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August 26, 2008

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-08152

Subject: MHI's Response to US-APWR DCD RAI No. 45-876

References: 1) "Request for Additional Information No. 45-876 Revision 0, SRP Section: 6.2.2 – Containment Heat Removal System – Design Certification and New License Applicants, Application Section: 6.2.2," dated July 31, 2008.

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. 45-876 Revision 0".

Enclosure 1 provides the response to the 4 questions that are 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. 45-876 Revision 0

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

D081
NRO

Contact Information

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Enclosure 1

UAP-HF-08152
Docket No. 52-021

Response to Request for Additional Information No. 45-876 (R0)

August 2008

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

8/26/2008

US-APWR Design Certification

Mitsubishi Heavy Industries, Ltd.

Docket No. 52-021

RAI NO.: **NO. 45-876 REVISION 0**

SRP SECTION: **6.2.2 – Containment Heat Removal System**

APPLICATION SECTION: **6.2.2**

DATE OF RAI ISSUE: **7/31/2008**

QUESTION NO.: 06.02.02-1

Generic Safety Issue (GSI) 191 addresses the potential for debris accumulation on PWR sump screens to affect emergency core cooling system (ECCS) pump net positive suction head margin. The NRC has issued Bulletin 2003-01, "Potential Impact of Debris Blockage On Emergency Sump Recirculation At Pressurized Water Reactors," and Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," related to the GSI-191 resolution. GL 2004-02 requests, in part, that licensees evaluate the maximum head loss postulated from debris accumulation (including chemical effects) on the submerged sump screen. Chemical effects are corrosion products, gelatinous material, or other chemical reaction products that form as a result of interaction between the PWR containment environment and containment materials after a loss-of-coolant accident (LOCA).

To satisfy the requirements of GDC 38 and 10 CFR 50.46(b)(5) regarding the long-term spray system(s) and ECCS(s), the containment emergency sump(s) in PWRs and suppression pools in BWRs should be designed to provide a reliable, long-term water source for ECCS and CSS pumps. In order to meet these regulatory criteria, SRP Section 6.2.2, "Containment Heat Removal Systems," recommends following the guidance of Regulatory Guide 1.82, Revision 3, as an acceptable method. For PWR plants, RG 1.82 Rev. 3 recommends that chemical effects be considered in any analyses of head loss.

To satisfy the requirement for an evaluation of chemical effects, MHI submitted its test plan for evaluation of chemical effects on sump strainer performance in MUAP-8006-P, "US-APWR Sump Debris Chemical Effects Test Plan," dated June 2008 (Reference 1). The test plan will use a similar methodology to the Integrated Chemical Effects Tests (ICET) documented in NUREG/CR-6914, using materials, buffer, and simulated post-LOCA environment representative of the US-APWR design.

The most recent NRC staff guidance for evaluation of chemical effects on sump strainer performance is contained in "NRC Staff Review Guidance Regarding Generic Letter 2004-02

Closure in the Area of Plant-Specific Chemical Effect Evaluations" , dated March 2008, (Reference 2).

Reference 2 recommends that coating materials be listed among the plant-specific materials to be included in the chemical effects evaluation. However, the test plan does not include any coatings materials among the materials to be included in the test, listed in Table 3.1-2. The US-APWR DCD, Section 6.1.2, does indicate that the containment liner will be coated with an inorganic zinc primer with an epoxy topcoat. It is not clear whether the contribution from the inorganic zinc primer will be represented by the "zinc coated steel" surface area listed in Table 3.1-2. Also, no epoxy coatings materials are included in Table 3.1-2.

Therefore, the staff requests the following information:

1. Is the zinc in the inorganic zinc primer included as part of the zinc coated steel surface area in Table 3.1-2 of the test plan? If not, how will the inorganic zinc primer be accounted for in the chemical effects test?
2. Why is the epoxy paint, or any other organic coating material, not included in the chemical effects testing?

References

1. MUAP-8006-P, "US-APWR Sump Debris Chemical Effects Test Plan (R0)" dated June 2008, ADAMS Accession No. ML081850510
2. NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Plant-Specific Chemical Effect Evaluations, dated March 2008, ADAMS Accession No. ML080380214," Enclosure 3 to letter from William H. Ruland, NRC, to Anthony Pietrangelo, NEI, dated March 28, 2008, Subject "Revised Guidance For Review Of Final Licensee Responses To Generic Letter 2004-02, "Potential Impact Of Debris Blockage on Emergency Recirculation During Design Basis Accidents At Pressurized-Water Reactors"," ADAMS Accession No. ML080230112
3. NUREG/CR-6877, "Characterization and Head-Loss Testing of Latent Debris from Pressurized-Water-Reactor Containment Buildings," July 2005

ANSWER:

The standard US-APWR will utilize only DBA epoxy coating systems in containment. There will be no Inorganic zinc coatings (IOZ). nor will any IOZ be destroyed by the postulated line break. "Zinc coated steel" described in Table 3.1-2 of MHI test plan was sum of surface area of "galvanized steel structures" such as grating, ducts, and cable trays.

Based on the debris generation and transport analysis, there are no metallic (zinc, aluminum or otherwise) coatings destroyed within the DEGB Zone of Influence. No unqualified coatings have been identified in the US-APWR containment.

DBA qualified, intact epoxy coatings are not considered in the test plan and have been accepted as chemically resistant by the U.S. NRC through the resolution of GSI-191 as below.

Qualified epoxy-based protective coatings (paints) are not included in the test plan because these coatings systems will be DBA qualified in accordance with ASTM D5144-00, "Standard Guide for Use of Protective Coatings Standards in Nuclear Power Plants" and ASTM D3912-95(2001), "Standard Test Method for Chemical Resistance of Coatings Used in Light-Water Power Plants."

Epoxy coatings were similarly not considered in the joint U.S. NRC and nuclear industry integrated chemical effects testing – see NUREG-6914, "Integrated Chemical Effects Project: Consolidated Data Report. Epoxy coatings have been shown to be chemically resistant in both highly acidic and caustic environments.

The US-APWR DCD Section 6.1.2 described the potential use of "zinc primer" for steel in containment. This was not correct, and will be corrected as appropriate.

Impact on DCD

This revision impacts revision 1 of the DCD in the first paragraph of Subsection 6.1.2, on page 6.1-5, with the following corrections:

With the notable exception of coatings and electrical insulation, organic materials (e.g., wood, plastics, lubricants, asphalt) are not freely available in containment. A corrosion inhibiting primer ~~(e.g., inorganic zinc)~~ typically is applied as a base coating over the steel plate lining of the containment vessel, as well as to structural steel support members.

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

8/26/2008

US-APWR Design Certification

Mitsubishi Heavy Industries

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RAI NO.: **NO. 45-876 REVISION 0**

SRP SECTION: **6.2.2 – Containment Heat Removal System**

APPLICATION SECTION: **6.2.2**

DATE OF RAI ISSUE: **7/31/2008**

QUESTION NO.: 06.02.02-2

RG 1.82 Rev.3, Section 1.3.2.5 states that the cleanliness of the containment during plant operation should be considered when estimating the amount and type of debris available to block the ECC sump screens. The potential for such material (e.g., thermal insulation other than piping insulation, ropes, fire hoses, wire ties, tape, ventilation system filters, permanent tags or stickers on plant equipment, rust flakes from unpainted steel surfaces, corrosion products, dust and dirt, latent individual fibers) to impact head loss across the ECC sump screens should also be considered. NUREG/CR-6877, "Characterization and Head-Loss Testing of Latent Debris from Pressurized-Water- Reactor Containment Buildings," (Reference 3) provides further definition of latent debris as debris that is already present and that resides inside the containment structure before a postulated loss-of-coolant accident (LOCA) occurs (as opposed to debris that is generated by the LOCA). NUREG/CR-6877 also states that examples of latent debris include ordinary dust and dirt, insulation fibers, clothing fibers, paper fibers, pieces of plastic, metal filings, paint chips, human hair, and anything else that may reside on a floor or other surface inside an industrial building. Reference 2 recommends that latent debris be considered in plant-specific chemical effects evaluations. The test plan (Reference 1) does not appear to account for latent debris in the listing of materials in Table 3.1-2. Therefore, the staff requests the following information:

Describe how latent debris will be accounted for in the chemical effects test plan, or justify why latent debris is not included.

ANSWER:

Latent debris is defined as unintended dirt, dust, paint chips, and fibers, which principally consist of fiber and particle debris. In the debris generation evaluation of the US-APWR, a conservative mass of 200 (lbm) was selected as the upper bound amount of latent debris, as per the guidance of the "NEI 04-07 Guidance Report (GR) amended by NRC Safety Evaluation (SE). (Reference-1)

The U.S. NRC has recommended a 85/15 split between particulate and fiber ratio for the latent debris source term based on the work performed in NUREG/CR-6877. The NUREG also recommends that NUKON fiber be used to represent the latent fibrous component. NUKON fiber debris was also assumed to be generated by jet impingement from the high energy line break (HELB) in the evaluation of debris generation of the US-APWR, and calculated to be 1.3m3 (46 ft3). Please note that this evaluation will be provided in MHI technical report (Reference 1) that will be revised and submitted to NRC in September, 2008. In addition to NUKON fiber debris generated by jet impingement, 0.354m3 (12.5 ft3) of latent NUKON fiber was assumed. Finally, total NUKON fiber was rounded to be 2.0 m3 (70.6ft3), and considered in the chemical test plan.

For latent particles, 170 lbs (85% of 200 lbs) was accounted for in the chemical test plan. Typical Dirt/Dust samples from various PWR's were obtained and analyzed in NUREG/CR-6877 for particle and chemical element composition. Dirt/Dust is approximately 70% Silicon, 30% Iron and less than 3% Calcium by weight. Based on this composition, MHI has selected concrete dust (silica sand and calcium) as the surrogate for dirt/dust in the US-APWR chemical effects test plan. The iron is already captured in the carbon steel plate included in the experiment.

<u>Reference</u>

1. "Pressurized Water Reactor Sump Performance Evaluation Methodology", amended by NRC, NEI 04-07 Revision 0, December 2004.

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.

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SRP SECTION: **6.2.2 – Containment Heat Removal System**

APPLICATION SECTION: **6.2.2**

DATE OF RAI ISSUE: **7/31/2008**

QUESTION NO.: 06.02.02-3

The pH is a key parameter in any chemical effects testing or evaluations. The autoclave portion of the US-APWR sump strainer test will be conducted a several different pH levels to simulate the increase of pH over time as the buffering agent dissolves in the ECCS fluid after a LOCA. However, for the autoclave test, the applicant did not include the target pH for each test run in Table 3.3-1 of the test plan. Therefore, the staff requests the following information:

Provide the pH corresponding to each test run in Table 3.3-1.

ANSWER:

The autoclave test conditions in Table 3.3-1 simulate the post-LOCA chemical control conditions for the US-APWR. The pH conditions for the chemical effects test are to be from 3 to 8 during the first 100 hours after the LOCA, based on initial/operational conditions for the US-APWR.

The estimated initial pH corresponding to each test run will be included in Table 3.3-1 as appropriate, and the final pH value for each test run will be determined by the test results.

Description "the pH transitions from approximately 4.0 to 7.7" in section 3.1(page6) of this test plan report will be also revised as appropriate.

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

8/26/2008

US-APWR Design Certification
Mitsubishi Heavy Industries
Docket No. 52-021

RAI NO.: **NO. 45-876 REVISION 0**
SRP SECTION: **6.2.2 – Containment Heat Removal System**
APPLICATION SECTION: **6.2.2**
DATE OF RAI ISSUE: **7/31/2008**

QUESTION NO.: 06.02.02-4

Section 3.1.3.1 of the test plan states that the temperature history expected in a post- LOCA environment is highly dependent upon plant operation scenarios and the nature of the break causing the LOCA. Figure 3.1-2(a) and (b) provide the recirculation sump water temperature profiles for the short-term (autoclave test) and long-term (recirculation test) based on preliminary calculations. Figure 3.1.2-b shows the long-term temperature reaching a minimum of around 120oF as compared to the selected long-term test temperature of 149oF. As a general principle, the test conditions should be those at which the maximum precipitate generation can be expected. However, the applicant did not adequately justify why the selected temperature is conservative. Therefore, the staff requests the following information:

Describe the basis for concluding that the environmental conditions selected for the recirculation test are the most conservative for precipitate generation (i.e., over the range of possible post-LOCA conditions, the conditions selected are those that theoretically would maximize the formation of precipitates).

ANSWER:

The environmental test conditions are selected to maximize the corrosion products generated (released) for the mission time, not necessarily the precipitates which are a function of equilibrium concentration and solubility. We agree that lower temperatures can produce precipitates and these lower temperatures can be realized through the sampling process (cooling) to identify precipitates. However, the purpose of the experiment is to produce a conservative release of corrosion products into the recirculation fluid and this is achieved through a higher temperature profile in the experiment.

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