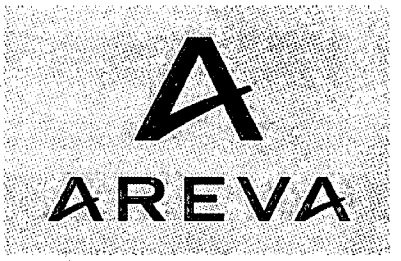

May 6, 2009
NRC:09:050

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

Response to U.S. EPR Design Certification Application RAI No. 160, Supplement 1

Ref. 1: E-mail, Getachew Tesfaye (NRC) to Ronda Pederson, et al (AREVA NP Inc.), "U.S. EPR Design Certification Application RAI No. 160 (1403), FSAR Ch. 3," January 23, 2009 (Accession No. ML090230695).

Ref. 2: E-mail, Ronda M. Pederson (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 160, FSAR Ch. 3," February 23, 2009 (Accession No. ML090540838).

In Reference 1, the NRC provided a request for additional information (RAI) regarding the U.S. EPR design certification application (i.e., RAI No. 160). In Reference 2, AREVA NP Inc. (AREVA NP) indicated that the response to two questions (i.e., 03.09.02-25 and 03.09.02-26) would be provided by May 14, 2009. Accordingly, a technically correct and complete response to RAI No. 160, Supplement 1, Questions 03.09.02-25 and 03.09.02-26 is enclosed with this letter.

The following table indicates the respective page(s) in the enclosure that contains AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 160—03.09.02-25	2	4
RAI 160—03.09.02-26	5	5

Also enclosed are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 160, Supplement 1, Question 03.09.02-25.

This concludes the formal AREVA NP response to RAI 160, and there are no questions from this RAI for which AREVA NP has not provided responses.

AREVA NP considers some of the material contained in the enclosure to be proprietary. As required by 10 CFR 2.390(b), an affidavit is enclosed to support the withholding of the information from public disclosure. Proprietary and non-proprietary versions of the enclosure to this letter are provided.

D077
NRO

AREVA NP INC.
An AREVA and Siemens company
3315 Old Forest Road, P.O. Box 10935, Lynchburg, VA 24506-0935
Tel.: (434) 832-3000 - Fax: (434) 832-3840

If you have any questions related to this submittal, please contact me. I may be reached by telephone at 434-832-2369 or by e-mail at sandra.sloan@areva.com.

Sincerely,

for SMS

Sandra M. Sloan, Manager
New Plants Regulatory Affairs
AREVA NP Inc.

Enclosures

cc: G. Tesfaye
Docket 52-020

AFFIDAVIT

COMMONWEALTH OF VIRGINIA)
) ss.
COUNTY OF CAMPBELL)

1. My name is Ronda M. Pederson. I am Licensing Manager, U.S. EPR Design Certification, Regulatory Affairs for New Plants, for AREVA NP Inc. 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 "Response to U.S. EPR Design Certification Application RAI No. 160, Supplement 1" 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 6th

day of May, 2009.

Kathleen A. Bennett
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES: 8/31/2011

KATHLEEN ANN BENNETT
Notary Public
Commonwealth of Virginia
110864
My Commission Expires Aug 31, 2011

Response to

Request for Additional Information No. 160, Supplement 1

01/23/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.09.02 - Dynamic Testing and Analysis of Systems Structures and Components
Application Section: RAI 3.9.2-1

QUESTIONS for Engineering Mechanics Branch 1 (AP1000/EPR Projects) (EMB1)

Question 03.09.02-25:

The applicant concluded in FSAR Tier 2, Section 3.9.2.4 that, based on operational experience, U.S. EPR SG components will not be subject to excessive vibration, and therefore no flow induced vibration analyses or startup testing is planned. However, changes in the U.S. EPR design due to increased power level introduce differences that may challenge the applicant's premise that flow induced vibration analyses or startup testing is not required. The applicant is requested to identify differences between the steam generator upper internals and flow conditions in the U.S. EPR design and those in the 'similar' plants cited by the applicant and explain why these differences will result in a similar and problem-free vibration response such that no flow induced vibration (FIV) analyses or startup testing is required. When FIV response results from other reactors are used to predict EPR component responses, provide complete justifications for the structural and flow similarities between the EPR and the other reactors for each EPR reactor component. The structural justifications should include discussions of geometry, mass distribution, and boundary conditions, modal frequencies, mode shapes, modal masses, and modal damping. The fluid flow justifications should include discussions of pressure amplitudes, frequencies, spatial and time distributions and their correlations, the flow properties, the flow velocity vector fields, the flow regimes and the turbulent characteristics of the flow, and the potential FIV forcing functions and mechanisms.

Response to Question 03.09.02-25:

The U.S. EPR steam generator (SG) upper internal consists of two primary components: the two stage primary steam separators (cyclone, type S 335-2) and the steam dryers (STAR type). The STAR steam dryer design of the operating plants is similar to the U.S. EPR in terms of their material specification, geometry, support configuration, and the velocity of steam flow through these components. Table 03.09.02-25-1—Comparison of U.S. EPR SG Steam Dryers to Other Operating Plants provides a summary of the operational experience for the STAR type SG dryers and presents design information that justifies their excitation resulting from the turbulent flow conditions integrity. Table 03.09.02-25-1 shows that the secondary side mass flow rate and the density entering the steam drum is approximately the same for the U.S. EPR and other plants with the same SG dryer design. Excessive vibration due to axial leakage is not possible because of the open flow design of the steam dryers. Therefore, the operational experience and geometry of the dryers preclude the need for startup testing and full scale analysis as described in RG 1.20.

Separators have been used in operating plants without being subject to excessive vibrations. While the separators perform a similar function, the geometry and flow characteristics of the steam separators in operating AREVA SG designs is not identical to the S 335-2 steam separator design of the U.S. EPR. Therefore, in lieu of a comparative justification, AREVA NP performed a flow induced vibration (FIV) analysis of the steam separator design; which determined that the steam separators are not subjected to excessive vibration. A summary of this FIV analysis is provided below.

The FIV analyses of the separators used an upper bound convective velocity equal to the mean free stream velocity and an upper bound correlation length equal to the hydraulic radius of the pipe-separator assembly. A power spectral density (PSD) function applicable to single phase turbulent flow in piping systems was used. Because the PSD of single phase flow is generally greater than that for the two phase flow in the U.S. EPR SG steam separators, this approach is conservative. The analytical results of the analysis show that these components are not

susceptible to excessive vibrations, considering the upper bound conservative inputs. This conclusion precludes any need for startup testing and full scale analysis per RG 1.20.

Excessive vibrations due to acoustic resonances as a result of flow in attached piping systems are eliminated by verifying that the piping systems are screened for phenomenon in the design phase. The methodology that predicts this source of acoustic excitation and its potential excitation of the structural components of the SG upper internals is provided in Reference 1. As stated in U.S. EPR FSAR Tier 2, Section 3.9.2.4, the main steam and main feedwater piping systems attached to the SG will be instrumented with permanent sensors to measure and monitor pipe vibrations during startup testing and during the service life of the plant. If unexpected vibrations resulting from acoustic resonance are observed in these piping systems during initial plant startup testing, the sources of excitation upon the SG internal components and piping systems will be appropriately addressed.

The U.S. EPR SG upper internals are evaluated for secondary side flow excitation resulting from random turbulence, vortex-shedding, axial leakage, and acoustic resonances. The conclusions of these evaluations show that the U.S. EPR SG upper internals are not subject to excessive vibration due to these mechanisms. Supporting information for the FIV evaluations of these components is available for NRC inspection.

U.S. EPR FSAR Tier 2, Section 3.9.2.4 will be revised to indicate that the basis for determining that the U.S. EPR SG upper internals are not subject to excessive vibration is based on both operational experience and analysis of the SG upper internals.

Reference for Question 03.09.02-25:

1. R.M. Baldwin and H.R. Simmons, "Flow-Induced Vibration in Safety Relief Valves," ASME Journal of Pressure Vessel Technology, Volume 108/267, August 1986.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.9.2.4 will be revised as described in the response and indicated on the enclosed markup.

Table 03.09.02-25-1—Comparison of U.S. EPR SG Steam Dryers to Other Operating Plants

Parameter	Doel Unit 4 and Tihange Unit 3	CZB Unit 1 and CV Unit 2	Olkiluoto Unit 3	U.S. EPR
SG Design	79/19T	73/19TE	79/19TE	79/19TE
Number of SGs per Unit	3	4	4	4
Operating Since	1996 (Doel-4) 1998 (TH-3)	1996 (CZB1) 1999 (CV2)	N/A	N/A
Power Level (Mwt per SG)	1000	1067.5	1081.5	1154

Question 03.09.02-26:

The applicant stated in FSAR Tier 2 Section 3.9.2.4, that the U.S. EPR SG upper internals are non-safety-related components and will not experience excessive vibration. However, industry experience indicates that flow-induced resonances may occur in SG systems, particularly those caused by flow over side-branch openings in the steam lines, such as those in the standpipes connected to valves. As is noted in RG 1.20, flow-excited and structural resonances are sensitive to minor changes in arrangement, design, size, and operating conditions. It is unclear to the staff if these sensitivities have been adequately addressed by the applicant. The applicant is requested to explain which U.S. EPR operating conditions could lead to resonance conditions in the SGs and discuss how the startup test plan will demonstrate that no flow-induced resonance effects will occur during the design life of the plant that could lead to excessive vibration and damage to components in the steam generation system.

Response to Question 03.09.02-26:

See the Response to Question 03.09.02-25.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

U.S. EPR Final Safety Analysis Report Markups

are considered structurally adequate. If such indications are detected, further evaluation is required.

The testing and visual inspection plan to be used for the prototype RPV internals at Olkiluoto-3 involves visual inspections before and after the preoperational tests of the internals. These visual examinations are concerned with the accessible areas of the internals, and in particular the fastening devices, the bearings surfaces, the interfaces between the RPV internal parts that are likely to experience relative motions, and the inside of the RPV. Inspections of the lower and upper RPV internals are described in Tables 3.9.2-1, through 3.9.2-5—Visual Inspection of the Inside of the RPV Head While on the Storage Stand.

The RPV internals flow-induced vibration measurement program is conducted during preoperational tests of the Olkiluoto-3 and U.S. EPR reactors. The U.S. EPR RPV internals testing and inspection programs conform to RG 1.20.

RG 1.20, Revision 3, recommends that the potential adverse effects from pressure fluctuations and vibrations in piping systems should be considered for the steam generator (SG) internals for both PWRs and BWRs. The U.S. EPR SG upper internals (e.g., steam dryers, separators) are subject to secondary side steam flow. Although there are instances of these components in BWR plant designs experiencing excessive vibration resulting from plant power uprate, to date none have been reported for PWR SG designs both internationally or within the United States. This is further supported by a review of the INPO steam generator operating experience database which also does not have any events related to vibration problems for PWR SG upper internals. In response to public comments on the proposed revisions to RG 1.20 (i.e., DG-1163), the NRC states: "In addition to BWR plants, the pressurized-water reactor (PWR) at the Palo Verde plant experienced degradation from excess vibration that had characteristics similar to those of the phenomenon affecting the BWR plants." However, AREVA NP understands that the excessive vibrations associated with the shut down coolant pipe at the Palo Verde plant did not lead to vibration problems with the SG upper internals.

03.09.02-25

The design of the U.S. EPR SG upper internals and the flow conditions for which they are subjected are similar to the existing and currently operating SGs in the United States and Europe. Based on operational experience and analysis of the SG upper internals, AREVA NP concludes that these non-safety-related components will not experience excessive vibration. Therefore, no flow-induced vibration analyses or startup testing is currently planned for these components.

The vibration of representative trains of piping attached to the RCS as well as main steam and main feedwater lines are measured during initial startup testing. These measurements will be taken at discrete piping locations and also at the other key components (e.g., valves and pumps) installed along the length of pipe. Accelerations