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

January 28, 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-09023

Subject: MHI's Response to US-APWR DCD RAI No. 127-1641

References: 1) "Request for Additional Information No. 127-1641 Revision 0, SRP Section: 03.05.01.01, Application Section: 3.5.1.1 – Internally Generated Missiles (Outside Containment)," dated (12/16/2008).

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. 127-1641 Revision 0."

Enclosed is the response to 5 RAIs 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 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. 127-1641, Revision 0

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

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

D081
NRO

Enclosure 1

UAP-HF-09023
Docket No. 52-021

Response to Request for Additional Information No. 127-1641,
Revision 0

January, 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/28/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 127-1641 REVISION 0**

SRP SECTION: **03.05.01.01 – Internally Generated Missiles (Outside Containment)**

APPLICATION SECTION: **03.05.01.01**

DATE OF RAI ISSUE: **12/16/08**

QUESTION NO. : RAI 3.5.1.1-01

Section 3.5.1.1.2.1 of the US-APWR DCD Tier 2, Revision 1, provides the rationale to exclude certain types of equipment from consideration as credible missile sources outside the containment. For example, missiles originating from valves, threaded connections and piping in high energy systems would not be credible due to ASME code criteria that control quality from production through operation, material characteristics, and in-service inspections. Qualitative discussions are also used to exclude other types of equipment (e.g. piping and valves of non-high energy fluid systems, gas explosions, gravitation missiles such as crane drops and falling objects resulting from non-seismic SSCs during a seismic event, secondary missiles, and unsecured maintenance equipment) from consideration as credible missile sources. However, the DCD does not provide the analysis to demonstrate that these missiles are of insufficient energy to cause unacceptable impact or to cause unacceptable damage. Also, it is not clear to the staff whether the applicant has followed the guidance described in SRP 3.5.1.1 for probabilistic analyses to determine which missiles may be non-credible by demonstrating that the event is not statistically significant if the product of the probability of missile occurrence, probability of impact on a significant target, and probability of significant damage is less than 1 x 10-7 per year.

Where the Tier 2 DCD has excluded equipment items from consideration as credible missile sources based on design features and other qualitative considerations, demonstrate how these design features and qualitative considerations would ensure a level of protection from missiles that is equivalent to the probability criteria described in SRP 3.5.1.1, Section II, "SRP Acceptance Criteria," Item 1. Include this information in the DCD and provide a markup in your response.

ANSWER:

DCD Tier 2, Subsection 3.5.1.1 is to be re-formatted in Revision 2 to reflect that for certain SSCs postulated as capable of generating missiles, the probability of missile occurrence (P_1), the product of the probability of missile occurrence and probability of missile impact (P_1 x P_2), or the combined product of the probability of missile occurrence, probability of missile impact, and probability of significant damage (P_1 x P_2 x P_3) demonstrate through probabilistic analyses that the events are not statistically significant.

The description of RAI 152-1642, Question 3.5.1.2-01 notes DCD Tier 2, Subsection 3.4.1.2 contains references to Subsection 3.5.1.1 that exclude certain types of equipment from consideration as credible missile sources inside the containment. To maintain consistency, changes to Section 3.5.1.2 that responds to RAI 152-1642, Question 3.5.1.2-01, are also included at this time.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Section 3.5, Revision 2, changes to be incorporated:

- **Replace the last 4 paragraphs (3rd through 6th paragraph) of Tier 2, Section 3.5 with the following:**

The SSCs to be protected from postulated missiles are identified in the Appendix of RG 1.117, Tornado Design Classification (Reference 3.5-18), and summarized by the following:

1. The RCPB.

2. Those portions of the MSS and main feedwater system up to and including the outermost isolation valves.

3. The reactor core and individual fuel assemblies at all times, including during refueling.

4. Systems or portions of systems that are required for (1) attaining safe shutdown; (2) RHR; (3) cooling the SFP; (4) mitigating the consequences of a tornado-caused steam line break; (5) primary makeup water system; and (6) supporting the above systems, such as essential service water, UHS, air supply, EFW, and safety-related ventilation systems.

5. The SFP, to the extent necessary to preclude significant loss of watertight integrity of the storage pit, and to prevent missiles from contacting fuel within the pit.

6. The reactivity control systems, e.g., control rod drives and boron system.

7. The MCR, including all equipment needed to maintain the MCR within safe habitability limits for personnel and safe environmental limits for tornado-protected equipment.

8. Those portions of the gaseous waste management system whose failure due to tornado effects could result in potential offsite exposures greater than the 25% of the guideline exposures of 10 CFR 100 using appropriately conservative analytical methods and assumptions.

9. Systems or portions of systems that are required for monitoring, actuating, and operating tornado protected portions of systems listed in items 4, 6, 7, and 13.

10. All electric and mechanical devices and circuitry between the process sensors and the input terminals of the actuator systems involved in generating signals that initiate protective actions by tornado protected portions of systems listed in items 4, 6, 7, and 13.

11. Those portions of the long-term ECCS that would be required to maintain the plant in a safe condition for an extended time after a LOCA.

12. PCCV and other safety related structures, such as the R/B and PS/B, to the extent that they not collapse, allow perforation by missiles, or generation of secondary missiles, any of which could cause unacceptable damage to tornado-protected items. However, the primary containment need not necessarily maintain its leaktight integrity.

13. The Class 1E electric systems, including the auxiliary systems for the onsite electric power supplies, that provide the emergency electric power needed for the functioning of plant features included in items 1 through 11 above.

14. Those portions of SSCs whose continued function is not required but whose failure could reduce to an unacceptable safety level the functional capability of any plant features included in items 1 through 13 above or could result in incapacitating injury to occupants of the MCR.

Missiles are postulated to be associated with failures of pressurized high-energy fluid system components, over-speed failures of rotating machinery (e.g., motor-driven pumps and fans), explosions within and outside the plant, falling objects, including falling objects resulting from a non-seismically designed SSC during a seismic event, and by tornados or transportation accidents external to the plant. This section discusses missile protection for the following sources:

- Internally generated missiles (Outside PCCV)
- Internally generated missiles (Inside PCCV)
- Turbine missiles
- Missiles generated by tornadoes and extreme winds
- Site proximity missiles (Except aircraft)
- Aircraft hazards

Missiles that could prevent SSCs from performing their intended safety functions are considered statistically significant. Potential missile sources are identified and statistically evaluated in subsequent subsections using the following methodology:

1. When a potential missile source is identified, the statistical significance of missile generation is evaluated by a probability analysis. The probability of occurrence (P_1) of generating a missile by any source is not statistically significant if it is less than 10^{-7} per year.

2. When the probability of occurrence, P_1, is greater than 10^{-7} per year for any potential missile source, the probability of impact (P_2) on a significant target is also determined. When considering both the probability of missile occurrence and the probability of missile impact, the missile is not statistically significant if the product of P_1 and P_2 is less than 10^{-7} per year. If the product of P_1 and P_2 is greater than 10^{-7} per year, the probability of significant damage (P_3) is determined.

3. For those cases where the product of P_1 and P_2 is greater than 10^{-7} per year, the missiles are evaluated for the probability of significant damage (P_3) based on the size, energy, and trajectory of the postulated missile, and the proximity to any potentially impacted SSCs. Alternately, an evaluation is performed to determine if sufficient redundancy remains to achieve and maintain a safe shutdown condition. No additional missile protection is required if the evaluations determine that the ability to achieve and maintain safe shutdown is maintained. If the combined probability ($P_1 \times P_2 \times P_3$) is less than 10^{-7} per year, the potential missile is not considered statistically significant.

Therefore, factors contributing to missile protection of potentially targeted SSCs is provided by one or more of the following methods:

- Locating the system or component in a missile-proof structure
- Separating redundant systems or components for the missile path or range
- Providing local shields and barriers for systems and components
- Designing the equipment to withstand the impact of the most damaging missile
- Providing design features to prevent the generation of missiles
- Orienting missile sources to prevent missiles from striking safety-related equipment
- When necessary, missile barriers are designed in accordance with Subsection 3.5.3.

- **Replace Subsection 3.5.1.1, including associated subsections, with the following:**

3.5.1.1 Internally Generated Missiles (Outside Containment)

Section 3.2 and Section 3.11 list applicable SSCs, their location, seismic category, and quality group/equipment classifications. General arrangement drawings showing locations of the SSCs are given in Section 1.2. The following component types have the potential to produce internally-generated missiles outside the PCCV.

3.5.1.1.1 Items Containing Pressurized High-energy Fluids or Steam

Items forming a pressurized boundary of high-energy fluid or steam may be postulated to have been damaged, broken pieces could become missiles when propelled by internal pressure or jet forces.

3.5.1.1.1.1 Piping

For potential missiles originating from piping under high pressure, the probability of occurrence, P_1, is maintained less than 10^{-7} by virtue of the design in accordance with ASME Code, Section III (Reference 3.5-3), and inspection program in compliance with ASME Code, Section XI (Reference 3.5-4). If piping as evaluated in Section 3.6 were to rupture, the pipe is held in place by its supports. However, the probability of occurrence, P_1, remains less than 10^{-7} since the section remains attached to the remainder of the piping system.

Pressurized high-energy piping systems and components, if not constructed to ASME Code, Section III criteria (Reference 3.5-3), can be a significant source of missiles (that is, $P_1 > 10^{-7}$). The probability of impact, P_2, is therefore also considered. The probability of impact, P_2, is minimized by locating a potential missile source or potential target outside the zone of postulated missile strike, by the robust building walls and slabs that are designed for applicable missile strikes, or the separation of piping systems and components that are missile sources from potentially impacted SSCs. When evaluating the credibility of missile impact, the product of P_1 x P_2 is less than 10^{-7} and therefore non-ASME Code piping systems and components are not credible missile sources.

For non-high energy fluid systems, the systems have insufficient stored energy to generate a missile. The probability of missile occurrence, P_1, from non-high energy fluid systems is therefore less than 10^{-7}.

3.5.1.1.1.2 Valves

In the case of postulated damage to threads, the stem (valve stem) will not eject because the backseat or valve body is larger in diameter than the stem. Therefore, the probability of missile occurrence, P_1, originating from an ejected valve stem is less than 10^{-7}.

In valves with bolted bonnets (covers), bonnets can not be perforated because the remaining bolts withstand the internal pressure even when one bolt is assumed to have been damaged. In valves of ANSI 900 Pressure Class and above, valves using bonnet types with a pressure seal will not perforate because they are pressed by a yoke or retainer ring (cover retaining ring). The valve design is in accordance with ASME Code, Section III (Reference 3.5-3), and inspected in accordance with ASME Code, Section XI (Reference 3.5-4). Therefore, the probability of missile occurrence, P_1, originating from a pressure seal-style valve bonnet is less than 10^{-7}.

In valves of threaded bonnets having canopy seals commonly used for ANSI 600 Pressure Class and below, the bonnets will not perforate due to loose threading, and have a historically low occurrence of total separation of the bonnet from the valve. Therefore, the probability of missile occurrence, P_1, originating from a threaded valve bonnet is less than 10^{-7}.

3.5.1.1.1.3 Pipe Fittings and Appurtenances

For potential missiles originating from pipe fittings and appurtenances under high pressure, the probability of occurrence, P_1, is maintained less than 10^{-7} for those components whose design is in accordance with ASME Code, Section III (Reference 3.5-3), and inspection program is in compliance with ASME Code, Section XI (Reference 3.5-4). Pipe fittings and appurtenances that may be a high probability of occurrence (that is, $P_1 > 10^{-7}$) are further qualified as statistically insignificant when the probability of missile impact on a critical component, P_2, is such that the product of $P_1 \times P_2$ is less than 10^{-7}. In addition, any postulated missile involving a pipe fitting or appurtenance is a small mass with a very small probability of significant damage (P_3). Therefore, a combined probability ($P_1 \times P_2 \times P_3$) of any postulated missile generated by a pipe fitting or appurtenance is less than 10^{-7} per year, and the potential missile is not considered statistically significant.

3.5.1.1.2 High-Speed Rotating Equipment

In general, the probability of occurrence, P_1, of rotating equipment is maintained less than 10^{-7} by virtue of the equipment design and manufacturing criteria. Justification for a low probability of occurrence, P_1, includes the fact that rotating equipment energized by alternating current power are governed by the frequency of the power supply. The narrow range of frequency variation for the alternating current power supply makes it highly unlikely that an overspeed condition of rotating equipment can occur. While it is postulated that missiles such as a fan blade may occur at rated speeds, the design of the casing prevents missile penetration. However, in the unlikely case of a high-speed rotating component penetrating the casing and P_1 is greater than 10^{-7}, the probability of impact, P_2, is also considered. P_2 is minimized by locating a potential missile source or potential target outside the zone of postulated missile strike, by the robust building walls and slabs that are designed for applicable missile strikes, or the separation of missile sources from potentially impacted SSCs. When considering both probability of occurrence and probability of impact, the product of $P_1 \times P_2$ is less than 10^{-7} and therefore high-speed rotating equipment are not credible missile sources.

Missiles are similarly not postulated from turbine-driven pumps because of the over-speed prevention system and deliberate quality assurance consideration for the inspection of materials, design, production, installation, and operation. The probability of occurrence, P_1, for turbine-driven pumps is therefore maintained less than 10^{-7}.

Missiles are also not postulated from the GTG because of the over-speed prevention system, deliberate quality assurance considerations in the inspection of materials, design, production, installation, and operation, and the casing material that prevents penetration. The probability of occurrence, P_1, for the GTG is therefore maintained less than 10^{-7}.

In the case of non safety-related high-speed rotating pumps, motors with thick casings are procured to prevent the probability of missile occurrence. Therefore, the probability of missile occurrence, P_1, originating from a non safety-related high-speed rotating pump is less than 10^{-7}.

In the case of non safety-related high-speed rotating fans, the probability of missile occurrence may be statistically significant ($P_1 > 10^{-7}$). When investigating these components, the probability of impact, P_2, is also evaluated to confirm that the product of $P_1 \times P_2$ is less than 10^{-7}. The probability of impact, P_2, is minimized by locating a potential missile source or potential target outside the zone of postulated missile strike, by the robust building walls and slabs that are designed for applicable missile strikes, and/or the separation of the rotating equipment that is a missile source from potentially impacted SSCs. Therefore, high-speed rotating fans are not a credible missile source since the product of $P_1 \times P_2$ is less than 10^{-7}.

Refer to Subsection 3.5.1.3 for discussion of turbine and turbine rotor missiles.

3.5.1.1.3 Gas or Pressurized Cylinder Explosion

Protective measures are taken as recommended by NUREG/CR-3551 (Reference 3.5-19), including procedures, analysis, and design details, to mitigate pressurized gas cylinders/bottles from generating or becoming a missile. Design features which resist the formation of missiles from a pressurized gas cylinder/bottle include the fabrication from rolled thick-wall steel material, and a steel collar at the neck of the bottle to protect the sensitive valve and other critical parts. In addition, the pressurized cylinders are oriented vertically with the bottle pointed towards the concrete slab roof in storage racks restrained in accordance with seismic Category II requirements. Therefore, the product of the probability of occurrence, P_1, and the probability of impacting a significant target, P_2, is less than 10^{-7}.

Battery compartments are ventilated to prevent the concentration of hydrogen. The hydrogen supply system and gas bottles are installed in a compartment independent of safety-related structures, and ventilation is provided to prevent the concentration of hydrogen. The probability of occurrence, P_1, for a gas explosion in battery compartments is therefore maintained less than 10^{-7}.

3.5.1.1.4 Gravitational Missiles

3.5.1.1.4.1 Crane Drop of Heavy Loads

As defined in ASME NOG-1 (Reference 3.5-5), a critical load is any lifted load whose uncontrolled movement or release could adversely affect any safety-related SSC when such a SSC is required for plant safety or could result in potential offsite exposure in excess of 10 CFR 100 limits.

Type I cranes are defined by ASME NOG-1 (Reference 3.5-5) as those used to handle critical loads. In accordance with ASME NOG-1, Type I cranes are designed to remain in place and are equipped with single failure-proof features to prevent load drops.

Refer to Subsection 9.1.5.1 for further discussion on the design bases for a postulated load drop by the overhead heavy load handling system of the US-APWR.

Additionally, cranes are designed to prevent diversion and derailment. Drop prevention design is also employed based on earthquake design criteria. Therefore, load drops and derailment of cranes do not represent credible sources of missiles that would jeopardize safety-related SSCs. Therefore, the probability of occurrence, P_1, of missiles generated by a gravity load crane drop is less than 10^{-7}.

3.5.1.1.4.2 Falling Objects Resulting from Non-Seismic SSCs During Seismic Event

Seismic Category II SSCs are defined as not essential for the safe shutdown of the plant, and need not remain functional during and after a SSE. However, such structures and subsystems must not fall or displace excessively where it could damage any seismic Category I SSCs. Therefore, any SSCs with the potential to cause damage to safety-related SSCs are analyzed and designed using the same methods and stress limits specified for seismic Category I SSCs. No non-seismic SSCs are permitted that could possibly affect the ability of the plant to achieve and maintain safe shutdown, and to maintain offsite radiological dose/concentration levels within defined limits. In addition, seismic Category I SSCs are not permitted in non-seismic areas and are therefore not impacted by falling objects during a seismic event. Therefore, the product of the probability of occurrence, P_1, and the probability of significant impact, P_2, of non-seismic SSCs missiles striking seismic Category I SSCs is maintained as less than 10^{-7}.

3.5.1.1.4.3 Secondary Missiles Caused by a Falling Object Striking a High-Energy System

Falling objects impacting a high-energy system or other surfaces may have the ability to generate secondary missiles. Falling objects are postulated to occur by either a crane drop of heavy load, or resulting from a non-seismic SSC during a seismic event. As described in the preceding paragraphs, these missiles sources are not credible, and no secondary missiles from these sources are capable of occurring. The probability of occurrence, P_1, is therefore inherently less than 10^{-7}.

- **Replace Subsection 3.5.1.2, including associated subsections, with the following:**

3.5.1.2 Internally Generated Missiles (Inside Containment)

Section 3.2 and Section 3.11 list applicable SSCs, their location, seismic category, and quality group/equipment classifications. General arrangement drawings showing locations of the SSCs are given in Section 1.2. The following component types have the potential to produce internally-generated missiles inside the PCCV.

3.5.1.2.1 Items Containing Pressurized High-energy Fluids or Steam

Subsection 3.5.1.1.1 discusses items containing pressurized high-energy fluids or steam outside containment. Conclusions relating to statistical significance of postulated missiles also apply to similar items containing pressurized high-energy fluids or steam inside containment. Pressurized items unique to inside containment are discussed as follows.

Inside the PCCV, postulated missiles originating from unique pressurized high-energy items such as the RV and associated fittings, SG, reactor coolant pump (RCP), pressurizer, and RCPB piping during normal operation are not considered credible due to ASME Code Section III (Reference 3.5-3) and Section XI (Reference 3.5-4) criteria controlling quality from production through operation, material characteristics, design strengths, and the preservice and inservice inspections. Additional assurances to prevent generation of missiles are provided by prudent operation of the system. The probability of missile occurrence from pressurized high energy items inside containment, P_1, is therefore less than 10^{-7}.

Additionally, postulated missiles in the form of a piece of the CRDM housing or a control rod ejected rapidly from the core is not considered credible. In addition to a low probability of occurrence similar to the RV, the following assurances specific to the CRDMs maintain a low probability of occurrence, P_1, and low probability of impact, P_2, provided by:

- Shop hydro-testing in excess of 125% of system design pressure.
- Hydro-testing of housings to 125% of system design pressure after they are installed on the RV to the head adapters. Housings are also tested during hydro-testing of the completed RCS.
- Housings are made of materials with excellent notch toughness.
- Stress levels in the mechanism are not affected by system thermal transients at power or by thermal movement of the reactor coolant loops.
- The welds in the pressure boundary of the CRDM satisfy ASME Code, Section III (Reference 3.5-3) requirements for design, procedure, examination, and inspection.
- A control rod ejection is considered in the safety analyses in Chapter 15, and the design transients in Subsection 3.9.1.1.

Therefore, the product of probability of missile occurrence, P_1, and probability of impact, P_2, is less than 10^{-7} for pressurized high energy items inside containment.

3.5.1.2.2 High-Speed Rotating Equipment

Subsection 3.5.1.1.2 discusses high-speed rotating equipment. Conclusions relating to statistical significance of postulated missiles also apply to similar high-speed rotating equipment inside containment. In addition, the RCP is an item unique to inside containment. The RCP and associated flywheel is designed to prevent the probability of missile occurrence by quality control, inservice inspection, and continuous monitoring for shaft vibration. The maximum allowable rotating speed in terms of the strength of the flywheel is sufficiently higher than the maximum rotating speed of the motor postulated at the plant, and the soundness of the flywheel is maintained. Therefore, the probability of missile occurrence from high-speed rotating equipment inside containment, P_1, is less than 10^{-7}.

3.5.1.2.3 Gas or Pressurized Cylinder Explosion

Conclusions relating to statistical significance of postulated missiles due to gas or pressurized cylinder explosion also apply inside containment. By an analysis similar to that in Subsection 3.5.1.1.3, it is concluded that no items have the capability of generating potential missiles related to a gas or pressurized cylinder explosion inside the containment. Therefore, the product of the probability of occurrence, P_1, and the probability of impacting a significant target, P_2, is less than 10^{-7}.

3.5.1.2.4 Gravitational Missiles

Subsection 3.5.1.1.4 discusses gravitational missiles, including crane drop of heavy loads, falling objects resulting from non-seismic SSCs during seismic event, and secondary missiles caused by a falling object striking a high-energy system. Conclusions relating to statistical significance of these postulated missiles also apply to similar potential gravitational missiles inside containment. Therefore, the probability of missile occurrence, P_1, or the product of P_1 and the probability of impacting a significant target, P_2, is less than 10^{-7}.

In addition, the COL Applicant is to prepare plant procedures that specify equipment required for maintenance or undergoing maintenance is to be removed from containment prior to operation, moved to a location where it is not a potential hazard to SSCs important to safety, or seismically restrained to prevent it from becoming a missile.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/28/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 127-1641 REVISION 0**

SRP SECTION: **03.05.01.01 – Internally Generated Missiles (Outside Containment)**

APPLICATION SECTION: **03.05.01.01**

DATE OF RAI ISSUE: **12/16/08**

QUESTION NO. : RAI 3.5.1.1-02

10 CFR 52.47(b) (1) requires that a DC application contain, "The proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the (Atomic Energy) Act, and the Commission's rules and regulations."

US-APWR DCD Tier 2, Revision 1, Section 3.5.1.1, describes the approach to identify potential missiles, determine the potential credible and not credible missiles, and provide measures for SSCs requiring protection against the effects of missiles outside containment. However, DCD Tier 1 Chapter 2.0, "Design Descriptions and ITAAC," does not contain an ITAAC to verify that SSCs outside containment are designed and constructed in accordance with the requirements as described in DCD Tier 2 Section 3.5.1.1 to prevent or mitigate the effects of internally generated missiles outside containment.

Provide an ITAAC that requires COL applicant to perform a walk-down of the SSCs to ensure that SSCs described in the above cited section are protected from internally generated missiles (outside containment) in accordance with the requirements as described in DCD Tier 2 Section 3.5.1.1. Also, the DCD needs to identify which of the SSCs are outside and which of the SSCs are inside the containment. Include this information in the DCD and provide a markup in your response.

ANSWER:

DCD Tier 1, Subsection 2.2.2 discusses protection against hazards. DCD Tier 1, Subsection 2.2.2.5 will be added in DCD Revision 2 to discuss protection of safety-related SSCs against credible missiles from internal sources inside and outside the containment. An ITAAC will also be provided in DCD Tier 1, Table 2.2-4, to verify that SSCs inside and outside the containment are protected from credible missiles.

As stated by Section 3.5 of DCD Tier 2, Revision 1, Section 3.2 and Section 3.11 list applicable SSCs, their location, seismic category, and quality group/equipment classifications. General arrangement drawings showing locations of the SSCs are given in Section 1.2. This information will be moved from Section 3.5 to Subsections 3.5.1.1 and 3.5.1.2 for applicability based on the location of the SSCs.

Impact on DCD

See Attachment 2 for a mark-up of DCD Tier 1, Section 2.2, Revision 2 changes to be incorporated:

- **Insert the following DCD Tier 1 Subsection 2.2.2.5 in it's entirety:**

2.2.2.5 Internally Generated Missiles (Inside and Outside Containment)

Factors contributing to missile protection of potentially targeted SSCs is provided by one or more of the following methods:

- Locating the system or component in a missile-proof structure
- Separating redundant systems or components for the missile path or range
- Providing local shields and barriers for systems and components
- Designing the equipment to withstand the impact of the most damaging missile
- Providing design features to prevent the generation of missiles
- Orienting missile sources to prevent missiles from striking safety-related equipment
- Missile barriers are designed if the ability to achieve and maintain safe shutdown is not determined.

Table 2.2-4 provide the ITAAC requirements and acceptance criteria for SSCs that require physical missile protection from any credible internal missiles inside and outside the containment.

- **Insert the following row at the end of Tier 1 Table 2.2-4 (Sheet 3 of 3):**

19. Safety-related SSCs are protected from any credible internal missile sources inside and outside the containment.	19. An inspection will be performed to verify as-built locations of safety-related SSCs are protected from potential impact by credible internal missiles.	19. Primary missile protection is provided by locating missile sources behind concrete walls and floors, and/or locating safety-related SSCs outside the zones of credible missile strikes.

- DCD Tier 2, Subsection 3.5.1.1 is to be re-formatted during DCD Revision 2 as part of the response to RAI 127-1641, Question 3.5.1.1-01. As part of the subsection re-formatting, information regarding identification of SSCs outside and inside containment will be moved from Section 3.5 to Subsections 3.5.1.1 and 3.5.1.2.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/28/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 127-1641 REVISION 0**

SRP SECTION: **03.05.01.01 – Internally Generated Missiles (Outside Containment)**

APPLICATION SECTION: **03.05.01.01**

DATE OF RAI ISSUE: **12/16/08**

QUESTION NO. : RAI 3.5.1.1-03

SRP 3.5.1.1, Section III, Items 4 and 5 require the applicant to address the procedures, analysis, and design to ensure that pressurized gas bottles will not become missiles capable of damaging SSCs important to safety to the extent that safety related functions are compromised. Portable compressed gas cylinders located/stored outside containment pose a significant missile hazard if not properly controlled. US-APWR DCD Tier 2, Revision 1, Section 3.5.1.1.2.1, describes the installation and storage of the hydrogen supply system and gas bottles to prevent the buildup of hydrogen concentrations to explosive levels, thereby preventing a gas explosion that could result in missile generation. However, the DCD does not provide any procedures, analysis or design details to ensure that pressurized gas cylinders will not become/generate missiles that may adversely impact safety-related SSCs during seismic events.

Revise DCD Tier 2, Section 3.5.1.1 to describe in detail any design features for missile protection from pressurized gas cylinders and revise Tier 2, Chapter 1, Table 1.8-2, "Compilation of All Combined License Applicant Items for Chapters 1-19," to include a COL information item which requires the COL applicant to establish/provide procedures to ensure that portable pressurized gas cylinders located/stored outside containment will not become/generate missiles that may adversely impact safety-related SSCs during seismic events. Include this information in the DCD and provide a markup in your response.

ANSWER:

DCD Tier 2, Subsection 3.5.1.1 is to be re-formatted in Subsection 3.5.1.1 during DCD Revision 2 as part of the response to RAI 127-1641, Question 3.5.1.1-01.

As part of the re-formatting, DCD Tier 2, Revision 2, Subsection 3.5.1.1.3 will add pressurized gas cylinders/bottles as potential sources of missiles. Protective measures are taken as recommended by NUREG/CR-3551 (Reference 3.5-19), including procedures, analysis, and design details, to mitigate pressurized gas cylinders/bottles from generating or becoming a missile. Design features to preclude the generation of a missile include the fabrication from rolled thick-wall steel material, a steel collar at the neck of the bottle to protect the sensitive valve and other critical parts. In addition, the pressurized cylinders will be oriented vertically with the neck of the bottle directed towards the concrete slab roof, and in storage racks restrained in accordance with seismic Category II requirements. As a result, the product of the probability of occurrence, P_1, and the probability of impacting a significant target, P_2, is less than 10^{-7}.

The features of a pressurized gas cylinder/bottle to mitigate the cylinder from becoming a missile are provided through standard plant criteria, thereby eliminating the necessity to specify on a site-specific basis. Therefore, it is not necessary for a COL information item to be added to require the COL Applicant to establish/provide procedures to ensure that portable pressurized gas cylinders located/stored outside containment will not become/generate missiles that may adversely impact safety-related SSCs during seismic events.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Section 3.5, Revision 2, changes to be incorporated:

- DCD Tier 2, Subsection 3.5.1.1 is to be re-formatted during DCD Revision 2 as part of the response to RAI 127-1641, Question 3.5.1.1-01. As part of the re-formatting, DCD Tier 2, Revision 2, Subsection 3.5.1.1.3 will add pressurized gas cylinders/bottles as potential sources of missiles.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/28/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 127-1641 REVISION 0**

SRP SECTION: **03.05.01.01 – Internally Generated Missiles (Outside Containment)**

APPLICATION SECTION: **03.05.01.01**

DATE OF RAI ISSUE: **12/16/08**

QUESTION NO. : RAI 3.5.1.1-04

With regard to unsecured maintenance equipment, DCD Tier 2, Revision 1, Section 3.5.1.1.2.1 specifies a COL action item that requires the applicant to address implementation of procedures to remove unsecured maintenance equipment from containment prior to operations, to a location where it is not potential hazard to SSCs important to safety or seismically restrained to prevent it from becoming a missile. This COL action item is also specified in Chapter 1, Table 1.8-2 of the Tier 2 DCD. However, there is not specified a COL action item to address implementation of procedures to remove unsecured maintenance equipment located/stored outside containment prior to operations.

Provide an assessment of potential gravitational missiles generated outside containment from unsecured maintenance equipment and discuss the measures provided to prevent the impact of a falling object on safety-related equipment necessary to achieve a safe shutdown. Also revise DCD Tier 2, Chapter 1, Table 1.8-2 to include a COL action item which requires the COL applicant to establish/provide procedures to ensure that unsecured maintenance equipment (outside containment) must be removed prior to operations to prevent those items from becoming missiles during seismic events. Include this information in the DCD and provide a markup in your response.

ANSWER:

DCD Tier 2, Subsection 3.5.1.1.2.1 is to be re-formatted in Subsection 3.5.1.1 during DCD Revision 2 as part of the response to RAI 127-1641, Question 3.5.1.1-01.

Due to the similarity of criteria for the selection and prevention of missiles, the subject of DCD Tier 2, Subsection 3.5.1.2, applicable to internally generated missiles inside containment, referred to Subsection 3.5.1.1, titled "Internally Generated Missiles (Outside Containment)." SRP 3.5.1.1 does not contain requirements for procedural controls of unsecured maintenance equipment outside of containment, and the discussion in Subsection 3.5.1.1.2.1 therefore intentionally limits the applicability of unsecured maintenance equipment to inside containment.

The requirement for procedural control was added as documented by Integrated Impact #535 to SRP 3.5.1.2, Revision 3 draft. The Integrated Impact specifies to remove unsecured maintenance equipment from containment prior to operations, to move to a location where it is not a potential hazard to SSCs important to safety, or to seismically restrain to prevent it from becoming a missile addresses the issues discussed in NRC Information Notice (IN) 80-21. In addition, the scope limitation of inside containment is consistent with staff guidance documented in Subsections 3.5.1.1 and 3.5.1.2 of the Advanced Boiling Water Reactor (ABWR) Final Safety Evaluation Report (FSER). Therefore, a COL action item is not applicable to require the COL applicant to establish/provide procedures to ensure that unsecured maintenance equipment (outside containment) must be removed prior to operations to prevent those items from becoming missiles during seismic events.

To clarify the scope of unsecured maintenance equipment is limited to inside containment, reference to those components which are not potential missiles outside containment will be moved from Subsection 3.5.1.1 to Subsection 3.5.1.2.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Section 3.5, Revision 2, changes to be incorporated:

- DCD Tier 2, Subsection 3.5.1.1.2.1 is to be re-formatted in Subsection 3.5.1.1 during DCD Revision 2 as part of the response to RAI 127-1641, Question 3.5.1.1-01. As part of the re-formatting, Item 4.d in Subsection 3.5.1.1.2.1 of DCD Revision 1, is deleted in its entirety.

- As part of the response to RAI 152-1642, Question 3.5.1.2-01 and as reflected in response to RAI 127-1641, DCD Tier 2, Subsection 3.5.1.2 is to be re-formatted during DCD Revision 2, which includes in Subsection 3.5.1.2.4 the scope of unsecured maintenance equipment inside containment.

Impact on COLA

- Change "**3.5.1.1.2.1 Missiles Not Considered Credible**" to "**3.5.1.2.4 Gravitational Missiles**".

- Change the first sentence in new Subsection 3.5.1.2.4: "Replace the last paragraph of DCD Subsection 3.5.1.1.2.1 with the following." to "Replace the last paragraph of DCD Subsection 3.5.1.2.4 with the following."

- Change the 2nd line in item 3.5(1) of Subsection 3.5.4 to the following: "*This COL item is addressed in Subsection 3.5.1.2.4.*"

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/28/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 127-1641 REVISION 0**

SRP SECTION: **03.05.01.01 – Internally Generated Missiles (Outside Containment)**

APPLICATION SECTION: **03.05.01.01**

DATE OF RAI ISSUE: **12/16/08**

QUESTION NO. : RAI 3.5.1.1-05

US-APWR DCD Tier 2, Revision 1, Section 3.5.1.1, "Internally Generated Missiles (Outside Containment)," stated that the following components also have the potential to produce missiles:

- Reactor vessel
- Control rod drive mechanism
- Fittings of reactor vessel

It is not clear to the staff how the above cited components located inside the containment would become potential sources of missiles outside the containment. Therefore, provide detailed discussion to demonstrate that the above cited components would become potential sources of missiles outside the containment. Include this information in the DCD and provide a markup in your response.

ANSWER:

Due to the similarity of criteria for the selection and prevention of missiles, discussion in DCD Tier 2, Revision 1, Subsection 3.5.1.2, relating to internally generated missiles inside containment, refers to Subsection 3.5.1.1.

The reactor vessel (RV), control rod drive mechanism (CRDM), and fittings of the RV are listed in Subsection 3.5.1.1 as examples of components containing high-energy fluids that have the potential to produce missiles. However, the identification as an example of potential missiles from components containing high-energy fluids is not intended to imply these therefore become missile sources endangering safety-related SSCs outside containment.

DCD Tier 2, Subsection 3.5.1.1 is to be re-formatted during DCD Revision 2 as part of the response to RAI 127-1641, Question 3.5.1.1-01. As part of the re-formatting, reference to items unique to inside containment and therefore are not potential missiles outside containment will be moved from Subsection 3.5.1.1 to Subsection 3.5.1.2.1.

Impact on DCD

See Attachment 1 for a mark-up of DCD Tier 2, Section 3.5, Revision 2, changes to be incorporated:

- DCD Tier 2, Subsection 3.5.1.1 is to be re-formatted during DCD Revision 2 as part of the response to RAI 127-1641, Question 3.5.1.1-01. As part of the re-formatting, reference to items unique to inside containment and therefore are not potential missiles outside containment will be moved from Subsection 3.5.1.1 to Subsection 3.5.1.2.1.
- To maintain consistency, changes to Section 3.5.1.2 that responds to RAI 152-1642, Question 3.5.1.2-01, are also included at this time. As part of the re-formatting, Subsection 3.5.1.2.1 refers to Subsection 3.5.1.1.1 for conclusions relating to similar items inside containment.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

This completes MHI's responses to the NRC's questions.

ATTACHMENT 1
to RAI 127-1641

3.5 Missile Protection

GDC 4 of Appendix A to 10 CFR 50 (Reference 3.5-1) requires safety-related SSCs to be protected from the effects of missiles. This includes all SSCs within containment and the containment itself. The containment is defined for the US-APWR as the PCCV. In addition, GDC 2 of Appendix A to 10 CFR 50 (Reference 3.5-1) also requires that safety-related SSCs be designed to withstand the effects of natural phenomena, which includes missiles potentially generated by tornadoes and hurricanes and similar extreme winds.

In accordance with GDC 2 and GDC 4 of 10 CFR 50, the safety-related areas of the US-APWR contain SSCs that provide the capability to safely shut down the reactor and maintain it in a safe-shutdown condition while also protecting the integrity of the RCPB and maintaining offsite radiological dose/concentration levels within the limits defined in 10 CFR 100 (Reference 3.5-2).

~~Missiles may be generated by pressurized components, rotating machinery, explosions within the plant, falling objects, and by tornados or transportation accidents external to the plant. This section discusses missile protection for the following sources:~~

- ~~Internally generated missiles (Outside PCCV)~~
- ~~Internally generated missiles (Inside PCCV)~~
- ~~Turbine missiles~~
- ~~Missiles generated by tornadoes and extreme winds~~
- ~~Site proximity missiles (Except aircraft)~~
- ~~Aircraft hazards~~

~~Missile protection is achieved through the following criteria:~~

- ~~Safety-related SSCs are protected from missiles to achieve and maintain safe shutdown of the plant, and prevent a significant release of radioactivity.~~
- ~~In addition to a postulated missile and any direct consequences of the missile, a single active component failure is considered in systems used to mitigate the consequences of the postulated missile impact and achieve a safe-shutdown condition. Only safety-related systems are assumed for safe shutdown coincident with a single active failure, although non safety-related systems are available to support safe shutdown if they are not affected by the missile.~~
- ~~Missiles are postulated to occur as a result of a single failure of a retention mechanism, unless the generation of missile is shown as not credible. Unrelated failure of two retention mechanisms is not postulated to generate simultaneous missiles.~~
- ~~A single active component failure need not be considered in the remaining train(s), or associated supporting trains, when the postulated missile is generated in one of two or more redundant trains of a dual-purpose safety-related fluid system designed to seismic category I standards and powered from either onsite or offsite sources.~~

ATTACHMENT 1
to RAI 127-1641

- A postulated missile from the RCS is mitigated to prevent loss of integrity of the primary containment, main steam, feedwater, or other loop of the RCS.
- A postulated missile from any system other than the RCS is mitigated to prevent loss of integrity of the containment or the RCPB.
- A postulated missile, except for tornado events, does not occur concurrent with other plant accidents or severe natural phenomena.
- In the event of a postulated missile that results in a trip of the turbine generator (T/G), offsite power is assumed to be unavailable.

The SSCs required to be protected from postulated missiles inside and outside containment are discussed in this section. For these systems, Section 3.2 and Section 3.11 list applicable SSCs, their location, seismic category, and quality group/equipment classifications. General arrangement drawings showing locations of the SSCs are given in Section 1.2.

Missile protection for SSCs important to safety is adequate if provided by one or more of the following methods:

- Locating the system or component in a missile-proof structure
- Separating redundant systems or components for the missile path or range
- Providing local shields and barriers for systems and components
- Designing the equipment to withstand the impact of the most damaging missile
- Providing design features to prevent the generation of missiles
- Orienting missile sources to prevent missiles from striking equipment important to safety

The SSCs to be protected from postulated missiles are identified in the Appendix of RG 1.117, Tornado Design Classification (Reference 3.5-18), and summarized by the following:

1. The RCPB.
2. Those portions of the MSS and MFWS up to and including the outermost isolation valves.
3. The reactor core and individual fuel assemblies at all times, including during refueling.
4. Systems or portions of systems that are required for (1) attaining safe shutdown; (2) RHR; (3) cooling the SFP; (4) mitigating the consequences of a tornado-caused steam line break; (5) primary makeup water system; and (6) supporting the above systems, such as essential service water, UHS, air supply, EFW, and safety-related ventilation systems.
5. The SFP, to the extent necessary to preclude significant loss of watertight integrity of the storage pit and to prevent missiles from contacting fuel within the pit.

6. The reactivity control systems, e.g., control rod drives and boron system.

7. The MCR, including all equipment needed to maintain the MCR within safe habitability limits for personnel and safe environmental limits for tornado-protected equipment.

8. Those portions of the gaseous waste management system whose failure due to tornado effects could result in potential offsite exposures greater than the 25% of the guideline exposures of 10 CFR 100 using appropriately conservative analytical methods and assumptions.

9. Systems or portions of systems that are required for monitoring, actuating, and operating tornado protected portions of systems listed in items 4, 6, 7, and 13.

10. All electric and mechanical devices and circuitry between the process sensors and the input terminals of the actuator systems involved in generating signals that initiate protective actions by tornado protected portions of systems listed in items 4, 6, 7, and 13.

11. Those portions of the long-term ECCS that would be required to maintain the plant in a safe condition for an extended time after a LOCA.

12. PCCV and other safety-related structures, such as the R/B and PS/B, to the extent that they not collapse, allow perforation by missiles, or generation of secondary missiles, any of which could cause unacceptable damage to tornado-protected items. However, the primary containment need not necessarily maintain its leaktight integrity.

13. The Class 1E electric systems, including the auxiliary systems for the onsite electric power supplies, that provide the emergency electric power needed for the functioning of plant features included in items 1 through 11 above.

14. Those portions of SSCs whose continued function is not required but whose failure could reduce to an unacceptable safety level the functional capability of any plant features included in items 1 through 13 above or could result in incapacitating injury to occupants of the MCR.

Missiles are postulated to be associated with failures of pressurized high-energy fluid system components, over-speed failures of rotating machinery (e.g., motor-driven pumps and fans), explosions within and outside the plant, falling objects, including falling objects resulting from a non-seismically designed SSC during a seismic event, and by tornados or transportation accidents external to the plant. This section discusses missile protection for the following sources:

- Internally generated missiles (Outside PCCV)
- Internally generated missiles (Inside PCCV)
- Turbine missiles
- Missiles generated by tornadoes and extreme winds
- Site proximity missiles (Except aircraft)

ATTACHMENT 1
to RAI 127-1641

- Aircraft hazards

Missiles that could prevent SSCs from performing their intended safety functions may be statistically significant. Potential missile sources are identified and statistically evaluated in subsequent subsections using the following methodology:

1. When a potential missile source is identified, the statistical significance of missile generation is evaluated by a probability analysis. The probability of occurrence (P_1) of generating a missile by any source is not statistically significant if it is less than 10^{-7} per year.

2. When the probability of occurrence, P_1, is greater than 10^{-7} per year for any potential missile source, the probability of impact (P_2) on a significant target is also determined. When considering both the probability of missile occurrence and the probability of missile impact, the missile is not statistically significant if the product of P_1 and P_2 is less than 10^{-7} per year. If the product of P_1 and P_2 is greater than 10^{-7} per year, the probability of significant damage (P_3) is determined.

3. For those cases where the product of P_1 and P_2 is greater than 10^{-7} per year, the missiles are evaluated for the probability of significant damage (P_3) based on the size, energy, and trajectory of the postulated missile, and the proximity to any potentially impacted SSCs. Alternately, an evaluation is performed to determine if sufficient redundancy remains to achieve and maintain a safe shutdown condition. No additional missile protection is required if the evaluations determine that the ability to achieve and maintain safe shutdown is maintained. If the combined probability ($P_1 \times P_2 \times P_3$) is less than 10^{-7} per year, the potential missile is not considered statistically significant.

Therefore, factors contributing to missile protection of potentially targeted SSCs is provided by one or more of the following methods:

- Locating the system or component in a missile-proof structure
- Separating redundant systems or components for the missile path or range
- Providing local shields and barriers for systems and components
- Designing the equipment to withstand the impact of the most damaging missile
- Providing design features to prevent the generation of missiles
- Orienting missile sources to prevent missiles from striking safety-related equipment
- When necessary, missile barriers are designed in accordance with Subsection 3.5.3.

3.5.1 Missile Selection and Description

3.5.1.1 Internally Generated Missiles (Outside Containment)

~~Missiles are postulated to be associated with failures of high-energy fluid system components, over-speed failures of rotating components (e.g., motor-driven pumps and fans), explosions within the plant, and gravitational missiles, including falling objects~~

ATTACHMENT 1
to RAI 127-1641

resulting from a non-seismically designed SSC during a seismic event. The design bases consider features for the continued safe operation or a shutdown during all operating conditions, operational transients, and postulated accident conditions.

The following components have the potential to produce missiles:

1. Items containing high-energy fluids

   If any item containing high-energy fluid is assumed to have been damaged, broken pieces could become missiles when propelled by internal pressure or jet forces. Potential sources of missiles include the following:

   - RV [synonymous with pressure vessel]
   - Pipes
   - Valves, including relief valves
   - CRDM
   - Fittings of RV or pipes (pressurizer heater or instrument well)

2. High-speed rotating equipment

   If any rotating components of high-speed rotating equipment are assumed to have been damaged, missiles are possibly produced when the rotating energy is converted into translational motion energy. Potential sources of missile generation include:

   - T/G (discussed in Subsection 3.5.1.3)
   - Turbine driven pump
   - Motor driven rotating equipment
   - Gas turbine generator (GTG)
   - Fans
   - Compressors

3. Gas Explosion

   If any gas explosion is assumed to have occurred due to a leak from a facility using, storing, or producing explosive gases, including hydrogen, missiles could be produced.

4. Gravitational Missiles

   Objects accelerated by gravitational forces create the potential for missile impacts from the following sources:

   - Crane drop of heavy loads
   - Falling objects resulting from non-seismic SSCs during seismic event
   - Secondary missiles caused by a falling object striking a high-energy system
   - Unsecured maintenance equipment

Missile hazards are minimized or eliminated through the proper selection of equipment, by the arrangement of structures and equipment outside the zone of influence of safety-related SSCs, or by the provision of missile barriers designed in accordance with Subsection 3.5.3. For those cases where elimination of missile hazard is impractical, credible missiles are evaluated based on the size, energy, and trajectory of the postulated missile, and the proximity to any potentially impacted SSCs. Alternately, an evaluation is performed to determine if sufficient redundancy remains to achieve and maintain a safe shutdown condition. No additional missile protection is required if the evaluations determine that the ability to achieve and maintain safe shutdown is maintained.

3.5.1.1.1 Missile Prevention

To prevent missiles from being generated, major equipment for the US-APWR is selected with the following considerations:

- Safety-related rotating equipment is designed such that there is insufficient energy to move the masses of their rotating parts through (perforate) the surrounding housings.
- Valves with only a threaded connection between the body and the bonnet are not used in high-energy systems. Selected valves utilize removable bonnets of the pressure-seal type, or have bolted bonnets in accordance with ASME Code, Section III (Reference 3.5-3).
- Valves located in high-energy systems utilize valve stems with at least two retention features. In addition to the stem threads, acceptable features include back seats on the stem or a power actuator, such as an air or motor operator.
- Threaded connections in high-energy systems are avoided. Welding is used for attaching appurtenances, such as drains, test connections, thermowells, and vents, to the piping or pressurized equipment. Weld connections are designed to have equal or greater design strength than the base metal.

3.5.1.1.2 Missile Selection

3.5.1.1.2.1 Missiles Not Considered Credible

The following potential missiles from internal sources outside the containment are discussed to clarify why they are not credible missile sources:

1. Items containing high-energy fluids

   a. Piping

   Missiles originating from piping under high pressure during normal operation are not considered credible due to ASME Code, Section III (Reference 3.5-3) and Section XI (Reference 3.5-4) criteria controlling quality from production through operation, material characteristics, design strengths and the preservice and inservice inspections. For non-high energy fluid systems, the systems have insufficient stored energy to generate a missile.

ATTACHMENT 1
to RAI 127-1641

b. Valves

In the pressurized portion of the valves in high-energy piping, missiles are not considered credible due to the ASME Code, Section III (Reference 3.5-3), and Section XI (Reference 3.5-4) criteria controlling quality from production through operation, design strengths, and the preservice and inservice inspections.

In any postulated damage of threads, the stem (valve stem) will not perforate due to the backseat or valve body being larger in diameter than the stem.

In valves with bolted bonnets (covers), bonnets will not perforate because the remaining bolts withstand the internal pressure even when one bolt is assumed to have been damaged. In valves with pressure seals, bonnets will not perforate because they are pressed by yoke or retainer ring (cover retaining ring). In valves of threaded bonnets having canopy seals, bonnets will not perforate due to loose thread.

2. High-speed rotating equipment

a. Rotating Equipment

The rotating element of motor-driven rotating equipment (pump, fan, etc.) is contained in the casing, and the induction motor is designed to withstand an over-speed. Missiles are therefore not postulated in motor driven rotating equipment.

Missiles are not postulated in turbine-driven pumps because of the over-speed prevention system, and deliberate considerations are made in the inspection of materials, design, production, installation, and operation.

Missiles are not postulated in the GTG because of the over-speed prevention system, deliberate considerations in the inspection of materials, design, production, installation, and operation, and casing material that prevents penetration.

b. T/G

Refer to Subsection 3.5.1.3 for discussion of turbine and turbine rotor missiles.

3. Gas Explosion

A hydrogen explosion is not deemed a credible source of missile generation because equipment containing hydrogen is designed to prevent hydrogen from leaking, or to prevent hydrogen from remaining inside by concentration monitoring and ventilation.

Battery compartments are ventilated to prevent the concentration of hydrogen. The hydrogen supply system and gas bottles are installed in a compartment independent of safety-related structures, and ventilation is provided to prevent the concentration of hydrogen.

4. Gravitational Missiles

a. Crane drop of heavy loads

As defined in ASME NOG-1 (Reference 3.5-5), a critical load is any lifted load whose uncontrolled movement or release could adversely affect any safety-related SSC when such a SSC is required for plant safety or could result in potential offsite exposure in excess of 10 CFR 100 limits.

Type I cranes are defined by ASME NOG-1 (Reference 3.5-5) as those used to handle critical loads. In accordance with ASME NOG-1, Type I cranes are designed to remain in place and are equipped with single failure-proof features to prevent load drops.

Refer to Subsection 9.1.5.1 for further discussion on the design bases for a postulated load drop by the overhead heavy load handling system of the US-APWR.

Additionally, cranes are designed to prevent diversion and derailment. Drop prevention design is also employed based on earthquake design criteria. Therefore, load drops and derailment of cranes do not represent credible sources of missiles that would jeopardize safety-related SSCs.

b. Falling objects resulting from non-seismic SSCs during seismic event

Seismic category II SSCs are defined as not essential for the safe shutdown of the plant, and need not remain functional during and after a safe-shutdown earthquake. However, such structures and subsystems must not fall or displace excessively where it could damage any seismic category I SSCs. Therefore, any SSCs with the potential to cause damage to safety-related SSCs are analyzed and designed using the same methods and stress limits specified for seismic category I SSCs. No non-seismic SSCs are permitted that could possibly affect the ability of the plant to achieve and maintain safe shutdown, and to maintain offsite radiological dose/concentration levels within defined limits. In addition, seismic category I SSCs are not permitted in non-seismic areas and are therefore not impacted by falling objects during a seismic event.

c. Secondary missiles caused by a falling object striking a high-energy system

Falling objects impacting a high-energy system or other surfaces may have the ability to generate secondary missiles. Falling objects are postulated to occur by either a crane drop of heavy load, or resulting from a non-seismic SSC during a seismic event. As described in the preceding paragraphs, these missiles sources are not credible, and therefore, no secondary missiles from these sources are capable of occurring.

d. Unsecured maintenance equipment

The COL Applicant is to prepare plant procedures that specify equipment required for maintenance or undergoing maintenance is to be removed from containment prior to operation, moved to a location where it is not a potential hazard to SSCs important to safety, or seismically restrained to prevent it from becoming a missile.

3.5.1.1.2.2 Missiles Considered Credible

Based on justification of non-credible missiles discussed in Subsection 3.5.1.1, non safety-related rotating equipment and non-ASME Code high-energy systems are the only missiles that may require further protection of safety-related SSCs.

3.5.1.1.2.3 Credible Sources of Internally Generated Missiles (Outside Containment)

The following credible sources of internally generated missiles outside the containment are discussed below:

1. Items containing high-energy fluids

   High-energy piping systems, if not constructed to ASME Code, Section III criteria (Reference 3.5-3), can be credible sources of missiles; however, due to mitigating features in the US-APWR design they do not pose a risk to safety-related SSCs. Such piping is separated from safety-related systems by heavy concrete walls or SSCs are located outside the zones of postulated missile strikes.

2. High-speed rotating equipment

   Non-safety-related high-speed rotating equipment located outside the PCCV can be credible sources of missiles; however, due to mitigating features in the US-APWR design, such equipment does not pose a risk to safety-related SSCs. Primary missile protection is provided by locating credible missile sources behind concrete walls and floors, and/or locating SSCs outside the zones of postulated missile strikes. For those cases where elimination of missile hazard is impractical, credible missiles are evaluated based on the size, energy, and trajectory of the postulated missile, and the proximity to any potentially impacted SSCs. Alternately, an evaluation is performed to determine if sufficient redundancy remains to achieve and maintain a safe-shutdown condition. If the ability to achieve and maintain safe shutdown is not determined, missile barriers are designed as discussed in Subsection 3.5.3.

Section 3.2 and Section 3.11 list applicable SSCs, their location, seismic category, and quality group/equipment classifications. General arrangement drawings showing locations of the SSCs are given in Section 1.2. The following component types have the potential to produce internally-generated missiles outside the PCCV.

3.5.1.1.1 Items Containing Pressurized High-energy Fluids or Steam

Items forming a pressurized boundary of high-energy fluid or steam may be postulated to have been damaged, broken pieces could become missiles when propelled by internal pressure or jet forces.

3.5.1.1.1.1 Piping

For potential missiles originating from piping under high pressure, the probability of occurrence, P_1, is maintained less than 10^{-7} by virtue of the design in accordance with ASME Code, Section III (Reference 3.5-3), and inspection program in compliance with

ASME Code, Section XI (Reference 3.5-4). If piping as evaluated in Section 3.6 were to rupture, the pipe is held in place by its supports. However, the probability of occurrence, P_1, remains less than 10^{-7} since the section remains attached to the remainder of the piping system.

Pressurized high-energy piping systems and components, if not constructed to ASME Code, Section III criteria (Reference 3.5-3), can be a significant source of missiles (that is, $P_1 > 10^{-7}$). The probability of impact, P_2, is therefore also considered. The probability of impact, P_2, is minimized by locating a potential missile source or potential target outside the zone of postulated missile strike, by the robust building walls and slabs that are designed for applicable missile strikes, or the separation of piping systems and components that are missile sources from potentially impacted SSCs. When evaluating the credibility of missile impact, the product of $P_1 \times P_2$ is less than 10^{-7} and therefore non-ASME Code piping systems and components are not credible missile sources.

For non-high energy fluid systems, the systems have insufficient stored energy to generate a missile. The probability of missile occurrence, P_1, from non-high energy fluid systems is therefore less than 10^{-7}.

3.5.1.1.1.2 Valves

In the case of postulated damage to threads, the stem (valve stem) will not eject because the backseat or valve body is larger in diameter than the stem. Therefore, the probability of missile occurrence, P_1, originating from an ejected valve stem is less than 10^{-7}.

In valves with bolted bonnets (covers), bonnets can not be perforated because the remaining bolts withstand the internal pressure even when one bolt is assumed to have been damaged. In valves of ANSI 900 Pressure Class and above, valves using bonnet types with a pressure seal will not perforate because they are pressed by a yoke or retainer ring (cover retaining ring). The valve design is in accordance with ASME Code, Section III (Reference 3.5-3), and inspected in accordance with ASME Code, Section XI (Reference 3.5-4). Therefore, the probability of missile occurrence, P_1, originating from a pressure seal-style valve bonnet is less than 10^{-7}.

In valves of threaded bonnets having canopy seals commonly used for ANSI 600 Pressure Class and below, the bonnets will not perforate due to loose threading, and have a historically low occurrence of total separation of the bonnet from the valve. Therefore, the probability of missile occurrence, P_1, originating from a threaded valve bonnet is less than 10^{-7}.

3.5.1.1.1.3 Pipe Fittings and Appurtenances

For potential missiles originating from pipe fittings and appurtenances under high pressure, the probability of occurrence, P_1, is maintained less than 10^{-7} for those components whose design is in accordance with ASME Code, Section III (Reference 3.5-3), and inspection program is in compliance with ASME Code, Section XI (Reference 3.5-4). Pipe fittings and appurtenances that may be a high probability of occurrence (that is, $P_1 > 10^{-7}$) are further qualified as statistically insignificant when the probability of missile impact on a critical component, P_2, is such that the product of $P_1 \times P_2$ is less than 10^{-7}. In addition, any postulated missile involving a pipe fitting or appurtenance is a small mass and small area, resulting in low velocity and therefore energy. This results in a very small probability of significant damage (P_3). Therefore, a combined probability (P_1 x P_2 x P_3) of any postulated missile generated by a pipe fitting or appurtenance is less than 10^{-7} per year, and the potential missile is not considered statistically significant.

3.5.1.1.2 High-Speed Rotating Equipment

In general, the probability of occurrence, P_1, of safety-related rotating equipment is maintained less than 10^{-7} by virtue of the equipment design and manufacturing criteria. Justification for a low probability of occurrence, P_1, includes the fact that rotating equipment energized by alternating current power are governed by the frequency of the power supply. The narrow range of frequency variation for the alternating current power supply makes it highly unlikely that an overspeed condition of rotating equipment can occur. While it is postulated that missiles such as a fan blade may occur at rated speeds, the design of the casing prevents missile penetration. However, in the unlikely case of a high-speed rotating component penetrating the casing and P_1 is greater than 10^{-7}, the probability of impact, P_2, is also considered. P_2 is minimized by locating a potential missile source or potential target outside the zone of postulated missile strike, by the robust building walls and slabs that are designed for applicable missile strikes, or the separation of missile sources from potentially impacted SSCs. When considering both probability of occurrence and probability of impact, the product of P_1 x P_2 is less than 10^{-7} and therefore high-speed rotating equipment are not credible missile sources.

Missiles are similarly not postulated from turbine-driven pumps because of the over-speed prevention system and deliberate quality assurance consideration for the inspection of materials, design, production, installation, and operation. The probability of occurrence, P_1, for turbine-driven pumps is therefore maintained less than 10^{-7}.

Missiles are also not postulated from the GTG because of the over-speed prevention system, deliberate quality assurance considerations in the inspection of materials, design, production, installation, and operation, and the casing material that prevents penetration. The probability of occurrence, P_1, for the GTG is therefore maintained less than 10^{-7}.

In the case of non safety-related high-speed rotating pumps, motors with thick casings are procured to prevent the probability of missile occurrence. Therefore, the probability of missile occurrence, P_1, originating from a non safety-related high-speed rotating pump is less than 10^{-7}.

In the case of non safety-related high-speed rotating fans, the probability of missile occurrence may be statistically significant (P_1 >10^{-7}). When investigating these components, the probability of impact, P_2, is also evaluated to confirm that the product of P_1 x P_2 is less than 10^{-7}. The probability of impact, P_2, is minimized by locating a potential missile source or potential target outside the zone of postulated missile strike, by the robust building walls and slabs that are designed for applicable missile strikes, and/or the separation of the rotating equipment that is a missile source from potentially impacted SSCs. Therefore, high-speed rotating fans are not a credible missile source since the product of P_1 x P_2 is less than 10^{-7}.

Refer to Subsection 3.5.1.3 for discussion of turbine and turbine rotor missiles.

3.5.1.1.3 Gas or Pressurized Cylinder Explosion

Protective measures are taken as recommended by NUREG/CR-3551 (Reference 3.5-19), including procedures, analysis, and design details, to mitigate pressurized gas cylinders/bottles from generating or becoming a missile. Design features which resist the formation of missiles from a pressurized gas cylinder/bottle include the fabrication from rolled thick-wall steel material, and a steel collar at the neck of the bottle to protect the sensitive valve and other critical parts. In addition, the pressurized cylinders are oriented vertically with the bottle pointed towards the concrete slab roof in storage racks restrained in accordance with seismic Category II requirements. Therefore, the product of the probability of occurrence, P_1, and the probability of impacting a significant target, P_2, is less than 10^{-7}.

Battery compartments are ventilated to prevent the concentration of hydrogen. The hydrogen supply system and gas bottles are installed in a compartment independent of safety-related structures, and ventilation is provided to prevent the concentration of hydrogen. The probability of occurrence, P_1, for a gas explosion in battery compartments is therefore maintained less than 10^{-7}.

3.5.1.1.4 Gravitational Missiles

3.5.1.1.4.1 Crane Drop of Heavy Loads

As defined in ASME NOG-1 (Reference 3.5-5), a critical load is any lifted load whose uncontrolled movement or release could adversely affect any safety-related SSC when such a SSC is required for plant safety or could result in potential offsite exposure in excess of 10 CFR 100 limits.

Type I cranes are defined by ASME NOG-1 (Reference 3.5-5) as those used to handle critical loads. In accordance with ASME NOG-1, Type I cranes are designed to remain in place and are equipped with single failure-proof features to prevent load drops.

Refer to Subsection 9.1.5.1 for further discussion on the design bases for a postulated load drop by the overhead heavy load handling system of the US-APWR.

Additionally, cranes are designed to prevent diversion and derailment. Drop prevention design is also employed based on earthquake design criteria. Therefore, load drops and derailment of cranes do not represent credible sources of missiles that would jeopardize safety-related SSCs. Therefore, the probability of occurrence, P_1, of missiles generated by a gravity load crane drop is less than 10^{-7}.

3.5.1.1.4.2 Falling Objects Resulting from Non-Seismic SSCs During Seismic Event

Seismic Category II SSCs are defined as not essential for the safe shutdown of the plant, and need not remain functional during and after a SSE. However, such structures and subsystems must not fall or displace excessively where it could damage any seismic Category I SSCs. Therefore, any SSCs with the potential to cause damage to safety-related SSCs are analyzed and designed using the same methods and stress limits specified for seismic category I SSCs. No non-seismic SSCs are permitted that could possibly affect the ability of the plant to achieve and maintain safe shutdown, and to maintain offsite radiological dose/concentration levels within defined limits. In addition, seismic Category I SSCs are not permitted in non-seismic areas and are therefore not impacted by falling objects during a seismic event. Therefore, the product of the probability of occurrence, P_1, and the probability of significant impact, P_2, of non-seismic SSCs missiles striking seismic Category I SSCs is maintained as less than 10^{-7}.

3.5.1.1.4.3 Secondary Missiles Caused by a Falling Object Striking a High-Energy System

Falling objects impacting a high-energy system or other surfaces may have the ability to generate secondary missiles. Falling objects are postulated to occur by either a crane drop of heavy load, or resulting from a non-seismic SSC during a seismic event. As described in the preceding paragraphs, these missiles sources are not credible, and no secondary missiles from these sources are capable of occurring. The probability of occurrence, P_1, is therefore inherently less than 10^{-7}.

3.5.1.2 Internally Generated Missiles (Inside Containment)

Refer to Subsection 3.5.1.1 for component types that also have the potential to produce missiles inside containment. Safety-related SSCs are identified in Section 3.2 and Section 3.11.

3.5.1.2.1 Missile Prevention

Refer to Subsection 3.5.1.1 for discussion of missile prevention applicable inside containment.

3.5.1.2.2 Missile Selection

3.5.1.2.2.1 Missiles Not Considered Credible

Discussion in Subsection 3.5.1.1 regarding missiles not considered credible is also applicable to missiles generated inside the PCCV. In addition, equipment located within the PCCV are discussed and clarified why these are not credible missile sources:

1. RCPB

   Inside the PCCV, missiles originating from the RV, SG, reactor coolant pump (RCP), pressurizer, and RCPB piping during normal operation are not considered credible due to ASME Code Section III (Reference 3.5-3) and Section XI (Reference 3.5-4) criteria controlling quality from production through operation, material characteristics, design strengths, and the preservice and inservice inspections. Additional assurances to prevent generation of missiles are provided by prudent operation of the system.

2. CRDM

   Missiles in the form of a piece of the CRDM housing or a control rod ejected rapidly from the core is not considered credible. In addition to justification equivalent to the RV, the following assurances specific to the CRDMs are provided:

   - Shop hydro testing in excess of 125% of system design pressure.

- Hydro-testing of housings to 125% of system design pressure after they are installed on the RV to the head adapters. Housings are also tested during hydro-testing of the completed RCS.
- Housings are made of materials with excellent notch toughness.
- Stress levels in the mechanism are not affected by system thermal transients at power or by thermal movement of the reactor coolant loops.
- The welds in the pressure boundary of the CRDM satisfy ASME Code, Section III (Reference 3.5-3) requirements for design, procedure, examination, and inspection.
- A control rod ejection is considered in the safety analyses in Chapter 15, and the design transients in Subsection 3.9.1.1.

3. RCP Flywheel

The RCP, with a flywheel, is designed to prevent missiles from occurring by quality control, inservice inspection, and continuous monitoring for shaft vibration. The maximum allowable rotating speed in terms of the strength of the flywheel is sufficiently higher than the maximum rotating speed of the motor postulated at the plant, and the soundness of the flywheel is maintained.

3.5.1.2.2.2 Missiles Considered Credible

Based on justification of non-credible missiles discussed in Subsection 3.5.1.2, non safety-related rotating equipment and pressurized components located in high-energy systems not required to satisfy ASME Code, Section III (Reference 3.5-3) are the only missiles considered credible that may require further protection for safety-related SSCs.

3.5.1.2.2.3 Credible Sources of Internally Generated Missiles (Inside Containment)

The following credible sources of internally generated missiles inside the PCCV are discussed below:

1. Items containing high-energy fluids

   All high-energy piping systems within PCCV comply with ASME Code, Section III (Reference 3.5-3).

2. High-speed rotating equipment

   The few non safety-related high-speed rotating equipment located inside PCCV are credible sources of missiles; however, do not pose a risk to safety-related SSCs. Primary missile protection is provided by locating credible missile sources behind concrete walls and floors, and/or locating SSCs outside the zones of postulated missile strikes. For those cases where elimination of missile hazard is impractical, credible missiles are evaluated based on the size, energy, and trajectory of the postulated missile, and the proximity to any potentially impacted SSCs. Alternately, an evaluation is performed to determine if sufficient redundancy remains to achieve and maintain a safe shutdown condition. If the ability to achieve and maintain safe shutdown is not determined, missile barriers are designed in accordance with Section 3.5.3.

Section 3.2 and Section 3.11 list applicable SSCs, their location, seismic category, and quality group/equipment classifications. General arrangement drawings showing locations of the SSCs are given in Section 1.2. The following component types have the potential to produce internally-generated missiles inside the PCCV.

3.5.1.2.1 Items Containing Pressurized High-energy Fluids or Steam

Subsection 3.5.1.1.1 discusses items containing pressurized high-energy fluids or steam outside containment. Conclusions relating to statistical significance of postulated missiles also apply to similar items containing pressurized high-energy fluids or steam inside containment. Pressurized items unique to inside containment are discussed as follows.

Inside the PCCV, postulated missiles originating from unique pressurized high-energy items such as the RV and associated fittings, SG, reactor coolant pump (RCP), pressurizer, and RCPB piping during normal operation are not considered credible due to ASME Code Section III (Reference 3.5-3) and Section XI (Reference 3.5-4) criteria controlling quality from production through operation, material characteristics, design strengths, and the preservice and inservice inspections. Additional assurances to prevent generation of missiles are provided by prudent operation of the system. The probability of missile occurrence from pressurized high energy items inside containment, P_1, is therefore less than 10^{-7}.

Additionally, missiles in the form of a piece of the CRDM housing or a control rod ejected rapidly from the core is not considered credible. In addition to a low probability of occurrence similar to the RV, the following assurances specific to the CRDMs maintain a low probability of occurrence, P_1, and low probability of impact, P_2, provided by:

- Shop hydro-testing in excess of 125% of system design pressure.
- Hydro-testing of housings to 125% of system design pressure after they are installed on the RV to the head adapters. Housings are also tested during hydro-testing of the completed RCS.
- Housings are made of materials with excellent notch toughness.
- Stress levels in the mechanism are not affected by system thermal transients at power or by thermal movement of the reactor coolant loops.
- The welds in the pressure boundary of the CRDM satisfy ASME Code, Section III (Reference 3.5-3) requirements for design, procedure, examination, and inspection.
- A control rod ejection is considered in the safety analyses in Chapter 15, and the design transients in Subsection 3.9.1.1.

Therefore, the product of probability of missile occurrence, P_1, and probability of impact, P_2, is less than 10^{-7} for pressurized high energy items inside containment.

3.5.1.2.2 High-Speed Rotating Equipment

Subsection 3.5.1.1.2 discusses high-speed rotating equipment. Conclusions relating to statistical significance of postulated missiles also apply to similar high-speed rotating equipment inside containment. In addition, the RCP is an item unique to inside containment. The RCP and associated flywheel is designed to prevent the probability of missile occurrence by quality control, inservice inspection, and continuous monitoring for shaft vibration. The maximum allowable rotating speed in terms of the strength of the flywheel is sufficiently higher than the maximum rotating speed of the motor postulated at the plant, and the soundness of the flywheel is maintained. Therefore, the probability of missile occurrence from high-speed rotating equipment inside containment, P_1, is less than 10^{-7}.

3.5.1.2.3 Gas or Pressurized Cylinder Explosion

Conclusions relating to statistical significance of postulated missiles due to gas or pressurized cylinder explosion also apply inside containment. By an analysis similar to that in Subsection 3.5.1.1.3, it is concluded that no items have the capability of generating potential missiles related to a gas or pressurized cylinder explosion inside the containment. Therefore, the product of the probability of occurrence, P_1, and the probability of impacting a significant target, P_2, is less than 10^{-7}.

3.5.1.2.4 Gravitational Missiles

Subsection 3.5.1.1.4 discusses gravitational missiles, including crane drop of heavy loads, falling objects resulting from non-seismic SSCs during seismic event, and secondary missiles caused by a falling object striking a high-energy system. Conclusions relating to statistical significance of these postulated missiles also apply to similar potential gravitational missiles inside containment. Therefore, the probability of missile occurrence, P_1, or the product of P_1 and the probability of impacting a significant target, P_2, is less than 10^{-7}.

In addition, the COL Applicant is to prepare plant procedures that specify equipment required for maintenance or undergoing maintenance is to be removed from containment prior to operation, moved to a location where it is not a potential hazard to SSCs important to safety, or seismically restrained to prevent it from becoming a missile.

3.5.1.3 Turbine Missiles

The two broad categories of turbine failures are referred to as design over-speed and destructive over-speed failures. Missiles resulting from design over-speed failures are the result of brittle fracture of turbine blade wheels or portions of the turbine rotor itself. Failures of this type can occur during startup or normal operation. Missiles resulting from destructive over-speed failures would be generated if the over-speed protection system malfunctions and the turbine speed increases to a point at which the low-pressure wheels or rotor undergo ductile failure.

3.5.1.3.1 Geometry

As defined by "Protection Against Low-Trajectory Turbine Missiles", RG 1.115, Rev. 1 (Reference 3.5-6), current evidence suggests low trajectory turbine missile strikes are concentrated within an area bounded by lines inclined at 25 degrees to the turbine wheel planes and passing through the end wheels of the low pressure stages.

The T/G is located south of the nuclear island with its shaft oriented along the north-south axis. In this orientation, the potential for low trajectory turbine missiles to impact

ATTACHMENT 2
to RAI 127-1641

from a safety viewpoint. Applicable regulatory requirements are to be identified, and discussions of how these regulatory requirements are met for the site envelope characteristics.

2.2.2.5 Internally Generated Missiles (Inside and Outside the Containment)

Factors contributing to missile protection of potentially targeted SSCs is provided by one or more of the following methods:

- Locating the system or component in a missile-proof structure
- Separating redundant systems or components for the missile path or range
- Providing local shields and barriers for systems and components
- Designing the equipment to withstand the impact of the most damaging missile
- Providing design features to prevent the generation of missiles
- Orienting missile sources to prevent missiles from striking safety-related equipment
- Missile barriers are designed if the ability to achieve and maintain safe shutdown is not determined.

Table 2.2-4 provide the ITAAC requirements and acceptance criteria for SSCs that require physical missile protection from any credible internal missiles inside and outside the containment.

2.2.3 System Structural Design

The location, safety classification, quality group, seismic classification, and code requirements for systems and components that are important to safety, affect safety and/or support safety functions are provided in the subsections of specific systems. Table 2.2-4 provides the ITAAC requirements and acceptance criteria for SSCs.

2.2.3.1 Piping Systems and Components

Details are discussed in Section 2.3, Piping Systems and Components, for structural information pertaining to piping systems and components.

2.2.3.2 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

The safety-related mechanical and electrical equipment, including instrumentation, and, where applicable, their supports classified as seismic Category I are demonstrated to be capable of performing their intended safety-related functions under the full range of normal and accident loadings, including seismic. This includes equipment in the reactor protection system (RPS), engineered safety feature (ESF), Class 1E electrical

ATTACHMENT 2
to RAI 127-1641

Table 2.2-4 Structural and Systems Engineering Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 3 of 3)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
13b. Flood doors and flood barrier penetrations of the R/B and the PS/B are provided with flood protection features.	13b. Inspections of the as-built flood doors and flood penetrations will be performed.	13b. For the R/B and PS/B, the as-built flood doors and flood barrier penetrations are provided with flood protection features to protect against water seepage.
14. Penetrations in the external walls, including those up to the subgrade level if necessary, of the R/B and PS/B are provided with flood protection features below flood level.	14. An inspection will be performed to verify that the flood protection features of the as-built penetrations in the external walls of the R/B and the PS/B exist below flood level.	14. The as-built penetrations in the external walls of the R/B and the PS/B are provided with flood protection features below flood level.
15. Redundant safe shutdown components and associated electrical divisions outside the containment and the control room complex are separated by 3-hour rated fire barriers to preserve the capability to safely shutdown the plant following a fire. The 3-hour rated fire barriers are placed as required by the FHA.	15. An inspection of the as-built fire barriers will be performed.	15. The 3-hour rated as-built fire barriers are placed as required by the FHA.
16. All penetrations and openings through the fire barriers are protected against fire.	16. An inspection will be performed to verify that the as-built components are provided to protect the penetrations and openings through fire barriers.	16. All as-built penetrations and openings are protected with rated components (i.e. fire doors in door openings, fire dampers in ventilation duct openings, and penetration seals).
17. Safety-related SSCs are designed to withstand the dynamic effects of pipe breaks.	17. Refer to Section 2.3 ITAAC #6	17. Refer to Section 2.3 ITAAC #6
18. The key dimensions of the RV conform with the licensed design and are documented in an as-built report.	18. Refer to Section 2.4.1 ITAAC #5	18. Refer to Section 2.4.1 ITAAC #5
19. Safety-related SSCs are protected from any credible internal missile sources inside and outside the containment.	19. An inspection will be performed to verify as-built locations of safety-related SSCs are protected from potential impact by credible internal missiles.	19. Primary missile protection is provided by locating missile sources behind concrete walls and floors, and/or locating safety-related SSCs outside the zones of credible missile strikes.