

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

STEAM GENERATOR WATER HAMMER

H.B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

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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 H.B. Robinson plant has not experienced a steam generator water hammer in its nine years of operation. The feedwater system has been subjected to conditions that are conducive to water hammer but none has occurred. This successful operation of the feedwater system is attributable to the piping arrangement adjacent to the steam generator. A downward turning elbow is connected directly to the steam generator nozzle. This arrangement minimizes the length of the piping in which a slug of water might form and also minimizes the volume of steam that might be trapped in the piping. These effects reduce the probability of slug formation and would limit the energy of a water hammer if one were to occur.

## 2.0 EVALUATION

Our consultant, Reece Engineering Associates, prepared the attached evaluation of steam generator water hammer at the H.B. Robinson Plant. ("Steam Generator Water Hammer Evaluation H.B. Robinson Steam Electric Plant, Unit No. 2" March 13, 1980.) We have reviewed this report together with the licensees submittals listed under item 4.0.

Our consultant concluded that the H.B. Robinson facility has been subjected to those conditions most likely to cause steam generator water hammer; but because a water hammer has not occurred during such conditions, none is expected in the future. However, it was pointed out that if auxiliary feedwater flow is not administratively controlled following a main steam line break, then the flow rate might exceed the 400 gallons per minute per steam generator that has been experienced during operational transients. Therefore, our consultant recommended that the licensee be informed of this possibility so that the plant operational procedures can be surveyed for any needed adjustment. Our consultant also recommended that the licensee and the NRC continue to monitor pipe hanger, snubber and feedwater line related equipment reports for evidence of any damage from water hammer at Robinson.

We agree with our consultant's conclusion and we will implement his recommendations. We have discussed the control of auxiliary feedwater flow following a steam line break with the licensee and the procedures for this event should reflect the need to prevent the excessive flow of auxiliary feedwater. With regard to monitoring for water hammer events, the licensee indicated in reference 4.5 that although dedicated instrumentation would not be employed to detect steam generator water hammer, such an event that requires a plant shutdown would be reported within 24 hours of its occurrence. We will continue to monitor the licensee's reports of other occurrences that might be related to steam generator water hammer.

### 3.0 CONCLUSION

Based on our knowledge of water hammer phenomena, and our review of the licensee's responses and the attached evaluation report, we concur with our consultants' conclusion that the potential for steam generator water hammer is sufficiently low to permit continued operation of this facility. The licensee should limit auxiliary feedwater flow to 400 gpm and 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 this facility.

We conclude that if auxiliary feedwater flow is limited to 400 gpm, 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 H. B. Robinson Steam Electric Plant, Unit No. 2.

#### 4.0 REFERENCES

- 4.1 Block, J.B., et al, An Evaluation of PWR Steam Generator Water Hammer, Creare, Inc. NUREG-0291 (December 1976).
- 4.2 Bennet, W.E., Waterhammer in Steam Generator Feedwater Lines, Westinghouse Technical Bulletin, NSD-TB-75-7 June 10, 1975.
- 4.3 Utley, E.E., (CP&L) letter to George Lear, NRC/DOR, "Response to NRC Request for Analysis to Determine Potential Occurrence of Secondary System Fluid Flow Instability", July 23, 1975. (Response to NRC letter request of May 15, 1975.)
- 4.4 Utley, E.E., (CP&L) letter to Robert W. Reid, NRC/DOR, "Response to Steam Generator Water Hammer Request," January 2, 1978. (Response to NRC letter request of September 2, 1977.)
- 4.5 Utley, E.E., (CP&L) letter to Albert Schwencer, NRC/DOR "Response to Request for Information - Steam Generator Water Hammer", November 16, 1979. (Response to NRC letter request of September 18, 1979.)