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INDIANA
MICHIGAN
POWER

August 22, 2000

C0800-04
10 CFR 50 Appendix A

Docket Nos.: 50-315
50-316

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop O-P1-17
Washington, DC 20555-0001

Donald C. Cook Nuclear Plant Units 1 and 2
REQUEST TO APPLY LEAK BEFORE BREAK (LBB)
METHODOLOGY TO THE PRESSURIZER SURGE LINE

Reference:

1. Letter, Allen G. Hansen, Nuclear Regulatory Commission, to C. A. Schrock, Wisconsin Public Service Corporation, "Kewaunee Nuclear Power Plant: Leak Before Break Evaluation of Pressurizer Surge Line (TAC NO. M72140)," dated January 3, 1992.

Pursuant to the provision of General Design Criteria (GDC) 4 of 10 CFR Part 50, Appendix A, Indiana Michigan Power Company (I&M) requests Nuclear Regulatory Commission (NRC) approval to apply LBB methodology to the pressurizer surge lines of the two units at Donald C. Cook Nuclear Plant (CNP). GDC 4 provides for the exclusion of the dynamic effects due to postulated pipe ruptures from the design basis, provided the NRC reviews and approves analyses demonstrating that the probability of fluid system piping rupture is extremely low under conditions consistent with the piping design basis. A similar request has been granted to Wisconsin Public Service Corporation (Reference 1).

I&M is requesting this approval because the requirement to design against the dynamic effects of a rupture of the pressurizer surge line is expected to require modifications to the originally installed Unit 1 pipe restraints. Recently, for the restart of Unit 2, modifications to the Unit 2 pressurizer surge line were needed and required approximately 6600 person-hours and resulted in a total accumulated radiation exposure of 21 rem as measured by the plant radiation

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exposure monitoring system. By adopting LBB methodology, personnel radiation exposure, as well as the resource expenditure to engineer and execute the modification, can be avoided for Unit 1.

This submittal consists of documentation of the details of the analyses that have been performed by I&M and additional information requested by the NRC. An overall summary of the problem and its solution is also included with this letter. Accordingly, in Attachment 1, I&M summarizes the technical basis of our application by presenting an overall summary of the work performed.

Attachment 2 to this letter contains Westinghouse Electric Company (Westinghouse) report WCAP-15434, Revision 1 "Technical Justification for Eliminating Pressurizer Surge Line Rupture as the Structural Design Basis For D. C. Cook Units 1 and 2 Nuclear Power Plants (Proprietary)," dated August 2000.

Attachment 3 to this letter contains Westinghouse report WCAP-15435, Revision 1, "Technical Justification for Eliminating Pressurizer Surge Line Rupture as the Structural Design Basis For D. C. Cook Units 1 and 2 Nuclear Power Plants (non-proprietary)," dated August 2000.

In response to an NRC request, Attachment 4 contains Westinghouse-supplied information for loads at the three highest stress locations including torsion, Safe Shutdown Earthquake acceleration level, and the pressure and temperatures used in the LBB analysis.

As the Attachment 2 report contains information proprietary to Westinghouse, it is supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the NRC and addresses with specificity the consideration listed in Paragraph (b)(4) of Section 2.790 of the NRC's regulations.

Correspondence with respect to the copyright or proprietary aspects of the items listed above or the supporting Westinghouse affidavit should reference CAW-00-1411 and should be addressed to Mr. H. A. Sepp, Westinghouse Manager of Regulatory and Licensing Engineering.

Attachment 5 to this letter contains the Westinghouse application letter for withholding proprietary information, accompanying affidavit, proprietary information notice, and a copyright notice for the Attachment 2 report.

As approval of the above evaluations has significant benefits to I&M in the design and operation of CNP, approval of the request by December 1, 2000, is requested to support the restart of Unit 1.

As a result of discussions during our August 15, 2000, meeting, I&M will provide the results of the LBB analyses of the three highest pressurizer surge line stress locations including torsion by September 5, 2000.

Should you have any questions, please contact Mr. Wayne J. Kropp, Director of Regulatory Affairs, at (616) 697-5056.

Sincerely,

Wayne J. Kropp

for M. W. Rencheck
Vice President Nuclear Engineering

/jen

Attachments

c: J. E. Dyer
MDEQ - DW & RPD, w/o attachments
NRC Resident Inspector
R. Whale, w/o attachments

ATTACHMENT 1 TO C0800-04

OVERVIEW OF LEAK BEFORE BREAK (LBB) EVALUATION

This attachment presents a summary evaluation of the work performed to evaluate the applicability of the LBB technology to the pressurizer surge lines at the two units at Donald C. Cook Nuclear Plant (CNP). This summary provides introductory information, evaluation methods, and evaluation findings.

References:

1. Nuclear Regulatory Commission, 10 CFR 50, Modification of General Design Criteria 4 Requirements for Protection Against Dynamic Effects of Postulated Pipe Ruptures, Final Rule, Federal Register/Vol. 52, No. 207/Tuesday, October 27, 1987/Rules and Regulations, pp. 41288-41295.

2. NUREG-1061, Volume 3, "Report of the U. S. Nuclear Regulatory Commission Piping Review Committee, Evaluation of Potential for Pipe Breaks," November 1984 (NUREG-1061).

3. Standard Review Plan: Public Comments Solicited; 3.6.3, "Leak Before Break Evaluation Procedures," Federal Register/Vol. 52, No. 167/August 28, 1987/Notices.

4. NRC Bulletin No. 88-11: "Pressurizer Surge Line Thermal Stratification," December 20, 1988.

5. WCAP-12850, "Structural Evaluation of Donald C. Cook Nuclear Plant Units 1 and 2 Pressurizer Surge Lines, Considering the Effects of Thermal Stratification," January 1991.

6. WCAP-12850, Supplement 1, "Structural Evaluation of Donald C. Cook Nuclear Plant Units 1 and 2 Pressurizer Surge Lines, Considering the Effects of Thermal Stratification," February 1993.

7. Letter from William O. Long (NRC) to E. E. Fitzpatrick (AEP), "Pressurizer Surge Line Thermal Stratification, NRC Bulletin 88-11, Donald C. Cook Nuclear Plant, Units 1 and 2 (TAC Nos. 72125 and 72126)," dated October 28, 1991.

8. Updated Final Safety Analysis Report, Tables 4.1-3, 4.1-4 and 4.1-7, Revision 16.1.

9. Nuclear Regulatory Commission Docket Nos. 50-315 and 50-316 Letter from Steven A. Varga, Chief Operating Reactor Branch #1, Division of Licensing, to Mr. John Dolan, Vice President, Indiana and Michigan Electric Company, dated November 22, 1985.

INTRODUCTION

This attachment provides an overview of the LBB technology and associated information required for an understanding of the evaluations performed. The items discussed are:

1. Understanding of the LBB Methodology
2. Regulatory Basis
3. Evaluation Approach
4. Characteristics of the Pressurizer Surge Lines
5. Material Characterization
6. Leak Detection System at CNP

Understanding of the Leak Before Break Methodology

In a nuclear power plant, all relevant structures, systems, and components important to safety require protection from accidents, including pipe breaks. A pipe break creates dynamic forces due to fluid discharge and pipe whip as a reaction to the jet created at the break location. The magnitude of the dynamic forces generated by a pipe break depends on the size of the break. One method to determine the size of the break is to assume an instantaneous formation of an arbitrary break and separation across the pipe diameter. This deterministic postulation is non-mechanistic and provides the severest condition requiring a complex protection system to counteract the dynamic forces created by the pipe break.

In reality, a pipe break occurs through the formation of a tiny crack in the line that, if unstable, develops into a full size crack over time. A second method for estimating the crack size makes use of this fact to examine the potential and the duration of the crack formation. Through this analysis, it is possible to predict whether a crack will form and, in the event of its formation, whether sufficient warning will be available to safely shut down the plant. This is a complex analysis requiring reliable engineering data of the pipe material, its configuration and plant operating experience. However, a successful implementation of this methodology reduces the complexity of systems required to protect the plant against pipe breaks. The application of this methodology, referred to as LBB methodology, reduces radiation exposure and maintenance costs while maintaining plant safety.

Regulatory Basis

The application of the LBB methodology for nuclear power plant piping is provided for in modified GDC 4 of Appendix A of 10 CFR Part 50 (Reference 1). Guidance for the application of this methodology is provided in NUREG-1061, Volume 3 (Reference 2) and in the proposed Standard Review Plan 3.6.3 (Reference 3).

Evaluation Approach

The evaluation demonstrates that the probability of the fluid system pipe rupture is extremely low under conditions consistent with the design basis of the piping. The approach to the evaluation consists of demonstrating that:

1. Water hammer, stress corrosion cracking, and fatigue are remote causes of pipe rupture.

2. Sufficient margins exist in engineering analyses to show that a circumferential break is extremely unlikely to occur in the line under consideration.

3. Under normal operating conditions, the plant leak detection system is capable of reliably detecting leakage from the line in time to allow for a safe plant shutdown.

Characteristics of the Pressurizer Surge Lines

The pressurizer surge line is sized to limit the pressure drop between the reactor vessel and the loops and the pressurizer. At CNP, during certain modes of plant heatup and cooldown, a large temperature differential (as much as 320°F) between the pressurizer and the hot leg can occur. These temperature differentials, coupled with a low flow rate in the pressurizer surge line, can cause the pipe to expand and contract. In response to NRC Bulletin 88-11 (Reference 4), effects of this phenomenon, referred to as thermal stratification, were examined for CNP in 1991. The results of the effects of the thermal stratification are documented in WCAP-12850 (Reference 5) and WCAP-12850, Supplement 1 (Reference 6). The NRC issued a 1991 letter (Reference 7) closing the issues related to Bulletin 88-11 for CNP Units 1 and 2.

Selected design data of pressure and temperatures for the reactor coolant system are provided in Table 1 below.

Table 1 Selected Design Data[1]	
Reactor Vessel: Design Pressure, psig Operating Pressure, psig Design Temperature, ° F	 2485 2085 (Unit 1)/ 2235 (Unit 2) 650
Pressurizer: Design Pressure, psig Design Temperature, °F Operating Pressure, psig Operating Temperature, °F Pressurizer Surge Line piping ID, in.	 2485 680 2085 (Unit 1)/ 2235 (Unit 2) 643 (Unit 1)/653 (Unit 2) 11.188
Reactor Coolant Piping Design Pressure, psig Operating Pressure, psig Design Temperature, ° F	 2485 2085 (Unit 1)/ 2235 (Unit 2) 650

(1) Reference 8.

Material Characterization

Pipe Material - At CNP, both pressurizer surge lines are 14 inch ASTM A376, Type 316, Schedule 160 stainless steel installed with a downward slope from the pressurizer to the hot leg. For the LBB analysis, room temperature material properties were obtained from CNP Certified Material Test Reports.

The pressurizer surge lines do not contain any cast pipe or fittings.

Welding Process - The welding processes used were Gas Tungsten Arc Weld and Shielded Metal Arc Weld.

Leak Detection System at Cook

A reliable leak detection system is required for the application of this methodology. This reliability is necessary to monitor initiation of a leak in the reactor coolant pressure boundary so that appropriate actions can be taken to place the plant in a safe condition. At CNP, the Technical Specifications for both units require that the reactor coolant leakage detection system be operable in Modes 1 through 4. The CNP reactor coolant leakage detection systems provide the capability to detect a 1 gpm leak in four hours. This criterion is stated in Generic Letter 84-04 (Reference 9) and NUREG-1061, Vol. 3, Section 5.7 (b) (Reference 2) as being acceptable for applying LBB methodology. In addition, the CNP reactor coolant leakage detection systems are consistent with the intent of the regulatory positions in Regulatory Guide 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems," in that they provide the means for detecting, and to the extent practical, identifying the location of the source of reactor coolant leakage, and at least one method is capable of detecting 1 gpm leak in 1 hour.

EVALUATION APPROACH

For application of the LBB methodology, Westinghouse performed a review of PWR operating history to validate that the possibility of crack development due to erosion, corrosion, water hammer, and creep is remote. Low cycle and high cycle fatigue are also not concerns. This validation has been provided through review of the operating history of the plant, including, but not limited to, vendor operating history, surge line design basis, water quality control, and the Updated Final Safety Analysis Report.

A review of the materials and their properties was also performed. A summary of this information is presented in WCAP-15434, Revision 1 (Attachment 2).

The final step in the evaluation is the determination of the margins against leakage and unstable flaw propagation. This evaluation is initiated through the calculation of applied loads. For the leak rate evaluation, a total of three load cases, with and without stratification, were considered. For flaw stability evaluation, four load cases including safe shutdown earthquake and stratification were considered. The piping system was then analyzed using these load cases to determine the limiting location. The leakage and the critical flaw sizes at this limiting location were calculated to determine the margin.

The highlights of this evaluation may be summarized as follows:

1. The forces and moments associated with normal operation (e.g., pressure, dead weight, and thermal expansion), thermal stratification effects, and safe shutdown earthquake (SSE) have been considered in the piping analyses.

2. A through-wall flaw under normal operating cases has been postulated at the highest stressed location based on the predicted stress levels and the weld procedures used in fabricating the pressurizer surge lines. The predicted flaw size is large enough to assure detection with at least a margin of 10 over the plant leak detection capability under normal operating conditions.

3. Using the fracture mechanics analytical model, flaw stability evaluations were performed to determine critical flaw sizes under faulted operating cases. The ratio of critical flaw sizes to leakage flaw sizes for various load analysis combination cases meets the required margin of 2.

4. A review of CNP operating experience has been performed to evaluate whether the pipe will experience stress corrosion cracking, fatigue, or water hammer. The review includes system operational procedures, system modification history, water chemistry parameters, limits and controls, resistance of piping material to various forms of stress corrosion, and performance of the pipe under cyclic loading.

5. The pipe material data have been examined for materials and material specification, thermal aging, and its potential for brittle cleavage-type failure over the range of the operating temperatures. Certified Material Test Reports have been used as input to the analyses performed.

EVALUATION FINDINGS

The results of this evaluation indicate that a factor of ten exists for leak detection and a factor of two exists between the leakage flaw and the critical flaw sizes for the CNP units. The faulted loads are combined by absolute summation method and therefore, the recommended margin on loads is satisfied. All other conditions relative to the operating history are also satisfied. The results of the evaluation are summarized below:

1. The results of analyses using the normal (pressure, deadweight, and thermal expansion with and without stratification effects) and faulted loads, with and without stratification effects, and SSE indicate that the highest stress location is at the weld location of the pipe to the hot leg nozzle. The next two highest stress locations are at the two welds sequential to this location.

2. The leakage flaw sizes are calculated for 10 gpm and therefore the margin of 10 on leak rate is satisfied. The faulted loads have been summed absolutely, a margin exceeding one exists for the load conditions. The minimum margin between the leakage size flaw and the critical flaw is two.

3. The CNP operating history indicates that there is reasonable assurance that the pipe will not be affected by water hammer, stress corrosion cracking, and fatigue.

It is, therefore, concluded that the LBB methodology is applicable to the CNP pressurizer surge lines.

ATTACHMENT 3 TO C0800-04

WCAP-15435, REVISION 1

"TECHNICAL JUSTIFICATION FOR ELIMINATING PRESSURIZER SURGE LINE RUPTURE AS THE STRUCTURAL DESIGN BASIS FOR D. C. COOK UNITS 1 AND 2 NUCLEAR POWER PLANTS (NON-PROPRIETARY)"