Xcel Energy®

April 28, 2009

L-PI-09-060
10 CFR 54

U S Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Prairie Island Nuclear Generating Plant Units 1 and 2
Dockets 50-282 and 50-306
License Nos. DPR-42 and DPR-60

Supplemental Information Closing License Renewal Commitment Number 36 Regarding Application for Renewed Operating Licenses

By letter dated April 11, 2008, Northern States Power Company, a Minnesota Corporation, (NSPM) submitted an Application for Renewed Operating Licenses (LRA) for the Prairie Island Nuclear Generating Plant (PINGP) Units 1 and 2. In a letter dated December 10, 2008, the NRC transmitted Request for Additional Information (RAI) 4.3.1.1-1 regarding that application. The NSPM response to that RAI, in a letter dated January 9, 2009, included License Renewal Commitment Number 36 to complete additional analyses and amend the LRA to incorporate the analysis results by April 30, 2009. Enclosure 1 of this letter transmits the LRA amendment with the updated analysis results.

If there are any questions or if additional information is needed, please contact Mr. Eugene Eckholt, License Renewal Project Manager.

Summary of Commitments

This letter contains no new commitments or changes to existing commitments. This letter completes the actions required by PINGP License Renewal Commitment Number 36.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on April 28, 2009.

Joel P. Sorensen

Joel P. Sorensen
Director Site Operations, Prairie Island Nuclear Generating Plant Units 1 and 2
Northern States Power Company - Minnesota

Enclosure (1)

cc:

Administrator, Region III, USNRC
License Renewal Project Manager, Prairie Island, USNRC
Resident Inspector, Prairie Island, USNRC
Prairie Island Indian Community ATTN: Phil Mahowald
Minnesota Department of Commerce

Enclosure 1
Supplemental Information Closing License Renewal Commitment Number 36

In a letter dated January 9, 2009, NSPM provided License Renewal Commitment Number 36 to amend the LRA to replace the results of fatigue analyses for two Reactor Coolant System locations using FatiguePro stress-based fatigue methodology with the results of fatigue analyses using ASME Code Section III methodology. The commitment reads as follows:

> NSPM will complete fatigue calculations for the pressurizer surge line hot leg nozzle and the charging nozzle using the methodology of the ASME Code (Subsection NB) and will report the revised CUFs and CUFs adjusted for environmental effects at these locations as an amendment to the PINGP LRA. Conforming changes to LRA Section 4.3.3, "PINGP EAF Results," will also be included in that amendment to reflect analysis results and remove references to stress-based fatigue monitoring.

ASME Code Section III (Subsection NB) fatigue analyses have been completed for the pressurizer surge line hot leg nozzle and the charging nozzle. The results of those analyses are being incorporated into the LRA by the following changes. This LRA amendment completes the actions required by License Renewal Commitment Number 36.

LRA Section 4.3.3, Environmentally-Assisted Fatigue (GSI-190), on Pages 4.3-19 through 4.3-24, is revised in its entirety to read as follows:

4.3.3 Environmentally-Assisted Fatigue (GSI-190)

Test data indicate that certain environmental effects (such as temperature and dissolved oxygen content) in the primary systems of light water reactors could result in greater susceptibility to fatigue than would be predicted by fatigue analyses based on the ASME Code Section III design fatigue curves. The ASME design fatigue curves were based on laboratory tests in air and at low temperatures. Although the failure curves derived from laboratory tests were adjusted to account for effects such as data scatter, size effect, and surface finish, these adjustments may not be sufficient to account for actual plant operating environments.

As reported in SECY-95-245, the NRC concluded that no immediate staff or licensee action was necessary to deal with the environmentally-assisted fatigue (EAF) issue. In addition, the staff concluded that it could not justify requiring a backfit of the environmental fatigue data to operating plants. However, the NRC also concluded that, because metal fatigue effects increase with service life, environmentally-assisted fatigue should be evaluated for any proposed extended period of operation for License Renewal.

NUREG/CR-6260 applied the fatigue design curves that incorporated environmental effects to several plants and identified locations of interest for consideration of environmental effects. Section 5.5 of NUREG/CR-6260 identified selected component locations to evaluate in older vintage Westinghouse plants, such as PINGP. The corresponding PINGP locations are as follows:

1. Reactor vessel shell to lower head
2. Reactor vessel inlet and outlet nozzles
3. Pressurizer surge line hot leg nozzle
4. RCS piping charging system nozzle
5. RCS piping safety injection accumulator nozzle
6. RHR Class 1 piping tee

Determination of Fatigue Usage Unadjusted for Environmental Effects

For the NUREG/CR-6260 locations listed above, design basis cumulative usage factors (CUFs) are reported in Section 4.3.1.1 for the reactor vessel shell to lower head and the reactor vessel inlet and outlet nozzles. The design basis CUFs for these locations are repeated in the Unadjusted CUF column of Table 4.3-8.

CUFs generated in response to NRC Bulletin 88-11 are reported in Section 4.3.1.6 for the pressurizer surge line piping (including the hot leg surge nozzles). The limiting pressurizer surge line location reported in NUREG/CR-6260 is at the safe end connected to the hot leg nozzle. As discussed below, the CUF for the PINGP surge line hot leg nozzle has been recalculated for the License Renewal determination of environmental effects.

The PINGP primary Class 1 piping NUREG/CR-6260 locations are designed in accordance with B31.1.0, and explicit fatigue analyses were not required. To support License Renewal, fatigue usage has been calculated in accordance with Section III of the ASME Code, Subsection NB, for the safety injection accumulator nozzle, RHR Class 1 piping tee, charging system nozzle, and the pressurizer surge line connection to the hot leg nozzle.

The CUFs for the safety injection accumulator nozzle and the RHR Class 1 piping tee were calculated using ASME Code Section III, 1989 Edition with 1989 Addenda. Transients defined for these locations include inadvertent RCS depressurization, inadvertent accumulator blowdown, RHR operation during plant cooldown, RCS refueling, high head safety injection, and OBE. The resulting CUFs for the safety injection accumulator nozzle and RHR Class 1 piping tee are reported in the Unadjusted CUF column of Table 4.3-8.

The CUFs for the charging system nozzles for Units 1 and 2 were calculated using ASME Code Section III, 2001 Edition with 2003 Addenda. Transients defined for this location are based on the selection of bounding NSSS design transients defined in Table 4.3-1, and also include inadvertent RCS depressurization, inadvertent auxiliary spray actuation, excessive feedwater flow, RCS refueling, and OBE. The numbers of transient cycles were modified to reflect the expected number of occurrences at 60 years. In addition, charging/letdown system flow shutoff and flow change transients were defined based on a standard set of Westinghouse design transients for auxiliary systems, as modified for the expected number of occurrences at 60 years. The resulting CUFs for the charging system nozzles for Units 1 and 2 are reported in the Unadjusted CUF column of Table 4.3-8.

The CUF for the pressurizer surge line hot leg nozzle for Units 1 and 2 was calculated using ASME Code Section III, 2001 Edition with 2003 Addenda. Transients defined for this location are based on the selection of bounding NSSS design transients defined in Table 4.3-1, and also include inadvertent RCS depressurization, inadvertent auxiliary spray actuation, control rod drop, excessive feedwater flow, RCS refueling, and OBE. The numbers of transient cycles were modified to reflect the expected number of occurrences at 60 years. Pressurizer insurge/outsurge transients before the implementation of modified operating procedures (MOP) are derived from WCAP-12839. The pressurizer insurge/outsurge transients that represent the time after implementation of MOP are based on WCAP-14950. The resulting CUF for the pressurizer surge line hot leg nozzle for Units 1 and 2 is reported in the Unadjusted CUF column of Table 4.3-8.

Determination of Environmentally-Assisted Fatigue Usage

PINGP evaluated the NUREG/CR-6260 locations using the guidance provided in NUREG-1801. NUREG-1801 calls for using the guidance (formulas) provided in NUREG/CR-5704 for austenitic stainless steel and NUREG/CR-6583 for carbon steel and low-alloy steel to calculate environmentally-assisted fatigue correction factors (F_{en}). The correction factors are applied to the unadjusted CUFs reported in Table 4.3-8 to obtain CUFs adjusted for environmental effects.

Carbon Steel

For PINGP, none of the locations identified in NUREG/CR-6260 are made of carbon steel, so calculation of the F_{en} for carbon steel is not required.

Low Alloy Steel

The environmentally-assisted fatigue correction factor (F_{en}) for low alloy steel is calculated as follows:

F_{en} = exp(0.929 - 0.00124T - 0.101S*T*O*$\dot{\varepsilon}$*), where:
F_{en} = fatigue life correction factor

T = fluid service temperature of transient, °C
(Note: In "-0.00124T" expression only, T is taken as room temperature, 25°C)

S^* = S for 0 < sulfur content, S ≤ 0.015 wt. %
= 0.015 for S > 0.015 wt. %

T^* = 0 for T < 150°C
= (T - 150) for 150 °C ≤ T ≤ 350°C

O^* = 0 for dissolved oxygen, DO < 0.05 parts per million (ppm)
= ln(DO/0.04) for 0.05 ppm ≤ DO ≤ 0.5 ppm
= ln(12.5) for DO > 0.5 ppm

$\dot{\varepsilon}^*$ = 0 for strain rate, $\dot{\varepsilon}$ > 1%/sec
= ln($\dot{\varepsilon}$) for 0.001 ≤ $\dot{\varepsilon}$ ≤ 1%/sec
= ln(0.001) for $\dot{\varepsilon}$ < 0.001%/sec

It is assumed that when the DO levels exceed 0.05 ppm when the RPV head is removed and reinstalled, the RCS temperature will stay below 150°C. As such, the increased DO levels during that process will not affect the F_{en} calculations. For a PWR environment, the DO is assumed to be below 0.05 ppm above 150°C and O*=0.

Therefore, the F_{en} for low alloy steel is 2.455.

Austenitic Stainless Steel
The environmentally-assisted fatigue correction factor (F_{en}) for Types 304 and 316 austenitic stainless steel is calculated as follows:

F_{en} = exp(0.935 - T*$\dot{\varepsilon}$*O*), where:
F_{en} = fatigue life correction factor

T = fluid service temperature of transient, °C

T^* = 0 for T < 200°C
= 1 for T ≥ 200°C

$\dot{\varepsilon}^*$ = 0 for strain rate, $\dot{\varepsilon}$ > 0.4%/sec
= ln($\dot{\varepsilon}$ /0.4) for 0.0004 ≤ $\dot{\varepsilon}$ ≤ 0.4%/sec
= ln(0.0004/0.4) for $\dot{\varepsilon}$ < 0.0004%/sec

O^* = 0.260 for dissolved oxygen, DO < 0.05 parts per million (ppm)
= 0.172 for DO ≥ 0.05 ppm

Therefore, the F_{en} for Stainless Steel is:

F_{en} = 2.55 (T < 200°C, any $\dot{\varepsilon}$, any DO)
F_{en} = 2.55 (T ≥ 200°C, $\dot{\varepsilon}$ ≥ 0.4%/sec, any DO)
F_{en} = 3.78 (T ≥ 200°C, $\dot{\varepsilon}$ = 0.04%/sec, DO ≥ 0.05 ppm)
F_{en} = 4.64 (T ≥ 200°C, $\dot{\varepsilon}$ = 0.04%/sec, DO < 0.05 ppm)

F_{en} = 5.62 (T ≥ 200°C, $\dot{\varepsilon}$ = 0.004%/sec, DO ≥ 0.05 ppm)
F_{en} = 8.45 (T ≥ 200°C, $\dot{\varepsilon}$ = 0.004%/sec, DO < 0.05 ppm)
F_{en} = 8.36 (T ≥ 200°C, $\dot{\varepsilon}$ ≤ 0.0004%/sec, DO ≥ 0.05 ppm)
F_{en} = 15.35 (T ≥ 200°C, $\dot{\varepsilon}$ ≤ 0.0004%/sec, DO < 0.05 ppm)

PINGP Environmentally-Assisted Fatigue Results

There are three low alloy steel NUREG/CR-6260 locations at PINGP: RPV outlet nozzle, RPV inlet nozzle, and RPV shell to lower head. When the design CUFs at these locations are multiplied by an F_{en} of 2.455, the environmentally-adjusted CUFs are all below 1.0. The resulting adjusted values of CUF are reported in Table 4.3-8. The environmentally-adjusted CUFs of the RPV outlet nozzle, RPV inlet nozzle and RPV shell to lower head have been projected to the end of the period of extended operation in accordance with 10 CFR 54.21(c)(1)(ii). The cumulative numbers of design transients experienced by the locations of interest will continue to be managed using cycle counting under the Metal Fatigue of Reactor Coolant Pressure Boundary Program in accordance with 10 CFR 54.21(c)(1)(iii).

The remaining NUREG/CR-6260 locations are all stainless steel. Environmentally-adjusted CUFs for the safety injection accumulator nozzle and RHR Class 1 piping tee are below 1.0. The safety injection nozzle and RHR tee environmentally-adjusted CUFs are based on ASME Code Section III analyses multiplied by a bounding F_{en}. The resulting adjusted values of CUF are reported in Table 4.3-8. The environmentally-adjusted CUFs for the safety injection nozzle and RHR tee have been projected to the end of the period of extended operation in accordance with 10 CFR 54.21(c)(1)(ii). The transients used for the fatigue evaluation will be added to the Metal Fatigue of Reactor Coolant Pressure Boundary Program, and EAF at these locations will be managed using cycle-based fatigue monitoring in accordance with 10 CFR 54.21(c)(1)(iii).

Environmentally-adjusted CUFs for the charging system nozzles are projected to be below 1.0 at 60 years. PINGP has calculated an unadjusted CUF at the charging nozzles for Units 1 and 2 at 60 years using the methodology of ASME Code Section III, Subsection NB. The unadjusted value of CUF that bounds both Units is 0.1024 for Unit 2. This value is the total CUF determined by summing the partial usage values calculated for each load set pair. Temperatures and stress values from the Unit 2 analysis, as well as a conservatively-assumed value for dissolved oxygen (DO), are used to determine an environmental fatigue correction factor (F_{en}) value for each load set pair using the Integrated Strain Rate approach provided in MRP-47, "Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application," Revision 1 (page 4-14). Detailed F_{en} calculations are performed only for those load set pairs with a reasonably significant air curve fatigue contribution, specifically usage value ≥0.001. For all other load set pairs, the F_{en} is taken to be 15.35, which is the maximum value for a stainless steel material. F_{en} is then multiplied by the air curve usage to yield EAF usage for each load set pair. These partial EAF usage factors are summed over all load set pairs to yield the total environmentally-adjusted CUF of 0.7431. This value of the environmentally-adjusted CUF is listed in Table 4.3-8. The environmentally-adjusted CUF for the charging system nozzle has been projected to the end of the period of extended operation in accordance with 10 CFR 54.21(c)(1)(ii). The additional transients and revised cycle limits used in the fatigue evaluation will be added to the Metal Fatigue of Reactor Coolant Pressure Boundary Program in conjunction with License Renewal Commitment No. 33, and environmentally-assisted fatigue at the charging nozzle will be managed during the period of extended operation using cycle counting in accordance with 10 CFR 54.21(c)(1)(iii).

The pressurizer surge line hot leg nozzle environmentally-adjusted CUF, using CUFs calculated in response to NRC Bulletin 88-11 (Section 4.3.1.6), would be greater than 1.0. However, as discussed above, PINGP has recalculated fatigue usage at the pressurizer surge line hot leg nozzle at 60 years using the methodology of ASME Code Section III, Subsection NB. The resulting unadjusted value of CUF that bounds both Units is 0.0759. This value is the total CUF determined by summing the partial usage values calculated for each load set pair. Temperatures and stress values from that analysis, as well as a conservatively-assumed value for dissolved oxygen (DO), are used to determine an environmental fatigue correction factor (F_{en}) value for each load set pair using the Integrated Strain Rate approach provided in MRP-47, Revision 1 (page 4-14). Detailed F_{en} calculations are performed only for those load set pairs with a reasonably significant air curve fatigue contribution, specifically usage values $\geq$0.0015. For all other load set pairs, the F_{en} is taken to be 15.35, which is the maximum value for a stainless steel material. F_{en} is then multiplied by the air curve usage to yield EAF usage for each load set pair. These partial EAF usage factors are summed over all load set pairs to yield the total environmentally-adjusted CUF of 0.9854. This value of the environmentally-adjusted CUF is listed in Table 4.3-8. The environmentally-adjusted CUF for the surge line hot leg nozzle has been projected to the end of the period of extended operation in accordance with 10 CFR 54.21(c)(1)(ii). The additional transients and revised cycle limits used in the fatigue evaluation will be added to the Metal Fatigue of Reactor Coolant Pressure Boundary Program in conjunction with License Renewal Commitment No. 33, and environmentally-assisted fatigue at the pressurizer surge line hot leg nozzle will be managed during the period of extended operation using cycle counting in accordance with 10 CFR 54.21(c)(1)(iii).

Table 4.3-8: Summary of EAF Results – Prairie Island Units 1 and 2

Component	Material	Unadjusted CUF	F_{en} Multiplier	CUF Adjusted for Environmental Effects
RPV Outlet Nozzle	Low Alloy Steel	0.035	2.455	0.086
RPV Inlet Nozzle	Low Alloy Steel	0.0165	2.455	0.041
RPV Shell to Lower Head	Low Alloy Steel	0.001	2.455	0.0027
Pressurizer Surge Line Hot Leg Nozzle	Stainless Steel	0.0759	12.99[1]	0.9854
Safety Injection Accumulator Nozzle	Stainless Steel	0.0377 (U1) 0.0318 (U2)	15.35	0.579 (U1) 0.488 (U2)
Charging System Nozzle	Stainless Steel	0.067 (U1) 0.1024[2] (U2)	7.26[1]	0.7431[2] (U1 & U2)
RHR Class 1 Piping Tee	Stainless Steel	0.0214 (U1) 0.0129 (U2)	2.55	0.0546 (U1) 0.0329 (U2)

1. The analysis determined an individual F_{en} for each load set pair using the Integrated Strain Rate approach of MRP-47, and did not apply a single value of F_{en}. The value shown in the table is an "effective" overall F_{en} multiplier which was back-calculated by dividing the total environmentally-adjusted CUF (sum of the adjusted usage factors from each load set pair) by the total unadjusted CUF (sum of the unadjusted usage factors from each load set pair).

2. The Unit 2 charging nozzle fatigue analysis is considered bounding for both PINGP Units. Therefore, the EAF evaluation for the Unit 1 and Unit 2 charging nozzles is based on the bounding Unit 2 analysis case.