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April 12, 1983

Mr. James A. Allen
Acting Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
631 Park Avenue
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SUSQUEHANNA STEAM ELECTRIC STATION
THIRD INTERIM REPORT OF A DEFICIENCY INVOLVING
EMERGENCY SERVICE WATER (ESW) SYSTEM WATER HAMMER
ERs 100450/100508 FILE 821-10
PLA-1604

Reference: PLA-1258

Dear Mr. Allen:

This letter serves to provide the Commission with a third interim report on the deficiency involving Water Hammer in the ESW System. In our second interim report we had projected that by March, 1983, we would be able to issue a final report; however, the final solution to the problem has not been identified. We plan to issue a final report in June, 1983.

This report contains an update on the current status of the water hammer fix.

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

Very truly yours,

B. D. Kenyon
Vice President-Nuclear Operations

fjc/ltc209c2:sah

Attachment



IE27

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SUSQUEHANNA STEAM ELECTRIC STATION
UNIT 1 AND COMMON
THIRD INTERIM REPORT

## WATER HAMMER IN THE EMERGENCY SERVICE WATER SYSTEM

### PURPOSE

This report supplements our previous Interim Report transmitted in our letter PLA-1258, dated August 27, 198

### DESCRIPTION OF DEFICIENCY

During preoperational testing at Susquehanna Steam Electric Station, water hammer occurred in the ESW System, which resulted in damage to three pipe hangers. An investigation into the cause of the hanger failures revealed that there are certain operating and test conditions under which the ESW system could be subjected to water hammer.

The water hammer occurs as a result of the following sequence of events:

(1) ESW System in operation - ESW pumps are on and the 36" Motor Operated Bypass Valves to the spray pond are open.

(2) Loss of Offsite Power (LOOP) occurs - ESW pumps trip; 36" MOVs remain open; ESW piping begins to drain down to spray pond.

(3) Power supply transfers from offsite source to onsite emergency diesel generators.

(4) Approximately 10 seconds after the diesel generators receive a start signal, the 36" bypass valves begin to close. The ESW System continues to drain down to the spray pond during the nominal 30-second closure time of the valves.

(5) 55 seconds after the start of the diesel generators, the ESW pumps restart simultaneously.

The restart of the ESW pumps causes water to be accelerated through partially emptied ESW piping, resulting in water hammer. It was also determined that the potential for water hammer exists on ESW (loop A only) due to an inadequate 1" keep fill cross-tie with service water. This has been corrected by a change to a 4" crosstie and verified by test.

As a result of the above-described events, the potential exists for the ESW System to experience stresses which exceed the design allowables during a water hammer event.

CAUSE

Non-simultaneous LOCA/LOOP was not a design basis for the plant.

Also, the water hammer can be caused from having ESW in service and experiencing a LOOP.

CORRECTIVE ACTION TAKEN

Four design change packages (DCP) have been issued and three (DCPs 82-346A, 82-346B, and 82-563A) were installed prior to exceeding 5% power. As a result of instrumented testing (described below), it was determined that acceptable piping stresses could be achieved without installation of the fourth DCP (DCP 82-346C).

(1) DCP 82-346A. Motorization of ESW Pump Discharge Valves.

This DCP added motor operators to each of the four 18" ESW pump discharge valves. These valves were previously manual only and locked in the open position. This change will allow the valves to throttle the initial flow from the ESW pumps thus mitigating the water hammer event. The control of these motor operators is automated for maximum mitigation of water hammer event; however, local manual operability is maintained.

(2) DCP 82-346B. Staggered Start of ESW Pumps.

This DCP staggers the start of the second pump in each loop of ESW by approximately 15 seconds. The pumps previously started simultaneously. This change coupled with the throttling of the pump discharge further mitigates system water hammer through a more gradual filling of the system.

(3) DCP 82-346C. Logic Change of 6" Control Structure Chiller Discharge Valves to Continuously Open (not installed).

This DCP would have changed the logic of the two 6" discharge valves so that they remain continuously open. These valves presently open when the emergency condenser water circulating pumps start and close when the emergency condenser water circulating pumps stop. This logic leaves these valves closed for the start of the ESW pumps thus increases the potential for a water hammer event. The DCP logic change would have allowed these valves to remain open for the start of the ESW pumps thus mitigating the water hammer event.

The ESW System was tested without this DCP installed and acceptable piping stresses resulted; therefore, it was decided not to install this DCP.

(4) DCP 82-563A. Delayed Opening of the Spray Pond Bypass Valve.

This DCP delays the opening of the spray pond bypass valves HV-0122A and B for an ESW pump start. This prevents the draining of the ESW piping while the system is slowly filled.

TESTS

Instrumented tests were conducted on both ESW loops after the three previously described DCPs were installed. To determine the pipe stress during the transient, strain gages were installed in the locations of predicted high stress. The results of the tests indicated that the pipe stresses are within allowables, and there was no visual damage to the pipe restraints. Some loosening of the expansion anchors did occur; however, this loosening was not considered to be significant since the bolts were able to be retorqued. It should be noted that all critical anchors are inspected for loosening and retorqued as necessary after a water hammer occurs.

FUTURE ACTIONS

PP&L is committed to demonstrating that all loadings on piping, hangers, and anchor bolts for this postulated abnormal event are within code and NRC allowables. This will be accomplished by refinement of analysis, modification, or additional testing prior to startup following the first refueling outage.

PP&L is evaluating the following as potential fixes either singly or in combination; however, we are not limiting the study to these items:

- vacuum breakers
- slow refill system (similar to current fix)
- head tanks
- check valves on ESW supply lines
- accumulators
- motor operated isolation valves on the lines to the control structure chillers
- hanger modifications

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