Alex L. Javorik
Columbia Generating Station
P.O. Box 968, PE04
Richland, WA 99352-0968
Ph. 509-377-8555 F. 509-377-2354
aljavorik@energy-northwest.com

January 4, 2012
GO2-12-002

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Subject: **COLUMBIA GENERATING STATION, DOCKET NO. 50-397 RESPONSE TO NRC INFORMATION REQUEST, LICENSE RENEWAL APPLICATION**

References:
1) Letter, GO2-10-11, dated January 19, 2010, WS Oxenford (Energy Northwest) to NRC, "License Renewal Application"
2) Letter, GO2-11-177, dated November 4, 2011, BJ Sawatzke (Energy Northwest) to NRC, "Responses to Request for Additional Information, License Renewal Application"
3) Letter, GO2-11-202, dated December 16, 2011, AL Javorik (Energy Northwest) to NRC, "Response to NRC Audit Questions, License Renewal Application"
4) Letter, GO2-10-164, dated November 11, 2010, SK Gambhir (Energy Northwest) to NRC, "Response to Request for Additional Information, License Renewal Application"

Dear Sir or Madam:

By Reference 1, Energy Northwest requested the renewal of the Columbia Generating Station (Columbia) operating license.

By Reference 2, Energy Northwest responded to request for additional information (RAI) 4.3-09 regarding the cumulative usage factor (CUF) for other limiting locations beyond those discussed in NUREG/CR-6260. The NRC conducted an audit the week of November 28 – December 2, 2011, to review the calculations and other documents which supported this response to RAI 4.3-09 as submitted under Reference 2. During the audit the NRC requested Energy Northwest to provide clarification on the selection criteria for other limiting locations. Responses to the NRC audit questions and request for clarifications were provided by Reference 3. The response provided via Reference 3

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noted that the 60 year environmentally assisted usage factors for reactor feedwater (RFW) and reactor water clean-up (RWCU) valves would be provided at a later date. Those values are provided in Amendment 51. Additionally, information requested by the NRC reviewers of Energy Northwest during a conference call on December 15, 2011 is provided in the attachment. Lastly, Amendment 51 also makes an editorial change to section 4.3.5.2 of the license renewal application (LRA).

No new or revised commitments are included in this letter.

If you have any questions or require additional information, please contact JD Twomey at (509) 377-4678.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the date of this letter.

Respectfully,

AL Javorik
Vice President, Engineering

Attachment: Response to NRC Information Request

Enclosure: License Renewal Application Amendment 51

cc: NRC Region IV Administrator
NRC NRR Project Manager
NRC Senior Resident Inspector/988C
EFSEC Manager
RN Sherman – BPA/1399
WA Horin – Winston & Strawn
AD Cunanan - NRC NRR (w/a)
MA Galloway – NRC NRR
RR Cowley – WDOH

Supplemental Letter for the NRC Audit Questions/Clarifications on RAI 4.3-09

Metal Fatigue Evaluation for RWCU and RFW Class 1 Valves

Cyclic Stress and Design (air) Fatigue Usage

The Class 1 valve cyclic stresses and 60 year design (air) fatigue usages were calculated in accordance with the procedures specified in Subsubarticle NB-3550 of the ASME Section III Code. These calculations were based on the thermal and pressure conditions identified in piping design specifications for the RWCU return piping to RFW and the RFW supply piping to the reactor pressure vessel (RPV). The fatigue usage calculations are based on the 60 year projected cyclic loading identified in LRA Table 4.3-2.

Environmental Fatigue Correction Factor

The 60 year design (air) fatigue usage was corrected for environmental effects using the procedures and the carbon steel environmental fatigue correction factor (F_{en}) formulations in NUREG/CR-6583.

An environmental factor, F_{en}, was calculated for each ΔT and ΔP cyclic load set condition. The transformed temperature environmental factor (T^*) is based on average temperatures for each load set thermal modes. Bounding value for the transformed environmental strain rate ($\dot{\varepsilon}^*$) and sulfur (S^*) factors were conservatively assumed.

The calculations consider the time Columbia operated under both normal water chemistry (NWC) and hydrogen water chemistry (HWC) dissolved oxygen conditions. The NWC and HWC dissolved oxygen concentrations values are based on operating chemistry data at Columbia.

As noted in LRA section 4.3.5.2, values for dissolved oxygen, before and after the adoption of HWC, were used in the F_{en} determination. Columbia operated with NWC for 20.9 years from January 19, 1984 (initial startup) until November 28, 2004. Columbia has operated with HWC from November 28, 2004 and is assumed to continue operating with HWC until the end of the period of extended operation: a combined time of 39.1 years. The time Columbia has operated under both NWC (21 years) and HWC (39 years) conditions was considered in the estimation of an effective F_{en}. At each load set an effective F_{en} is estimated based on a time weighted average of $F_{en}NWC$ and $F_{en}HWC$ values over 60 years of operation.

The environmental partial fatigue usage $Uenv_i$ for cyclic load set is then determined by multiplying the 60 year design (air) partial usage factor U_i by Fen_i. The environmental cumulative usage factor (CUF) is equal to the sum of the partial usage factors calculated with consideration of environmental effects.

For additional information regarding the application of dissolved oxygen to the F_{en} methodology, see responses to RAIs 4.3-07 and 4.3-08 as provided in Reference 4.

Results:

The cumulative fatigue usage factor, U_{env}, based on the analysis performed for 60 years of plant life remains below 1.0 for valves RWCU-V-40, RFW-V-10A/B, RFW-V-11A/B, RFW-V-32A/B, and RFW-V-65A/B. The bounding U_{env} values for these valves are provided in Amendment 51. The values for these RWCU and RFW valves are bounded by the limiting condition associated with the RPV head spray (zone 1) as shown in Table 4.3-7.

Methodology for Reduction of Preliminary CUF Values to Below 1.0

A variety of methods were utilized to reduce the ASME Class 1 component usage factors in air and with environment for the evaluated additional limiting locations beyond those specified in NUREG/CR-6260. If the in air usage was high, such that the environmental penalty would cause the usage to exceed 1.0, the design analysis was refined to reduce the cumulative usage factor (CUF). The reduction was achieved by de-bundling of transients, refining transients using updated design specification transients or utilizing NB-3200 analysis methods to reduce computed stresses.

If the environmental fatigue penalty (F_{en}) caused the environmental usage to exceed 1.0, then an integrated F_{en} was calculated over the duration of the fatigue cycle. The analysis refinements and detailed F_{en} calculations made it possible to reduce all component environmental fatigue usages to less than 1.0 for the 60 year projected plant life.

Clarification on Amendment 49 Table Revisions

As requested by the NRC staff to assist in their review of Amendment 49 previously submitted under Reference 3, the following items provide the bases for changes to values in tables 4.3-3, 4.3-6, and 4.3-7:

1. Table 4.3-3: RFW nozzle-shell junction usage changed from 0.650 to 0.709. The original value listed in the table for the nozzle-shell junction usage was taken from the original Chicago Bridge & Iron (CB&I) vessel stress report. GE issued a report in May 2009 that changed the usage value resulting from the 1995 Power Uprate to 0.709 which is now inserted into the table.

2. Table 4.3-6: Line 6 reflected a 40 year air usage value (0.097) while the column required a 60 year value. Thus, the value of 0.097 is replaced with the 60 year air usage value of 0.210. The 60 year environmental usage value was originally listed as 0.389. This value was changed to 0.4333. The listing of 0.389 occurred

due to a swap of F_{en} values in the summary table. The applicable calculation was revised accordingly.

3. Table 4.3-7: Vessel Head Spray Nozzle. Credit has been taken for the thermal sleeve and spray nozzle that are inserted into the vessel nozzle to direct reactor core isolation cooling (RCIC) spray onto the steam dryer. The nozzle is at the top of the RPV head and is exposed to dry steam. It was assessed as a wetted surface in a previous analysis.

4. Table 4.3-7: Last line for 'HPCS/LPCS/RHR', the environmental CUF is changed from 0.558 to 0.568 to address a transposition of the value of CUF from the spreadsheet tabulation to the calculation results summary sheet.

LICENSE RENEWAL APPLICATION AMENDMENT 51

Section Number	Page Number	RAI Number
Section 4.3.5.2	4.3-13	Editorial
Table 4.3-7 Insert Line Items	4.3-16b	4.3-09

4.3.5 Effects of Reactor Coolant Environment on Fatigue Life of Components and Piping

4.3.5.1 Background

The NRC requires applicants for license renewal to address the reactor coolant environmental effects on fatigue of plant components (NUREG-1800 Section 4.3). The minimum set of components for a BWR of Columbia's vintage is derived from NUREG/CR-6260 (Reference 4.8-10), as follows:

1. Reactor vessel shell and lower head
2. Reactor vessel feedwater nozzle
3. Reactor recirculation piping (including inlet and outlet nozzles)
4. Core spray line reactor vessel nozzle and associated Class 1 piping
5. Residual heat removal return line Class 1 piping
6. Feedwater line Class 1 piping

In NUREG-1800, the NRC mentions using the calculational approach whereby the fatigue life adjustment factor (F_{en}) is determined for each fatigue-sensitive component and applying those environmental fatigue correction factors to the component CUFs to verify acceptability of the components for the period of extended operation. In NUREG-1800, the NRC further points out equations for calculating F_{en} values as being those contained in NUREG/CR-6583 (Reference 4.8-11) for carbon steel and low alloy steel components and in NUREG/CR-5704 (Reference 4.8-12) for austenitic stainless steel components. Nickel alloy components were also analyzed using the stainless steel equations in NUREG/CR-5704.

Environmentally assisted fatigue (EAF) evaluations are not applied during the current licensing basis. EAF evaluations done for the period of extended operation apply the EAF correction factors per NUREG-6260.

4.3.5.2 Columbia Evaluation

Using projected cycles from the Fatigue Monitoring Program and methodology accepted by the NRC, as noted above, the limiting locations (a total of 14 component locations corresponding to the six NUREG/CR-6260 components) for the material for each component location were evaluated. None of the 14 locations evaluated have an environmentally adjusted CUF of greater than 1.0 (see Table 4.3-6).

Values for dissolved oxygen, before and after the adoption of Hydrogen Water Chemistry (HWC), were used in the F_{en} determination. The plant operated with Normal Water Chemistry (NWC) for 20.9 years from January 19, 1984 (initial startup) until November 28, 2004. The plant has operated with HWC from November 28, 2004, and is assumed to continue operating with HWC until ~~January 13, 2044~~ the end of the period of extended operation; a combined time of

Table 4.3-7 (continued)
CUFs for components beyond NUREG/CR-6260 locations

LRA Table 4.3-3 or 4.3-5 Component	CGS Specific Location	Component Material	60-year U_{air}	Fen	Environmentally assisted CUF
RWCU	Piping	CS	0.164	Min[3] = 1.0 Max = 4.266	0.193
RCIC	Piping	CS	Dry steam environment – No environmental effects		
RPV Head Spray	Piping	CS	0.259	1.74	0.451
RPV Vent to MS	Piping	CS	Dry steam environment – No environmental effects		
RPV Level	Condensing Pot	SS	0.245	2.547	0.624
SLC	Piping	CS ← /SS	0.424[4]	Min[3] = 1.0 Max = 1.74	0.737
RPV Head Spray Zone 1	Check Valve	CS	0.386	2.439	0.941
Zone 2			0.331	2.503	0.828
HPCS/LPCS ← /RHR	Valve	CS	0.326	1.74	~~0.558~~ 0.568
RWCU	Valve	CS	0.073	2.675	0.196
RFW	Valve	CS	0.527	Min[3] = 1.737 Max = 2.059	0.920

[3] Highest and lowest Fen for multiple load pairs

[4] A portion of the SLC system is stainless steel. For evaluation of environment the carbon steel portion was assessed because its usage was over 5 times the maximum stainless steel usage, while the default maximum Fen for SS was only 1 1/2 times larger than CS. Thus the CS location was limiting.