



May 19, 2011  
NRC:11:044

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

### **Response to U.S. EPR Design Certification Application RAI No. 422, Supplement 19**

In Reference 1, the NRC provided a request for additional information (RAI) regarding the U.S. EPR design certification application. Reference 2 provided a schedule for technically correct and complete responses to RAI No. 422. Reference 3 provided a technically correct and complete response to 2 (Questions 03.09.02-86 and 03.09.02-143) of the 63 questions. Reference 4 provided a revised schedule for a technically correct and complete response to the remaining 61 questions based on additional evaluations. Reference 5 provided a revised schedule for a technically correct and complete response to 6 of the remaining 61 questions based on additional evaluations. Reference 6 provided a revised schedule for a technically correct and complete response to 16 of the remaining 61 questions to allow additional time for AREVA NP to interact with the NRC. Reference 7 provided a technically correct and complete response to 11 (Questions 03.09.02-125, 03.09.02-128, 03.09.02-129, 03.09.02-130, 03.09.02-132, 03.09.02-133, 03.09.02-135, 03.09.02-136, 03.09.02-137, 03.09.02-139, and 03.09.02-141) of the remaining 61 questions. Reference 8 provided a revised schedule for a technically correct and complete response to 13 of the remaining 50 questions to allow additional time for AREVA NP to interact with the NRC. Reference 9 provided a revised schedule for a technically correct and complete response to 5 of the remaining 50 questions to allow additional time for AREVA NP to address NRC comments. Reference 10 provided a revised schedule for a technically correct and complete response to 3 of the remaining 50 questions based on additional evaluations. Reference 11 provided a revised schedule for a technically correct and complete response to 13 of the remaining 50 questions to allow additional time for AREVA NP to interact with the NRC. Reference 12 provided a revised schedule for a technically correct and complete response to 13 of the remaining 50 questions based on additional evaluations. Reference 13 provided a revised schedule for a technically correct and complete response to 16 of the remaining 50 questions based on additional evaluations. Reference 14 provided a revised schedule for a technically correct and complete response to 18 of the remaining 50 questions to allow additional time for AREVA NP to interact with the NRC. Reference 15 provided a technically correct and complete response to 1 (Question 03.09.02-126) of the remaining 50 questions. Reference 16 provided a technically correct and complete response to 8 (Questions 03.09.02-89, -91, -92, -93, -95, -96, -97, 142) of the remaining 49 questions. Reference 17 provided a revised schedule for a technically correct and complete response to 32 of the remaining 41 questions to allow additional time for AREVA NP to interact with the NRC. Reference 18 provided a revised schedule for a technically correct and complete response to 6 of the remaining 41 questions to allow additional time for AREVA NP to interact with the NRC. Reference 19 provided a revised schedule for a technically correct and complete response to 3 of the remaining 41 questions to allow additional time for AREVA NP to interact with the NRC. Reference 20 provided a revised schedule for a technically correct and

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complete final response to 29 of the remaining 41 questions to allow additional time for AREVA NP to interact with the NRC.

The attached file, "RAI 422 Supplement 19 Response US EPR DC - Proprietary.pdf" provides a technically correct and complete final response to 3 of the 41 remaining questions. AREVA NP considers some of the material contained in the attached response to be proprietary. As required by 10 CFR 2.390(b), affidavits are attached to support the withholding of the information from public disclosure.

The following table indicates the respective pages in the response document, "RAI 422 Supplement 19 Response U.S. EPR DC - Proprietary.pdf," that contain AREVA NP's final response to the subject questions.

<b>Question #</b>	<b>Start Page</b>	<b>End Page</b>
RAI 422 — 03.09.02-105	2	2
RAI 422 — 03.09.02-106	3	3
RAI 422 — 03.09.02-123	4	4

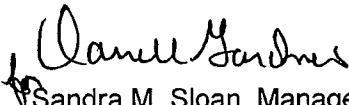
The schedule for the technically correct and complete final response to the remaining 38 questions is unchanged and is provided below.

<b>Question #</b>	<b>Response Date</b>
RAI 422 — 03.09.02-82	June 15, 2011
RAI 422 — 03.09.02-84	June 15, 2011
RAI 422 — 03.09.02-85	June 15, 2011
RAI 422 — 03.09.02-87	June 1, 2011
RAI 422 — 03.09.02-88	June 1, 2011
RAI 422 — 03.09.02-90	June 1, 2011
RAI 422 — 03.09.02-94	June 1, 2011
RAI 422 — 03.09.02-98	June 15, 2011
RAI 422 — 03.09.02-99	June 15, 2011
RAI 422 — 03.09.02-100	June 15, 2011
RAI 422 — 03.09.02-101	June 15, 2011
RAI 422 — 03.09.02-102	June 15, 2011
RAI 422 — 03.09.02-103	June 15, 2011
RAI 422 — 03.09.02-104	June 15, 2011
RAI 422 — 03.09.02-107	June 15, 2011
RAI 422 — 03.09.02-108	June 15, 2011
RAI 422 — 03.09.02-109	June 15, 2011
RAI 422 — 03.09.02-110	June 15, 2011
RAI 422 — 03.09.02-111	June 15, 2011
RAI 422 — 03.09.02-112	June 15, 2011
RAI 422 — 03.09.02-113	June 15, 2011
RAI 422 — 03.09.02-114	June 15, 2011
RAI 422 — 03.09.02-115	June 15, 2011
RAI 422 — 03.09.02-116	June 15, 2011
RAI 422 — 03.09.02-117	June 15, 2011

Question #	Response Date
RAI 422 — 03.09.02-118	June 15, 2011
RAI 422 — 03.09.02-119	June 15, 2011
RAI 422 — 03.09.02-120	June 15, 2011
RAI 422 — 03.09.02-121	June 15, 2011
RAI 422 — 03.09.02-122	June 15, 2011
RAI 422 — 03.09.02-124	June 1, 2011
RAI 422 — 03.09.02-127	June 1, 2011
RAI 422 — 03.09.02-131	June 15, 2011
RAI 422 — 03.09.02-134	June 1, 2011
RAI 422 — 03.09.02-138	June 1, 2011
RAI 422 — 03.09.02-140	June 1, 2011
RAI 422 — 03.09.02-144	June 15, 2011
RAI 422 — 03.09.02-145	June 15, 2011

If you have any questions related to this submittal, please contact me by telephone at 434-832-2369 or by e-mail to [sandra.sloan@areva.com](mailto:sandra.sloan@areva.com).

Sincerely,



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

Enclosures

cc: G. Tesfaye  
Docket No. 52-020

### References

- Ref. 1: E-mail, Getachew Tesfaye (NRC) to Martin C. Bryan (AREVA NP Inc.), "U.S. EPR Design Certification Application RAI No. 422 (4792), FSAR Ch. 3," August 3, 2010.
- Ref. 2: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3," September 2, 2010.
- Ref. 3: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 1," September 9, 2010.
- Ref. 4: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 2," September 27, 2010.
- Ref. 5: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 3," November 2, 2010.
- Ref. 6: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 4," November 22, 2010.
- Ref. 7: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 5," December 22, 2010.
- Ref. 8: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 6," January 12, 2011.
- Ref. 9: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 7," January 13, 2011.
- Ref. 10: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 8," January 27, 2011.
- Ref. 11: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 9," February 8, 2011.
- Ref. 12: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 10," February 10, 2011.

- Ref. 13: E-mail, Martin C. Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 11," February 17, 2011.
- Ref. 14: E-mail, Russell Wells (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 12," March 16, 2011.
- Ref. 15: E-mail, Russell Wells (AREVA NP Inc.) to Getachew Tesfaye (NRC), "PROPRIETARY Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 13," March 24, 2011.
- Ref. 16: E-mail, Russell Wells (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 14," March 30, 2011.
- Ref. 17: E-mail, Russell Wells (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 15," March 31, 2011.
- Ref. 18: E-mail, Russell Wells (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 16," April 13, 2011.
- Ref. 19: E-mail, Russell Wells (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 17," April 20, 2011.
- Ref. 20: E-mail, Russell Wells (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 422, FSAR Ch. 3, Supplement 18," May 11, 2011.

A F F I D A V I T

COMMONWEALTH OF VIRGINIA            )  
   ) ss.  
 COUNTY OF CAMPBELL                 )

1.        My name is Gayle F. Elliott. I am Manager, Product Licensing, 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 the “Response to U.S. EPR Design Certification Application RAI No. 422, Supplement 19,” 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:

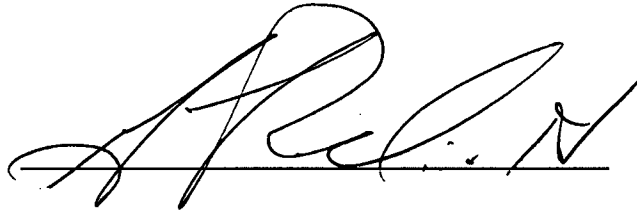
- (a) The information reveals details of AREVA NP's research and development plans and programs or their results.
- (b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or 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.

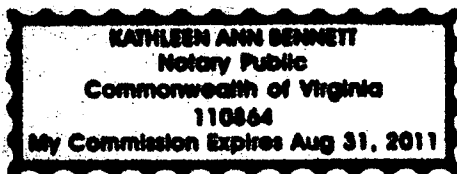
9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

A handwritten signature in black ink, appearing to be 'A.R.N.', written over a horizontal line.

SUBSCRIBED before me this 20<sup>th</sup>  
day of May, 2011.

A handwritten signature in black ink, reading 'Kathleen A. Bennett', written over a horizontal line.

Kathleen A. Bennett  
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA  
MY COMMISSION EXPIRES: 8/31/2011  
Reg. #110864





**Response to**

**Request for Additional Information No. 422(4792), Supplement 19  
8/3/2010**

**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: 3.9.2**

**QUESTIONS for Engineering Mechanics Branch 2 (ESBWR/ABWR Projects)  
(EMB2)**

**Question 03.09.02-105:**

**This is related to RAI 03.09.02-47 (a).**

The dynamic model of the upper internals is described in CVAP sections 4.5.1 and 4.5.3. The damping used in the analysis is provided in CVAP sections 4.5.1.1.2, 4.5.1.1.3, 4.5.1.1.4 and Table 4-17. Values used for the upper internals are acceptable. However, the applicant is requested to provide either FRFs or mode shapes for the upper internals that form the basis of the upper internals dynamic model.

**Response to Question 03.09.02-105:**

The response power spectral densities (PSDs) were not generated for the column supports identified in Technical Report ANP-10306P, Table 4-18. However, this table does identify frequencies and mode shapes for the column supports. Due to the simple mode shapes created with a beam model when supported at both ends, (e.g., beam (M=1) and beam (M=2)), it was not deemed essential to include this type of graphical information in the Technical Report ANP-10306P.

As stated in the Response to RAI 422, Question 03.09.02-130 and Question 03.09.02-132, the flow induced vibration (FIV) analysis for the upper column supports will be revised to consider an improved thermal hydraulic prediction in the upper internals. The revised FIV results will be updated in the Technical Report ANP 10306P with the Response to RAI 422, Question 03.09.02-131 and will include the mode shapes and the response PSDs for each of the column supports.

**FSAR Impact:**

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

**Technical Report Impact:**

ANP-10306P, "Comprehensive Vibration Assessment Program for U.S. EPR Reactor Internals Technical Report," Revision 0 will not be changed as a result of this question.

**Question 03.09.02-106:**

**This is related to RAI 03.09.02-47 (a).**

The CRGA, the normal support column, the level measurement probe (LMP) and the guide tubes modal frequencies are provided in CVAP Table 4-18. The staff reviewed CVAP section 4.6.5 and did not locate the modal frequencies, the mode shapes or the FRF for these components. The applicant is requested to provide the modal frequencies, the mode shapes and the FRFs that form the basis of the CRGA and RCCA dynamic models.

**Response to Question 03.09.02-106:**

The modal frequencies, mode shapes, and response PSDs for the control rod guide assemblies (CRGA) and the rod control cluster assembly (RCCA) will be included in Technical Report ANP-10306P, Section 4.6.5.

**FSAR Impact:**

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

**Technical Report Impact:**

ANP-10306P, "Comprehensive Vibration Assessment Program for U.S. EPR Reactor Internals Technical Report," Revision 0 will be revised as described in the response and indicated on the enclosed markup.

**Question 03.09.02-123:**

**This is related to RAI 03.09.02-48c.**

The applicant stated in CVAP Section 4.2.1, that the HYDRAVIB scale model was designed to make an assessment of the lower internals vibrations induced by flow turbulences in the downcomer and the RV bottom head, and to identify other potential sources of flow-induced vibration phenomena like vortex shedding (discrete frequency). The staff noted that the applicant only included an assessment of flow-induced vibration due to turbulence and did not include an assessment of flow-induced vibration from other sources. The applicant is requested to provide an assessment of other sources of flow induced vibration that could be determined by the HYDRAVIB and the implications of the testing on the full scale RV internals.

**Response to Question 03.09.02-123:**

The intent of the HYDRAVIB mockup was to assess the vibrations of the lower internals due to flow excitation resulting from random turbulence and vortex-shedding. Due to the patterns of flow in the lower internals, flow excitation of the lower internals as a result of vortex-shedding is not possible. This assertion is confirmed by the absence of fluid velocity related spectral peaks in all of the dynamic pressure measurements obtained during the flow tests.

**FSAR Impact:**

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

**Technical Report Impact:**

ANP-10306P, "Comprehensive Vibration Assessment Program for U.S. EPR Reactor Internals Technical Report," Revision 0 will not be changed as a result of this question.

Comprehensive Vibration  
Assessment Program for  
the U.S. EPR™ Reactor  
Internals Technical Report  
Markups

#### 4.6.4.2 Vortex-Shedding Induced Vibration

##### Acceptance Criteria for Displacements

The acceptance criterion for the off-resonant response of the CRGA internal is identical to that established for random turbulence with the exception of the units. Because the response to vortex-shedding is harmonic, the allowable displacement and the allowable stress are in units of 0-peak. As computed for turbulence, the allowable displacement limit of [ ] inch, (0-peak) is applied to the tie rods, the c-tube and RCCA.

##### Acceptance Criteria for High Cycle Fatigue

The ASME fatigue curve "B" shown in Figure 4-21 is applied for the off-lock in response of the austenitic stainless steel components of the CRGA. The allowable high cycle fatigue stress of [ ] psi (0-peak) is at  $10^{11}$  cycles for fatigue curve "B."

#### 4.6.5 Response of the CRGA Components

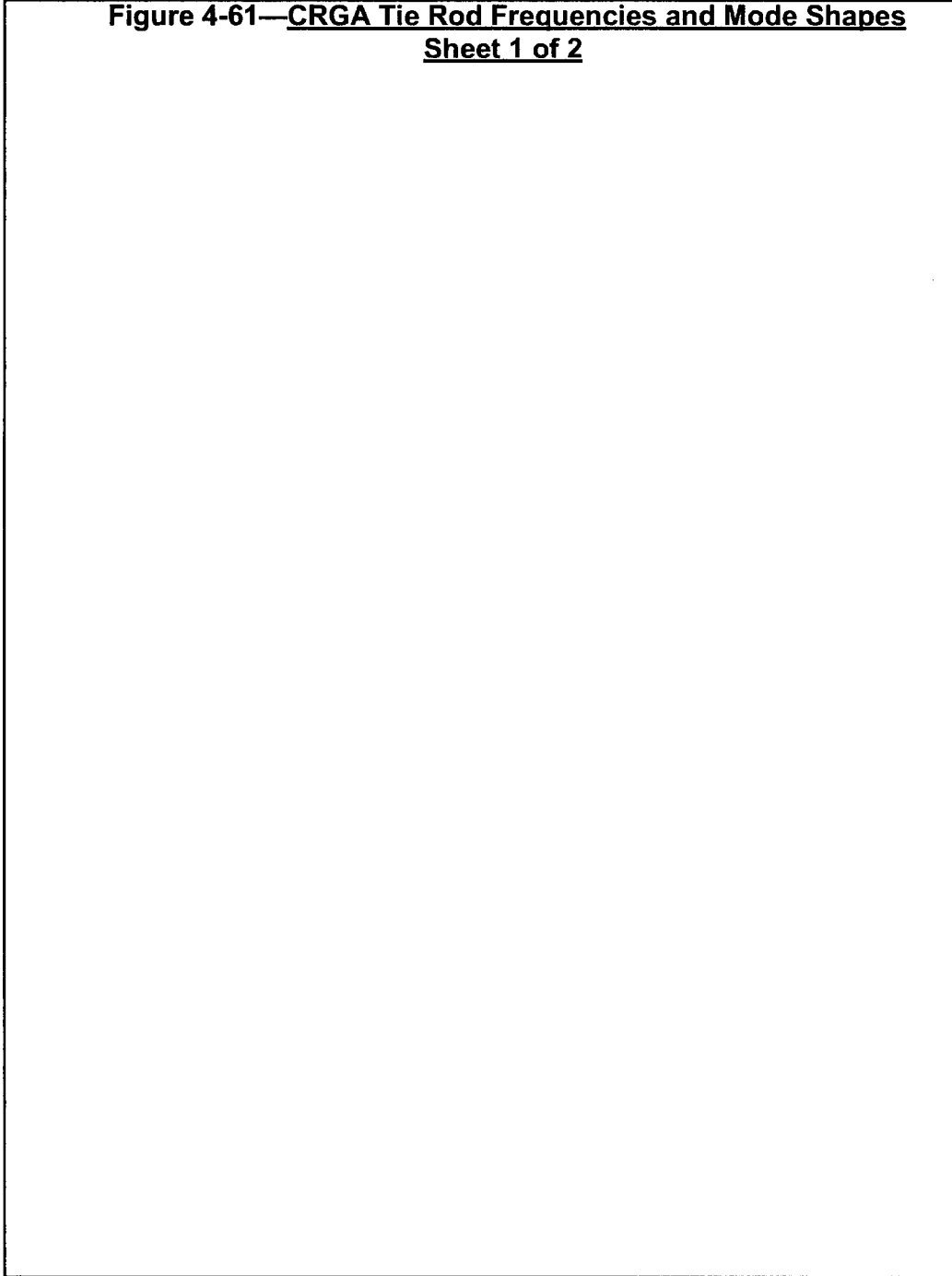
The CRGA tie rods, the c-tubes, and the RCCA control rod assemblies are not susceptible to vortex-shedding vortex lock-in conditions because this mechanism is suppressed based on the criteria shown in Table 4-22 through Table 4-24. Figure 4-61 through Figure 4-65 provide the frequency and mode shape plots for these CRGA components. Figure 4-66 through Figure 4-71 provide the displacement response PSD for these CRGA components. The vortex-shedding frequencies for these components are well separated from the modal frequencies. The response to this type of flow excitation, if occurring, can be considered quasi-static and no further evaluation is required.

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The results of the full scale analysis for random turbulence demonstrated that the CRGA tie rods, c-tubes, and the RCCA should not be susceptible to high cycle fatigue failure. The results show that the tie rods, c-tubes, and the RCCA will not impact each other or result in failure caused by impact.

A comparison of the modal frequencies for the c-tubes and the RCCA confirms that conditions do not exist between these components that would lead to resonant excitation during contact with each other. The fundamental modal frequencies are separated by more than [ ] Hz and therefore, the c-tube can not be mechanically excited by the RCCA.

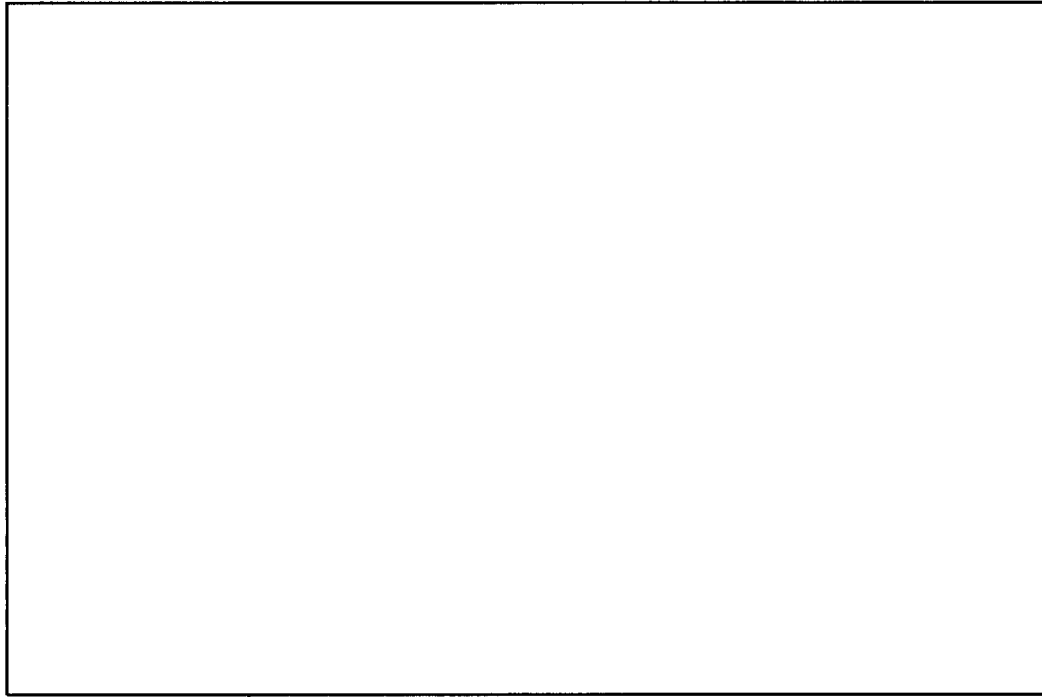
**Figure 4-61—CRGA Tie Rod Frequencies and Mode Shapes**  
**Sheet 1 of 2**



03.09.02-106



**Figure 4-61—CRGA Tie Rod Frequencies and Mode Shapes**  
**Sheet 2 of 2**



03.09.02-106



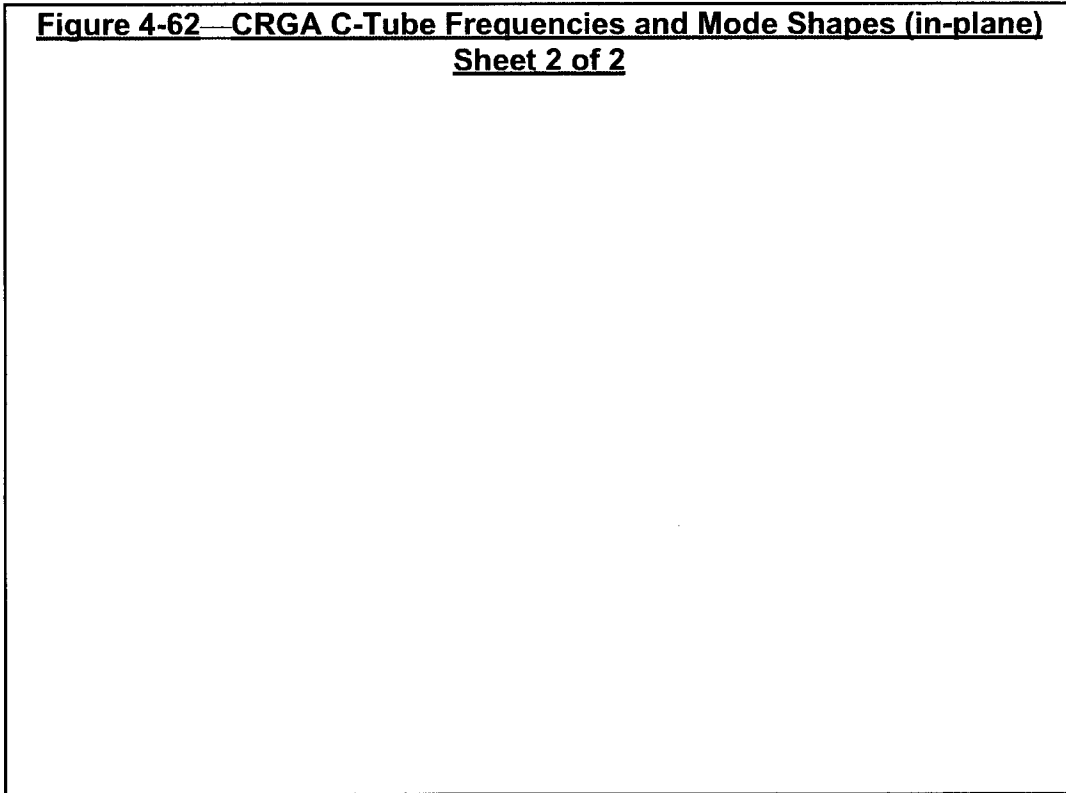


**Figure 4-62—CRGA C-Tube Frequencies and Mode Shapes (in-plane)**  
**Sheet 1 of 2**

03.09.02-106



**Figure 4-62—CRGA C-Tube Frequencies and Mode Shapes (in-plane)**  
**Sheet 2 of 2**



03.09.02-106



**Figure 4-63—CRGA C-Tube Frequencies and Mode Shapes (out-of-plane)**  
**Sheet 1 of 2**

03.09.02-106

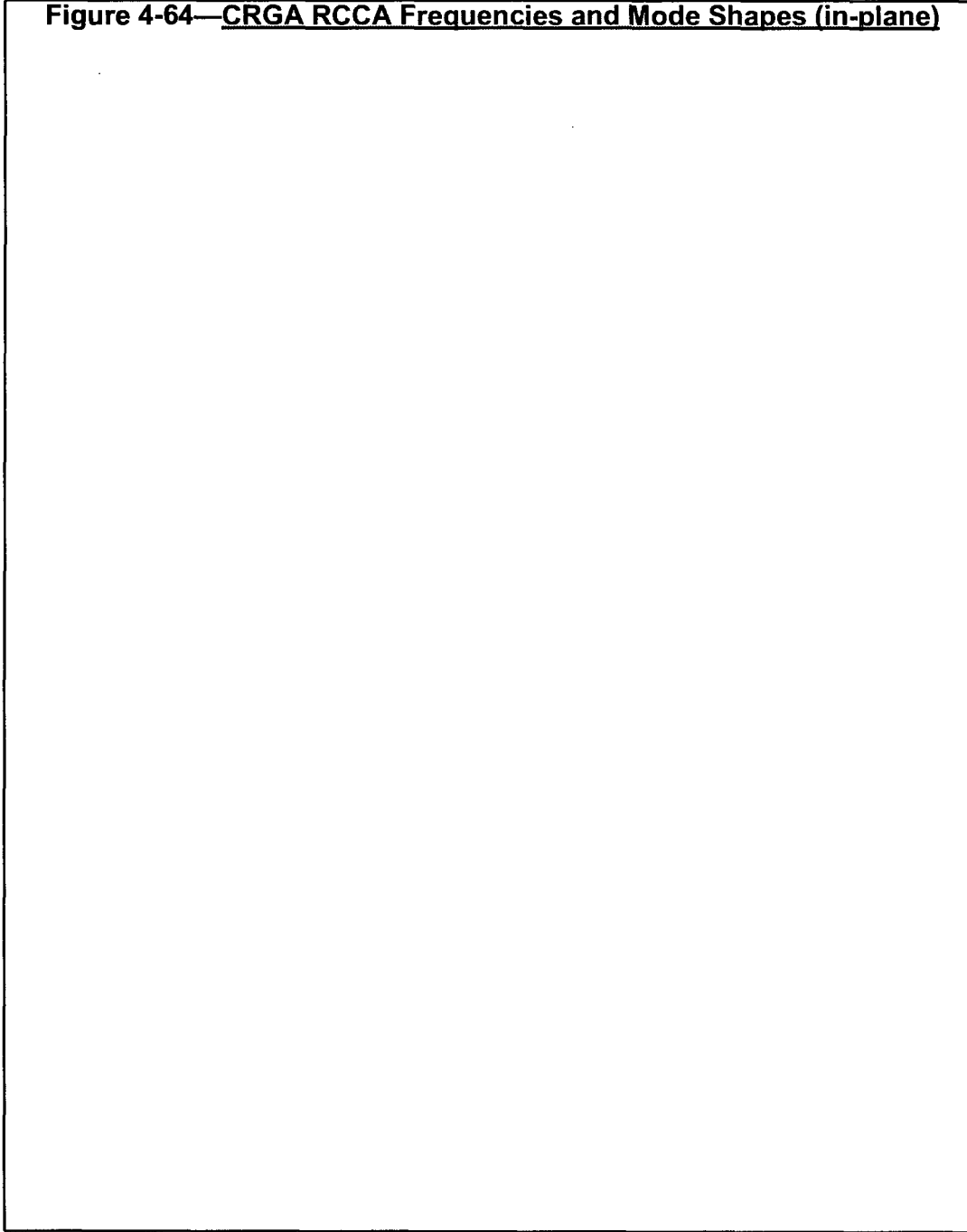


**Figure 4-63—CRGA C-Tube Frequencies and Mode Shapes (out-of-plane)**  
**Sheet 2 of 2**

03.09.02-106



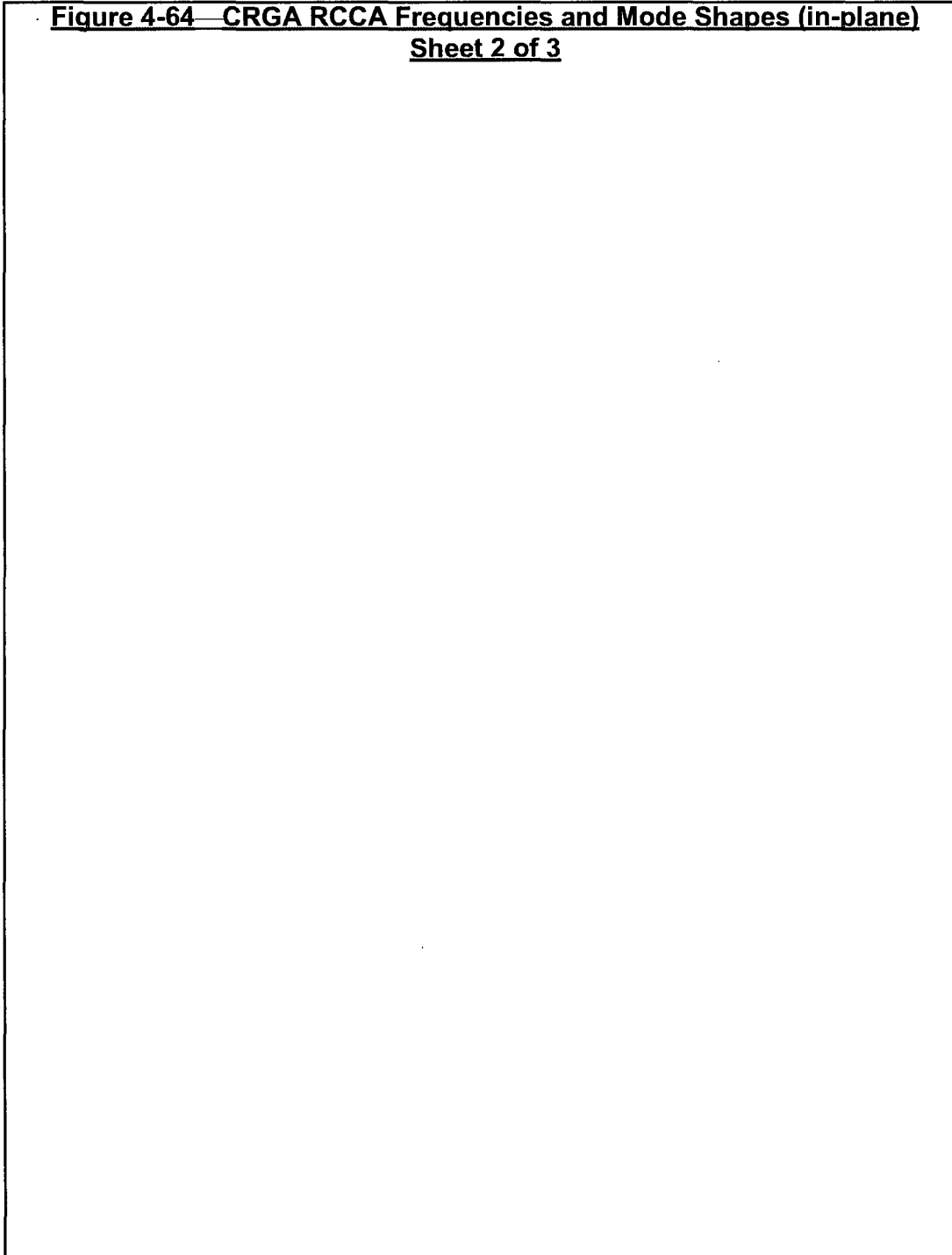
**Figure 4-64—CRGA RCCA Frequencies and Mode Shapes (in-plane)**



03.09.02-106



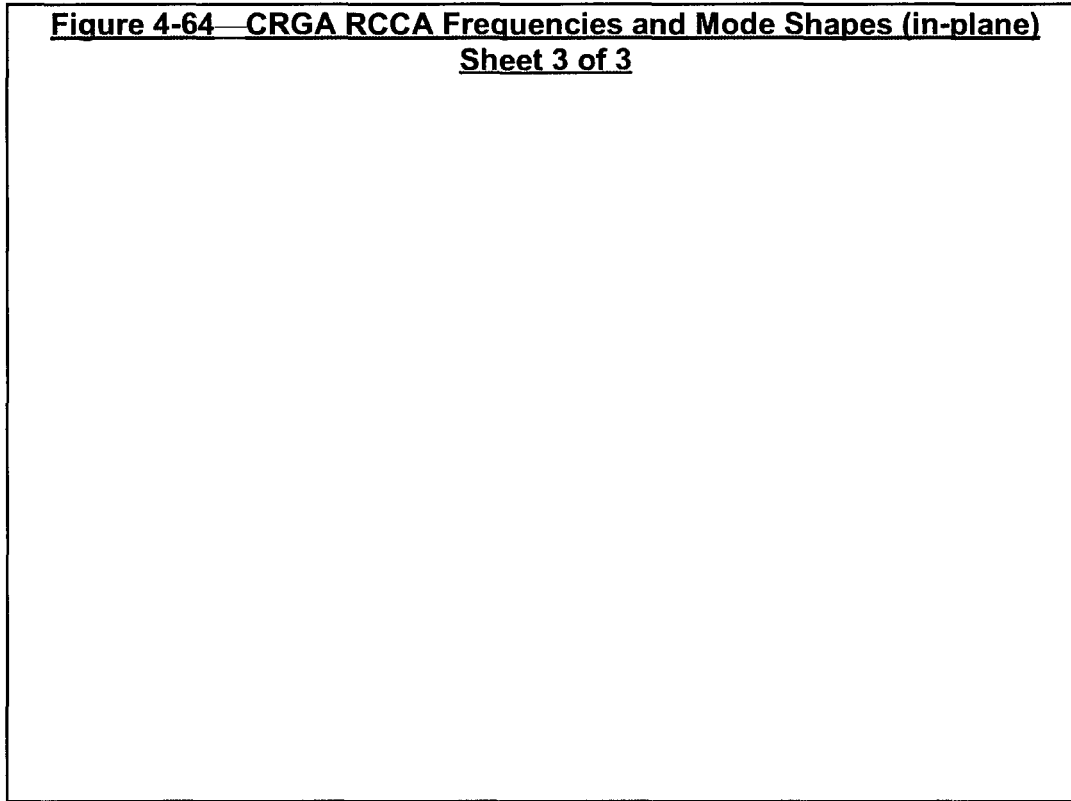
**Figure 4-64 – CRGA RCCA Frequencies and Mode Shapes (in-plane)**  
**Sheet 2 of 3**



03.09.02-106



**Figure 4-64 — CRGA RCCA Frequencies and Mode Shapes (in-plane)**  
**Sheet 3 of 3**



03.09.02-106



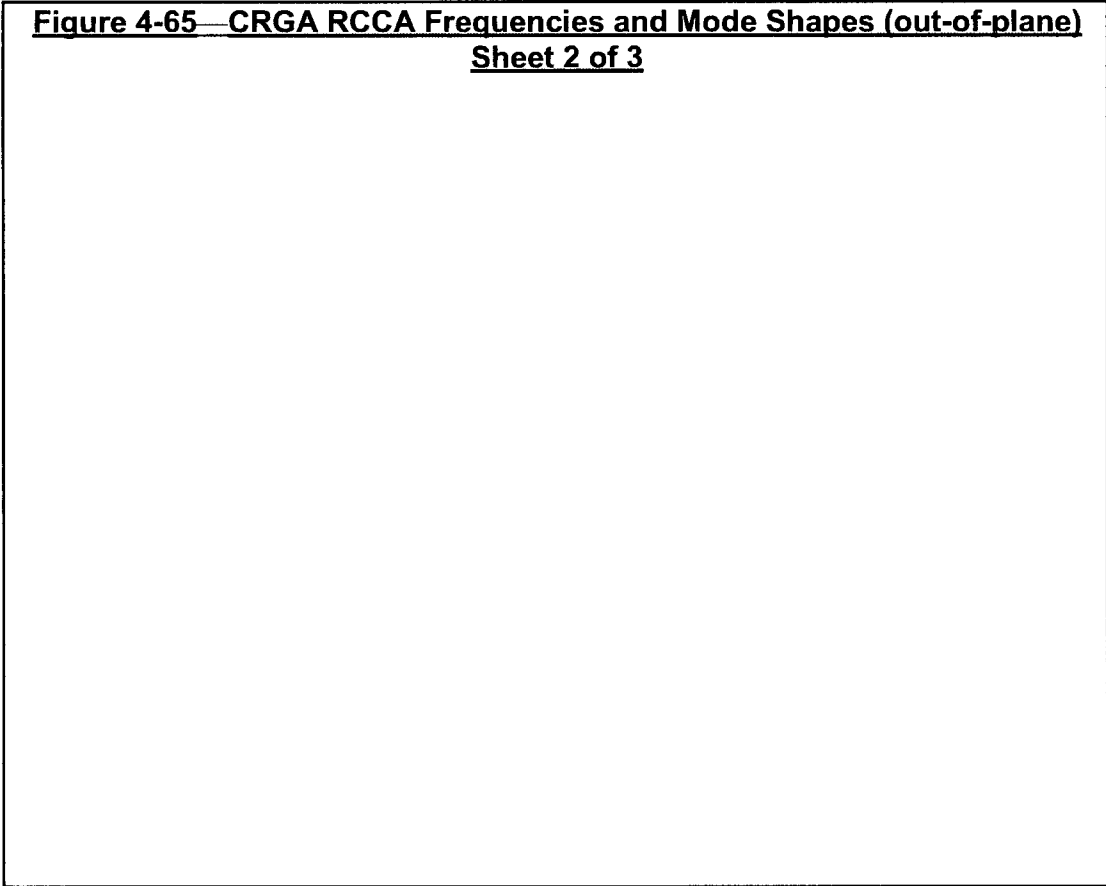
**Figure 4-65—CRGA RCCA Frequencies and Mode Shapes (out-of-plane)**  
**Sheet 1 of 3**

03.09.02-106





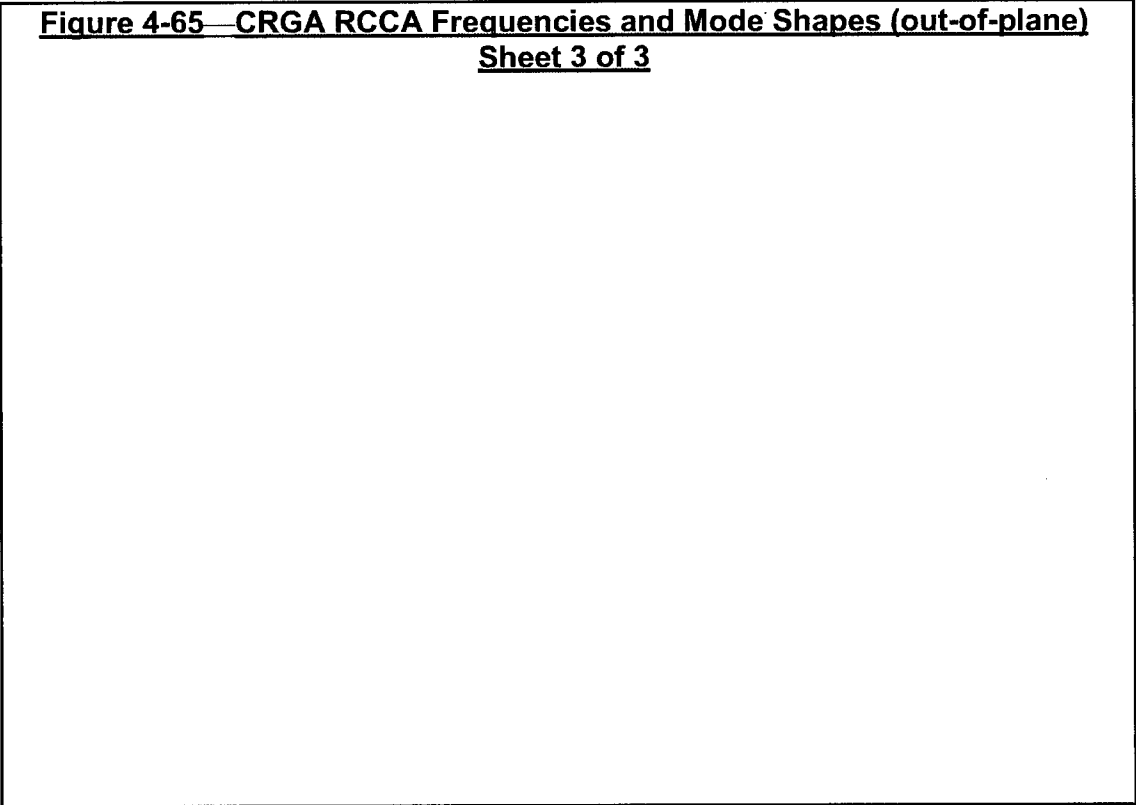
**Figure 4-65 — CRGA RCCA Frequencies and Mode Shapes (out-of-plane)**  
**Sheet 2 of 3**



03.09.02-106



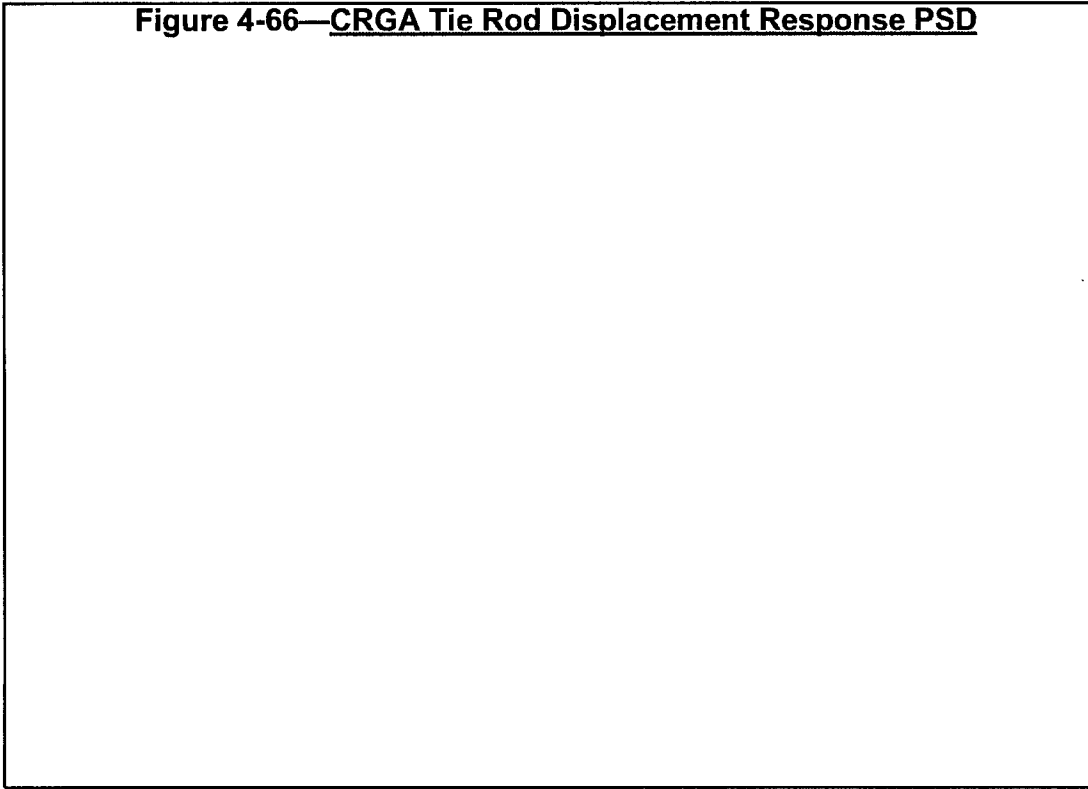
**Figure 4-65—CRGA RCCA Frequencies and Mode Shapes (out-of-plane)**  
**Sheet 3 of 3**



03.09.02-106



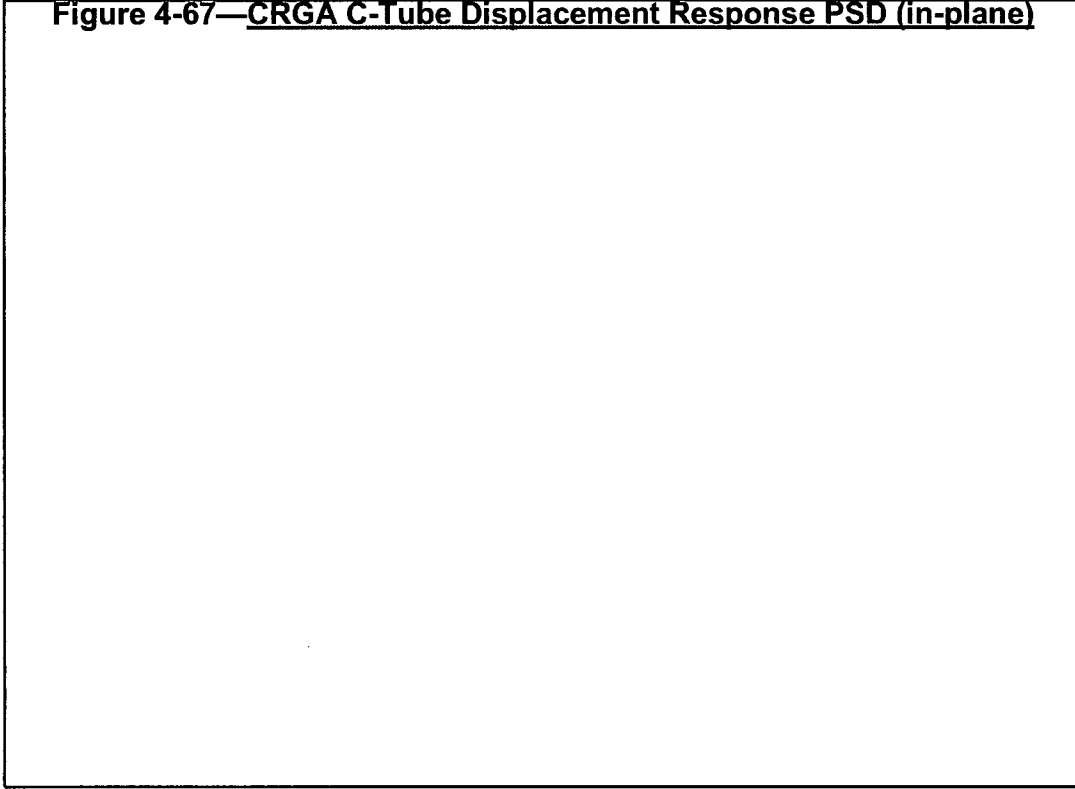
**Figure 4-66—CRGA Tie Rod Displacement Response PSD**



03.09.02-106



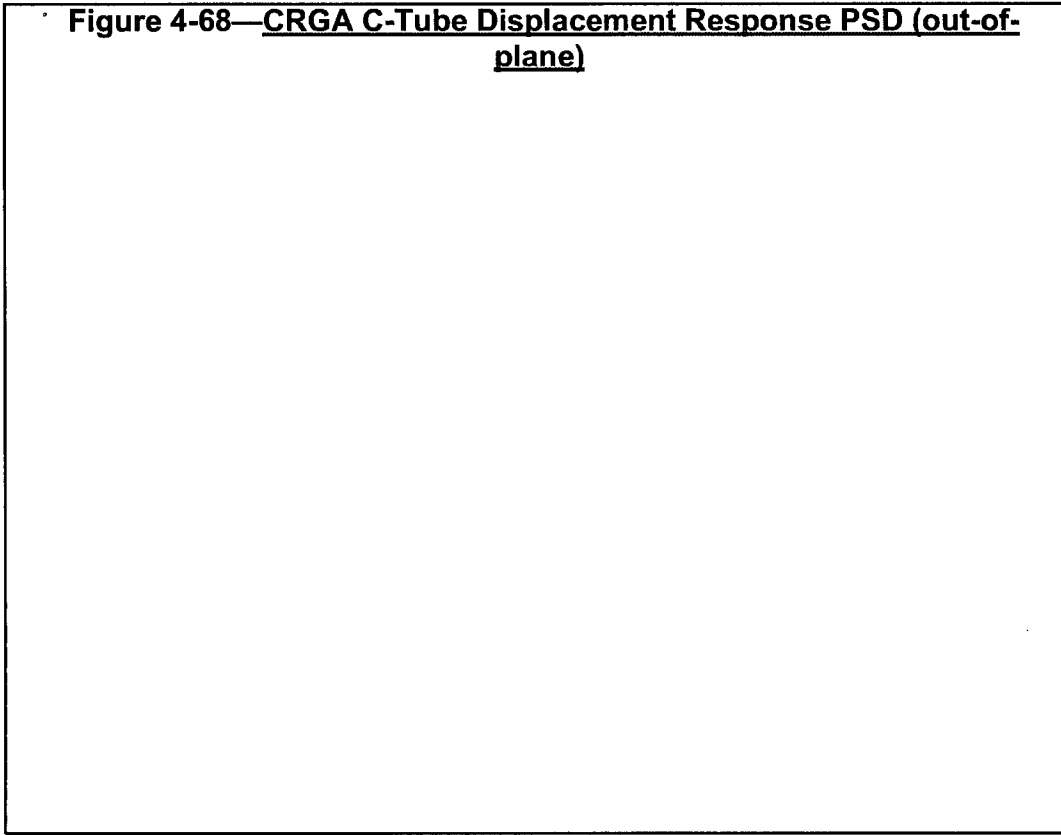
**Figure 4-67—CRGA C-Tube Displacement Response PSD (in-plane)**



03.09.02-106



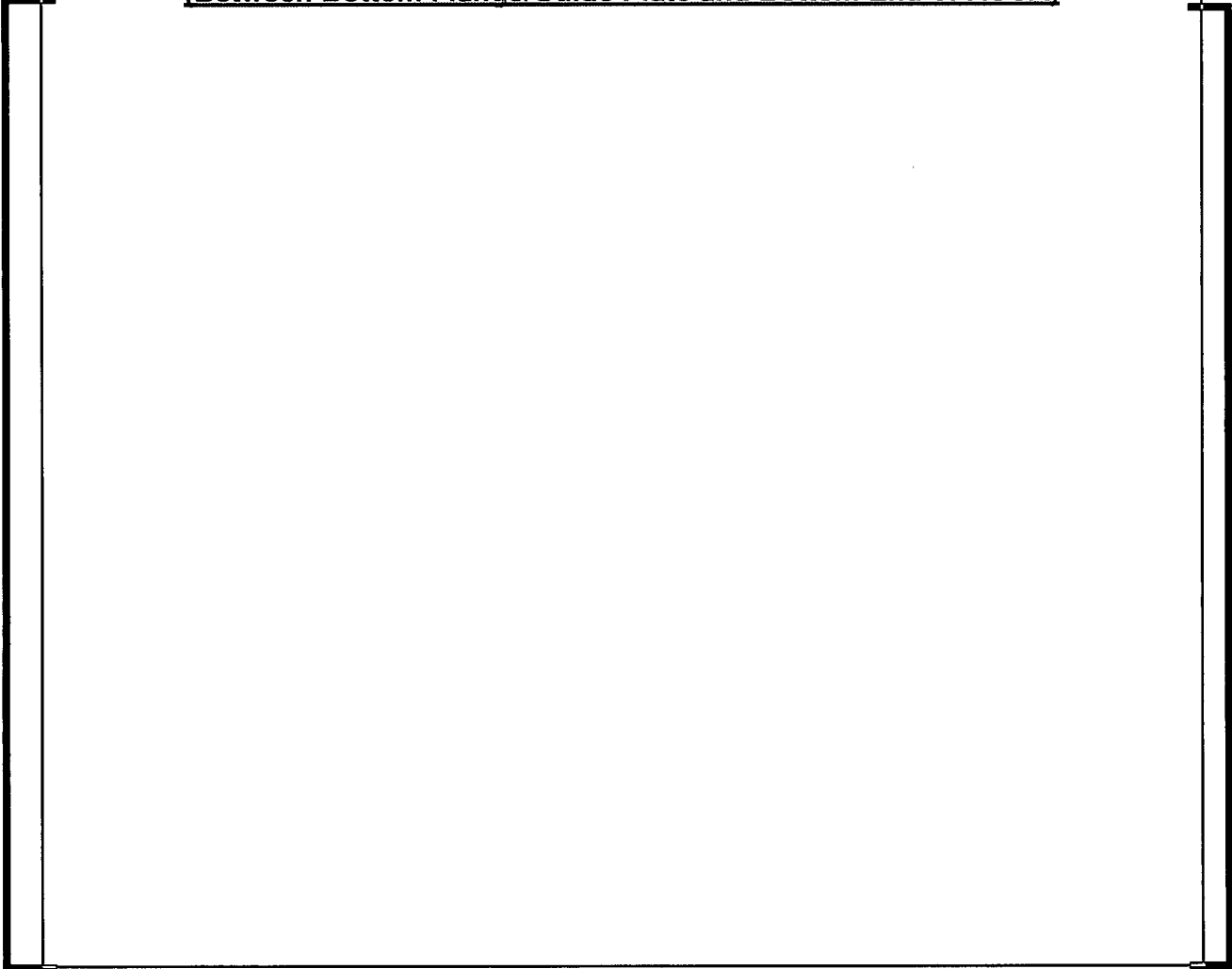
**Figure 4-68—CRGA C-Tube Displacement Response PSD (out-of-plane)**



03.09.02-106



**Figure 4-69—CRGA RCCA Displacement Response PSD (in-plane)  
(Between Bottom Flange/Guide Plate and Bottom End of RCCA)**



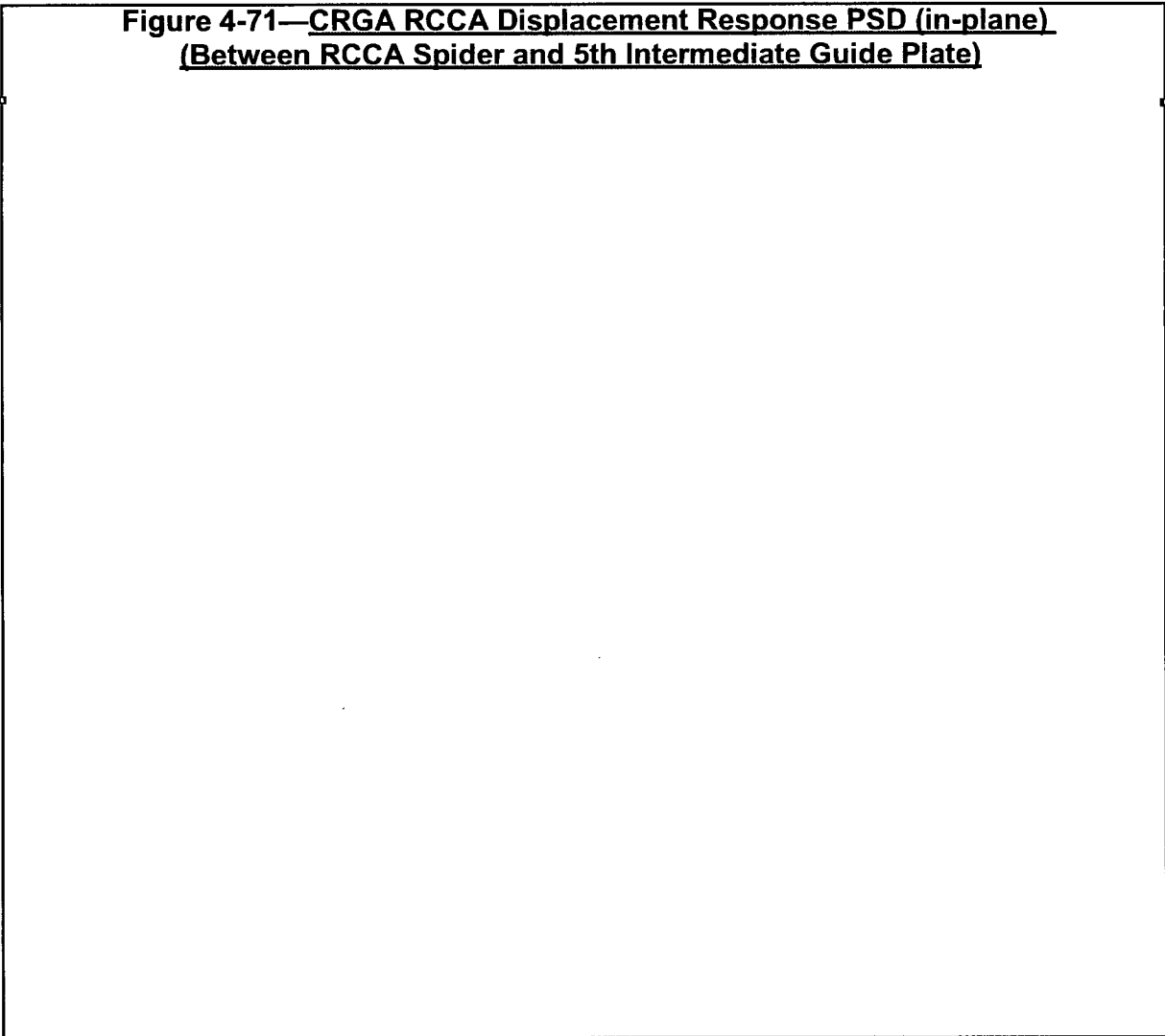
03.09.02-106



**Figure 4-70—CRGA RCCA Displacement Response PSD (in-plane)**  
**(Between 5th Intermediate Guide Plate and Bottom Flange/Buide**  
**Plate)**

03.09.02-106

**Figure 4-71—CRGA RCCA Displacement Response PSD (in-plane)  
(Between RCCA Spider and 5th Intermediate Guide Plate)**



03.09.02-106

