

October 26, 2000

Mr. Mike Reandeau
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SUBJECT: CLINTON POWER STATION, UNIT 1 - REVISED RESPONSE TO GENERIC
LETTER 94-03 (TAC NO. MA9549)

Dear Mr. Reandeau:

By letter dated July 17, 2000, you informed the staff of a revision to your previous commitment to inspect the Clinton core shroud during the seventh refueling outage (RF-7), instead deferring the inspection until the eighth refueling outage (RF-8). The original commitment to inspect during RF-7 was made in response to Generic Letter (GL) 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors," dated July 25, 1994, which requested Boiling Water Reactor (BWR) licensees to inspect their core shrouds by the next outage and to justify continued safe operation until inspections can be completed.

While the requested change is inconsistent with the schedule specified in GL 94-03 and with the staff-approved schedule in the BWRVIP-01 report, "BWR Core Shroud Inspection and Flaw Evaluation Guidelines," the staff finds, with the maintenance of good reactor water chemistry, that the likelihood of significant cracking during this additional cycle of operation is negligible, and you may defer inspections of the core shroud for one operating cycle until refueling outage 8 (RF-8). Inspections of the circumferential and axial core shroud welds, in accordance with the latest staff approved guidance, shall be accomplished at that time. Our safety evaluation is enclosed.

Sincerely,

/RA/

Jon B. Hopkins, Senior Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-461

Enclosure: As stated

cc w/encl: See next page

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U.S. NUCLEAR REGULATORY COMMISSION
SAFETY EVALUATION OF CLINTON POWER STATION
REVISED RESPONSE TO GENERIC LETTER 94-03

1.0 INTRODUCTION

By letter dated July 17, 2000, AmerGen Energy Company, LLC, the licensee for the Clinton Power Station (Clinton), informed the Nuclear Regulatory Commission (NRC) staff of a revision to its previous commitment to inspect the Clinton core shroud during the seventh refueling outage (RF-7), instead deferring the inspection until the eighth refueling outage (RF-8). The original commitment to inspect during RF-7 was made in response to Generic Letter (GL) 94-03.

2.0 BACKGROUND

Significant circumferential cracking of the core shroud was first observed in the U.S. in September 1993. The NRC staff evaluated potential safety concerns associated with the possibility of a 360° circumferential separation of the shroud following a postulated loss-of-coolant accident (LOCA). The staff considered the potential for separation of the shroud during postulated accidents either to prevent full insertion of the control rods or to open a gap large enough to preclude the emergency core cooling system (ECCS) from fulfilling the intended safety functions. The staff concluded that core shroud cracking did not pose a high degree of risk for the short term and that immediate plant shutdowns were not warranted for inspections. However, the staff concluded that in the long term, appropriate inspections and repairs should be implemented.

On July 25, 1994, the NRC staff issued GL 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors," which requested that BWR licensees inspect their core shrouds by the next outage and provide an analysis justifying continued operation until such inspections could be completed. In response to GL 94-03, a special industry review group (Boiling Water Reactor Vessels and Internals Project - BWRVIP) was formed to focus on resolution of reactor vessel and internals age-related degradation, and was instrumental in facilitating licensee responses to GL 94-03.

The NRC evaluated the BWRVIP reports, submitted in 1994 and early 1995, addressing core shroud cracking issues, and all plant responses, including that from Clinton. All of the plants evaluated were able to demonstrate continued safe operation until inspection or repair on the basis of: (1) no 360° through-wall cracking observed to date; (2) low frequency of pipe breaks; and (3) short period of operation (2 to 6 months) before all of the highly susceptible plants complete repairs of, or inspections to, their core shrouds.

Further, some plants, including Clinton, were able to show, based on several factors described in the BWRVIP reports on this issue, and approved generically by the NRC staff, that the initial inspection of the core shroud could be safely deferred until after the plant had completed eight on-line years of operation.

3.0 STAFF EVALUATION

The licensee provided the General Electric (GE) Nuclear Energy report B13-02051-00, "Justification For The Deferral of The Clinton Shroud Inspection by One Cycle," dated June 2000, as its technical justification for the deferral of the core shroud inspection. The GE report describes the materials utilized in the core shroud, the reactor chemistry maintained during operation, an analysis of comparable industry data, and an analysis of the crack growth models based on Clinton-specific factors and accident conditions.

The Clinton shroud inspection deferral assessment provides (1) a basis for delaying the shroud inspection based on an evaluation of the plant-specific crack susceptibility, tolerance, and water chemistry; (2) a comparison of Clinton to the BWR/6 reference plant; and (3) a comparison of Clinton with Limerick Unit 2. The last two items provide recent instances and benchmarks of cracking in L-grade plants for comparison purposes.

3.1 Clinton Technical Justification Basis

3.1.1 Water Chemistry

The proposed inspection deferral is supported in part by the quality of reactor water chemistry. The licensee stated that the water chemistry at Clinton has been excellent, with average conductivity below 0.3 $\mu\text{S}/\text{cm}$ and chloride levels below 5 ppb, on average, for the first five years of operation.

The average reactor water conductivity in the BWR fleet in 1980, as shown in Figure 2-2 of the Electric Power Research Institute's (EPRI) BWR Water Chemistry Guidelines, 1996 Revision (BWRVIP-29), was over 0.4 $\mu\text{S}/\text{cm}$ and in 1998 it had improved to approximately 0.15 $\mu\text{S}/\text{cm}$.

The staff finds that consistent with deferring inspection of the core shroud for one cycle, Clinton should maintain its reactor water chemistry for the upcoming cycle at a conductivity level of 0.15 $\mu\text{S}/\text{cm}$ or less, equal to the BWR fleet average for 1998. Further, chloride levels should be maintained below 2.0 ppb during the upcoming operating cycle.

3.1.2 Crack Growth Rates

The licensee discussed crack growth dependence and the reduction in crack growth rates (CGR) with reduced conductivity. The NRC staff in its safety evaluation dated December 3, 1999, found that by using an appropriately reduced value for the CGR from the 5×10^{-5} in/hr value found in NUREG-0313, Rev. 2, "Technical Report on Material Selection and Process Guidelines for BWR Coolant Pressure Boundary Piping," dated January 1988, it would be possible for licensees to be given credit for improved water chemistry and other measures taken to mitigate cracking. The revised CGR of 2.2×10^{-5} in/hr in the staff's safety evaluation, dated December 3, 1999, corresponds to water chemistries with a conductivity of $\leq 0.15 \mu\text{S}/\text{cm}$.

and an electro-chemical potential (ECP) of -200 mV. This crack growth rate is only applicable to components with fluences $< 5 \times 10^{20}$ n/cm² (E > 1MeV) since the CGR database is presently based only on unirradiated materials.

The NRC staff finds that Clinton can use the reduced CGR of 2.2×10^{-5} in/hr, based on the licensee maintaining a conductivity of ≤ 0.15 μ S/cm and an ECP of ≤ -200 mV.

3.1.3 Allowable Crack Sizes

The third position stated in the basis for deferral was crack tolerance and allowable crack sizes. The licensee stated that allowable flaw size is largely dependent on seismic loading, and that Clinton is a low seismic load plant. However, the area of greatest concern, the mid-core region (weld locations H3 - H5), which is subjected to the highest fluences and has the smallest allowable crack sizes, also has an additional "closure weld" from the joining of the two parts of the core shroud. Unlike the other welds, this closure weld was not given a dimensional stabilization heat treatment, and is thus more susceptible to weld residual stresses.

The staff finds, with the improved water chemistries discussed above, that the likelihood of significant cracking during this additional cycle of operation is negligible, and that a one cycle deferment of core shroud inspection is justifiable.

3.2 Comparison of Clinton to BWR/6 Reference Plant

The licensee stated that the reference BWR/6 plant had higher water conductivity and chloride levels than Clinton did during the same operating period. Further, the reference BWR/6 plant did not find cracking in its core shroud H4 weld until after 11 effective full power years (EFPY), and that the fluence levels on the Clinton H4 weld will be less than that of the reference BWR/6. Finally, the licensee states that the reference BWR/6 has a much higher seismic loading than Clinton.

Based on this information, and that described in Section 3.1 of this Safety Evaluation (SE), above, the staff finds, with the improved water chemistries discussed above, that the likelihood of significant cracking during this additional cycle of operation is negligible.

3.3 Comparison of Clinton with Limerick Unit 2

Limerick Unit 2 is a BWR/4 with a Type 304L shroud, with similar operating time, but with better water chemistries than Clinton. However, the core shroud at Limerick Unit 2 was not given a dimensional stabilization heat treatment, and had moderate cracking on the H3 and H4 welds. Based on current staff-approved BWRVIP inspection criteria, and assuming conditions similar to Limerick Unit 2, Clinton would not need to inspect during the coming outage.

4.0 CONCLUSION

The staff finds that while the requested change is inconsistent with the schedule specified in GL 94-03 and with the staff-approved schedule contained in the BWRVIP-01 report, based on the water chemistries discussed above, the likelihood of significant cracking during this additional cycle of operation is negligible, and therefore, the licensee may defer inspections of the core shroud for one operating cycle until RF-8. Inspections of the circumferential and axial core shroud welds, in accordance with the latest staff approved guidance, shall be accomplished at that time.

Principal Contributor: C. Carpenter

Date: October 26, 2000