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.:	**309-8389**
SRP Section:	**12.03-12.04-Radiation Protection Design Feature**
Application Section:	**12.03**
Date of RAI Issue:	**11/16/2015**

Question No. 12.03-48

This is a follow-up to the response to RAI 7999, Question 12.03-7.

REQUIREMENTS

10 CFR 20.1101(b) requires that the licensee use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).

10 CFR 20.1406(b) requires that applicants for standard design certifications describe in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

ISSUE / ADDITIONAL INFORMATION NEEDED

In the response to RAI 7999, Question 12.03-7, the applicant provided additional information on the cobalt content of components in contact with primary coolant. While the response specified additional limitations on cobalt content for certain components and expanded on the information originally provided in the FSAR, it is unclear that the information provided is entirely consistent with guidance documents referenced in the SRP, including RG 8.8 and EPRI TR-016780. Specifically, RG 8.8 states that low-cobalt material should be used for materials in contact with reactor coolant to the extent practical and EPRI TR-016780 states that justification should be provided for the use of cobalt-based alloys and that they should only be used where no proven alternative exists.

Therefore, the staff has the following questions:

1. In the response to Question 12.03-7, the applicant provided a proposed FSAR markup to Table 12.3-1, which provides the cobalt content for reactor coolant system components. The markup does not provide any cobalt limitations for the impeller in the reactor coolant pumps or for the metals in fuel assemblies. Please specify the cobalt content of these components in FSAR Table 12.3-1, or justify why the cobalt content in these components do not need to be limited.

2. Note 5 of the proposed FSAR Table 12.3-1 markup states that small quantities of cobalt base alloy will be used in bar, casting, or hardfacing of the control element drive mechanism, reactor vessel internal, pumps, or valves. Consistent with EPRI TR-016780, provide additional information on where cobalt base alloys will be used and provide justification for why they are being used. Update the FSAR accordingly.

3. RG 8.8 and EPRI TR-016780 both specify that the cobalt content for materials in contact with reactor coolant should be limited, however, in the response to Question 12.03-7 the applicant indicates that the cobalt content of materials other than those in the RCS is not limited, without providing any justification or reasoning for why they will not be limited. Please justify why it is not necessary to limit the cobalt content in these systems in the APR 1400 design or update FSAR Section 12.3 to provide information regarding cobalt levels and how cobalt will be limited for these systems, or as is otherwise appropriate.

Response

1. DCD Table 12.3-1 will be revised to incorporate the cobalt limitation to the impeller material of the reactor coolant pumps. For the fuel assembly components, a separate table (DCD Table 12.3-2) will be added to identify the cobalt limitations to the stainless steel or nickel base materials of the components.

   However, please note that the total surface area of the fuel assembly components is significantly smaller than the surface area of fuel cladding. Therefore, even though there are a few components in fuel assembly whose cobalt contents are higher than 0.05 w/o, the average cobalt content of the fuel assembly would be significantly lower than 0.05 w/o of cobalt since fuel cladding is made of Zirlo, which has a very low cobalt content. The cobalt contents and surface areas of the fuel assembly components are shown in the Table 12.03-48-1 below.

Table 12.03-48-1 Cobalt Contents and Outer Surface Areas
of the Fuel Assembly Components

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2. Cobalt-base hard-facing alloys are used to provide wear resistance only when no proven alternative exists. Because there are no other proven alternatives, cobalt-base hard-facing alloys will be applied to the following parts:

   - Pin in the motor assembly of the CEDM: AMS 5894 (i.e., Stellite No. 6B as bar or equivalents)

   - Latch and Link in the motor assembly of the CEDM: AMS 5759 (i.e., Haynes Alloy No. 25 as bar or 36 as casting, equivalents)

   - CSB (core support barrel) snubber lug inner surface and FAP (fuel alignment plate) key inner surface in RVI: weld deposited hardfacing (AMS 5796 and AMS 5797, or equivalents)

   - Valves hardfacing: the information on cobalt hardfacing alloys to be used to the APR1400 valves is not available since the valves are procured as commercial items and it can be provided at the construction phase.

   The total surface area of cobalt base alloys in the above mentioned components is very small compared to the total RCS coolant contacting surface area of RCPB components.

3. The APR1400 (1400 MWe) has a similar design to the Combustion Engineering (now Westinghouse) plants. Millstone 2 is one of the plants designed by Combustion Engineering. The basic configuration of Millstone 2 is similar to APR1400, even though there is a difference in power output. (Millstone 2 has a maximum power output of 870 MWe.)

EPRI NP-2685, Cobalt Source Identification Program, reports the surface areas of the stainless steel, Inconel and high cobalt alloys used in the systems of Millstone 2, which are in contact with primary coolant. They are shown in the Table 12.03-48-2 below.

Table 12.03-48-2 System Area Summary, By Material, ft^2 (Millstone 2 plant)

System	Inconel	Stainless Steels	High cobalt alloys
Reactor	2.046	15,430	72.2
Reactor Coolant System	160,070	3,710	0.6
Chemical and Volume Control System (CVCS)		2,320	4.4
Boric Acid Supply System		2,300	2.3
Shutdown Cooling System		11,900	6.1

According to the Table 12.03-48-2, the total surface of the stainless steel, Inconel and high cobalt alloys of all systems which are in contact with primary water is 195818 ft^2 and that of the boric acid supply system, shutdown cooling system and CVCS is 16533 ft^2. That means the surface portion contributed by the boric acid supply system, shutdown cooling system, and CVCS would be less than 10%.

Owing to the similarity in the design between APR1400 and Millstone 2, it is a good assumption that the boric acid supply system, shutdown cooling system and CVCS of APR1400 also has a similar percentage for the surface portion, less than 10%.

In addition, the shut down cooling system is utilized infrequently, which is a large portion of the total surface area for the auxiliary systems, and some components of the auxiliary systems operates at lower temperature, which reduces corrosion.

Therefore, since the total surface area portion of auxiliary systems for APR1400 would be less than 10% of the total system surface area contacting primary coolant, their low temperature operations, and infrequent operation of shutdown cooling system, KHNP believes that the cobalt content of materials other than those in the RCS does not significantly influence the sound radiation protection principles to achieve occupational doses and doses to members of the public even though they will not be limited in cobalt content.

Impact on DCD

DCD Tables 12.3-1 and Table 12.3-2 will be revised and added as indicated on the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on Technical Specification.

Impact on Technical/Topical/Environmental Reports

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

Table 12.3-1

Cobalt Contents of Finished Surface for Primary System Materials

Component	Cobalt Content
Reactor Vessel Assembly Cladding[1)]	0.05 w/o (max)
Reactor Coolant Pipe Cladding[1)]	0.05 w/o (max)
Pressurizer Assembly Cladding[1)]	0.05 w/o (max)
Steam Generator Cladding[1)]	0.05 w/o (max)
Reactor Coolant Pump Cladding[1)]	0.05 w/o (max)
Core Support Barrel Assembly[2)]	0.05 w/o (max)
Lower Support Structure Assembly[2)]	0.05 w/o (max)
Instrument Nozzle Assembly[2)]	0.05 w/o (max)
Upper Guide Structure Assembly[2)]	0.05 w/o (max)
Inner Barrel Assembly[2)]	0.05 w/o (max)
Core Shroud Assembly[2)]	0.05 w/o (max)
Surge Line[4)]	0.05 w/o (max)
Control Element Driving Mechanisms including RV CEDM nozzles [2, 3)]	0.05 w/o (max)
Steam Generator Tube[3)]	0.015 w/o (mean value)
The components except where identified in this table	Not Limited

1) Austenitic Stainless Steel Type 308, or Type 309, or Ni based Alloy (Alloy 690 equivalent weld material)
2) Austenitic Stainless Steel Type 304
3) Alloy 690TT
4) Austenitic Stainless Steel Type 347
5) Small quantity of cobalt base alloy (Stellite or Haynes alloy) as bar, casting, or hardfacing is used for the CEDMs, RVIs, pumps, or valves.

Replace:
Table 12.3-1 with the tables on the following pages.

APR1400 DCD TIER 2

Table 12.3-1

Cobalt Contents of Finished Surface for Primary System Materials

Component	Cobalt Content
Reactor Vessel Assembly Cladding(1)	0.05 w/o (max)
Reactor Coolant Pipe Cladding(1)	0.05 w/o (max)
Pressurizer Assembly Cladding(1)	0.05 w/o (max)
Steam Generator Cladding(1)	0.05 w/o (max)
Reactor Coolant Pump Cladding(1)	0.05 w/o (max)
Reactor Coolant Pump Impeller(6)	0.05 w/o (max)
Core Support Barrel Assembly(2)	0.05 w/o (max)
Lower Support Structure Assembly(2)	0.05 w/o (max)
Instrument Nozzle Assembly(2)	0.05 w/o (max)
Upper Guide Structure Assembly(2)	0.05 w/o (max)
Inner Barrel Assembly(2)	0.05 w/o (max)
Core Shroud Assembly(2)	0.05 w/o (max)
Surge Line(4)	0.05 w/o (max)
Control Element Driving Mechanisms including RV CEDM nozzles(2),(3)	0.05 w/o (max)
Steam Generator Tube(3)	0.015 w/o (mean value)
The components except where identified in this table	Not Limited

(1) Austenitic Stainless Steel Type 308, or Type 309, or Ni based Alloy (Alloy 690 equivalent weld material)
(2) Austenitic Stainless Steel Type 304
(3) Alloy 690TT
(4) Austenitic Stainless Steel Type 347
(5) Small quantity of cobalt base alloy (Stellite or Haynes alloy) as bar, casting, hardfacing is used for the CEDMs, RVIs, pumps, or valves. (6) Martensitic Stainless Steel F6MN or equivalent

Table 12.3-2

Cobalt Contents of Fuel Assembly Components Materials

Components	Cobalt Content
Top Nozzle except Holddown Spring(1)	0.05 w/o (max)
Top Nozzle Holddown Spring(2)	0.10 w/o (max)
Bottom Nozzle(1)	0.05 w/o (max)
Top, Bottom and Protective Grids(2)	0.04 w/o (max)
Top and Bottom Grid Sleeves(1)	0.12 w/o (max)
Guide Thimble Screw(1)	0.12 w/o (max)
(1) Austenitic Stainless Steel Type 304/304L (2) Nickel Alloy 718 (3) Small surface components compared to Fuel Rod	