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NUCLEAR REGULATORY COMMISSION
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February 4, 1980

Dockets Nos. 50-250
and 50-251

Dr. Robert E. Uhrig
Vice President
Florida Power & Light Company
Advanced Systems & Technology
P. O. Box 529100
Miami, Florida 33152

Dear Dr. Uhrig:

We have completed our review of the Turkey Point Plant Units Nos. 3 and 4 in regard to steam generator water hammer. We have found that acceptable precautions are being taken to minimize the occurrence of water hammer in the feedwater piping. The bases for our conclusions are provided in the enclosed Safety Evaluation Report dated January 1980. This completes our review of steam generator water hammer in the Turkey Point Plant.

Sincerely,

A handwritten signature in cursive script, appearing to read "Albert Schwencer".

Albert Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors

Enclosure:
Safety Evaluation Report

cc w/enclosure:
See next page

A large, handwritten mark resembling a stylized number 7 or the letter U, with a horizontal top bar and a vertical stem.

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MA
Y

Dr. Robert E. Uhrig
Florida Power and Light Company

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February 4, 1980

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SAFETY EVALUATION REPORT
STEAM GENERATOR WATER HAMMER
TURKEY POINT UNIT NOS. 3 AND 4
DOCKET NOS. 50-250 AND 50-251
JANUARY 1980



1.0 INTRODUCTION

Steam generator water hammer has occurred in certain nuclear power plants as a result of the rapid condensation of steam in a steam generator feedwater line and the consequent acceleration of a slug of water which upon impact within the piping system causes undue stresses in the piping and its support system. The significance of these events varies from plant to plant. Since a total loss of feedwater could affect the ability of the plant to cool down after a reactor shutdown, the NRC is concerned about these events occurring, even though an event with potentially serious consequences is unlikely to happen.

Because of the continuing occurrence of water hammer events, the NRC, in September 1977, informed all PWR licensees that water hammer events due to the rapid condensation of steam in the feedwater lines of steam generators represented a safety concern and that further actions by licensees for Westinghouse and Combustion Engineering designed nuclear steam supply systems are warranted to assure that an acceptably low risk to public safety due to such events is maintained. Accordingly, these licensees were requested to submit proposed hardware and/or procedural modifications, if any, which would be necessary to assure that the feedwater lines and feedrings remain filled with water during normal as well as transient operating conditions. As the same time, the NRC provided each PWR licensee with a copy of its consultant's report, "An Evaluation of PWR Steam Generator Water Hammer," NUREG-0291

The evaluation of the potential for steam generator water hammer at the Turkey Point plants shows that the feedwater piping adjacent to the steam generator consists of a favorably short run of horizontal piping and that during five years of successful operation they have experienced those conditions that might induce steam generator water hammer but no water hammer has occurred.

2.0 EVALUATION

Our consultant, EG&G Idaho Inc., prepared the attached evaluation of steam generator water hammer at the Turkey Point Plants as part of our technical assistance program. (Letter from J.A. Dearien, EG&G, to R.E. Tiller, DOE, dated January 9, 1980.) We have reviewed this report together with the licensee's submittals listed under item 4.0.

3.0 CONCLUSION

Based on our knowledge of water hammer phenomena, and our review of the licensee's responses and the enclosed evaluation report, we concur with our consultants' conclusion that the potential for steam generator water hammer is sufficiently low to permit continued operation of these facilities. However, even though steam generatbr



water hammer is not likely to occur, the licensee should be vigilant and monitor for water hammers that might impose significant stresses on the piping systems or their supports. We will continue to monitor reports from this licensee for indications of possible water hammer. If such indications appear in the future, this matter will be reexamined and may result in additional requirements to reduce the probability of steam generator water hammer at these facilities.

We have concluded that steam generator water hammer is not likely to occur at these facilities and, therefore, we find no undue risk to the health and safety of the public as a result of the continued operation of the Turkey Point Unit Nos. 3 and 4.

4.0 REFERENCES

- 4.1 Robert E. Uhrig (FPL), letter to George Lear, NRC, Subject - "Water Hammer in PWR Feedwater System" July 3, 1975.
- 4.2 Robert E. Uhrig (FPL), letter to George Lear, NRC, Subject - "Water Hammer in PWR Feedwater Systems," January 3, 1978.
- 4.3 Robert E. Uhrig (FPL), letter to A. Schwencer, NRC, Subject - "Water Hammer," December 26, 1979.

STEAM GENERATOR WATER HAMMER TECHNICAL EVALUATION

TURKEY POINT UNIT NOS. 3 AND 4

January 1980

EG&G Idaho, Inc.

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I. INTRODUCTION

An evaluation was performed for the Turkey Point Power Station (TPPS) Unit Nos. 3 and 4 feedwater system. The purpose of this evaluation was to assess the susceptibility of the feedwater system to water hammer during operating transients and situations that could result in conditions conducive to water hammer.

Steam-water slugging resulting in water hammer in the steam generator feedings and adjacent feedwater piping was considered in this review. This type of water hammer is generally referred to as steam generator water hammer.

The information for this evaluation was obtained from:

1) discussions with the licensee, 2) licensee submittals to NRC of July 3, 1975¹, and January 3, 1978², 3) the "Turkey Point Unit Nos. 3 and 4 Final Safety Analysis Report"³, 4) "An Evaluation of PWR Steam Generator Water Hammer", NUREG-0291⁴, and 5) "NRC requirements for Auxiliary Feedwater Systems at the Turkey Point Power Station"⁵.

A review of steam generator water hammer events at TPPS is presented in Section II. The means to reduce the potential for water hammer at this facility are presented in Section III. Section IV presents descriptions of the feedwater system geometry and operation pertaining to the susceptibility of the system to steam generator water hammer. Conclusions and recommendations are presented in Section V concerning the susceptibility of the feedwater system at this facility to steam generator water hammer.

II. WATER HAMMER EXPERIENCE

There are three known occurrences of water hammer prior to feeding piping modifications in 1974 in the feedwater piping at TPPS Unit Nos. 3 and 4.

The first occurrence was indicated by body-to-bonnet leakage and slight elongation of some body-to-bonnet bolts on the 3B feedwater check valve.

The second occurrence was indicated by the same kind of leakage and bolt elongation on the 4B feedwater check valve.

The third occurrence was indicated by the following deformations discovered inside containment during an outage of Unit No. 4. They occurred on the "A" steam generator feedwater piping.

1. Some expansion bolts for two hydraulic pipe restraints had been pulled approximately one inch out of a concrete wall.
2. Two spring hanger mounting plates had been deformed.
3. A 90° elbow located in the piping leading to the steam generator feedwater nozzle experienced plastic deformation.

Subsequent to the 1974 feedwater piping modifications, no steam generator water hammers have occurred.

III. MEANS TO REDUCE THE POTENTIAL FOR WATER HAMMER

In 1974 the effective horizontal length of main feedwater piping adjacent to any steam generator was modified not to exceed eight feet.

The corrective action was to minimize the length of feedwater piping which could drain into the steam generator through the feedring. This was done by shortening the horizontal length of pipe at the level of the feedring inlet nozzle. As a result of these modifications, the piping turns downward through a 90° elbow approximately five feet from the steam generator. These modifications were performed on the "A" and "B" steam generator feedwater piping for both units. The feedwater piping for the "C" steam generator was not modified because the eight foot horizontal length at the nozzle elevation was evaluated and found to be acceptable. There has been no evidence of water hammer occurrences in any steam generator feedwater piping since completion of the modifications.

Auxiliary feedwater flow is manually controlled to the minimum necessary to meet operating requirements. However, specific administrative means, or other positive means, such as top discharge feedrings or administrative auxiliary feedwater flow limitations, have not been incorporated into plant design or procedure.

Based on past experience, steam generator water hammer would be most likely during startup, shutdown, and low power situations when feedwater is under manual control and the flow rates are insufficient to maintain uncovered feedrings full of water. To avoid admission of steam and possible slugging during these operational conditions, the feedrings must remain covered with water.



IV. OPERATING EXPERIENCE AND WATER HAMMER SUSCEPTIBILITY

The conditions most conducive to steam generator water hammer occur when the steam generator feedrings are uncovered and steam enters the feedrings and attached horizontal feedwater piping. Steam-water slugging and subsequent water hammer may occur when incoming feedwater mixes with the steam in the piping and rapid condensation occurs. These conditions could conceivably occur during certain operating conditions for facilities with bottom discharge feedrings because of large drainage rates.

Since the piping modifications in 1974, TPPS Unit Nos. 3 and 4 have experienced numerous reactor trips. A reactor trip almost always results in feedring uncover in all steam generators. The drop or "shrinkage" in water level and subsequent feedring uncover is the result of interrupted reactor power production causing the collapse of steam voids within the secondary side of the steam generators. A similar situation would be experienced during events such as loss of main feedwater, loss of offsite power, steam line break, or loss-of-coolant accident. Normal startups and shutdowns with feedwater under manual control could also result in a substantial number of feedring uncover events even with the administrative steam generator water level controls.

Our review of the operating history shows that drainage of the feedrings and adjacent piping has been experienced at TPPS Unit Nos. 3 and 4. Although we would expect steam generator water hammer to occur under certain operating conditions, no steam generator water hammer has been experienced at the facility since 1974. This has demonstrated that subsequent to the feedwater piping modifications, the facility at the Turkey Point site has an apparently low susceptibility to steam generator water hammer under all conditions.

V. CONCLUSIONS AND RECOMMENDATIONS

We have reviewed the operating history of the TPPS Unit Nos. 3 & 4 pertinent to steam generator water hammer and the related operational and procedural characteristics of the feedwater system. The review has shown that conditions conducive to steam generator water hammer have occurred at the TPPS Unit Nos. 3 & 4 but no water hammer events have been observed subsequent to the 1974 steam generator feedwater piping modifications. The conditions have been encountered during normal operating transients and startup and shutdown operation. Such conditions would also be expected in the future during the normal and accident operating situations addressed in the review. Based on this review we have concluded that the potential for steam generator water hammer is sufficiently low to permit continued operation of this facility.

VI. REFERENCES

1. Robert E. Uhrig (FPL), letter to George Lear, NRC, Subject - "Water Hammer in PWR Feedwater System", July 3, 1975.
2. Robert E. Uhrig (FPL); letter to George Lear, NRC, Subject - "Water Hammer in PWR Feedwater Systems", January 3, 1978.
3. Final Safety Analysis Report, Turkey Point Units 3 and 4, Florida Power and Light Company, NRC Docket Nos. 50-250 and 50-251.
4. J. A. Block, et al, An Evaluation of PWR Steam Generator Water Hammer, Creare, Inc. NUREG-0291 (December 1976).
5. D. G. Eisenhut letter to R. E. Uhrig, FPL, Subject - "NRC Requirements for Auxiliary Feedwater Systems at Turkey Point Units 3 and 4", October 16, 1979.

