MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

June 4, 2009

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

Attention: Mr. Jeffery A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-09278

Subject: MHI's Response to US-APWR DCD RAI No. 322-1999 (60-day response)

References: 1) "Request for Additional Information No. 322-1999 Revision 0, SRP Section: 03.08.03 – Concrete and Steel Internal Structures of Steel or Concrete Containments, Application Section: 3.8.3" dated 4/8/2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 322-1999 Revision 0."

Enclosed are the responses to questions 3.8.3- 1, 7, 8, 13, 14, and 15 of the RAI (Reference 1). This completes the response for this RAI.

As indicated in the enclosed materials, this submittal contains information that MHI considers proprietary, and therefore should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential. A non-proprietary version of the document is also being submitted with the information identified as proprietary redacted and replaced by the designation "[ ]".

This letter includes a copy of the proprietary version (Enclosure 2), a copy of the non-proprietary version (Enclosure 3), and the Affidavit of Yoshiki Ogata (Enclosure 1) which identifies the reasons MHI respectfully requests that all materials designated as "Proprietary" in Enclosure 2 be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

D081
NRO

Enclosures:
1. Affidavit of Yoshiki Ogata
2. Response to Request for Additional Information No. 322-1999, Revision 0 (60-day response, Proprietary Version)
3. Response to Request for Additional Information No. 322-1999, Revision 0 (60-day response, Non-Proprietary Version)

CC: J. A. Ciocco
C. K. Paulson

Contact Information
C. Keith Paulson, Senior Technical Manager
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Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-09278

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Yoshiki Ogata, state as follows:

1. I am General Manager, APWR Promoting Department, of Mitsubishi Heavy Industries, LTD ("MHI"), and have been delegated the function of reviewing MHI's US-APWR documentation to determine whether it contains information that should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential.

2. In accordance with my responsibilities, I have reviewed the enclosed document entitled "Response to Request for Additional Information No. 322-1999, Revision 0 (60-day response"; June 2009, and have determined that portions of the document contain proprietary information that should be withheld from public disclosure. Those pages contain proprietary information are identified with the label "Proprietary" on the top of the page, and the proprietary information has been bracketed with an open and closed bracket as shown here "[ ]". The first page of the document indicates that all information identified as "Proprietary" should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

3. The information identified as proprietary in the enclosed document has in the past been, and will continue to be, held in confidence by MHI and its disclosure outside the company is limited to regulatory bodies, customers and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and is always subject to suitable measures to protect it from unauthorized use or disclosure.

4. The basis for holding the referenced information confidential is that it describes the unique design parameters developed by MHI as it provides the analytical and testing basis for the qualification of steel concrete modules.

5. The referenced information is being furnished to the Nuclear Regulatory Commission ("NRC") in confidence and solely for the purpose of information to the NRC staff.

6. The referenced information is not available in public sources and could not be gathered readily from other publicly available information. Other than through the provisions in paragraph 3 above, MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI.

7. Public disclosure of the referenced information would assist competitors of MHI in their design of new nuclear power plants without incurring the costs or risks associated with the design of the subject systems. Therefore, disclosure of the information contained in the referenced document would have the following negative impacts on the competitive position of MHI in the U.S. nuclear plant market:

A. Loss of competitive advantage due to the costs associated with the development of the unique design parameters.

B. Loss of competitive advantage of the US-APWR created by the benefits of the steel concrete module design.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

Executed on this 4th day of June 2009.

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Docket No. 52-021
MHI Ref: UAP-HF- 09278

Enclosure 3

UAP-HF-09278
Docket No. 52-021

Response to Request for Additional Information No. 322-1999,
Revision 0 (60-day response)

June 2009
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/4/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 322-1999 REVISION 0**
SRP SECTION:	**03.08.03 – Concrete and Steel Internal Structures of Steel or Concrete Containments**
APPLICATION SECTION:	**03.08.03**
DATE OF RAI ISSUE:	**4/8/2009**

QUESTION NO.: 3.8.3-1

In DCD Subsection 3.8.3.4.1 (Page 3.8-39), equations are given in the paragraph to calculate the equivalent elastic stiffnesses of the SC modules. They are:

- Axial and Shear Stiffnesses of SC Modules:
  $\Sigma EA = EcAc + EsAs$, $\Sigma GA = GcAc + GsAs$
- Bending Stiffness of SC Modules:
  $\Sigma EI = EcIc + EsIs$

The applicant is requested to provide the following information:

These equations ignore the effect of concrete shrinkage and creep and assume that concrete is not cracked. In ACI 318-63 Section 1102, an effective modular ratio of 2n, where n=Es/Ec, is specified for transforming the compression reinforcement and computing its stress to account for the effect of concrete shrinkage and creep. SRP

Acceptance Criteria 4.D of SRP 3.8.1 (Page 3.8.1-13 of SRP 3.8.1 Revision 2, March 2007) states that concrete cracking needs to be considered. Provide the technical justifications for not following these recommendations.

When the SC Module is subjected to compression, describe how the effect of creep, shrinkage, and cracking of concrete was considered in the SC member stiffness calculation, and provide the equations for the calculation.

ANSWER:

Creep, shrinkage, and cracking of concrete are insignificant and are therefore not included in the stiffness calculation. The stress analysis, described in DCD Subsection 3.8.3.4.1, describes the member forces being statically obtained using equivalent elastic stiffness. Reducing this equivalent elastic stiffness, while considering creep, shrinkage, and cracking of concrete; does not significantly affect the results of member forces. Therefore, effects of creep, shrinkage, and cracking of concrete are negligible in the stiffness calculation.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/4/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 322-1999 REVISION 0**
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DATE OF RAI ISSUE:	**4/8/2009**

QUESTION NO.: 3.8.3-7

In DCD Subsection 3.8.3.3.5, Accident Thermal Load (T_a), it is stated, "Thermal loads due to temperature gradients caused by the postulated pipe breaks are considered in the design. The temperature gradients are calculated using the temperatures corresponding to LOCA and MSLB, or a spent fuel pit accident, and are presented in Table 3.8.1-3." DCD Table 3.8.1-3 further refers to several figures, specifically DCD Figures 3.8.1-10, 3.8.1-11, 3.8.1-12 and 3.8.1-13, for the time temperature relationships in several areas, including the SG compartment, Primary Shield Atmosphere, and Refueling Cavity Sump Water.

Maximum temperatures shown in DCD Figures 3.8.1-10 and 3.8.1-11 are 300°F, while in DCD Figures 3.8.1-12 and 3.8.1-13 the maximum temperatures are 570°F and 580°F. Further, the temperatures shown in DCD Figures 3.8.1-12 and 3.8.1-13 exist for almost 24 hours, in which case it seems likely that the concrete surface temperatures will be quite high.

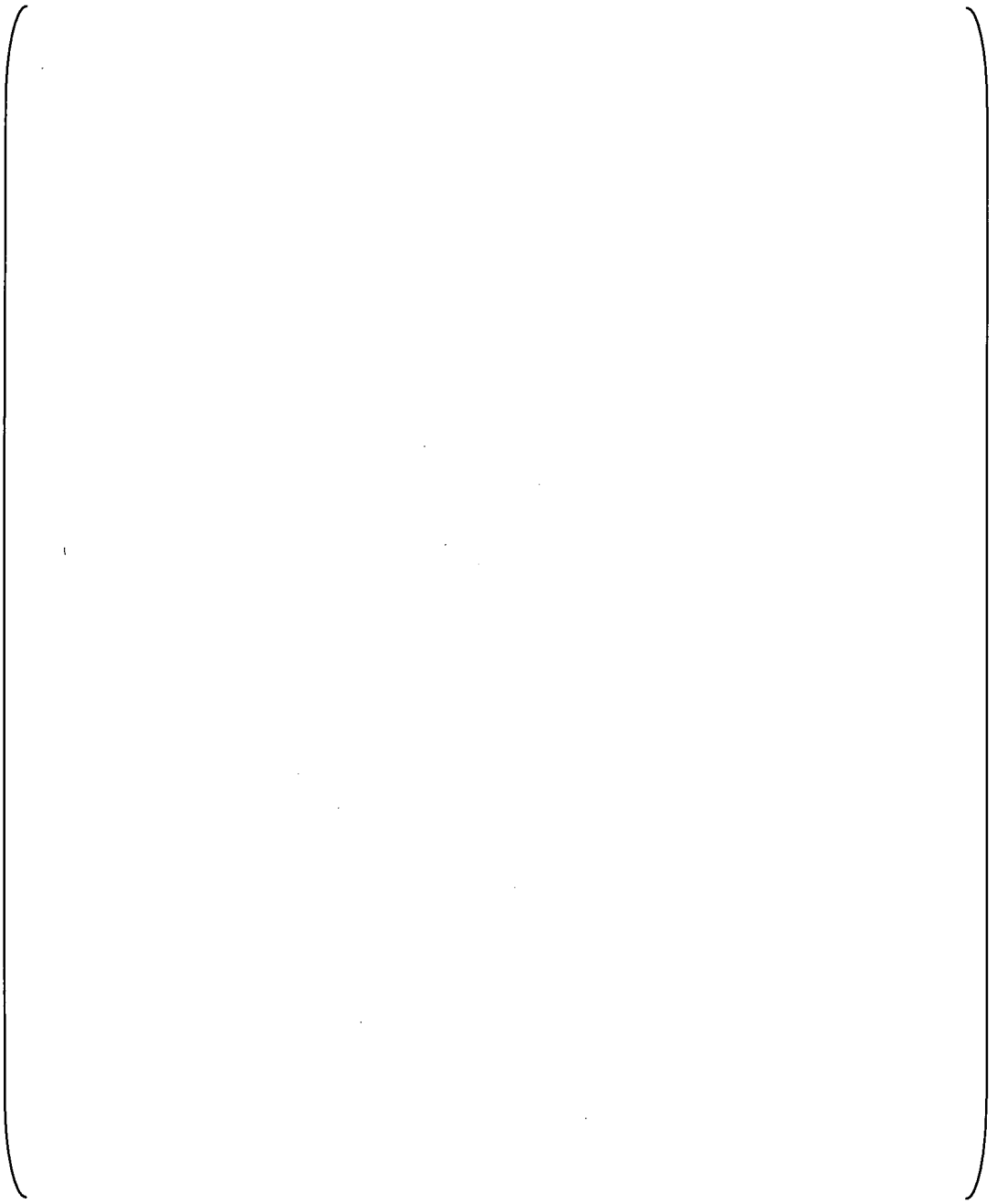
Appendix E of ACI 349-01, states that for accident or any other short term events the temperature of the surface of the concrete shall not exceed 350°F. However, local areas are allowed to reach 650°F from steam or water jets in the event of a pipe failure. ACI 349 states further that after such exposure to elevated temperatures the serviceability of the concrete wall needs to be assessed before resuming operation of the plant. The extent of the assessment will be determined by the engineer and it may be limited to visual inspection only.

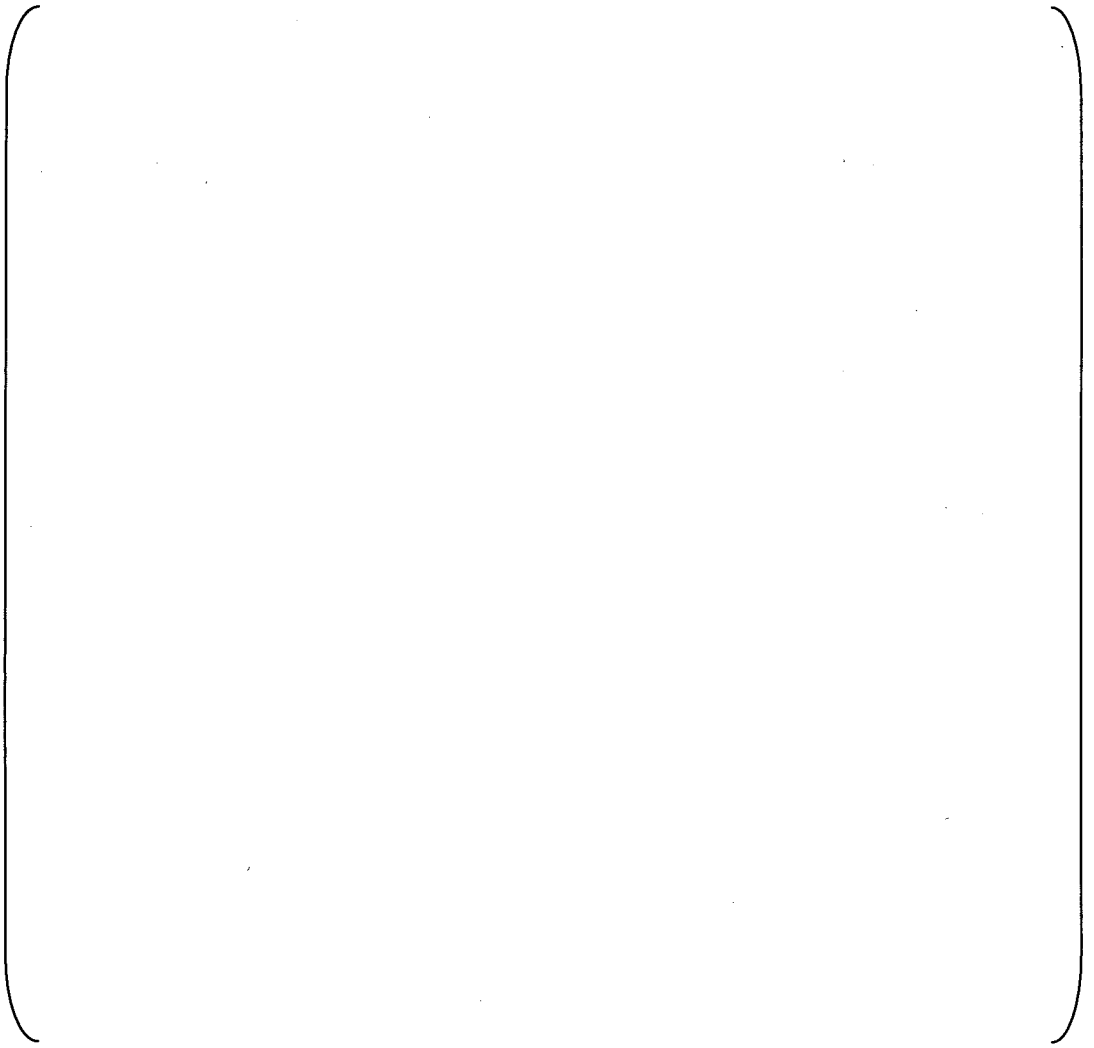
The applicant is requested to provide the following information:

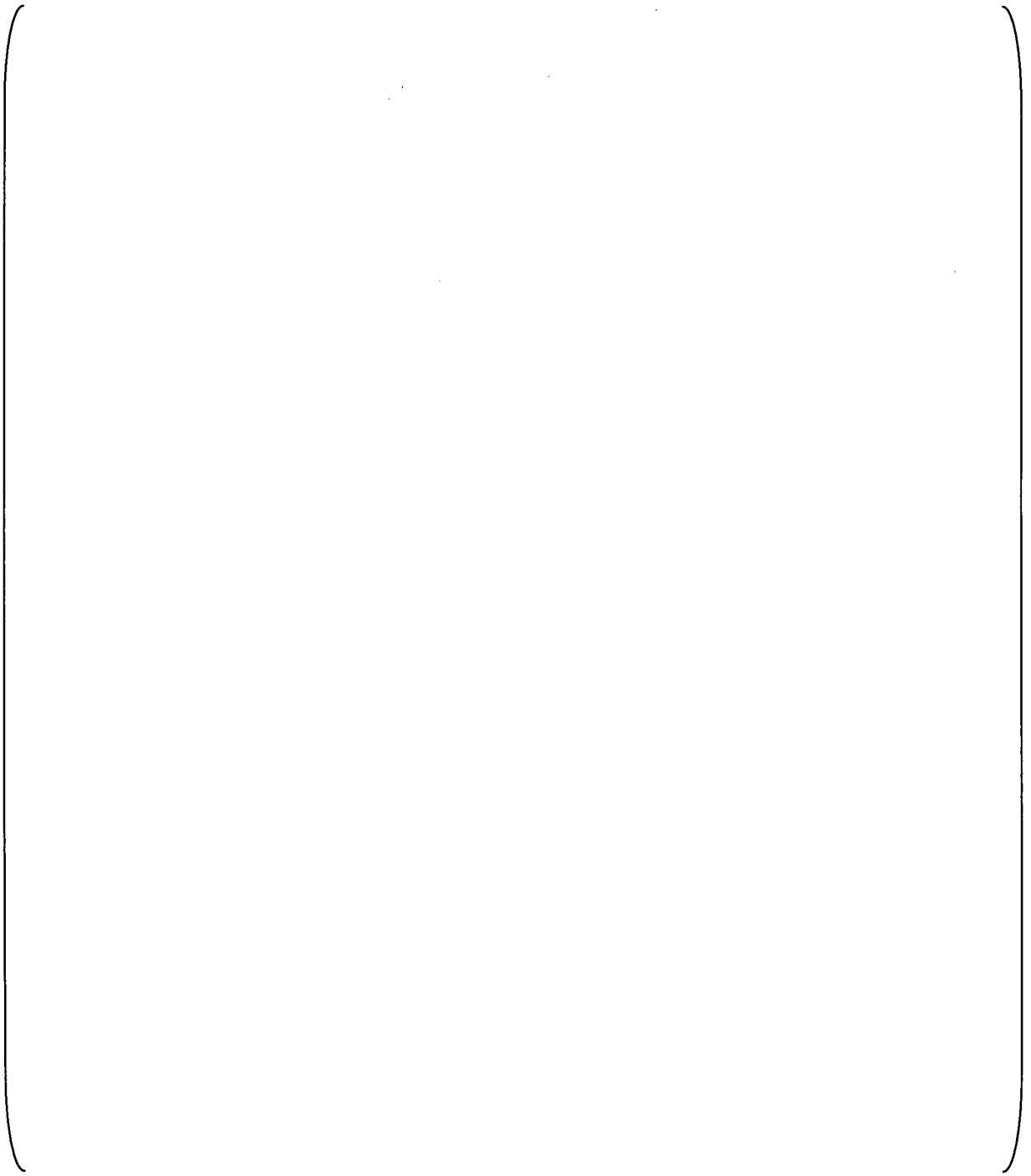
a) Temperature gradient plots versus time through the ½ in. thick steel faceplates and concrete in the SC module walls in the SG compartment.
b) Stress analysis results for the thermal gradients described in (a) above.
c) What is the maximum thermal gradient across the concrete wall in the SC module for the thermal time history loadings shown in DCD Figures 3.8.1-12 and 3.8.1-13? Would the resulting thermal stresses due to this thermal gradient cause the concrete to crack?
d) What is the maximum local concrete temperature at the interface between the concrete and the steel plate of the SC module from steam or water jets resulting from a pipe failure associated with the thermal time history loadings shown in DCD Figures 3.8.1-12 and 3.8.1-13?

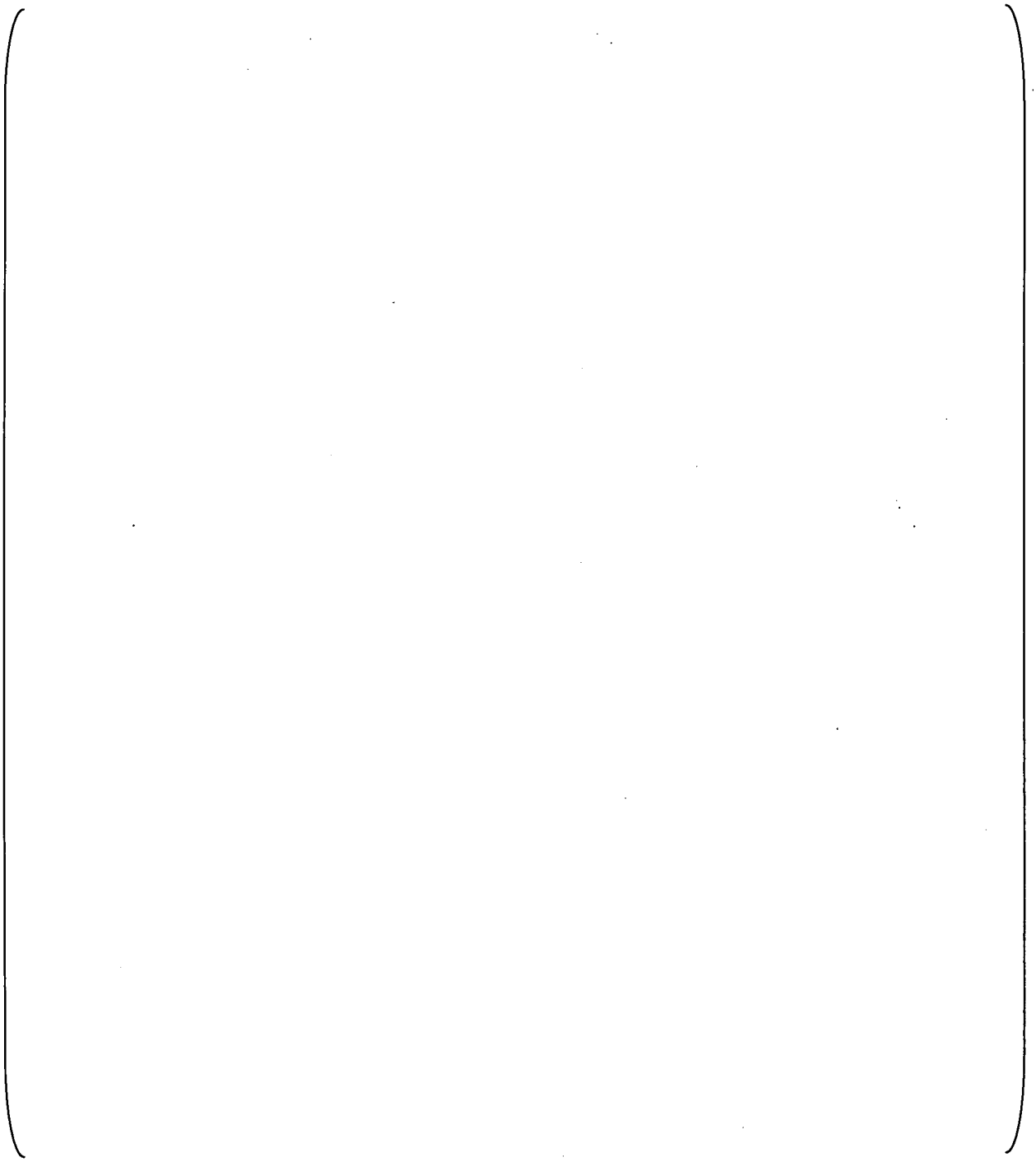
How will the assessment of the serviceability of the SC wall module be carried out in the event of a LOCA or steam pipe break resulting in these elevated temperatures?

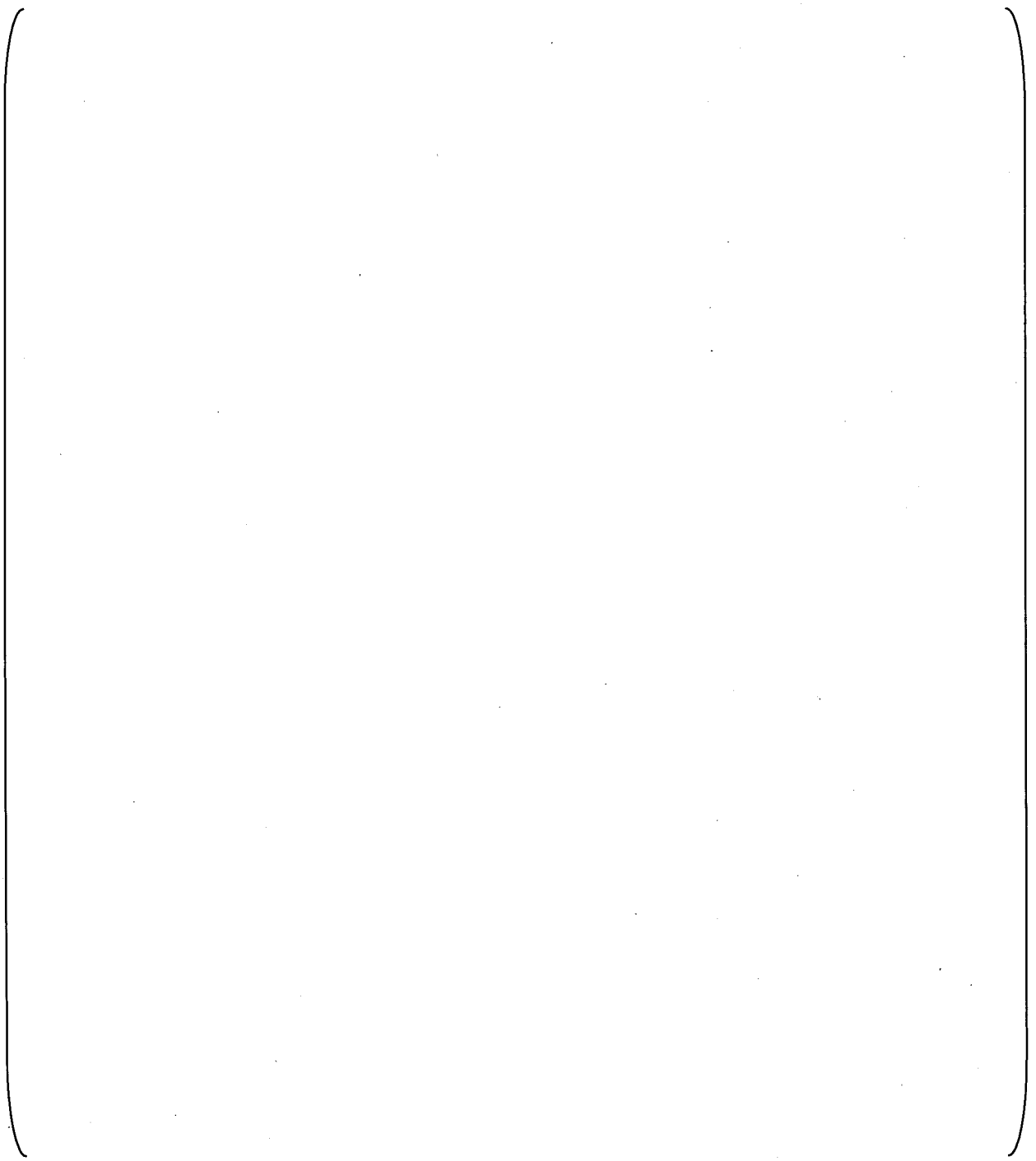
ANSWER:

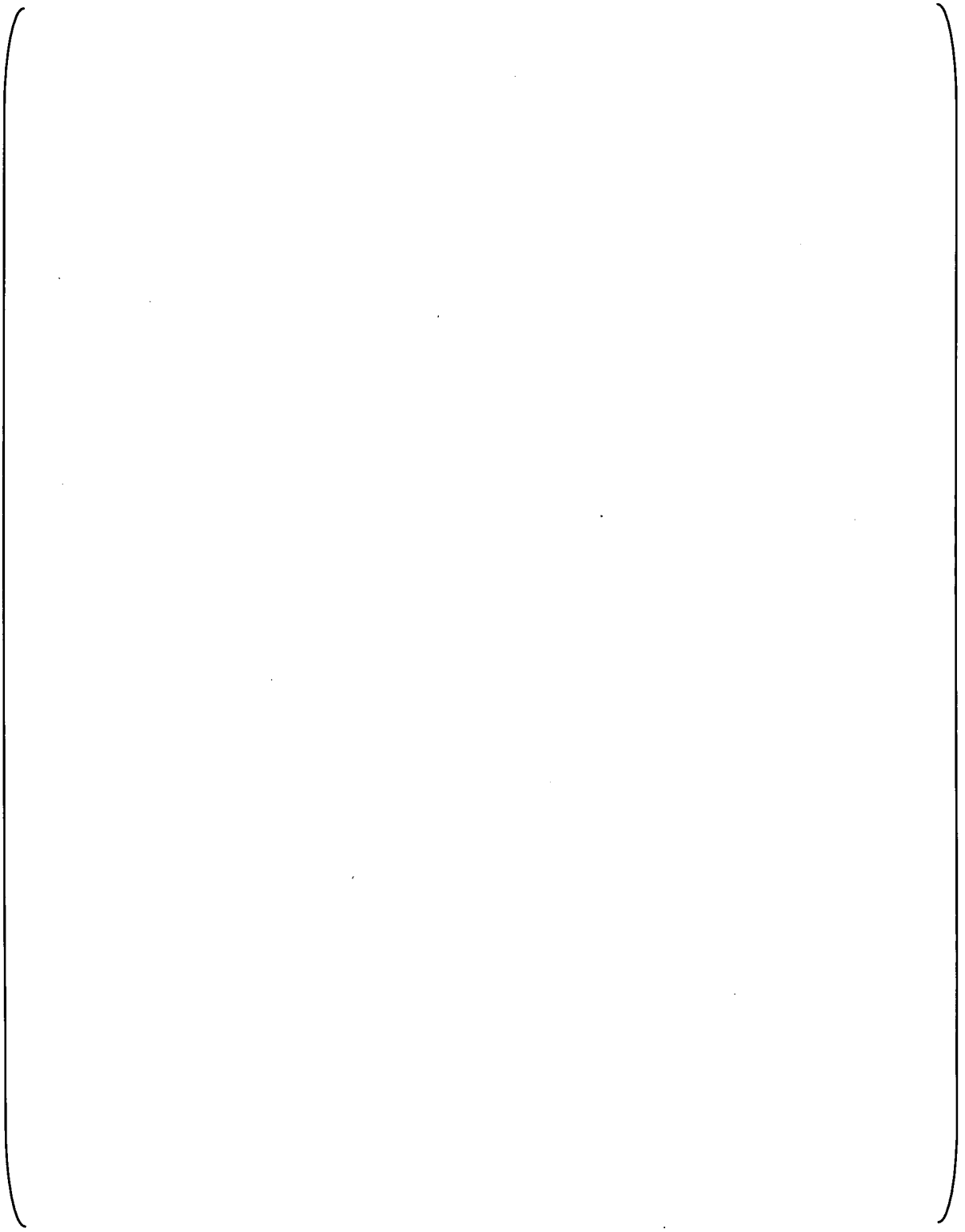


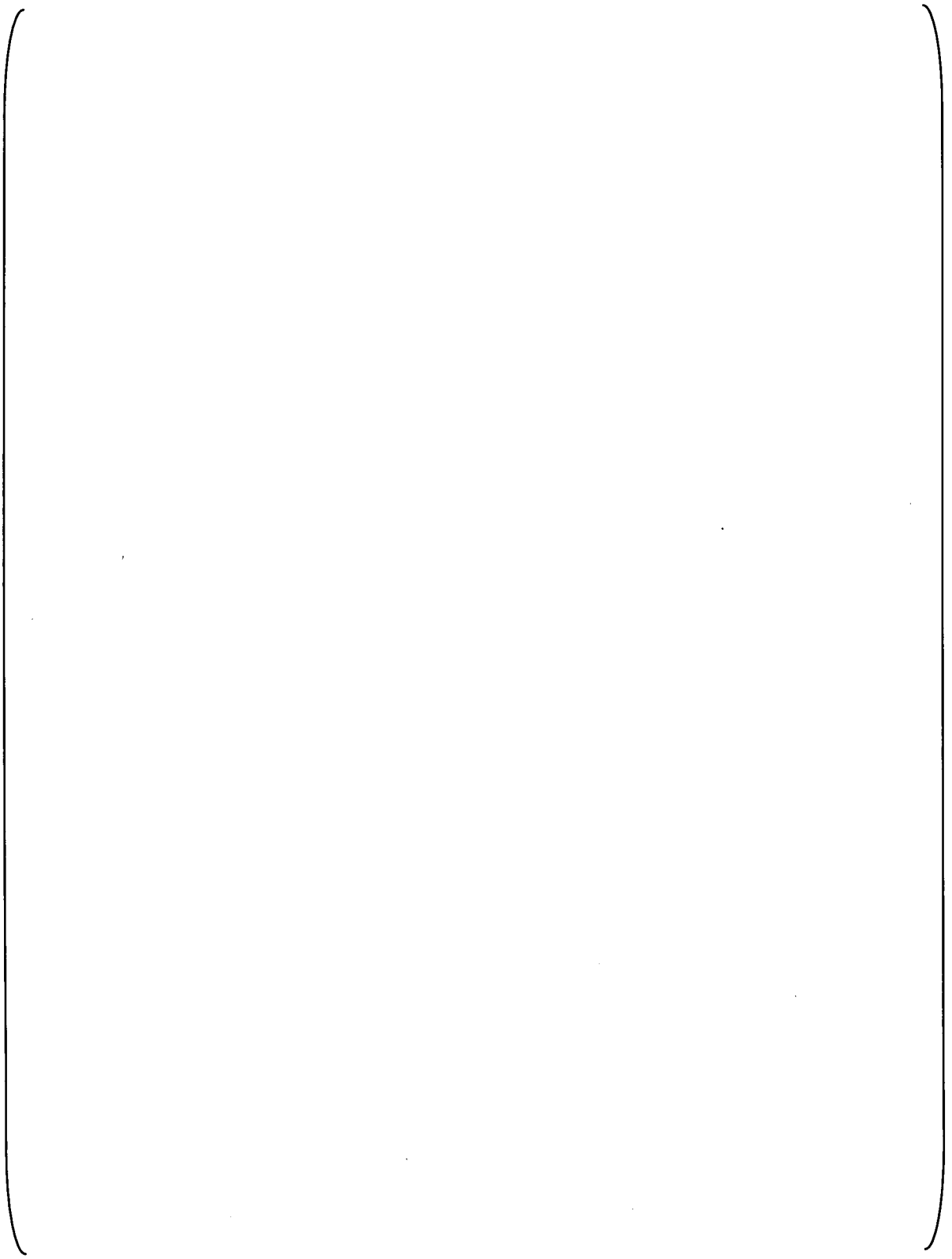


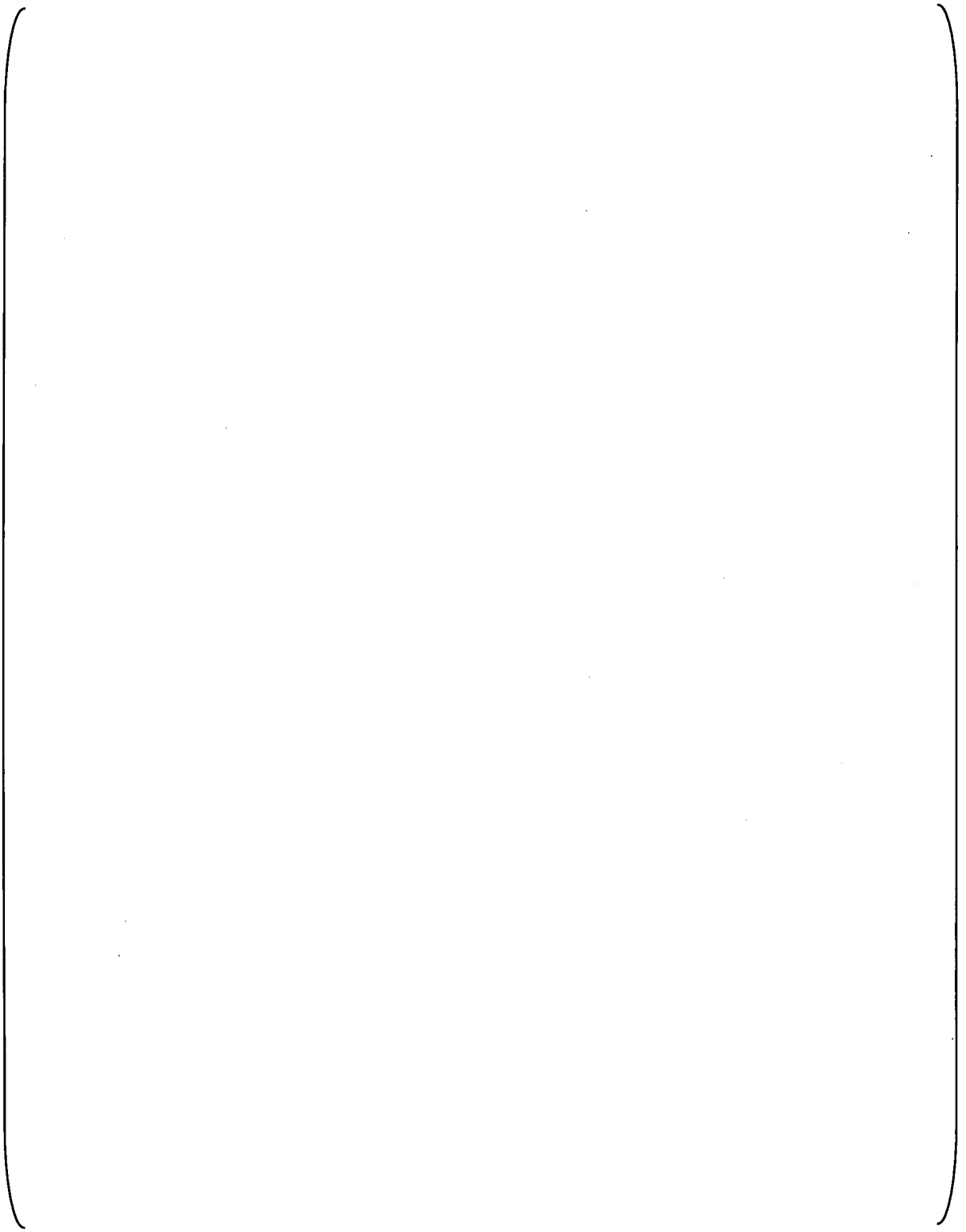


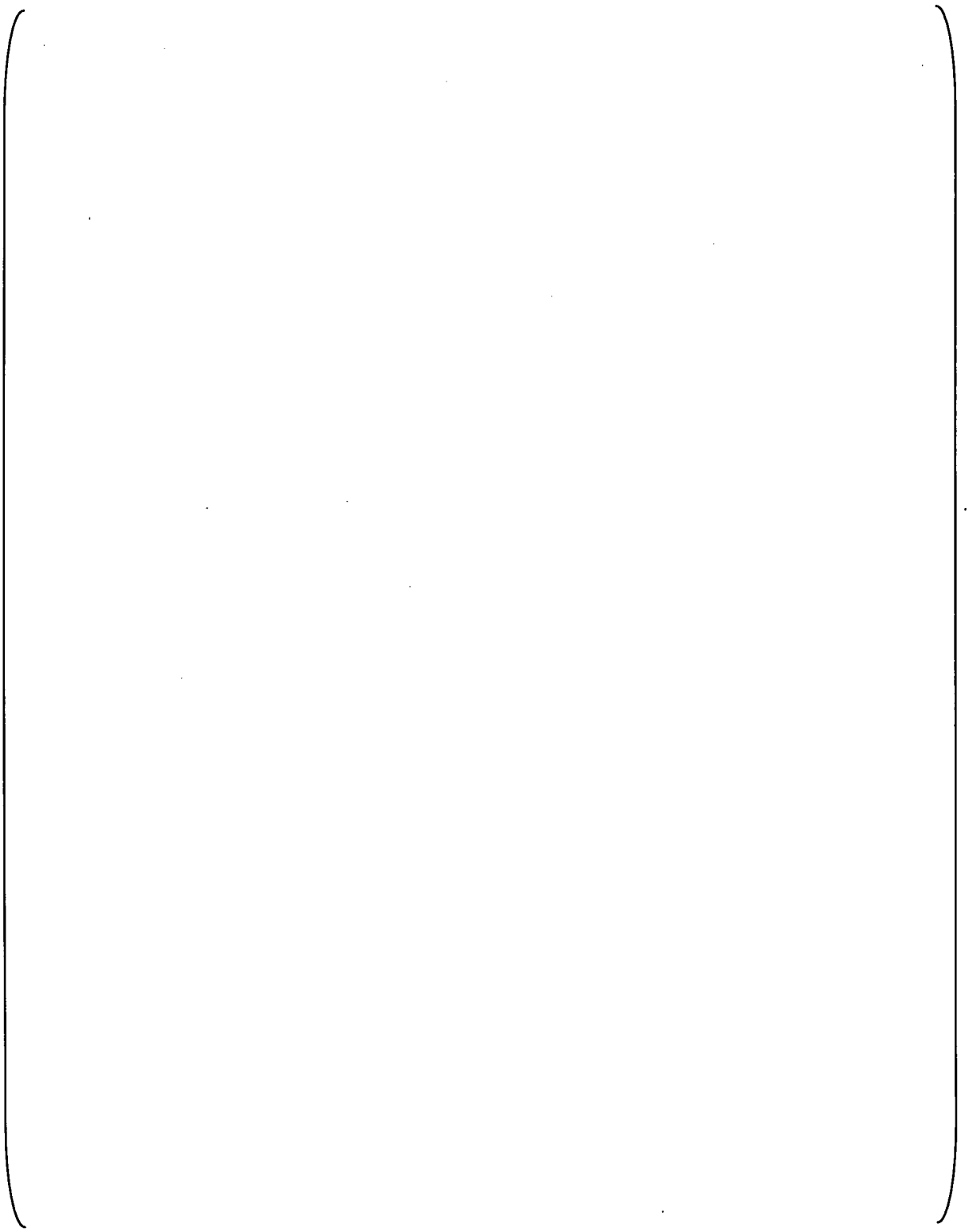


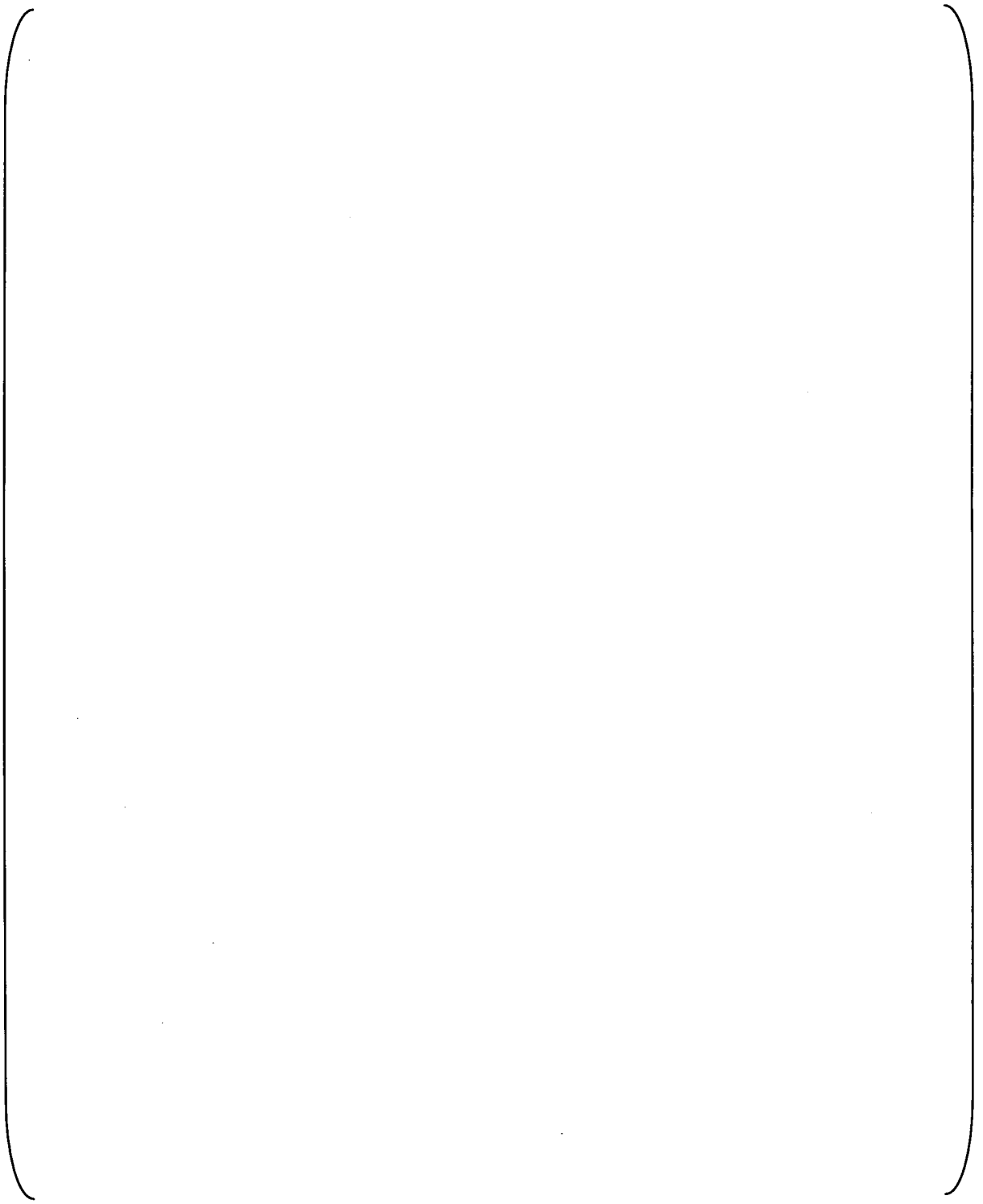












Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/4/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 322-1999 REVISION 0**
SRP SECTION:	**03.08.03 – Concrete and Steel Internal Structures of Steel or Concrete Containments**
APPLICATION SECTION:	**03.08.03**
DATE OF RAI ISSUE:	**4/8/2009**

QUESTION NO.: 3.8.3-8

The US-APWR design makes extensive use of modular construction. In particular, walls inside the containment vessel and other Seismic Category I structures are constructed of steel concrete composite components, identified as SC modules. These SC modules use two steel faceplates separated by web plates or other means and are shop fabricated and then shipped to the jobsite, where they are welded together to form large assemblies which are then fastened into place in the structure. Concrete is then placed in the space between the faceplates. The faceplates act as the primary steel reinforcing for the composite section.

At the present time, US codes and standards, such as ACI-349, do not explicitly cover this type of design and construction. In Subsection 3.8.3.4.5, "*SC Modules Design and Analysis*" of the US-APWR DCD. p. 3.8-41, it states that, "SC modules are designed as reinforced concrete structures in accordance with the requirements of ACI 349 (Reference 3.8-8), as supplemented in the following paragraphs."

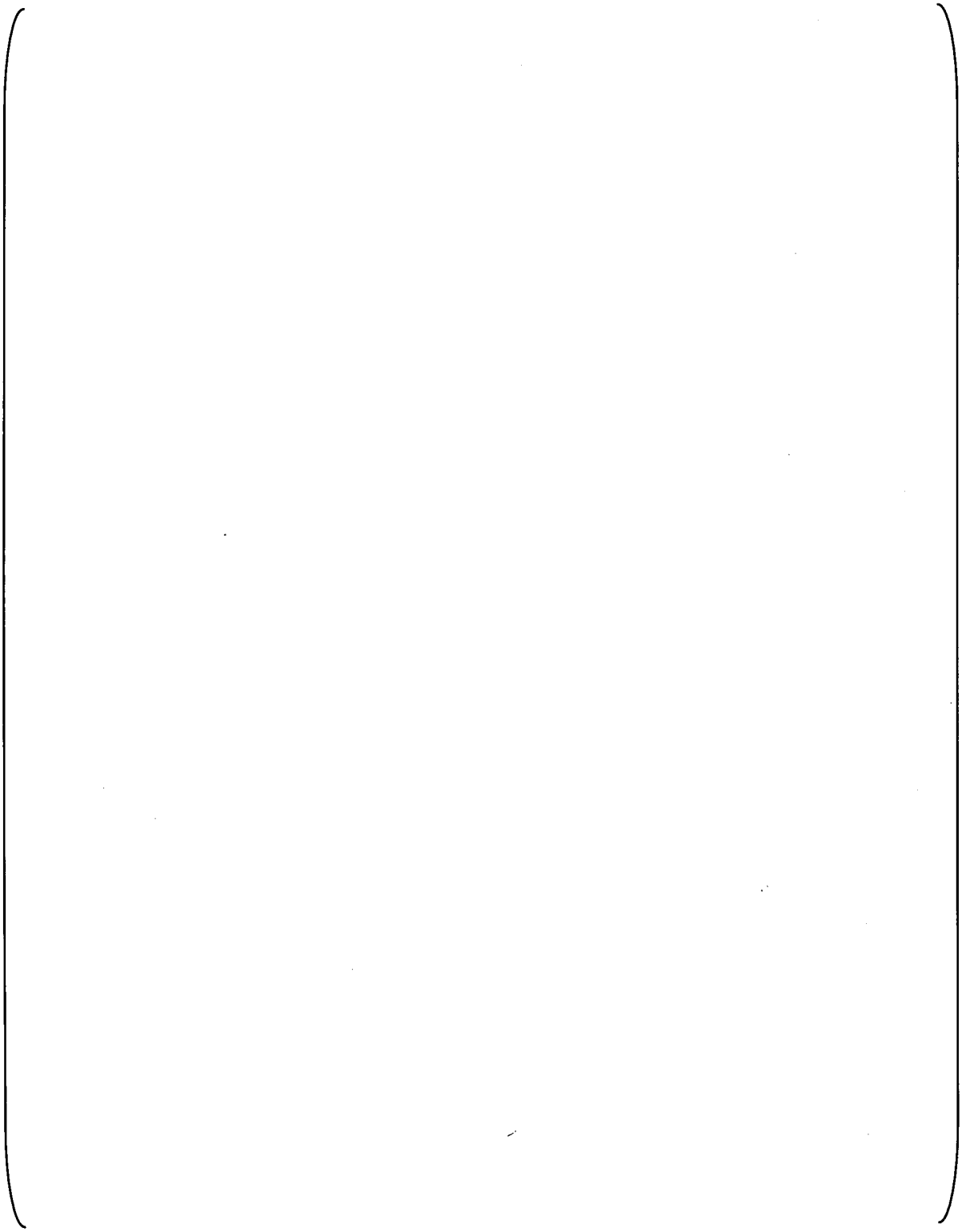
The applicant is requested to provide the following information:

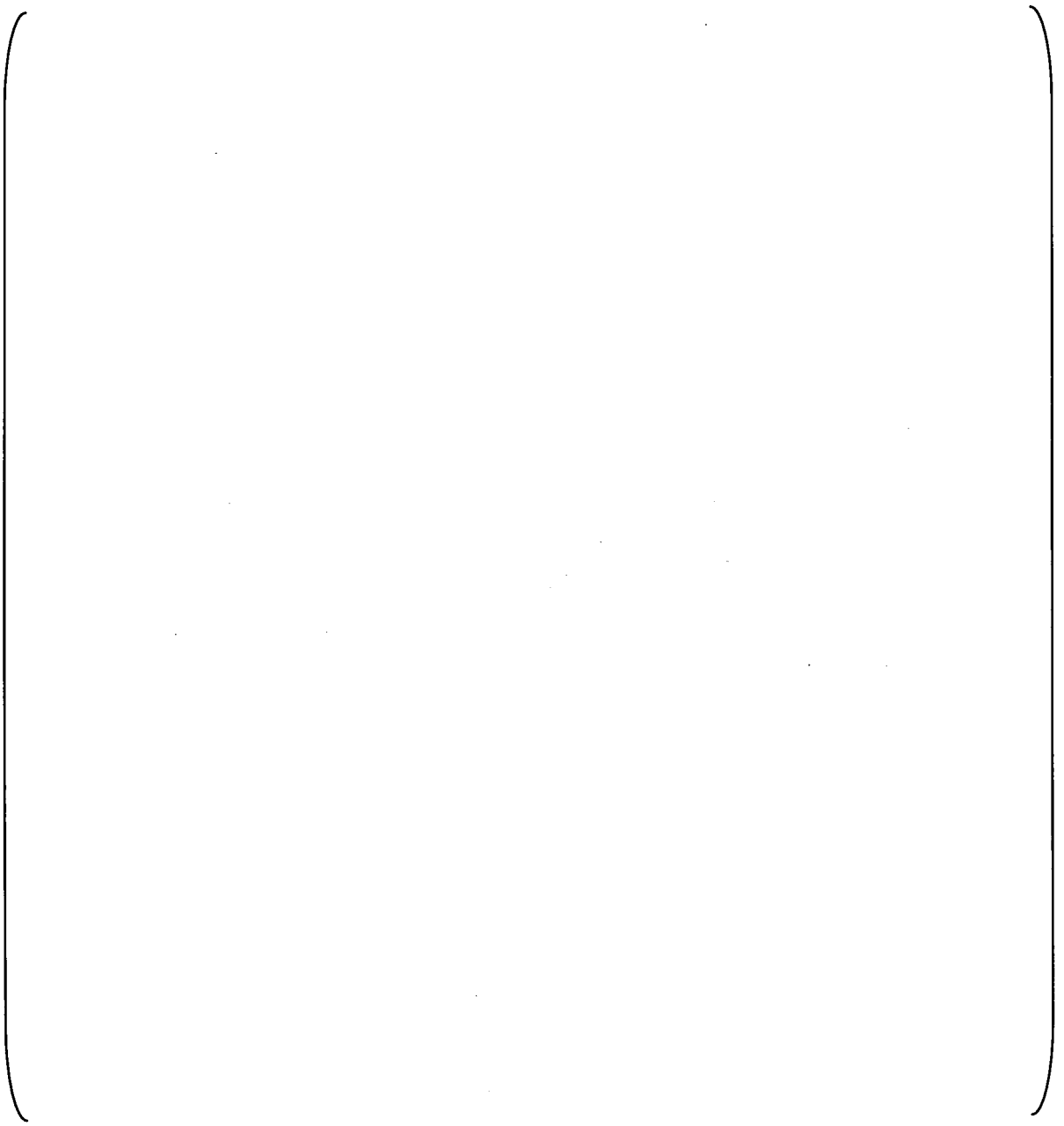
In the absence of specific U.S. code requirements and guidance for the SC module, more information is needed for the staff to evaluate the adequacy of the design method for these SC module structures. The most important information is the applicant's demonstration that its design method for the SC module structures was derived from, or substantiated by, test data that is cited in the DCD. Include a summary of results of tests of SC modules cited in the DCD and how these results support the design approach. Additional information should include more detailed descriptions of any specific additional requirements and criteria which were used in the design of these SC modules, which are different from the ordinary reinforced concrete structures that are covered by ACI 349. Provide more explicit information in the following areas, including a discussion of why the direct and sole use of ACI 349-06 for some items (such as for *Design for In-Plane Shear*) results in an structure that has, as a minimum, a level of structural integrity as that of a reinforced concrete shear wall of similar dimensions and level of steel reinforcement:

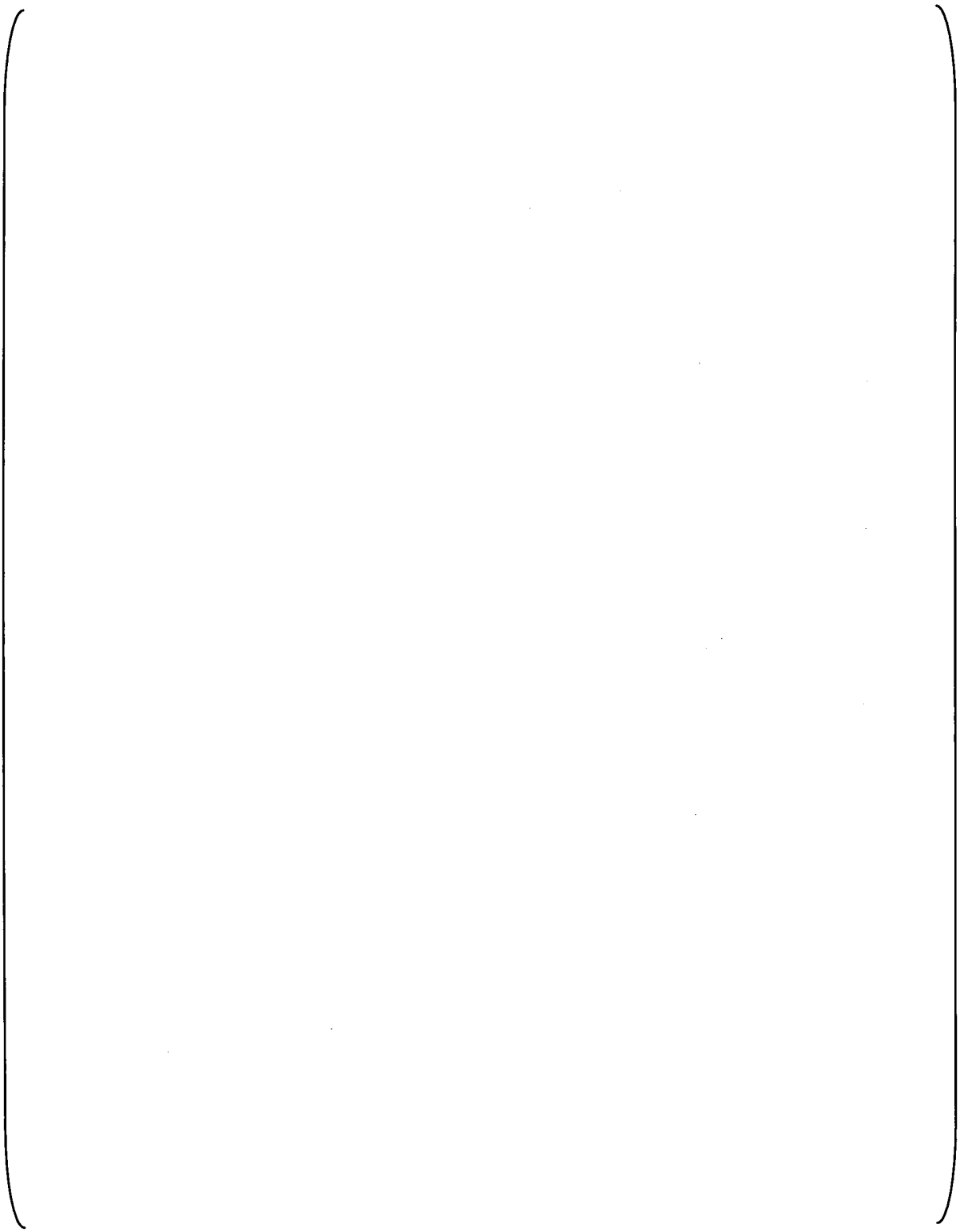
- Overall structural design and behavior of the SC modules
- Design of connections between adjoining SC modules, including corner joints. (Describe how continuity of the concrete and steel faceplates are preserved at these joints.)
- Design for in-plane shear
- Design for out-of-plane shear
- Design of shear studs
- Design of web plates
- Design of steel faceplates

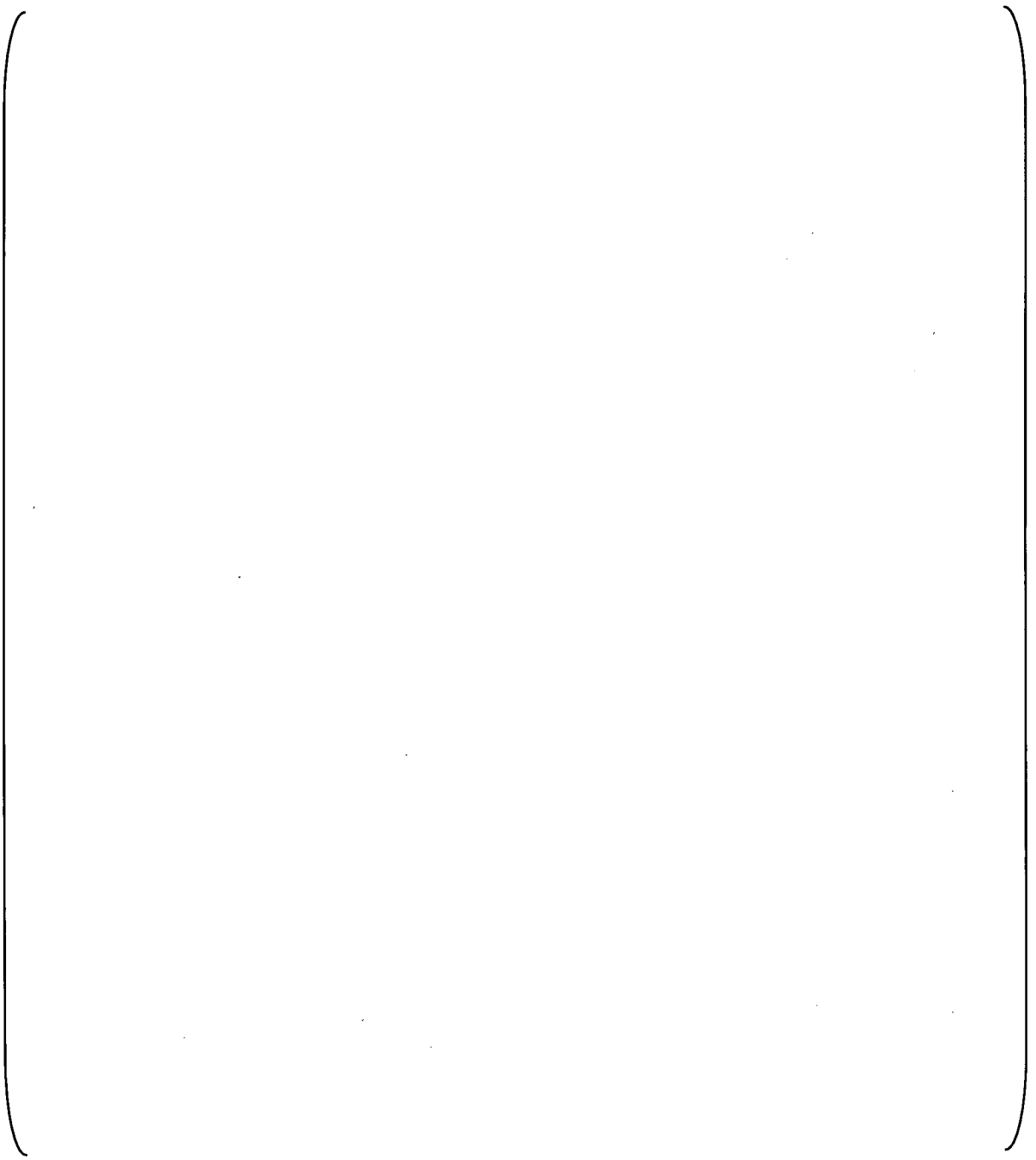
In addition, it is the staff's understanding that floor slabs supported on the top of the SC wall modules are designed as conventional reinforced concrete slabs, not as composite steel concrete slabs. Provide confirmation of this observation.

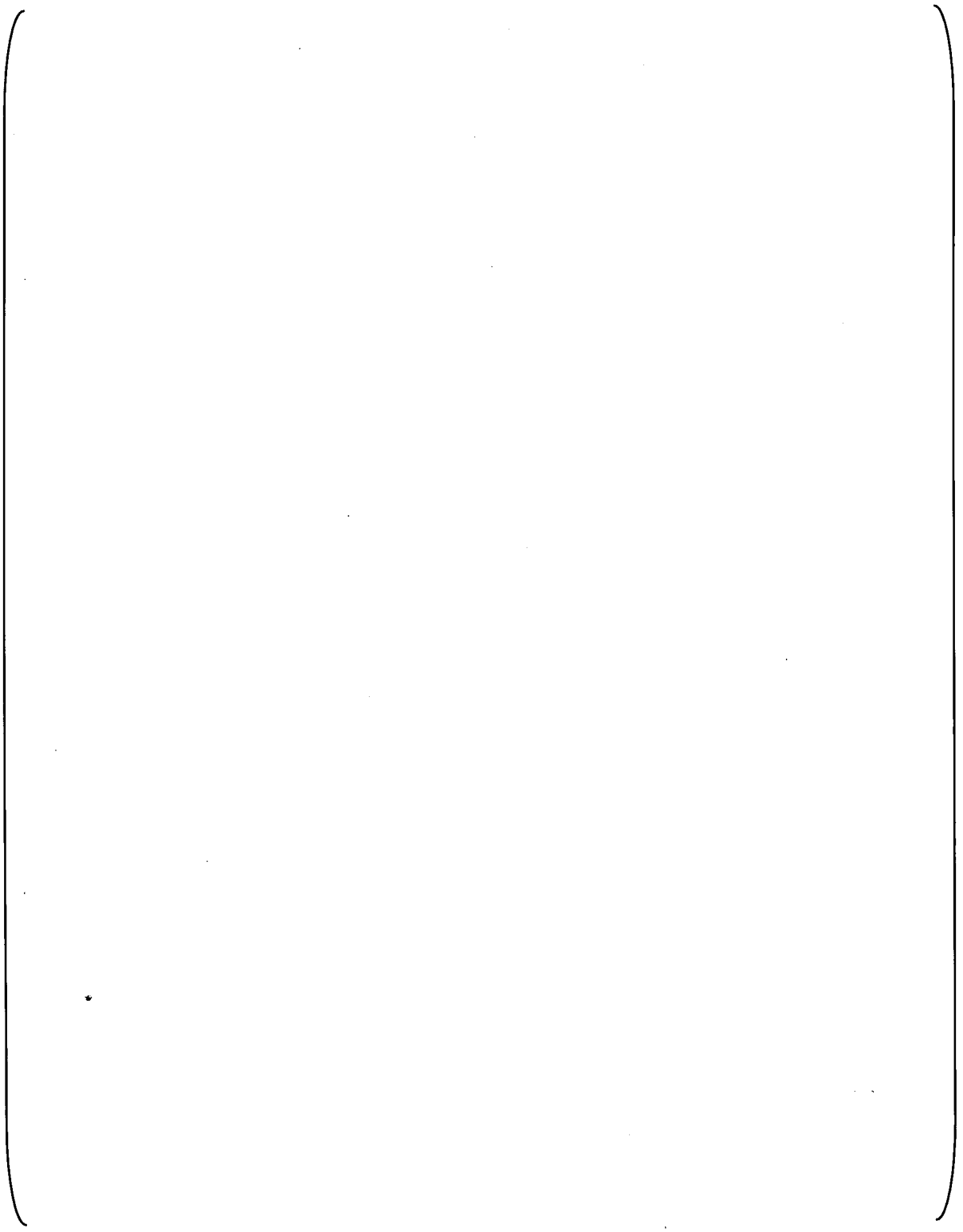
ANSWER:

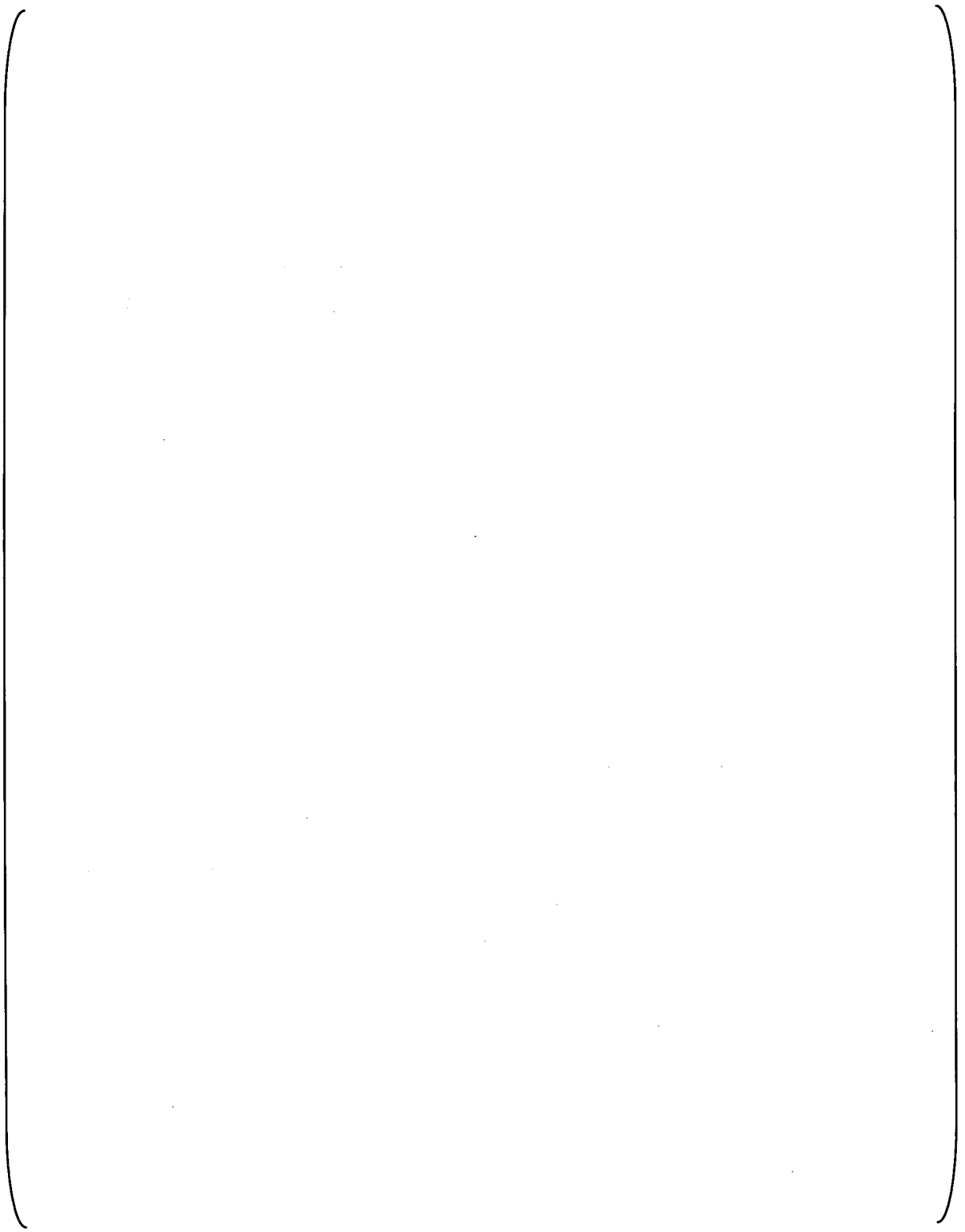


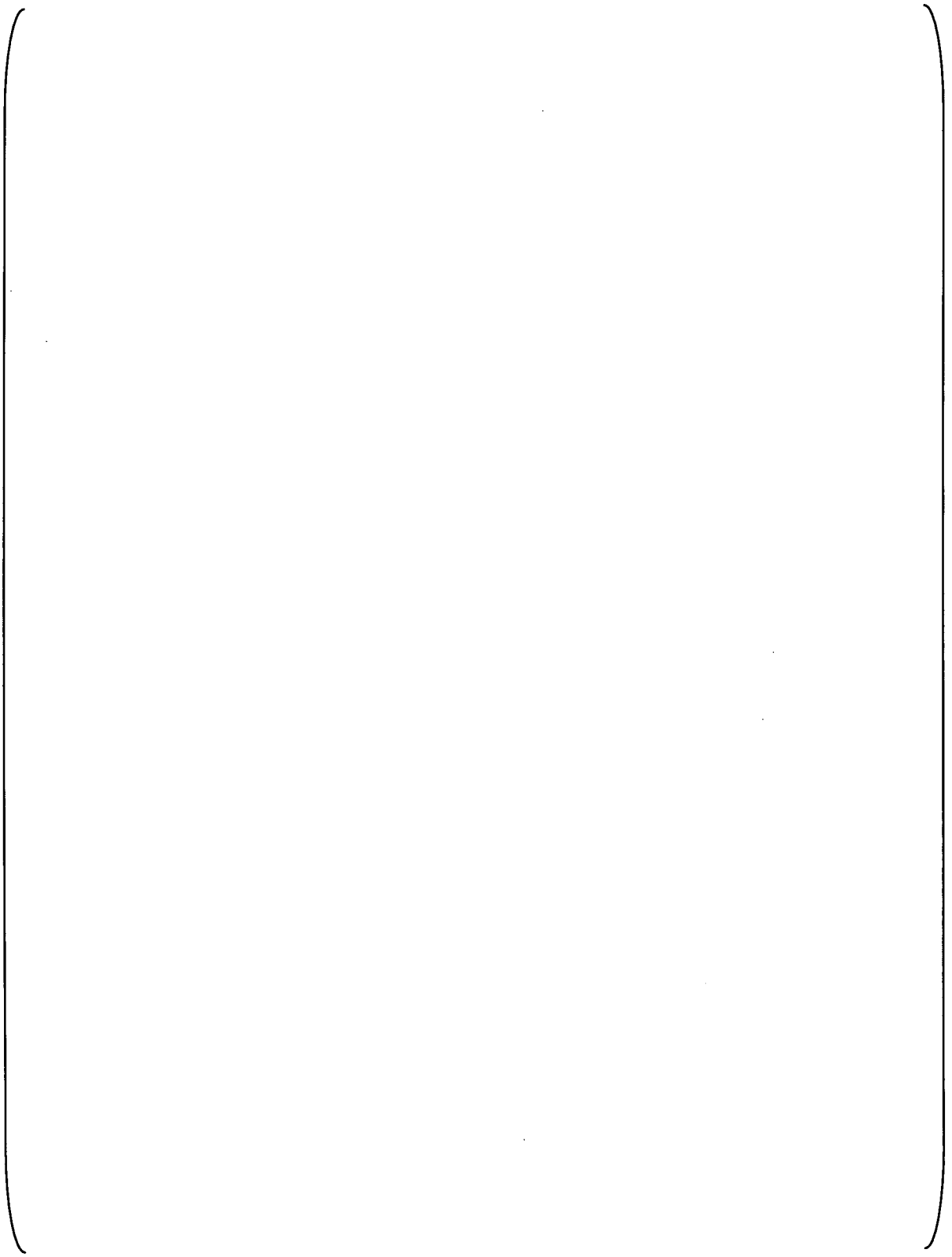


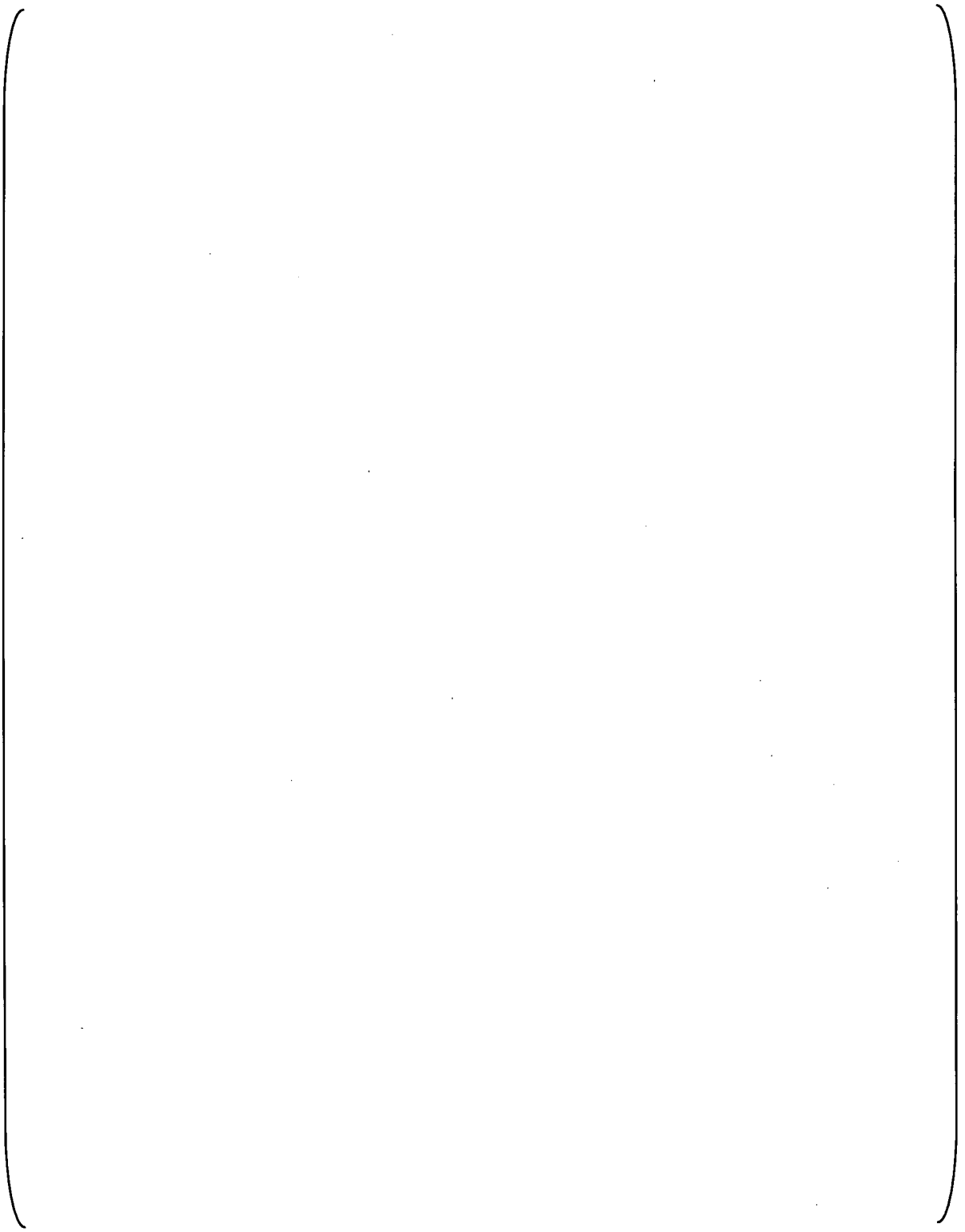












Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/4/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 322-1999 REVISION 0**
SRP SECTION:	**03.08.03 – Concrete and Steel Internal Structures of Steel or Concrete Containments**
APPLICATION SECTION:	**03.08.03**
DATE OF RAI ISSUE:	**4/8/2009**

QUESTION NO.: 3.8.3-13

In reviewing the applicant's response to Question 06.02.06-11 dealing with containment vessel penetration cooling, concern was generated about the stress that would be placed on the in-containment penetration collar welds between the penetration sleeve and the end cap and between the end cap and the steam pipe. The penetration arrangement of concern is depicted in DCD Figure 3.8.1-8 (Sheet 12 of 16) on page 3.8-148 of the DCD. As shown, on the in-containment side of the penetration there is a full penetration weld between a thickened section of the steam pipe and the end cap (collar) and a corner weld between the penetration sleeve and the end cap (collar).

The applicant is requested to provide the following information:

- Provide the stress analysis demonstrating the structural integrity of this weld over time for all loads and load combinations, including the effects of induced steam flow vibrational movements in the steam piping, and any other piping loads imposed on the penetration assembly. Also, provide the inspections and nondestructive tests to be performed on these welds to meet code requirements. In addition, confirm that the function of these welds is to provide the containment barrier leak tightness and structural support of the steam piping.

It is noted further that the weld details (i.e., between the penetration sleeves and the end caps and between the end cap and the piping) used in penetrations for the main steam lines, are also used for other major penetrations, including the Feedwater piping (DCD Figure 3.8.1-8, Sheet 13 of 16), and the SG Blowdown piping (DCD Figure 3.8.1-8, Sheet 14 of 16).

- Provide the stress analysis for these other major piping penetrations for all loads and load combinations, (including Feedwater piping and SG Blowdown piping), taking into account the piping loads imposed on the penetration assembly, thermal effects, and any dynamic loads anticipated from the piping systems in these penetrations.

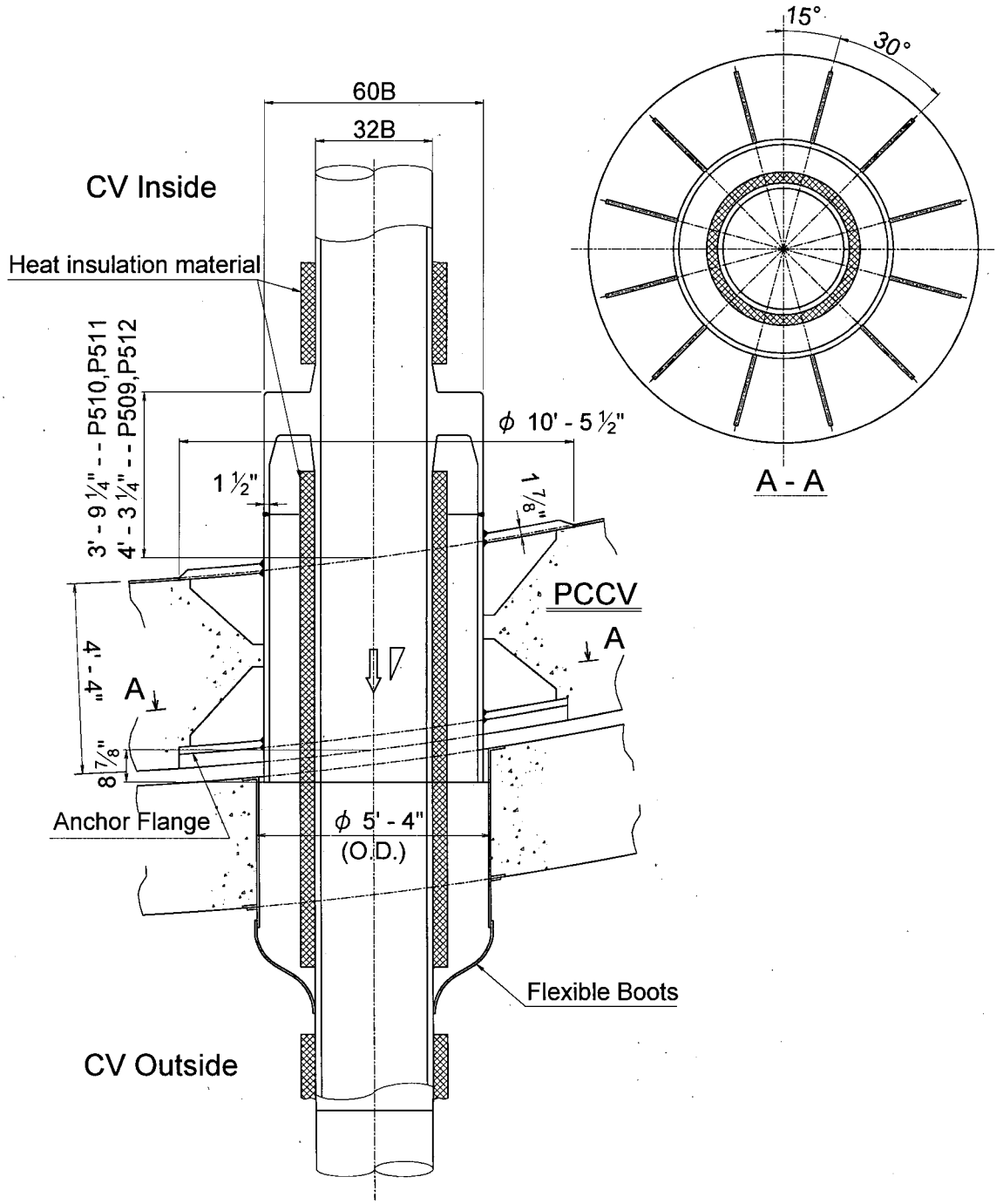
ANSWER:

Please refer to Item (e) of the answer to question 03.06.02-2 of RAI 71-986.

Welds located between the inner side of flat heads and pipes of PCCV penetrations for high-energy fluid system piping, main steam piping, feedwater piping, and SG blow down piping; do not satisfy the criterion of BTP 3-4, Part B, Item A(ii)(5).

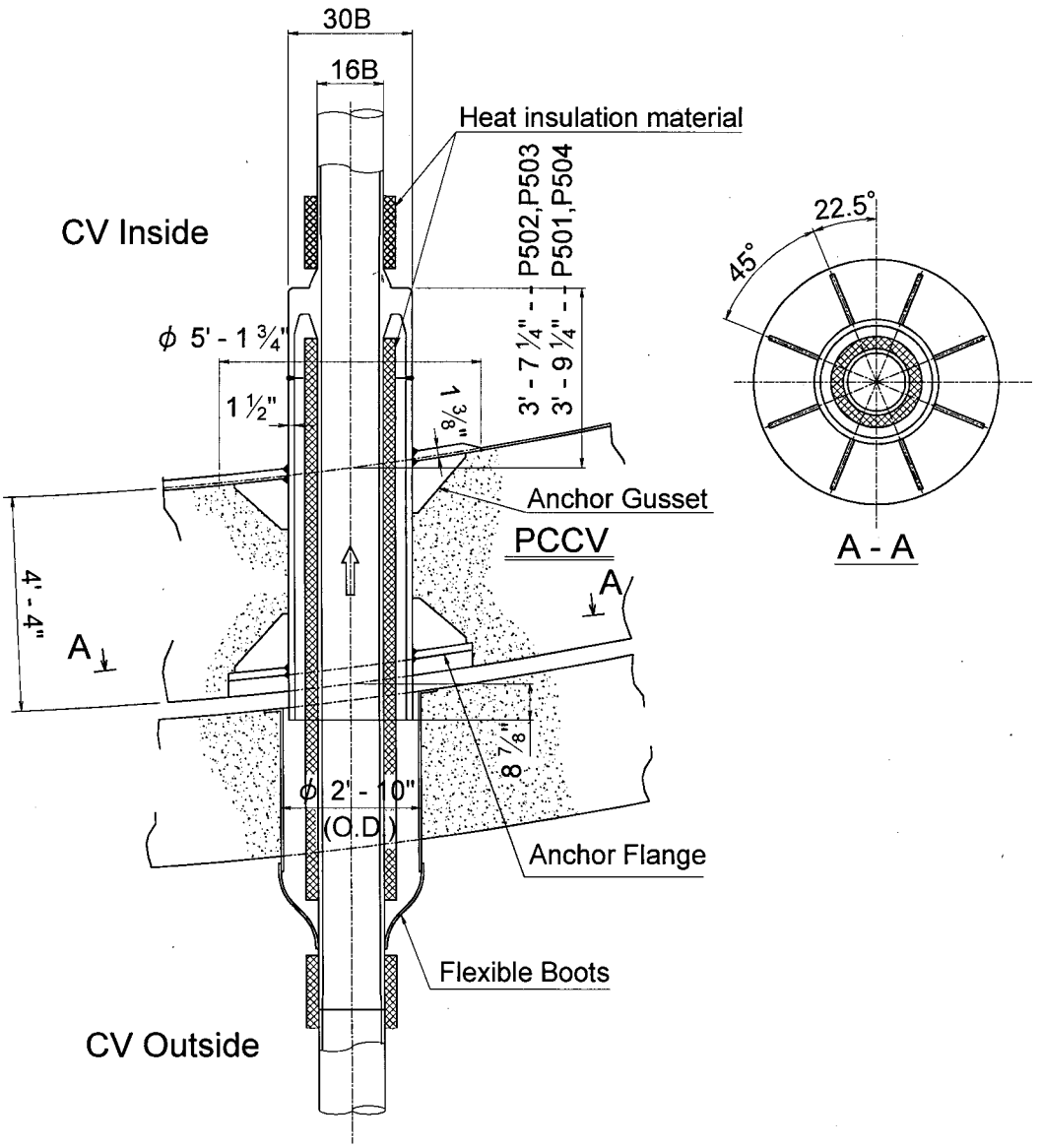
These penetrations are modified with welded attachments to the flued head structure to satisfy the criterion of BTP 3-4, Part B, Item A(ii)(5) as shown in Figure 3.8.1-8 (Sheet 12 of 17) in MUAP-09003 (R0), US-APWR DCD RAI Tracking Report. See Figure 3.8.1-8 (Sheets 12, 13, and 14 of 17) below.

Therefore, the modified penetration structure addresses the NRC concerns raised in this RAI.



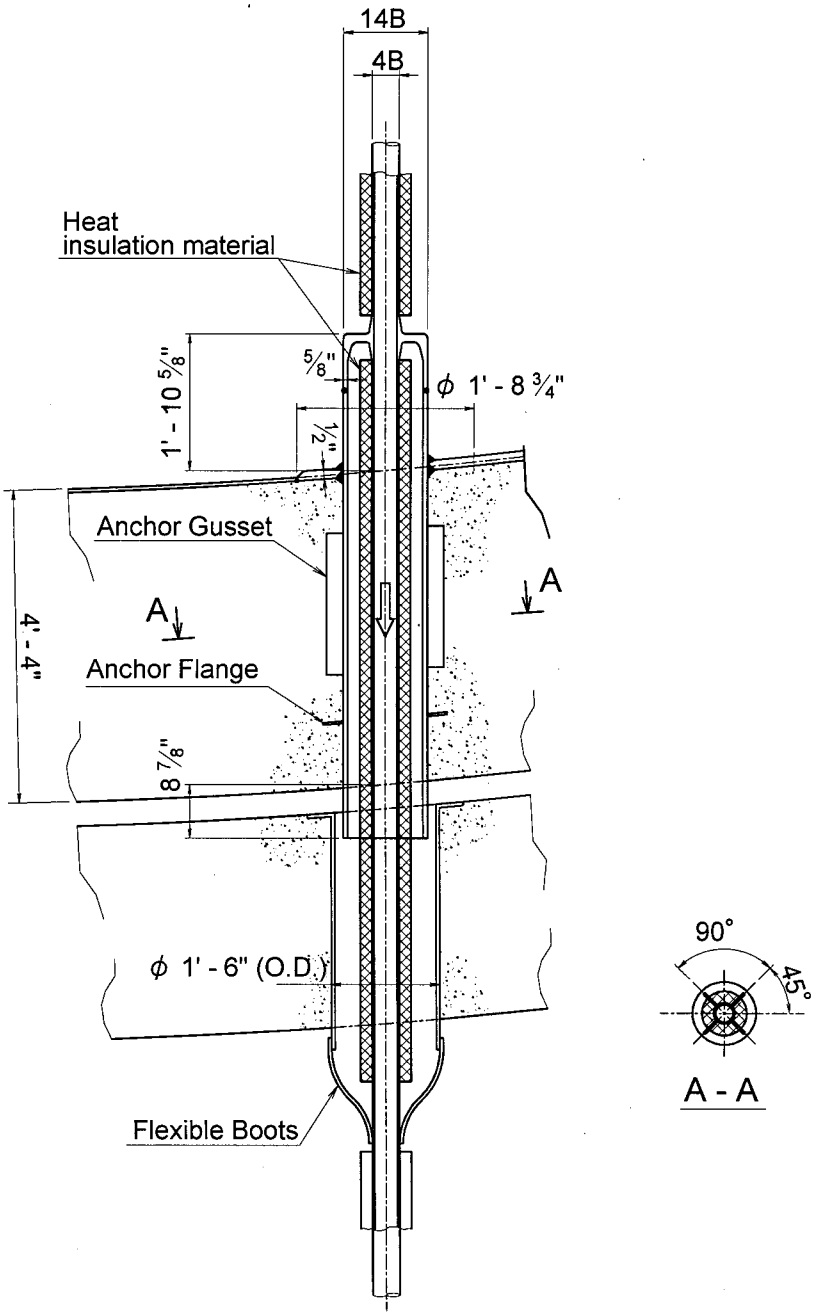
P509～P512
(Main Steam)

Figure 3.8.1-8 Containment Penetrations
(Sheet 12 of 17)



P501～P504
(Feed Water)

Figure 3.8.1-8 Containment Penetrations
(Sheet 13 of 17)



P505～P508
(SG Blowdown)

Figure 3.8.1-8 Containment Penetrations
(Sheet 14 of 17)

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/4/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

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QUESTION NO.: 3.8.3-14

In DCD Subsection 3.8.3.1.5, it states that the SC module walls are welded at the base to a continuous embedded plate in the PCCV basemat. DCD Subsection 3.8.3.1.10 further states that the SC modules are anchored to the basemat through reinforcement doweled with the slab. DCD Figure 3.8.3-7 provides sketches of typical details for the SC module construction including connection details and anchorage connection details to the reinforced concrete basemat.

In order to more fully understand the connection between the SC module walls and the basemat, the applicant is requested to furnish information in greater detail of this connection joint, identifying all of the structural components, including embedded base plates, SC module faceplates, PCCV liner plate, rebars, dowels, and welds between plates, and the design method for the connection(s).

ANSWER:

[

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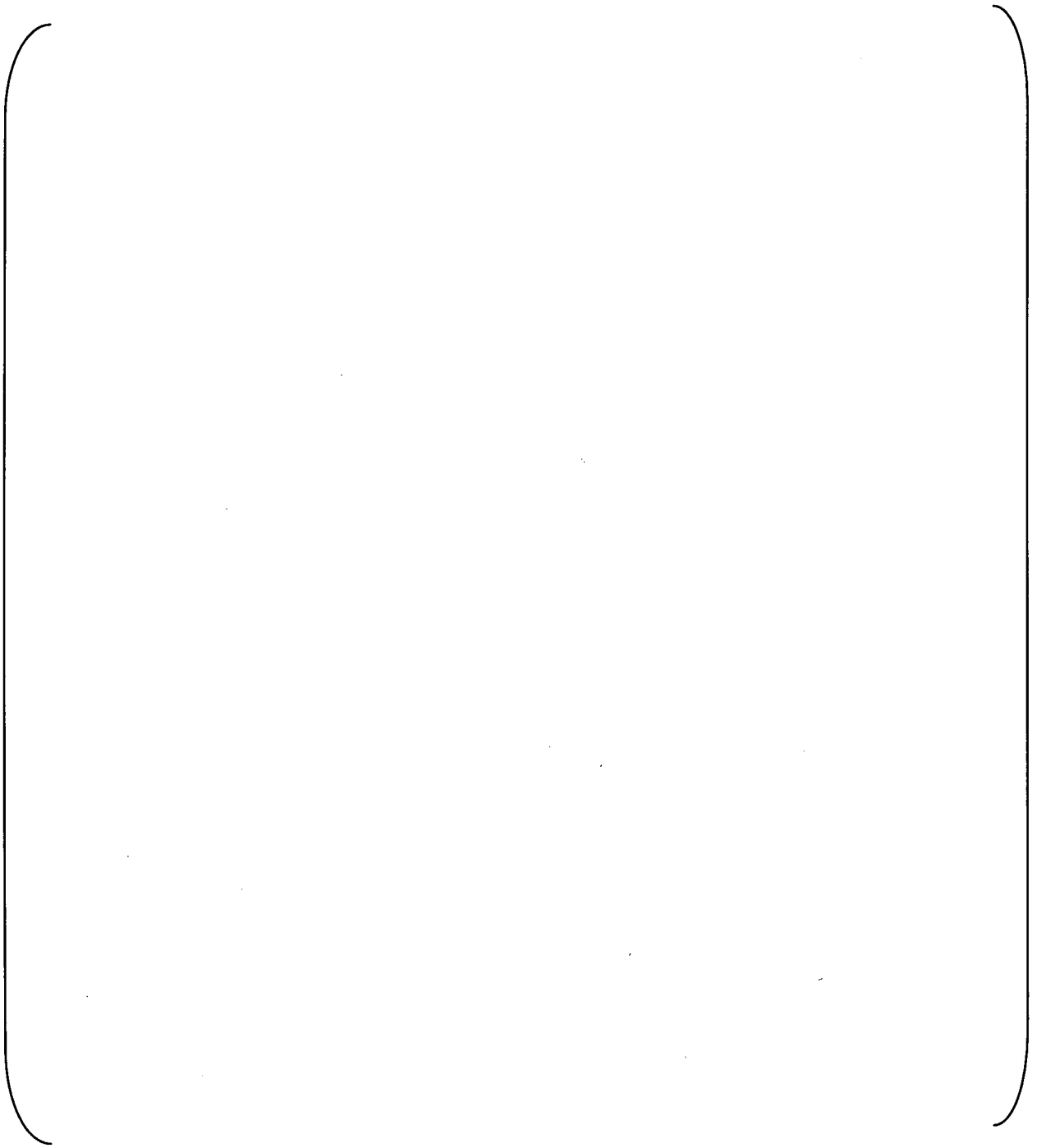

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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QUESTION NO.: 3.8.3-15

In DCD Subsection 3.8.3.4, the 7th paragraph (Page 3.8-39) states, "Case 1 assumes monolithic behavior of the steel plate and uncracked concrete. This stiffness is the basis for the stiffness of the SC modules in the seismic analyses and the stress analysis."

The applicant is requested to provide the following information:

Both ACI 349-01 Section 10.11 and Design and Analysis Procedure 4D of SRP 3.8.3 (page 3.8.3-24 of SRP 3.8.3 Revision 2, March 2007) require the consideration of concrete cracking. Since all the seismic analyses and the stress analysis that involve the SC modules assumed that concrete was uncracked, demonstrate that the analyses results of the floor response spectra, the strength of the walls, and all other structural elements are conservative compared to the results if concrete cracking was considered in the analyses.

ANSWER:

With respect to SSE load conditions, an analysis of the containment internal structure comprised of SC Modules determined that the resulting shear forces and moments do not cause cracking at the base of the containment internal structure. Based on this check, the effects of concrete cracking were determined to have only an insignificant effect on the seismic response of the overall the containment internal structure.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

This completes MHI's response(s) to the NRC's question(s).