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TOKYO, JAPAN

May 28, 2010

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

Attention: Mr. Jeffery A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10156

Subject: MHI's Responses to US-APWR DCD RAI No. 471-3699

Reference: 1) "Request for Additional Information No. 471-3699 Revision 1, SRP Section: 06.02.05 - Combustible Gas Control in Containment," dated 10/6/2009.

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 No. 471-3699, Revision 1."

Enclosed are the responses to the RAI 6.2.5-36 contained within Reference 1. This transmittal completes the response to this RAI.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Atsushi Kumaki for.

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

Enclosure:

1. Response to Request for Additional Information No. 471-3699, Revision 1

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

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Enclosure 1

UAP-HF-10156
Docket No. 52-021

Response to Request for Additional Information No. 471-3699, Revision 1

May, 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

5/28/2010

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

RAI NO.:	**NO. 471-3699 REVISION 1**
SRP SECTION:	**06.02.05 - COMBUSTIBLE GAS CONTROL IN CONTAINMENT**
APPLICATION SECTION:	**6.2.5**
DATE OF RAI ISSUE:	**10/6/2009**

QUESTION NO. RAI 06.02.05-36:

Provide an analysis that demonstrates that the US-APWR containment can withstand severe accident loads, as described in RG 1.7 and RG 1.136.

The staff requested, in RAIs 6.2.5-19 and 34 and RAI 3.8-01 that the applicant clarify the analysis used to demonstrate that the US-APWR containment can withstand severe accident loads.

In a letter dated June 5, 2009 MHI responded to RAI 6.2.5-34 with a proposed revision to DCD Subsection 19.2.4.1. Although somewhat reassuring, the comparison of the factored load to the ultimate pressure capacity is not the acceptance criteria recommended by RG 1.136.

In addition, on p. 6.2.5-44 of MHI's response to 6.2.5-34, MHI assumes that the Pg1 and Pg2 loads do not occur at the same time. Therefore, they state that the pressure before uncontrolled burn is D+Pg1=50.1 psia, and D+Pg2=130.4 psia after the uncontrolled burn. MHI then compared the larger of these, 130 psia, to the ultimate capacity of the PCCV (216 psia), and concluded that sufficient margin exists. However, according to the equation in RG 1.136 (p.8) concerning the hydrogen burn, the two loads, Pg1 and Pg2, are additive. In other words, the equation in RG 1.136 and the total pressure would be as follows:

D+Pg1+Pg2=3.4+46.7+127=177.1 psia.

Not D + Pg1=50.1 psia

or D+ Pg2=130.4 psia,

as given in MHI's response.

Please provide an analysis that computes the factored load in accordance with RG 1.136. In addtion analyze the resultant factored load (D+Pg1+Pg2) to determine if it results in meeting allowable limits from stresses and strains, in accordance with ASME Article CC-3720. (i.e. a discussion on how this pressure on the liner does not result in calculated strain for the liner exceeding Table CC-3720-1)

ANSWER:

The allowable strain of PCCV liner plate specified in ASME Article CC-3720 for Factored Load Condition is 3000μ or 0.3%. PCCV internal pressure which produces 0.3 % strain in the liner plate is calculated as follows.

Initial pre-stressing force applied to the US-APWR PCCV is equivalent to minimum 1.2 times the design pressure. Compressive strains are introduced to rebar and liner plate due to the pre-stressing force before pressurization.

Therefore if internal pressure would be increased, strain of the rebar and liner plate will become 0 (zero) at the pressure of 1.2 times the design pressure. Then the internal pressure will increase further, tensile strains of the rebar, liner plate and tendons will increase.

The increase of the internal pressure which will cause increase of the strain of the rebar, liner plate and tendons equal to 0.3% is calculated below. All calculation is performed for mid height of the PCCV cylinder in hoop direction which should be a critical for internal pressure.

1. Basic Conditions

1) PCCV Design Pressure
   Pd = 68 psig
2) Internal Pressure at the Factored Load
   D + Pg1 + Pg2 = 177.1 psia = 162.4 psig
3) PCCV Inside Radius
   R = 895 inch
4) Material Properties

(Tendon : ASTM A416 Grade 1860 #15)

Modulus of Elasticity	Et = 28,000 ksi
Sectional area per unit height	At = 0.5907 in^2/in
Yield strength	σyt = 243,000 psi

(Rebar : ASTM A615 Gr. 60)

Modulus of Elasticity	Er = 29,000 ksi
Sectional area per unit height	Ar = 0.5 in^2/in
Yield strength	σyr = 60,000 psi
Yield Strain	Єyr = σyr / Er = 0.207 %

(Liner plate : ASTM A516 Gr. 60)

Modulus of Elasticity	El = 29,000 ksi
Sectional area per unit height	Al = 0.25 in^2/in
Yield strength	σyl = 27,300 psi
Yield Strain	Єyl =σyl / El = 0.094 %

2. Calculation of the Internal Pressure which produces 0.3 % Strain in the Liner Plate

1) Calculation of the increase of internal pressure which will cause increase of the strain of the rebar, liner plate and tendons equal to 0.3%

Because 0.3% strain exceeds yield strains of the rebar and liner plate, they are assumed to be yielded.

The increase of sustained force per unit height by the tendon, rebar and liner plate (dNt, dNr and dNl) equivalent to the increase of the strains of them equal to 0.3% are:

Tendon	dNt = 0.003 x Et x At = 49,619 p/in
Rebar	dNr = σyr x Ar = 30,000 p/in
Liner	dNl = σyl x Al = 6,825 p/in

The increase of internal pressure which causes the increase of the above forces (dP) is:

$$dP = (dNt + dNr + dNt) / R = 96.59 \text{ psig}$$

2) Internal pressure which produces 0.3 % strain in the liner plate

The internal pressure which produces 0.3 % strain in the liner plate (P) is:

$$P = 1.2 \times Pd + dP = 178.19 \text{ psig}$$

The internal pressure P=178.19 psig which produces 0.3 % strain in the liner plate is well greater than the internal pressure D + Pg1 + Pg2 = 162.4 psig at the Factored Load. This means that the strain due to the pressure at the hydrogen burn is below the allowable limit of ASME CC-3720.

Reference
(1) Rules for Construction of Nuclear Facility Components, Division 2, Concrete Containments. Section III, American Society of Mechanical Engineers, 2001 Edition through the 2003 Addenda

(2) ASME Boiler and Pressure Vessel Code, Section II. 2001 Edition through the 2003 Addenda, American Society of Mechanical Engineers.

(3) Code Requirements for Nuclear Safety-Related Concrete Structures. ACI 349-01, American Concrete Institute, 2001.

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.