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.:	**396-8463**
SRP Section:	**12.03-12.04 – Radiation Protection Design Features**
Application Section:	**12.03**
Date of RAI Issue:	**02/03/2016**

Question No. 12.03-52

10 CFR 20.1101(b), 10 CFR 20.1406(b) require licensees to describe design feature to maintain Occupational Radiation Exposure (ORE) ALARA, reduce contamination of the facility, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste. 10 CFR 52.47 requires applications to include information describing how operating experience has been incorporated into the design. SRP Section 12.3-4 Acceptance Criteria, and Regulatory Guides 8.8 and 4.21, provide guidance for meeting the requirements of 10 CFR 20.1001 and 10 CFR 20.1406. Regulatory Guide 1.206 sections C.I.5.4 and C.I.9.3 note that applicants should discuss system reliability considerations.

The following questions are a follow-up to the applicant's response to RAI 8275, Questions 12.03-44 and 12.03-45.

1. In the response to Part 1 of Question 12.03-44, the applicant indicated that, "The application of metallic bellows and diaphragms is limited to the valves with low-stroke length applications, or infrequent movement in the APR1400 design." Please include this statement in the FSAR.

2. In the response to Part 2 of Question 12.03-44, the applicant indicates that they are using graphite lantern rings in accordance with industry guidance. In the response to Question 12.03-45, the applicant updated FSAR Figures 5.1.2-3, 6.3.2-1, and 9.3.4-1 to show valves with leak off lines (and therefore, double packing with lantern rings), and there are a large number of valves with this feature. Also, even though the applicant did not update the figures for other systems such as the liquid radwaste management system or component coolant water system, FSAR Sections 12.3.1.2.e and 12.3.1.2.i specify that graphite lantern rings with leak off between the double packing is provided for valves 4 inches and larger as well as normally open

valves greater than 2 inches and all valves greater than 2 inches inside the containment building.

However, the more recent documents referenced by the applicant in the response either recommend against the use of lantern rings (URD, Vol. 2, Chapter 1, Section 12.2.2.10) or only recommend graphite lantern rings for limited circumstances when monitoring and a leak off line is required (EPRI-TR-1000923, Section 4.2.5). The reference EPRINP-5697 is from 1988.

Leaking valves or valve failures can result in increased worker dose for workers fixing the problem and leaks can result in contamination in the plant. In addition, valve leaks and failures can result in other operational problems and safety hazards (for example, see NRC Information Notice 93-90).

a. Please provide additional justification for the widespread use of lantern rings and leak off lines in the APR1400 design and indicate why lantern rings and leak off lines are appropriate for use instead of live loading and other designs for valves greater than 4 inches, valves normally open over 2 inches, and valves greater than 2 inches in containment; or revise the FSAR (text and appropriate figures) to limit the use of lantern rings and leak off lines to only valves where a leak off feature is necessary and update the FSAR to revise the criteria for specifying the use of lantern rings and leak off lines in the FSAR.

b. The response indicates that where lantern rings are used, they are graphite lantern rings, however, certain sections of the FSAR do not specify if the lantern rings used are made of graphite (such as FSAR Section 9.3.4.3.3). Please ensure that all FSAR sections specify that the lantern rings being used are graphite lantern rings or include a statement in Chapter 12 clearly stating that all lantern rings specified within the design are graphite lantern rings.

c. In the response to Question 12.03-45 the applicant updated FSAR Figures 5.1.2-3, 6.3.2-1, and 9.3.4-1 to show where leak off lines are located in those figures. Please specify if there are any other valves in the FSAR which contain leak off lines and update the FSAR, as appropriate, to label these valves. Please ensure that the text in the FSAR is consistent with the information in the figures.

3. In the response to Part 5 of Question 12.03-44, the applicant indicates that the reactor coolant pump casing is fabricated with austenitic stainless steel cladding and that the finished surface of the cladding is machined to have smooth surfaces to limit the buildup of radioactive contamination on its surface. Besides the reactor coolant pumps, specify if other pumps have similar design features to limit the buildup of radioactive material and if not, specify why it is not necessary. Update FSAR Section 12.3.1.2.a to include these design features.

4. In the response to Part 5 of Question 12.03-44, the applicant indicated that electro-polishing was not used on pumps. Electro-polishing can significantly reduce the dose rate from components and is recommended for consideration in industry guidance documents, (such as URD, Vol. 2, Chapter 1, Section 8.3.3) for areas

where the dose rate can be significantly reduced, such as large diameter reactor system piping, steam generator channel heads and divider plates, and reactor cavity and transfer canal liners. Please specify if electro-polishing was considered and will be used for any components in the plant, such as those specified above. If so, please update the FSAR to specify which components electro-polishing will be used on. If electro-polishing is not specified in the design, please provide an explanation for why electro-polishing is not necessary to maintain doses ALARA and to minimize contamination as part of the APR1400 design.

Response

1. As requested by NRC, the following sentence will be included in Section 12.3.1.2.e of the DCD:

   "The application of metallic bellows and diaphragms is limited to the valves with low-stroke length applications, or infrequent movement in the APR1400 design."

2.
   a. Based on KHNP experience, there has been no leaking problem when the double packing and leak off line with lantern rings are used when periodical inspection and maintenance are performed. Therefore, the double packing and leak off lines with lantern rings have been the standard design in the KHNP's nuclear power plants. However, KHNP understands that the use of live loading packing in addition to the double packing and leak off lines with graphite lantern rings is a better design for minimizing the leakage problem of valve packing. KHNP will apply the live load packing and double packing with leak off lines for the valves greater than 2 inches in diameter or all of modulating valves in order to satisfy the EPRI URD requirements after technical discussion with the valve Supplier. KHNP will also revise the APR1400 DCD to limit the only use of double packing and leak off lines with graphite lantern rings to the valves less than 2 inches in diameter except modulating valves, and to state that the design of leak off lines shall be practical and proven.

   b. Section 12.3.1.2.e.1).c) of the DCD will be revised to include a statement as follows: "All lantern rings within the double packing design being used are graphite lantern rings."

   c. Valves with stem leak off are listed in the reply to RAI 235-8277, Question 12.03-45. Even though there are no additional valves with leak off lines, item c) of Section 12.3.1.2.e in DCD will be modified.

3. Other major NSSS pumps, besides the reactor coolant pump, are the charging pump, the shutdown cooling pump, and the safety injection pump. Justification why the smooth surfaces to limit the buildup of radioactive contamination on the surface is not necessary is as follows;

   - Charging pump

The suction fluid for the charging pump is purified through the filters and ion exchangers of CVCS during normal operation. The probability of the buildup of radioactive contamination on the surface is very low. Therefore, it is not recommended that the charging pump be machined to have smooth surfaces.

- Shutdown cooling pump
  The shutdown cooling pump does not operate during normal operation. During shutdown operations, the shutdown cooling pump takes suction from the RCS, which is purified by CVCS charging pump. The probability of the buildup of radioactive contamination on the surface is very low. Therefore, it is not recommended that the shutdown cooling pump be machined to have smooth surfaces.

- Safety injection pump
  The safety injection pump does not operate during normal operation. The probability of the buildup of radioactive contamination on the surface is very low. Therefore, it is not recommended that the safety injection pump be machined to have smooth surfaces.

The APR1400 DCD 12.3.1.2.a will be updated to address the design features of the reactor coolant pump to limit the buildup of radioactive contamination on its surface.

4. For the purpose of reducing the radiation field and exposure to personnel during maintenance, surfaces will be polished in those areas of the plant where this treatment will significantly reduce the dose. The COL applicant will determine the areas that will require either electro or mechanical polishing. The potential areas that may require polishing are as follows:

   - Steam generator channel head, including divider plate
   - Pressurizer shell (pressure boundary portion) except heads and nozzles
   - Reactor vessel closure head and bottom head excluding reactor vessel shells and flange
   - Reactor permanent pool seal (reactor cavity area)
   - Reactor coolant system main piping (pressure boundary portion) excluding surge line and nozzles attached on the piping.
   - J-groove weld surface of the reactor vessel closure head

   The APR1400 DCD Table 1.8-2, Sections 12.3.1.2 and 12.3.6 will be revised to clarify where electro and mechanical polishing may be used.

Impact on DCD

DCD Table 1.8-2, Sections 12.3.1.2 and 12.3.6 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 and Environmental Reports.

Table 1.8-2 (20 of 29)

Item No.	Description
COL 11.5(4)	The COL applicant is to prepare an ODCM that contains a description of the methodology and parameters for calculation of the offsite doses for the gaseous and liquid effluents. The COL applicant is to follow NEI 07-09A as an alternative to providing an offsite dose calculation manual.
COL 11.5(5)	The COL applicant is to provide analytical procedures and sensitivity for selected radioanalytical methods and types of sampling media for site-specific matter.
COL 11.5(6)	The COL applicant is to develop the calibration procedures in accordance with NRC RG 1.33 and 4.15.
COL 11.5(7)	The COL applicant is to develop detailed location and tubing installation and provide the sampling method including the sampling time to acquire representative sampling.
COL 11.5(8)	The COL applicant is to provide operational procedures and maintenance programs related to leak detection and contamination control.
COL 11.5(9)	The COL applicant is to develop a radiological and environmental monitoring program, taking into consideration local land use and census data in identifying all potential radiation exposure pathways. The COL applicant is to follow NEI 07-09A as an alternative to providing a radiological and environmental monitoring program.
COL 12.1(1)	The COL applicant is to provide the organizational structure to effectively implement the radiation protection policy, training, and reviews consistent with operational and maintenance requirements, while satisfying the applicable regulations and Regulatory Guides including NRC RGs 1.33, 1.8, 8.8, and 8.10.
COL 12.1(2)	The COL applicant is to describe the operational radiation protection program to provide reasonable assurance that occupational radiation exposures are ALARA.
COL 12.1(3)	The COL applicant is to describe how the plant follows the guidance provided in NRC RGs 8.2, 8.7, 8.9, 8.13, 8.15, 8.20, 8.25, 8.26, 8.27, 8.28, 8.29, 8.34, 8.35, 8.36, and 8.38.
COL 12.2(1)	The COL applicant is to provide any additional contained radiation sources, such as instrument calibration radiation sources, that are not identified in Subsection 12.2.1.
COL 12.3(1)	The COL applicant is to provide portable instruments and the associated training and procedures in accordance with 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737.
COL 12.3(2)	The COL applicant is to determine the WARN and ALARM setpoints of the ARMS based on the site-specific conditions and operational requirements

Add.
COL 12.3(3)
The COL applicant is to determine the areas that will require either electro or mechanical polishing.

For the purpose of reducing the radiation field and the exposure to personnel during maintenance, surfaces will be polished in those areas of the plant where this treatment will significantly reduce the dose. The COL applicant is to determine the areas that will require either electro or mechanical polishing (COL 12.3(3)). The potential areas that may require polishing are as follows:
- Steam generator channel head, including divider plate
- Pressurizer shell (pressure boundary portion) except heads and nozzles
- Reactor vessel closure head and bottom head excluding reactor vessel shells and flange
- Reactor permanent pool seal (reactor cavity area)
- Reactor coolant system main piping (pressure boundary portion) excluding surge line and nozzles attached on the piping
- J-groove weld surface of the reactor vessel closure head

12.3.1.2 Equipment and System Design Features

The APR1400 design specifies the use of reliable and simplistic equipment with a minimal number of parts and straightforward operation to reduce the frequency of maintenance and radiation exposure to plant personnel. The design characteristics of the equipment used in radioactive systems are as follows:

a. Pumps

1) Pumps and associated piping are flanged to facilitate pump removal to a lower-radiation area for maintenance or repair. Pump internals are also removable. This design approach is consistent with NRC RG 8.8, Position 2.b (9).

2) All pump casings are provided with drain connections to facilitate decontamination. The drain connections are free of internal crevices to minimize accumulation of radioactive corrosion products (crud).

3) Pump seals are easily serviceable without the removal of the entire pump or motor. The seals of reactor coolant pump, centrifugal charging pump, shutdown cooling pump, and safety injection pump are of the cartridge type to facilitate their removal for maintenance or repair.

4) The reactor coolant pump casing is fabricated with austenitic stainless steel cladding and that the finished surface of the cladding is machined to have smooth surfaces to limit the buildup of radioactive contamination on its surface.

e. Valves

1) The following descriptions summarize the valve design features that minimize valve leakage and extend valve design life.

a) A packless valve is used as an isolation valve that is non-modulating, is less than 5.08 cm (2 in) in diameter, and operates on a weekly interval in the radioactive material processing systems to minimize external leakage from the valves.

or

b) Modulating valves ~~and~~ valves greater than 5.08 cm (2 in) in diameter use live loading of the packing by conical spring washers or equivalent means to maintain a compressive force on the packing, where possible.

5.08 cm (2 in) and under, except modulating valves.

c) Double stem packing with a leakoff between the packings and a graphite lantern ring is used for valves ~~10.16 cm (4 in) and larger, as well as normally open valves 5.08 cm (2 in) to 10.16 cm (4 in) in diameter.~~ Stem leakage is piped to an appropriate drain sump or tank.

as shown on Figures 5.1.2-3, 6.3.2-1 and 9.3.4-1.

d) Valves using stem packing are provided with a backseat capability.

e) Radiation-resistant seals, gaskets, and elastomers are used, when practicable, to extend the design life and reduce maintenance frequency.

f) Valves located in high-radiation areas are equipped with reach rods or motor operators to allow operation from lower radiation zones to minimize radiation exposure.

2) Fully ported valves are used so that valves are fully open and radioactive fluid flows freely. This minimizes internal accumulation of cruds.

3) Valves requiring removal during maintenance and inspection activities are flanged.

All lantern rings within the double packing design being used are graphite lantern rings.

4) Internal valve surfaces are designed to be as smooth as possible and free of crevices to minimize the accumulation of crud.

5) Valve wetted parts are made of austenitic stainless steel or a similar corrosion-resistant material.

6) Valves are designed so that they may be repacked without removing the yoke or topworks.

7) Valves for highly radioactive components are located in shielded valve galleries to the extent possible to minimize operator exposure.

8) Check valves are used only where necessary. The type and size of valve selected are compatible with system requirements to reduce disc flutter related wear. Check valves are located and oriented properly in the piping system.

9) The application of metallic bellows and diaphragms is limited to the valves with low-stroke length applications, or infrequent movement in the APR1400 design.

as close to each other as possible.

b) Piping is routed through shielded pipe chases whenever possible to minimize the radiation exposure rate in personnel access corridors.

c) Large-diameter piping (greater than 12.7 cm [5 in] in diameter) is used to minimize the potential for clogging during slurry or resin transfer without violating minimum flow requirements.

d) The number of pipe fittings, such as elbows and tees, is minimized to reduce the potential for radioactive crud accumulation. Where elbows are needed, large-radius bends are used.

e) Low points, deadlegs, elbows, and vertical pipe runs that may cause accumulation of radioactive material are minimized.

COL 12.3(2) The COL applicant is to determine the WARN and ALARM setpoints of the ARMS based on the site-specific conditions and operational requirements.

12.3.7 References

1. Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be ALARA," Rev. 3, U.S. Nuclear Regulatory Commission, June 1978.

COL 12.3(3)
The COL applicant is to determine the areas that will require either electro or mechanical polishing.

Regulatory Commission, May 1977.

3. 10 CFR Part 20, "Standards for Protection against Radiation," U.S. Nuclear Regulatory Commission.

4. Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," U.S. Nuclear Regulatory Commission, June 2008.

5. Regulatory Guide 8.25, "Air Sampling in the Workplace," Rev. 1, U.S. Nuclear Regulatory Commission, June 1992.

6. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission.

7. NUREG-0737, "Clarification of TMI Action Plan Requirements" U.S. Nuclear Regulatory Commission.

8. Regulatory Guide 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2006.

9. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluation Design Basis Accidents at Nuclear Power Reactors," U.S. Nuclear Regulatory Commission, July 2000.

10. Regulatory Guide 1.69, "Concrete Radiation Shields and Generic Shield Testing for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Rev. 1, May 2009.