

ArevaEPRDCPEm Resource

From: Tesfaye, Getachew
Sent: Friday, June 05, 2009 8:34 PM
To: 'usepr@areva.com'
Cc: Spicher, Terri; Dixon-Herrity, Jennifer; Patel, Jay; Miernicki, Michael; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: Draft - U.S. EPR Design Certification Application RAI No. 245 (2981, 3036), FSAR Ch. 3
Attachments: Draft RAI_245_EMB1_2981_3036.doc

Attached please find draft RAI No. 245 regarding your application for standard design certification of the U.S. EPR. If you have any question or need clarifications regarding this RAI, please let me know as soon as possible, I will have our technical Staff available to discuss them with you.

Please also review the RAI to ensure that we have not inadvertently included proprietary information. If there are any proprietary information, please let me know within the next ten days. If I do not hear from you within the next ten days, I will assume there are none and will make the draft RAI publicly available.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-336

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 557

Mail Envelope Properties (C56E360E9D804F4B95BC673F886381E71FB9740E25)

Subject: Draft - U.S. EPR Design Certification Application RAI No. 245 (2981, 3036),
FSAR Ch. 3
Sent Date: 6/5/2009 8:34:19 PM
Received Date: 6/5/2009 8:34:17 PM
From: Tesfaye, Getachew

Created By: Getachew.Tesfaye@nrc.gov

Recipients:

"Spicher, Terri" <Terri.Spicher@nrc.gov>
Tracking Status: None
"Dixon-Herrity, Jennifer" <Jennifer.Dixon-Herrity@nrc.gov>
Tracking Status: None
"Patel, Jay" <Jay.Patel@nrc.gov>
Tracking Status: None
"Miernicki, Michael" <Michael.Miernicki@nrc.gov>
Tracking Status: None
"Colaccino, Joseph" <Joseph.Colaccino@nrc.gov>
Tracking Status: None
"ArevaEPRDCPEm Resource" <ArevaEPRDCPEm.Resource@nrc.gov>
Tracking Status: None
"usepr@areva.com" <usepr@areva.com>
Tracking Status: None

Post Office: HQCLSTR02.nrc.gov

Files	Size	Date & Time
MESSAGE	726	6/5/2009 8:34:17 PM
Draft RAI_245_EMB1_2981_3036.doc		86010

Options

Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Draft

Request for Additional Information No. 245 (2981, 3036), Revision 0

6/5/2009

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
SRP Section: 03.09.04 - Control Rod Drive Systems
Application Section: 3.9

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

03.09.02-40

Follow-up to RAI Question 03.09.02-12

In **RAI Question 03.09.02-12**, the staff requested the applicant to provide a list of selected locations in the piping system at which visual inspections and measurements (as needed) will be performed during testing. The applicant responded to **RAI Question 03.09.02-12** in their Response to Request for Additional Information No. 160, Revision 0, by stating that SRP 3.9.2, subsection II.1, Acceptance Criteria C states that an acceptable test program will include a list of selected locations in a piping system at which visual inspections and measurements will be performed during the tests. These locations will be at pipe supports, particularly supports with allowances for free thermal movements (e.g., spring and snubber supports). The criteria for determining these locations are described in U.S EPR FSAR Tier 2, Section 3.9.2.1. Additionally, this FSAR section states: "Specific information concerning the locations where visual inspection or measurements are to be taken is also addressed in the applicable test procedures." The staff could not identify the locations in test procedures cited by the applicant. Based on the applicant's response, the staff determined that a list of the selected locations as required and requested has not been provided. Therefore, the staff is initiating a follow-up RAI requesting the locations where visual inspections or measurements will be taken.

03.09.02-41

Follow-up to RAI Question 03.09.02-15

In **RAI Question 03.09.02-15**, the staff requested the applicant to explain how Level A and B vibration loading is addressed in the analysis of U.S. EPR piping systems and if excessive system vibration mitigation and corrective actions results in additional testing. The applicant responded to **RAI Question 03.09.02-15** in their Response to Request for Additional Information No. 160, Revision 0 by stating that the vibration monitoring evaluation method VMG-2, as described in Reference 3 of U.S. EPR FSAR Tier 2, Section 3.9.2.7, is used to evaluate the Level A and Level B vibrations in the U.S. EPR piping systems. VMG-2 is the method by which the vibration is evaluated, involving beam calculations of the piping to develop conservative criteria for vibration velocity and displacement based on limiting the stress to the fatigue stress limit. As stated in U.S.

EPR FSAR Tier 2, Section 3.9.2.1.1, in the event that vibrations arising from Level A or Level B loads in Phase I and Phase II tests are observed to be excessive when compared to those computed using the VMG-2 method, more detailed analyses based on VMG-1 methodology may be performed to demonstrate the acceptability of measured vibrations. If unacceptable results are obtained, appropriate corrective actions will be performed and included in the results of the comprehensive vibration assessment program, which is the responsibility of the COL holder as noted in U.S. EPR FSAR Tier 2, Table 1.8-2. The staff reviewed the applicant's response and could not determine if the applicant will perform additional testing after corrective action is taken. In addition, a reference to a comprehensive vibration program that includes piping vibration assessment was not identified in U.S. EPR FSAR Tier 2, Table 1.8-2. Therefore, the staff is initiating this RAI to request that further information be provided regarding additional testing after corrective action is taken.

03.09.02-42

Follow-up to RAI Question 03.09.02-16

In **RAI Question 03.09.02-16**, the staff requested the applicant to provide clarification of how piping attached to the reactor cooling system (RCS) was selected for measurement, the required specifications for the handhelds, and discussion for the plans for their use in characterizing the piping system response relative to the analytical predictions. The applicant responded to **RAI Question 03.09.02-16** in their Response to Request for Additional Information No. 160, Revision 0, by stating that representative piping systems attached to the RCS are monitored by hand held devices and are selected based upon their acoustic connection with the RCS system through acoustic pressure fluctuations.

Specifications for hand held devices will be in accordance with the vendor recommendations at the time they are procured. In accordance with the guidance of RG 1.20, Revision 3, the details of the vibration measurement program, including the specifications for the handheld devices, will be included in the comprehensive vibration assessment report which is the responsibility of the COL holder as noted in U.S. EPR FSAR Tier 2, Table 1.8-2. Regarding clarification of how the piping systems are selected, the applicant stated that the representative piping systems are selected based upon their acoustic connection with the RCS system through acoustic pressure fluctuations.

The staff noted that the applicant was also requested to provide the "required specifications" for the handhelds. The "required specifications" refers to requirements that will be used to identify an appropriate device. The "required specifications" for measurement devices is set by the intended use; that is, the environment operated in and the phenomenon that is intended to be measured. The actual device procured may be equal to or better than this "required specification." Further, to evaluate the appropriateness of the device requirements and their use in this application, the applicant was requested to provide discussion of the plans for their using in characterizing the piping system response relative to the analytical predictions. To propose the use of the device, the applicant must possess a more detailed conception of how the handheld device use will enable adequate description of the vibratory response of the piping systems attached to the RCS. In addition, a reference to a comprehensive vibration program that includes a review of vibration measurement devices for piping was not identified in U.S. EPR FSAR Tier 2, Table 1.8-2. Therefore, the staff is initiating this RAI requesting further clarification of how piping attached to the reactor cooling

system (RCS) was selected for measurement, the required specifications for the handhelds, and discussion for the plans for their use in characterizing the piping system response relative to the analytical predictions.

03.09.02-43

Follow-up to RAI Question 03.09.02-17

In **RAI Question 03.09.02-17**, the staff requested the applicant to justify the use of representative trains instead of all lines encompassing the RCS in the assessment of flow-excited acoustic and structural resonances or other self-excited responses given that flow-excited acoustic and structural resonances are sensitive to small changes in the construction of even supposedly identical systems. The staff reviewed the applicant's response and was unable to determine how a problem will be localized. As a follow-up, this RAI is initiated and requests the applicant to explain how they will localize a problem area so that corrective action can be taken. Further, flow excited acoustic resonances are sensitive to small changes in plant construction and operating conditions. The applicant has only indicated plans to test "representative" piping trains at full-power conditions. Sensitivity to small changes suggests that so-called representative piping trains will not be "representative." Additionally, at conditions just below and just above that range of conditions where the lock-in occurs, local vibratory response can be high without coupling system wide. Measurements schemes that depend upon system wide response to determine unacceptably high response may not detect locally high levels. In addition, the applicant is requested to describe plans for assuring that measuring representative piping systems will capture excessive vibration in the remaining piping systems.

03.09.02-44

Follow-up to RAI Question 03.09.02-17

An additional follow-up to RAI 03.09.02-17 is required. The applicant stated in the response to **RAI Question 03.09.02-17** that U.S. EPR FSAR Tier 2, Section 3.9.2.4 describes that the RCS, main steam, and main feedwater systems are measured for vibration during initial start-up testing. This section also states the main steam and main feedwater systems will be instrumented with permanent sensors during the operating life of the plant. The staff agrees that if the main steam and main feedwater systems are permanently instrumented and should be capable of identifying acoustic resonances throughout the affected system.

The applicant was requested to discuss how pressure fluctuations would be measured and analyzed to determine loads on any safety related or critical structures. The applicant responded by stating that the details of the vibration measurement, including the use of test results, would be addressed by the COL holder. The staff noted that this position and discussion of the planned pressure instrumentation and the plans for analyzing the pressures to compute loads are not dependent upon the results from the comprehensive RPV vibration assessment program referenced in U.S. EPR FSAR Tier 2, Table 1.8-2, Item 3.9-1. Therefore the staff determined that the applicant is required to provide additional information to complete the review of how pressure fluctuations

would be measured and analyzed. Therefore, the staff is initiating this RAI requesting further information on the measurement and analysis of pressure fluctuations.

03.09.02-45

Follow-up to RAI Question 03.09.02-24

In **RAI Question 03.09.02-24**, the staff requested the applicant to:

- a. Provide details of the preoperational vibration and test program which is consistent with the NUREG 0800, SRP Section 3.9.2 subsection II.4 for a prototype. The information requested includes test conditions (e.g. flow conditions, power levels, and temperatures), transducer types, specifications and locations, and methods for preparing the data for comparisons to both the acceptance criteria and the analytical predictions from FSAR Tier 2 Section 3.9.2.3. The applicant is also requested to provide the vibration prediction, test acceptance criteria and bases, and permissible deviations from the criteria prior to the tests. Finally, the applicant should provide a listing of the major reactor internal components that would be subjected to flow induced vibration testing.
- b. The applicant has expressed the intent to recategorize the U.S. EPR as a Non-prototype Category I with the Olkiluoto-3 reactor, currently under construction, as the prototype. If the applicant makes this reclassification, per RG 1.20, the applicant is requested to provide the detailed results of the comprehensive vibration assessment program conducted on the Olkiluoto-3 which is consistent with the requirements of RG 1.20 and should include a listing of the major reactor internal components that would be subjected to flow induced vibration testing.

The applicant responded to **RAI Question 03.09.02-24(a)** in their Response to Request for Additional Information No. 160, Revision 0 by stating that, in accordance with the guidance of RG 1.20, Revision 3, details of the preoperational vibration and test program, including the requested information, will be included in the comprehensive vibration assessment program, which is the responsibility of the COL holder as noted in U.S. EPR FSAR Tier 2, Table 1.8-2.

The applicant responded to **RAI Question 03.09.02-24(b)** in their Response to Request for Additional Information No. 160, Revision 0 by stating that in U.S. EPR FSAR Tier 2, Section 3.9.2.4, the U.S. EPR reactor pressure vessel (RPV) internals are classified as prototype design per RG 1.20. Additionally, as stated in U.S. EPR FSAR Tier 2, Section 3.9.2.4, if design changes to the RPV internals are required as a result of the hot functional testing and subsequent inspection at Olkiluoto-3, the appropriate classification of the U.S EPR RPV internals will be determined in accordance with RG 1.20. Accordingly, the associated experimental and/or analytical justification, including any required changes to the comprehensive vibration assessment program, will be provided to the NRC.

The staff noted that the applicant's response to **RAI Question 03.09.02-24(a)** deferred details of the preoperational vibration and test program to the COL holder. The applicant's response to **RAI Question 03.09.02-24(b)** deferred designation of the design as prototype or non-prototype contingent upon the comprehensive vibration assessment

program conducted on the as yet unbuilt Olkiluoto-3 plant. However, the requested information in **RAI Question 03.09.02-24(a) and (b)** is inconsistent with what is required and should be available for determining compliance with regulation. The requested information on the vibration assessment program and the prototype design or the justification of classification of the U.S. EPR as non-prototype is needed to complete the DCD review to meet 10 CFR 52.47 to meet 10 CFR 52.47. This requested information has not been provided and therefore this RAI is initiated as a follow-up to request this information.

03.09.02-46

Follow-up to RAI Question 03.09.02-27

In **RAI Question 03.09.02-27**, the staff requested the applicant to provide a discussion of the analyses of these potential adverse flow conditions and the operating conditions that give rise to such flow conditions. The discussion should include the bias errors, uncertainties, and any operational experience the applicant possesses or of which the applicant is cognizant, particularly for situations that have led to past failures, as it relates to the U.S. EPR.

The applicant responded to **RAI Question 03.09.02-27** in their Response to Request for Additional Information No. 160, Revision 0 by stating that in accordance with the guidance of RG 1.20, Revision 3, the details of the assessment of acoustic resonances and self-excited response, along with discussion of the bias errors, uncertainties and operational experience, will be included in the results from the comprehensive vibration assessment program, which is the responsibility of the COL holder as noted in U.S. EPR FSAR Tier 2, Table 1.8-2. The staff requests the applicant to provide the comprehensive vibration assessment program for review by the NRC staff as part of the FSAR to meet 10 CFR 52.47. Therefore, this follow-up RAI is initiated requesting the program for review.

03.09.02-47

Follow-up to RAI Question 03.09.02-28

In **RAI Question 03.09.02-28**, the staff requested the applicant to supply the results of the analyses so that review of the dynamic properties of the structures and of the methods for obtaining the overall vibration and stress response from the forcing functions, and the vibration and stress models may be made. The results should include:

- a. The dynamics of the internal structures, including natural frequencies, mode shapes relevant to the vibration and stress response, damping factors, and the frequency response functions (FRF).
- b. The methodology for combining the vibrations and stress response models with the forcing functions to obtain the overall stress and vibration response of the RPV internals.
- c. The method for combining the uncertainties and bias errors and the effect of these on the resulting overall stress and vibration response prediction of the RPV internals.

- d. The prediction of the overall stress and vibration response for the U.S. EPR RPV internals together with the comparisons to the criteria which demonstrate the stated conformance of the vibration levels with RG 1.20.

The applicant responded to each item in **RAI Question 03.09.02-28** in their Response to Request for Additional Information No. 160, Revision 0 as follows:

- a. In accordance with the guidance of RG 1.20, Revision 3, the requested information is addressed in the comprehensive vibration assessment program, which is the responsibility of the COL holder as noted in U.S. EPR FSAR Tier 2, Table 1.8-2. Additionally, the flow-induced vibration (FIV) analyses provide details of the methodology and analysis inputs to the comprehensive vibration assessment program.
- b. See Item a above.
- c. In accordance with the guidance of RG 1.20, Revision 3, the discussion of the bias errors and uncertainties is part of the results from the comprehensive vibration assessment program. The combined effect of these uncertainties and bias errors on the response of the RPV internals will be assessed after hot functional testing when these inputs are confirmed with test measurements. A comparison of these analysis inputs and their incorporation into the revised prediction of the RPV internals to achieve an agreement between the analytical and test results will be included in the comprehensive vibration assessment program final report.
- d. See item a above.

The staff reviewed the applicant's response to **RAI Question 03.09.02-28** and concluded that the applicant needs to provide the comprehensive vibration assessment program for review by the NRC staff as part of the FSAR to meet 10 CFR 52.47. Therefore, this follow-up RAI is initiated requesting a review of the program.

03.09.02-48

Follow-up to RAI Question 03.09.02-29

In **RAI Question 03.09.02-29**, the staff requested the applicant to supply the following information, as recommended by SRP 3.9.2.3 acceptance criteria, that addresses the critical area of flow-excited acoustic and structural resonances or other self-excited response to vortex-induced vibration, turbulence and turbulence buffeting, flow separation, reattachment and impinging flow instabilities:

- a. The scale model tests should be discussed with reference to dynamic similarity of the model tests to the full scale structures and operating conditions being analyzed. Additionally, the types and placement of the transducers employed in the small scale model test should be included in the discussion.
- b. Because the analysis of the small scale models is used to baseline the analytical/computational procedures for use on the full scale structure, the

analytical/computational models of the small scale structures and the analytical procedures employed should be discussed together with an assessment of the bias and uncertainties in the predictions.

- c. Comparisons of the small scale model results and the analytical model results should be provided with discussion quality of the comparisons and the implications of the comparison on the use of the procedure on the full scale structure.
- d. Discuss the analysis methodologies or software used in the modeling of both the full-scale and the scale model structures. Further, the methodology used to assess the accuracy, limitations and applicability of the software package or analysis procedure should be provided. The discussion of the analysis procedures should include the interaction of the various software packages/models such as providing inputs to each other or any required iterations between models.
- e. The applicant stated that "during preoperational testing, the full-scale analytical results are confirmed...." Provide a basis and discussion of the acceptance criteria for confirmation of the results.
- f. Because any disagreement between the full scale analysis and the full scale test results will be addressed by adjusting the inputs to the analysis, the identification of the parameters together with the methods and criteria for setting limits on the appropriate adjustment of those input parameters should be provided.
- g. The applicant has not specified or referenced locations of transducers or test conditions.

The applicant responded to **RAI Question 03.09.02-29** in their Response to Request for Additional Information No. 160, Revision 0 as follows for each item: The requested information will be provided in the comprehensive vibration assessment program, which is the responsibility of the COL holder as noted in U.S. EPR FSAR Tier 2, Table 1.8-2.

The staff reviewed the applicant's response to **RAI Question 03.09.02-29** and concluded that the applicant needs to provide the comprehensive vibration assessment program for review by the NRC staff as part of the FSAR to meet 10 CFR 52.47. Therefore, this follow-up RAI is initiated requesting a review of the program.

03.09.02-49

Follow-up to RAI Question 03.09.02-30

The applicant stated in its response to **RAI Question 03.09.02-30** that because transient evaluation of the RPV lower internals to transient conditions will occur during hot functional testing, no analytical evaluation of these transient conditions is planned. The analysis and testing portions of the comprehensive vibration assessment program are intended to compliment, not supplant, each other. The applicant is requested to provide justification for relying solely on the hot functional testing to determine the safety of the plant response to transients and to explain in detail why transient analysis is not performed.

Further, the applicant has stated that if acoustic loadings are observed in the reactor coolant system during hot functional testing, appropriate corrective actions will be taken to eliminate these acoustic loadings. If testing is conducted only at the full-power, steady-state operating state, as noted above, flow-excited and self-excited response occurring at other flow conditions may be missed. In this follow-up RAI, the applicant is requested to provide the details of their plans to ensure that these conditions are identified and mitigated.

03.09.02-50

Follow-up to RAI Question 03.09.02-31

In **RAI Question 03.09.02-31**, the staff requested the applicant provide a comparison of the U.S. EPR and the German Konvoi plants support columns including the impedances of the mounting arrangements and a comparative analysis or testing that demonstrates the applicability of the German Konvoi experience to the U.S. EPR. The comparison should address placement of the instrumentation and the test conditions intended to evaluate the support columns in the U.S. EPR with those used by the German Konvoi plants.

The staff reviewed the applicant's response to **RAI Question 03.09.02-31** and concurs that the criteria for the FIV analysis of the RPV upper internals has been provided. The acceptance criteria for the random turbulence-induced vibration and for vortex-shedding induced vibrations were acceptable. However, in this follow-up RAI, the applicant is requested to identify the references for the fluid-elastic instability criteria.

Additionally, the applicant was also requested to describe "...any plans for testing to indicate acceptable behavior, including the acceptance criteria, details on the validations of the test plan and the instrumentation and test conditions that will be employed in the U.S. EPR preoperational testing to confirm the acceptable design of the upper internals." The applicant deferred this discussion to the comprehensive vibration assessment program which is the responsibility of the COL holder as noted in U.S. EPR FSAR Tier 2, Table 1.8-2, Item 3.9.1. The staff concludes that the applicant needs to provide the comprehensive vibration assessment program for review by the NRC staff as part of the FSAR to meet 10 CFR 52.47. Therefore, this follow-up RAI is initiated requesting a review of the program in addition to identification of the reference for the fluid-elastic instability criteria.

03.09.02-51

Follow-up to RAI Question 03.09.02-32

In **RAI Question 03.09.02-32**, the staff requested details of the analyses and testing that indicate acceptable behavior, including the acceptance criteria, details on the validations of the test plan, and the instrumentation and test conditions that will be employed in the U.S. EPR preoperational testing to confirm the acceptable CRGA design.

The applicant responded to **RAI Question 03.09.02-32** in their Response to Request for Additional Information No. 160, Revision 0 by stating that the information is provided in the response to **RAI Question 03.09.02-31**, which stated that the applicant deferred this

discussion to the comprehensive vibration assessment program which is the responsibility of the COL holder as noted in U.S. EPR FSAR Tier 2, Table 1.8-2, Item 3.9.1.

Also, in the applicant's response to **RAI Question 03.09.02-32**, they stated in FSAR Tier 2, Section 3.9.2.3 that the full-scale CRGA components have been shown analytically to have acceptable vibrational behavior. This description indicates that the analysis is complete and conclusions indicate that the CRGA design is acceptable. In **RAI Question 03.09.02-32** the applicant was requested to provide details of the analyses. The applicant did not provide this information and the staff initiates this follow-up RAI to request details of the analyses.

03.09.02-52

Follow-up to RAI Question 03.09.02-33

In **RAI Question 03.09.02-33**, the staff requested the applicant to explain the various conditions to cover potential situations for flow-induced vibration (including flow-excited acoustic and structural resonances or other self-excited response to vortex-induced vibration, turbulence and turbulence buffeting, flow separation, reattachment and impinging flow instabilities) and provide the basis for selection of these conditions to ensure a conservative basis exists for determining the vibratory response of the tested components.

The staff reviewed the applicant's response to **RAI Question 03.09.02-33** and noted that the applicant stated that flow-induced vibration (FIV) analytical evaluations of the U.S. EPR reactor pressure vessel internals (RPVI) were performed at full power, steady state operating and transient conditions considering the susceptibility of these components to the applicable sources of flow excitations. In **RAI Question 03.09.02-33** the applicant was requested to provide the basis for determining the vibratory response of the tested components. This is a request for the flow-induced vibration (FIV) analytical evaluations of the U.S. EPR reactor pressure vessel internals (RPVI) that were performed. The applicant did not provide this information and consequently the staff is initiating this follow-up RAI.

03.09.02-53

Follow-up to RAI Question 03.09.02-34

In **RAI Question 3.9.34**, the staff requested the applicant to discuss the types of non-destructive testing planned during the inspections process, if walkdowns are included, what monitoring and testing equipment is required, and what actions will be taken as a result of these inspections. It is noted that Tables 3.9.2-3 through 3.9.2-5 reference the storage stands. The applicant should clarify at which points in the testing process components will be removed, placed on storage stands, and inspected.

The staff reviewed the applicant's response to **RAI Question 03.09.02-34** and concluded that the applicant has deferred providing details of the nondestructive testing until after development of the comprehensive vibration assessment program which is the responsibility of the COL holder, as noted in U.S. EPR FSAR Tier 2, Table 1.8-2, Item

3.9.1. The staff concludes that the applicant needs to provide the comprehensive vibration assessment program for review by the NRC staff as part of the FSAR to meet 10 CFR 52.47. Therefore, this follow-up RAI is initiated requesting a review of the program in addition to identification of the reference for the fluid-elastic instability criteria.

03.09.02-54

Follow-up to RAI Question 03.09.02-35

In **RAI Question 03.09.02-35**, the staff requested the applicant to provide a detailed discussion of the basis for the comparison, including acceptance criteria used for determining the relevance of the analytical results and how the results of the analysis using the revised forcing functions are used.

The staff reviewed the applicant's response to **RAI Question 03.09.02-35** and concurs that it is appropriate that results of the hot functional testing and any modifications required to obtain the necessary agreement between the revised analytical solution and the hot functional testing, such as modifications to the forcing function or other analysis inputs, will be included in the comprehensive vibration assessment program final report.

However, prior to the development of the testing program, factors that can influence accurate and meaningful comparison between analytical predictions used in design of the system and test results should be identified. The applicant was requested to provide a discussion of these factors that influence the comparison of the test results to the analysis and how they will be incorporated into the testing program. The information requested has not been provided and consequently the staff is initiating this follow-up RAI.

03.09.02-55

Follow-up to RAI Question 03.09.02-37

In **RAI Question 03.09.02-37** the staff requested the applicant to explain why the results from the vibration assessment program for the U.S. EPR RPV internals as shown in Item Number 3.9-1 of FSAR Tier 2 Table 1.8-2 are site specific and cannot be provided as part of the FSAR but must be deferred until the COL application.

The applicant responded to **RAI Question 03.09.02-37** in their Response to Request for Additional Information No. 160, Revision 0 by stating that this COL information item is the responsibility of the COL holder not the COL applicant and is contingent on preoperational vibration testing of the first U.S. EPR prior to hot functional testing and associated field testing consistent with the guidance of Regulatory Guide 1.20. The staff concludes that the applicant needs to provide the comprehensive vibration assessment program for review by the NRC staff as part of the FSAR to meet 10 CFR 52.47. Therefore, this follow-up RAI is initiated requesting a review of the program.

03.09.02-56

In FSAR Tier 2 Section 1.8, table 1.8-2, AREVA states the [COL Item No. 3.9-1](#), with regard to section 03.09.02.04,: "A COL applicant that references the U.S. EPR design certification will submit the results from the vibration assessment program for the U.S.

EPR RPV internals, in accordance with RG 1.20.” The staff understands that Areva is proposing to have COL applicants (or Holders in this case) provide all the details of the vibration assessment program required in section 03.09.02.04 of RG 1.20 and NUREG 0800 section 03.09.02. However, the staff concern is that COL applicants must address all COL Items whether final action is taken before or after the license is issued. If the information is not provided, COL applicants need to meet RG 1.206 and let the staff know when and how the information will be provided. Given that it is acknowledged that the action will occur following the vibration assessment program, to allow the staff to perform necessary inspection of the report results ensuring the U.S. EPR RPV internals vibration assessment program has been properly designed and executed, the staff finds that an ITAAC in the [EPR FSAR Tier 1](#) is necessary. The staff requests the applicant to add an appropriate ITAAC in EPR FSAR Tier 1 to address the issue.

03.09.02-57

Follow-up to RAI Question 03.09.02-25

In its response to RAI Question 03.09.02-25, AREVA states that a flow-induced vibration (FIV) analysis had been performed of the U.S. EPR steam separator design, which determined that the steam separators are not subjected to excessive vibration. The NRC staff requests that AREVA provide this analysis for review, including the analysis of potential FIV effects on the steam dryer and other internal parts in the U.S. EPR steam generator. Also, AREVA is requested to include FIV analysis information in DCD, Tier 2 Section 3.9.2.

03.09.02-58

Follow-up to RAI Question 03.09.02-25

In its response to RAI Question 03.09.02-25, AREVA states that 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 this phenomenon in the design phase. The NRC staff requests that AREVA provide the methodology used in screening the U.S. EPR steam system design for potential flow-excited and structural resonances, and the results of its implementation of the methodology for the U.S. EPR design. The staff also requests that AREVA discuss the performance of scale model testing to confirm the validity of the methodology in predicting resonance in the U.S. EPR steam system. . Also, AREVA is requested to include the methodology and scale modeling testing information in DCD, Tier 2 Section 3.9.2.

03.09.02-59

Follow-up to RAI Question 03.09.02-25

In its response to RAI Question 03.09.02-25, AREVA provides design information comparing the U.S. EPR steam dryers to those in other similar plants in Table 03.09.02-25-1, “Comparison of U.S. EPR SG Steam Dryers to Other Operating Plants.” The NRC staff requests that AREVA provide a comparison of the structural capability of the U.S. EPR steam generator internal parts with those in other similar plants. The staff also requests that AREVA provide a comparison of the U.S. EPR steam system design, layout, branch line size and locations, steam velocity, and other applicable parameters

that could affect potential flow-excited and structural resonances in the steam system with those parameters in similar plants. Also, AREVA is requested to include this information in DCD, Tier 2 Section 3.9.2.

03.09.02-60

Follow-up to RAI Question 03.09.02-26

AREVA refers to its response to RAI Question 03.09.02-25 in responding to RAI Question 03.09.02-26. The NRC staff does not consider AREVA's response to RAI Question 03.09.02-25 to be sufficient to resolve RAI Question 03.09.02-26. For example, AREVA did not address the consideration of sensitivities in the arrangement, design, size, and operating conditions of the U.S. EPR steam system that can influence flow-excited and structural resonances. Further, AREVA did not explain which U.S. EPR operating conditions could lead to resonance conditions in the steam generators, or 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. The NRC staff requests that AREVA address these considerations in its response to this RAI and include in DCD, Tier 2 Section 3.9.2..

03.09.04-2

Follow-up to RAI Question 03.09.04-1a

In RAI 03.09.04-1a, the staff requested the applicant to provide a reference that documents CRDM qualification to operate in the RPV environment for 60 years. The applicant in their response indicated that the Primary Stress Analysis will provide justification for the 60 year design life. The NRC staff finds this response acceptable. The applicant went on to explain that endurance testing was based on nine million steps. The NRC staff requests the applicant to provide the basis for enveloping the number of cycles or steps for the 60 year design life.