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.:	**291-8347**
SRP Section:	**04.05.02 – Reactor Internal and Core Support Structure Materials**
Application Section:	**4.5.2**
Date of RAI Issue:	**11/04/2015**

Question No. 04.05.02-1

APR-1400 Final Safety Analysis Report (FSAR) Section 4.5.2.1 states, “Reactor internals and core support materials satisfy the requirements of ASME Section III NG-2000. Code Case N-60-5 is acceptable per NRC RG 1.84.” The NRC staff understands this statement to mean that all reactor internals and core support materials will comply with ASME Code, Section III, NG-2000 requirements. This is beyond the minimum application of ASME Code, Section III, Subsection NG provisions which specifically apply to only core support structures.

Confirm if the staff’s understanding of the intent of this FSAR statement is correct.

Response

Yes. Staff’s understanding of the intent of this FSAR statement is correct.

Impact on DCD

There is no impact on the DCD.

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 Reports.

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.: **291-8347**

SRP Section: **04.05.02 – Reactor Internal and Core Support Structure Materials**

Application Section: **4.5.2**

Date of RAI Issue: **11/04/2015**

Question No. 04.05.02-2

APR-1400 FSAR Section 4.5.2.1 links materials specifications to the corresponding reactor internals and core supports at the assembly level. This level of detail is insufficient for the NRC staff to make an adequate safety finding.

The staff requests that the applicant revise FSAR Section 4.5.2 to contain a comprehensive table of reactor internals and core supports organized by assembly, with entries for sub-assemblies and components listing their corresponding material specification and whether that component is a reactor internal or core support component. An example of how such a table may be effectively organized for the staff's review is given below:

Component	Material Specification	Component Type
Core Support Barrel Assembly		
Upper Guide Structure Assembly		
… Fuel Assembly Upper Support …	SA-###, Grade X	Core Support
Lower Support Structure Assembly		
… Fuel Insert Pin …	SA-###, Grade X	Core Support

In addition, the staff requests that the applicant provide accompanying assembly diagrams for all components in the table specifying where welds are located and of what material they will be made.

Response

Please see the following tables of reactor internals and core supports organized by assembly, with entries for sub-assemblies and components listing their corresponding material specification and whether that component is a reactor internal or core support component. The weld materials for reactor internals and core supports are provided in Table 2.

FSAR Section 4.5.2.1 a., b., c. and d. will be replaced with the following Table 1.
FSAR Section 4.5.2.1 h. will be revised as follows:

"d. Weld materials

The weld materials used with the components are provided in Table 4.5-3."

In addition, an assembly diagram identifying weld materials is provided with the following Table 3 for staff's review.

Table 1 Reactor Internals and Core Support Structures Materials (1/3)

Component	Material Specification	Component Type
Core Support Barrel		
Upper Flange	SA965 Grade F304	Core Support
Upper Cylinder	SA240 Type 304	Core Support
Nozzle	SA182 Grade F304	Reactor Internals
Nozzle Cylinder	SA240 Type 304	Core Support
Center Cylinder	SA240 Type 304	Core Support
Lower Cylinder	SA240 Type 304	Core Support
Snubber Lug	SA182 Grade F304	Core Support
Lower Flange	SA182 Grade F304	Core Support
Lift Bolt Insert	SA479 S21800	Reactor Internals
Alignment Key	SA638 Grade 660	Reactor Internals
Alignment Key Dowel Pin	SA479 Type 304	Reactor Internals
Core Shroud		
Ring	SA240 Type 304	Reactor Internals
Top Plate	SA240 Type 304	Reactor Internals
Bottom Plate	SA240 Type 304	Reactor Internals
Brace	SA240 Type 304	Reactor Internals
Guide Lug	SA182 Grade F304 or SA182 Grade F348	Reactor Internals
Lifting Block	SA240 Type 304	Reactor Internals
Rib	SA240 Type 304	Reactor Internals
Shroud Plate	SA240 Type 304	Reactor Internals
SHCS Dowel Pin	SA479 Type 304	Reactor Internals
Guide Lug Inert	SA479 Type 348	Reactor Internals
CS Socket Head Cap Screw	SA193 Grade B8M Class2	Reactor Internals
CS Guide Lug Dowel Pin	SA638 Grade 660	Reactor Internals

Table 1 Reactor Internals and Core Support Structures Materials (2/3)

Component	Material Specification	Component Type
Lower Support Structure Assembly		
LSS Cylinder	SA240 Type 304	Core Support
Insert Pin	SA638 Grade 660	Core Support
Main Support Beam	SA240 Type 304	Core Support
Secondary Support Beam	SA240 Type 304	Core Support
Cross Beam	SA240 Type 304	Core Support
Instrument Nozzle Support Beam	SA182 Grade F304 or SA240 Type 304	Reactor Internals
Side Beam	SA240 Type 304	Core Support
Bottom Plate	SA240 Type 304	Core Support
Raised Bottom Plate	SA240 Type 304	Core Support
Lock Bar	SA479 Type 304	Reactor Internals
Instr. Nozzle Support Plate	SA240 Type 304	Core Support
Instrument Nozzle	SA479 Type 304	Reactor Internals
Column	SA479 Type 304	Reactor Internals
Column Boss	SA479 Type 304	Reactor Internals
Gusset	SA240 Type 304	Reactor Internals
Support Lug	SA240 Type 304	Reactor Internals

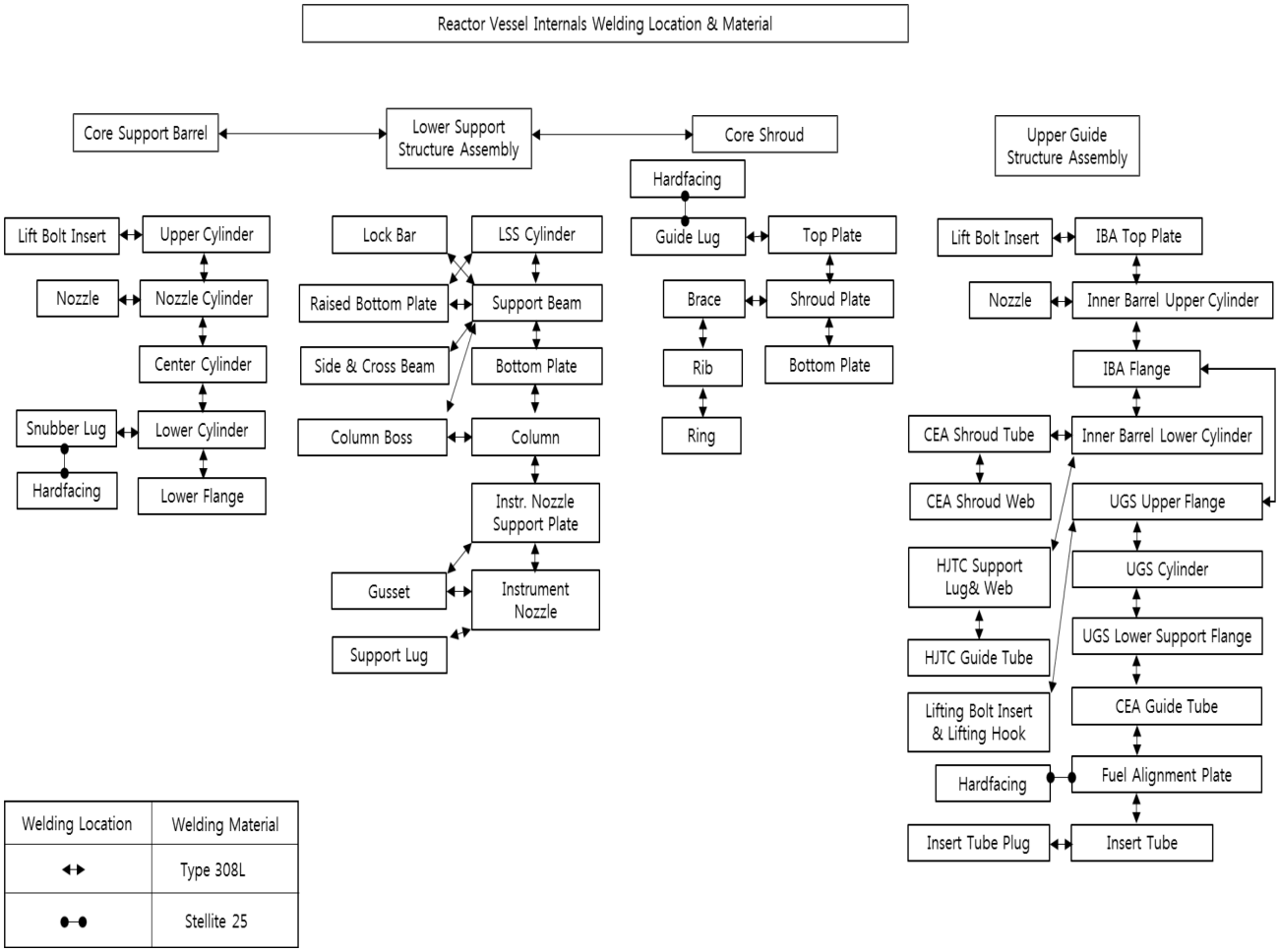
Table 1 Reactor Internals and Core Support Structures Materials (3/3)

Component	Material Specification	Component Type
Upper Guide Structure Assembly		
IBA Top Plate	SA240 Type 304	Reactor Internals
IBA Flange	SA182 Grade F304	Reactor Internals
Inner Barrel Upper Cylinder	SA240 Type 304	Reactor Internals
Inner Barrel Lower Cylinder	SA240 Type 304	Reactor Internals
CEA Shroud Tube	SA240 Type 304 or SA312 Grade TP304	Reactor Internals
CEA Shroud Web	SA240 Type 304	Reactor Internals
HJTC Support Lug	SA240 Type 304	Reactor Internals
HJTC Support Web	SA240 Type 304 or SA479 Type 304	Reactor Internals
HJTC Tube Ass'y - Connector	SA240 Type 304 or SA479 Type 304 or SA479 S21800	Reactor Internals
HJTC Tube Ass'y - Tube	A511 Grade MT 304(Code Case N-60-5) or SA213 Grade TP304 or SA312 Grade TP304	Reactor Internals
HJTC Tube Ass'y – Bushing, Pin, Reducer, Nose	SA479 S21800	Reactor Internals
UGS Upper Flange	SA965 Grade F304	Core Support
UGS Cylinder	SA240 Type 304	Core Support
UGS Lower Support Flange	SA965 Grade F304	Core Support
CEA Guide Tube	SA213 Grade TP304	Core Support
Fuel Alignment Plate	SA240 Type 304 or SA965 Grade F304	Core Support
Lift Rig Guide	SA240 Type 304 or SA479 Type 304	Reactor Internals
Lifting Bolt Insert	SA479 S21800	Reactor Internals
Lifting Hook	SA240 Type 304	Reactor Internals
Insert Tube	SA213 Grade TP304	Core Support
Insert Tube Plug	SA479 Type 304	Reactor Internals
HJTC Guide Tube	SA213 Grade TP304	Reactor Internals
HJTC Plug	SA479 Type 304	Reactor Internals
HJTC Connector	SA479 Type 304	Reactor Internals
Holddown Ring	SA182 Grade F6NM	Reactor Internals

Table 2 Reactor Internals and Core Support Structures Weld Materials

Weld Material	Weld Process
SFA-5.9 ER308L/CA-101S (Flux)	SAW
SFA-5.4 E308L-16	SMAW
SFA-5.9 ER308L	GTAW
SFA-5.30 IN308L	GTAW (Insert)
Stellite 25 (AMS 5796D or AMS 5797C)	GTAW (Insert)
SFA-5.9 ER308L	GMAW

Table 3 RVI Aassembly Diagram



Impact on DCD

DCD Table 4.5-2 and 4.5-3 will be added 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 Reports.

Add
"Table 4.5-2 Reactor Internals and Core Support Structures Materials .....4.5-17"
"Table 4.5-3 Reactor Internals and Core Support Structures Weld Materials .....4.5-18"

Revise
"Table 4.5-2 is a list of the components of the core support barrel assembly, core shroud assembly, lower support structure assembly and upper guide structure assembly with their material specifications. Supplementary material specifications and explanations are provided as follows:"

Strain-hard e
controlled t 0
ksi) to reduce the probability of stress corrosion cracking.

The following is a list of the major components of the reactor internals and core support structures together with their material specifications:

a. Core support barrel assembly

1) Type 304 austenitic stainless steel to the following specifications:

SA-182, SA-240, SA-479, and SA-965

2) Precipitation-hardened stainless steel to the following specification:

SA-638, Grade 660

3) S21800 stainless steel to the following specification:

SA-479

4) Type 348 stainless steel to the following specification:

SA-182

b. Upper guide structure assembly

1) Type 304 austenitic stainless steel to the following specifications:

SA-182, SA-240, SA-213, SA-479, SA-965, A511 (ASME Code Case N-60-5)

2) Type 347 austenitic stainless steel to the following specification:

SA-479, SA-312

Delete (Information moved to newly added Table 4.5-2)

3) Precipitation-hardened stainless steel to the following specifications:

SA-453, Grade 660; SA-638, Grade 660

4) S21800 stainless steel to the following specification:

SA-479

5) SA-193, Grade B8M; SA-194, Grade 8M

c. Core shroud assembly

1) Type 304 austenitic stainless steel to the following specification:

SA-479, SA-240

2) Type 348 stainless steel to the following specification:

SA-479, SA-182

3) Precipitation-hardened stainless steel to the following specification:

SA-453, Grade 660

d. Hold-down ring

1) SA-182, Grade F6NM

e. Bolt and pin material

Delete (Information moved to newly added Table 4.5-2)

Revise "a."

ASME SA-193, Grade B8M, ASME SA-479, Type 304 and S21800, and ASME SA-638, Grade 660 materials are used for bolt and pin applications. ASME SA-638, Grade 660 material is heat treated in accordance with the ASME specification by precipitation hardening to have a minimum yield strength of 585 MPa (85 ksi). The corrosion properties of the alloy are similar to those of the Type 300 series

Revise "b."

austenitic stainless steels. The alloy has an austenitic structure in all conditions of fabrication and heat treatment.

f. Chrome plating and hardfacing

Chrome plating or hardfacing is used on the reactor internals and core support structures or portions of the structures where required by function. Chrome plating conforms with SAE AMS 2460. The hardfacing material is Haynes Alloy-25 or an alternate material that has been demonstrated to be functionally equivalent.

Revise "c."

g. Special-purpose material

1) SA-479, S21800 is used for special applications where anti-galling properties are desired.

h. Weld materials

The weld rod filler materials used with the above-listed components are Stainless Steel Type 308L and Type 347.

All the materials used in the reactor internals and core support structures have performed satisfactorily in operating reactors such as Palisades, Fort Calhoun, Hanbit Units 3 through 6, and Hanul Units 3 through 6.

4.5.2.2 Controls on Welding

Welds used on reactor internals and core support structures are fabricated in accordance with ASME Section III NG-4000 and meet the acceptance standards delineated in ASME Section III NG-5000. The control of welding is performed in accordance with ASME Section III and Section IX. Consistency with the recommendations of NRC RGs 1.31 and 1.44 is described in Subsection 4.5.2.4.

Revise
"d. Weld materials

The weld materials used with the components are provided in Table 4.5-3."

Table 4.5-2 Reactor Internals and Core Support Structures Materials (1/3)

Component	Material Specification	Component Type
Core Support Barrel		
Upper Flange	SA965 Grade F304	Core Support
Upper Cylinder	SA240 Type 304	Core Support
Nozzle	SA182 Grade F304	Reactor Internals
Nozzle Cylinder	SA240 Type 304	Core Support
Center Cylinder	SA240 Type 304	Core Support
Lower Cylinder	SA240 Type 304	Core Support
Snubber Lug	SA182 Grade F304	Core Support
Lower Flange	SA182 Grade F304	Core Support
Lift Bolt Insert	SA479 S21800	Reactor Internals
Alignment Key	SA240 Type 304	Reactor Internals
Alignment Key Dowel Pin	SA479 Type 304	Reactor Internals
Core Shroud		
Ring	SA240 Type 304	Reactor Internals
Top Plate	SA240 Type 304	Reactor Internals
Bottom Plate	SA240 Type 304	Reactor Internals
Brace	SA240 Type 304	Reactor Internals
Guide Lug	SA182 Grade F304 or SA182 Grade F348	Reactor Internals
Lifting Block	SA240 Type 304	Reactor Internals
Rib	SA240 Type 304	Reactor Internals
Shroud Plate	SA240 Type 304	Reactor Internals
SHCS Dowel Pin	SA479 Type 304	Reactor Internals
Guide Lug Inert	SA479 Type 348	Reactor Internals
CS Socket Head Cap Screw	SA193 Grade B8M Class2	Reactor Internals
CS Guide Lug Dowel Pin	SA638 Grade 660	Reactor Internals

Table 4.5-2 Reactor Internals and Core Support Structures Materials (2/3)

Component	Material Specification	Component Type
Lower Support Structure Assembly		
LSS Cylinder	SA240 Type 304	Core Support
Insert Pin	SA638 Grade 660	Core Support
Main Support Beam	SA240 Type 304	Core Support
Secondary Support Beam	SA240 Type 304	Core Support
Cross Beam	SA240 Type 304	Core Support
Instrument Nozzle Support Beam	SA182 Grade F304 or SA240 Type 304	Reactor Internals
Side Beam	SA240 Type 304	Core Support
Bottom Plate	SA240 Type 304	Core Support
Raised Bottom Plate	SA240 Type 304	Core Support
Lock Bar	SA479 Type 304	Reactor Internals
Instr. Nozzle Support Plate	SA240 Type 304	Core Support
Instrument Nozzle	SA479 Type 304	Reactor Internals
Column	SA479 Type 304	Reactor Internals
Column Boss	SA479 Type 304	Reactor Internals
Gusset	SA240 Type 304	Reactor Internals
Support Lug	SA240 Type 304	Reactor Internals

Table 4.5-2 Reactor Internals and Core Support Structures Materials (3/3)

Component	Material Specification	Component Type
Upper Guide Structure Assembly		
IBA Top Plate	SA240 Type 304	Reactor Internals
IBA Flange	SA182 Grade F304	Reactor Internals
Inner Barrel Upper Cylinder	SA240 Type 304	Reactor Internals
Inner Barrel Lower Cylinder	SA240 Type 304	Reactor Internals
CEA Shroud Tube	SA240 Type 304 or SA312 Grade TP304	Reactor Internals
CEA Shroud Web	SA240 Type 304	Reactor Internals
HJTC Support Lug	SA240 Type 304	Reactor Internals
HJTC Support Web	SA240 Type 304 or SA479 Type 304	Reactor Internals
HJTC Tube Ass'y - Connector	SA240 Type 304 or SA479 Type 304 or SA479 S21800	Reactor Internals
HJTC Tube Ass'y - Tube	A511 Grade MT 304(Code Case N-60-5) or SA213 Grade TP304	Reactor Internals
HJTC Tube Ass'y – Bushing, Pin, Reducer, Nose	SA479 S21800	Reactor Internals
UGS Upper Flange	SA965 Grade F304	Core Support
UGS Cylinder	SA240 Type 304	Core Support
UGS Lower Support Flange	SA965 Grade F304	Core Support
CEA Guide Tube	SA213 Grade TP304	Core Support
Fuel Alignment Plate	SA240 Type 304 or SA965 Grade F304	Core Support
Lift Rig Guide	SA240 Type 304 or SA479 Type 304	Reactor Internals
Lifting Bolt Insert	SA479 S21800	Reactor Internals
Lifting Hook	SA240 Type 304	Reactor Internals
Insert Tube	SA213 Grade TP304	Core Support
Insert Tube Plug	SA479 Type 304	Reactor Internals
HJTC Guide Tube	SA213 Grade TP304	Reactor Internals
HJTC Plug	SA479 Type 304	Reactor Internals
HJTC Connector	SA479 Type 304	Reactor Internals
Holddown Ring	SA182 Grade F6NM	Reactor Internals

Table 4.5-3 Reactor Internals and Core Support Structures Weld Materials

Weld Material	Weld Process
SFA-5.9 ER308L/CA-101S (Flux)	SAW
SFA-5.4 E308L-16	SMAW
SFA-5.9 ER308L	GTAW
IN308L	GTAW (Insert)
Stellite 25	GTAW (Insert)
SFA-5.9 ER308L	GMAW

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.:	**291-8347**
SRP Section:	**04.05.02 – Reactor Internal and Core Support Structure Materials**
Application Section:	**4.5.2**
Date of RAI Issue:	**11/04/2015**

Question No. 04.05.02-3

ASME Code, Section III, Subarticles NG-2160 and NG-3120 describe how materials must be selected for compatibility with the reactor coolant environment. APR-1400 FSAR Section 4.5.2 does not contain an explanation of how the reactor internal and core support structure materials were selected to ensure compatibility with the reactor coolant.

The staff requests that the applicant revise FSAR Section 4.5.2 to address how reactor internals and core support structure materials were selected to ensure compatibility with reactor coolant.

Response

The material used in reactor vessel internals and core support structures of APR1400 is the austenitic stainless steel. Only exception is the hold-down ring made of martensitic stainless steel, SA182 F6NM. (Please see the material table in the response to RAI No. 04.05.02-28437)

The usage of Alloy 600, Alloy 82 and 182 are prohibited and unstabilized austenitic stainless steels are fabricated to meet the requirements of RG 1.44. Cold worked grade materials, such as SA193 Grade B8M Class 2 are controlled to have yield strength less than 90 ksi to avoid SCC. For the insert pins made of SA 638 Grade 660, applied stress is calculated less than 40 ksi considering a concentration factor, which is far less than SCC threshold value, 100 ksi.

Therefore, these materials are resistant to the various kinds of corrosion in the primary reactor coolant and have performed satisfactorily in operating reactors such as Palisades, Fort Calhoun, Hanbit Units 3 through 6, and Hanul Units 3 through 6.

In addition, the fast neutron irradiation effects on materials of reactor vessel internals and core support structures are addressed in FSAR 4.5.2.6.

The following statement will be added at the end of the first paragraph of FSAR 4.5.2.1.

"The materials used in reactor internals and core support structures were selected for compatibility with the reactor coolant, as described in ASME Code NG-2160 and NG-3120".

Impact on DCD

DCD 4.5.2.1 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 Reports.

austenitic stainless steels. The alloy has an austenitic structure in all conditions of fabrication and heat treatment.

f. Chrome plating and hardfacing

Chrome plating or hardfacing is used on the reactor internals and core support structures or portions of the structures where required by function. Chrome plating conforms with SAE AMS 2460. The hardfacing material is Haynes Alloy-25 or an alternate material that has been demonstrated to be functionally equivalent.

g. Special-purpose material

1) SA-479, S21800 is used for special applications where anti-galling properties are desired.

Add
"The materials used in reactor internals and core support structures were selected for compatibility with the reactor coolant, as described in ASME Code NG-2160 and NG-3120"

h. Weld materials

The weld rod filler materials used with the above-listed components are Stainless Steel Type 308L and Type 347.

All the materials used in the reactor internals and core support structures have performed satisfactorily in operating reactors such as Palisades, Fort Calhoun, Hanbit Units 3 through 6, and Hanul Units 3 through 6.

4.5.2.2 Controls on Welding

Welds used on reactor internals and core support structures are fabricated in accordance with ASME Section III NG-4000 and meet the acceptance standards delineated in ASME Section III NG-5000. The control of welding is performed in accordance with ASME Section III and Section IX. Consistency with the recommendations of NRC RGs 1.31 and 1.44 is described in Subsection 4.5.2.4.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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Docket No. 52-046

RAI No.:	**291-8347**
SRP Section:	**04.05.02 – Reactor Internal and Core Support Structure Materials**
Application Section:	**4.5.2**
Date of RAI Issue:	**11/04/2015**

Question No. 04.05.02-4

APR-1400 FSAR Section 4.5.2.5 cites identical heat treatment requirements for both SA-638, Grade 660 and SA-453, Grade 660 material. However, the specifications for SA-453, Grade 660 and SA-638, Grade 660 are not identical in ASME Code Section II.

The staff requests that the applicant revise FSAR Section 4.5.2.5 to justify why the heat treatment requirements are appropriate for both materials or to add separate language for SA-453, Grade 660 consistent with ASME Section II Code specifications.

Response

The first paragraph of FASR Section 4.5.2.5 will be revised to incorporate the heat treatment requirements for SA-638 Grade 660 material specification and delete the heat treatment of SA453 Grade 660 material which is not applied to the APR 1400 RVIs.

"The precipitation-hardened stainless steel used in the reactor internals and core support structures is SA 638 Grade 660. SA638 Grade 660 is solution treated at 900 ℃ ± 15 ℃ (1,650 ℉ ± 25℉) for 2 hours minimum, oil or water quenched for Type 1 condition and at 980 ℃ ± 15 ℃ (1,800 ℉ ± 25℉) for 1 hours minimum, oil or water quenched for Type 2 condition, final precipitation hardened at 705 ℃ to 760 ℃ (1,300 ℉ to 1,400 ℉) for 16 hours, and air cooled or furnace cooled for Type 1 and Type 2 condition."

Impact on DCD

DCD 4.5.2.5 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 Reports.

4.5.2.5 Other Materials

The precipitation-hardened stainless steel used in the reactor internals and core support structures is SA-453 Grade 660 or SA-638 Grade 660. These materials are solution treated to type 1 or 2 condition at 900 °C ± 15 °C (1,650 °F ± 25 °F) for 2 hours minimum, oil or water quenched, final precipitation hardened at 705 °C to 760 °C (1,300 °F to 1,400 °F) for 16 hours, and air cooled or furnace cooled.

SA-479, S21800 is supplied in the annealed condition.

SA-182 F6NM material, which is used for the hold-down ring, is heat-treated as follows: Solution heat treated at 1,010 °C (1,850 °F) and air cooled

Thermally treated Alloy 690 (690TT), and Alloys 52/52M and 152 weld metals are used for the APR1400 DC design, which have shown excellent performance against PWSCC in field operations and laboratory experiments. Alloy 600 and Alloys 82/182 are not used. Resistance to PWSCC of Alloy 690, 52/52M, and 152 in pressurized water reactors is discussed in EPRI report MRP-111, "Resistance to Primary Water Stress Corrosion Cracking of Alloys 690, 52, and 152 in Pressurized Water Reactors." There are no reports of cracking of Alloy 690, and the welds up-to-date (as of April 2012).

4.5.2.6 Other D
Crackin

Revise
"The precipitation-hardened stainless steel used in the reactor internals and core support structures is SA 638 Grade 660. SA638 Grade 660 is solution treated at 900 ℃ ± 15 ℃ (1,650 ˚F ± 25˚F) for 2 hours minimum, oil or water quenched for Type 1 condition and at 980 ℃ ± 15 ℃ (1,800 ˚F ± 25˚F) for 1 hours minimum, oil or water quenched for Type 2 condition, final precipitation hardened at 705 ℃ to 760 ℃ (1,300 ˚F to 1,400 ˚F) for 16 hours, and air cooled or furnace cooled for Type 1 and Type 2 condition"

IASCC and void
integrity of the rea
for these degrada
stress analyses are performed. An activity flow chart generally describing the IASCC and void swelling evaluation steps is presented in Figure 4.5-1.

The APR1400 RVI consists of two major structures, referred to as the core support structures and internal structures. The core support structures are those structures or parts of structures which are designed to provide direct support or restraint of the core. Internal structures are all the structures within the reactor pressure vessel other than the core support structures, fuels, control element assemblies, and instrumentations. The core support

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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Application Section:	**4.5.2**
Date of RAI Issue:	**11/04/2015**

Question No. 04.05.02-5

APR-1400 FSAR Section 4.5.2.6 details evaluations conducted concerning irradiation-assisted stress corrosion cracking (IASCC) and void swelling. Significant detail is provided concerning the calculation of neutron fluence and temperature. The staff requires additional information regarding the specific criteria used to evaluate the components for IASCC and void swelling to make a safety finding.

The staff requests that the applicant provide the report(s) that evaluate the reactor internals and core support structures using specific criteria including neutron fluence values, stress values, and temperature. Alternatively that the applicant revise FSAR Section 4.5.2.6 to include a complete discussion and enumeration of the criteria applied to determine whether individual components would be susceptible to IASCC and/or void swelling.

Response

A summary report which shows specific criteria including neutron fluence values, stress values, and temperature will be available by ERR on 13th of November 2015.

Impact on DCD

There is no impact on the DCD.

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 Reports.

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.: **291-8347**

SRP Section: **04.05.02 – Reactor Internal and Core Support Structure Materials**

Application Section: **4.5.2**

Date of RAI Issue: **11/04/2015**

Question No. 04.05.02-6

APR-1400 FSAR Section 4.5.2.3 states that:

> For the reactor internal and core support structure materials, nondestructive examination (NDE) is performed in accordance with the requirements of ASME Section III NG. For other materials that are not defined as ASME Section III NG, NDE examinations are performed in accordance with the applied material specification.

The staff notes that the only material specified that is not defined as ASME Code, Section III, Subsection NG is A511, Grade 304. However, the applicant cited ASME Code Case N-60-5 to justify the use of A511, Grade 304 material. This Code Case specifies that, "All other requirements of Subsection NG of Section III, Division 1, shall be met." Therefore, the NRC staff interprets this to mean that the NDE requirements of ASME Code, Section III, Subsection NG would apply to components made of A511, Grade 304 material as well.

If the staff's understanding is correct, the staff request that the applicant revise FSAR Section 4.5.2.3 to specify that all reactor internal and core support materials are to have NDE performed in accordance with ASME Code, Section III, Subsection NG.

Response

Nondestructive examination (NDE) of the reactor internal and core support structure materials will be performed in accordance with the requirements of ASME Section III NG-2500. And FASR Section 4.5.2.3 will be revised to delete the exceptions as follow:

Delete

"For other materials that are not defined as ASME Section III NG, NDE examinations are performed in accordance with the applied material specification."

Impact on DCD

DCD 4.5.2.3 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 Reports.

Delete

4.5.2.3 Nondestructive Examination

For the reactor internal and core support structure materials, nondestructive examination (NDE) is performed in accordance with the requirements of ASME Section III NG. For other materials that are not defined as ASME Section III NG, NDE examinations are performed in accordance with the applied material specification.

4.5.2.4 Fabrication and Processing of Austenitic Stainless Steel Components

The recommendations of NRC RG 1.44 are applied to control the use of sensitized austenitic stainless steel. Only those procedures and/or practices demonstrated not to produce a sensitized structure are used in the fabrication of reactor internals and core support structures.

Austenitic stainless steels used in the reactor internals and core support structures are addressed in Subsection 5.2.3.4.

All raw austenitic stainless steel material, both wrought and cast, used in the fabrication of the reactor internals and core support structures, is supplied in the solution-annealed condition, as specified in the applicable ASTM or ASME material specification. The time at temperature is determined by the size and the type of component.

Solution heat treatment is not performed on completed or partially fabricated components. Rather, the extent of chromium carbide precipitation is controlled during all stages of fabrication.

Conformance with the recommendations of NRC RG 1.31 for the reactor internals and core support materials is addressed in Subsection 5.2.3.4.4.

Conformance with the recommendations of NRC RG 1.71 (Reference 11) for welder qualification for areas of limited accessibility is addressed in Subsection 5.2.3.3.

Conformance with the recommendations of NRC RG 1.28 for quality assurance requirements for cleaning of fluid systems and associated components of water-cooled nuclear power plants is addressed in Subsection 5.2.3.4.

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.:	**291-8347**
SRP Section:	**04.05.02 – Reactor Internal and Core Support Structure Materials**
Application Section:	**4.5.2**
Date of RAI Issue:	**11/04/2015**

Question No. 04.05.02-7

APR-1400 FSAR Section 4.5.2.3 does not address the cold working of materials. While FSAR Section 4.5.2.4 references Section 5.2.3.4 with regard to austenitic stainless steels, FSAR Section 5.2.3.4 addresses the cold working of reactor coolant pressure boundary materials only.

The staff request that the applicant revise APR-1400 FSAR Section 4.5.2 to address the cold working of reactor internals and core support materials.

Response

The cold worked material of SA193 B8M Class 2 (stain hardened grade) will be applied to Socket Head Cap Screw in the Core Shroud (Please see the table in the response to RAI No. 04.05.02-28437.)

In front of the last sentence of the first paragraph of the FSAR Section 4.5.2.1 (FSAR page 4.5-8), the following sentence will be added:

"Cold worked austenitic stainless steel is not used in the core support structure or the reactor internals of the APR1400 except for bolting or pins."

Impact on DCD

DCD 4.5.2.1 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 Reports.

Strain-hardened austenitic Type 300 stainless steel bolting or pin materials, if used, are controlled to have a 0.2 percent offset yield strength that is no greater than 620 MPa (90 ksi) to reduce the probability of stress corrosion cracking.

The following is a list of the major components of the reactor internals and core support structures together with their material specifications:

Add
"Cold worked austenitic stainless steel is not used in the core support structure or the reactor internals of the APR1400 except for bolting or pins."

a. Core suppor

1) Type 304 austenitic stainless steel to the following specifications:

SA-182, SA-240, SA-479, and SA-965

2) Precipitation-hardened stainless steel to the following specification:

SA-638, Grade 660

3) S21800 stainless steel to the following specification:

SA-479

4) Type 348 stainless steel to the following specification:

SA-182

b. Upper guide structure assembly

1) Type 304 austenitic stainless steel to the following specifications:

SA-182, SA-240, SA-213, SA-479, SA-965, A511 (ASME Code Case N-60-5)

2) Type 347 austenitic stainless steel to the following specification:

SA-479, SA-312