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APR-1400 Loop Seal and Its Impact on Long Term Cooling During A Postulated Loss-of-Coolant Accident

by

Shanlai Lu

NRO/DSRA/SRSB

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Regulatory Basis

10CFR50.46(a)(iii)(5)

After any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radio-activity remaining in the core.

APR-1400 Long Term Cooling

Draft RAI (7508)

NRC Regulation 10CFR 50.46 requires that a light water reactor must have an Emergency Core Cooling System (ECCS) to mitigate a Loss of Coolant Accident. In addition to a short time period of reflood, the ECCS must be capable of providing long term decay heat removal for up to 30 days. During a postulated design basis cold leg slot break, the ECCS of the APR1400 design must also provide decay heat removal to prevent the core from being uncovered. With a reactor coolant pump suction side loop seal elevation close to the midpoint of the core height, the steam pressure in the upper part of the core may increase to the point of overcoming the static head of the loop seal. Provide the technical basis to show that the reactor core cooling will be maintained before and after the potential loop seal clearing and that the peak cladding temperature remains within acceptable limits.

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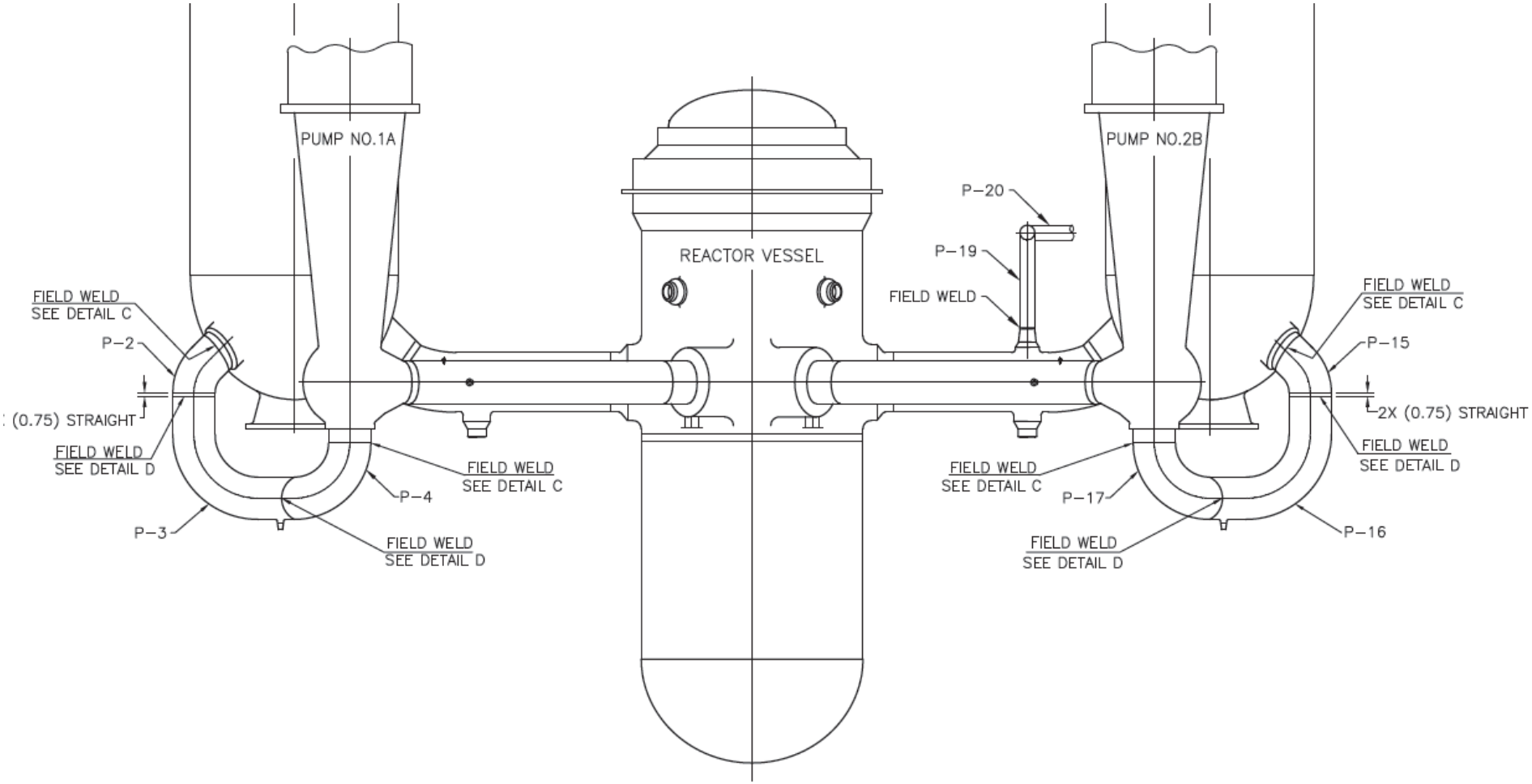
APR-1400 Primary System



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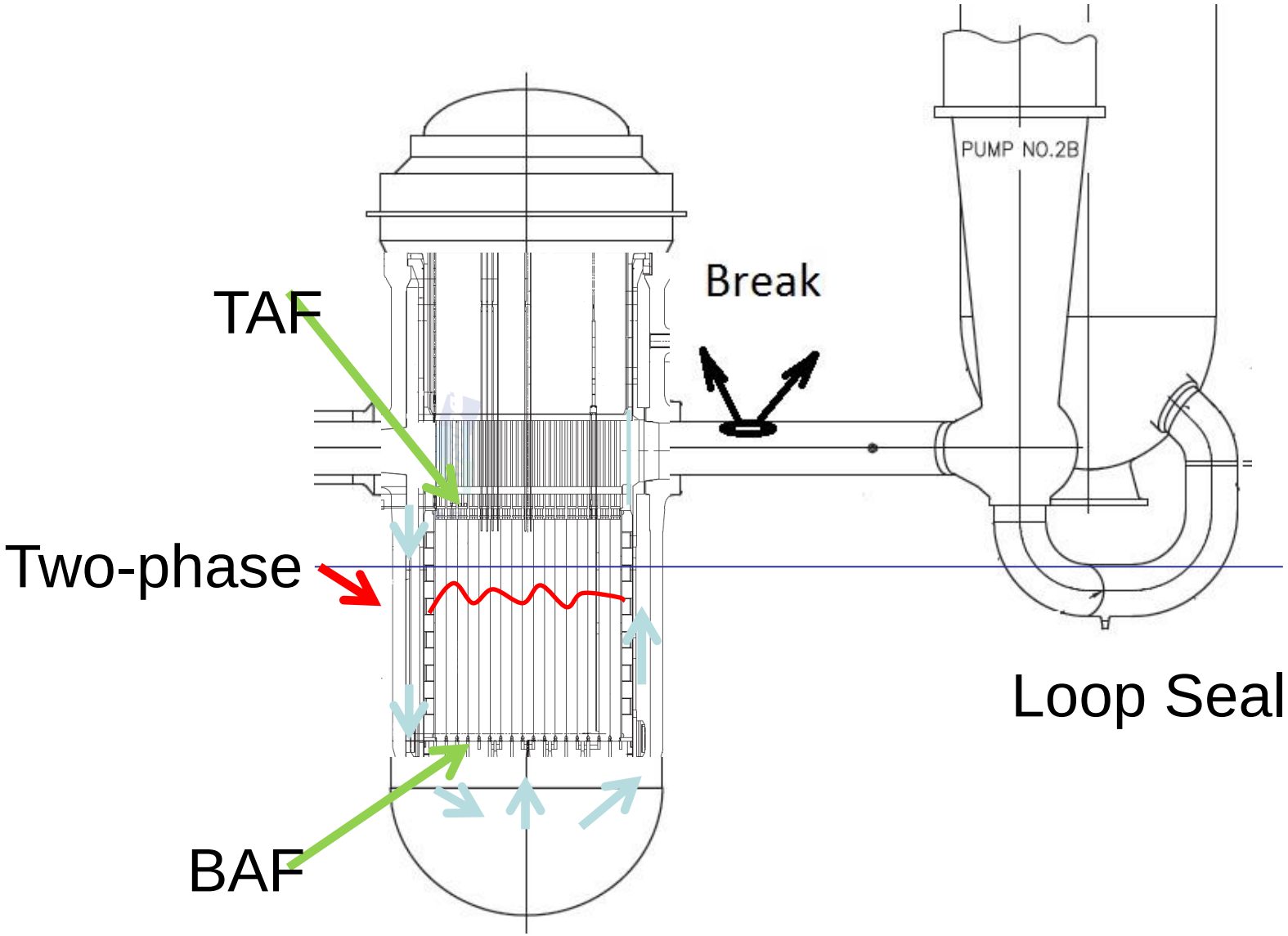
Cold Leg Slot Break



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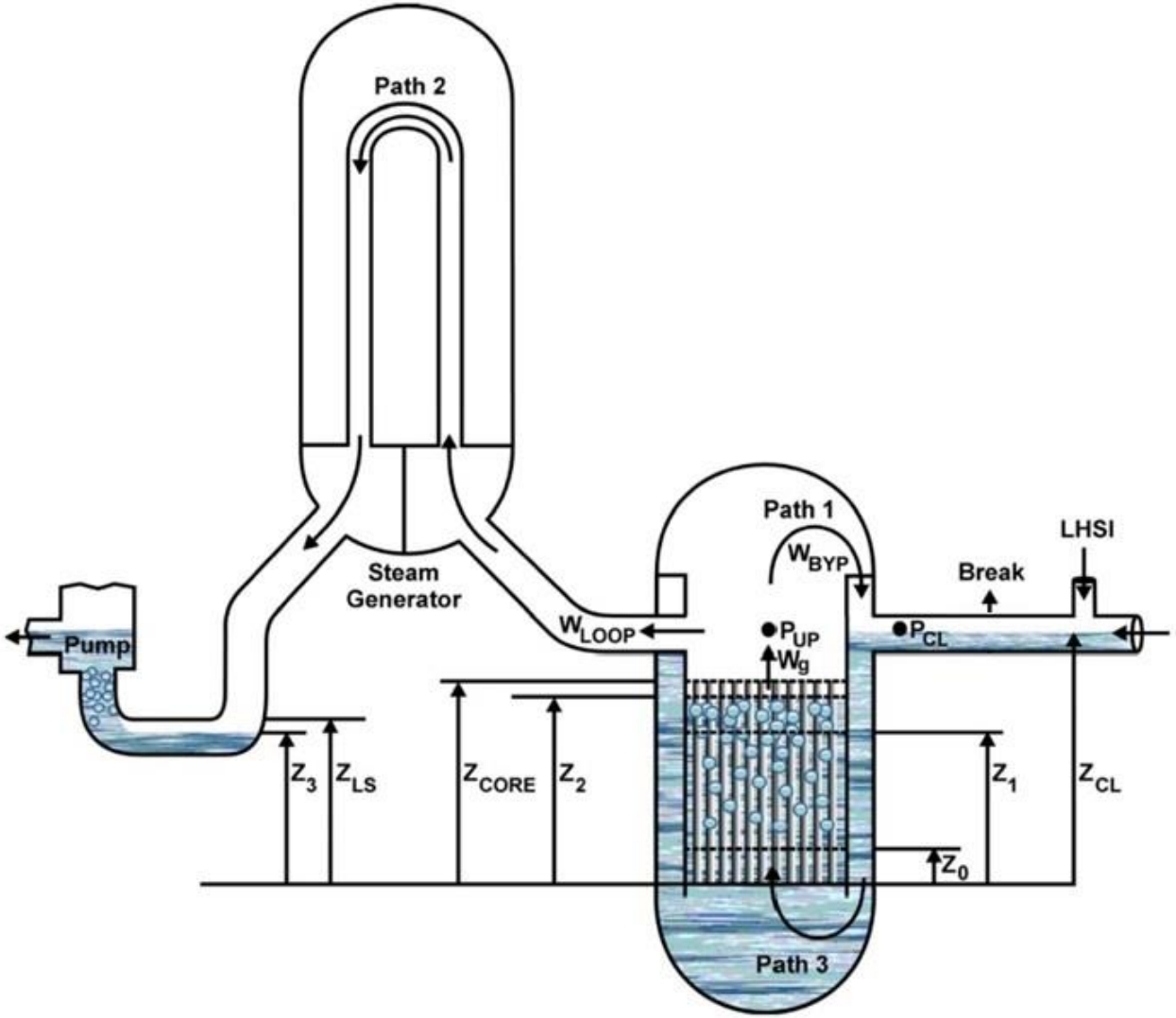
Loop Seal Formation And Clearing



Past NRC Practice

NRC RAI Regarding US EPR Long Term Cooling

Time: 5/25/2010 **ADAMS #:** ML101450526
Question 15.06.05-51:

If the two-phase mixture level drops below the TAF anytime during the U.S. EPR long term cooling phase of a LOCA, cladding heatup and oxidation can result. Please provide the results of a thermal-hydraulic analysis quantifying the two-phase mixture level within the reactor core barrel during the long term cooling of the U.S. EPR core under the most limiting break size, break location and ECCS performance conditions. Discuss the conservatism of the obtained results. For important modeling parameters that are expected to vary within a certain range, substantiate the conservatism in selecting the value for each parameter or provide sensitivity assessments over the expected range of variation. This question is as a follow-up to the reactor systems audit held on April 21-24, 2009

Past NRC Practice

NRC Audit Report – US EPR

Time: 03/24/2010 **ADAMS#**: ML100810280
Issue #3: Quasi Steady State Steaming Assumption – Too conservative?

Current long term cooling evaluation model assumes quasi steady state steaming through the loop seal. It appears that the method ignores the possible dynamic clearing of the loop seal for EPR. If this is the case, does this mean that the quasi steady state assumption may result in extremely conservative and unrealistic prediction of core uncovery and oxidation?

Issue #4: Quasi Steady State Steaming Assumption – Extreme Case

Following the analysis approach of a quasi steady state evaluation, the worst scenario could be the minimum steaming condition. The belief is that the minimum steaming rate results in the maximum core uncovery.

Assuming this is true, for EPR, the minimum steaming rate would result in very shallow penetration through the loop seal. The estimated collapsed water level would be only a few inches into the core. What is the problem?

Path Forward

Impact of this issue:

Affect the available DP for the cold leg break case, which is the important parameter for fuel bundle head loss testing acceptance criteria

Possible Resolution Paths:

LBLOCA Topical Report

DCD 15.6.5