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TOKYO, JAPAN

April 04, 2011

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-11096

Subject: **MHI's Amended Responses to US-APWR DCD RAI 500-4012 Revision 0 (SRP 10.03.06)**

Reference: 1) "MHI's Response to US-APWR DCD RAI No. 500-4012 Revision 0" MHI Ref: UAP-HF-09578 dated December 24, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Amended Responses to Request for Additional Information 500-4012 Revision 0." This amended response is submitted to reflect the discussion on clarification call on October 13, 2010.

Enclosed is the amended response to Question 10.03.06-12 contained within Reference 1. MHI replaces the previous letter (Reference 1) with this amended response letter.

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,

Atsushi Kumaki for

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

Enclosure:

1. Amended Responses to RAI No. 500-4012 Revision 0 Question 10.03.06-12

D081
NRO

CC: J. A. Ciocco
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Docket No. 52-021
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Enclosure 1

UAP-HF-11096
Docket No. 52-021

Amended Responses to RAI No. 500-4012
Revision 0

April 2011

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/04/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: NO. 500-4012 REVISION 0

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:

DCD will be revised to state that final system design is evaluated by an analysis tool, which also takes general corrosion into account, for safety and non-safety related carbon steel piping

susceptible to FAC identified in the DCD Subsection 10.3.6, which is determined based on NUREG-1344. DCD will be also revised to state that if necessary, addition of wall thickness or material upgrade of piping and components exposed to water or wet steam is performed to provide reasonable assurance for 40 year design life.

The 60 year design life of piping is not practical without consideration of piping replacement as well as other consumable. Actual service life of the piping will be evaluated as determined based on the results of preservice and inservice inspections. Minimum wall thickness will be maintained by FAC monitoring program which requires preservice and inservice inspections.

Impact on DCD

The 2nd paragraph to 3rd 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.

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.

All safety and non-safety related piping and components are designed to mitigate the effects of FAC as well as erosion, corrosion and cavitation. ~~The following portions have the potential for FAC from past experiences in operating power plants and are included in FAC monitoring program. These portions~~ Portions of the systems potentially susceptible to FAC ~~are , will be~~ are identified ~~basically~~ based on NUREG-1344 attached to GL 89-08~~.~~ and operation experience. ~~Generally~~In general, ~~most of these portions are entirely made of~~ carbon steel is used for the systems~~.~~. ~~h~~However, ~~materials for the portions extremely susceptible to FAC are~~ FAC-resistant alloys (Cr-Mo steel, austenitic stainless steel) ~~taking into consideration past experiences.~~are applied to portions for which it is considered difficult to provide a reasonable wall thickness of carbon steel piping. The final system design is analyzed and material upgrades are made as necessary to provide reasonable

assurance of a 40 year 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.~~
~~-Main feedwater recirculation to condenser~~
~~This portion is made of carbon steel.~~
~~-Feedwater pump suction line~~
~~This portion is made of carbon steel.~~
~~-Feedwater pump discharge line~~
~~This portion is made of carbon steel.~~
~~-Condensate pump recirculation to condenser line~~
~~This portion is made of carbon steel.~~

~~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 %.~~
~~-Cross-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, however, material of extremely susceptible to FAC portion such as downstream of control valves are made of FAC-resistant alloy.~~
- ~~Steam generator blowdown line~~
~~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 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.~~ 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 after consideration of tolerances and minimum thickness by a large and appropriate amount to account for the expected wall thinning during fabrication. FAC aging degradation and general corrosion. ~~The fabrication thinning is controlled by establishing fabrication tolerances.~~ The FAC monitoring program will be based on EPRI guidelines "Recommendations for an effective Flow-Accelerated

Corrosion Program (NSAC-202L-R3)" and operating experience gained in US and Japanese operating plants. 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 inspections, the frequency of the pipe replacement will be predicted. Integrity and safety of ~~a~~the plant is assured ~~by the COL applicant~~ by conducting inspection and maintenance during ~~over 60 years of~~ the service life of the plant with~~and replacing~~ piping replacement 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 description will address consistency with Generic Letter 89-08 and NSAC-202L-R3~~2~~ and will provide a milestone schedule for implementation of the program.

10.3.7 Combined License Information

COL 10.3(1) FAC monitoring program
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 description will address consistency with Generic Letter 89-08 and NSAC-202L-R3~~2~~ and will provide a milestone schedule for implementation of the program.

COL 10.3(2) Deleted

COL 10.3(3) Operating and maintenance procedures for water hammer prevention
The Combined License Applicant is to provide operating and maintenance procedures including adequate precautions to prevent water (steam) hammer, relief valve discharge loads and water entrainment effects in accordance with NUREG-0927 and a milestone schedule for