July 29, 2008

Mr. Keith J. Polson
Vice President Nine Mile Point
Nine Mile Point Nuclear Station, LLC
P.O. Box 63
Lycoming, NY 13093

SUBJECT: NINE MILE POINT NUCLEAR STATION, UNIT NO. 1 – ADDITIONAL ENGINEERING EVALUATIONS FOR TWO REACTOR PRESSURE VESSEL WELD FLAWS IN ACCORDANCE WITH AMENDED LICENSE RENEWAL APPLICATION COMMITMENT (TAC NO. MD6620)

Dear Mr. Polson:

By letter dated August 22, 2007, as supplemented by letter dated April 2, 2008, Nine Mile Point Nuclear Station, LLC (NMPNS) submitted for the Nuclear Regulatory Commission (NRC) staff review, a reevaluation of flaws that were detected in the reactor pressure vessel (RPV) welds through ultrasonic examination during the 1999 refueling outage (RFO-15) at Nine Mile Point, Unit No. 1 (NMP1). Continued operation with these flaws in the RPV welds without repair was approved by the NRC staff on May 5, 2000, for the current licensing period until the end of 28 effective full-power years (EFPYs) of operation. NMPNS's letter was submitted to fulfill a commitment that NMPNS made as part of NRC's approval of its license renewal application, which requires NMPNS to reevaluate the above mentioned RPV flaws for an additional 20 years and submit the reevaluation for NRC review and approval no later than 2 years prior to the period of extended operation.

The NRC staff finds that NMPNS's flaw reevaluation meets the rules of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). Since the actual flaw depth is less than the allowable flaw depth based upon Subsection IWB-3600 of Section XI of the ASME Code adjusted for crack growth to the end of the 46 EFPY, the NRC staff concludes that NMPNS adequately demonstrated that NMP1 can be operated without repair of the RPV welds until the end of the 46 EFPY.

The NRC staff's safety evaluation is enclosed. If you have any questions, please contact me at (301) 415-1030.

Sincerely,

/RA/

Richard V. Guzman, Senior Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-220

Enclosure:
As stated

cc w/encl: See next page

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NINE MILE POINT NUCLEAR STATION, UNIT NO. 1 – ADDITIONAL ENGINEERING EVALUATIONS FOR TWO REACTOR PRESSURE VESSEL WELD FLAWS IN ACCORDANCE WITH AMENDED LICENSE RENEWAL APPLICATION COMMITMENT (TAC NO. MD6620)

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cc: Plant Service list

Nine Mile Point Nuclear Station, Unit No. 1

cc:

Mr. Michael J. Wallace, Chairman and CEO
Constellation Energy Nuclear Group, LLC
750 East Pratt Street, 18th Floor
Baltimore, MD 21202

Mr. Michael J. Wallace, Vice-Chairman
Constellation Energy
100 Constellation Way, Suite 1800P
Baltimore, MD 21202

Mr. Henry B. Barron, President, CEO &
Chief Nuclear Officer
Constellation Energy Nuclear Group, LLC
100 Constellation Way, Suite 200C
Baltimore, MD 21202

Mr. Terry F. Syrell
Director, Licensing
Nine Mile Point Nuclear Station
P.O. Box 63
Lycoming, NY 13093

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Resident Inspector
U.S. Nuclear Regulatory Commission
P.O. Box 126
Lycoming, NY 13093

Supervisor
Town of Scriba
Route 8, Box 382
Oswego, NY 13126

Charles Donaldson, Esquire
Assistant Attorney General
New York Department of Law
120 Broadway
New York, NY 10271

Mr. Paul D. Eddy
New York State Department of
Public Service
3 Empire State Plaza, 10th Floor
Albany, NY 12223

Mark J. Wetterhahn, Esquire
Winston & Strawn
1700 K Street, NW
Washington, DC 20006

Carey W. Fleming, Esquire
Sr. Counsel - Nuclear Generation
Constellation Energy Nuclear Group, LLC
750 East Pratt Street, 17th Floor
Baltimore, MD 21202

Mr. John P. Spath
New York State Energy, Research, and
Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Mr. Paul Tonko
President and CEO
New York State Energy, Research, and
Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Mr. Gary L. Detter
Manager – Nuclear Safety and Security
100 Constellation Way, Suite 200C
Baltimore, MD 21202

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE EVALUATIONS FOR TWO REACTOR PRESSURE VESSEL

WELD FLAWS IN ACCORDANCE WITH

AMENDED LICENSE RENEWAL APPLICATION COMMITMENT

NINE MILE POINT NUCLEAR STATION, LLC

NINE MILE POINT NUCLEAR STATION, UNIT NO. 1

DOCKET NO. 50-220

1.0 INTRODUCTION

By letter dated August 22, 2007 (Agencywide Documents Access and Management Systems (ADAMS) Accession No. ML072410389), as supplemented by letter dated April 2, 2008 (ML081050034), Nine Mile Point Nuclear Station, LLC (NMPNS or the licensee) submitted for the Nuclear Regulatory Commission (NRC) staff review, a reevaluation of flaws that were detected in the reactor pressure vessel (RPV) welds through ultrasonic (UT) examination during the 1999 refueling outage (RFO15) at Nine Mile Point, Unit 1 (NMP1). Continued operation with these flaws in the RPV welds without repair was approved by the staff on May 5, 2000, for the NMP1 until the end of 28 effective full-power years (EFPY) of operation. The licensee's letter was submitted to fulfill a commitment that NMPNS made as part of NRC's approval of its license renewal application, which requires NMPNS to (1) reevaluate the above-mentioned RPV flaws for an additional 20 years and (2) submit for NRC review and approval no later than 2 years prior to the period of extended operation.

2.0 REGULATORY EVALUATION

The Inservice Inspection (ISI) of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Class 1, Class 2, and Class 3 components shall be performed in accordance with Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the ASME Code and applicable editions and addenda as required by Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(g), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i).

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in Section XI of the ASME Code to the extent practical within the limitations of design, geometry, and materials of construction of the components.

When flaws are detected by volumetric examinations, acceptance of them by supplemental examination, repairs, replacement, or analytical evaluation shall be in accordance with Subarticle IWB-3130, "Inservice Volumetric and Surface Examinations." For the RPV weld flaws that were detected by UT in 1999, the licensee applied Subarticle IWB-3600, "Analytical Evaluation of Flaws," specified in Subarticle IWB-3132.3, "Acceptance by Analytical Evaluation," to demonstrate that the unit can be operated for 28 EFPY without repair of the RPV welds. By letter dated May 5, 2000 (ML003712053), the NRC staff accepted the licensee's flaw evaluation for the current licensing period.

For license renewal applications, 10 CFR 54.21(c)(1) requires that time-limited aging analyses (TLAAs) be provided and the analyses remain valid for, or have been projected to the end of the period of extended operation. The licensee's August 22, 2007, letter was submitted to fulfill its commitment to reevaluate the subject RPV flaws as a TLAA for an additional 20 years as part of NRC's approval of NMPNS's license renewal application.

Regulatory Guide (RG) 1.190," Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," describes the attributes of pressure vessel fluence calculational methodologies that the staff finds acceptable. RG 1.190 is intended to ensure the accuracy and reliability of fluence calculations required by the General Design Criterion (GDC) 14, 30, and 31 of Appendix A to 10 CFR Part 50.

3.0 TECHNICAL EVALUATION

3.1 Background

On September 14, 1999, Niagara Mohawk Power Corporation (the previous licensee) submitted for NRC staff review, a structural evaluation of subsurface flaw indications found in two NMP1 RPV welds during its 15th refueling outage. The evaluation accounted for fatigue crack growth and irradiation embrittlement to 28 EFPYs of operation (i.e., the end of the original operating license). The NRC staff reviewed the evaluation and found it acceptable for NMP1 to continue operation with these flaws up to 28 EFPYs.

During the license renewal review, the weld flaws were considered to be TLAA items; therefore, the licensee committed to perform a reevaluation of the flaws for fatigue crack growth and irradiation embrittlement using the projected fluence value for 46 EFPYs (i.e., to the end of 60 calendar years of operation).

In its letter dated December 5, 2005 (ML053480197), NMPNS made the following commitment regarding the RPV weld flaw evaluations:

> The RPV weld flaw evaluations will be revised to consider additional fatigue crack growth and the effects of additional irradiation embrittlement (for beltline materials) associated with operation for an additional 20 years (i.e., out to at least 46 EFPY) and submitted for NRC review and approval no later than 2 years prior to the period of extended operation. If the revised calculation shows the identified flaws cannot meet the applicable acceptance criteria, the indications will be reexamined in accordance with ASME Section XI requirements.

3.2 RPV Flaw Evaluation

A typical flaw evaluation for detected flaws includes five general steps or attributes: (1) flaw sizing; (2) a crack growth evaluation based on applied stress intensity factors ($K_{applied}$); (3) an estimation of the final flaw size, (4) an estimation of the allowable flaw size based on the failure resistance considering degradation; and (5) a stability evaluation using NRC-approved acceptance criteria. Since this application is a reevaluation of an approved flaw evaluation for the current licensing period, the original flaw sizing remains the same. The other four elements of the licensee's flaw evaluation are evaluated in the following.

The licensee revised its crack growth calculations for the two limiting RPV weld flaws, the vessel flange horizontal weld flaw and the lower-intermediate course weld flaw, using the number of transient cycles corresponding to the difference between 46 EFPY (i.e., 60 calendar years of operation) and the EFPY at the time of flaw detection. The limiting transients continue to be the boltup condition for the vessel flange horizontal weld and the pressure test condition for the lower-intermediate course weld. The crack growth calculation is acceptable since the evaluation now applies to the entire extended period of operation. It should be noted, however, that the revised crack growth calculations reflected the current boltup and pressure test temperatures which are lower (indicating lower fracture toughness) than those used in the 1999 analyses.

In lieu of the conventional, "forward" approach of using the actual detected flaw size, determining flaw growth based on applied stress intensity factor calculations ($K_{applied}$), and then comparing the "final" projected flaw size at the end of 60 years of operation (46 EFPY) to an allowable flaw size based on the ASME Code specified safety factor and the failure resistance of the RPV material, the licensee performed a "backward" calculation. That is, the licensee started with the allowable flaw size based on the failure resistance of the RPV material, subtracted the expected flaw growth between the time the flaws were discovered and the end of 60 years of operation (46 EFPY), and used the ASME Code specified safety factor to establish modified allowable flaw sizes (as a function of allowable flaw depth versus flaw aspect ratio) which could be compared to the characteristics of the original indications. Inasmuch as the licensee's "backward" approach conservatively addressed the crack growth (the second attribute), the NRC staff found the licensee's approach to this evaluation to be acceptable.

The licensee's "backward" analysis led to the generation of a set of modified allowable flaw depths and aspect ratios which were plotted as a curve in Figures 1 and 2 (termed the "flaw evaluation charts") in Attachment 1 of the licensee's submittal[1]. The interpretation of this curve was that any flaw indication which fell below the curve (i.e., one with a smaller flaw depth for a given aspect ratio than that represented by the curve) would be acceptable through 60 years of operation (46 EFPY). The licensee plotted the detected flaw size on the flaw evaluation chart to see whether the plotted point is below the allowable flaw depth curve for acceptability. As indicated in Figure 1 in the licensee's submittal, the detected flaw in the vessel flange horizontal weld is acceptable for 46 EFPY. However, Figure 2 in the submittal indicated that the detected flaw in the lower-intermediate course weld is not acceptable for 46 EFPY.

[1] Enclosure 1 which contains flaw evaluation charts was included in the licensee's submittal dated August 22, 2007, but has not been included in this safety evaluation.

For the lower-intermediate course weld, the licensee removed two conservatisms from the original 1999 analysis: (1) use of a location-specific neutron fluence at the lower-intermediate course weld instead of the maximum RPV upper-plate fluence (which is 2.33 times of the former), and (2) use of K_{Ic} instead of the crack arrest fracture toughness, K_{Ia}. The reduced location-specific neutron fluence value was reviewed and accepted by the NRC staff as part of this review, and the use of K_{Ic} instead of K_{Ia} is consistent with the IWB-3600 (flaw evaluation) and Appendix G to Section XI of the ASME Code, which have been endorsed by the NRC. These two changes have the effect of increasing the fracture toughness of the subject weld. As indicated in Figure 3 in the licensee's submittal, the detected flaw in the lower-intermediate course weld is acceptable for 46 EFPY after removing two conservatisms from the licensee's 1999 flaw evaluation.

As a separate issue, the NRC staff clarifies here the applicability of this flaw evaluation to avoid potential misusing of it in future applications. The submittal stated, "Note that any potential future increases in the leak test pressure are bounded by this evaluation since a higher leak test pressure will yield a higher temperature…" The staff requested the licensee to substantiate this statement by an analysis in a request for additional information. The licensee replied in its response dated April 2, 2008, that this statement should be discarded. Hence, the bounding nature of the proposed flaw evaluation has not been established, and technical bases must be provided to justify the integrity of the welds without repair for 46 EFPY for cases of any potential future increases in the leak test pressure.

3.3 RPV Neutron Fluence Evaluation

The initial study of the pressure vessel flaws determined the boltup and pressure test conditions to be limiting; therefore, the allowable flaw size was determined from the pressure test conditions using the local fluence for 28 EFPYs. The reevaluation uses the same method but for a fluence value that corresponds to 46 EFPYs or 60 calendar years of operation.

The licensee's calculation and methodology are provided in Technical Report MPM-405778, "Neutron Transport Analysis for Nine Mile Point Unit 1," (MPM Technologies Inc., May 2006). The method described in the report has been previously approved by the NRC for NMP1 and for NMP2 plant-specific applications. The NRC staff reviewed the neutron source, meshing, and synthesis methods, which are described in this report. In addition, information to support the adherence to RG 1.190 is also described in detail including benchmarking and uncertainty determination. The NRC staff finds that the calculation and methodology provided in the technical report for NMP1 is consistent with RG 1.190 and is, therefore, acceptable.

The numerical fluence value used in the submittal for the determination of the allowable flaw at the circumferential weld at an azimuthal angle of 225° is 2.71×10^{18} neutrons per centimeter squared (n/cm^2). This value is higher than the peak fluence value in the inside diameter of the vessel, and is, therefore, conservative with respect to the actual value at the flaw. The NRC staff finds the licensee's proposed value of 2.71×10^{18} n/cm^2 was determined in accordance with RG 1.190 and is, therefore, acceptable.

4.0 CONCLUSION

The NRC staff has reviewed the licensee's letter dated August 22, 2007, as supplemented by letter dated April 2, 2008, and has concluded that the licensee's flaw evaluation meets the rules in the latest edition of Section XI of the ASME Code for 46 EFPY. Since the detected flaw sizes are bounded by the adjusted allowable flaw sizes considering a crack growth until the end of 46 EFPY, the staff concludes that NMP1 can be operated without repair of the subject RPV welds for 46 EFPY. Consequently, the licensee has fulfilled a commitment that it made as part of NRC staff's approval of the licensee's license renewal application to (1) reevaluate the detected RPV flaws for an additional 20 years and (2) submit for NRC review and approval no later than 2 years prior to the period of extended operation.

The staff also reviewed the licensee's submittal and supplemental information regarding the vessel fluence calculation and methodology provided in Technical Report MPM-405778. The review indicated that the calculation and methodology is consistent with RG 1.190, and the value used in the evaluation is conservative. Therefore, the staff concludes that the proposed value of 2.71×10^{18} n/cm^2 at the circumferential weld at an azimuthal angle of 225° is acceptable.

Principal Contributors: Simon Sheng
Lambros Lois

Date: July 29, 2008