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November 3, 1982

Mr. R. C. Haynes
Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

50-387

SUSQUEHANNA STEAM ELECTRIC STATION
FINAL REPORT OF A DEFICIENCY INVOLVING
AC ELECTRICAL DISTRIBUTION SYSTEM
ERs 100450/100508 FILE 821-10
PLA-1370

Reference: PLA-1102

Dear Mr. Haynes:

This letter serves to provide the Commission with a final report on a deficiency involving the capability of the AC electric distribution system to support two unit operation.

This deficiency was originally reported by telephone to Mr. E. C. McCabe of NRC Region I on April 20, 1982 by Mr. A. R. Sabol of PP&L. At that time, the condition was identified as "Potentially Reportable". On May 21, 1982 an interim report on the subject deficiency was transmitted to the NRC via PLA-1102.

The attachment to this letter contains a description of the deficiency, its cause, an analysis of safety implications and the corrective actions taken and planned. This information is furnished pursuant to the provisions of 10 CFR 50.55(e).

Since the details of this report provide information relevant to the reporting requirements of 10CFR21, this correspondence is considered to also discharge any formal responsibility PP&L may have in compliance thereto.

We trust the Commission will find this report to be satisfactory.

Very truly yours,

RJ Shovlin for

N. W. Curtis
Vice President-Engineering & Construction-Nuclear

WLB:rla

Attachment

IE27

cc: Mr. Richard C. DeYoung (15)
Director-Office of Inspection & Enforcement
U.S. Nuclear Regulat ry Commission
Washington, D.C. 20555

Mr. G. McDonald, Director
Office of Management Information & Program Control
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Gary Rhoads
U.S. Nuclear Regulatory Commission
P.O. Box 52
Shickshinny, PA 18655

November 3, 1982

SSES
ERs 100450/
100508

PLA-1370
File 821-10

SUBJECT

AC ELECTRICAL DISTRIBUTION SYSTEM

DESCRIPTION OF PROBLEM

The AC Electrical Distribution System provides the power to operate and control equipment required for normal plant operation, for plant shutdown, and for mitigation of design basis accidents. This system was modeled using computer based simulations and studied to verify that the system meets design specifications.

The initial studies for two unit operation were completed on February 12, 1982. They indicated that with one ES and one startup transformer out of service, the minimum post-LOCA steady state voltage would be 90.6% and the minimum post-LOCA motor starting voltage would be 81%. The conclusion from the engineering studies was that the design was in compliance with design criteria.

On March 14, 1982, voltage verification tests were conducted to determine the accuracy of the voltage calculations. The result was that calculated voltages for the test condition were as much as 3% higher than the observed values. With this difference applied as a design margin the minimum design voltages, 90% for steady state and 80% for motor starting, could not be met for two unit operation.

The AC Electrical System was therefore reported as deficient for two unit operation under 10 CFR 50.55 (e) on 5/21/82, PLA-1102.

To assure that the 3/14/82 voltage test results were correct and to determine the cause of the apparently larger voltage drop than predicted, additional voltage tests were conducted on 6/19/82. These tests were more extensively instrumented than the March tests, with loading conditions more representative of a LOCA.

Using the computer, the second test was modeled by fixing the 230kv bus voltage and adjusting the bus loads to obtain the real and reactive current flows read during the test. The resulting computer calculated voltages were as much as 6% higher than the observed voltages.

Hand calculations from the 13.8 and 4kv flow and voltage data indicate the impedance of both ES transformers was approximately 9%, which is significantly higher than the specified 7%.

To determine if the ES transformer impedance was the cause of the voltage discrepancy, on August 29, 1982, an impedance test was performed on ES transformer 201. The impedance was found to be only slightly higher than the nameplate value (Z=7.46% by test) but within manufacturing tolerances. An improper ES transformer impedance was determined not be the cause of the voltage discrepancy.

The confirmation of the transformer impedance and the inability to predict the observed voltage drop through the transformer using classical hand calculation techniques proved that the error was in a portion of the test data and not in the computer model or in the assumptions used in the study.

In an attempt to determine the source of the data error the following actions were taken:

- o Recorder and transducer calibrations were reverified.
- o The effect of reduced power supply voltages on the recorder and transducers was examined.
- o The turns ratio of the ES transformers was verified by test.
- o The transient response of the transducers was reviewed.
- o PT and CT error caused by circuit burden was evaluated.

None of these were found to be at fault.

Engineering believes the error was caused by the use of average reading watt/var transducers. These respond to the average value of each half cycle.

The voltage and current wave forms on the 4kv and 480 volt buses show visible distortion. Bench tests performed by our electrical test section confirm that the output of the transducers is reduced when the measured wave form is distorted by the addition of harmonics.

To date PP&L has been unable to positively identify the watt/var transducers as the source of the data error. Comparison of simultaneous readings of voltage, watts and current taken on the 4kv bus after the test show no disagreement between transducer and RMS reading meters. But since the system was lightly loaded for these readings the distortion may not be representative of conditions during the test.

Discussions with the transducer manufacturers indicate that two quantity devices such as the watt and var tranducers are more affected by distortion than are the single quantity voltage and current transducers.

The validity of the voltage calculation techniques was checked using the 6/19/82 test voltage data only. The voltage data was considered valid because the recorder and transducer calibrations were verified by voltmeter readings just prior to the test.

Pre-start conditions for the second set of RHR pumps were simulated on the computer by adjusting the modeled loads to produce the observed pre-start voltages. The motor starts during the test were

then simulated by using motor data from the plant voltage study. Verification of the voltage studies by test data utilizing this method showed the calculated voltage to be conservative, a minimum of 1% less than the observed value. Engineering has concluded from this analysis that no margin needs to be applied to the voltage criteria.

Because the 8/29/82 transformer impedance test shows slightly higher impedance than used in previous voltage studies, the February voltage study for two unit operation was redone using the test value for ES transformer impedance. The resulting minimum post-LOCA steady state voltage was 89.8% and the minimum post-LOCA motor starting voltage was 79.6%. These values are slightly below the steady state and motor starting voltage criterias of 90% and 80% respectively.

ANALYSIS OF SAFETY IMPLICATIONS

Continuous operation of motors below design voltage limits will result in motor overheating and accelerated loss of life. Starting of motors with less than minimum design voltage will result in increased starting times, increased heating during starting, and accelerated loss of life. The 480v motor starters used at Susquehanna SES have been designed to operate above a minimum 90% bus voltage. Because the analysis predicts voltages below the minimum criteria, the voltage study leads to the conclusion that during two unit operation, even though motor operation may be possible, the motor starter operation is uncertain and some safety related 480v motors (pumps, valves, fans etc.) may not start when required.

PP&L has concluded that since design limits cannot be met for two unit operation, this deficiency is reportable under the provisions of 10 CFR 50.55(e).

CAUSE OF DEFICIENCY

This deficiency resulted from the failure of Bechtel Power Corporation to include sufficient margins in their initial design calculations to account for equipment tolerances and computational inaccuracies.

CORRECTIVE ACTION

The safe operation of Unit I during the construction of Unit 2 was assured (Ref. PLA-1167) by the implementation of a design change to trip all Unit 2 safety-related loads that might be running for construction activities in the event of a Unit #1 LOCA.

To assure adequate voltage margins for two unit operation two additional ES transformers of the same rating as the existing ES transformers will be installed prior to unit two fuel load.

These transformers will be installed between the startup bus and the 4kv system. Two 4kv safety related buses will normally be aligned to each transformer.

With this change the minimum design voltages will be met for two unit operation. The minimum post-LOCA steady state voltage will be 94.4% and the minimum post-LOCA motor starting voltage will be 88.7%. These voltages are calculated assuming one startup and two ES transformers are out of service and the startup transformer load tap changer has operated to maintain the startup bus voltage for the post-LOCA steady state condition. No credit has been taken for voltage boost from the automatic tap changer during the initial loading of the LOCA load sequence.

For future studies, a 2% design margin will be applied for starting and steady state conditions at the 4kv and 480 volt class 1E buses. This margin is 20% of the allowable steady voltage drop and 10% of the allowable drop for motor starting.