MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

April 23, 2009

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-09192

Subject: MHI's Response to US-APWR DCD RAI No. 217-2025

References: 1) "Request for Additional Information No. 217-2025 Revision 1, SRP Section: 03.06.03 – Leak-Before-Break Evaluation Procedures, Application Section: DCD, Tier 1 – Section 3.6.3," dated 2/26/2009.
2) "MHI's Response to US-APWR DCD RAI No. 217-2025, Question 15," UAP-HF-09103, dated March 24, 2009

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. 217-2025 Revision 1."

Enclosed is the response to question 16 of the RAI (Reference 1). This transmittal, in addition to Reference 2, 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,

Y. Ogata

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

Enclosures:

1. Response to Request for Additional Information No. 217-2025, Revision 1

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

D081
NRO

Contact Information

C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Enclosure 1

UAP-HF-09192
Docket No. 52-021

Response to Request for Additional Information No. 217-2025, Revision 1

April, 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 217-2025**
SRP Section:	**03.06.03 – Leak-Before-Break Evaluation Procedures**
APPLICATION SECTION:	**03.06.03**
DATE OF RAI ISSUE:	**02/26/09**

QUESTION NO.: RAI 3.6.3-16

DCD Tier 2 Section 3.6.3.1, "Application of LBB," indicates that the application of LBB includes RCL piping, RCL branch piping, and main steam piping in PCCV. DCD Section 3.6.3.4.1, "Leak Detection Capability," describes the leak detection methods used for the reactor coolant are the containment sump water levels, inventory balance, and the radiation in the environment of containment. DCD Section 3.6.3.4.1 states that the method to detect leaks from the main steam pipe in containment is the containment sump water level. The condensate water flow rate of containment air cooler, containment pressure, and temperatures provide qualitative information for the possibility of leakage.

The staff reviewed the above information and found that the leak detection methods identified for the RCL piping such as inventory balance, and the radiation in the environment of containment are not applicable for the main steam piping. For main steam leak, there is only one quantitative leak detection method, containment sump level, to support main steam LBB. The staff was not able to confirm the seismic qualification of the containment sump level detector in DCD Table 3.2-2, "Classification of Mechanical and Fluid Systems, Components, and Equipment." It is not listed in Table 3.2-2. DCD Section 3.6.3.2, "Design Criteria for LBB," states that leak detection systems meet the requirements of RG 1.45 (Revision 0). The applicant is requested to demonstrate how the methods for the main steam leakage detection meet RG 1.45 or its equivalent in terms of instrument capability, sensitivity, diversity (and/or redundancy), response time, seismic qualification, and Technical Specification operability requirements.

ANSWER:

As a leak detection methods for main steam line leakage inside containment, air cooler condensate flow rate monitor as well as containment sump level monitor is able to detect, monitor and quantify the leakage. The description of DCD Section 3.6.3.4.1 will be revised as shown in "Impact on DCD" below. These leak detection instruments are designed to meet the requirements of RG 1.45 for RCPB leakage detection, and also have a leakage detection capability for main steam leakage in containment of 0.5 gpm within one hour of detector response time. In terms of seismic classification, it is important for the operator to quickly assess the condition within the containment if a seismic event comparable to a safe-shutdown earthquake (SSE) occurs. The seismic qualification of containment sump level monitor will be changed to Seismic

Category I to have a capability for evaluating the non-radioactive fluid leakage that may develop in the containment as a result of a seismic event. This modification will be described in DCD Tier 2 Subsection 5.2.5.5.4.1.1 "Containment Sump Level and Flow Monitoring System" as shown in the following "Impact on DCD". Also, a Technical Specification (TS) for the main steam line leakage will be added as shown in the following "Impact on DCD" since the Limiting Condition for Operation (LCO) 3.4.13 and Bases 3.4.13 state the Operability requirements and its bases for RCPB leakage but do not address that of main steam line leakage.

Impact on DCD

See Attachment 1 for the mark-up of DCD Tier 2, Section 3.6, Revision 2, changes to be incorporated:

- Change the third and fourth sentences of the second paragraph of Subsection 3.6.3.4.1 to "The method to detect leaks from the main steam pipe in containment is the containment sump water level. Leaks can also be detected by the condensate water flow rate of containment air cooler. The containment environmental pressures and temperatures also suggest the possibility of leakage."

See Attachment 2 for the mark-up of DCD Tier 2, Section 5.2, Revision 2, changes to be incorporated:

- Change the third paragraph of Subsection 5.2.5.4.1.1 to "The sump level monitoring system is qualified for a safety shutdown earthquake."

See Attachment 3 and 4 for the mark-up of DCD Tier 2, Chapter 16, Revision 2, changes to be incorporated:

- Add a TS for the limit of main steam line leakage inside containment as a new LCO 3.7.15 and Bases B3.7.15.

Impact on COLA

The COLA will be changed in Section B of Part 4 consistent with the Chapter 16 changes noted above and shown in Attachment 3.

Impact on PRA

There is no impact on the PRA.

This completes MHI's response to this question.

ATTACHMENT 1
to RAI 217-2025

3.6.3.4 Analytical Methods and Criteria

The method and criteria used for LBB analysis are consistent with the guidelines in NUREG-1061 (Reference 3.6-23) and Standard Review Plan 3.6.3, Rev. 1 (Reference 3.6-4).

LBB BACs are prepared for each applicable piping system. These curves provide the design guidelines meeting the allowable standards for stress limits and LBB acceptance criteria. The critical location having the highest stress point from piping analysis is determined and compared to the BAC. The maximum stress location must be on or below the BAC to satisfy the LBB criteria.

The bounding analysis methods are described in Appendix 3B. Preparation of BAC provides an evaluation method meeting the requirements and guidelines of the NRC documents.

Piping analysis boundary is from one terminal end or anchor to the other terminal end or anchor. Connection to a larger pipe or a component of larger diameter is generally considered a terminal end. LBB evaluation is based on the fracture mechanics of cracks and analysis of break mechanism which compares the selected leakage cracks with critical crack sizes. This analysis method is outlined below.

Crack stability is demonstrated by leak detection analysis on the assumption that postulated circumferential cracks are limited if the stresses are on or below the "LBB BAC."

3.6.3.4.1 Leak Detection Capability

Leakage flaws are postulated for piping identified in Subsection 3.6.3.1 as following. Sizes of postulated flaws are sufficiently large so that leaks can be detected by a sufficient margin. Leak rate of 10 times the capability of the leak detector is postulated for normal operating load combinations.

Rated detection capability of the leak detector for reactor coolant in the containment is 1.0 gpm within one hour. The methods used for the reactor coolant are the containment sump water levels, inventory balance, and the radiation in the environment of containment. The method to detect leaks from the main steam pipe in containment is the containment sump water level. Leaks can also be detected by the~~The~~ condensate water flow rate of containment air cooler~~,~~. The containment environmental pressures~~,~~ and temperatures also suggest the possibility of leakage.

3.6.3.4.2 Stability and Critical Crack Sizes

The local and global break mechanisms are evaluated, as required, to provide a margin to the break size and load. Local mode of breaks deals with the behaviors of crack tips: slowdown, start, development, and instability. Mechanisms of local breaks are evaluated by using J integration method for ferritic steel pipes. Global break mode deals with the behaviors of all cross sections: initial yield, strain hardening, and plastic hinge formation. Global break mechanisms (critical loading method) are evaluated for the stainless steel pipes not containing the casting materials and shielded metal arc weld. From these

Additionally, humidity, temperature, and pressure monitoring of the containment atmosphere are used for alarms and indirect indication of leakage to the containment. They do not quantify the reactor coolant leakage.

5.2.5.4.1 System Description of Unidentified Leakage detection

5.2.5.4.1.1 Containment Sump Level and Flow Monitoring System

Any leakage inside the containment from the RCPB and other components, not otherwise identified, condenses and flows by gravity through the floor drains and other drains to the containment sump, where the sump level meter measures the increase in the sump level indicating the leak rates. Indication of increasing sump level is transmitted from the sump to the MCR by means of a sump level transmitter and recorded.

A leak rate greater than or equal to 1 gpm is detectable within one hour, with an alarm actuating in the MCR to alert the operators as stated in positions 5 and 7 of regulatory guide 1.45.

The sump level monitoring system is qualified for a safety shutdown earthquake ~~seismic events not requiring a plant shutdown~~.

5.2.5.4.1.2 Containment Airborne Particulate Radioactivity Monitor

In US-APWR, this monitor corresponds to the containment radiation monitor (RMS-RE-40). Refer to Chapter 11, Subsection 11.5.2. The containment airborne particulate radioactivity monitor performs continuous sampling of the containment air and measures the radiation level in the particulate. This monitor is qualified for a safe-shutdown earthquake (SSE). An air sample is drawn outside the containment and passed through a gamma monitor that monitors its gamma rays in radioactive particulate. After passing through the monitor, the sample is returned via the closed system to the containment atmosphere. The measuring range for the monitor is from 1×10^{-10} μ Ci /cm^3. An indication of the monitor counting rate is provided to the MCR and electronically recorded.

The detection sensitivity of the airborne particulate radioactivity monitor for reactor coolant leak rate depends on conditions, such as radioactive concentration in the reactor coolant and a distribution coefficient of radioactive particles to the containment atmosphere.

In addition, provided that a radioactive concentration of airborne particulate in the containment is within the measuring range of the airborne particulate radioactivity monitor, an alarm is adjustable to actuate upon detection of a severalfold increase.

Assuming that corrosion and activation product concentration in the reactor coolant is 2×10^{-1} μ Ci /g (Na-24,Cr-51,Z~~r~~n-65,Mn-54,56, Co-58,60, Fe-55,59) and the distribution coefficient is 0.3, after leak occurrence, a leak rate of ~~1~~0.5 gpm can be detected within one hour.

ATTACHMENT 3
to RAI 217-2025

3.7 PLANT SYSTEMS

3.7.15 Main Steam Line Leakage

LCO 3.7.15 Main steam line leakage through the pipe walls inside containment shall be limited to 0.5gpm.

APPLICABILITY: MODES 1, 2, 3and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Main steam line leakage exceeds Operational limit.	A.1 Be in MODE 3. AND A.2 Be in MODE 5.	6 hours 36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.7.15.1 Verify main steam line leakage into the containment Sump ≤ 0.5 gpm	[72 hours OR In accordance with the Surveillance Frequency Control Program]

ATTACHMENT 4
to RAI 217-2025

B 3.7 PLANT SYSTEMS

B 3.7.15 Main Steam Line Leakage

BASES

BACKGROUND

The purpose of the Main Steam Line Leakage LCO is to limit system operation in the presence of leakage from the main steam line inside containment to amounts that do not compromise safety consistent with the Leak-Before-Break (LBB) analysis discussed in Chapter 3, Section 3.6 (Ref. 1). This LCO specifies the amounts of leakage from the main steam line inside containment.

LBB methodology allows elimination of postulated pipe breaks in certain piping systems based on the system characteristics and failure mechanics-based crack growth in conjunction with leak detection capability. As described in Section 3.6 (Ref. 1), the LBB concept is applied to the main steam piping inside containment.

This LCO deals with protection of the main steam line inside containment from degradation and helps assure that serious leaks will not develop. The consequences of violating this LCO include the possibility of further degradation of the main steam lines, which may lead to pipe break.

APPLICABLE SAFETY ANALYSES

The safety analyses do not address the main steam line leakage. The safety significance of leakage inside containment varies widely depending on its source, rate, and duration. Therefore, detecting and monitoring leakage into the containment area is necessary. The leakage detection instrumentations required by LCO 3.4.15 perform this function. Quickly separating the identified LEAKAGE from the unidentified LEAKAGE provides quantitative information to the operators, allowing them to take corrective action should a leakage occur detrimental to the safety of the unit and the public. Although the main steam line leakage limit is not required by the 10 CFR 50.36(c)(2)(ii) criteria, this specification has been included in Technical Specifications because the LBB concept is applied to the main steam piping as well as RCL piping.

LCO

Main steam line leakage shall be limited to: 0.5 gallon per minute (gpm) including leakage from the main steam line inside containment is since it is below the leakage rate for LBB analyzed cases of a main steam line crack twice as long as a crack leaking at ten (10) times the detectable leak rate under normal operating load conditions. Violation of this LCO could result in continued degradation of the main steam line.

APPLICABILITY

In MODES 1, 2, 3, and 4, the potential for main steam line leakage is greatest when the main steam line is pressurized.

In MODES 5 and 6, main steam line leakage limits are not required because the main steam line pressure is far lower, resulting in lower stresses and reduced potentials for main steam line leakage.

ACTIONS

A.1 and A.2

If main steam line leakage is not within limit, the unit must be brought to lower pressure conditions to reduce the severity of the LEAKAGE and its potential consequences.

The reactor must be brought to MODE 3 within 6 hours and MODE 5 within 36 hours. This action reduces the main steam line leakage and also reduces the factors that tend to degrade the main steam line. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems. In MODE 5, the pressure stresses acting on the main steam line are much lower, and further deterioration is much less likely.

SURVEILLANCE REQUIREMENTS

SR 3.7.15.1

Verifying main steam line leakage to be within the LCO limits ensures the integrity of the main steam line inside containment is maintained. Main steam line leakage would at first appear as unidentified LEAKAGE and can only be positively identified by inspection.

An early warning of main steam line leakage or unidentified LEAKAGE is provided by the automatic systems that monitor the level of containment sump used to collect unidentified LEAKAGE and air cooler condensate flow rate. These leakage detection systems are specified in LCO 3.4.15, "RCS Leakage Detection Instrumentation."
Also, by performance of an RCS water inventory balance, indication of containment environmental pressures, temperatures and radiation allow the determination of whether the main steam line is a potential source of unidentified LEAKAGE inside containment.

REFERENCES

1. Chapter 3, Section 3.6 “Protection Against Dynamic Effects Associated with Postulated Rupture of Piping.”