ENCLOSURE 3

UAP-HF-10074

MHI's 2nd Response to the NRC's Request for Additional Information on Topical Report MUAP-07013-P (R0) "Small Break LOCA Methodology for US-APWR" on 2/16/2010

March 2010
(Non-Proprietary)

REQUEST 8.1.2-14-1
(Related RAI 8.1.2-14)
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RESPONSE
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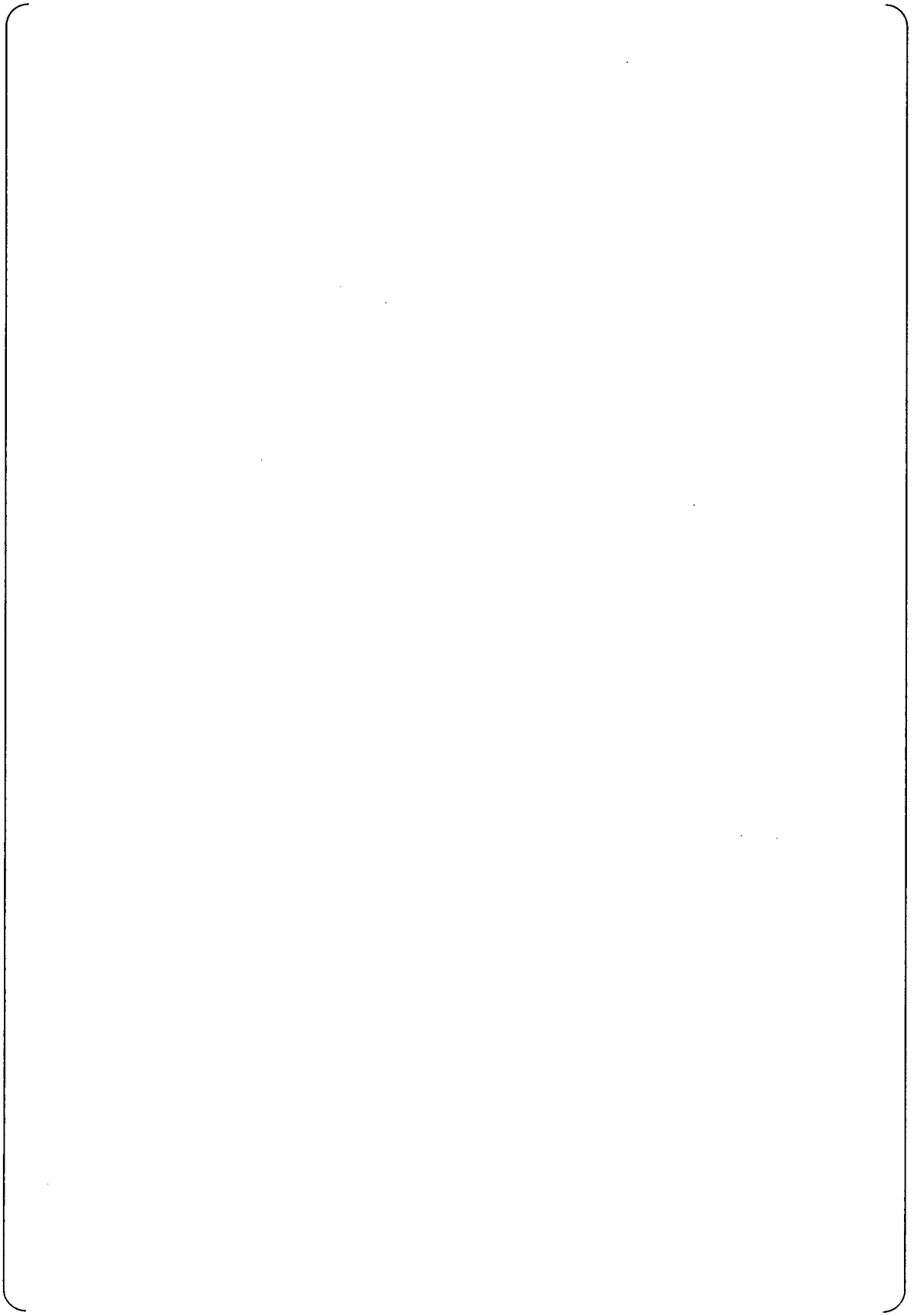

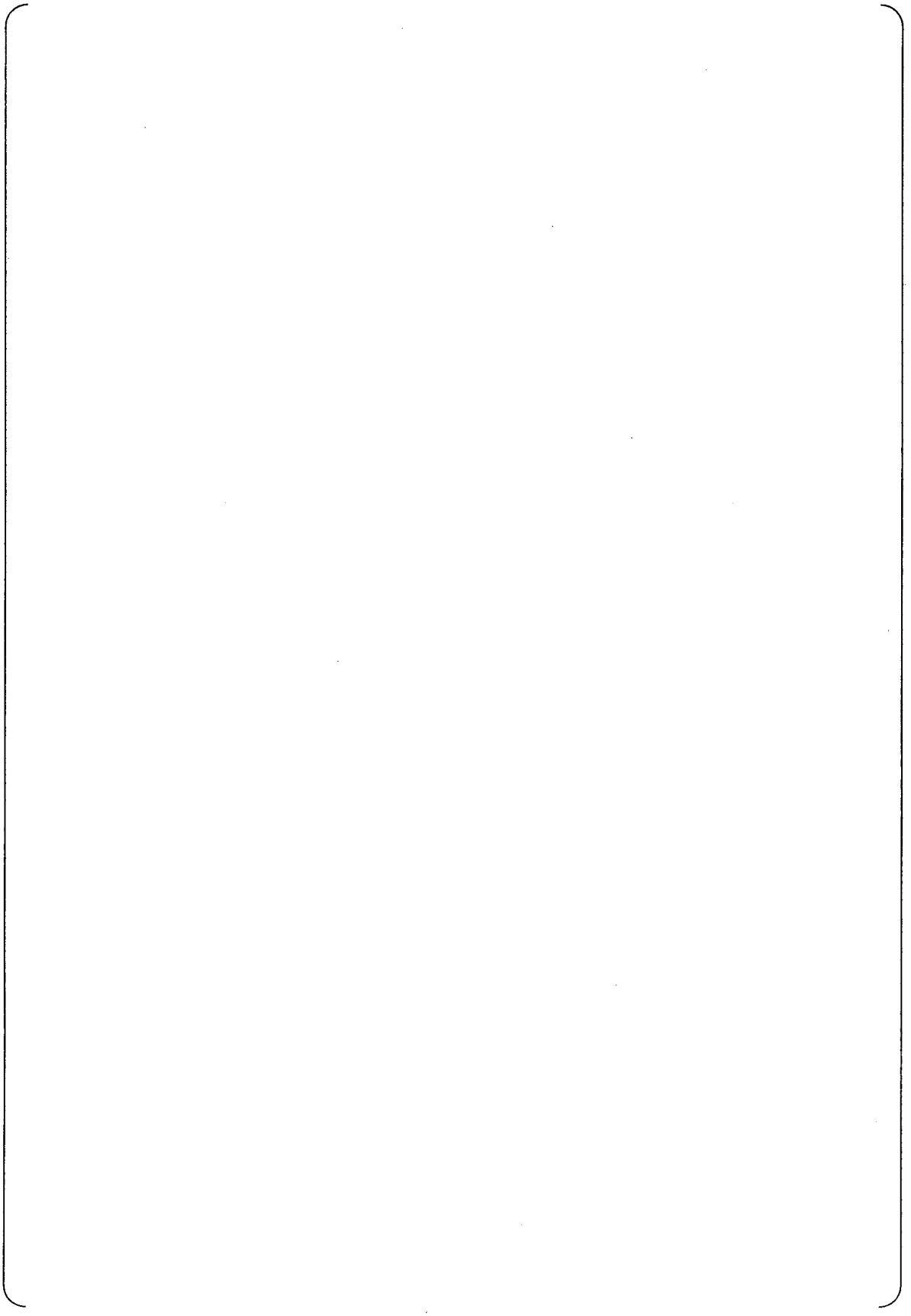

REQUEST 8.1.3-9-1
(Related RAI 8.1.3-9)
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RESPONSE
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REQUEST 8.1.4-11-1
(Related RAI 8.1.4-11)
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RESPONSE
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REQUEST 8.2.1-8-1
(Related RAI 8.2.1-8)
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RESPONSE
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REQUEST 8.2.1-12-1
(Related RAI 8.2.1-12)

MHI mentioned that errors may arise by not specifying some important parameters as boundary conditions. However, if that is the case then one might expect that similar errors can arise in the US-APWR SBLOCA simulations. That is why M-RELAP5 needs to be assessed against IETs' data and the errors need to be identified and considered in establishing the capability of M-RELAP5 to predict the plant response for SBLOCA events.

The approach that MHI used in this case makes this a SET and not an IET. MHI has performed other tests in an IET manner. The documentation should reflect the limitations of the conclusions that can be drawn from this assessment. Either modify the discussion to accurately portray what can be concluded from this assessment or explain how the assessment of ROSA-IV/LSTF Small Break (5%) LOCA test in Section 8.2.1 establishes the ability of M-RELAP5 to predict the US-APWR response for SBLOCA events in light of specifying important parameters as boundary conditions.

RESPONSE

As the Moody critical flow model incorporated in M-RELAP5 generally predicts an excessive break flowrate, it is not expected that the break flowrate of an experiment can be matched when the Moody model is applied. Break flowrate significantly affects the thermal hydraulic behavior in the primary system. Therefore, break flowrate is specified as the boundary condition to validate important phenomena during SBLOCA transients in the ROSA-IV/LSTF test analysis presented in MUAP-07013-P (Ref. 1). The secondary pressure is also specified as the boundary condition to focus on the code's ability to predict primary system behavior. [

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NRC pointed out that the SG primary to secondary heat transfer is not validated by the calculation in which the primary and secondary pressures are specified as boundary conditions (Ref. 2). [

] Therefore, an additional calculation was performed to respond to REQUEST 8.2.1-12 (Ref. 3). The secondary system mechanical motions, like the main steam isolation valve closing and relief valve opening and closing, are simulated in the calculation. And it is confirmed that M-RELAP5 predicts excellently the SG primary to secondary heat transfer.

NRC also pointed out in REQUST 8.2.1-22 that the integral applicability of M-RELAP5 to US-APWR SBLOCA analysis has not been validated because the break flowrate was specified as the boundary condition and the assessment was not performed in the same manner as the plant analysis was performed (Ref. 2). MHI responded that the Moody critical flow model required by Appendix K is used in the US-APWR SBLOCA analysis, the uncertainty in the calculation of break flow is adequately considered in the break spectrum sensitivity calculations, and that the accuracy of the Moody model compared to ROSA-IV/LSTF test data is not relevant (Ref. 4). However, it is meaningful to perform the assessment with the break flow model in the same manner as the plant analysis and confirm an absolute conservatism of M-RELAP5.

Therefore, an additional assessment with the break flow model is performed for the ROSA-IV/LSTF. In this calculation, the secondary system behaviors are also simulated. [

] Obtained results are shown in the Appendix to this response. The predicted PCTs are higher than the measured values during both loop seal clearance and boil-off periods. It is confirmed that M-RELAP5 can be conservatively applied to US-APWR SBLOCA analysis by this assessment. In addition, both the primary and secondary pressure responses agree well with the measured values from the break initiation through the loop seal clearance, indicating that M-RELAP5 is able to predict the SG primary to secondary heat transfer [

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MHI intends to modify Chapter 8.2.1 of MUAP-07013-P (Ref. 1) to reflect the NRC's comments about the primary and secondary boundary conditions and to include the additional calculations performed to respond to the NRC's requests. The structure of the section will be changed as shown in Table RAI-8.2.1-12-1.1. The sensitivity calculations performed to investigate the core water level predictions during the boil-off phase are included in section 8.2.1.8. Contents of the revised or added description for each section are shown in Table RAI-8.2.1-12-1.2.

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] Finally, the conservatism of M-RELAP5 for US-APWR SBLOCA analysis is confirmed by the ROSA-IV/LSTF calculation performed in the same manner as the plant analysis. The conclusions obtained from these calculations will be described in Section 8.2.1.10 of MUAP-07013-P.

References:

1. Mitsubishi Heavy Industries, Ltd., Small Break LOCA Methodology for US-APWR, MUAP-07013-P (R0), July 2007.
2. NRC, "Request for Additional Information on Topical Report MUAP-07013-P, 'Small Break LOCA Methodology for US-APWR'," dated on September 8, 2009.
3. Mitsubishi Heavy Industries, Ltd., MHI's 2nd Response to the NRC's Request for Additional Information on Topical Report MUAP-07013-P (R0), "Small Break LOCA Methodology for US-APWR" on 09/08/2009, UAP-HF-09512, November 2009.
4. Mitsubishi Heavy Industries, Ltd., MHI's 1st Response to the NRC's Request for Additional Information on Topical Report MUAP-07013-P (R0), "Small Break LOCA Methodology for US-APWR" on 09/08/2009, UAP-HF-09492, Octorber 2009.

Table RAI-8.2.1-12-1.1 Revision of the Content Table of Chapter 8.2

Table RAI-8.2.1-12-1.2 Description Revision of Chapter 8.2

Appendix to Response to REQUEST 8.2.1-12-1

REQUEST 8.2.1-12-2
(Related RAIs 8.2.1-10, 8.2.1-11, 8.2.1-12)
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RESPONSE
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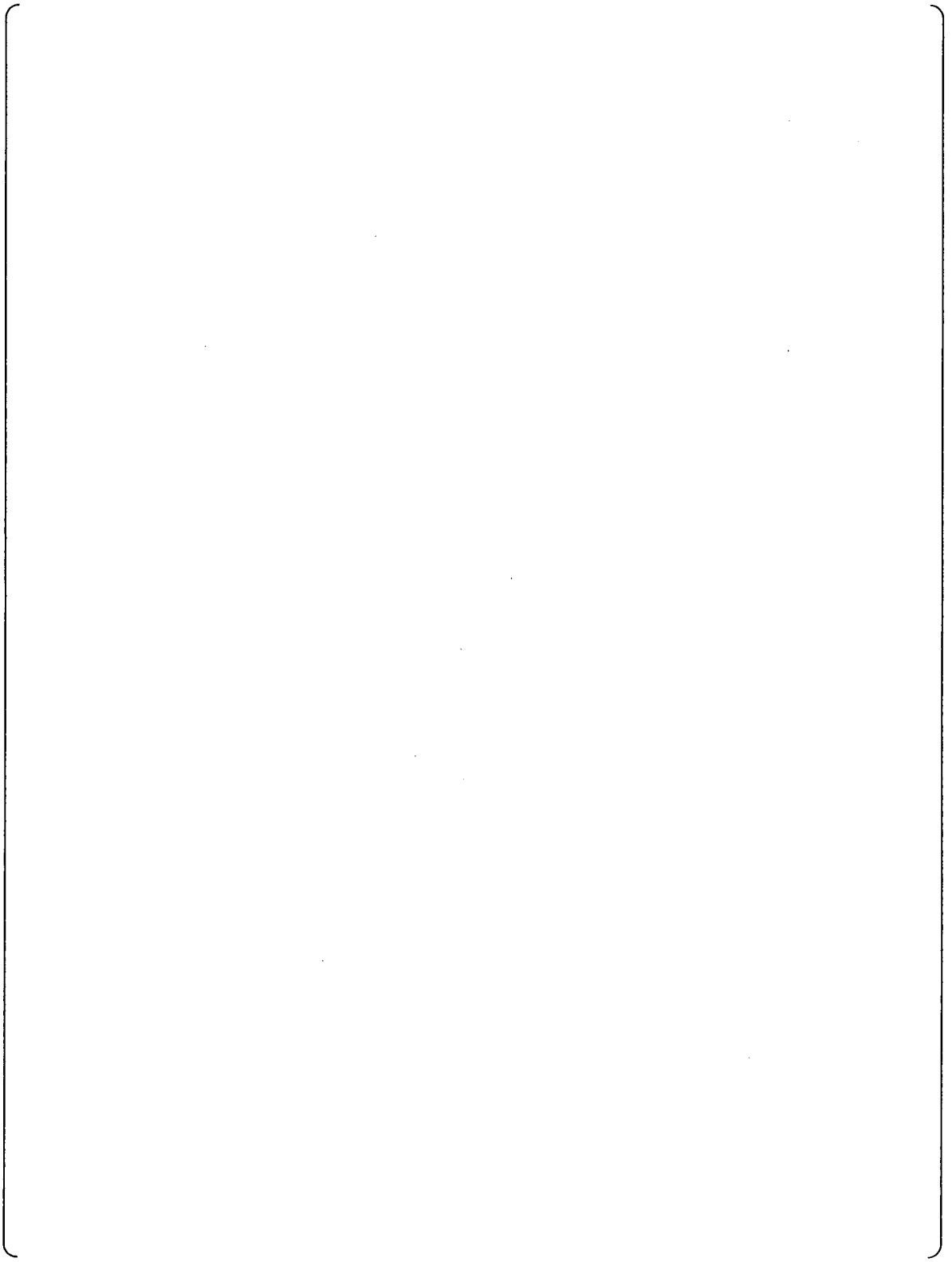

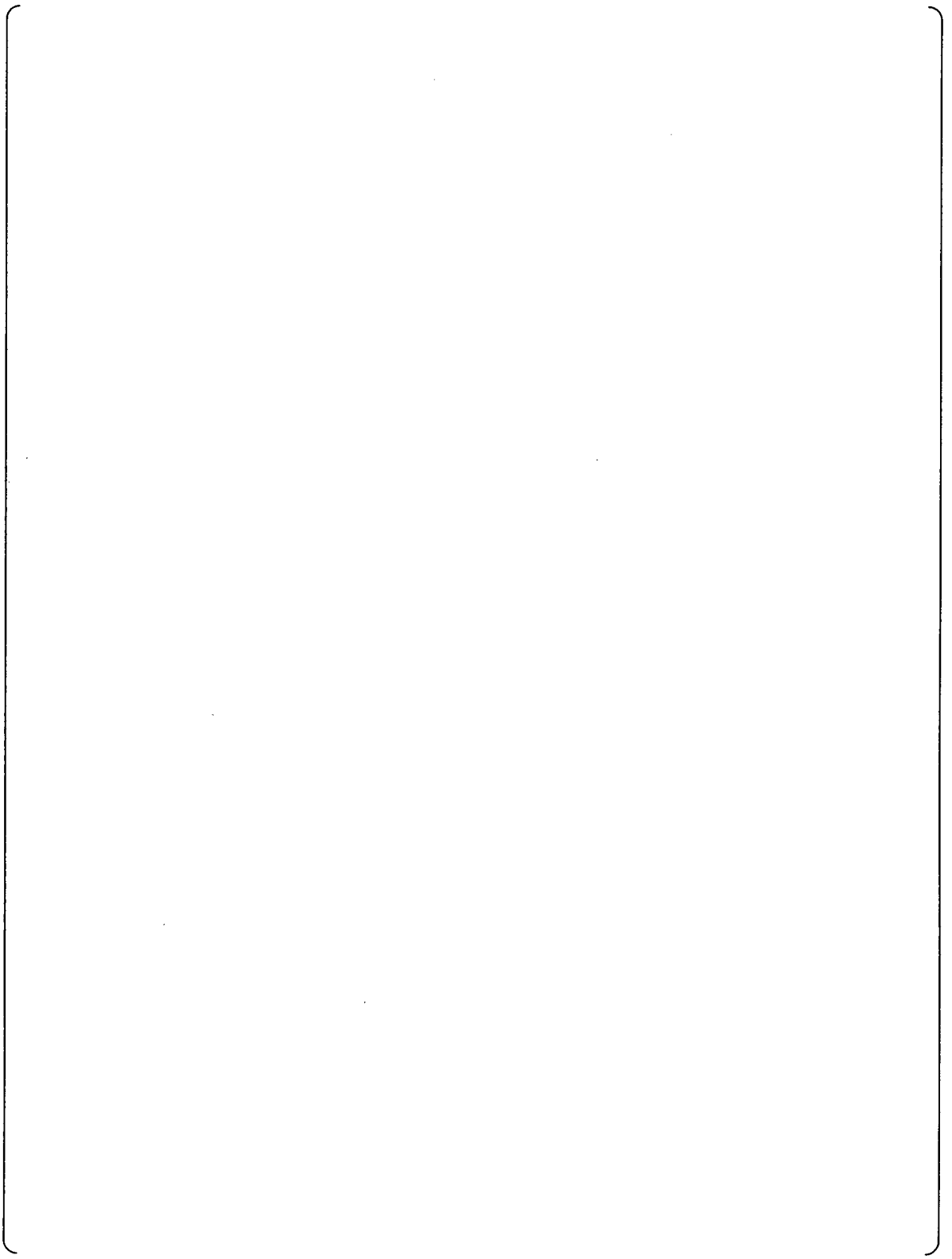

Figure RAI-8.2.1-12-2.1 M-RELAP5 noding diagram for ROSA-IV/LSTF Loop-A SG

REQUEST 8.2.1-14-1
(Related RAI 8.2.1-14)

Please confirm that the figures provided in the RAI response 8.2.1-14 will be incorporated into MUAP-07013-P.

RESPONSE

MHI will incorporate Figures RAI-8.2.1-14.1 and 2 into the revised topical report MUAP-07013-P (R1), which is scheduled to submit to the NRC at the end of March, 2010, as agreed between the NRC and MHI.

REQUEST 8.2.1-23-1
(Related RAI 8.2.1-23)

In the response to RAI 8.2.1-23, MHI committed to modifying the conclusions in the subject report section to such that the reviewer is able to recognize the remaining uncertainty. In revising the conclusion, please address the following concern.

MHI states that M-RELAP5 predicts the total vessel mass inventory lower than the measurement, in spite of the uncertainty resulting from the upper head mass inventory. The reviewer understands the MHI's believes that there is a distortion of the initial total vessel mass inventory. However, Figures 8.2.1-15 and -16 show good agreements of the break flowrate and the pressurizer pressure between the prediction and the measurement. This means that if the geometry of the facility was modeled accurately, the mass inventory in the primary system is similar in the analysis and the test during the transient period.

As shown in Figure RAI 8.2.1-23-2, the mass was accumulated in the upper plenum in the experiment from around 150 s to 320 s and then started decreasing and the water level reached the upper elevation of the core region at around 400 s while M-RELAP5 does not predict the mass accumulation in the upper plenum during that time period. Figure 8.2.1-17 shows that the water started decreasing from around 400 s in the core region of the test facility. Therefore, the difference in the core water level dropping time appears to be caused by the accumulation of water in the upper plenum in the test, while it is not accumulated in the analysis. The source of the water being accumulated in the upper plenum in the test seems to be the upper head water.

RESPONSE

MHI's response to RAI 8.2.1-6 describes the water being accumulated in the upper plenum in the test as a possible cause of the earlier decrease in the core liquid level in the calculation than in the test. A draft of the additional explanations for the calculated downcomer and core liquid level behaviors including sensitivity calculations is attached below. The draft is to be incorporated into the revised topical report as Chapter 8.2.1.8.

Appendix to Response to REQUEST 8.2.1-23-1