RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**117-8061**
SRP Section:	**03.05.01.01 – Internally Generated Missiles (Outside Containment)**
Application Section:	**3.5.1.1**
Date of RAI Issue:	**07/27/2015**

Question No. 03.05.01.01-1

GDC 4, in part, requires SSCs important to safety to be protected from internally generated missiles. SRP 3.5.1.1 acceptance is based, in part, on meeting the guidance of RG 1.115 and RG 1.117. Appendix A of RG 1.115 and RG 1.117 provides guidance as to which SSCs should be protected against missiles; these lists include some SSCs that may not be classified as safety-related (e.g. gaseous radwaste treatment facility).

DCD Tier 2, Section 3.5, states “[m]issile protection is provided for safety-related equipment…,” and “[t]he protection of safety-related SSCs is accomplished by …” It is unclear whether the APR 1400 design provides missile protection for all SSCs important to safety as required by GDC 4.

The applicant is requested to specify in the DCD if there are any nonsafety-related SSCs that require missile protection and provide justification if any SSCs listed in the aforementioned RGs are not protected from missiles; either internal or external.

Response

In the APR1400 design, there are non-safety related SSCs that require tornado missile protection. These non-safety related SSCs are located in the compound building where the radwaste treatment facilities are located and designed in accordance with the guidance of RG 1.143 (refer to Table 3.2-1 Note 4). The compound building houses the gaseous waste management system (GWMS), liquid waste management system (LWMS), and solid waste management system (SWMS). These three systems are classified as RW-IIa according to RG 1.143; thus, the external structures of the compound building are designed to be protected from external missiles. The compound building meets the missile protection requirement for gaseous radwaste treatment systems stipulated in RG 1.115 and RG 1.117 Appendix A.

The compound building is located outside the low trajectory turbine missile strike zone as shown in Figure 3.5-1 (Note: Figure 3.5-1 is to be revised as requested in RAI 241-8316).

Impact on DCD

DCD Tier 2, Section 3.5 and Table 3.5-4 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

3.5 Missile Protection

In accordance with 10 CFR Part 50, Appendix A, GDC 2 and 4 (Reference 1), essential structures, systems, and components (SSCs) important to safety are required to be protected from internal and external missiles.

SSCs important to safety

Missile protection is provided for ~~safety-related equipment and components~~ so that internal and external missiles do not cause the release of significant amounts of radioactivity or prevent the safe and orderly shutdown of the reactor.

SSCs important to safety

The protection of ~~safety-related SSCs~~ is accomplished by one or more of the following:

a. Minimizing the sources of missiles by equipment design features that prevent missile generation

b. Orienting or physically separating potential missile sources away from safety-related equipment and components

c. Containing the potential missiles through the use of protective shields or barriers near the missile source or safety-related facility and equipment

d. Hardening of safety-related equipment and components to withstand missile impact when such impacts cannot be reasonably avoided by the methods listed above

Table 3.2-1 is the list of SSCs. Essential SSCs outside containment to be protected from missiles are provided in Table 3.5-4. SSCs located inside the seismic Category I containment building are protected from missiles outside containment by thick concrete walls and are therefore omitted. General arrangement drawings showing locations of the SSCs are given in Section 1.2.

3.5.1 Missile Selection and Description

For equipment with energy sources capable of generating a missile, the selection is based on the application of a single failure criterion to the retention features of the component.

Table 3.5-4

Essential Systems and Components to Be Protected
from Externally Generated Missiles

Protected Components	Missile Barrier
Chemical and Volume Control System Regenerative heat exchanger Letdown heat exchanger Charging pump mini-flow heat exchanger Control volume tank Charging pump (auxiliary charging pump) Boric acid storage tank Safety-related pipes and valves	Auxiliary Building
Class 1E electric systems, including on-site safety-related portions of the Emergency Diesel Generator System necessary to provide emergency electric power to the other systems identified in this table.	Auxiliary Building
Spent Fuel Pool Cooling Cleanup System Spent Fuel Pool Heat Exchanger Spent Fuel Pool Clean Up Pump Safety-related Pipes and Valves	Auxiliary Building
Main Steam System MSIVs and pipe between MSIVs and containment	Auxiliary Building
Shutdown Cooling System Shutdown Cooling Pump and Heat Exchanger RCPB Pipes and Valves	Reactor Containment and Auxiliary Building
Essential Service Water System Essential Service Water Pump Safety-related Pipes and Valves	ESW Building
Control Room HVAC System AHU, ACU Control, Isolate and Smoke Damper	Auxiliary Building
Component Cooling Water System Component Cooling Water Heat Exchanger Component Cooling Water Pump Component Cooling Water Makeup Pump Safety-related Pipes and Valves	Component Cooling Water Heat Exchanger Building

Add the "A" following end of table

"A"

Liquid Waste Management System Floor drain tank Equipment waste tank RW-IIa component in R/O package (Refer to Table 11.2-6)	Compound Building
Gaseous Waste Management System Header drain tank Charcoal guard bed Charcoal delay bed HEPA filter Waste gas dryer	Compound Building
Solid Waste Management System Low-activity spent resin tank Spent resin long-term storage tank Concentrate treatment system	Compound Building

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**117-8061**
SRP Section:	**03.05.01.01 – Internally Generated Missiles (Outside Containment)**
Application Section:	**3.5.1.1**
Date of RAI Issue:	**07/27/2015**

Question No. 03.05.01.01-2

GDC 4 requires SSCs important to safety to be protected from internally generated missiles. In addition, SRP 3.5.1.1 acceptance is based, in part, on meeting the guidance of RG 1.115 and RG 1.117.

DCD Tier 2, Section 3.5.1, states “the selection is based on the application of a single failure criterion to the retention features of the component.” However, the DCD does not specify whether a single failure of an SSC necessary for safe shutdown is assumed, as discussed in RG 1.115 and RG 1.117.

The applicant is requested to revise the DCD and demonstrate the APR 1400 design conforms to the guidance of RG 1.117 and RG 1.115 with respect to the single failure criterion and protection against missiles.

Response

A single failure of SSCs necessary for safe shutdown is considered in the selection of missiles sources and in the protection from missiles based on RG 1.115 and RG 1.117.

Because the structures (including exterior walls and/or roofs of the buildings) that house the important to safety SSCs are designed to protect against the external missiles, all redundant trains encompassed within the structures can be used for safe shutdown. Therefore, the single failure criterion is met for external missile protection.

The components of each train of redundant systems is designed to be protected from internal missiles by missile protection measures such as physical separation, protective shielding or barriers as stated in DCD Tier 2 Section 3.5. Therefore, the single failure criterion is met for internal missile protection. Subsection 3.5.1 will be revised to incorporate it.

Impact on DCD

DCD Tier 2, Subsection 3.5.1 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

3.5 Missile Protection

In accordance with 10 CFR Part 50, Appendix A, GDC 2 and 4 (Reference 1), essential structures, systems, and components (SSCs) important to safety are required to be protected from internal and external missiles.

Missile protection is provided for safety-related equipment and components so that internal and external missiles do not cause the release of significant amounts of radioactivity or prevent the safe ~~and orderly~~ shutdown of the reactor~~.~~ considering a single failure.

The protection of safety-related SSCs is accomplished by one or more of the following:

a. Minimizing the sources of missiles by equipment design features that prevent missile generation

b. Orienting or physically separating potential missile sources away from safety-related equipment and components

c. Containing the potential missiles through the use of protective shields or barriers near the missile source or safety-related facility and equipment

d. Hardening of safety-related equipment and components to withstand missile impact when such impacts cannot be reasonably avoided by the methods listed above

Table 3.2-1 is the list of SSCs. Essential SSCs outside containment to be protected from missiles are provided in Table 3.5-4. SSCs located inside the seismic Category I containment building are protected from missiles outside containment by thick concrete walls and are therefore omitted. General arrangement drawings showing locations of the SSCs are given in Section 1.2.

3.5.1 Missile Selection and Description

For equipment with energy sources capable of generating a missile, the selection is based on the application of a single failure criterion to the retention features of the component.

~~Where sufficient retention redundancy is provided in the event of a failure, no missile is postulated.~~

Where sufficient redundancy of retention features is provided to a component, then no missile impact is postulated due to a single failure of a retention feature of that component.

The types of missiles considered in the design of safety-related SSCs are categorized as follows, based on their origin:

a. Internally generated missiles (outside the containment)

b. Internally generated missiles (inside the containment)

c. Turbine missiles

d. Natural phenomena missiles

e. Site proximity missiles (except aircraft)

f. Aircraft hazards

The criteria for each type of missiles are described below. An evaluation is performed to verify that missiles do not adversely affect the safety functions of safety-related SSCs.

3.5.1.1 Internally Generated Missiles (Outside the Containment)

The criteria used for protection from internally generated missiles outside the containment are generally consistent with the NRC guidelines in Standard Review Plan (SRP) 3.5.1.1 (Reference 2).

Barriers or retention features in structures other than containment are designed in accordance with the design procedure described in Subsection 3.5.3. The following procedures are used to achieve conformance with design criteria for protection against missiles that are generated by the failure of pressurized or rotating components outside the containment.

a. Classifying missiles based on their source

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**117-8061**
SRP Section:	**03.05.01.01 – Internally Generated Missiles (Outside Containment)**
Application Section:	**3.5.1.1**
Date of RAI Issue:	**07/27/2015**

Question No. 03.05.01.01-3

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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

DCD Tier 1, Table 2.2.5-1, item 4 contains an ITAAC for internally-generated missiles. The acceptance criteria states, “the as-built nuclear island structure including EDG building conforms with the following criteria;” however, there are additional structures onsite that house SSCs that require missile protection.

The applicant is requested to include in the aforementioned ITAAC all structures that house SSCs requiring missile protection or justify why those structures are omitted from the ITAAC.

Response

DCD Tier 1, Table 2.2.5-1, item 4 will be revised to include all structures, (e.g., RCB, AB, and ESW/CCW heat exchanger buildings) that house SSCs requiring internal missile protection.

Impact on DCD

DCD Tier 1, Table 2.2.5-1 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

RCB, AB, and ESW/CCW heat exchanger buildings

Table 2.2.5-1 (4 of 4)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4. The key characteristics of the protective provisions against internally generated missiles are as follows: - Minimizing the sources of missiles by equipment design features that prevent missile generation - Orientation of physical separation of potential missile source away from safety-related equipment and component - Containing the potential missiles through the use of protective shields barriers near the missile source of safety-related facility and equipment - Hardening of safety-related equipment and components to withstand missile impact	4. Inspection of the as-built protective provisions against internally missile will be conducted.	4. The as-built ~~nuclear island structure~~ including EDG building conforms with the following criteria: - Minimizing the sources of missiles by equipment design features that prevent missile generation - Orientation of physical separation of potential missile source away from safety-related equipment and component - Containing the potential missiles through the use of protective shields barriers near the missile source of safety-related facility and equipment - Hardening of safety-related equipment and components to withstand missile impact

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**117-8061**
SRP Section:	**03.05.01.01 – Internally Generated Missiles (Outside Containment)**
Application Section:	**3.5.1.1**
Date of RAI Issue:	**07/27/2015**

Question No. 03.05.01.01-4

GDC 4, in part, requires SSCs to be protected from internally generated missiles. In addition, 52.47(a)(2) requires the applicant to provide “a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification … required to show that safety functions will be accomplished.”

DCD Tier 2, Section 3.5.1.1 provides a list of components that are not considered credible missile sources; however, the applicant has not provided an adequate explanation or technical justification as to why the components are not credible. For example, the applicant uses non-specific terms and phrases, such as, “valves constructed in accordance with regulation,” “ASME vessels,” and “industry pump,” without specifying the specific regulation or ASME section.

The applicant is requested to provide in DCD Tier 2, Section 3.5.1.1, the design criteria and applied codes and standards that demonstrate a high level of quality (e.g. material, design, fabrication, examination, testing, over pressure protection) thus assuring structural integrity of the components in order to conclude that the missile sources are not considered credible.

Response

DCD Tier 2, Section 3.5.1.1 will be revised to specify the design criteria and applied codes and standards for rotating and pressurized components and to provide additional explanation of the basis for concluding that the missile sources are not considered credible. Additional details will be provided to state that the missile protection design of industry pumps is provided under overspeed conditions through vendor demonstration that the supplied pump casing is adequate to retain postulated fragments.

Impact on DCD

DCD Tier 2, Subsection 3.5.1.1 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

c. Safety-related pumps have relatively low suction pressures and are not driven to overspeed due to a pipe break in their discharge lines. In addition, the induction motor would act as a brake to prevent pump overspeed.

d. Industry pumps are designed to prevent the penetration of pump casings from impeller pieces under overspeed conditions through vendor demonstration that the supplied pump casing is adequate to retain postulated fragments.

3.5.1.1.1.2 Balance of Plant Components

All rotating components inside seismic Category I structures outside the containment are considered potential missile generation sources. Rotating parts in these components are therefore designed to be contained by a protective casing or structures.

The turbine building, which contacts with the seismic Category I auxiliary building, is designed as seismic Category II. The turbine building does not contain safety-related systems or components and does not require design for protection from rotating components that become missiles.

The turbine, the object with the largest kinetic energy in the turbine building, is considered a missile generation source. Turbine missiles are described in Subsection 3.5.1.3. The main feedwater pump, the object with the second largest kinetic energy outside containment, is considered to be a generation source for a missile that flies toward the auxiliary building, even though the main feedwater pump is designed such that the inside fragment cannot perforate the casing. By assuming penetration of its casing by a fragment, the results provide reasonable assurance that missiles from the main feedwater pump would not perforate the external wall of the auxiliary building. Considering that missiles that are generated from rotating components near the auxiliary building have rotors that are oriented toward the auxiliary building, reasonable assurance of the protection of safety-related systems and components inside the auxiliary building is provided.

3.5.1.1.2 Potential Missiles from Pressurized Components

3.5.1.1.2.1 NSSS Components

If the probability of missile generation P_1 is maintained less than 10^{-7} per year, the missile

c. The missile is postulated to occur only if the energy of the missile is sufficient to perforate the equipment's protective housing.

Missiles generated by postulated failures of pressurized components are selected and evaluated based on the following conditions:

a. Pressurized components in the systems whose maximum operating pressure exceeds 19.3 kg/cm^2 (275 psig) are assumed to be missile generation sources.

b. Connecting portions installed on piping or components are assumed to be missile generation sources. Connecting portions include thermowells, pressure gauges, and lines for vents, drains, and testing.

c. A connecting portion may be eliminated as a missile generation source if it is welded and its design strength is stronger than that of the basement.

Insert "A"

~~d. Valves constructed in accordance with regulation and valves designed to prevent ejection are not considered credible missile generation sources.~~

h. ~~e.~~ Non-ASME pressurized vessels with an operating pressure greater than 19.3 kg/cm^2 (275 psig) are considered missile generation sources. ASME vessels are not considered missile generation sources b~~ecause of their controlled design and fabrication.~~

because they are designed, fabricated, examined, and tested in accordance with ASME codes.

i. ~~f.~~ Non-ASME valves in piping systems with an operating pressure greater than 19.3 kg/cm^2 (275 psig) are considered missile generation sources.

j. ~~g.~~ An industrial pressure bottle containing highly pressurized gas is considered a missile generation source except when the bottle is designed with overpressure protection and is located in a separate room to control the effect of an explosion.

Internally generated missiles (outside the containment) from rotating and pressurized components are not considered credible in accordance with the criteria described above.

"A"

d. Valves with bolted bonnets are most commonly used valve type such as gate, check or globe valves in high energy piping. The body and bolted bonnet of these valves constructed with ASME Code Section III or ASME B16.34 are unlikely to become missile sources due to the limitation of stresses in the bonnet-to-body bolting material by rules set forth in ASME Code. Even if a bonnet-to-body bolt failure were to occur, the likelihood of all bolts experiencing a simultaneous complete failure is very remote. The widespread use of valves with bolted bonnet in nuclear industry and the low historical incidence of complete valve bonnet failures demonstrate that the valves with bolted bonnets type need not be considered as credible missile sources.

e. Pressure seal bonnet type valves are also constructed in accordance with ASME Code Section III or ASME B16.34. The valve bonnets are prevented from becoming missiles by the retaining ring. If retaining ring were to fail in shear, then the yoke would capture the bonnet or at least significantly reduce its energy. Because of the combination of these design features bonnet ejection incident is highly improbable, and hence bonnets are not considered missile sources.

f. The design feature of threaded valve stem with face hardened backseats prevents the ejection of stems. The stems are prevented from becoming credible missiles. And the stems having valve actuators are additionally restrained by the valve actuators.

g. Nuts, bolts, nut-and-bolt combinations, and nut-and-stud combinations need not be considered as credible missile sources because it has not enough energy to eject a missile.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**117-8061**
SRP Section:	**03.05.01.01 – Internally Generated Missiles (Outside Containment)**
Application Section:	**3.5.1.1**
Date of RAI Issue:	**07/27/2015**

Question No. 03.05.01.01-5

GDC 4, in part, requires SSCs to be protected from internally generated missiles. In addition, 52.47(a)(2) requires the applicant to provide “a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification … required to show that safety functions will be accomplished.”

DCD Tier 2, Section 3.5.1.1 and Section 3.5.1.2 use the sub-categories of “NSSS Components” and “BOP Components.” It is unclear what the definition and purpose of these sub-categories are. In addition, it is unclear whether these sub-sections provide a description of all potential missile sources or a description of what needs to be protected. Missiles can be generated from many different sources, not just safety-related, and it is unclear to the staff whether the two aforementioned sub-categories include the appropriate scope of potential missiles.

The applicant is requested to revise DCD Tier 2, Sections 3.5.1.1 and 3.5.1.2, in order to clarify what is meant by “NSSS Components” and “BOP components” and demonstrate that all sources of potential internally-generated missiles have been evaluated.

Response

There is no technical difference between NSSS and BOP components in terms of missile protection. DCD Tier 2 subsections 3.5.1.1 and 3.5.1.2 will be revised to delete reference to the sub-categories of NSSS and BOP components to avoid confusion. Missile protection design is performed considering all potential missile sources from safety related and non-safety related components.

Impact on DCD

DCD Tier 2, Subsections 3.5.1.1 and 3.5.1.2 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Missiles falling from heavy load transfers by crane and missiles from dropped SSCs designed to non-seismic category outside the containment are considered gravity-based missiles. The design conforms with SRP 9.1.5 (Reference 3) and NUREG-0612 (Reference 4) for falling heavy loads from equipment or component transfers, and the design provides reasonable assurance that the effect of heavy load drops during transfers by a crane is eliminated by blocking the path above the systems and components that are necessary to achieve a safe shutdown or accident. The drop of nonseismically designed SSCs outside the containment could affect safety-related systems. Therefore, they are designed to seismic Category II to protect the safety-related systems from the impact of dropped objects.

The COL applicant is to provide the procedure for heavy load transfer to strictly limit the transfer route during plant maintenance and repair periods (COL 3.5(1)).

3.5.1.1.1 Potential Missiles from Rotating Component ← (Outside Containment)

~~3.5.1.1.1.1 NSSS Components~~

If the probability of missile generation P_1 is maintained less than 10^{-7} per year, the missile is not considered statistically significant. If the probability of occurrence is greater than 10^{-7} per year, the probability of impact on a significant target is determined. If the product of these two probabilities is less than 10^{-7} per year, the missile is not considered statistically significant.

All rotating components such as pumps and motors

~~Safety-related NSSS pumps and associated motors~~ are considered rotating missile generation sources outside containment. However, there is no postulated missile because P_1 is less than 10^{-7} per year for the following reasons.

a. Pump motors are an induction type that have relatively slow running speeds and are not prone to overspeed. These motors are pretested at full running speed by the motor vendor prior to installation.

b. The motor stator serves as a natural container of rotor missiles if any are generated.

c. Safety-related pumps have relatively low suction pressures and are not driven to overspeed due to a pipe break in their discharge lines. In addition, the induction motor would act as a brake to prevent pump overspeed.

d. Industry pumps are designed to prevent the penetration of pump casings from impeller pieces.

~~3.5.1.1.1.2 Balance of Plant Components~~

~~All rotating components inside seismic Category I structures outside the containment are considered potential missile generation sources. Rotating parts in these components are therefore designed to be contained by a protective casing or structures.~~

The turbine building, which contacts with the seismic Category I auxiliary building, is designed as seismic Category II. The turbine building does not contain safety-related systems or components and does not require design for protection from rotating components that become missiles.

The turbine, the object with the largest kinetic energy in the turbine building, is considered a missile generation source. Turbine missiles are described in Subsection 3.5.1.3. The main feedwater pump, the object with the second largest kinetic energy outside containment, is considered to be a generation source for a missile that flies toward the auxiliary building, even though the main feedwater pump is designed such that the inside fragment cannot perforate the casing. By assuming penetration of its casing by a fragment, the results provide reasonable assurance that missiles from the main feedwater pump would not perforate the external wall of the auxiliary building. Considering that missiles that are generated from rotating components near the auxiliary building have rotors that are oriented toward the auxiliary building, reasonable assurance of the protection of safety-related systems and components inside the auxiliary building is provided.

3.5.1.1.2 Potential Missiles from Pressurized Components ← (Outside Containment)

~~3.5.1.1.2.1 NSSS Components~~

If the probability of missile generation P_1 is maintained less than 10^{-7} per year, the missile

is not considered statistically significant. If the probability of occurrence is greater than 10^{-7} per year, the probability of impact on a significant target is determined. If the product of these two probabilities is less than 10^{-7} per year, the missile is not considered statistically significant.

Valves are considered potential missiles from pressurized components outside containment.

~~Safety-related NSSS pumps and associated motors are considered rotating missile generation source outside containment~~. However, no postulated missiles are generated by valves ~~in the NSSS vendor scope,~~ ~~and~~ P_1 is less than 10^{-7} per year for one or more of the following reasons:

because

a. All valve stems are provided with a backseat or shoulder larger than the valve bonnet opening.

b. Motor-operated and manual valve stems are restrained by stem threads.

c. Operators on motor, hydraulic, and pneumatic operated valves prevent stem ejection.

d. Pneumatic-operated diaphragms and safety valve stems are restrained by the actuator casing.

~~3.5.1.1.2.2~~ ~~Balance-of-Plant Components~~

~~Missile protection analysis is performed to provide reasonable assurance that the SSCs required for safe shutdown are located outside the trajectory of postulated missiles, capable of withstanding the impact, or protected from impact by a barrier or wall.~~

3.5.1.2 Internally Generated Missiles (Inside Containment)

The criteria used for protection of internally generated missiles inside the containment are generally consistent with the guidelines in SRP 3.5.1.2 (Reference 5).

Structures inside the containment, including the secondary shield wall, refueling pool wall, structural beams, and floor slabs, serve as missile shields for equipment, including the reactor coolant loop, that must be protected from missiles. These structures and additional

3.5.1.2.1 Potential Missiles from Rotating Components (Inside Containment)

~~3.5.1.2.1.1 NSSS Components~~

Rotating components inside the containment building are reactor coolant pumps, heating, ventilation and air conditioning (HVAC) equipment, and pump impellers.

If the probability of missile generation P_1 is maintained less than 10^{-7} per year, the missile is not considered statistically significant. If the probability of occurrence is greater than 10^{-7} per year, the probability of impact on a significant target is determined. If the product of these two probabilities is less than 10^{-7} per year, the missile is not considered statistically significant.

~~The only safety-related NSSS rotating components inside the containment are the reactor coolant pumps.~~ However, ~~there~~ are ~~no~~ postulated missiles ~~generated~~, ~~and~~ P_1 is less than 10^{-7} per year for the reasons described in Subsection ~~3.5.1.1.1.1~~.

sources because they not 3.5.1.1.1.

~~3.5.1.2.1.2 Balance of Plant Components~~

~~If the probability of missile generation P_1 is maintained less than 10^{-7} per year, the missile is not considered statistically significant. If the probability of occurrence is greater than 10^{-7} per year, the probability of impact on a significant target is determined. If the product of these two probabilities is less than 10^{-7} per year, the missile is not considered statistically significant.~~

~~The only safety-related BOP rotating components inside the containment are heating, ventilation and air conditioning (HVAC) equipment, pump impellers, and blades of turbine-driven components. Since the casings of these components are designed to preclude missile ejection, no missiles for HVAC are postulated. Therefore, there is no missile generated and P_1 is less than 10^{-7} per year.~~

3.5.1.2.2 Potential Missiles from Pressurized Components (Inside Containment)

~~3.5.1.2.2.1 NSSS Components~~

Table 3.5-1 lists the postulated missiles and their weight, shape, dimensions, and impact energy. Major pretensioned studs and nuts, instruments, and the control rod drive

mechanism missiles are included. Items that are excluded because of redundant retention features are valve stems, valve bonnets, and pressurized cover plates.

~~3.5.1.2.2.2 Balance of Plant Components~~

Credible missiles resulting from failures of pressurized components ~~in the balance of plant components~~ are selected based on the same conditions as listed in Subsection 3.5.1.1.

Potential

might be generated

~~As mentioned above,~~ ~~potential~~ missiles from ~~balance of plant~~ pressurized components ~~inside the containment~~ are in the high-energy system ~~range~~. Most of the valves installed on a high-energy line are designed according to ANSI Class 900 and are excluded as a missile source from pressurized components. Valves installed on auxiliary steam systems are also excluded as a missile source because the operating pressure is below 19.3 kg/cm^2 (275 psig). ~~Therefore, there is no missile influence from missile generation of balance of plant pressurized components inside the containment.~~

piping

installed

3.5.1.3 Turbine Missiles

Although the auxiliary system associated with the turbine is non-safety-related, missiles generated by turbine failure can adversely affect the integrity of essential SSCs as defined in Regulatory Guide 1.115 (Reference 13) Appendix A. Table 3.5-4 lists the essential SSCs outside the reactor building that are evaluated to provide reasonable assurance that they are adequately protected from potential turbine missiles. None of the essential SSCs listed are within the low-trajectory missile strike zone.

3.5.1.3.1 Geometry

The turbine generator is composed of one high-pressure and three low-pressure turbines. As shown in Figure 3.5-1, the turbine shaft is placed in a line with the containment and auxiliary building. The figure shows that the turbine generator is placed with favorable orientation so that all essential the SSCs are excluded from the low-trajectory turbine missile strike zone, as defined by Regulatory Guide 1.115, and are concentrated in 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 arrangement is selected to meet Regulatory Guide 1.115 approach C.2.a. An assessment of the orientation of the turbine generator of

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**117-8061**
SRP Section:	**03.05.01.01 – Internally Generated Missiles (Outside Containment)**
Application Section:	**3.5.1.1**
Date of RAI Issue:	**07/27/2015**

Question No. 03.05.01.01-6

GDC 4 requires SSCs important to safety to be protected from internally generated missiles. In addition,SRP 3.5.1.1 acceptance is based, in part, on meeting the guidance of RG 1.115 and RG 1.117.

During the review of DCD Tier 2, Section 3.5.1.1, the staff noted the following items that need to be clarified:

1. DCD Tier 2, Section 3.5.1.1.2.1, states “[s]afety-related NSSS pumps and associated motors are considered rotating missile generation source outside containment;” however; this section discusses pressurized components, not rotating components. Staff requests the applicant to clarify this statement in the DCD.

2. DCD Tier 2, Section 3.5.1.1.1.1, states “safety-related NSSS pumps and associated motors.” The staff requests the applicant to clarify why this statement is specific to safety-related and does not include nonsaftey-related pumps.

3. DCD Tier 2, Section 3.5.1.1.1.2 states the turbine building does not contain any safety-related systems or components and does not require design for protection from rotating components that become missiles. The staff requests the applicant to specify if this statement is also true for pressurized components.

4. DCD Tier 2, Section 3.5.1.1 uses a unique term, “basement.” The staff requests the applicant to either clarify what is meant by “basement” or revise the text to be consistent with common industry terms.

Response

1. The statement regarding potential missiles from pumps and associated motors in DCD Tier 2, Section 3.5.1.1.2.1 will be replaced with the pertinent description of potential missile sources from valves outside containment.

2. Both safety related and non-safety related pumps are considered in the missile analysis. DCD Tier 2, Section 3.5.1.1.1.1 will be revised to state that all rotating pumps and associated motors have the potential for generating missiles outside containment.

3. The turbine building and contained components do not need to be protected from pressurized components similar to rotating components.

4. The term “basement” in not correct and will be revised to “base metal.”

Impact on DCD

DCD Tier 2, Subsection 3.4.1.1 will be revised as indicated on the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

is not considered statistically significant. If the probability of occurrence is greater than 10^{-7} per year, the probability of impact on a significant target is determined. If the product of these two probabilities is less than 10^{-7} per year, the missile is not considered statistically significant.

Valves are considered potential missiles from pressurized components outside containment. #1

~~Safety-related NSSS pumps and associated motors are considered rotating missile generation source outside containment.~~ However, no postulated missiles are generated by valves ~~in the NSSS vendor scope, and~~ P_1 is less than 10^{-7} per year for one or more of the following reasons:

because

a. All valve stems are provided with a backseat or shoulder larger than the valve bonnet opening.

b. Motor-operated and manual valve stems are restrained by stem threads.

c. Operators on motor, hydraulic, and pneumatic operated valves prevent stem ejection.

d. Pneumatic-operated diaphragms and safety valve stems are restrained by the actuator casing.

3.5.1.1.2.2 Balance-of-Plant Components

Missile protection analysis is performed to provide reasonable assurance that the SSCs required for safe shutdown are located outside the trajectory of postulated missiles, capable of withstanding the impact, or protected from impact by a barrier or wall.

3.5.1.2 Internally Generated Missiles (Inside Containment)

The criteria used for protection of internally generated missiles inside the containment are generally consistent with the guidelines in SRP 3.5.1.2 (Reference 5).

Structures inside the containment, including the secondary shield wall, refueling pool wall, structural beams, and floor slabs, serve as missile shields for equipment, including the reactor coolant loop, that must be protected from missiles. These structures and additional

Missiles falling from heavy load transfers by crane and missiles from dropped SSCs designed to non-seismic category outside the containment are considered gravity-based missiles. The design conforms with SRP 9.1.5 (Reference 3) and NUREG-0612 (Reference 4) for falling heavy loads from equipment or component transfers, and the design provides reasonable assurance that the effect of heavy load drops during transfers by a crane is eliminated by blocking the path above the systems and components that are necessary to achieve a safe shutdown or accident. The drop of nonseismically designed SSCs outside the containment could affect safety-related systems. Therefore, they are designed to seismic Category II to protect the safety-related systems from the impact of dropped objects.

The COL applicant is to provide the procedure for heavy load transfer to strictly limit the transfer route during plant maintenance and repair periods (COL 3.5(1)).

3.5.1.1.1 Potential Missiles from Rotating Component

3.5.1.1.1.1 NSSS Components

If the probability of missile generation P_1 is maintained less than 10^{-7} per year, ~~the~~ missile is not considered statistically significant. If the probability of occurrence is greater than 10^{-7} per year, the probability of impact on a significant target is determined. If the product of these two probabilities is less than 10^{-7} per year, the missile is not considered statistically significant.

All rotating components such as pumps and motors #2

~~Safety-related NSSS pumps and associated motors~~ are considered rotating missile generation sources outside containment. However, there is no postulated missile because P_1 is less than 10^{-7} per year for the following reasons.

a. Pump motors are an induction type that have relatively slow running speeds and are not prone to overspeed. These motors are pretested at full running speed by the motor vendor prior to installation.

b. The motor stator serves as a natural container of rotor missiles if any are generated.

c. Safety-related pumps have relatively low suction pressures and are not driven to overspeed due to a pipe break in their discharge lines. In addition, the induction motor would act as a brake to prevent pump overspeed.

d. Industry pumps are designed to prevent the penetration of pump casings from impeller pieces.

3.5.1.1.1.2 Balance of Plant Components

All rotating components inside seismic Category I structures outside the containment are considered potential missile generation sources. Rotating parts in these components are therefore designed to be contained by a protective casing or structures.

The turbine building, which contacts with the seismic Category I auxiliary building, is designed as seismic Category II. The turbine building does not contain safety-related systems or components and does not require design for protection from rotating components that become missiles.

#3 and pressurized

The turbine, the object with the largest kinetic energy in the turbine building, is considered a missile generation source. Turbine missiles are described in Subsection 3.5.1.3. The main feedwater pump, the object with the second largest kinetic energy outside containment, is considered to be a generation source for a missile that flies toward the auxiliary building, even though the main feedwater pump is designed such that the inside fragment cannot perforate the casing. By assuming penetration of its casing by a fragment, the results provide reasonable assurance that missiles from the main feedwater pump would not perforate the external wall of the auxiliary building. Considering that missiles that are generated from rotating components near the auxiliary building have rotors that are oriented toward the auxiliary building, reasonable assurance of the protection of safety-related systems and components inside the auxiliary building is provided.

3.5.1.1.2 Potential Missiles from Pressurized Components

3.5.1.1.2.1 NSSS Components

If the probability of missile generation P_1 is maintained less than 10^{-7} per year, the missile

c. The missile is postulated to occur only if the energy of the missile is sufficient to perforate the equipment's protective housing.

Missiles generated by postulated failures of pressurized components are selected and evaluated based on the following conditions:

a. Pressurized components in the systems whose maximum operating pressure exceeds 19.3 kg/cm^2 (275 psig) are assumed to be missile generation sources.

b. Connecting portions installed on piping or components are assumed to be missile generation sources. Connecting portions include thermowells, pressure gauges, and lines for vents, drains, and testing.

c. A connecting portion may be eliminated as a missile generation source if it is welded and its design strength is stronger than ~~that of the basement~~. base metal #4

d. Valves constructed in accordance with regulation and valves designed to prevent ejection are not considered credible missile generation sources.

e. Non-ASME pressurized vessels with an operating pressure greater than 19.3 kg/cm^2 (275 psig) are considered missile generation sources. ASME vessels are not considered missile generation sources because of their controlled design and fabrication.

f. Non-ASME valves in piping systems with an operating pressure greater than 19.3 kg/cm^2 (275 psig) are considered missile generation sources.

g. An industrial pressure bottle containing highly pressurized gas is considered a missile generation source except when the bottle is designed with overpressure protection and is located in a separate room to control the effect of an explosion.

Internally generated missiles (outside the containment) from rotating and pressurized components are not considered credible in accordance with the criteria described above.