RESPONSE TO AUDIT ISSUES

APR1400 Topical Reports

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

Docket No. PROJ0782

Review Section	**TR Realistic Evaluation Methodology for LBLOCA of the APR1400**
Application Section	**Topical Report: APR1400-F-A-TR-12004 Realistic Evaluation Methodology for Large-Break LOCA of the APR1400**
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Audit Issues No. 20

The guidance in RG 1.157, Section 2.1.2 establishes acceptable controls for the calculation of the effects of noncondensible gases in best estimate analysis. In addition, NUREG/CR-5249 (pg. 68) explicitly addresses the bias due to dissolved nitrogen. The RELAP5/MOD3.3 code does not model dissolved nitrogen in the liquid and therefore, the predicted reflood peak cladding temperature does not reflect its effect. An assessment and documentation of the effect of dissolved nitrogen on the PCT is needed.

Response

Dissolved nitrogen release from SIT-FD was evaluated in Section 5.2 of Reference [1]. This report conservatively estimates mass and volume flow rate of dissolved nitrogen from SIT-FD and analyzes their effects on the fluidic device K-factors as shown in Figure 5.2-1 and Figure 5.2-2 of Reference [1]. The estimated mass and volume flow rate results of dissolved nitrogen are relatively small compared with those of ECCW from the SIT-FD. Especially, since SIT-FD of APR1400 has large amount of ECCW during high injection period, the impact of dissolved nitrogen on the refill phase duration can be insignificant.

In this response, sensitivity calculation is performed to evaluate dissolved nitrogen effects on the refill phase using APR1400 LBLOCA input deck. The amount of dissolved nitrogen is calculated based upon a few conservative assumptions that nitrogen gas is fully saturated in the water of SIT-FDs (nitrogen gas can be fully dissolved only near the water surface), amount of dissolved nitrogen in the water is proportional to partial pressure of nitrogen gas, and all dissolved nitrogen is released when the water from SIT-FDs is discharged through the DVI nozzle. In this calculation, pressure change in the tank is not considered and larger amount of dissolved nitrogen is released than the evaluated in Reference [1] to make the effects of dissolved nitrogen on downcomer hydraulics clearly and the conservative ECCW bypass phenomena.

Solubility of nitrogen gas at 303.15 K and atmospheric pressure is about 17 mg per one kilogram of water [2]. [

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Four time-dependent volumes and junctions are used to simulate dissolved nitrogen gas release, and each set of time-dependent volume and junction installed at the same position of DVI. The amount of released nitrogen gas is controlled by control variable of RELAP and it refer to mass flow rates of SIT-FDs.

Most of the LBLOCA analysis results show that refill is ended at about 33 sec after break, thus, this study focuses on the time frame between initiation of break and 50 sec after.

Figure 1 shows the total dissolved nitrogen gas release rate from four SIT-FDs. The peak mass flow rate of dissolved nitrogen is about 2.7 kg/s, and this value exceeds the maximum value of Reference [1] as described above. This is intended to demonstrate the apparent effect of dissolved nitrogen on ECCW bypass.

Figure 2 shows core collapsed water level. Bottom of active core is about 2.5 m, and collapsed water level reaches that elevation at about 35 seconds in common. It means dissolved nitrogen gas has no effects on the refill phase duration. Since discharged water mass flow rate from SIT-FDs is large enough, dissolved nitrogen effects are negligible and this results is consistent with the above description.

Figure 3 shows accumulated break liquid mass flow through vessel side break to investigate ECCW bypass. Accumulated liquid break mass flow rates of both cases are similar, and it means that dissolved nitrogen effects on ECCW bypass are also insignificant.

As discussed above, the dissolved nitrogen has no effects during refill phase because dissolved

nitrogen gas release rate is relatively small and large amount of ECCW from SIT-FD are injected during APR1400 LBLOCA.

After 50 sec, the downcomer is filled and maintained with ECCW from SIT-FDs even though the dissolved nitrogen gas released, as shown in Figure 4. Therefore, the dissolved nitrogen gas has minimal effects on the core cooling and it can be concluded that additional bias on dissolved nitrogen is not considered in APR1400 LBLOCA analysis.

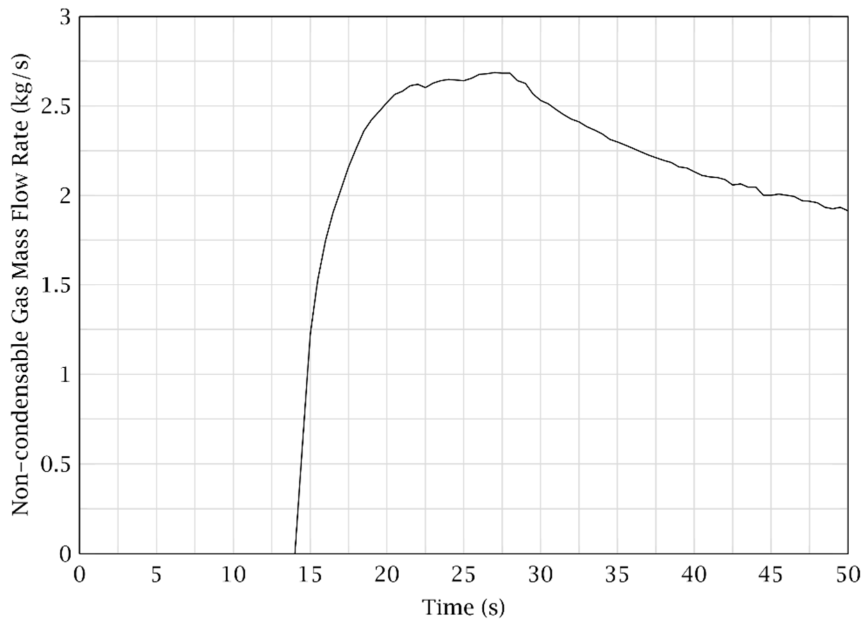

Figure 1. Total Nitrogen Gas Release Rate from Four SIT-FDs

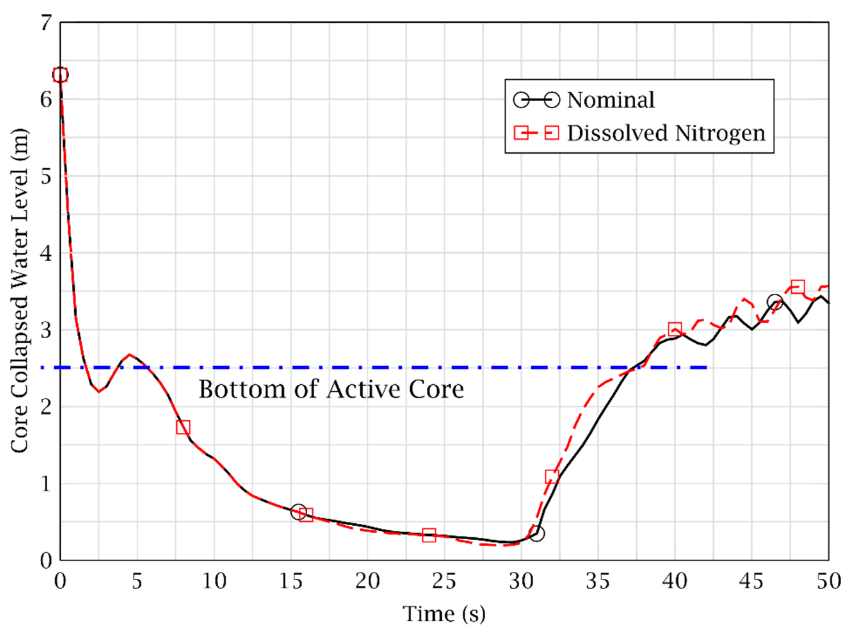

Figure 2. Core Collapsed Water Level

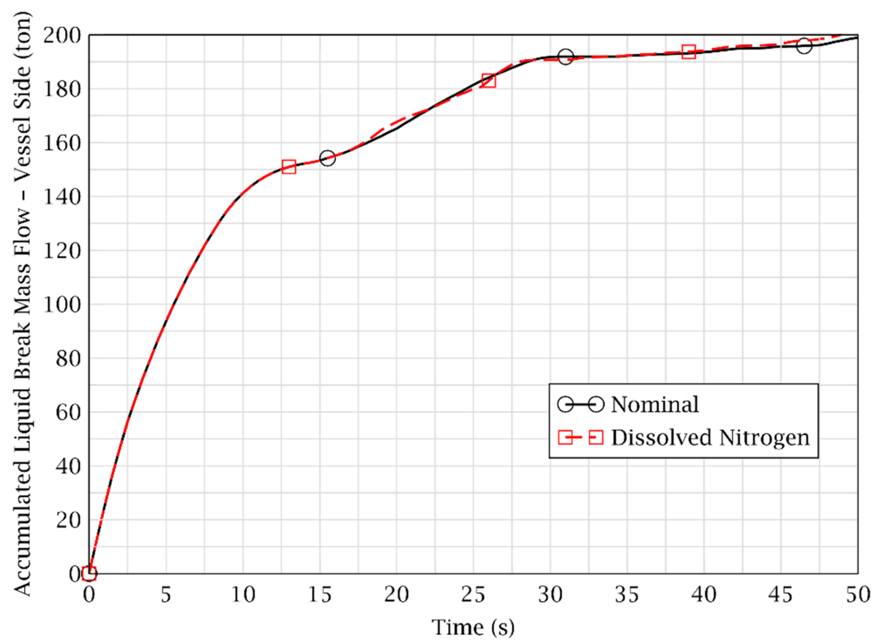

Figure 3. Accumulated Break Liquid Mass Flow Rate

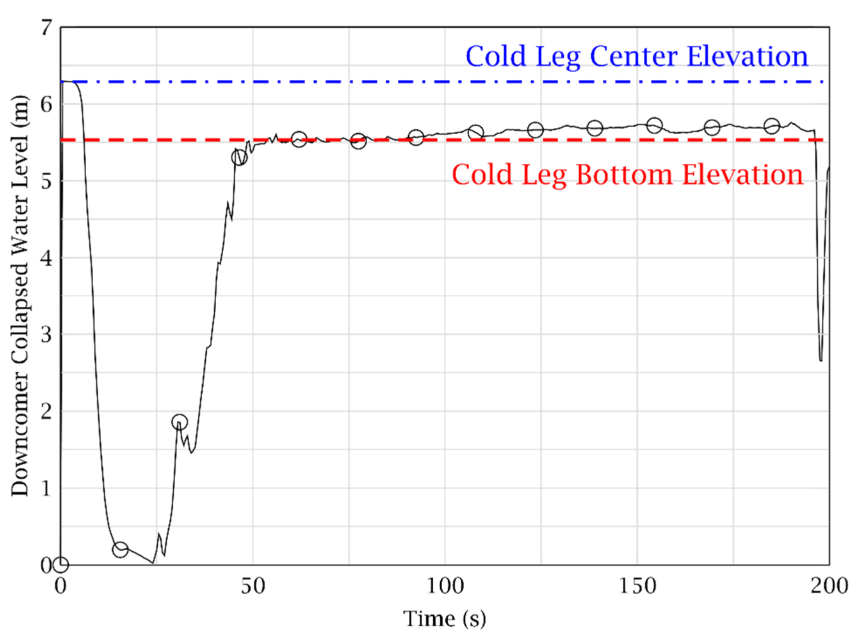

Figure 4. Downcomer Collapsed Water Level Result of Dissolved Nitrogen Injection Case

Reference

[1] KHNP, “Fluidic Device Design for the APR1400,” APR1400-Z-M-TR-12003-P, Rev. 0, December, 2012.

[2] Nikolay Ivanov Kolev, “Multiphase Flow Dynamics 4: Nuclear Thermal Hydraulics,” Springer, page 409, Fig. 11.6.

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 Report

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