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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-12095

Subject: MHI's Responses to the Questions at the US-APWR ACRS Subcommittee Meeting on November 30, 2011 regarding GSI-191

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") the responses to the questions that were discussed during the US-APWR ACRS Subcommittee meeting on November 30, 2011 regarding GSI-191.

Please contact Mr. Joseph Tapia, General Manager of Licensing Department, Mitsubishi Nuclear Energy Systems, Inc., if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

Yoshiki Ogata
Director - APWR Promoting Department
Mitsubishi Heavy Industries, Ltd.

Enclosure:

1. MHI's Responses to the Questions at the US-APWR ACRS Subcommittee Meeting on November 30, 2011 regarding GSI-191

CC: J. A. Ciocco
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ENCLOSURE 1

UAP-HF-12095
Docket No. 52-021

MHI's Responses to the Questions at the US-APWR ACRS Subcommittee Meeting on November 30, 2011 regarding GSI-191

April 2012

RESPONSE FOR ACRS INFORMATIVE MEETING

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US-APWR Design Control Document

Mitsubishi Heavy Industries, Ltd.

CHAPTER: 6

CHAPTER TITLE: ENGINEERED SAFETY FEATURES

DATE OF MEETING: 11/30/11

QUESTION: Item 1

Address ACRS request for a detailed calculation supporting MHI's stated conclusion that only 5 transfer pipes are needed to ensure adequate return flow to the RWSP. (This should also explicitly address why localized plugging effects are not a concern - the RWSP is not compartmentalized, all transfer pipes drain to the same area, etc.)

ANSWER:

MHI submitted the Updated Closure Plan for Issues Associated with GSI-191 for the US-APWR Design Certification on December 21, 2011, MHI Letter UAP-HF-11449. This closure plan proposes changes in the recirculation path design which eliminates the transfer pipes. Instead, recirculation flow will drain through floor openings at the SG compartment floor level into the reactor cavity and containment air distribution header compartment before returning to the RWSP through overflow piping. The new design utilizes a total of 8 floor openings and 12 overflow pipes, which include physical separation and redundancy to prevent complete blockage of the return flow path. Moreover, the floor openings and overflow pipes are located such that a complete or partial blockage of some floor openings or overflow pipes would be offset by an increase in return flow through the unblocked paths. Although total margin to minimum required flow area is not evaluated, the updated recirculation flow path design assumes 20% of the perimeter of each of the floor openings is blocked in the determination of the overflow height for the hold-up volume calculation. The design requirements for localized plugging on the flow paths will be presented to the NRC in a technical audit scheduled for April 16-17, 2012.

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QUESTION: Item 2

MNES assumed that small air bubbles released by the depressurization of the flow through the debris bed on the strainer disc surfaces would be carried to the pumps. Since the velocities in the strainer discs are very low, it is more likely that these bubbles will accumulate and grow until they are able to slide to the center pipe where they will rise to the top. Eventually there will be enough air in this region that it will probably be able to escape through some part of the topmost filter disc where the debris bed is weakest. ACRS doubts if much, if any, air will make it to the pumps. In any case MNES should develop a quantitative explanation of the likely scenario, with testing as appropriate.

ANSWER:

The US-APWR strainer module incorporates venting holes that preclude the accumulation of air/gas inside the core tube upper area during filling of the RWSP after maintenance activities and during accident conditions for entrained or deaerated bubbles.

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QUESTION: Item 3

Address ACRS request for the total amount of fiber inside containment (not just in the ZOI).

ANSWER:

US-APWR Sump Strainer Performance Technical Report, MUAP-08001 Revision 5 submitted on August 31, 2011, MHI letter UAP-HF-11286 indicates that the design fibrous insulation is excluded from the ZOI. However, the actual plant design excludes fiber insulation inside all of the containment, not only from the ZOI.

Note: The US-APWR strainer design allows for the use of a limited amount of fibrous insulation (4.5 lbs) as a plant design margin. The design latent fiber amount inside the containment is 30 lbs as described in MUAP-08001. Similar to above, this limit is applied to the entire containment and not limited only to within the ZOI.

MHI will update MUAP-08001 to clarify the above information.

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QUESTION: Item 4

Confirm whether or not the pressurizer relief tank rupture disk was evaluated as a potential debris generating path in the ZOI determination. If not, it should be included.

ANSWER:

The Pressurizer Relief Tank (PRT) rupture disk is not included in the break selection since this rupture disk is not part of the design basis accident. The PRT is designed to have sufficient capacity to handle the design discharge from the pressurizer during accidents. In addition, the PRT does not constitute part of the reactor coolant pressure boundary (RCPB), so the failure of this rupture disk does not result in a loss of coolant accident. This is the reason why the rupture disk break is not considered in the break selection. However, the impacts of a PRT rupture disk break are discussed below.

In the beyond design basis condition, the rupture disk would break because of inadvertent operator action or failure of the pressurizer safety valve. In this case, the ZOI is smaller since the opening size of the rupture disk is smaller than that during the large break LOCA. In addition, as described in the response to Item 3, design fibrous insulation is excluded from containment. Therefore, the amount of the fiber debris transferred to the sump strainers does not depend on the ZOI locations. The transport of operational margin fiber debris and latent fiber debris also does not depend on the ZOI locations. As a result, the debris generation for a beyond design-basis PRT rupture disk break is bounded by the debris generation for a design-basis break.

In addition, the rupture disk is not expected to generate any large debris which could block flow passages. The rupture disk configuration is a solid peripheral ring with a central disc area that is defined by a circular groove cut into the rupture disk inner surface to form a disc-shaped central area. Due to this annular groove, the central disc connects to the peripheral ring by a thinner ductile region. Radial grooves are cut into the central disc to divide it into approximately equal circular sectors. When burst pressure is reached, the circular sectors separate along their radial grooves (engineered failure points). Each circular sector remains attached to the peripheral ring by its respective portion of the thinner ductile region (metallic "hinge") while rotating outward to relieve PRT pressure. In this manner disc segments are removed from the relief flow stream but do not separate from the PRT and, thus, do not become large debris that could potentially block flow passages.

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QUESTION: Item 5

Question regarding pH sensitivity, coupon size, and upper bound of the aluminum solubility limit of 19 mg/L as compared to the ICET result of 50 mg/L. The real issue is the conservatism of MHI's result. Clarification wanted on temperature and pressure used, and how it was determined that they are representative. Concerns over downstream chemical effects.

ANSWER:

MHI presented the uncertainties considered in the Mitsubishi Chemical Effect Test (MCET) in the NRC public meeting on February 9th, 2012. The MCET is discussed in MUAP-08006 Sump Debris Chemical Effects Test Plan and MUAP-08011 Sump Debris Chemical Effects Test Results. A summary of those uncertainties is discussed as follows:

- Conservative pH is used in the test assuming minimum boric acid and maximum lithium in the RCS, and maximum sodium tetra-borate (NaTB) in the C/V. These assumptions maximize pH (i.e. most alkaline) which accelerates aluminum corrosion.
- The fluid temperature is kept higher than the design C/V temperature through the test.
- The bounding material amount per water volume is used for each material.
- The un-submerged aluminum coupons are continuously sprayed throughout the duration of the test.

Comparison between the MCET and the Integrated Chemical Effect Test (ICET) reported in NUREG/CR-6914 was also discussed in the public meeting. Table 5-1 shows that the aluminum concentration obtained in the ICET test #5 is 2.9 times higher than the concentration obtained in the MCET. MHI attributes this difference mainly to the difference in the fluid pH condition and volume of aluminum. Because there are many differences in the test condition and it is difficult to perform a simple comparison, however, the difference between these test results is reasonable since the fluid pH and amount of aluminum are dominant factors for the chemical tests.

In summary, the MCET was performed under sufficiently conservative conditions and the result is reasonable considering the comparison with the ICET conditions and results.

Table 5-1 Summary of Test Conditions and Results of MCET and ICET

		MCET	ICET #5	ICET #5 / MCET - acceleration ratio	Evaluation basis
Test condition	Temperature	149 °F, after 100 Hr max 284 °F, at 1-3 Hr	140 °F, constant	< 1	MCET is higher temperature than ICET #5
	pH	7.8	8.2-8.3, mode	3.8	Solubility and reaction speed will be accelerated by $10^{\Delta pH}$
	Aluminum amount	0.024 ft^2 / ft^3	0.18 ft^2 / ft^3	7.3	1)
	Test duration	30 days	30 days	= 1	
Test result	Aluminum concentration	19 ppm	55 ppm, max	2.9	Test result

1) MCET :All test coupons were corroded in 30 days spray zone and are counted in surface area in this table.
ICET #5 :25% of submerged coupons are counted and 75% of unsubmerged coupons sprayed only for 4 hrs are not counted.

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QUESTION: Item 6

Is sodium tetraborate a foaming agent? Should add something to the documentation that foaming is not an issue.

ANSWER:

Sodium tetraborate (NaTB) is not a foaming agent. Foaming agents, also called surface-active-agents, are generally organic molecules which consist of a hydrophilic group and a hydrophobic group. NaTB is, on the other hand, an inorganic ion that does not contain a hydrophobic group.

Additionally, foaming was not observed during the sodium tetraborate (NaTB) dissolution process in the MCET. This result is also confirmed in other MHI domestic NaTB dissolution tests.

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QUESTION: Item 7

In Appendix A of Regulatory Guide 1.82 Rev.3, methodology for modified NPSH required in consideration of air ingestion rate is described. In the ACRS meeting, it was discussed whether the unit of air ingestion rate was percentage or not. As a result, it should be confirmed that void fraction equation that is described in report compared to the RG. Specifically look for factor of 100 that seems to be causing a misunderstanding.

ANSWER:

MHI confirmed that the units of the input value used in the RG 1.82 Rev.3 methodology to modify NPSH required for air ingestion is percentage of air by volume, and not the decimal value. The calculated air percent by volume at the pump inlet for the US-APWR is 0.25%. Therefore, 0.25 is used in the RG 1.82 equation and not 0.0025.

The basis for the NPSH required modification in RG 1.82 is NUREG/CR-2792, which explains that a 2% limit on air ingestion is recommended to prevent impacts on pump hydraulic performance. The NUREG recommends use of the RG 1.82 equation as a very conservative method to adjust NPSH required. Figure 4-3 of NUREG/CR-2792 illustrates application of the equation and that 2% air ingestion would result in a 100% increase of NPSH required according to the equation. This confirms that the value for air ingestion used in the RG 1.82 equation should be "percent" rather than "decimal".

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QUESTION: Item 8

We asked about the assumption of a 50mil maximum debris thickness coating the cladding. Historically this has been justified by the space available for such a coating between adjacent rods. This may impose a limit. Please clarify what the flow paths look like when most (or all) of the space between rods is blocked in this way.

ANSWER:

MHI's response to RAI 530-3989 Question 04.04-29 describes how MHI determined that the 50 mils was the thickest debris formation that could be trapped on the cladding of the US-APWR fuel. Please see this RAI response for the details of the debris thickness determination.

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QUESTION: Item 9

Amount of fiber blockage used. Answer of 18.3 grams provided. ACRS wants to see details of fuel assembly design and such. ACRS wants to know what unique qualities Mitsubishi fuel has that makes it better than the 15 grams other tests are providing.

ANSWER:

The detailed US-APWR fuel assembly design is provided in Figures 4.2-1 4.2-4 in DCD Chapter 4.

MHI does not have detailed information on the design of other vendor's fuel assemblies and thus a direct comparison cannot be made. It is difficult to justify applicability of the criteria utilized in the PWROG report (WCAP-16793-NP Revision 2) to the MHI fuel assembly design. Therefore, MHI has performed an independent core inlet blockage test using their own fuel assemblies to verify core coolability in the long term.

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QUESTION: Item 10

ACRS member were confused that the US-APWR does not utilized silicon carbide as insulation of the plant but why use it in the CIB tests?

ANSWER:

As the ACRS indicated in the question, the US-APWR utilizes RMI as insulation so that materials such as Calcium Silicate and Microtherm do not exist in the ZOI. On the other hand, silicon carbide is used in the CIB tests as a surrogate of coating debris, not as insulation.

Note: The US-APWR strainer design allows for the use of a limited amount of fibrous insulation (4.5 lbs) as a plant design margin. The design latent fiber amount inside the containment is 30 lbs as described in MUAP-08001.