

SAFETY EVALUATION REPORT  
BY THE  
OFFICE OF NUCLEAR REACTOR REGULATION  
U.S. NUCLEAR REGULATORY COMMISSION  
REGARDING THE POTENTIAL FOR  
STEAM GENERATOR WATER HAMMER AT  
ST. LUCIE PLANT, UNIT NO. 1  
DOCKET NO. 50-335

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## 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. At 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 means employed at the St. Lucie Plant to reduce the potential for steam generator water hammer include feedrings that discharge water from the top of the rings rather than the bottom and a favorably short length of horizontal feedwater piping at the entrance to each steam generator.

## 2.0 EVALUATION

Our consultant, EG&G Idaho Inc., prepared the enclosed evaluation of steam generator water hammer at the St. Lucie Plant as part of our technical assistance program (Enclosure No. 2). We have reviewed this report together with the licensee's submittals listed under item 4.0.

Our consultant concluded that the means to reduce the potential for water hammer at the St. Lucie Plant, Unit 1, are effective in maintaining sufficiently full feedrings and feedwater piping until feeding recovery occurs, provided Auxiliary Feedwater Flow (AFF) is initiated promptly. On this basis, our consultant recommended the installation of an automatic auxiliary feedwater flow initiation system and recommended that the manual capability to initiate auxiliary feedwater flow be retained.



We have considered manual operation of the auxiliary feedwater system, and we have found this mode of operation to be acceptable with regard to steam generator water hammer. We have found that the 10 minutes allowed for operator action is sufficiently limiting to prevent conditions conducive to water hammer and that it is reasonable to expect the operator to perform the required action within this time. We have also considered the possibility that the operator may fail to perform this function. In this case, the feedring might drain to the extent that conditions conducive to water hammer may exist in the feedring and piping. However, the tests performed at St. Lucie demonstrate a low susceptibility to steam generator water hammer and our consultant states in his report that:

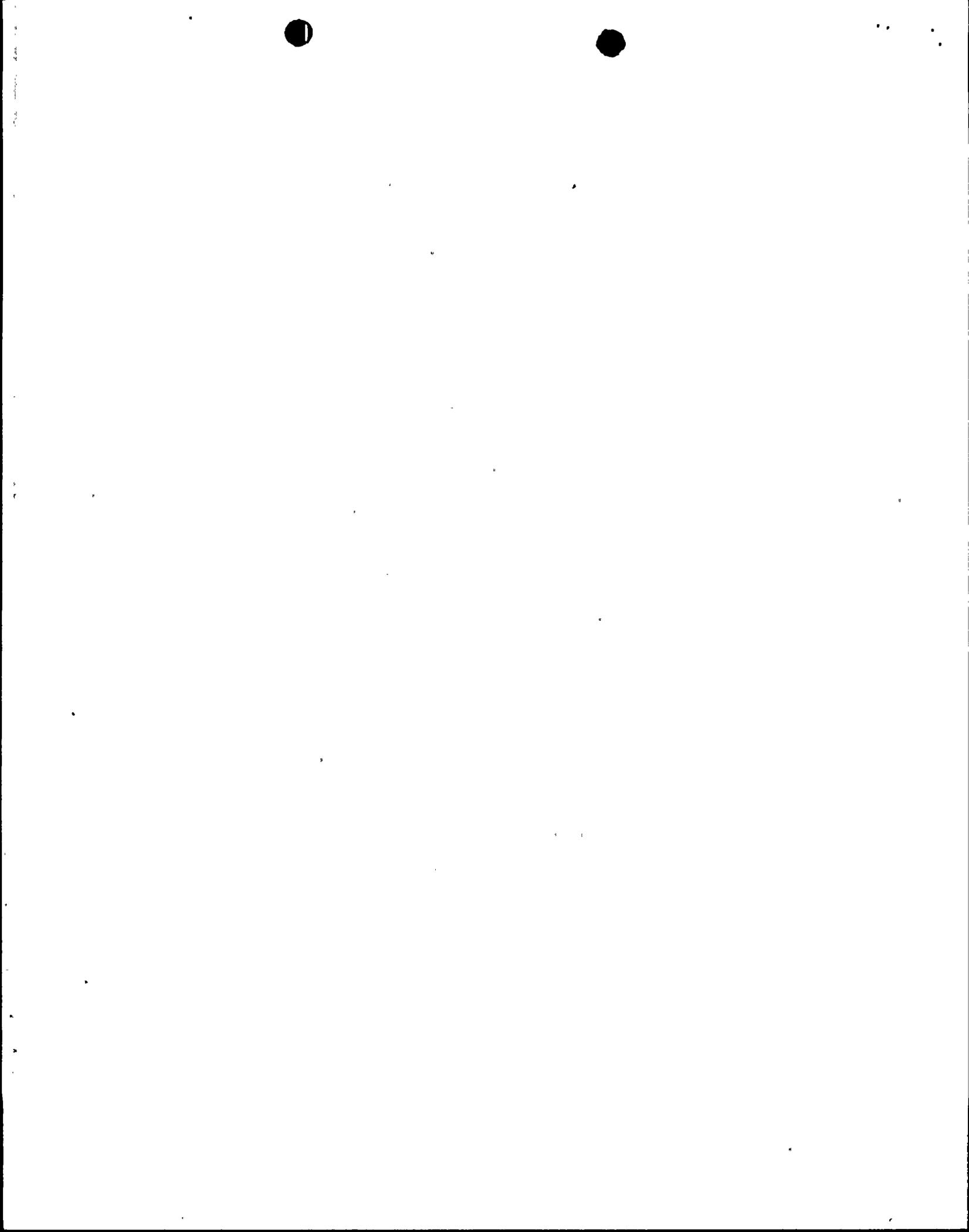
"Although a broader spectrum of steam generator pressures and flow rates would be necessary before this testing could be considered conclusive with respect to all possible conditions, the tests indicate that steam generator water hammer is not likely to occur even when the feedring is inadvertently drained."

We have also considered that the St. Lucie feedwater system contains no horizontal piping between the steam generator nozzle and the downward turning elbow. This results in a distance of approximately four feet from the outside of the steam generator to the centerline of the adjacent vertical pipe. Studies by Westinghouse as reflected in the bulletin NSD-TB-75-7 indicate that if this distance is limited to 8 feet or less, such limitation will ensure that the energy of a slug of water (if a slug were to form) would be well below those values that could cause pipe damage.

Based on the above considerations, we have concluded that with regard to steam generator water hammer at the St. Lucie Plant, automatic initiation of auxiliary feedwater is not necessary. However, the licensee is considering the installation of equipment that would automatically initiate the flow of auxiliary feedwater. We have found that automatic initiation of auxiliary feedwater would not adversely affect the operation of the St. Lucie Plant with regard to steam generator water hammer and may, under certain conditions, reduce the likelihood of water hammer.

### 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 have concluded that the means for reducing the potential for steam generator water hammer at this facility are adequate. However, even though steam generator 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 review St. Lucie, Unit No. 1 reports for indications of possible water hammer. If such indications appear, this matter will be reexamined and we may impose additional requirements to reduce the probability of steam generator water hammer.

We have concluded that steam generator water hammer is not likely to occur at this facility and, therefore, we find no undue risk to the health and safety of the public as a result of the continued operation of the St. Lucie Plant, Unit No. 1.

#### 4.0 REFERENCES

- 4.1 R. E. Uhrig letter to D. L. Ziemann, NRC, Subject - "Licensee Response to NRC Test Requirements Concerning the Proposed St. Lucie Unit 1 Feedwater Hammer Test," L-77-27, January 21, 1977.
- 4.2 R. E. Uhrig letter to D. L. Ziemann, NRC, Subject - "Transmittal of St. Lucie Unit 1 Feedwater Hammer Test Results," L-77-59, February 25, 1977.
- 4.3 R. E. Uhrig letter to D. K. Davis, NRC, Subject - "Licensee Response to NRC Request for Information Concerning Design and/or Procedural Modifications Required to Preclude Water Hammer in the St. Lucie Steam Generator Feedwater System," L-78-5, January 3, 1978.
- 4.4 D. G. Eisenhut, letter to R. E. Uhrig, FPL, Subject - "NRC Requirements of Auxiliary Feedwater Systems at St. Lucie Unit 1", October 17, 1979.
- 4.5 J. A. Block, et al, An Evaluation of PWR Steam Generator Water Hammer, Creare, Inc. NUREG-0291 (December 1976).
- 4.6 W. E. Bennett, Waterhammer in Steam Generator Feedwater Lines, Westinghouse Technical Bulletin, NSD-TB-75-7 (June 10, 1975).



Idaho, Inc.

Enclosure No. 2

P. O. Box 1625  
Idaho Falls, Idaho 83401

January 9, 1980

Mr. R. E. Tiller, Director  
Reactor Operations and Programs Division  
Idaho Operations Office - DOE  
Idaho Falls, ID 83401

ST. LUCIE POWER STATION UNIT NO. 1 STEAM GENERATOR WATER HAMMER  
TECHNICAL EVALUATION (A6257) - JAD-4-80

Ref: J. A. Dearien Ltr to R. E. Tiller, JAD-225-79, PWR  
Steam Generator Water Hammer Reviews, November 8, 1979

Dear Mr. Tiller:

The attachment completes the assessment of the effectiveness of the existing means to reduce the potential for steam generator water hammer at the St. Lucie Power Station Unit No. 1.

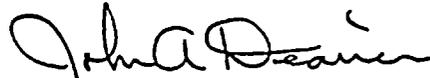
The assessment has shown that under conditions which are most conducive to water hammer in the feedwater systems (specifically, uncovered and draining feedrings and feedwater piping subjected to admission of cold auxiliary feedwater), the means to reduce the potential for water hammer at the St. Lucie Power Station are effective, provided AFW is initiated promptly.

On the basis of this evaluation, we recommend the installation of an automatic auxiliary feedwater flow initiation system. The manual capability to initiate the auxiliary feedwater system should be retained.

R. E. Tiller  
January 9, 1980  
JAD-4-80  
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This transmittal constitutes completion of the St. Lucie Power Station SER, Task A6257 of the Milestone Chart in the referenced letter.

Very truly yours,



J. A. Dearien, Manager  
Code Assessment and  
Applications Program

BLH:tn

Attachment:  
As stated

cc: ✓ S. D. MacKay, NRC-DOR  
R. W. Kiehn, EG&G Idaho w/o attach