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.:	**523-8684**
SRP Section:	**04.05.01 – Control Rod Drive Structural Materials**
Application Section:	**4.5.1**
Date of RAI Issue:	**10/01/2016**

Question No. 04.05.01-16

REGULATORY BASIS: GDC 14 and 26

This RAI is a follow-up to RAI 303-8391, Question 04.05.01-02 and RAI 436-8538, Question 04.05.01-11.

The response to RAI 8538, Question 04.05.01-11, submitted by letter dated April 19, 2016 (ADAMS Accession No. ML16110A454), stated the following:

> "The Versa Vent™ is installed at the initial installation phase of CEDM and venting is performed through the vent stem to eliminate the air trapped in the top of the CEDM. During normal operation the Versa Vent™ is not used for venting. The Versa Vent™ is used during the refueling period for venting."

The applicant stated that it will eliminate the air trapped in the top of the CEDM (to keep the oxygen levels low) by venting during refueling periods. However, there is no data/justification to substantiate that this approach will actually work so that non-L grade Stainless Steels can safely be used (as previously discussed in RAI 8391, Question 04.05.01.01-2, see also Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel"). Therefore, the staff is requesting data/operational experience that demonstrates this approach works in practice.

Response

Venting and oxygen level of CEDM housing

Versa Vent™ has been used for approximately 20 years (since the late 1990s) to vent the air trapped in the top of the CEDMs in the OPR1000 plants. Versa Vent™ has a good operating history in the OPR1000 plants. No cracks have been found in the Versa Vent™ nor CEDMs of the OPR1000 plants. The venting process of the APR1400 CEDMs will be the same as the one that the OPR1000 plants have adopted.

As the RCS pressure increases during the start-up, the trapped volume of air in CEDMs is squeezed to a fraction of its original volume. In this condition, the CEDM venting is performed using Versa Vent^{TM} to result in the easy elimination of this small size of air pocket. Also, it should be noted that the refilled water inside the CEDMs contains hydrazine which is a strong oxygen scavenger.

After venting, the control rod drop testing for all control rods is performed before reactor criticality is reached. At first, some of the water in the upper pressure housing is displaced when the rods are withdrawn. After that, when the rods are dropped, water with dissolved oxygen levels typical of the bulk primary coolant flows into each of the housings and mixes with the water in the CEDM housing. Since the volume inside the CEDM is small and the rods drop fast (drop time at 90% inserted position is ≤ 4 sec.), there must be a significant movement of water and large dilution of the dissolved oxygen level in the housing. After this testing, the most rods are withdrawn again to achieve reactor criticality. Also, additional CEDM stepping and any residual hydrazine or hydrogen reactions to the oxygen will reduce the oxygen level further.

Therefore, KHNP believes that this venting process and CEDM operation condition ensures the low dissolved oxygen level in the top of the CEDMs.

Potential for Degradation of the Highest Weld Region of CEDM Housing

Even though it would be unlikely to occur, the weld joint area between CEDM upper housing and upper end fitting, that is, the highest weld region of CEDM housing may suffer a somewhat high dissoved oxygen level due to unsufficient venting of the CEDM. However, if this area may be exposed to this level of dissolved oxygen, SCC would not be expected to occur because of the following reasons:

1) Control of the use of sensitized austenitic stainless steel
   As stated in the response to RAI 303-8391, Question 04.05.01-2, Type 316 stainless steel base materials used in the CEDM housings are supplied in a solution annealed condition and are not sensitized by welding operation because the welding procedures qualified in accordance with the RG 1.44 are only applied. In addition, the welding material is a low carbon grade stainless steel, Type 316L which is SCC resistant.

2) Small residual weld stress
   Residual stress is one of main factors to cause SCC. Even though the stress is always present as a result of welding, the stresses on the CEDM housing inside diameter surfaces are minimized by the following:

   - The small weld volume due to narrow U-groove weld application,
   - The welding direction from inside diameter to outside, and
   - Impossibility of an inside diameter repairs due to the small inside diameter of CEDM housing.

3) Low operating temperature
   The low operating temperature of the CEDM column just below the weld between the CEDM upper housing and upper end fitting decreases the susceptibility to SCC. The

operating temperature of the similar weld area in the CEDM has been measured to be 135°F during operation on the St. Lucie Unit 2 (See Note 1). It is expected that the temperature would be similarly low in the highest weld area of APR1400 CEDM upper housing because of the similarity in design between St. Lucie Unit 2 and APR1400 CEDMs.

Therefore, KHNP believes that the potential for SCC degradation of the highest CEDM housing weld is extremely low.

Note 1: L-2014-339, Letter from Steve Catron (FPL) to NRC, “RAI Reply – Third Ten-Year Interval Unit 2 Relief Request No. 14”, 2014. Nov. 3.

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 Report.