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September 7, 2012
L-12-335

10 CFR 54

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

SUBJECT:
Davis-Besse Nuclear Power Station, Unit No. 1
Docket No. 50-346, License Number NPF-3
Supplemental Reply to Request for Additional Information for the Review of the Davis-Besse Nuclear Power Station, Unit No. 1, License Renewal Application (TAC No. ME4640) and License Renewal Application Amendment No. 34

By letter dated August 27, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102450565), FirstEnergy Nuclear Operating Company (FENOC) submitted an application pursuant to Title 10 of the *Code of Federal Regulations*, Part 54 for renewal of Operating License NPF-3 for the Davis-Besse Nuclear Power Station, Unit No. 1 (Davis-Besse). By letter dated May 15, 2012 (ML12118A542), the Nuclear Regulatory Commission (NRC) issued request for additional information (RAI) 4.2.2-4, to complete its review of the License Renewal Application (LRA). By letter dated June 14, 2012 (ML12167A369), FENOC responded to the RAI by providing a commitment to submit equivalent margins analyses for selected reactor vessel circumferential welds, and amend the LRA to incorporate the results of the equivalent margins analyses for the welds.

The actions described in the commitment have been completed. The Attachment provides a supplemental response to NRC RAI 4.2.2-4 – Upper Shelf Energy (USE) Evaluation, including a description of the equivalent margins analysis performed and results obtained. The NRC request is shown in bold text followed by the FENOC response. Enclosure A provides Amendment No. 34 to the Davis-Besse LRA.

Enclosure C provides AREVA NP Inc. (AREVA NP) Calculation No. 32-9184568-000, "Equivalent Margins Assessment of Davis-Besse Transition Welds for 52 EFPY." The calculation documents the equivalent margins analysis for the nozzle belt forging to upper shell forging circumferential weld and the lower shell forging to Dutchman forging circumferential weld. The AREVA NP equivalent margins analysis contains proprietary information that is to be withheld from public disclosure pursuant to 10 CFR 2.390.

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A nonproprietary version of the calculation does not exist. Enclosure B provides the AREVA NP affidavit to support the disclosure request for the proprietary equivalent margins analyses.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Clifford I. Custer, Fleet License Renewal Project Manager, at 724-682-7139.

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 7, 2012.

Sincerely,

Barry S. Allen

Barry S. Allen

Attachment:

Reply to Requests for Additional Information for the Review of the Davis-Besse Nuclear Power Station, Unit No. 1 (Davis-Besse), License Renewal Application (LRA), Section 4.2.2

Enclosures:

A. Amendment No. 34 to the Davis-Besse License Renewal Application
B. Affidavit for Calculation No. 32-9184568-000, "Equivalent Margins Assessment of Davis-Besse Transition Welds for 52 EFPY"
C. Calculation No. 32-9184568-000, "Equivalent Margins Assessment of Davis-Besse Transition Welds for 52 EFPY" (Proprietary)

cc: NRC DLR Project Manager
NRC Region III Administrator

cc: w/o Attachment or Enclosures
NRC DLR Director
NRR DORL Project Manager
NRC Resident Inspector
Utility Radiological Safety Board

## Section 4.2.2

**Question RAI 4.2.2-4 – Upper Shelf Energy (USE) Evaluation – Supplement**

Background:

**LRA Table 4.2-2 lists a generic initial USE of 70 ft-lbs for all Linde 80 reactor vessel (RV) beltline welds (Weld Nos. WF-232, WF-233, and WF-182-1). In its April 15, 2011, response to RAI 4.2.2-2, the applicant stated that 70 ft-lbs is based on a statistical analysis of measured initial USE data from archived Linde 80 weld specimens from plant-specific surveillance capsules. The applicant stated that the initial USE data and the statistical analysis is reported in B&W Owners Group (B&WOG) Topical Report BAW-1803, "Correlations for Predicting the Effects of Neutron Radiation on Linde 80 Submerged-Arc Welds," Revision 1, May 1991.**

Issue:

**The staff has concerns with the use of a generic initial USE of 70 ft-lbs for Linde 80 welds for implementation in direct projections of end-of-license (EOL) USE for the period of extended operation (52 EFPY), for the following reasons:**

1. **The mean value from a database has generally not been acceptable to the staff for establishing a generic initial USE value for a specification, class, and/or type of RV material because generic mean values are not statistically defensible for embrittlement calculations. In the past, the staff has generally only accepted generic initial USE values if they are based on a statistically-conservative position, such as the mean value minus two standard deviations, or the lowest value in the database.**

2. **The BAW-1803 initial USE database has not been reviewed and approved by the staff as a statistical basis for the selection of any generic initial USE value for Linde 80 welds.**

**Request:**

**To demonstrate acceptable USE for the RV beltline materials, WF-232 and WF-233, provide a response to either (a) or (b):**

**(a) Provide a direct projection of USE through 52 EFPY based on either (i) measured heat-specific initial USE values from certified material test reports (CMTRs), or (ii) a statistically-based conservative generic initial USE value, along with a technical justification for the value.**

**(b) Provide EMAs for weld materials WF-232 and WF-233 in the shell region of the RV, which may use the existing methods developed in B&WOG Topical Reports BAW-2191P-A and BAW-2178P-A, or the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Appendix K, accounting for neutron embrittlement through 52 EFPY. EMAs for non-shell welds must use applied J-integral values based on the specific weld geometry.**

RESPONSE RAI 4.2.2-4 – UPPER SHELF ENERGY (USE) EVALUATION – SUPPLEMENT

In response to RAI 4.2.2-4 submitted by letter dated June 14, 2012 (ML12167A369), FENOC provided the following commitment:

> The following activities will be completed on or before September 14, 2012:
>
> FENOC commits to submit an equivalent margins analysis for the nozzle belt forging to upper shell forging circumferential weld and the lower shell forging to Dutchman forging circumferential weld.
>
> The following License Renewal Application Sections will be revised to include the results of the equivalent margins analyses for the nozzle belt forging to upper shell forging circumferential weld, the lower shell forging to Dutchman forging circumferential weld, nozzle belt forging to bottom of RV inlet nozzle forging welds and nozzle belt forging to bottom of RV outlet nozzle forging welds:
>
> - 4.2.2.2, "USE Projections,"
> - 4.2.2.3, "Equivalent Margins Analyses,"
> - Table 4.2-2, "USE Values at 52 EFPY for Davis Besse Reactor Vessel Beltline Materials," and
> - A.2.2.2, "Upper-Shelf Energy."

The actions described in the commitment have been completed.

The equivalent margins analysis for the nozzle belt forging to upper shell forging circumferential weld and the lower shell forging to Dutchman forging circumferential weld (also known as transition welds) is documented in AREVA NP Inc. (AREVA NP) Calculation No. 32-9184568-000, "Equivalent Margins Assessment of Davis-Besse Transition Welds for 52 EFPY," dated August 30, 2012, and is included as an enclosure to this supplemental response. This calculation demonstrates that the RV transition welds at Davis-Besse satisfy the requirements of Appendix K to Section XI of the ASME Boiler and Pressure Vessel Code for low upper-shelf Charpy impact energy levels at 52 effective full power years (EFPY) of plant operation.

LRA Sections 4.2.1.3, "Beltline Evaluation," 4.2.2.2, "USE Projections," 4.2.2.3, "Equivalent Margins Analyses," Table 4.2-2, "USE Values at 52 EFPY for Davis Besse Reactor Vessel Beltline Materials," 4.8, "References," and A.2.2.2," Upper-Shelf Energy," are revised to include the results of the equivalent margins analyses for the RV beltline welds (i.e., nozzle belt forging to upper shell forging circumferential weld, the lower shell forging to Dutchman forging circumferential weld, nozzle belt forging to bottom of RV inlet nozzle forging welds and nozzle belt forging to bottom of RV outlet nozzle forging welds). The results of the equivalent margins analysis for the upper shell forging to lower shell forging circumferential weld (WF-182-1) were previously provided in Section 4.2.2.3 of the LRA. All RV beltline welds at Davis-Besse satisfy the ASME Code requirements of Appendix K for ductile flaw extensions and tensile stability at 52 EFPY.

See Enclosure A to this letter for the revision to the Davis-Besse LRA.

See Enclosure C to this letter for a copy of AREVA NP Calculation 32-9184568-000. This calculation document contains information that is classified by AREVA NP as proprietary, and is requested to be withheld from public disclosure pursuant to 10 CFR 2.390. See Enclosure B to this letter for an AREVA NP Affidavit requesting the withholding of the proprietary information from pubic disclosure in accordance with 10 CFR 2.390.

# Enclosure A

**Davis-Besse Nuclear Power Station, Unit No. 1 (Davis-Besse)**

**Letter L-12-335**

**Amendment No. 34 to the**
**Davis-Besse License Renewal Application**



**License Renewal Application**
**Sections Affected**

Section 4.2.1.3

Section 4.2.2.2

Section 4.2.2.3

Table 4.2-2

Section 4.8

Section A.2.2.2

The Enclosure identifies the change to the License Renewal Application (LRA) by Affected LRA Section, LRA Page No., and Affected Paragraph and Sentence. The count for the affected paragraph, sentence, bullet, etc. starts at the beginning of the affected Section or at the top of the affected page, as appropriate. Below each section the reason for the change is identified, and the sentence affected is printed in *italics* with deleted text ~~*lined-out*~~ and added text <u>*underlined*</u>.

| Affected LRA Section | LRA Page No. | Affected Paragraph and Sentence |
|---|---|---|
| **4.2.1.3** | **Page 4.2-3** | **3rd paragraph** |

Based on the supplemental response to request for additional information (RAI) 4.2.2-4 – Upper Shelf Energy (USE) Evaluation, the 3rd paragraph of LRA Section 4.2.1.3, “Beltline Evaluation,” is revised to read as follows:

For the period of extended operation, the beltline will include all items with 52 EFPY surface fluence greater than 1.0E+17 n/cm$^2$, as shown in Table 4.2-1. Upper-shelf energy (USE), reference temperature for pressurized thermal shock ($RT_{PTS}$) and adjusted reference temperature (ART) values are provided in Table 4.2-2, Table 4.2-3, and Table 4.2-4. *The limiting weld with regard to ~~USE,~~ ART~~,~~ and $RT_{PTS}$ is the upper shell to lower shell weld, WF-182-1, as was the case at 40 years.* The limiting forging with regard to ART and $RT_{PTS}$ is lower shell forging BCC 241 as was the case at 40 years. Both of these materials are included in the Reactor Vessel Surveillance Vessel Program and no additional materials are required for irradiation and testing. *In regard to USE, the 52 EFPY USE values for the reactor vessel beltline welds were conservatively assumed to be below 50 ft-lb and therefore, the welds were qualified by equivalent margins analysis. The reactor vessel beltline forgings were shown to have 52 EFPY USE values above 50 ft-lb with the reactor vessel inlet nozzle forging BSS 270 as the limiting location.*

| **Affected LRA Section** | **LRA Page No.** | **Affected Paragraph and Sentence** |
|---|---|---|
| **4.2.2.2** | **Page 4.2-5** | **Entire Section** |

Based on the supplemental response to RAI 4.2.2-4 – Upper Shelf Energy (USE) Evaluation, LRA Section 4.2.2.2, "USE Projections," is revised to read as follows:

### 4.2.2.2 USE Projections

***Reactor Vessel Beltline Forgings***

*For license renewal, the initial USE values for the reactor vessel beltline forgings are projected to 52 EFPY using Regulatory Guide 1.99, Revision 2, Position 1.2. Position 2.2, use of surveillance data, was also used for ~~weld WF-182-1 and~~ lower shell forging BCC 241.* Note that since there is only one capsule that has been tested that includes upper shell forging (AKJ 233), there is insufficient data to conduct surveillance data credibility assessments relative to Regulatory Guide 1.99, Revision 2 for forging AKJ 233.~~*Fluence is from Table 4.2-1.*~~

~~*All locations are above 50 ft-lb with the exception of weld WF-182-1.*~~ *The predicted USE is conservatively calculated based on a 1/4T fluence of 1.0E+18 n/cm$^2$ (the lowest fluence in Regulatory Guide 1.99, Revision 2, Figure 2), for the RV inlet nozzle forging ~~and attachment weld~~, the RV outlet nozzle forging ~~and attachment weld~~, and the Dutchman forging ~~and weld that connects the lower shell forging to the dutchman forging~~. The 52 EFPY USE values for the reactor vessel beltline forgings are above 50 ft-lb and therefore, an equivalent margins analysis is not required.* The results are presented in Table 4.2-2.

***Reactor Vessel Beltline Welds***

*The 52 EFPY USE values for the reactor vessel beltline welds were conservatively assumed to be below 50 ft-lb and therefore, required qualification by equivalent margins analysis. The beltline welds are listed in Table 4.2-2. See Section 4.2.2.3 for discussion of the equivalent margins analyses.*

| Affected LRA Section | LRA Page No. | Affected Paragraph and Sentence |
|---|---|---|
| **4.2.2.3** | **Page 4.2-5**<br>**Page 4.2-6**<br>**Page 4.2-7** | **1st paragraph;**<br>**Footnote 1; and,**<br>**New paragraphs** |

Based on the supplemental response to RAI 4.2.2-4 – Upper Shelf Energy (USE) Evaluation, the 1st paragraph and footnote 1 of LRA Section 4.2.1.3, "Beltline Evaluation," are revised, and new paragraphs are added to the end of the section, to read as follows (note that the entire section is reproduced below for clarity):

**4.2.2.3 Equivalent Margins Analyses**

***Upper Shell Forging to Lower Shell Forging Circumferential Weld (WF-182-1)***

*~~The limiting Davis-Besse reactor vessel beltline weld WF-182-1 is the only 60-year (52 EFPY) beltline location with a projected Charpy impact energy level below 50 ft-lbs.~~ The equivalent margins analysis (fracture mechanics evaluation) of weld WF-182-1 at Davis-Besse was extended from 40-years (32 EFPY) to 60-years (52 EFPY) based on the projected 52 EFPY neutron fluence values. The analysis demonstrates that ~~the limiting reactor vessel beltline weld at Davis-Besse~~ weld WF-182-1 satisfies the ASME Code requirements of Appendix K for ductile flaw extensions and tensile stability ~~using projected upper-shelf Charpy impact energy levels for the weld material~~ at 52 EFPY.*

The 52 EFPY fracture mechanics analysis addresses ASME Level A, B, C, and D Service Loadings and is performed using the procedures and acceptance criteria in Appendix K to Section XI of the ASME Code. Level C and D Service Loadings are evaluated using the one-dimensional, finite element, thermal and stress models and linear elastic fracture mechanics methodology of the PCRIT computer code to determine stress intensity factors for a worst case pressurized thermal shock transient.

In order to extend the 32 EFPY analysis to 52 EFPY, the calculations that are time dependent were identified and updated accordingly. It was confirmed that the analytical methodology and applied loadings have not changed. Key points of the analysis are summarized below.

Initial $RT_{NDT}$ was revised from +2 °F to -80.2 °F and margin from +56 °F to +59 °F (Revised initial $RT_{NDT}$ and margins for weld WF-182-1 were obtained from BAW-2308, Revision 1-A)[1]. All other mechanical properties are unchanged. The ASME transition region fracture toughness curve $K_{Ic}$, used to define the beginning of the upper-shelf toughness region, is indexed by the initial $RT_{NDT}$ of the weld material. The existing transition region fracture toughness curve evaluation is conservative for 52 EFPY since the initial $RT_{NDT}$ has decreased.

Projected inside surface fluence at 52 EFPY has increased, affecting the *J*-integral resistance of the material. Fluence at the crack tip is determined using the attenuation equation from Regulatory Guide 1.99, Revision 2.

The Hot Leg Large Break Loss of Coolant Accident (LOCA) is the limiting transient at 32 EFPY and 52 EFPY since it most closely approaches the $K_{Jc}$ limit of the weld. In the upper-shelf toughness range, the $K_I$ curve is closest to the lower bound $K_{Jc}$ curve at 5.60 minutes into the transient. This time is selected as the critical time in the transient at which to perform the flaw evaluation for Level C and D Service Loadings.

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[1] *~~FENOC submitted a request (FENOC Letter L-09-225 [Reference 4.8-16]) for exemption to use an alternate method, as described in approved topical report BAW-2308, Revision 1-A, for determining initial $RT_{NDT}$ values of the Linde 80 weld materials present in the beltline region of the Davis-Besse reactor pressure vessel.~~ The NRC required licensees to obtain an exemption from 10 CFR 50.61 and 10 CFR 50, Appendix G to use the alternate initial $RT_{NDT}$ values provided in BAW-2308 Revisions 1-A and 2-A. The required exemption was granted by the NRC by letter dated December 14, 2010 (ML103060213).*

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**Summary of Results for Level A, B, C and D Service Loadings at 52 EFPY**

Evidence that the ASME Code, Section XI, Appendix K acceptance criteria have been satisfied for Level A and B Service Loadings is provided by the following:

(1) With factors of safety of 1.15 on pressure and 1.0 on thermal loading, the applied *J*-integral ($J_1$) is less than the *J*-integral of the material at a ductile flaw extension of 0.10 in. ($J_{0.1}$). The ratio $J_{0.1}/J_1 = 3.69$ which is significantly greater than the required value of 1.0.

(2) With factors of safety of 1.25 on pressure and 1.0 on thermal loading, flaw extensions are ductile and stable since the slope of the applied *J*-integral curve is less than the slope of the lower bound *J-R* curve at the point where the two curves intersect.

Evidence that the ASME Code, Section XI, Appendix K acceptance criteria have been satisfied for Level C and D Service Loadings is provided by the following:

(1) With a factor of safety of 1.0 on loading, the applied J-integral ($J_1$) is less than the *J*-integral of the material at a ductile flaw extension of 0.10 in. ($J_{0.1}$). The ratio $J_{0.1}/J_1$ = 2.16, which is significantly greater than the required value of 1.0.

(2) With a factor of safety of 1.0 on loading, flaw extensions are ductile and stable since the slope of the applied *J*-integral curve is less than the slopes of both the lower bound and mean *J-R* curves at the points of intersection.

(3) Flaw growth is stable at much less than 75% of the vessel wall thickness. It has also been shown that the remaining ligament is sufficient to preclude tensile instability by a large margin.

***Nozzle Belt Forging to Upper Shell Forging Circumferential Weld and Lower Shell Forging to Dutchman Forging Circumferential Weld (also known as transition welds)***

*The equivalent margins analyses reported in topical reports BAW-2178P-A [Reference 4.8-2] and BAW-2192P-A [Reference 4.8-3] did not include fracture mechanics evaluations for the Davis-Besse transition welds. These welds were not considered to be limiting for Davis-Besse at 40 years of operation based on consideration of J-integral of the material as discussed in Section 5.2 of BAW-2192P-A. For license renewal, FENOC has elected to quantitatively evaluate the transition welds in accordance with the evaluation procedures and acceptance criteria of ASME Section XI, Appendix K, 2007 Edition with 2008 Addenda. Since the one-dimensional stress intensity factor formulations of Appendix K are directly applicable to only simple cylindrical shells, alternative solutions are developed from published solutions for circumferential surface flaws using location specific temperatures and stresses determined by two-dimensional finite element analysis of the transition regions. The equivalent margins analysis for the transition welds is documented in AREVA NP Calculation 32-9184568-000, "Equivalent Margins Assessment of Davis-Besse Transition Welds for 52 EFPY," dated August 30, 2012 [Reference 4.8-24].*

*The equivalent margins analysis demonstrates that the transition welds at Davis-Besse satisfy the ASME Code requirements of Appendix K for ductile flaw extensions and tensile stability at 52 EFPY.*

***Summary of Results for Level A, B, C and D Service Loadings at 52 EFPY***

*Evidence that the ASME Code, Section XI, Appendix K acceptance criteria have been satisfied for Level A and B Service Loadings for the transition welds is provided by the following:*

(1) *With factors of safety of 1.15 on pressure and 1.0 on thermal loading, the applied J-integral ($J_1$) is less than the J-integral of the material at a ductile flaw extension of 0.10 in. ($J_{0.1}$) for both upper and lower transition welds. The ratio $J_{0.1}/J_1 = 3.58$ for the upper transition weld and ratio $J_{0.1}/J_1 = 3.67$ for the lower transition weld, which are significantly greater than the required value of 1.0.*

(2) *With factors of safety of 1.25 on pressure and 1.0 on thermal loading, flaw extensions are ductile and stable since the slopes of the applied J-integral curves are less than the slopes of the lower bound J-R curves at the points of intersection.*

*Evidence that the ASME Code, Section XI, Appendix K acceptance criteria have been satisfied for Level C and D Service Loadings for transition welds is provided by the following:*

(1) *With a factor of safety of 1.0 on loading, the applied J-integral ($J_1$) is less than the J-integral of the material at a ductile flaw extension of 0.10 in. ($J_{0.1}$) for both the upper and lower transition welds. The ratio $J_{0.1}/J_1 = 3.15$ for the upper transition weld and ratio $J_{0.1}/J_1 = 4.73$ for the lower transition weld, which are significantly greater than the required value of 1.0.*

(2) *With a factor of safety of 1.0 on loading, flaw extensions are ductile and stable since the slopes of the applied J-integral curves are less than the slopes of the lower bound J-R curves at the points of intersection.*

(3) *Flaw growth is stable at much less than 75% of the vessel wall thickness for the upper and lower transition welds. In addition, the remaining ligaments are sufficient to preclude tensile instability by a large margin.*

***Nozzle Belt Forging to Bottom of Reactor Vessel Inlet Nozzle Forging Welds and Nozzle Belt Forging to Bottom of Reactor Vessel Outlet Nozzle Forging Welds (also known as nozzle welds)***

*The equivalent margin analysis for the nozzle welds is documented in AREVA NP Calculation 32-9110426-000, "DB-1 EMA of RPV Inlet & Outlet Nozzle-to-Shell Welds for 60 Years," dated May 28, 2010 [Reference 4.8-25].*

*The nozzle welds were evaluated for low upper-shelf energy levels by linear elastic fracture mechanics analytical techniques to satisfy the requirements of ASME Section XI, Appendix K, 1995 Edition through 1996 Addenda. The primary* *coolant 28" inlet and 36" outlet nozzles are similar in that the full penetration attachment welds are located in the 12" thick nozzle belt forging (NBF) section of the reactor vessel shell. Envelope stresses from outlet and inlet nozzles for attached pipe loads were considered. Due to the close proximity of the larger diameter outlet nozzle to the reactor core, the outlet nozzle welds are subjected to higher levels of fluence than the inlet nozzle welds and lower J-integral of materials. Stresses were used to characterize Level A and B Service Loadings. Previously derived pressure stresses were used to analyze the nozzle-to-nozzle belt interface area for Level C and D Service Loadings. Thermal stresses for Level C and D Service Loadings were developed using for the most limiting transient for the nozzle belt forging section.*

*The equivalent margins analysis demonstrates that the nozzle welds at Davis-Besse satisfy the ASME Code requirements of Appendix K for ductile flaw extensions and tensile stability at 52 EFPY.*

***Summary of Results for Level A, B, C and D Service Loadings at 52 EFPY***

*Evidence that the ASME Code, Section XI, Appendix K acceptance criteria have been satisfied for Level A and B Service Loadings for the nozzle welds is provided by the following (results are for outlet nozzle welds, which are limiting):*

(1) *With a factor of safety of 1.15 on pressure and 1.0 on thermal loading, the applied J-integral ($J_1$) is less than the J-integral of the material at a ductile flaw extension of 0.10 in. ($J_{0.1}$). The ratio $J_{0.1}/J_1$ = 1.27, which is greater than the required value of 1.0.*

(2) *With a factor of safety of 1.25 on pressure and 1.0 on thermal loading, flaw extensions are ductile and stable since the slope of the applied J-integral curve is less than the slope of the lower bound J-R curve at the points of intersection.*

*Evidence that the ASME Code, Section XI, Appendix K acceptance criteria have been satisfied for Level C and D Service Loadings for the nozzle welds is provided by the following (results are for outlet nozzle welds, which are limiting):*

(1) *With a factor of safety of 1.0 on loading, the applied J-integral ($J_1$) is less than the J-integral of the material at a ductile flaw extension of 0.10 in. ($J_{0.1}$). The ratio $J_{0.1}/J_1$ = 1.20, which is greater than the required value of 1.0.*

(2) *With a factor of safety of 1.0 on loading, flaw extensions are ductile and stable since the slopes of the applied J-integral curves are less than the slopes of the lower bound J-R curves at the points of intersection.*

(3) *Flaw growth is stable at much less than 75% of the vessel wall thickness for the upper and lower transition welds. In addition, the remaining ligament is sufficient to preclude tensile instability by a large margin.*

*The ~~limiting reactor vessel beltline weld~~ reactor vessel beltline welds at Davis-Besse ~~satisfies~~ satisfy the ASME Code requirements of Appendix K for ductile flaw extensions and tensile stability ~~using projected upper-shelf Charpy impact energy levels for the weld material~~ at ~~32 EFPY and~~ 52 EFPY.*

**Disposition:** 10 CFR 54.21(c)(1)(ii) Reactor vessel USE and equivalent margin analyses have been projected to the end of the period of extended operation in accordance with 10 CFR 54.21(c)(1)(ii).

| Affected LRA Section | LRA Page No. | Affected Paragraph and Sentence |
|---|---|---|
| **Table 4.2-2** | **Page 4.2-8** | **Reactor Vessel Weld rows; and, Footnote 3** |

Based on the supplemental response to RAI 4.2.2-4 – Upper Shelf Energy (USE) Evaluation, LRA Table 4.2-2, "USE Values at 52 EFPY for Davis-Besse Reactor Vessel Beltline Materials," is revised to read as follows:

**Table 4.2-2 USE Values at 52 EFPY for Davis-Besse Reactor Vessel Beltline Materials**

(RG 1.99 Position 1.2, Unless Otherwise Noted)

| Item | Material Type | Material ID. | USE @ 52 EFPY at 1/4T, ft-lbs | 1/4T Neutron Fluence, n/cm$^2$, E>1MeV | Unirradiated USE, ft-lbs | % Drop in USE @ EOL 1/4T | Cu, % |
|---|---|---|---|---|---|---|---|
| **Reactor Vessel Welds** | | | | | | | |
| Nozzle Belt Forging to Bottom of Reactor Vessel Inlet Nozzle Forging | Linde 80 | WF-233 / 232 | ~~55.8~~ <50[3] | ~~1.00E+18[1]~~ NA[3] | ~~70~~ NA[3] | ~~20.3~~ NA[3] | ~~0.21~~ NA[3] |
| Nozzle Belt Forging to Bottom of Reactor Vessel Outlet Nozzle Forging | Linde 80 | WF-233 | ~~55.8~~ <50[3] | ~~1.00E+18[1]~~ NA[3] | ~~70~~ NA[3] | ~~20.3~~ NA[3] | ~~0.21~~ NA[3] |
| Nozzle Belt Forging to Upper Shell Forging Circumferential Weld (inner 9%) | Linde 80 | WF-232 | ~~NA[3]~~ <50[3] | NA[3] | ~~70~~ NA[3] | NA[3] | ~~0.18~~ NA[3] |
| Nozzle Belt Forging to Upper Shell Forging Circumferential Weld (outer 91%) | Linde 80 | WF-233 | ~~54.8~~ <50[3] | ~~1.34E+18~~ NA[3] | ~~70~~ NA[3] | ~~21.7~~ NA[3] | ~~0.21~~ NA[3] |
| Upper Shell Forging to Lower Shell Forging Circumferential Weld | Linde 80 | WF-182-1 | ~~43.5~~ ~~43.4[2]~~ <50[3] | ~~9.87E+18~~ ~~9.87E+18~~ NA[3] | ~~70~~ ~~70~~ NA[3] | ~~37.9~~ ~~38.0[2]~~ NA[3] | ~~0.24~~ ~~0.24~~ NA[3] |
| Lower Shell Forging to Dutchman Forging Circumferential Weld (inner 12%) | Linde 80 | WF-232 | ~~NA[3]~~ <50[3] | NA[3] | ~~70~~ NA[3] | NA[3] | ~~0.18~~ NA[3] |
| Lower Shell Forging to Dutchman Forging Circumferential Weld (outer 88%) | Linde 80 | WF-233 | ~~55.8~~ <50[3] | ~~1.00E+18[1]~~ NA[3] | ~~70~~ NA[3] | ~~20.3~~ NA[3] | ~~0.21~~ NA[3] |

[3] ~~*Location does not extend to 1/4T*~~ *The 52 EFPY USE values for the reactor vessel beltline welds were conservatively assumed to be below 50 ft-lb and therefore, required qualification by equivalent margins analysis. Percent (%) drop in USE evaluation for the beltline welds is not applicable (NA).*

| Affected LRA Section | LRA Page No. | Affected Paragraph and Sentence |
|---|---|---|
| **4.8** | **Page 4.8-2** | **2 new references** |

Based on the supplemental response to RAI 4.2.2-4 – Upper Shelf Energy (USE) Evaluation, LRA Section 4.8, "References," previously revised by FENOC letters dated April 15, 2011 (ML11109A083), August 17, 2011 (ML11231A966) and August 24, 2012, is revised to add 2 new references, to read as follows:

*4.8-24 AREVA NP Calculation 32-9184568-000, "Equivalent Margins Assessment of Davis Besse Transition Welds for 52 EFPY," dated August 30, 2012*

*4.8-25 AREVA NP Calculation 32-9110426-000, "DB-1 EMA of RPV Inlet & Outlet Nozzle-to-Shell Welds for 60 Years," dated May 28, 2010*

| Affected LRA Section | LRA Page No. | Affected Paragraph and Sentence |
|---|---|---|
| **A.2.2.2** | **Pages A-31 and A-32** | **Entire Section** |

Based on the supplemental response to RAI 4.2.2-4 – Upper Shelf Energy (USE) Evaluation, LRA Section A.2.2.2, "Upper-Shelf Energy," is revised to read as follows:

### A.2.2.2 Upper-Shelf Energy

10 CFR 50 Appendix G requires the USE for the reactor vessel beltline materials to be no less than 50 ft-lb at all times during plant operation, including the effects of neutron radiation. *If USE cannot be shown to remain above this limit, then an equivalent margins analysis (EMA) must be performed to show that the margins of safety against fracture are equivalent to those required by Appendix G of ASME Section XI.* ~~*Initial (unirradiated) USE values for the Davis-Besse reactor vessel are recorded in USAR Table 5.2-15. As no initial USE is available for the beltline welds (Linde80 welds), operation for 32 EFPY was justified based on an equivalent margins analysis (fracture mechanics analysis).*~~

***Reactor Vessel Beltline Forgings***

For license renewal, the initial USE values are projected to 52 EFPY using Regulatory Guide 1.99, Revision 2, Position 1.2. *Position 2.2, use of surveillance data, was also used for* ~~*weld WF-182-1 and*~~ *the lower shell forging BCC 241.* ~~*All locations are above 50 ft lb with the exception of weld WF-182-1.*~~ *The 52 EFPY USE values for the reactor vessel beltline forgings are above 50 ft-lb and therefore, an equivalent margins analysis is not required.*

~~*The limiting reactor vessel beltline weld WF-182-1 is the only 60-year (52 EFPY) beltline location with a projected Charpy impact energy level below 50 ft-lbs. The fracture mechanics evaluation of weld WF-182-1 was extended from 40 years (32 EFPY) to 60 years (52 EFPY) based on the projected 52 EFPY neutron fluence values. The analysis demonstrates that the limiting reactor vessel beltline weld satisfies the ASME Code requirements of Appendix K for ductile flaw extensions and tensile stability using projected upper-shelf Charpy impact energy levels for the weld material at 52 EFPY.*~~

***Reactor Vessel Beltline Welds***

*The 52 EFPY USE values for the reactor vessel beltline welds were conservatively assumed to be below 50 ft-lb at 52 EFPY and therefore, required qualification by equivalent margins analysis. Equivalent margins analyses performed for the reactor vessel beltline welds demonstrated that the welds satisfied the ASME Code requirements of Appendix K for ductile flaw extensions and tensile stability at 52 EFPY.*

*Reactor vessel USE and the equivalent margin analyses have been projected to the end of the period of extended operation in accordance with 10 CFR 54.21(c)(1)(ii).*

# Enclosure B

**Davis-Besse Nuclear Power Station, Unit No. 1 (Davis-Besse)**

**Letter L-12-335**

**<u>Affidavit for</u>**
**<u>Calculation No. 32-9184568-000,</u>**
**<u>"Equivalent Margins Assessment of Davis-Besse Transition Welds for 52 EFPY"</u>**

3 pages follow

# AFFIDAVIT

COMMONWEALTH OF VIRGINIA )
) ss.
COUNTY OF CAMPBELL )

1. My name is Gayle F. Elliott. I am Manager, Product Licensing, for AREVA NP Inc. (AREVA NP) and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA NP to determine whether certain AREVA NP information is proprietary. I am familiar with the policies established by AREVA NP to ensure the proper application of these criteria.

3. I am familiar with the AREVA NP information contained in the Calculation Summary Sheet 32-9184568-000, "Equivalent Margins Assessment of Davis Besse Transition Welds for 52 EFPY," and referred to herein as "Document." Information contained in this Document has been classified by AREVA NP as proprietary in accordance with the policies established by AREVA NP for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA NP and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information":

6. The following criteria are customarily applied by AREVA NP to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA NP's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA NP.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA NP in product optimization or marketability.

(e) The information is vital to a competitive advantage held by AREVA NP, would be helpful to competitors to AREVA NP, and would likely cause substantial harm to the competitive position of AREVA NP.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b) and 6(c) above.

7. In accordance with AREVA NP's policies governing the protection and control of information, proprietary information contained in this Document has been made available, on a limited basis, to others outside AREVA NP only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA NP policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

SUBSCRIBED before me this 5th
day of September 2012.

Kathleen A. Bennett
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES: 8/31/2015
Reg. #110864

KATHLEEN ANN BENNETT
Notary Public
Commonwealth of Virginia
110864
My Commission Expires Aug 31, 2015