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TOKYO, JAPAN

December 24, 2009

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-09578

Subject: MHI's Responses to US-APWR DCD RAI 500-4012 Revision 0

Reference: 1) "REQUEST FOR ADDITIONAL INFORMATION 500-4012 REVISION 0, SRP Section: 10.03.06 – Steam and Feedwater System Materials, Application Section: 10.3.6, dated December 1, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Responses to Request for Additional Information 500-4012 Revision 0."

Enclosed are the responses to 3 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.

Enclosure:

1. Responses to Request for Additional Information 500-4012 Revision 0

CC: J. A. Ciocco
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Docket No. 52-021
MHI Ref: UAP-HF-09578

Enclosure 1

UAP-HF-09578
Docket No. 52-021

Responses to Request for Additional Information No. 500-4012
Revision 0

December 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/24/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: NO. 500-4012 REVISION 1

SRP SECTION: 10.03.06 STEAM AND FEEDWATER SYSTEM MATERIALS

APPLICATION SECTION: 10.3.6

DATE OF RAI ISSUE: 12/1/2009

QUESTION NO.: 10.03.06-10

In response to RAI 10.03.06-1, the applicant modified Table 10.3.2-3 to list main steam piping flanges. The applicant listed SA-508 Class 1, Class 900 material for flanges for the steam generator to containment penetration main steam piping. Material specification SA-508 does not include or list Class 1 or Class 900 as a grade of material. The applicant also listed material specification SA-182 but specifies no material grade for valves in feedwater piping from the feedwater piping area wall to the MFIV. The staff requests that the applicant modify the Design Control Document to address the above errors.

ANSWER:

DCD Table 10.3.2-3 will be revised as requested.
The description of flanges in SG outlet to containment penetration piping in Table 10.3.2-3 will be deleted because the flanges do not exist in the piping.

Impact on DCD

See attached mark-up of DCD Table 10.3.2-3.

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

12/24/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: NO. 500-4012 REVISION 1

SRP SECTION: 10.03.06 STEAM AND FEEDWATER SYSTEM MATERIALS

APPLICATION SECTION: 10.3.6

DATE OF RAI ISSUE: 12/1/2009

QUESTION NO.: 10.03.06-11

In RAI 10.03.06-6, the staff requested that the applicant revise COL Item 10.3(1) to provide clarity to the COL Applicants requirements for an FAC monitoring program. The applicant responded by letter dated April 1, 2009. The staff found the applicant's response and proposed FSER modifications acceptable. The proposed FSER modifications referenced EPRI Technical Report NSAC-202L-3. However, in reviewing modifications made to Design Control Document (DCD) Revision 2, the staff noticed that the applicant referenced Revision 2 (NSAC-202L -2) in lieu of Revision 3 (NSAC-202L-3) which is the most current revision. The staff requests that the applicant modify the DCD sections 10.3.6.3, 10.3.7 and Table 1.8-2 to reference EPRI Technical Report NSAC-202L-3.

ANSWER:

The latest version of NSAC-202L-3 is revision 3, however, SRP 10.3.6 and C.I.10.3.6.3 of RG 1.206, refers revision 2. Therefore, the version of NSAC-202L-3 is changed from 3 to 2 in US-APWR DCD revision 2.

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

12/24/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: NO. 500-4012 REVISION 1

SRP SECTION: 10.03.06 STEAM AND FEEDWATER SYSTEM MATERIALS

APPLICATION SECTION: 10.3.6

DATE OF RAI ISSUE: 12/1/2009

QUESTION NO.: 10.03.06-12

RAI 10.03.06-9 requested, in part, that the applicant describe the corrosion allowance specified and discuss how the corrosion allowance covers the design life of the plant for all high-energy systems (ASME Code Class 1, 2 and 3 and non-safety related systems) potentially susceptible to FAC. The applicant's response stated that the design wall thickness is determined based on piping design pressure/temperature and allowable stress in accordance with ASME Code Section III or ASME B31.1. The specified wall thickness (prior to fabrication) is specified to exceed the required design wall thickness by a large and appropriate amount to account for the expected wall thinning during fabrication. Wall thinning during fabrication is controlled by establishing fabrication tolerances. The applicant also states that the FAC monitoring program provided by the COL Applicant will include preservice thickness measurements of as-built piping considered susceptible to FAC. The applicant further states that by performing this preservice measurement, the piping thickness margin that will be used as a wall thinning margin will be known, and then by combing the measurement with regular inspection the frequency of pipe replacement will be predicted.

Given that analytical tools are available to predict FAC degradation, the staff expects that an evaluation of the final system design will be conducted to determine if carbon steel components will require the addition of wall thickness or an upgrade in materials to provide reasonable assurance that piping and components will maintain the minimum required design wall thickness for the design life of the system. The staff requests that: (a) the applicant modify the Design Control Document (DCD) to specify that it will perform an evaluation of its final design of all ASME Code Class 2 and 3 as well as non-ASME Code systems or portions of systems susceptible to FAC and (b) modify its design if necessary to provide reasonable assurance that piping and components exposed to water or wet steam will maintain their minimum design wall thickness for the design life of the plant. If the design life of the applicable systems is less than the 60-year design life of the plant, the staff requests that the applicant identify the design life of these systems. The staff also requests that the applicant provide, in the DCD, its corrosion allowance for general corrosion and a basis for this allowance.

ANSWER:

The nominal wall thicknesses for US-APWR piping are fundamentally selected based on the standard tables of ASME B36.10M and ASME B36.19M. And the minimum wall thickness, which

consider the additional thickness for the minus tolerances of pipe thicknesses, the thinning due to fabrication processing and FAC aging degradation for relatively-mild FAC degradation, shall be larger than the required wall thickness calculated on the pressure design of ASME Sec. III NX-3641 or ASME B31.1.
In this case, since US-APWR doesn't have any actual records of pipe wall thinning management in USA, MHI appropriately prepares the initial thinning rate based on the actual measurement records from Japanese PWR nuclear power plants to estimate the additional thicknesses against thinning within the design life of piping with relatively-mild FAC degradation. Setting the initial thinning rate due to FAC is around 0.2×10^{-4} (mm/hr) and also estimating operational rates, the required additional thickness applicable to the 10-year of postulated design life is around 60-70 mils.

As the measure for the specific pipelines identified in NUREG-1344 attached to GL89-08, MHI adopts the FAC-resistant materials (Cr-Mo steel, austenite stainless steel) on the lines which tend to have severe FAC aging degradation in accordance with the past several and periodic reports of Japanese PWR nuclear power plants. This measure will bring little possibility of failure of pressure boundaries caused by FAC degradation in a short period of time.

The statuses of taking measures for US-APWR are described in the DCD 10.3.6.3 Flow-Accelerated Corrosion (FAC), 3rd paragraph. This portion will be revised to incorporate this response as shown in Impact on DCD below.

And for the other carbon lines with 10-year corrosion margin which have relatively-mild FAC degradation, the pipe wall thinning management program based on EPRI "Recommendations for an effective Flow-Accelerated Corrosion Program (NSAC-202L-R2)" shall be prepared and implemented by using knowledge acquired from experiences of pipe wall thinning managements via Electric Power Companies in USA and Japan.

Impact on DCD

The 2nd paragraph to 5th paragraph of the DCD 10.3.6.3 will be revised. See attached mark-up of DCD 10.3.6.3.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

Table 10.3.2-3 Main Steam and Feedwater Piping Design Data

Main Steam Piping

Segment	Material specification	Nominal OD	ASME Class
SG outlet to containment penetration	SA-333, Grade 6 (Seamless)	32 inch	Section III, Class 2
Containment penetration to MSIV	SA-333, Grade 6 (Seamless)	32 inch	Section III, Class 2
MSIV to main steam/feedwater piping area wall	SA-333, Grade 6 (Seamless)	32 inch	Section III, Class 3
Fittings	SA-181, Gr. 70 or SA-333, Grade 6 (Seamless)	32 inch	Note: Material Spec. for fittings, ~~flanges~~ and valves is same between ASME Section III Class 2 and 3.
~~Flanges~~	~~SA-508 Class 1, Class 900~~		
Valves (Globe, Gate, Check)	SA-352, Grade LCB		
Main steam steam/feedwater piping area wall to equalization piping	ASTM A-672 Grade B60	32 inch	B31.1
Equalization piping	ASTM A-672 Grade B60	28 inch & 42 inch	
Lines to TSV	ASTM A-672 Grade B60	32 inch & 30 inch	
Fittings	ASTM A-105, A-672 Grade B60	28 inch, 32 inch, 42 inch	
Flanges	ASTM A-105		
Valves (Globe, Gate, Check)	ASTM A-181 Grade 70 or ASTM A-216 Grade WCB, Class 900		

Feedwater Piping

Segment	Material specification	Nominal OD	ASME Class
Feedwater pump outlet to feedwater pump discharge equalization piping	ASTM A-672 Grade B60	22 inch	B31.1
Feedwater pump discharge equalization piping	ASTM A-672 Grade B60	36 inch	
Feedwater pump discharge equalization piping to feedwater heaters 6/7	ASTM A-672 Grade B60	26 inch	
Feedwater heaters 6/7 outlet to feedwater heater 7 discharge equalization piping	ASTM A-672 Grade B60	26 inch	
Feedwater heater 7 discharge equalization piping	ASTM A-672 Grade B60	36 inch	
Fittings	ASTM A-105	22 inch, 26 inch & 36 inch	
Flanges	ASTM A-105		
Valves (Globe, Gate, Check)	ASTM A-181 Grade 70, or ASTM A-216 Grade WCB, Class 900		
Feedwater heater 7 discharge equalization piping to main/steam feedwater piping area wall	A-335 Grade P22 (Seamless)	18 inch	B31.1
Fittings	ASTM A-182 Grade F22, ASTM A-336 Grade F22 or ASTM A-335 Grade P22	18 inch	
Flanges	ASTM A-182 Grade F22		
Valves (Globe, Gate, Check)	ASTM A-182 Grade F22, or ASTM A-217 Grade WC9		
Main/steam feedwater piping area wall to MFIV	SA-335 Grade P22 (Seamless)	18 inch	Section III, Class 3
MFIV to SG	SA-335 Grade P22 (Seamless)	16 inch	Section III, Class 2
Fittings	SA-182 Grade F22 or SA-336 Grade F22 or SA-335 Grade P22	16 inch & 18 inch	Note: Material Spec. for fittings, flanges and valves is same between ASME Section III Class 2 and 3.
Flanges	SA-182 Grade F22		
Valves (Globe, Gate, Check)	SA-182 Grade F22 or SA-217 Grade WC9		

The material selection and fabrication methods used for Class 2 and 3 components conform to the following:

- In designing US-APWR, the material used for the piping and components of the CFS and the MSS conform with Appendix I to Section III (Reference 10.3-12), Parts A (Reference 10.3-13), Parts B (Reference 10.3-14), and Parts C (Reference 10.3-15) of Section II of the ASME Code Regulatory Guide 1.84 (Reference 10.3-16).

- Cleaning and handling of Class 2 and Class 3 components of the MSS and CFS are conducted in accordance with the acceptable procedures described in RG 1.37.

- The welding of low-alloy materials conform to the guidance provided in Regulatory Guide 1.50, "Control of Preheat Temperature for Welding of Low-Alloy Steel" (Reference 10.3-19) for the MSS and the CFS. The minimum preheat temperatures for carbon steel and low alloy materials conform to the recommendations in ASME Section III, Appendix D, Article D-1000 (Reference 10.3-6).

- As for welds in areas of limited accessibility, the qualification procedure is specified in conformances with the guidance of Regulatory Guide 1.71 (Reference 10.3-20) (i.e., assurance of the integrity of welds in locations of restricted direct physical and visual accessibility) and as described with respect to all applicable components.

- The nondestructive examination procedures and acceptance criteria used for the examination of tubular products conform to the provisions of the ASME Code, Section III, Paragraphs NC/ND-2550 through 2570 (Reference 10.3-6). Refer to Section 6.6 for details on equipment class 2 and 3 components.

10.3.6.3 Flow-Accelerated Corrosion (FAC)

As noted in Subsection 10.3.6.2, MSS and CFS piping materials selected are corrosion resistant. CFS chemistry is controlled to have an environment that minimizes corrosion. This is further described in Subsection 10.3.5.

~~The following portions have the potential for FAC from past experiences in operating power plants and are included in FAC monitoring program. These~~ The following portions with potential for FAC are basically based on NUREG-1344 attached to GL 89-08. Generally, most of these portions are entirely made of carbon steel, however, materials for the portions extremely susceptible to FAC are FAC-resistant alloy (Cr-Mo steel, austenite stainless steel) taking into consideration past experiences. For other safety/non-safety carbon pipelines with relatively-mild FAC degradation identified in NUREG-1344 attached to GL 89-08, the initial thinning rate is prepared based on the actual measurement records from Japanese PWR nuclear power plants. Setting the initial thinning rate due to FAC is 0.2×10^{-4} mm/hr and also estimating operational rates, the additional thickness 70 mils is applied for the 10-year of design life.

Single-Phase Line

- Main feedwater line
  The piping from steam generator up to and excluding main feedwater equalization piping in the upstream of feedwater flow meter is made of high content of chrome-moly materials as shown in table 10.3.2-3. This portion is resistant to FAC. Other feedwater lines upstream of feedwater equalization piping are generally made of carbon steel with 10 year corrosion margin, however, material of extremely susceptible to FAC portion such as feedwater heater and elbows are made of FAC resistant alloy.
- Steam generator blowdown line (upstream of angle valves)
  This portion is made of carbon steel with 10 year corrosion margin.
- Main feedwater recirculation to condenser
  ~~This portion is made of carbon steel.~~ Most of this entire portion is made of carbon steel with 10 year corrosion margin, however, material of extremely susceptible to FAC portion such as condenser and elbows are changed to FAC-resistant alloy.
- Feedwater pump suction line
  ~~This portion is made of carbon steel.~~ Most of this entire portion is made of carbon steel with 10 year corrosion margin, however, material of extremely susceptible to FAC portion such as elbows are made of FAC-resistant alloy.
- Feedwater pump discharge line
  ~~This portion is made of carbon steel.~~ Most of this entire portion is made of carbon steel with 10 year corrosion margin, however, material of extremely susceptible to FAC portion such as feedwater pump discharge, feedwater pump minimum flow line and elbows are changed to FAC-resistant alloy.
- Condensate pump recirculation to condenser line
  ~~This portion is made of carbon steel.~~ Most of this entire portion is made of carbon steel with 10 year corrosion margin, however, material of extremely susceptible to FAC portion such as elbows are made of FAC-resistant alloy.

Two-Phase Line

- Main steam line
  This portion is made of carbon steel. There is no portion which is susceptible to FAC because of the low moisture is approximately 0.1 %.
- Turbine cross-over piping
  Most of this entire portion is made of carbon steel with 10 year corrosion margin.
- Turbine C~~c~~ross-under piping
  This portion is made of FAC-resistant alloy as shown in table 10.3.2-4. This portion is immune to FAC.
- Extraction steam line
  This portion is made of FAC-resistant alloy. This portion is immune to FAC.
- Feedwater heater drain piping
  Most of this entire portion is made of carbon steel with 10 year corrosion margin, however, material of extremely susceptible to FAC portion such as downstream of control valves are made of FAC-resistant alloy.

- Steam generator blowdown line (downstream of angle valves)
  ~~Most of this portion is entirely made of carbon steel, however, material for the portion extremely susceptible to FAC portion such as downstream of angle valves are~~ This portion is made of stainless steal or chrome-moly materials.

~~Corrosion allowance is the difference between the actual minimum wall thicknesses after any wall thinning that occurs during fabrication, and the required design wall thickness.~~ As for the safety/non-safety carbon pipelines with relatively-mild FAC degradation, ~~T~~the required design wall thickness is determined based on piping design pressure/ temperature and allowable stress in accordance with ASME Sec.III NX-3641 or ASME B31.1 paragraph 104. The specified wall thickness (prior to fabrication) is a standardized wall thickness stipulated in ASME B36.10M and ASME B36.19M. It is specified to exceed the required design wall thickness with consideration of minus tolerances of the thicknesses by a large and appropriate amount to account for the expected wall thinning during fabrication and FAC aging degradation of 70 mils. ~~The fabrication thinning is controlled by establishing fabrication tolerances.~~ As for the safety/non-safety carbon pipelines with relatively-mild FAC degradation, the FAC monitoring program based on EPRI "Recommendations for an effective Flow-Accelerated Corrosion Program (NSAC-202L-R2)" shall be prepared and implemented by using knowledge acquired from experiences of pipe wall thinning managements via Electric Power Companies in USA and Japan. The FAC monitoring program ~~provided by COL applicant~~ will include preservice thickness measurements of as-built piping considered susceptible to FAC. By performing this preservice measurement, the piping thickness margin that will be used as a wall thinning margin will be known, and then by combining the measurement with regular inspection the frequency of the pipe replacement will be predicted. Integrity and safety of a plant is assured ~~by the COL applicant~~ by conducting inspection and maintenance during ~~over 60 years of~~ the service life of the plant and replacing piping if necessary.

The US-APWR design and piping layout has considered several features for the various piping systems to minimize incidence of FAC in piping. These features include:

- elimination of high turbulence points wherever possible (example: adequate straight pipe length downstream of flow orifice or control valve, etc)
- use of long radius elbows
- smooth transition at shop or field welds
- selection of pipe diameter to have velocities within industry recommended values
- use of corrosion resistant materials
- use of austenite stainless steel and P11 and P22 chrome-moly materials

The type of fluid, flow rates, fluid temperatures and pressure of ASME Code Class 2 and 3 piping for steam and feedwater system are shown in Table 10.3.2-6.

The Combined License Applicant will provide a description of the FAC monitoring program for carbon steel portions of the steam and power conversion systems that contain water or wet steam and are susceptible to erosion-corrosion damage. The