UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 2, 2012

Mr. Ken Langdon
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 RE: NRC APPROVAL OF REACTOR PRESSURE VESSEL HEAD WELD FLAW EVALUATION (TAC NO. ME6721)

Dear Mr. Langdon:

By letter dated June 28, 2011, as supplemented by letter dated May 7, 2012, Nine Mile Point Nuclear Station, LLC (NMPNS, the licensee) in accordance with the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, Subsection IWB-3610(e) (2004 Edition), submitted its structural flaw evaluation of a subsurface flaw indication found in a Nine Mile Point Unit 1 (NMPNS-1) reactor pressure vessel (RPV) closure head weld for NRC staff review and approval.

The Nuclear Regulatory Commission (NRC) staff has reviewed the request and as set forth in the enclosed staff evaluation. Based on the review and evaluation of the submittals, the NRC staff found that the licensee's flaw evaluation meets the rules in the 2004 Edition of Section XI of the ASME Code. The NRC staff concludes that the closure head weld joining the RPV closure flange forging to the head is acceptable for continued service.

Please contact me at (301) 415-3308, if you have any questions.

Sincerely,

B.K. Vaidya

Bhalchandra Vaidya, Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-220

Enclosures:
Safety Evaluation

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REACTOR PRESSURE VESSEL HEAD WELD FLAW EVALUATION

NINE MILE POINT NUCLEAR STATION, UNIT 1

DOCKET NO. 50-220 (TAC NO. ME6721)

1.0 INTRODUCTION

By letter, dated June 28, 2011, as supplemented by letter dated May 7, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML11188A194 and ML12138A135, respectively), CENG (the licensee) submitted for the Nuclear Regulatory Commission (NRC) staff's review a flaw evaluation report for Nine Mile Point Nuclear Station (NMPNS), Unit 1, regarding an indication found in the closure head weld joining the reactor pressure vessel (RPV) closure flange forging to the head (referred to as the subject weld in the rest of the document) during the spring 2011 outage. In accordance with the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, IWB-3610(e), the licensee requested the NRC's approval of the analytical flaw evaluation to demonstrate that the RPV closure head weld is acceptable for continued service.

2.0 REGULATORY REQUIREMENTS

The inservice inspection (ISI) of the ASME Code, Class 1, 2, and 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), Section 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 the flaws by supplemental examination, repairs, replacement, or analytical evaluation shall be in accordance with ASME Code, Section XI, IWB-3130, "Inservice Volumetric and Surface Examinations." In this application, IWB-3600, "Analytical Evaluation of Flaws," as required in IWB-3132.3, "Acceptance by Analytical Evaluation," was applied by the licensee to demonstrate that the RPV shell-to-flange weld is acceptable for continued service.

The ASME Code of record for the fourth 10-year ISI interval at NMPNS, Unit 1 is the 2004 Edition of the ASME Code, Section IX.

3.0 TECHNICAL EVALUATION

A typical evaluation for any detected flaw that exceeds the limits in IWB-3500 includes five steps:

1. conservative estimate of the flaw size;
2. flaw growth evaluation;
3. estimation of final flaw size;
4. estimation of the allowable flaw size; and
5. stability evaluation using ASME, Section XI acceptance criteria.

During the Spring 2011 refueling outage, the indication found in the subject weld was detected , via an ultrasonic inspection complying with ASME Code, Section XI, Appendix VIII as required and modified by 10 CFR 50.55a(b)(2)(xv). This examination indicated that the flaw length (l) was 79 inches and the through-wall extent of the flaw (2a) was 1.23 inches. The flaw was located 1.98 inches from the inside surface of the RPV. Given the location, this flaw is characterized as subsurface according to the ASME Section XI rules. This satisfies step 1 for a conservative estimate of the flaw size because the Appendix VIII ultrasonic inspection is an acceptable methodology for flaw sizing according to ASME Code, Section XI.

The licensee's flaw growth evaluation, in Section 6.3.2 of its submittal dated June 28, 2011, considers only fatigue crack growth, as this is a subsurface flaw and is based on the following:

- The indication is located in a region of the vessel where the neutron fluence is negligible.

- The maximum allowable value of the stress intensity factor (K_I), for the applied (mode I) loading was calculated to be 63.25 ksi√in, using the upper shelf fracture toughness of 200 kilo pound per square inch multiplied by squareroot if inch (ksi√in) and a safety factor of √10. Upper shelf properties are appropriate because the ASME Code, Section XI, Appendix A, Paragraph A-5200 states that the cumulative fatigue crack growth analysis for flaw evaluations need not include emergency and faulted conditions.

- The number of stress cycles was estimated to be 463 cycles for 46 effective full power years (EFPY).

- The R ratio, as defined in ASME Code, Section XI, Appendix A, Paragraph A-4300, was chosen to be 0.9.

The staff asked the licensee to calculate the maximum applied K_I for the flaw in the subject weld under normal operating conditions. In their May 7, 2012 response to the staff's request for additional information (RAI), the licensee calculated the value of K_I by modeling the flaw as a semi-elliptical subsurface crack in a plate as described in ASME Code (2004 Edition), Section XI, Appendix A. The calculation accounted for the bending and membrane stresses, corrected for the estimated flaw dimensions, as well as the flaw shape factor Q and a plastic zone correction factor. The analysis considered pressure, boltup, heatup, cooldown, and emergency blowdown transients. Based on the stress distributions, under load combinations of pressure, boltup, and emergency blowdown, the licensee calculated a maximum applied K_I of 20.39 ksi√in. The staff has reviewed the May 7, 2012 response and agrees that the maximum allowable K_I is larger than

the maximum applied K_I; therefore, the use of the maximum allowable K_I is acceptable for use in the flaw growth calculation.

The assumed 463 cycles is an estimate based on the past history of operation and the remaining license operating life (46 EFPY), and is, therefore, conservative under current operating conditions.

The flaw growth calculation was performed according to ASME Section XI, A-4300. The change in the flaw dimension 'a' was 9.84×10^{-2} inches. The NRC staff independently performed the analysis using all the above-listed assumptions and found the same amount of fatigue crack growth. The NRC staff considers the flaw growth calculation in the June 28, 2011 submittal to be conservative because the licensee has included conservative assumptions and inputs to each part of the analysis. The large margin between the maximum allowable K_I (63.25 ksi$\sqrt{in}$,) that was used in the analysis and the highest calculated K_I (20.39 ksi$\sqrt{in}$) is the most significant factor that contributes to the conservative nature of the analysis. This satisfies step 2.

For steps 3 and 4, the licensee, in the June 28, 2011 submittal, calculated the final flaw size (1.43 inches) by adding the crack growth to the initial crack size. The allowable flaw size was calculated based on the following assumptions:

1. The flaw is assumed to be elliptical in shape.
2. The plastic zone size is small compared to the section size so that the failure mode can be characterized by linear elastic fracture mechanics.
3. The neutron fluence in the region of the flaw is negligible so that neutron embrittlement is not a factor that must be considered.
4. The flaw handbook for Oyster Creek RPV provides a conservative methodology to evaluate the NMPNS, Unit 1 subject weld flaw because the Oyster Creek RPV has a higher limiting Reference Temperature (RT_{NDT}) of 45°F compared with 40°F for the limiting RT_{NDT} for Nine Mile Point, Unit 1.

The licensee's analysis determined that the allowable flaw size was between 1.99 and 2.15 inches, depending upon the assumed stress state on the inside surface under different load combinations. The staff has reviewed the methodology used to estimate the allowable flaw size and agrees with the licensee that the methodology is conservative because the analysis is based on the worst case load combination and the flaw handbook for a sister plant (similar dimensions and loading) that has a higher limiting RT_{NDT}. This satisfies steps 3 and 4.

Finally, Subarticle IWB-3613 of the ASME Code, Section XI (2004 Edition), lists the acceptance criteria for flanges and shell regions near structural discontinuities. The staff constructed Table 1 to summarize the different acceptance criteria and how the information presented in the licensee's submittal, as supplemented by its May 7, 2012 RAI response, compare to the different criteria. In all three cases, the maximum applied K_I was less than the related acceptance criteria. Note that the K_I for the final flaw size after 46 EFPY increased by about 6% compared to the starting flaw size reported in the May 7, 2012 RAI response so that the K_I for final flaw size will be about 22 ksi$\sqrt{in}$. The K_{Ia} and K_{Ic} terms in Table 1 represent.the crack arrest and crack initiation fracture toughness of the material as defined in the ASME Code, Section XI, A-4200. The licensee did not identify the minimum temperature for emergency and faulted conditions. However, for the emergency and faulted condition, the fracture toughness value of 26 ksi$\sqrt{in}$ represents an assumed minimum service temperature of RT_{NDT} - 40°F or 0°F, which is a much

initiation fracture toughness of the material as defined in the ASME Code, Section XI, A-4200. The licensee did not identify the minimum temperature for emergency and faulted conditions. However, for the emergency and faulted condition, the fracture toughness value of 26 ksi√in represents an assumed minimum service temperature of RT_{NDT} - 40°F or 0°F, which is a much lower temperature then any temperature that could be anticipated to occur during a plant transient and therefore, is extremely conservative.

Table 1. NRC Staff Evaluation of ASME, Section XI (2004 Edition) Acceptance Criteria.

Condition	IWB-3613 criteria	K_I for final flaw size	Staff's Comments
Bolt up & pressurization < 20% of design pressure*	$K_{Ia} / \sqrt{2}$ = 40 ksi√in	~22 ksi√in	Meets criteria
Normal including upset and test excluding those described above**	$K_{Ia} / \sqrt{10}$ = 65 ksi√in	~22 ksi√in	Meets criteria
Emergency and faulted	$K_{Ic} / \sqrt{2}$ = 26 ksi√in***	~22 ksi√in	Meets criteria

*minimum temperature is not less than RT_{NDT} + 60°F, K_{Ia} = 57 ksi√in
** assumed operating temperature of 525 to 550°F, K_{Ia} assumed to be 200 ksi√in.
***minimum toughness for temperatures not less than RT_{NDT} -40°F,

Based on the review detailed above, the NRC staff finds that the subject flaw will meet the ASME Code, Section XI, IWB-3613 requirements through the remainder of the plant's licensed life barring change in loading conditions or other circumstances not currently considered. Adherence to ASME Code, Section XI, IWB-2420(b), requiring that the area containing the analyzed flaw be reexamined during the "next three inspection periods listed in the schedule" provides further assurance.

4.0 CONCLUSION

The NRC staff has completed the review of the licensee's submittals dated June 28, 2011 and May 7, 2012, and found that the licensee's flaw evaluation meets the rules in the 2004 Edition of Section XI of the ASME Code. As the projected flaw growth is predicted to be negligible and to pose no challenge to the integrity of the component, the NRC staff concludes that the closure head weld joining the RPV closure flange forging to the head is acceptable for continued service provided that the subsequent examinations required by ASME Code, Section XI are performed as described above.

Principal Contributor(s): P. Purtscher, NRR/DE/EVIB

Date: July 2, 2012

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Mr. Ken Langdon
Vice President Nine Mile Point
Nine Mile Point Nuclear Station, LLC
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Please contact me at (301) 415-1711, or the Project Manager, Bhalchandra K. Vaidya at (301) 415-3308, if you have any questions.

Sincerely,
/ra/
Bhalchandra Vaidya, Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-220
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ADAMS Accession No.: ML12180A267 **(*) No substantial change in SE Input Memo**

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