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

March 1, 2010

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

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10058

Subject: Amended MHI's Response to US-APWR DCD RAI No.289

References: 1) "Request for Additional Information No. 289 Revision 1, SRP Section: 05.02.03 – Reactor Coolant Pressure Boundary Materials," dated March, 25, 2009
2) "MHI's Response to US-APWR DCD RAI No.289 Revision 1, UAP-HF-09236, dated May 13, 2009"

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Amended Response to Request for Additional Information No.289 Revision 1."

Enclosed is the response to the Question No.05.02.03-12 of the RAI (Reference 1).

This response amend the previously transmitted answers submitted under MHI Reference UAP-HF-09236 on May 13, 2009 (Reference 2) in order to correct description of carbon content of stainless steels used in Reactor Coolant Pressure Boundary materials.

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.

Enclosure:

1. Amended Response to Request for Additional Information No.224 Revision 1

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

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NRO

- <u>Contact Information</u>

C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Enclosure 1

UAP-HF-10058
Docket No. 52-021

Amended Response to Request for Additional Information No.289 Revision 1

March 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/1/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 289-2217 REVISION 1**

SRP SECTION: **05.02.03 - REACTOR COOLANT PRESSURE BOUNDARY MATERIALS**

APPLICATION SECTION: **05.02.03**

DATE OF RAI ISSUE: **3/25/2009**

QUESTION NO. : 05.02.03-12

The applicant has listed standard grades of stainless steels (non-low carbon) in Table 5.2.3-1. The staff requests that the applicant specify its maximum carbon content for all austenitic stainless steels, other than cast materials, used in the RCPB. If the maximum carbon content is greater that 0.03%, provide a justification for the use of these materials given that such materials may be susceptible to stress corrosion cracking. The maximum carbon content should be included in Table 5.2.3-1.

ANSWER:

MHI understands that low-carbon austenitic stainless steel is a better choice of material because of its high resistance against stress corrosion cracking (IGSCC) and sensitization even in the PWR environment.

Therefore, when MHI uses the standard grades of SS (stainless steel), the maximum carbon content will be limited as follows;

[MHI's standard stainless steel (MHI's SS)]

Carbon content : Maximum 0.05%(heat analysis)/0.06%(product analysis)

MHI's understandings about the requirements from RG 1.44 and EPRI Utility Requirement Document (URD) (5.3.1.8 Prevention of IGSCC of austenitic stainless steel) is shown in table 1.

According to RG 1.44 requirement, in case of PWR environment (dissolved oxygen is less than 0.10 ppm), the low carbon material, which means less than or equal to 0.03% carbon material, is not required, and as MHI's manufacturing practice, the heat treatment such as post weld heat treatment (PWHT) will not be subjected to stainless steel during manufacturing components. Therefore, MHI's SS will meet RG 1.44 requirements even if MHI applies MHI's SS for US-APWR (PWR plant).

In addition, MHI's SS will also meet URD requirements, because MHI's SS is categorized as "(C) proven material" of table 1, URS 5.3.1.8 line. Figure 1 is demonstration data of the standard grades of SS that shows high IGSCC resistance. The figure 1 shows the relationship between SCC potential and chemical condition of dissolved oxygen and chloride ion (*1). It is confirmed that the chemical conditions of the US-APWR primary water is in the no SCC area below the curve. This means that the standard grades of SS will not occur IGSCC in PWR environment even if these materials are sensitized. Furthermore, MHI's SS has been applied for pressure boundary components, piping and reactor internal structures in the existing Japanese domestic PWR plants. This service experience which have occurred no IGSCC can support the demonstration data in figure 1.

The above explanation showed that MHI's SS has the high resistance against IGSCC in PWR environment and meets the requirements from R.G 1.44 and URD.

On the other hand, to select material grade, the procurement availability (market condition) should be considered. Therefore, MHI will decide the material grade (MHI' SS or low carbon material including LN grade) by considering the material procurement condition.

Through the progress of the detail design, if the significant stagnant areas where the dissolved oxygen is evaluated to be elevated to over 0.10 ppm is generated on the design, MHI will evaluate the possibility of SCC caused by the elevated dissolved oxygen considering the other factors such as temperature. Then, if the evaluated potions have possibilities to cause this type of SCC, the low carbon stainless steel (Carbon content : less than 0.03%) will be applied for portions around that area.

(*1)Ref. : the 1st U.S.–Japan Joint Symposium on Light Water Reactors, Fuji, Japan (1978), presented by M. O. Speidel.

Impact on DCD

The maximum carbon content will be added to the footnote of the DCD Table 5.2.3-1 as shown in the attached mark-up.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

Table 1 MHI's understanding about RG 1.44 and URD requirements

Requirements	MHI's understanding
RG 1.44	The following cases are not required to select stainless steel which carbon content is less than 0.03%. (a) PWR environment (dissolved oxygen is less than 0.10ppm) (*1) (b) Small diameter piping (c) Retest of ASTM A262 (in case of receiving heat treatment without welding) (d) Material which the service experience and or test data to demonstrate that it will not result in increased susceptibility to IGSCC exists (in case of receiving heat treatment without welding). And If the heat treatment other than welding is subjected to material, carbon content has to limited or retest is required.
URD 5.3.1.8	Although the low carbon materials are recommended, the "proven" materials with IGSCC resistance are also available. Recommendation : (a) Low carbon wrought austenitic steel (304L, 316L, 304LN, 316LN, 304NG, and 316NG) (b) Modified 347 austenitic stainless steel (c) Other specific grades which have proven to be resistant to sensitization and IGSCC.

(*1)The standard value of the dissolved oxygen in US-APWR is 0.005ppm, as discussed in the DCD Table-5.2.3-2.

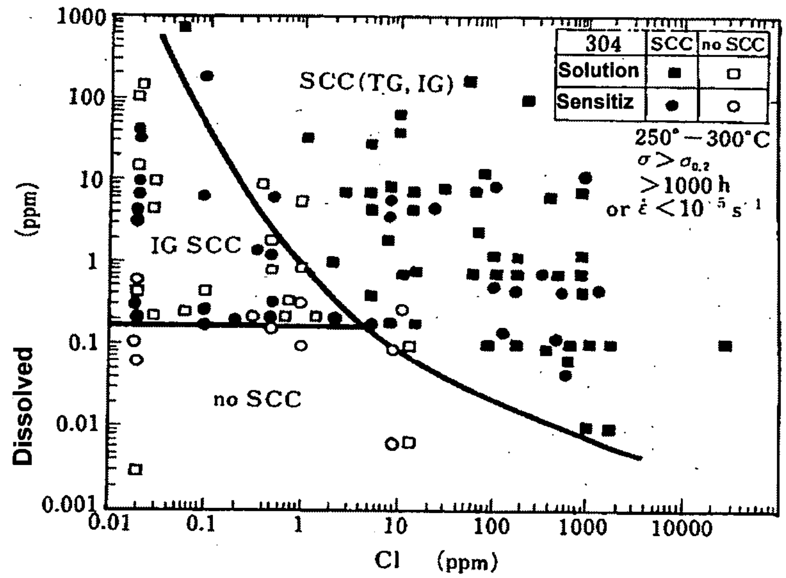

Figure 1 SCC resistance of stainless steel against dissolved oxygen

Table 5.2.3-1 Reactor Coolant Pressure Boundary Material Specifications (Sheet 1 of 4)

Component	Material	Class, Grade, or Type
Reactor Vessel Parts		
Top head dome	SA-508	Gr. 3 Cl.1
Shell and flange ring forgings	SA-508	Gr. 3 Cl.1
Bottom head dome	SA-508	Gr. 3 Cl.1
Nozzle forgings	SA-508	Gr. 3 Cl.1
Nozzle safe ends	SA-182	Gr. F316(*) or F316LN
Upper head penetration nozzles	SB-167	UNS N06690 (Thermally Treated 690)
Vent pipe	SB-167	UNS N06690 (Thermally Treated 690)
Radial support	SB-166	UNS N06690 (Thermally Treated 690)
Reactor vessel closure stud bolts, nuts, washers	SA-540	Gr.B24
Cladding, buttering and welds	SFA-5.4	E309L-16 E308L-16
	SFA-5.9	ER309L ER308L ER316L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7
	Code Case 2142-2 UNS N06054	-
	Type 308L/309L Stainless Steel Strip Electrode	-
Pressure boundary welds (Low alloy steel)	SFA-5.5	E9016-G
	SFA-5.23	F9P4-EG-G, E9P4-EGN-GN
	SFA-5.28	ER80S-G
Pressure boundary welds (Stainless steel or Ni-base alloy)	SFA-5.4	E309L-16 E308L-16
	SFA-5.9	ER309L ER308L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7
	Code Case 2142-2 UNS N06054	-
Steam Generator Parts		
Pressure forgings (including nozzles)	SA-508	Gr. 3 Cl.2
Pressure plates	SA-533	Type B Cl.2
Tubes	SB-163	UNS N06690 (Thermally Treated 690)

Table 5.2.3-1 Reactor Coolant Pressure Boundary Material Specifications (Sheet 2 of 4)

Component	Material	Class, Grade, or Type
Nozzle safe ends	SA-182	Gr. F316(*) or F316LN
Closure Stud bolts	SA-193	Gr. B7
Closure nuts	SA-194	Gr. 4
Cladding, buttering and welds	SFA-5.4	E309L-16 E308L-16
	SFA-5.9	ER309L ER308L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7
	Code Case 2142-2 UNS N06054	-
	Type 308L/309L Stainless Steel Strip Electrode	-
Pressure boundary welds (Low alloy steel)	SFA-5.5	E9016-G E10016-G
	SFA-5.23	F9P4-EG-G E9P4-EGN-GN P10P2-EG-G
	SFA-5.28	ER80S-G ER90S-G
Pressure boundary welds (Stainless steel or Ni-base alloy)	SFA-5.4	E309L-16 E308L-16
	SFA-5.9	ER309L ER308L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7
	Code Case 2142-2 UNS N06054	-
Pressurizer Parts		
Pressure forgings	SA-508	Gr. 3 Cl.1 or Cl.2
Pressure plates	SA-533	Type B Cl.1 or 2
Nozzle safe ends	SA-182	Gr. F316(*) or F316LN
Heater sleeves	SA-182	Gr. F316(*) or F316LN
	or SB 167	UNS 06690
Closure Stud bolts	SA-193	Gr. B7
Closure nuts	SA-194	Gr. 4

Table 5.2.3-1 Reactor Coolant Pressure Boundary Material Specifications (Sheet 3 of 4)

Component	Material	Class, Grade, or Type
Cladding, buttering and welds	SFA-5.4	E309L-16 E308L-16
	SFA-5.9	ER309L ER308L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7
	Code Case 2142-2 UNS N06054	-
	Type 308L/309L Stainless Steel Strip Electrode	-
Pressure boundary welds (Low alloy steel)	SFA-5.5	E9016-G E10016-G
	SFA-5.23	F9P4-EG-G E9P4-EGN-GN P10P2-EG-G
	SFA-5.28	ER80S-G ER90S-G
Pressure boundary welds (Stainless steel or Ni-base alloy)	SFA-5.4	E309L-16 E308L-16
	SFA-5.9	ER309L ER308L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7
	Code Case 2142-2 UNS N06054	-
Reactor Coolant Pump Parts		
Pressure casting	SA-351	Gr. CF8(*)
Pressure forgings	SA-182	Gr.F304(*) or F304LN Gr.F316(*) or F316LN
Tubes and pipes	SA-213 SA-312	TP 316(*) TP 316(*)
Flywheel	SA-533	Type B Class 1
Closure Stud bolts, Nuts, Washer	SA-540	Gr. B24 Cl.4 and Cl.2
Reactor Coolant Piping		
Main coolant pipe and elbow	SA-182 or SA-336	Gr. F316(*) or F316LN
Main coolant branch nozzles	SA-182	Gr. F316(*) or F316LN
Pressure Boundary Welds	SFA-5.4 SFA-5.9	E316L-16 ER316L
Surge line, spray line, and other RCS piping	SA-312 or SA-376	TP 316(*), or 316LN or 316L

Table 5.2.3-1 Reactor Coolant Pressure Boundary Material Specifications (Sheet 4 of 4)

Component	Material	Class, Grade, or Type
Auxiliary Pressure Vessels, Tanks		
Pressure Plates	SA-240	Type 304(*) or Type304L
Pressure Forgings	SA-182	Gr.F304(*) or TypeF304L
	SA-105	-
Valves		
Bodies	SA-351	CF3A, CF3M, CF8(*), CF8M(*)
	SA-182	Gr.F304(*), F304L, F304LN Gr.F316(*), F316L, F316LN
Bonnets	SA-351	CF3A, CF3M, CF8(*), CF8M(*)
	SA-240	Type 304(*), 304L, 304LN Type 316(*), 316L, 316LN
	SA-182	Gr.F304(*), F304L, F304LN Gr.F316(*), F316L, F316LN
Disks	SA-564	Type 630
	SA-479	Type 304(*), 304L, 304LN Type 316(*), 316L, 316LN
	SA-351	CF3A, CF3M, CF8(*), CF8M(*)
	SA-182	Gr.F304(*), F304L, F304LN Gr.F316(*), F316L, F316LN
	SB-637	UNS N07718
Stems	SA-564	Type 630
	SA-479	Type 304(*), 304L, 304LN Type 316(*), 316L, 316LN Type 403
	SB-637	UNS N07718
Closure Stud Bolts	SA-453	Gr.660
	SA-193	Gr.B7, B16
	SA-564	Type 630
Closure Nuts	SA-453	Gr.660
	SA-193	Gr.B7, B16
	SA-194	Gr.6 or 8

(Note) Material specifications for Reactor Vessel Internals and Control Rod Drive Mechanism are described at Section 4.4.

(*)Maximum carbon content will be controlled under 0.05% (heat analysis) and 0.06% (product analysis) when standard grade stainless steel is used