MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

June 14, 2010

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-10169

Subject: MHI's Responses to US-APWR DCD RAI No.588-4617 REVISION 0

References: 1) "Request for Additional Information No. 588-4617 Revision 0, SRP Section: 05.03.02 - Pressure-Temperature Limits, Upper-Shelf Energy, and Pressurized Thermal Shock, Application Section: 05.03.02/ Technical Report MUAP-09016, Rev. 1," dated May 11, 2010.

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. 588-4617 Revision 0."

Enclosed is the responses to 7 RAIs contained within Reference 1.

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

Sincerely,

Y. Ogata

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

Enclosures:

1. Response to Request for Additional Information No. 588-4617 Revision 0

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

Contact Information
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NRO

Docket No. 52-021
MHI Ref: UAP-HF-10169

Enclosure 1

UAP-HF-10169
Docket Number 52-021

Response to Request for Additional Information
No. 588-4617 Revision 0

June 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/14/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 588-4617 REVISION 0**
SRP SECTION:	**05.03.02 – Pressure-Temperature Limits, Upper-Shelf Energy, and Pressurized Thermal Shock**
APPLICATION SECTION:	**05.03.02/ Technical Report MUAP-09016, Rev.1**
DATE OF RAI ISSUE:	**5/11/2010**

QUESTION NO.: 05.03.02-2

Provide a table of the data points (reactor coolant temperature vs. pressure) for each pressure-temperature (P-T) curve displayed in Technical Report MUAP-09016, Rev. 1.

ANSWER:

The data points for each pressure-temperature (P-T) curve displayed in Technical Report MUAP-09016, Rev.1 are listed below.

- Data Points for Figure 7-1

Reactor Coolant Temp. (°F)	Allowable Pressure (psi)		
	Heatup Rate 50 (°F/Hr) Core not Critical	Leak and Hydrostatic Test	Heatup Rate 50 (°F/Hr) Core Critical
70	0 - 621	-	-
177.8	621	2000	-
185	621	2192	-
194	621	2474	-
195	621 ~ 1358	-	-
203	1488	-	-
212	1665	-	-
221	1875	-	-
230	2129	-	-
239	2434	-	-
280	-	-	(Vertical Line)

- Data Points for Figure 7-2

Reactor Coolant Temp. (°F)	Allowable Pressure (psi) Cooldown Rate					
	0 (°F/Hr)	20 (°F/Hr)	40 (°F/Hr)	60 (°F/Hr)	80 (°F/Hr)	100 (°F/Hr)
70	0 ~ 621	0 ~ 618	0 ~ 559	0 ~ 508	0 ~ 465	0 ~ 435
77	621	621	583	538	503	482
86	621	621	619	585	561	553
95	621	621	621	621	621	621
130	621 ~ 926	621 ~ 923	621 ~ 923	621 ~ 923	621 ~ 923	621 ~ 923
131	934	931	931	931	931	931
140	1007					
149	1092					
158	1195					
167	1320					
176	1466					
185	1643					
194	1855					
203	2109					
212	2413					

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

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Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 588-4617 REVISION 0**
SRP SECTION:	**05.03.02 – Pressure-Temperature Limits, Upper-Shelf Energy, and Pressurized Thermal Shock**
APPLICATION SECTION:	**05.03.02/ Technical Report MUAP-09016, Rev.1**
DATE OF RAI ISSUE:	**5/11/2010**

QUESTION NO.: 05.03.02-3

Revise Technical Report MUAP-09016, Rev. 1 to provide the vessel thickness used to calculate the adjusted reference temperature (ART) at the 1/4t and 3/4t locations.

ANSWER:

The base metal thickness at the beltline region, 10.4" was used as the vessel thickness (t) to calculate the adjusted reference temperature (ART) at the 1/4t and 3/4t locations.

Table 7-1 of Technical Report MUAP-09016, Rev.1 will be revised to include a new note providing the thickness.

See the attached marked-up page of MUAP-09016, Rev.1.

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.

Table 7-1 Calculation of RT_{NDT} ~~/ RT_{PTS}~~ at EOL (60EFPY)

Location[8]		Initial RT_{NDT} (°F)	f[1]	FF[2]	CF[3] (°F)	ΔRT_{NDT}[4] (°F)	σ_i[5] (°F)	σ_Δ[6] (°F)	Margin[7] (°F)	ART (°F)
Beltline Region Forgings	~~ID~~	0	~~0.98~~	~~0.99~~	31	~~30.8~~	~~17~~	~~15.4~~	~~45.9~~	~~76.7~~
	1/4-T		0.52	0.82		25.4	17	12.7	42.4	67.8
	3/4-T		0.15	0.50		15.6	17	7.8	37.4	53.0
Beltline Region Weld	~~ID~~	-20	~~0.85~~	~~0.95~~	108	~~103.1~~	~~17~~	~~28~~	~~65.5~~	~~148.6~~
	1/4-T		0.45	0.78		84.3	17	28	65.5	129.8
	3/4-T		0.13	0.47		50.9	17	25.5	61.2	92.1

Notes:
1. Fluence f (10^{19}n/cm^2, E>1MeV) at a depth of x (in inches) based on the fluence f_{surf} (10^{19}n/cm^2, E>1MeV) at the ID is calculated by;
   $f = f_{surf} (e^{-0.24x})$, where fsurf is the fluence of ID from Table 3-1.
2. FF (Fluence Factor) = $f^{(0.28 - 0.10 \cdot \log f)}$.
3. Values from Table 1 and Table 2 of Regulatory Guide 1.99 (Reference 7) for Cu = 0.05 wt% and Ni = 1.0 wt% for the forgings, and Cu = 0.08 wt% and Ni = 0.95 wt% for the weld material.
4. ΔRT_{NDT} = CF × FF.
5. Standard deviation for Initial RT_{NDT}. 17°F selected from Table-P Footnote (5) of Reference 14.
6. Standard deviation for ΔRT_{NDT}. σ_Δ = smaller of 17°F or 0.5 × ΔRT_{NDT} for the forgings, and smaller of 28°F or 0.5 × ΔRTNDT for the weld material.
7. Margin determined by $2\sqrt{\sigma_i^2 + \sigma_\Delta^2}$
8. T = 10.4", the base metal thickness at the beltline region.

- The title and contents of Table 7-1 will be revised in accordance with the response to Question No. 05.03.02-7.
- Revision of Note 7 is on editorial correction.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/14/2010

US-APWR Design Certification

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Docket No. 52-021

RAI NO.:	**NO. 588-4617 REVISION 0**
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APPLICATION SECTION:	**05.03.02/ Technical Report MUAP-09016, Rev.1**
DATE OF RAI ISSUE:	**5/11/2010**

QUESTION NO.: 05.03.02-4

To address PTLR Criterion 4(GL 96-03), Clearly identify both the limiting adjusted reference temperature (ART) values and limiting materials at the 1/4t and 3/4 t locations (t= vessel thickness) used in the development of the P-T limits.

ANSWER:

According to Table 7-1 of Technical Report MUAP-09016, Rev.1, the limiting adjusted reference temperature (ART) values at EOL (60EFPY) are 129.8°F at 1/4t and 92.1°F at 3/4t, which were used to develop the P-T limits. The limiting material is the beltline region weld material.

Subsection 7.2 of Technical Report MUAP-09016, Rev.1 will be revised to clearly identify both the limiting adjusted reference temperature (ART) values and the limiting material as shown in the attached marked-up page.

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.

7.0 OPERATING LIMITS

As the generic Pressure and Temperature Limits Report (PTLR) for US-APWR, the items required by Generic Letter 96-03 have been prepared according to Section 3.0 to 6.0 to meet the requirements of LCO 3.4.3 "RCS Pressure and Temperature (P/T) Limits", and LCO 3.4.12 "Low Temperature Overpressure Protection (LTOP)".

This PTLR has been developed based on the evaluations of the beltline region materials exposed to the neutron fluence shown in Table 3-1 for 60EFPY. The material properties applied are the bounding values taken from the material specification as described in Section 4.1, as the actual values are not available.

In plant-specific PTLRs, items required by Generic Letter 96-03 will be discussed based on the actual material properties.

7.1 RCS Temperature Rate-of-Change Limits (LCO 3.4.3)

7.1.1 Maximum Heatup Rate

The RCS heatup rate limit is 50°F in any 1-hour period.

7.1.2 Maximum Cooldown Rate

The RCS cooldown rate limit is 100°F in any 1-hour period.

7.1.3 Maximum Temperature Change During Inservice Leak and Hydrostatic Testing

During inservice leak and hydrostatic testing operations above the heatup and cooldown limit curves, constant RCS temperature is assumed.

7.2 Calculation of Adjusted Reference Temperature

The bounding material specification for the copper and nickel weight percent values for the US-APWR reactor vessel beltline region materials are used to calculate the chemistry factors in accordance with Section 4.2. The limiting materials and the EOL ARTs at the 1/4-t and 3/4-t locations are presented in Table 7-1. The limiting EOL ART values used in the development of the P-T limits are 129.8°F (1/4-t) and 92.1°F (3/4-t) of the beltline weld material.

~~In accordance with Reference 13, the pressurized thermal shock reference temperature (RT_{PTS}) values are calculated in the same manner as the ART values. Therefore, RT_{PTS} values of the beltline material are equal to the ART values and also shown in Table 7-1. The RT_{PTS} values at EOL are not expected to exceed the pressurized thermal shock (PTS) screening criteria of Reference 13.~~

- The second paragraph of Subsection 7.2 will be moved in accordance with the response to Question No. 05.03.02-7.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/14/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 588-4617 REVISION 0**
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APPLICATION SECTION:	**05.03.02/ Technical Report MUAP-09016, Rev.1**
DATE OF RAI ISSUE:	**5/11/2010**

QUESTION NO.: 05.03.02-5

To address the Technical Specification (TS) change requirements of GL 96-03, modify TS 5.6.4.b to appropriately reference (by title and number) the US-APWR pressure and temperature limits report (PTLR).

ANSWER:

Technical Specification 5.6.4.b will be revised to reference the US-APWR PTLR by title and number.

Impact on DCD

Subsection 5.6.4.b of DCD Chapter 16 will be revised as shown in the attached marked-up page.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

5.6 Reporting Requirements

5.6.4 Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

a. RCS pressure and temperature limits for heat up, cooldown, low temperature operation, criticality, and hydrostatic testing, as well as heatup and cooldown rates shall be established and documented in the PTLR for the following:

3.4.3, "RCS Pressure and Temperature (P/T) Limits"
3.4.12, "Low Temperature Overpressure Protection System"

b. The analytical methods used to determine the RCS pressure and temperature limits shall be those previously reviewed and approved by the NRC, specifically those described in the ~~Chapter 5.~~ following document:

MUAP-09016, "Pressure and Temperature Limits Report."

c. The PTLR shall be provided to the NRC upon issuance for each reactor vessel fluence period and for any revision or supplement thereto.

5.6.5 Post Accident Monitoring Report

When a report is required by Condition B of LCO 3.3.3, "Post Accident Monitoring (PAM) Instrumentation," a report shall be submitted within the following 14 days. The report shall outline the preplanned alternate method of monitoring, the cause of the inoperability, and the plans and schedule for restoring the instrumentation channels of the Function to OPERABLE status.

5.6.6 Tendon Surveillance Report

Any abnormal degradation of the containment structure detected during the tests required by the Prestressed Concrete Containment Tendon Surveillance Program shall be reported to the NRC within 30 days. The report shall include a description of the tendon condition, the condition of the concrete (especially at tendon anchorages), the inspection procedures, the tolerances on cracking, and the corrective action taken.

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DATE OF RAI ISSUE:	**5/11/2010**

QUESTION NO.: 05.03.02-6

To address PTLR Criterion 6 (GL 96-03), clearly identify the minimum boltup temperature on the P-T limit curve (MUAP-09016, Rev.1, Figure 7-1).

ANSWER:

Figure 7-1 of Technical Report MUAP-09016, Rev.1 will be revised to identify the minimum boltup temperature (70°F) described in Subsection 7.3.3.

See the attached marked-up page of MUAP-09016, Rev.1.

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.

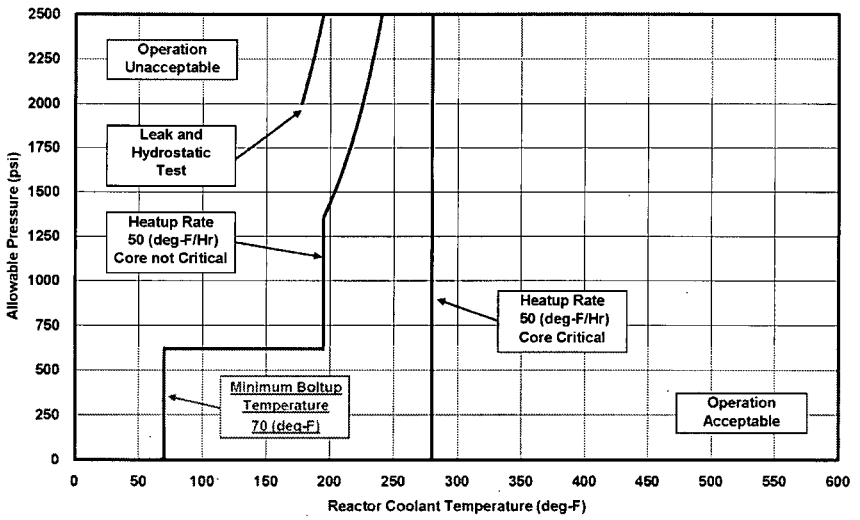

Figure 7-1 Generic P-T Limit Curves for Heatup, Inservice Leak and Hydrostatic Testing, and Criticality up to 60EFPY

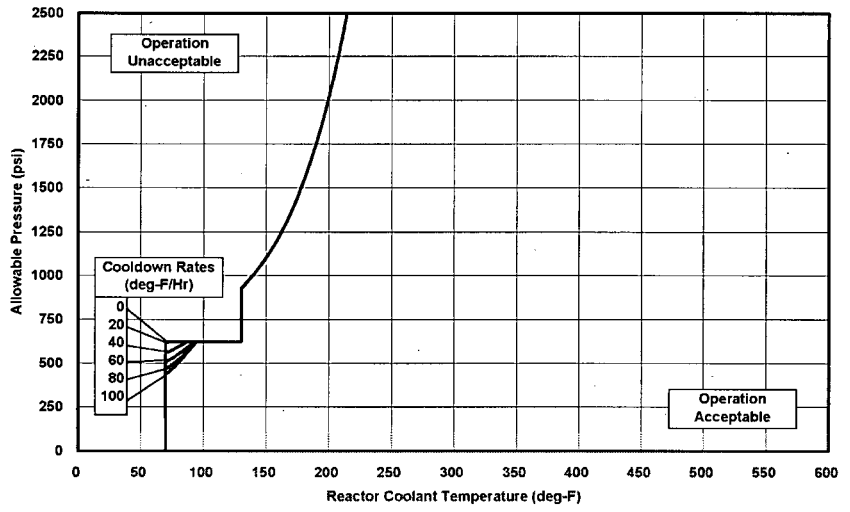

Figure 7-2 Generic P-T Limit Curve for Cooldown up to 60EFPY

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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DATE OF RAI ISSUE:	**5/11/2010**

QUESTION NO.: 05.03.02-7

MUAP-09016, Rev. 1, Section 7.2 states that in accordance with 10 CFR 50.61, the pressurized thermal shock reference temperature (RT_{PTS}) values are calculated in the same manner as the ART values. Therefore RT_{PTS} values of the beltline material are equal to the ART values and are also shown in Table 7-1. However, the ART values used to develop the P-T limits are calculated in accordance with RG 1.99, Rev. 2, and not 10 CFR 50.61. Therefore it is inappropriate to reference 10 CFR 50.61 when discussing the methods used to determine the ART values. Revise Technical Report MUAP-09016, Revision 1, accordingly.

ANSWER:

Section 7.2 explains that the calculation procedure for the pressurized thermal shock reference temperature (RT_{PTS}) specified in 10 CFR 50.61 is essentially identical to that for ART values specified in Regulatory Guide 1.99, Rev.2. In order to clarify the current description, MUAP-09016, Rev.1 will be revised as follows.

- The explanation of RT_{PTS} values will be moved from Section 7.2 to a new section.
- The RT_{PTS} values will be moved from Table 7-2. Table 7-2 will include only ART values at 1/4-T and 3/4-T, and the RT_{PTS} value will be shown in a newly added table.

See the attached marked-up pages of MUAP-09016, Rev.1.

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.

7.0 OPERATING LIMITS

As the generic Pressure and Temperature Limits Report (PTLR) for US-APWR, the items required by Generic Letter 96-03 have been prepared according to Section 3.0 to 6.0 to meet the requirements of LCO 3.4.3 "RCS Pressure and Temperature (P/T) Limits", and LCO 3.4.12 "Low Temperature Overpressure Protection (LTOP)".

This PTLR has been developed based on the evaluations of the beltline region materials exposed to the neutron fluence shown in Table 3-1 for 60EFPY. The material properties applied are the bounding values taken from the material specification as described in Section 4.1, as the actual values are not available.

In plant-specific PTLRs, items required by Generic Letter 96-03 will be discussed based on the actual material properties.

7.1 RCS Temperature Rate-of-Change Limits (LCO 3.4.3)

7.1.1 Maximum Heatup Rate

The RCS heatup rate limit is 50°F in any 1-hour period.

7.1.2 Maximum Cooldown Rate

The RCS cooldown rate limit is 100°F in any 1-hour period.

7.1.3 Maximum Temperature Change During Inservice Leak and Hydrostatic Testing

During inservice leak and hydrostatic testing operations above the heatup and cooldown limit curves, constant RCS temperature is assumed.

7.2 Calculation of Adjusted Reference Temperature

The bounding material specification for the copper and nickel weight percent values for the US-APWR reactor vessel beltline region materials are used to calculate the chemistry factors in accordance with Section 4.2. The limiting materials and the EOL ARTs at the 1/4-t and 3/4-t locations are presented in Table 7-1. The limiting EOL ART values used in the development of the P-T limits are 129.8°F (1/4-t) and 92.1°F (3/4-t) of the beltline weld material.

~~In accordance with Reference 13, the pressurized thermal shock reference temperature (RT_{PTS}) values are calculated in the same manner as the ART values. Therefore, RT_{PTS} values of the beltline material are equal to the ART values and also shown in Table 7-1. The RT_{PTS} values at EOL are not expected to exceed the pressurized thermal shock (PTS) screening criteria of Reference 13.~~

- The first paragraph of Subsection 7.2 will be revised in accordance with the response to Question No. 05.03.02-4.

7.6 Pressurized Thermal Shock Reference Temperature

In accordance with 10 CFR 50.61 (Reference 13), the pressurized thermal shock reference temperature (RT_{PTS}) values are calculated as shown in Table 7-4. The RT_{PTS} values at EOL are not expected to exceed the pressurized thermal shock (PTS) screening criteria of Reference 13.

Table 7-1 Calculation of RT_{NDT} ~~/ RT_{PTS}~~ at EOL (60EFPY)

Location[8]		Initial RT_{NDT} (°F)	f[1]	FF[2]	CF[3] (°F)	ΔRT_{NDT}[4] (°F)	σ_I[5] (°F)	σ_Δ[6] (°F)	Margin[7] (°F)	ART (°F)
Beltline Region Forgings	~~ID~~	0	~~0.98~~	~~0.99~~	31	~~30.8~~	~~17~~	~~15.4~~	~~45.9~~	~~76.7~~
	1/4-T		0.52	0.82		25.4	17	12.7	42.4	67.8
	3/4-T		0.15	0.50		15.6	17	7.8	37.4	53.0
Beltline Region Weld	~~ID~~	-20	~~0.85~~	~~0.95~~	108	~~103.1~~	~~17~~	~~28~~	~~65.5~~	~~148.6~~
	1/4-T		0.45	0.78		84.3	17	28	65.5	129.8
	3/4-T		0.13	0.47		50.9	17	25.5	61.2	92.1

Notes:
1. Fluence f (10^{19}n/cm^2, E>1MeV) at a depth of x (in inches) based on the fluence f_{surf} (10^{19}n/cm^2, E>1MeV) at the ID is calculated by;
   $f = f_{surf} (e^{-0.24x})$, where fsurf is the fluence of ID from Table 3-1.
2. FF (Fluence Factor) = $f^{(0.28 - 0.10 \log f)}$.
3. Values from Table 1 and Table 2 of Regulatory Guide 1.99 (Reference 7) for Cu = 0.05 wt% and Ni = 1.0 wt% for the forgings, and Cu = 0.08 wt% and Ni = 0.95 wt% for the weld material.
4. ΔRT_{NDT} = CF × FF.
5. Standard deviation for Initial RT_{NDT}. 17°F selected from Table-P Footnote (5) of Reference 14.
6. Standard deviation for ΔRT_{NDT}. σ_Δ = smaller of 17°F or 0.5 ×ΔRT_{NDT} for the forgings, and smaller of 28°F or 0.5 × ΔRTNDT for the weld material.
7. Margin determined by $2\sqrt{\sigma_I^2 + \sigma_\Delta^2}$
8. T = 10.4", the base metal thickness at the beltline region.

- Revision of Note 7 is on editorial correction.
- Note 8 will be added in accordance with the response to Question No. 05.03.02-3.

Table 7-4 Calculation of RT_{PTS} at EOL (60EFPY)

Location	Initial RT_{NDT} (°F)	f[1]	FF[2]	CF[3] (°F)	ΔRT_{PTS}[4] (°F)	σ_U[5] (°F)	σ_Δ[6] (°F)	Margin[7] (°F)	RT_{PTS} (°F)
Beltline Region Forgings	0	0.98	0.99	31	30.8	17	15.4	45.9	76.7
Beltline Region Weld	-20	0.85	0.95	108	103.1	17	28	65.5	148.6

Notes:
1. Fluence (10^{19}n/cm^2, E>1MeV) at ID from Table 3-1.
2. FF (Fluence Factor) = $f^{(0.28 - 0.10 \log f)}$
3. Values from Table 1 and Table 2 of 10 CFR 50.61 (Reference 13) for Cu = 0.05 wt% and Ni = 1.0 wt% for the forgings, and Cu = 0.08 wt% and Ni = 0.95 wt% for the weld material.
4. ΔRT_{NDT} is expressed as ΔRT_{PTS} in the calculation for RT_{PTS}. $\Delta RT_{NDT} = CF \times FF$.
5. Standard deviation for Initial RT_{NDT}. 17°F selected from Table-P Footnote (5) of Reference 14.
6. Standard deviation for ΔRT_{NDT}. σ_Δ = smaller of 17°F or 0.5 ×ΔRT_{NDT} for the forgings, and smaller of 28°F or 0.5 × ΔRT_{NDT} for the weld material.
7. Margin determined by $2\sqrt{\sigma_U^2 + \sigma_\Delta^2}$.

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DATE OF RAI ISSUE:	**5/11/2010**

QUESTION NO.: 05.03.02-8

See Attachment

ANSWER:

The referenced attachment was not found with the RAI.

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.