May 5, 2000

Mr. John H. Mueller
Chief Nuclear Officer
Niagara Mohawk Power Corporation
Nine Mile Point Nuclear Station
Operations Building, Second Floor
Lycoming, NY 13093

SUBJECT: NINE MILE POINT NUCLEAR STATION, UNIT NO. 1 -- EVALUATION OF FLAW INDICATIONS IN REACTOR PRESSURE VESSEL WELDS (TAC NO. MA6510)

Dear Mr. Mueller:

By letter dated September 14, 1999, as supplemented by letter dated April 13, 2000, Niagara Mohawk Power Corporation (NMPC) submitted for NRC staff's review the examination results of the reactor pressure vessel (RPV) welds, and the associated flaw evaluation for the detected flaws for Nine Mile Point Nuclear Station, Unit No. 1 (NMP1). The ultrasonic (UT) examination of these welds was conducted during NMP1's 1999 refueling outage (RFO15). The examination results revealed nine subsurface flaw indications: two in the longitudinal shell weld RV-WD-140, and seven in the shell-to-flange circumferential weld RV-WD-099. The worst flaw in the longitudinal weld is 2 inches below the RPV surface, 0.396 inch in depth, and 13.75 inches in length. The worst flaw in the circumferential weld is 3.5 inches below the RPV surface, 0.396 inch in depth, and 6.75 inches in length. These indications exceed the specifications of Subsection IWB-3500 of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for allowable planar flaws in RPV welds. Consequently, NMPC intended to demonstrate, through its analytical flaw evaluation, that NMP1 can be operated without repair of the RPV welds for 28 effective full-power years (EFPY).

The NRC staff has completed its review of your submittals, with details of its review delineated in the enclosed safety evaluation. The staff finds that the flaw evaluation meets the rules of the ASME Code. Since the predicted flaw depth at the end of the 28 EFPY is less than the allowable value based upon Subsection IWB-3600, the NRC staff concludes that NMPC has adequately demonstrated that NMP1 can be operated without repair of the RPV welds until the end of the 28 EFPY. However, successive inspections should be conducted according to Subsection IWB-2420 for the welds with indications.

This completes our effort for TAC No. MA6510. If you have questions regarding this matter, call me at (301) 415-1451 or email: pst@nrc.gov.

Sincerely,

/RA/

Peter S. Tam, Senior Project Manager, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-220

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REACTOR PRESSURE VESSEL WELDS INDICATION EVALUATION

NINE MILE POINT NUCLEAR STATION, UNIT NO. 1

NIAGARA MOHAWK POWER CORPORATION

DOCKET NO. 50-220

1.0 INTRODUCTION

By letter dated September 14, 1999, as supplemented by letter dated April 13, 2000, Niagara Mohawk Power Corporation (NMPC, or the licensee) submitted for NRC staff's review the examination results of the reactor pressure vessel (RPV) welds, and the associated flaw evaluation for the detected flaws at Nine Mile Point Nuclear Station, Unit No. 1 (NMP1). The ultrasonic (UT) examination of these welds was conducted during NMP1's 1999 refueling outage number 15 (RFO15). The examination results revealed nine subsurface flaw indications: two in the longitudinal shell weld RV-WD-140 and seven in the shell-to-flange circumferential weld RV-WD-099. The worst flaw in the longitudinal weld is 2 inches below the RPV surface, 0.396 inch in depth, and 13.75 inches in length. The worst flaw in the circumferential weld is 3.5 inches below the RPV surface, 0.396 inch in depth, and 6.75 inches in length. These indications exceed the specifications of Subsection IWB-3500 of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for allowable planar flaws in RPV welds. Consequently, NMPC intended to demonstrate, through its analytical flaw evaluation, that NMP1 can be operated without repair of the RPV welds for 28 effective full-power years (EFPY).

2.0 EVALUATION

2.1 Licensee's Flaw Evaluation

Instead of performing a plant-specific flaw evaluation, NMPC used a handbook by General Electric Nuclear Energy, GENE-B13-01805-124, Revision 0 (the GE report, submitted as part of Enclosure 2 of the September 14, 1999, submittal), to determine the acceptability of the detected flaws. This handbook provides a description of the methodology and evaluation charts (figures showing allowable flaw depths for various flaw configurations) for various welds in the NMP1 RPV based upon the criteria of Subsection IWB-3612. The associated pressure stresses were then added to a cladding stress of 18.15 ksi and a weld residual stress of 8 ksi

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to calculate the applied stress intensity factors (K) for the surface and subsurface flaws in each beltline weld. The applied K calculation is in accordance with Appendix A of Section XI of the ASME Code.

On the fracture resistance side, the crack arrest fracture toughness K_{Ia} for each beltline weld was obtained using the K_{Ia} curve of Appendix A of Section XI and the adjusted reference temperature (ART) for the weld corresponding to 28 EFPY. The ART is the sum of initial reference temperature (initial RT_{NDT}), the increase in reference temperature due to irradiation (ΔRT_{NDT}), and a proper margin (M). Initial RT_{NDT} is a material property and ΔRT_{NDT} is determined by copper and nickel contents, and fluence. The licensee calculated the ART based upon Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials." Equating the applied K to K_{Ia} divided by $\sqrt{10}$ or $\sqrt{2}$, depending upon whether the normal or the faulted condition is limiting, this report obtained the allowable flaw depth for various RPV welds. Fatigue crack growth using Figure A-4300-1 of the ASME Code has also been considered. Since all detected flaws, when plotted on the appropriate evaluation charts of the GE report, are within the bound of the limiting curve for 28 EFPY, NMPC concluded that all detected flaws meet the criteria of Subsection IWB-3600, and NMP1 can be operated without repair of the RPV welds until the end of the 28 EFPY.

2.2 NRC Staff's Evaluation

The NRC staff has reviewed NMPC's submittals and confirmed that NMPC's flaw evaluation methodology is in accordance with Subsection IWB-3600. The limiting transients for the normal and faulted conditions are consistent with those identified in previously approved GE reports of similar nature. The weld residual stress is consistent with that in the report by the Boiling Water Reactor Vessel and Internals Project, BWRVIP-05, " BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations." BWRVIP-05 is the latest report that covered extensive issues on RPV integrity, and was approved by the NRC staff in a letter dated July 28, 1998 (G. C. Lainas to C. Terry, Accession No. 9808040041). Nevertheless, the formulas for cladding stresses in the licensee's submittal are different from that in BWRVIP-05. The NRC staff made a comparison and found the licensee's formulas give more conservative cladding stresses (approximately 30% higher) and, thus, are acceptable. The subsequent applied K calculation is in accordance with Appendix A of Section XI of the ASME Code. However, the licensee conservatively simplified the Appendix A methodology by using the largest flaw eccentricity ratio (closest to the surface) in Figures A-3310-1 and A-3310-2 of the ASME Code, regardless of the flaw configuration, to develop the evaluation charts for the subsurface flaws. This is why the flaw proximity to the surface does not appear as a variable in the evaluation charts for subsurface flaws.

To determine K_{Ia} using the K_{Ia} curve of Appendix A of Section XI, one needs to first obtain the appropriate ART for the RPV material. The NRC staff examined the initial RT_{NDT}, copper and nickel contents, and the bounding fluence for the beltline welds and found they were consistent with the information in the Reactor Vessel Integrity Database maintained on the internet (http://www.nrc.gov/NRR/RVID/index.html). The licensee calculated the ART for the shell-to-flange circumferential weld to be 40 °F. Since the K_{Ia} of this weld with an ART of 40 °F is not defined in the ASME Code for the leak test temperature at 247 °F, conservatively using the cut-off value of 200 ksi$\sqrt{in}$ is appropriate. The NRC staff has performed the K_{Ia} and the applied K calculations for the two types of vessel weld with flaw indications (the longitudinal shell weld

RV-WD-140 and the shell-to-flange circumferential weld RV-WD-099), and has validated the allowable flaw depths in Figures D-3 and D-12 of the GE report. The NRC staff has also determined that NMPC applied the handbook charts adequately in evaluating all nine detected flaws.

On the basis of the above, the NRC staff determined that NMPC's flaw evaluation methodology is appropriate, and Figures D-3 and D-12 of the GE report can be used to perform flaw evaluations in this application.

3.0 CONCLUSION

On the basis of the above evaluation, the NRC staff finds that the methodology and criteria used in generating flaw evaluation charts for the NMP1 RPV (Figures D-3 and D-12) are in accordance with Section XI of the ASME Code. The NRC staff has confirmed that NMPC applied these charts adequately in its flaw evaluation, and agrees that all detected flaws are less than the allowable flaw depths at 28 EFPY. Hence, the NRC staff concludes that NMPC has demonstrated that NMP1 can be operated without repair of the RPV welds until the end of the 28 EFPY. Successive inspections should be conducted according to appropriate requirements of the ASME Code (i.e., Subsection IWB-2420) for the welds with indications.

Principal Contributor: Simon Sheng

Date: May 5, 2000

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