THE STATE OF NEW YORK

JAMES A. FITZPATRICK NUCLEAR POWER PLANT (PASNY)

DOCKET NO. 50-333

1.0 INTRODUCTION

Since 1986, the NRC staff has expressed concerns regarding the reliability of the offsite power supply design at the James A. FitzPatrick Nuclear Power Plant. The first concern regards the reliability of manual bus transfers between onsite and offsite power supplies. Specifically, the NRC staff questioned the operator's ability to reliably transfer (manually) emergency bus power between the offsite and onsite power supplies because of the observed phase angle differences (25 degrees). The second concern regards the adequacy of the emergency bus breakers to interrupt the fault current associated with three-phase bolted faults when the emergency diesel generators (EDGs) are operating in parallel with the Normal Station Service Transformer (NSST).

The NRC staff has reviewed the licensee's evaluations and corrective actions pertaining to the above concerns and has prepared the following evaluation.

2.0 EVALUATION

Reliability of Manual Bus Transfers Between Onsite and Offsite Power Supplies

The reliability of manual bus transfers between onsite and offsite power supplies became an NRC staff concern when the licensee submitted an application dated August 5, 1986, to amend the technical specifications to remove the requirement to transfer the power supply for the emergency power buses from the main generator to the Reserve Station Service Transformer (RSST) if the EDG associated with that emergency bus was inoperable. The licensee requested the amendment because for manual bus transfers, large phase angles between the two power sources frequently resulted in high current flow which could lead to a breaker trip, loss of power, or a plant scram.

The large phase angle problem existed for manual power transfers only because automatic power transfers involve deenergizing the bus prior to the transfer of power to the RSST. Manual power transfers from the onsite power system to

the offsite power supply are required during planned and controlled shutdowns and start-ups of the plant. Currently, the licensee is also performing a manual transfer during the monthly full-load test of the emergency diesel generators in parallel with the RSST. Since 1988 the NRC staff has conducted an extensive exchange of questions and discussion with the licensee to address the phase angle problem.

By letter dated December 28, 1990, the licensee informed the NRC staff that the Niagara Mohawk Power Corporation has permanently installed a power transformer between the 345kV system and the 115kV system at the Oswego Steam Station. This transformer, which connects the two systems near the FitzPatrick plant, has virtually eliminated the phase angle difference between the reserve power supply and the normal power supply. Therefore, the NRC staff considers this concern resolved and no further action is necessary.

Three Phase Bolted Bus Fault Protection

As documented in Safety System Functional Inspection (SSFI) Report 50-333/89-80, dated August 22, 1989, during the course of an SSFI, the NRC requested an analysis to demonstrate adequate short circuit interrupting capability for 4.16kV emergency switchgear. Subsequently, Stone & Webster Engineering Corporation (SWEC) performed an analysis (SWEC Calculation No. 14620-E-9017-4, Rev. 0) for the licensee to determine fault current magnitudes under various (6) electrical configurations. The analysis indicated that momentary and/or interrupting currents for a hypothetical three-phase bolted fault were of concern for one electrical configuration. Specifically, the analysis outlined the potential for exceeding the interrupting ratings of certain emergency bus switchgear if a worse case three phase fault occurred while the EDGs were operating in parallel with the NSST during monthly testing.

On July 27, 1989, the licensee stated in their Justification for Continued Operation (JCO) that when the EDGs are operated in parallel with the NSST while performing the monthly 1-hour testing, the probability of occurrence of a fault exceeding the breaker rating is less than 7.39 E-6. This probability value was based on a Licensee Event Report (LER) data base search which indicated that there were only five three-phase and phase-to-phase faults in all nuclear plants in the United States. A review by the NRC staff indicated that substantially more electrical faults (i.e., 57 events between 1980 and 1989) were present in our LER data base. Therefore, the NRC staff found the probability analysis used by the licensee to be questionable.

During a telephone conference call between the NRC and PASNY, the NRC staff expressed concern regarding the use of the 4.16kV Class 1E switchgear beyond its equipment rating. The licensee committed to test the EDGs in parallel with the RSST and not the NSST to ensure that the breakers will not be

operated in any configuration in which the breakers may be potentially exposed to fault currents beyond their momentary and interrupting ratings.

By letter dated September 4, 1990, the licensee proposed that the long-term solution to the switchgear deficiency is to waive the design requirements for the three-phase fault protection criteria based on the following rationale:

1. The current method of manually transferring station loads from the NSST to the RSST and then back to the NSST during EDG testing is an undesirable practice since each transfer has the potential for causing a plant trip. Therefore, this method is not an acceptable long term solution.

2. The licensee identified high costs ($500,000 to $5,000,000) associated with potential modifications or testing program to qualify existing equipment. Based on the probabilistic analysis, which was identical to the one used in the Justification for Continued Operation dated July 27, 1989 (discussed above), the licensee concluded that the probability of a bolted fault is very small compared to the risk associated with the multiple switchgear operations needed for the monthly load transfers. Therefore, given the procedural changes in place, the licensee proposed to perform no modifications and return to the pre-SSFI test method of performing EDG tests with station loads supplied from the NSST.

The NRC staff reviewed the subject calculation (SWEC Calculation No. 14620-E-9017-4, Rev. 0) and made an independent probabilistic assessment of the generic safety concern involving a three phase bolted fault occurring during parallel testing of an emergency diesel generator. The staff also reviewed the procedural controls proposed by the licensee as preventative measures to ensure proper operating conditions.

The methodology used in the subject calculation utilizes a lower multiplier than cited in ANSI C37.010 to calculate the momentary asymmetrical current for those cases where the impedance (R/Z) values is below 24.3. Although the worst case operating conditions were not modelled (i.e., Turbine Building Closed Loop Cooling Water Pump 37P-2B on Bus 104 is assumed not to be running during any Modes), the assumptions and hand calculations used during the subject calculation seem appropriate. Listed below is a brief summary of those 4 kV switchgear buses which exceed or nearly exceed their momentary and interrupting rating under certain operating conditions (MODES).

MODE 2: EDG test mode-one train of EDGs connected in parallel with the NSST

(3 Phase) Fault	Bus	% of Momentary Duty	% of Interrupting Duty
	10100	96.3	93.8
	10200	96.1	93.5
	10400 (10300)	125.7	102.7
	10600 (10500)	123	99.8
(Phase to Phase) Fault	10400 (10300)	109.3	---
	10600 (10500)	107	---

MODE 4: One train of EDGs tested in parallel with RSST T2 (RSST T3)
NOTE: Current test mode in use at JAF

(3 Phase) Fault	Bus	% of Momentary Duty	% of Interrupting Duty
	10400 (10300)	99.6	---
	10600 (10500)	93.1	---

MODE 6: RHR motor surveillance test - Plant supplied from the NSST and three RHR motors running

(3 Phase) Fault	Bus	% of Momentary Duty	% of Interrupting Duty
	10400 (10300)	99.6	---
	10600 (10500)	97.1	---

As shown by the above data, the safety related switchgear buses (Buses 10500 and 10600) exceed their momentary and interrupting ratings for the desired test mode - Mode 2, and are marginal in other conditions.

The scope of the switchgear deficiency involves 52 undersized breakers total on the five normal power buses (i.e., Buses 10100, 10200, 10300, 10400, and 10700) and the two emergency power buses (i.e., Buses 10500 and 10600). The redundant emergency 4.16kV switchgear buses 10500 and 10600 are located in separate rooms. Normal 4.16kV switchgear buses 10100, 10300, and 10700 share the same room as 600V emergency buses L25, MCC C251, and MCC C252. Normal 4.16kV switchgear buses 10200 and 10400 and redundant emergency buses L26, MCC C261, and MCC C262 are located in an adjacent room. The potential failure mechanism considered consists of the fault damage on the affected breaker and the resultant missiles, explosive forces, molten metal, etc. associated with

the magnitude of the short circuit currents which would probably damage other equipment in proximity to the faulted breaker. Given the test mode (i.e., once per month for 1-hour of testing on each set of EDGs), the redundant set of EDGs and associated emergency bus should remain operable and available to shut down the plant. Therefore, the fault event would be the single failure assumed in plant design, impacting only one train of safe shutdown equipment. The licensee also conducted a 10 CFR Part 50, Appendix R, evaluation of the fire consequences which may result from a possible fault and concluded that there is no impact on the ability to safely shut down the plant.

The licensee also indicated that the following preventative measures are in place to ensure that no conditions exist that could increase the possibility of a fault occurring during the EDG test: (1) inspection of the switchgear areas to ensure that personnel are not working in the area and (2) no maintenance work in the switchgear will be performed during the EDG test.

A probabilistic assessment was conducted by the NRC staff for a three-phase bolted fault occurring during parallel testing of an EDG. This assessment concluded that the probability of a three-phase bolted fault during diesel load testing and the subsequent failure of the bus is in the order of 1.0 E-5 per reactor year. This is based on a conservative estimate of the breaker reliability, and the assumption that the interrupting fault current is sufficiently larger than the momentary duty capacity, resulting in breaker failure. This assessment also projected a core damage state as a worst case event whose frequency is less than 1.0 E-9 per reactor year. Based on the very small core damage frequency contribution of fault scenarios, the NRC staff concludes that an additional requirement to include the EDG fault contribution during parallel testing would not be cost beneficial. Furthermore, the NRC staff concludes that the frequency of manual bus transfer should be reduced because they have the overall effects of potentially destabilizing the electrical system, needlessly challenging protective functions, and potentially damaging equipment. Therefore, the NRC staff concludes that the current commitment to manually transfer loads from the NSST to the RSST to perform EDG testing is no longer required.

3.0 CONCLUSION:

Based on the above evaluation, the NRC staff has concluded that the concern regarding the ability of operators to reliably transfer (manually) emergency bus power supply between the offsite and onsite power supplies has been adequately resolved with the addition of the new power transformer. The staff has also concluded that due to the small core damage frequency contribution of postulated fault scenarios during monthly testing of the diesel generator coupled with the implementation of the recommended preventative measures discussed above, there is no need for imposing a design change to correct the subject switchgear deficiency. Furthermore, the NRC staff concludes that the frequency of manual bus transfers should be reduced because they have the overall effect of potentially destabilizing the electrical system, needlessly

challenging protective functions, and damaging equipment. Therefore, the NRC staff concludes that the current commitment to manually transfer loads from the NSST to the RSST to perform EDG testing is no longer required.

The NRC staff requests that the following administrative measures be implemented to ensure that future switchgear reliability is not degraded:

1. Future station modifications should not adversely impact the present momentary duty and interrupting duty capability of the switchgear.

2. Station management should ensure that operators and maintenance personnel receive training regarding the three-phase bolted fault switchgear deficiency and the preventative measures taken to ensure that no conditions exist that could increase the possibility of a fault occurring during EDG testing.

Principal Contributor:
R. V. Jenkins

Date: March 16, 1992

References

1. NYPA letter, W. Fernandez to NRC, dated July 16, 1990, "Postulated Fault 4KV Bus Fault."

2. NRC letter, B. Boger to W. Fernandez, dated August 22, 1989, "NRC Safety System Functional Inspection (SFI) Report 50-333/89-80."

3. Justification For Continued Operation, JAF-JCO-89-065, New York Power Authority, dated July 27, 1989.

You are requested to provide the NRC staff, in writing, an affirmation of your commitment to conduct the preventative measures outlined on page 5 of the enclosed safety evaluation during future EDG testing. This submittal should also include your plans to address the administrative measures outlined on page 6 of the enclosed safety evaluation. We request that you provide us with the stated information within 60 days of receipt of this letter. If you have any questions regarding this matter, please contact me at (301) 504-1423.

This action completes our review activities on TAC No. M76947.

Sincerely,
Original Signed By
Brian C. McCabe, Project Manager
Project Directorate I-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosure:
Safety Evaluation

cc w/enclosure:
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