REQUEST FOR ADDITIONAL INFORMATION QUESTIONS

AREVA NP INC. TOPICAL REPORT

EMF-2328(P)(A), REVISION 0, SUPPLEMENT 1, REVISION 0, "PWR SMALL

BREAK LOCA EVALUATION MODEL, S-RELAP5 BASED"

The following request for additional information (RAI) questions are based on the U. S. Nuclear Regulatory Commission (NRC) staff review of AREVA NP Inc. (AREVA) Topical Report (TR) EMF-2328(P)(A), Revision 0, Supplement 1, Revision 0, "PWR [Pressurized Water Reactor] Small Break LOCA [Loss-of-Coolant Accident] Evaluation Model, S-RELAP5 Based." Please note that a general observation is that there were no discussions or presentations of the validation of the proposed changes against integral and separate effects test data. For this reason the RAI questions below, for the given changes, request validation of the new code against appropriate experimental data.

<u>RAI # 1</u>:

1.1 Section 2.3 of the TR describes changes to the hot leg model in S-RELAP5.

   a). Please describe the counter current flow limit (CCFL) correlation and coefficient employed in the hot leg and identify the junctions in the hot legs to which the CCFL correlation is applied.
   b). Please provide comparison of the new S-RELAP5 model predictions to data (such as ROSA SB-CL-18) and demonstrate that the code correctly captures stratified counter current flow conditions in the hot leg as well as carry over into the steam generators when steam flow conditions are sufficient to reduce or preclude liquid downflow.
   c). Identify the steam mass flow rate at which complete liquid carry over is predicted and show that this condition is supported by the UPTF Test 11 conditions and CCFL correlation. Please note that there are other tests in UPTF test series to validate this model and other facilities such as the Transient Two-Phase Flow experiments.

1.2 Justify that **[ ]** volumes are sufficient to capture the full range of conditions in the hot leg, when NUREG/IA-0116 states that **[ ]** volumes are required to properly simulate counter current flow conditions in the hot leg.

   a). Present nodal sensitivity studies to show that **[ ]** volumes are adequate.
   b). Please show the sensitivity of the code results to inclination angle.

ENCLOSURE 1

c). Please show the sensitivity of the CCFL correlation coefficients to the prediction of counter current flow (liquid downflow versus steam upflow) and carry over in the hot leg.

1.3 No validation of these or the other method changes in EMF-2328(P)(A), Revision 0, Supplement 1, Revision 0, were identified or referenced.

a). Please show the validation of the model and CCFL correlation against the SEMISCALE Test S-UT-8 experiment, which treats water hold-up in the steam generators.
b). Show plots of the fluid levels in the steam generator uphill volumes and hot legs.
c). Show liquid levels in the loop seal regions.
d). Also, present the clad temperature versus time at the peak cladding temperature (PCT) location and core two-phase and liquid levels, and core pressure responses with the test data.
e). Also, please show a plot of the flow regimes in the hot legs for this test.
f). Please demonstrate that loop seal behavior is also captured for this test.

1.4 Please compare the S-RELAP5 predictions to other integral test data such as the larger small breaks in the ROSA IV large scale test facility test series (see SB-CL-14 10 percent break, for example) to further demonstrate and validate the changes to the hot leg model against integral data.

a). Please show that the model correctly simulates hot leg counter current flow behavior for the largest break sizes included in the small break LOCA (SBLOCA) spectrum (i.e., severance of the largest diameter safety injection line at the discharge leg connection).

1.5 Please also show plant calculations for the largest SBLOCA in the cold leg (0.5 - 1.0 square feet (ft^2)).

a). Show with the changes to the hot leg **[ ]** and CCFL correlation.
b). Show without the changes to the hot leg **[ ]** and CCFL correlation.
c). Show the clad temperature versus time and hot leg liquid levels as well as the core two-phase steam generator and liquid levels.
d). Show that carry over and stratification are correctly simulated.

1.6 Please describe the CCFL correlation **[ ]**.

a). Show comparisons to appropriate test data to validate these models.

b). Show that the correlation properly limits the counter current flow behavior in these regions.

RAI # 2:

Section 3 of the TR describes the core bypass modeling. Since the S-RELPA5 code will be applied to plants with upper head spray nozzles.

2.1 Please demonstrate through a comparison to test data that S-RELAP5 can properly capture the effect of core bypass on system response following a SBLOCA.

2.2 Show that loop seal hydraulic behavior is properly captured as well as the core two-phase and liquid level responses in the core during uncovery.

2.3 Present data comparison to the clad temperature at the PCT location. Please see NUREG/CR-4438 for a description of these tests and data.

RAI # 3:

3.1 Please demonstrate that the downcomer modeling for the case when the reactor coolant pumps (RCPs) are operating capture the proper hydraulic phenomena.

a). Should the downncomer levels decrease toward the bottom of the downcomer (cross-over to the lower plenum), demonstrate that the model simulates the two-phase flow communication properly between the downcomer and lower plenum as the fluid transitions from a low quality two- phase mixture to vapor.

b). Also, as vapor is pumped into the down comer from the cold legs describe how the code models the penetration of vapor into the downcomer liquid region at the surface and show that entrainment of downcomer liquid as vapor passes from the intact loops is properly accounted for in the model.

3.2 Please justify the applicability of the S-RELAP5 physical models and modeling techniques to SBLOCAs with the RCP running.

a) Please present validation of the model against integral and separate effects test data.

RAI # 4:

Section 7 discusses the approach to loop seal clearing following an SBLOCA. There are concerns when with the limiting break analysis when multiple loop seal clearing behavior results in the suction legs. Typically, PCT is maximized when only the broken loop seal clears due to the increased resistance of vapor flow through only one loop versus multiple venting loops.

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4.1 Please provide an analysis an appropriate sample plant with and without the proposed modification. Show the impact on PCT for these two cases.

4.2 Also, describe any changes to the downcomer model that impacts entrainment of liquid out the break.

4.3 To validate the suggested approach, please show that the scaling approach to set the maximum break size for which only one loop seal clears, predicts test data for loop seal clearing in different facilities (ROSA test facility, as well as SEMISCALE Tests S-07-10 and S-07-10D, for example). Please see EGG-SEMI-5201 for these test data. These tests included loop seal effects and the impact on long term core uncovery.

   a). Please provide plots of the loop seal levels as well as the core two-phase and liquid level responses.
   b). Also provide the relevant transient plots to demonstrate that the key phenomena, including loop seals completely or partially cleared, are properly simulated.

(The Bethsy facility also provides additional integral data to validate the changes in EMF-2328(P)(A), Revision 0, Supplement 1, Revision 0.)

<u>RAI # 5</u>:

Please provide a plant sample break spectrum analysis with all of the EMF-2328(P)(A), Revision 0, Supplement 1, Revision 0, changes included. This could be accomplished by comparing the results of a sample plant SBLOCA spectrum with and without the EMF-2328(P)(A), Revision 0, Supplement 1, Revision 0, changes. This should include the severance of the safety injection line, as well.

RAI # 6:

NUREG/IA-0116 documented S-RELAP5 code failures for the UPTF Test 11 for runs 36 – 45, please verify that the coding error has been corrected in the AREVA version and that these tests were properly simulated.