SAFETY EVALUATION REPORT
STEAM GENERATOR WATER HAMMER
KEWAUNEE
POINT BEACH UNITS 1 AND 2
PRAIRIE ISLAND UNITS 1 AND 2

SEPTEMBER
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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. A total loss of feedwater could affect the ability of the plant to cool down after a reactor shutdown; therefore, 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 five operating power units considered in this safety evaluation include Kewaunee, Point Beach Units 1 and 2, and Prairie Island Units 1 and 2. These five units have a particular arrangement of main feedwater piping that apparently is not susceptible to steam generator water hammer. Although they have been subjected to system transients that affect the thermal and hydraulic conditions in the feedwater lines and feedwater rings, these units have experienced no steam generator water hammer.

2.0 EVALUATION

Our consultant, EG&G, Idaho, Inc. prepared evaluations of steam generator water hammer at Kewaunee, Point Beach 1 and 2 and Prairie Island 1 and 2 as part of our technical assistance program. Three individual evaluations (references 4.4.1, 4.4.2 and 4.4.3) were prepared separately for each of the three power stations and the conclusion was reached in each case that the means to reduce the potential for water hammer were inadequate to maintain sufficiently full feedrings and feedwater piping until feedring recovery occurs. However, these systems have been subjected to the conditions conducive to water hammer and no water hammer has occurred. Therefore, the potential for steam generator water hammer at these three power stations was reevaluated (reference 4.4.4) based on their record of successful operation and the particular arrangement of auxiliary feedwater piping in relation to main feedwater piping that is common to all three power stations. The results of that integrated

reevaluation showed that since these nuclear power units had been subjected to those conditions conducive to water hammer that might be expected during normal operation, transient or accident conditions and no water hammer had occurred, water hammer is not likely to occur at these units in the future.

Our consultant concluded that steam generator water hammer is not likely to occur in these 5 units during normal or transient operating conditions and recommended that installation of top discharge feedrings in the steam generators to avoid steam generator water hammer is not necessary for continued safe operation of Point Beach Units 1 and 2, Prairie Island Units 1 and 2 and Kewaunee. Also, our consultant concluded from his integrated reevaluation that, in view of past operating experience, the test program recommended in the initial individual evaluations is not necessary. We have reviewed the licensees' submittals and our consultant's reports listed under Section 4 of this evaluation. We concur with our consultant's final conclusions and recommendations.

However, even though steam generator water hammer is not likely to occur in these units, these licensees should be vigilant and monitor for water hammers that might impose significant stresses on the piping systems or their supports. We previously requested in our letter of September 2, 1977, that licensees for operating pressurized water reactors report all damaging water hammer events occurring in safety related systems or occurring in other systems that affect safety related systems. A damaging water hammer was defined therein as an event that resulted in damage to pipe supports or pipe insulation; pipe displacement; or failure of pipes or components.

We will continue to monitor licensee event reports as well as water hammer reports from these licensees 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.

3.0 CONCLUSION

Based on our knowledge of water hammer phenomena and our review of the referenced technical evaluation reports by our consultant, the licensee's responses listed in Section 4 and the particular piping geometry and operating history of these five nuclear power units, we have concluded that steam generator water hammer is not likely to occur at these units during normal operation or as a result of transient or accident conditions. We, therefore, find that modifications to prevent steam generator water hammer are not necessary for the continued safe operation of the Kewaunee, Point Beach Units 1 and 2 and Prairie Island Units 1 and 2 nuclear power stations.

4.0 REFERENCES

4.1 Kewaunee

4.1.1 E. W. James, Wisconsin Public Service Corporation (WPSC), letter to R. A. Purple, NRC, Subject - "Response to May 13, 1975 NRC letter on Steam Generator Water Hammer", August 1, 1975.

4.1.2 E. W. James, WPSC, letter to R. A. Purple, NRC, Subject - "Transmittal of report entitled, 'Water Hammer Analysis for Feedwater and Steam Generator Systems'", dated March 10, 1976.

4.1.3 E. W. James, WPSC, letter to A. Schwencer, NRC, Subject - "Response to September 2, 1977 NRC letter on Steam Generator Water Hammer", February 3, 1978.

4.2 Point Beach Units 1 and 2

4.2.1 S. Burstein letter to G. Lear, Subject - "Response to May 15, 1975 NRC letter on Steam Generator Water Hammer," June 19, 1975.

4.2.2 S. Burstein letter to G. Lear, Subject - "Response to September 2, 1977 NRC letter on Steam Generator Water Hammer," November 1, 1977.

4.3 Prairie Island Units 1 and 2

4.3.1 L. O. Mayer, Northern States Power Company (NSPC), letter to D. Ziemann, NRC, Subject - "Response to May 12, 1975 NRC letter on Steam Generator Water Hammer", September 2, 1975.

4.3.2 L. O. Mayer, NSPC Letter to V. Stello, NRC, Subject - "Transmittal of report entitled "Analysis of PWR Secondary System Fluid Flow Instability'", January 29, 1976.

4.3.3 L. O. Mayer, NSPC, letter to Director of Nuclear Reactor Regulation, NRC, Subject - "Response to September 2, 1977 NRC letter on Steam Generator Water Hammer", December 30, 1977.

4.3.4 W. E. Bennett, Waterhammer in Steam Generator Feedwater Lines, Westinghouse Technical Bulletin, NSD-TB-75-7, June 10, 1975.

4.4 Consultant; EG&G, Idaho, Inc.

4.4.1 J. A. Dearien letter to R. E. Tiller, JAD-128-79, Point Beach Units 1 and 2 Steam Generator Water Hammer Technical Evaluation (A6257), June 12, 1979.

4.4.2 J. A. Dearien letter to R. E. Tiller, JAD-129-79, Kewaunee Power Station Steam Generator Water Hammer Technical Evaluation (A6257), June 12, 1979.

4.4.3 J. A. Dearien letter to R. E. Tiller, JAD-135-79, Prairie Island Power Station Steam Generator Water Hammer Technical Evaluation (A6257), June 27, 1979.

4.4.4 J. A. Dearien letter to R. E. Tiller, JAD-162-79 Reevaluation of Steam Generator Water Hammer for Point Beach Units 1 and 2 Prairie Island Units 1 and 2, and Kewaunee, August 6, 1979.