# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**APR1400 Design Certification**

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

**Docket No. 52-046**

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| **RAI No.:** | **391-8462** |
| **SRP Section:** | **06.02.02 - Containment Heat Removal Systems** |
| **Application Section:** | |
| **Date of RAI Issue:** | **02/01/2016** |

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## Question No. 06.02.02-38

Based on the TR and the November 24, 2015, responses (ML15328A218) to MCB Issues #7 and #8 (KHNP AI 6-19.7 and -19.8), it is the staff's understanding that the APR1400 chemical effects analysis was based on bounding pH values in the WCAP-16530-NP-A methodology. However, the TR includes Figure 3.8-1, "Minimum IRWST pH vs. Time Curve," without explaining how it was used. In order to support the staff's understanding of the APR1400 chemical effects analysis, please describe how Figure 3.8-1 was generated and how it was used in the analysis. Explain whether multiple WCAP-16530-NP-A analysis were performed to compare different pH transients or whether only the bounding analysis in the TR was performed.

## Response

This minimum IRWST pH curve is not used in the chemical effects analysis; the bounding pH values (the highest pH values during the short-term and long-term responses, respectively) are used. Figure 3.8-1 of the Technical Report will be replaced with the pH curve used in the analysis and renamed appropriately, as shown in the attachment.

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### 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**

Technical Report APR1400-E-N-NR-14001-P/NP, Section 3.8.2 and Figure 3.8-1 will be revised as indicated in the attachment.

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IRWST and Containment Spray pH vs. Time Curve used in Chemical Effects Analysis

### 3.8 Chemical Effects

In order to assess potential chemical effects in the APR1400 sump, the materials that are in the containment building that may react with coolant in the post-accident containment environment have been identified. Reactive plant materials in the containment building are categorized as metallic and non-metallic items and generally include insulation and concrete, as well as other potential sources of aluminum. The materials inventory includes the overall mass, location in containment and potential for being sprayed with or immersed in coolant following a LOCA.

The WCAP-16530-NP methodology (Reference [3-11]) referenced in NRC RG 1.82 (Reference [1-1]) provides a conservative model to predict the corrosion and dissolution of containment materials in a post-LOCA environment and the formation of chemical precipitates for participating PWRs. The primary corrosion products contributing to these chemical precipitates are calcium, silicon, aluminum, and the precipitates that can form aluminum oxy-hydroxide, calcium phosphate, and sodium aluminum silicate. Surrogate suspensions of chemical precipitates representing this chemical debris can be included as an additional debris source to the strainer testing program to qualify the strainer for “chemical effects.” The quantities of chemical precipitates are based on reactive material surface areas and quantities, temperature, water level, pH, and other parameters related to the plant specific environment and post-accident evolution.

#### 3.8.1 Containment Spray pH Control

The pH of IRWST water is evaluated to provide reasonable assurance that the calculated minimum and maximum pH values under any possible water chemistry conditions caused by a LOCA are between 7.0 and 8.5. The calculated minimum and maximum IRWST pH during operation of the CSS is 7 and 10, respectively. ~~The minimum time to reach a minimum pH of 7.0 is 157 minutes, as shown in Figure 3.8-1.~~ The IRWST pH ranges are included in Table 3.8-1.

#### 3.8.2 Assumptions

1) The maximum IRWST water volume is used for the chemical effects analysis. Using the maximum water volume ensures that the maximum material dissolution and quantity of precipitates are analyzed.

2) Temperature data is only available from zero to 1,000,000 seconds post-LOCA. Since the mission time is 30 days (2,592,000 seconds), the containment air temperature and IRWST temperatures are extrapolated using a logarithmic fit of the last 9 days of available temperature data to predict the containment air and IRWST temperatures from 1,000,000 seconds to 2,592,000 seconds. This time period is chosen due to the consistently logarithmic temperature decrease for the entire time period.

3) The maximum IRWST and spray pH profile is used to conservatively maximize dissolution and precipitate generation.

4) The minimum ECCS flow case is used because it results in the highest sump temperatures, and therefore the highest corrosion rate of reactive materials in the sump. Both the minimum and maximum ECCS flow cases result in the comparable containment air temperature profiles.

Figure 3.8-1 shows that the IRWST and containment spray pH versus time curve used in the chemical effects analysis.

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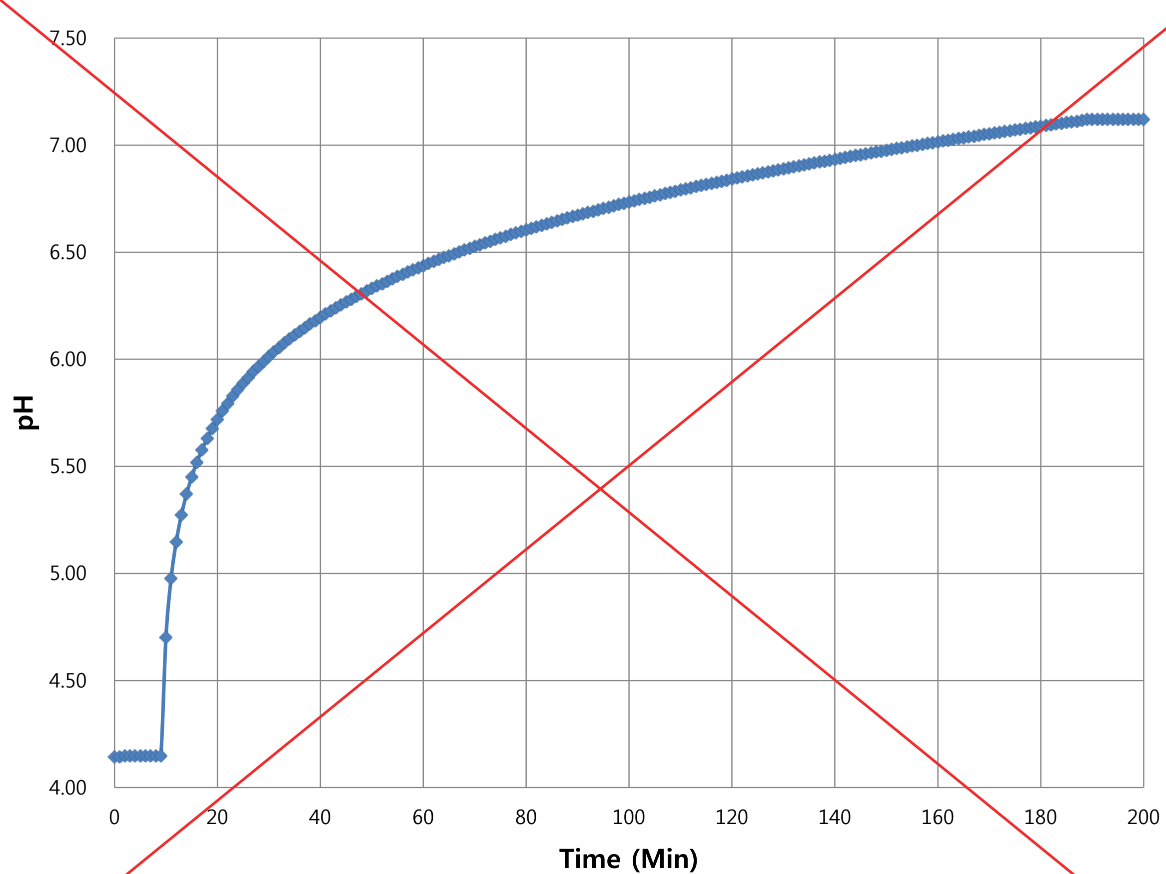


**Figure 3.8-1 Minimum IRWST pH vs. Time Curve**

A

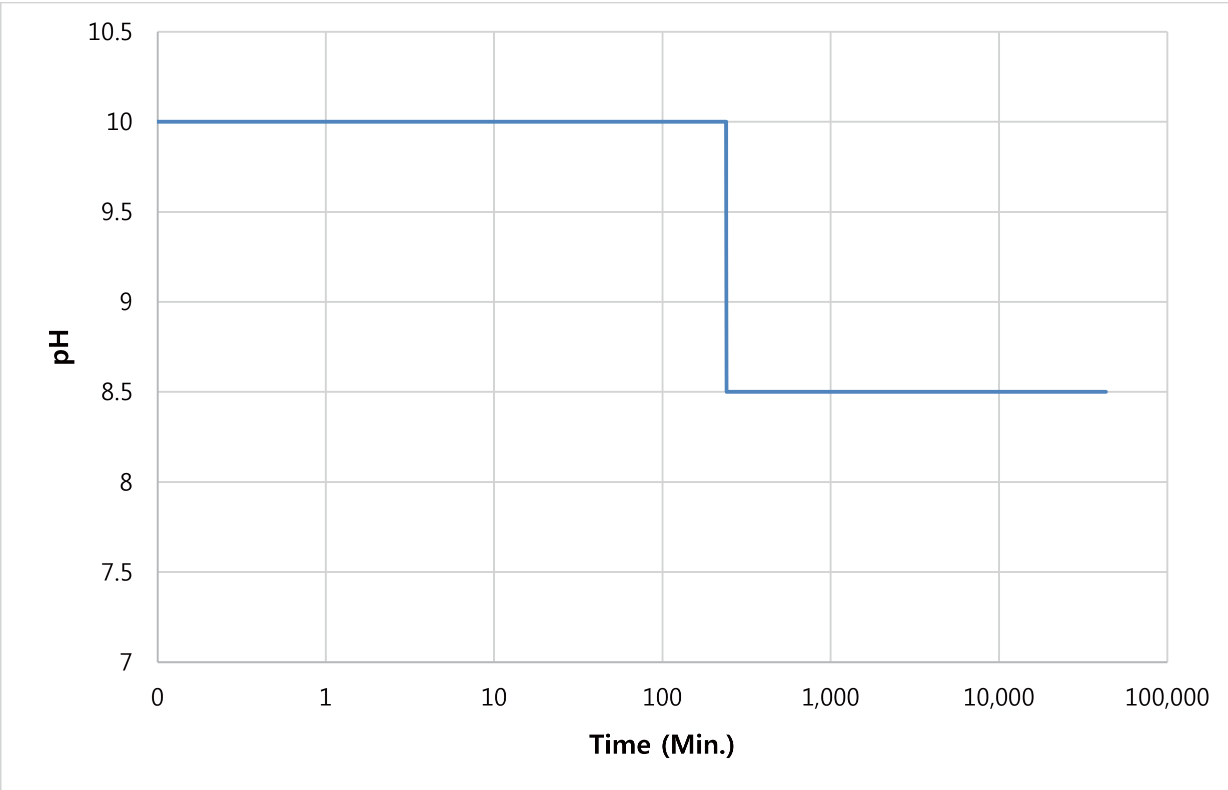


Figure 3.8-1 IRWST and Containment Spray pH vs. Time Curve used in Chemical Effects Analysis

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## Question No. 06.02.02-39

The November 24, 2015, response (ML15328A218) to MCB Issue #9 (KHNP AI 6-19.9) states that it is conservative for the APR1400 chemical effects analysis to treat unsubmerged aluminum and concrete as if it were submerged. The response also proposes stating this as an assumption in Section 3.8.2 of the GSI-191 Technical Report. Please describe the basis for concluding it is conservative to treat the unsubmerged materials as being submerged, including consideration of the temperature of the containment atmosphere and pH profile of the containment spray solution. (The WCAP model assumes unsubmerged materials are at the containment temperature.) It is not clear to that staff how that assumption was justified since the report does not discuss the pH of the containment spray solution or temperature profile of the containment atmosphere (corresponding to unsubmerged coupons).

## Response

The chemical debris that potentially causes the chemical effects is caused by both submerged and unsubmerged concrete and unsubmerged aluminum, as specified in the GSI-191 Technical Report, Section 3.5.1 and Table 3.8-2. The chemical precipitates generated from the chemical debris in the chemical effects analysis is calculated in accordance with WCAP-16530-NP methodology. The unsubmerged concrete is considered as submerged concrete in order to maximize the precipitates from concrete dissolution. The unsubmerged aluminum surface area is used as input for unsubmerged material not submerged material. A conservatively large number (1,000,000 lbm) is used for both the submerged and un-submerged aluminum masses to calculate the chemical precipitates, even though the exact mass of unsubmerged aluminum is known and the submerged aluminum is equal to zero. The input data for the WCAP-16530-NP-A chemical product formation are listed in Table 3.8-3.

Based on the above, the response (ML15328A218) to MCB Issue #9 (KHNP AI 6-19.9) will be revised.

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**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.