Constellation Energy
Nine Mile Point Nuclear Station

P.O. Box 63
Lycoming, NY 13093

March 23, 2006

U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTENTION: Document Control Desk

SUBJECT: Nine Mile Point Nuclear Station
Unit Nos. 1 & 2; Docket Nos. 50-220 & 50-410

SER Open Item 4.7B.1-1 and Closure of Amended License Renewal Application (ALRA) Section A2.4, Commitment 39 – Nine Mile Point Unit 2 (NMP2) Biological Shield Wall Neutron Fluence Analysis (TAC Nos. MC3272 and MC3273)

By letter dated January 11, 2006, Nine Mile Point Nuclear Station, LLC (NMPNS) submitted a response to NRC aRAI 4.7.1B-1 in which it committed to submit, for NRC review and approval, the summary of the Reg. Guide 1.190 based analysis that determines the maximum neutron fluence at the NMP2 Biological Shield Wall or at the shield wall flaw locations that were the basis for the ALRA Section 4.7.1 Time-Limited Aging Analysis (TLAA). This analysis is addressed as Open Item 4.7B.1-1 in the NRC's "Safety Evaluation Report With Open Items Related to the License Renewal of Nine Mile Point Nuclear Station, Units 1 and 2", dated March 2006.

The subject analysis has been completed. Attachment 1 provides a summary of the results of the analysis and provides the revisions to the NMPNS ALRA that are required based on those results. This letter contains no new regulatory commitments.

Should you have questions regarding the information in this submittal, please contact P. A. Mazzaferro, NMPNS License Renewal Project Manager, at (315) 349-1019.

Very truly yours,

Timothy J. O'Connor
Vice President Nine Mile Point

A107

STATE OF NEW YORK :
: **TO WIT:**
COUNTY OF OSWEGO :

I, Timothy J. O'Connor, begin duly sworn, state that I am Vice President Nine Mile Point, and that I am duly authorized to execute and file this submittal on behalf of Nine Mile Point Nuclear Station, LLC. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other Nine Mile Point employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

Subscribed and sworn before me, a Notary Public in and for the State of New York and County of Oswego, this 23 day of March, 2006.

WITNESS my Hand and Notarial Seal:

Notary Public

My Commission Expires:

3/23/06
Date

SANDRA A. OSWALD
Notary Public, State of New York
No. 01OS6032276
Qualified In Oswego County
Commission Expires 10/25/09

TJO/MRF/sac

Attachments: (1) SER Open Item 4.7B.1-1 and Closure of ALRA Section A2.4, Commitment 39 – NMP2 Biological Shield Wall Neutron Fluence Analysis

cc: S. J. Collins, NRC
T. G. Colburn, NRC
N. B. Lee, NRC
Resident Inspector, NRC
J. P. Spath, NYSERDA

ATTACHMENT (1)

SER OPEN ITEM 4.7B.1-1 AND CLOSURE OF ALRA SECTION A2.4, COMMITMENT 39 – NMP2 BIOLOGICAL SHIELD WALL NEUTRON FLUENCE ANALYSIS

Nine Mile Point Nuclear Station, LLC
March 23, 2006

SER OPEN ITEM 4.7B.1-1 AND CLOSURE OF ALRA SECTION A2.4, COMMITMENT 39 – NMP2 BIOLOGICAL SHIELD WALL NEUTRON FLUENCE ANALYSIS

In NMPNS Letter NMP1L 2015, dated January 11, 2006, in response to NRC aRAI 4.7.1B-1, the following commitment was made:

> "No later than two years prior to entry in the PEO, NMP will submit, for NRC review and approval, the summary of the Reg. Guide 1.190 based analysis that determines the maximum neutron fluence at the NMP2 Biological Shield Wall or at the shield wall flaw locations that are the basis for the ALRA Section 4.7.1 TLAA. The submittal will include revised ALRA Sections 4.7.1 and A2.2.5.1, and any other supporting analysis, as applicable."

This commitment was made because the referenced TLAA (ALRA Section 4.7.1), on neutron embrittlement of the NMP2 Biological Shield Wall (BSW), was based on the initial fluence analysis that was performed for NMP2 that used the fluence analysis methodology that was accepted by the NRC at that time. Using that methodology, the calculated neutron fluence at the BSW was greater than the 10 CFR 50, Appendix H defined threshold of 1E17 n/cm^2 for the onset of neutron embrittlement of steel. Based on that calculated fluence and the presence of minor indications in the BSW, a fracture mechanics analysis of the BSW was performed that qualified as a TLAA under 10 CFR 54.3(a).

Since that time, Reg. Guide 1.190 has been issued for the performance of fluence analyses and the methodology in this guide is less conservative that the methodology utilized in the original fluence analysis. The Reg. Guide 1.190 methodology was utilized in the NRC approved reactor pressure vessel neutron embrittlement analyses addressed in NMPNS ALRA Section 4.2. These analyses and the fluence analysis methodology utilized were approved by the NRC in its SER transmitted via letter to NMPNS dated October 27, 2003 (TAC No. MB6687). The same fluence analysis model utilized in the reactor vessel neutron embrittlement analyses was re-run with receptor points for the BSW to determine the neutron fluence at the inside of the wall.

The results of this reanalysis are presented as follows to fulfill the above commitment.

ANALYSIS SUMMARY

The revised NMP2 BSW fluence evaluation is defined using the NMP2 transport calculation methods approved for use for NMP2 reactor vessel fluence applications. The NRC reviewed and accepted these methods in the "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 183 to Facility Operating License No. Dpr-63 Nine Mile Point Nuclear Station, LLC Nine Mile Point Nuclear Station, Unit No. 1 Docket No. 50-220." The review determined that these methods met the requirements of RG 1.190 and the Safety Evaluation concluded, in the section entitled "Acceptability of Neutron Transport Calculation":

> "Based on review of the licensee's submittals set forth above, the NRC staff finds that the licensee used acceptable methodology to derive the applicable fluence values. The licensee's September 15, 2003, letter submitted the revised version of the benchmarking report ("Benchmarking of Nine Mile Point Unit 1 and Unit 2 Neutron Transport Calculations," MPM-402781 (Revision 1), September, 2003, MPM Technologies, Inc.) to update the data, discussions, and conclusions contained in the licensee's July 31, 2003 letter."

The calculations in the active fuel region were carried out using a synthesis of two dimensional neutron transport calculations, including plant-specific R-θ and R-Z calculations, for each fuel cycle through the end of NMP2 Cycle 10 (14.08 EFPY, current operating cycle) as described in this benchmark report. Each active fuel region case consisted of three transport analyses (R-θ, R-Z, and R), which were synthesized to provide a three dimensional flux profile at the shroud, vessel, and BSW. The active fuel region transport synthesis includes the air gap and the biological shield wall. The calculations for the BSW are defined for end of Cycle 10 and project the fluence for this location to exposures of 22 EFPY and 54 EFPY (end of the period of extended operation). The beltline region calculation procedures, which include the BSW, meet standards specified by the NRC and ASTM, as appropriate, and meet the requirements of Reg. Guide 1.190.

At the inside of the concrete shield is a steel shield plate 1.5 inches in thickness. The maximum fluence to this plate was evaluated similarly to the analysis of the reactor vessel in the beltline region. The maximum BSW fluence occurs at the plate inner radius and the values at this radius were determined as a function of azimuthal angle and axial height. The variation with angle is tempered by streaming within the cavity and the greater distance from the core. The maximum fluence was found to be at an angle of about 30 degrees in the first octant. The azimuthal distribution varies slightly with each cycle. The maximum fluence to the shield at the end of Cycle 10 was found to be less than 2E16 n/cm^2 and the maximum fluence at 54 EFPY was found to be 6.2E16 n/cm^2 for fast neutrons (E>1.0 MeV).

Since the 54 EFPY maximum fluence value at the BSW is less than the threshold fluence value (1E17 n/cm^2) for the susceptibility of steel to neutron embrittlement identified in 10 CFR 50, Appendix H, the consideration of this aging effect no longer applies. Since the aging effect no longer applies, TLAA criterion 10 CFR 54.3(a)(2) is no longer applicable to the original analysis. Since all six (6) of the 10 CFR 54.3(a) criteria must apply for an analysis to qualify as a TLAA, the analysis described in ALRA Section 4.7.1 no longer qualifies as a TLAA; therefore, the ALRA needs to be revised accordingly.

ALRA REVISIONS

With the elimination of the NMP2 BSW TLAA, there are several revisions to the ALRA that are shown beginning on the following page. Additions to the ALRA are shown with *italicized* font and deletions are shown with text ~~strikethroughs~~.

On page 4.1-3 of the ALRA, Table 4.1-1 is revised as shown below.

Table 4.1-1
Time-Limited Aging Analyses Applicable to NMPNS

TLAA Category	Description	Disposition Category	Section
1.	**Reactor Vessel Neutron Embrittlement Analysis**		4.2
	Upper-shelf Energy	§54.21(c)(1)(ii)	4.2.1
	Pressure-Temperature (P-T) Limits	§54.21(c)(1)(iii)	4.2.2
	Elimination of Circumferential Weld Inspection (NMP1 only)	§54.21(c)(1)(ii)	4.2.3
	Axial Weld Failure Probability	§54.21(c)(1)(ii)	4.2.4
2.	**Metal Fatigue Analysis**		4.3
	Reactor Vessel Fatigue Analysis	§54.21(c)(1)(iii)	4.3.1
	ASME Section III Class 1 Piping and Components Fatigue Analysis (NMP2 only)	§54.21(c)(1)(iii)	4.3.2
	Feedwater (FWS) Nozzle and Control Rod Drive Return Line (CRDRL) Nozzle Fatigue and Cracking Analyses	§54.21(c)(1)(iii)	4.3.3
	Non-ASME Section III Class 1 Piping and Components Fatigue Analysis	§54.21(c)(1)(iii)	4.3.4
	Reactor Vessel Internals Fatigue Analysis	§54.21(c)(1)(iii)	4.3.5
	Environmentally Assisted Fatigue	§54.21(c)(1)(iii)	4.3.6
	Fatigue of the Emergency Condenser (NMP1 only)	§54.21(c)(1)(iii)	4.3.7
3.	**Environmental Qualification (EQ)**		4.4
	Electrical Equipment EQ	§54.21(c)(1)(iii)	4.4.1
	Mechanical Equipment EQ (NMP2 only)	§54.21(c)(1)(iii)	4.4.2
4.	**Concrete Containment Tendon Prestress Analysis**	Not Applicable	4.5
5.	**Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis**		4.6
	Torus Shell and Vent System Fatigue Analysis (NMP1 only)	§54.21(c)(1)(i) and §54.21(c)(1)(ii)	4.6.1
	Torus Attached Piping Analysis (NMP1 only)	§54.21(c)(1)(iii)	4.6.2
	Torus Wall Thickness (NMP1 only)	§54.21(c)(1)(iii)	4.6.3
	Containment Liner Analysis (NMP2 only)	§54.21(c)(1)(ii)	4.6.4
	Fatigue of Primary Containment Penetrations	§54.21(c)(1)(i), §54.21(c)(1)(ii) and §54.21(c)(1)(iii)	4.6.5
	Downcomer and Safety/Relief Valve Discharge Line Fatigue Evaluation (NMP2) Only	§54.21(c)(1)(ii) and §54.21(c)(1)(iii)	4.6.6
6.	**Other Plant-specific TLAAs**		4.7
	~~RPV Biological Shield (NMP2 only)~~*Deleted*	~~§54.21(c)(1)(ii)~~	4.7.1
	Main Steam Isolation Valve Corrosion Allowance (NMP2 only)	§54.21(c)(1)(iii)	4.7.2
	Stress Relaxation of Core Plate Hold-Down Bolts (NMP2 only)	§54.21(c)(1)(iii)	4.7.3
	Reactor Vessel and Reactor Vessel Closure Head Weld Flaw Evaluations (NMP1 only)	§54.21(c)(1)(i) and §54.21(c)(1)(iii)	4.7.4

ALRA Section 4.7.1, on pages 4.7-1, -2, and -3, is revised as shown below.

4.7 OTHER PLANT-SPECIFIC TLAAS

4.7.1 ~~RPV BIOLOGICAL SHIELD (NMP2 ONLY)~~*DELETED*

~~Summary Description~~

~~A biological shield wall (BSW) with an inner radius of 14 feet, ¾ inch and an outer radius of 15 feet, 9 ¼ inch surrounds the NMP2 RPV. The BSW consists of two concentric 1 ½ inch thick steel cylinders connected by internal horizontal and vertical stiffeners. Full penetration welds connect the plates that make up the cylinders. The space between the steel cylinders is filled with nonstructural heavy density fill material for radiation shielding. (Refer to Section 3.8.3.1.3 of Reference 4.8-34.)~~

~~Discovery of weld defects during fabrication of the BSW resulted in stress and fracture mechanics analyses to determine an acceptable flaw size; the results showed the majority of the flaws were acceptable, while a small number of flaws required repair (Tables 1, 2, and 3 in enclosure to Reference 4.8-65). A related calculation was prepared to estimate the amount of neutron irradiation embrittlement (in terms of the 30 ft-lb transition temperature shift) of the BSW structural steel at the end of a 40-year life. Since this calculation confirmed the validity of the BSW fracture mechanics analyses for the current license term, it satisfies the criteria of §54.3(a). As such, this analysis is a TLAA.~~

~~Analysis~~

~~A threshold fluence value was determined below which the transition temperature shift would be zero. The 40-year neutron fluence at the BSW inside surface was determined to be less than the threshold value; therefore, the conclusion of the subject calculation states that no neutron embrittlement of the structural steel would occur during the 40-year life of the plant.~~

~~The original fracture mechanics analysis specified that the stress intensity factor (K_I) be less than a dynamic fracture toughness (K_{Id}) of 48.8 ksi(in)$^{0.5}$, based on a Charpy V-notch energy (C_v) of 20 ft-lbs at 100°F. This value was applied as an acceptance criterion for flaws in the base metal. Measured C_v values showed that the K_{Id} values used for the weld metal and heat affected zone in the original calculation both had higher fracture toughness than the base metal. Since the shift in the C_v values for the weld and heat affected zone was expected to be no greater than that predicted for the base metal, the base metal toughness was considered bounding for this evaluation (Section IV.B.2 in enclosure to Reference 4.8-65).~~

~~The NRC reviewed the repairs to the BSW welds and the associated fracture mechanics evaluations, and concluded that all BSW welds were acceptable for the intended service (Section 2.2 in Enclosure to Reference 4.8-66).~~

Disposition: §54.21(c)(1)(ii) The analyses have been projected to the end of the period of extended operation.

At the BSW outer wall, neutron fluence is negligible due to attenuation through the heavy-density fill material; therefore, the fracture toughness properties of the outer wall plates and welds will be unaffected.

The neutron fluence at the surface of the BSW inner wall has been projected through the period of extended operation. For E>1.0 MeV, the most recent RPV surveillance report (the attachment to Reference 4.8-20) documents a projected peak fluence at the RPV inner radius of $1.95x10^{17}$ n/cm^2 at 8.72 EFPY, with an average flux value of $8.78x10^8$ n/cm^2-s at the same location. This flux value can be used to extrapolate the fluence for an additional 45.28 EFPY exposure, yielding a fluence value of $1.45x10^{18}$ n/cm^2 at 54 EFPY. A conservative value of the corresponding fluence at the RPV outer radius is predicted by multiplying the inner surface fluence value by the exponential attenuation factor ($e^{-0.24x}$) presented in RG 1.99 (Reference 4.8-10), where x is the thickness of the RPV wall (6.4375 inches, determined from Table 3-2 in the attachment to Reference 4.8-20). The neutron flux with E>1.0 MeV falls off by approximately 18% in the void between the exterior surface of the RPV and the BSW inside surface; thus, a 54 EFPY fluence of $2.54x10^{17}$ n/cm^2 is projected at the surface of the inner steel cylinder of the BSW.

More recent data for irradiation of structural steels at low temperatures enables a more accurate estimation of embrittlement for the BSW. Materials from the Shippingport Reactor neutron shield tank and the High Flux Isotope Reactor vessel were irradiated to $5.07x10^{17}$ n/cm^2 (E>1.0 MeV) in a test reactor at a controlled temperature of 130°F to approximate the normal service temperatures of the structures. The results indicated a maximum elevation in 30 ft-lb transition temperature of 35°F and a reduction in USE of less than 6 ft-lb (Reference 4.8-67). Since the projected fluence for the NMP2 BSW is less than the value reported in Reference 4.8-67, the shift in C_v due to irradiation is also reduced. Reduction in material properties due to irradiation has been shown to be proportional to the square root of fluence for low fluence irradiation; thus, the reduction in C_v energy at 100°F was determined by multiplying the 30 ft-lb temperature shift at $5.07x10^{17}$ n/cm^2 (reported in Reference 4.8-67) by the ratio of the square roots of the projected fluence at the BSW inner wall and the reference fluence ($5.07x10^{17}$ n/cm^2). This results in a revised C_v for the BSW steel of 9.62 ft-lbs at 100°F, and K_{Id} of 37.1 ksi(in)$^{0.5}$.

A review of Tables 1, 2, and 3 in the enclosure to Reference 4.8-65 shows that no indications with applied K_I greater than or equal to the projected K_{Id} were allowed to remain in service without repair. Based on projected fluence value, the USE of the BSW material is reduced but does not invalidate the original fracture mechanics analyses. Therefore, fracture toughness of the NMP2 BSW has been projected (reevaluated) for the period of extended operation in accordance with §54.21(c)(1)(ii). *This section deleted.*

On ALRA pages 4.8-7 and 4.8-8, References 4.8-65, -66, and -67 are deleted as shown below.

4.8-65 ~~Letter from Niagara Mohawk Power Corporation to U.S. Nuclear Regulatory Commission dated August 1, 1980 forwarding the final report concerning the Nine Mile Point Unit 2 biological shield wall in accordance with 10 CFR 50, paragraph 50.55(e)(3).~~*(deleted)*

4.8-66 ~~Letter from U.S. Nuclear Regulatory Commission to Niagara Mohawk Power Corporation dated November 8, 1985,~~ ~~*Subject: Inspection No. 50-410/85-29.*~~*(deleted)*

4.8-67 ~~SAND92-2420, MEA-2494,~~ ~~*Accelerated 54°C Irradiated Test of Shippingport Neutron Shield Tank and HFIR Vessel Materials*~~~~, January 1993.~~*(deleted)*

On ALRA page A2-30, Section A2.2.5.1 is revised as shown below.

A2.2.5.1 ~~RPV BIOLOGICAL SHIELD~~*DELETED*

~~Discovery of weld defects during fabrication of the Biological Shield Wall (BSW) resulted in stress and fracture mechanics analyses to determine an acceptable flaw size. The results showed the majority of the flaws were acceptable, while some flaws required repair (Reference A2.3.4). A related calculation was prepared to estimate the amount of neutron irradiation embrittlement (in terms of the 30 ft-lb transition temperature shift) of the BSW structural steel at the end of a 40-year life.~~

~~Based on projected fluence value, the USE of the BSW material is reduced but does not invalidate the original fracture mechanics analyses. Therefore, fracture toughness of the NMP2 BSW has been projected (reevaluated) for the period of extended operation.~~*This section deleted.*