July 11, 2001

Mr. James F. Mallay
Director, Regulatory Affairs
Framatome ANP
2101 Horn Rapids Road
Richmond, WA 99352

SUBJECT: INADEQUATE DOCUMENTATION OF REVISION TO LOSS-OF-COOLANT ACCIDENT EVALUATION MODEL (TAC NOS. MA9763, MA9764, AND MA9765)

Dear Mr. Mallay:

The Nuclear Regulatory Commission staff has performed a preliminary review of the Framatome Technologies Inc., now Framatome ANP, letters of July 31, 2000, which discuss proposed changes to loss-of-coolant accident evaluation methodologies described in Topical Reports BAW-10164P, Revision 5, BAW-10168P, Revision 4, and BAW-10192P, Revision 1. The staff review also considered additional information provided by Framatome at several public meetings on this subject. The staff concludes that the information contained in the letters and the topical report revisions, in their present form, lacks sufficient detail, clarity, and justification to permit the staff to complete its review. To enable the staff to complete its review, Framatome must address the following issues:

1. The proposed changes are substantial and, as such, constitute a new emergency core cooling system (ECCS) model. The new ECCS model warrants its own separate designation and documentation and must meet the provisions contained in 10 CFR 50.46 and 10 CFR Part 50, Appendix K.

2. Certain items (e.g. “end of bypass” and reverse flow through the break) must be demonstrated to conform with the provisions of 10 CFR Part 50, Appendix K.

3. Many proposed changes are presented without discussion of their bases, what they affect, and why they are proposed.

4. For some items where justification is given, there is insufficient clarity to permit the reader to know the purpose of the information or to evaluate the acceptability.

5. A single, concise description of the methodology is needed, covering the theory and models, user’s guidance, input description, and code assessment.

In addition, in order to facilitate the review, the staff requests that you provide all information pertinent to the proposed code version(s) of RELAP5, including full documentation and manuals, an electronic version of the code in both source and executable forms, and a representative input deck for each plant type that the proposed version of RELAP5 will be applied to.

Further, enclosed are questions that identify the type of information that the staff expects to be presented. The documentation of the new ECCS model must be upgraded, including consideration of the enclosed questions, in order for the staff to commence the next phase of its review.

Pursuant to 10 CFR 2.790, the staff has determined that the enclosed questions do not contain proprietary information. However, the staff will delay placing the questions in the public document room for 10 calendar days from the date of this letter to allow you the opportunity to comment on the proprietary aspects only. If, after that time, you do not request that all or portions of the questions be withheld from public disclosure in accordance with 10 CFR 2.790, the questions will be placed in the NRC Public Document Room.

An appropriate schedule for the review will be determined when Framatome provides the necessary information. The schedule will consider the issues listed above, the issues identified in the enclosed questions, the review process, and the necessary adjunctive processes, including a review by the Advisory Committee for Reactor Safeguards (ACRS).

If you wish to discuss the staff's review, ways to expedite information exchange, or ways to expedite the review process, please contact Stewart Bailey at (301) 415-1321.

Sincerely,

***/RA/***

Stuart A. Richards, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 693

Enclosure: Questions

cc w/encl: See next page

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ADDITIONAL STAFF QUESTIONS

FRAMATOME ECCS MODEL REVISIONS

JULY 2000

**BAW-10164 (RELAP5) and BAW-10166 (BEACH reflood model)**

GENERAL QUESTIONS

A. REFLOD3B replacement: refill and reflood flow, drag, and heat transfer were changed and/or added using RELAP5 correlations.

   1. Identify where these changes are discussed in detail (by document, section, and page).

   2. How are these phenomena treated (bounding or representative)?

   3. How is the treatment of these phenomena substantiated (engineering manuals, empirical data, or sensitivity studies)? Provide details (quote bases from manuals; give data, including plots; show the results of sensitivity studies with a discussion of the parameters that were varied).

   4. Justify that the models, as incorporated, do not by their interactive effects compromise the acceptability of unchanged portions of the methodology.

   5. How is the treatment of the phenomena adjusted to accommodate the different plant designs that the models will be applied to?

   6 Show how the treatment of the phenomena, as implemented, is consistent with RELAP5 capabilities.

   7. Show how the treatment of the phenomena, as implemented, is appropriate for a 10 CFR Part 50, Appendix K, methodology.

B. Downcomer, lower head, and lower plenum: Wilson bubble rise model, interphase drag reduction, and interphase heat transfer increase.

   1. Identify where these changes are discussed in detail (by document, section, and page).

   2. How are these phenomena treated (bounding or representative)?

   3. How is the treatment of these phenomena substantiated (engineering manuals, empirical data, or sensitivity studies)? Provide details (quote bases from manuals; give data, including plots; show the results of sensitivity studies with a discussion of the parameters that were varied).

4. Justify that the models, as incorporated, do not by their interactive effects compromise the acceptability of unchanged portions of the methodology.

5. What are the bases for the special options described on page 2.1-184 of BAW-10164? Describe the technical data that support these options and the bases for the user-specified information (junction and multiplier $C1_{172}$). What are the limits imposed on $C1_{172}$ and how are those limit established?

6. How is the treatment of the phenomena adjusted to accommodate the different plant designs that the models will be applied to?

7. Show how the treatment of the phenomena, as implemented, is consistent with RELAP5 capabilities.

8. Show how the treatment of the phenomena, as implemented, is appropriate for a 10 CFR Part 50, Appendix K, methodology.

C. Core exit junction counter-current flow limitation (CCFL) correlation (BAW-10164, page 2.1 -133).

1. Identify where these changes are discussed in detail (by document, section, and page).

2. How are these phenomena treated (bounding or representative)?

3. How is the treatment of these phenomena substantiated (engineering manuals, empirical data, or sensitivity studies)? Provide details (quote bases from manuals; give data, including plots; show the results of sensitivity studies with a discussion of the parameters that were varied)?

4. Justify that the models, as incorporated, do not by their interactive effects compromise the acceptability of unchanged portions of the methodology.

5. How is the treatment of the phenomena adjusted to accommodate the different plant designs that the models will be applied to?

6. Show how the treatment of the phenomena, as implemented, is consistent with RELAP5 capabilities.

7. Show how the treatment of the phenomena, as implemented, is appropriate for a 10 CFR Part 50, Appendix K, methodology.

8. Identify and justify where the reference parameters and coefficients in equation 2.1.5-87 come from and how they are derived.

D. Distributed rupture zone.

1 How is this implemented?

2. What is the user input value and what is its basis?

3. Provide sensitivity studies and/or data.

4. Justify that the models, as incorporated, do not by their interactive effects compromise the acceptability of unchanged portions of the methodology.

5. How is this treatment of the phenomena adjusted to accommodate the different plant designs that the models will be applied to?

6. Show how this treatment of the phenomena, as implemented, is consistent with RELAP5 capabilities.

7. Show how this treatment of the phenomena, as implemented, is appropriate for a 10 CFR Part 50, Appendix K, methodology.

E. NEWQUEN reflood heat transfer option change to better predict SCTF test data.

   1. Is this the only data used to tune NEWQUEN?

   2. How much data is there, and is it prototypic for the reactor core geometries and conditions to which it will be applied (scaling)?

F. Comparisons to UPTF, SCTF, and REBEKA test data.

   1. Provide a summary table to show what comparisons were performed, for what phenomena and behaviors, and the results. Also identify where the details are by document, section, and page.

<u>SOME SPECIFIC QUESTIONS</u>

1. Provide a discussion and information to demonstrate that the mechanistic bypass model complies with the requirements of 10 CFR Part 50, Appendix K, Section I.C.1.c, for the "end of bypass."

2. The reflood heat transfer correlations in BEACH have been modified. Please redo your code assessments for reflood heat transfer so that they accurately represent the present code.

3. Please provide plots of predicted peak clad temperature (PCT) verses measured PCT. Provide a separate plot for forced reflood tests and gravity driven reflood tests.

4. Provide comparisons of predicted differential pressures (DPs) to measured DPs for both the downcomer and the core in the reflood heat transfer assessment cases.

5. The REFLOD3B code will be replaced by the RELAP5 code and the BEACH core constitutive package. Please provide discussions of comparisons to experimental data to

show that the new model complies with the requirements of 10 CFR Part 50, Appendix K, Section I.D.3, for calculating reflood rates.

6. Please provide assessment cases of gravity driven reflood tests and compare the predicted magnitude and frequency of condensation oscillations to the measured magnitude and frequency.

7. Please provide the algorithm and quantitative information from code calculations and data describing how the multipliers on code correlations were selected.

8. It was stated that the full plant calculations were consistent with the results of UPTF test 21D and 25. Provide comparisons of these test results with RELAP5 predictions with a test nodalization that is consistent with the plant nodalization. Also compare the test conditions to the plant calculation conditions.

9. Test results were cited from FLECHT-SEASET steam generator test to justify the conservatism of the steam binding in your plant calculations. Provide comparisons of RELAP5 predictions to the test results. Use a test facility nodalization that is consistent with the full plant calculations. Discuss the test conditions and scaling and how the test results compare to the full plant calculations.

10. Provide comparisons to experimental data that assess your code for predictions of water holdup in the upper plenum, hot legs, steam generator inlet plenum, and steam generator tubes. Provide comparisons to data that shows the distribution of the water holdup.

11. Provide code predictions of LOFT large break loss-of-coolant accident (LOCA) data. Justify the test selection and use a test nodalization that is consistent with the plant calculations.

12. BAW-10164, Rev. 5, page 2.1-49, states, "an option ... was added to reproduce previous BEACH results." When is this to be done and why?

13. ibid, page 2.1-184; justify the values for the multipliers used under "Special Options."

14. ibid, page M-4, Section M.1.1.1, states, "reactor vessel downcomer and lower plenum noding differs from the current [evaluation model]." A basic principle of code assessment is consistency of noding. Justify use of inconsistent noding.

15. ibid, page M-5; correct spelling of the code name (it is neither REALP5 nor RELP5).

16. ibid; justify the selection of all user input values C1n.

**BAW-10168 (Once-through steam generator, OTSG) and BAW-10192 (Recirculating steam generator, RSG) plant models**

GENERAL QUESTIONS

BAW-10168 (RSG plants) only

A. Unheated core inlet/exit nodes.

1. Where is documentation discussing this?
2. What is the change from/to?
3. Is this consistent with RELAP5 capabilities?
4. Does this involve bypass flow?
5. What is the justification?
6. Are other models affected?

B. Hot leg/SG inlet modeling/noding change.

1. Where is documentation discussing this?
2. Is this consistent with RELAP capabilities?
3. Does this involve bypass flow?
4. What is the justification?
5. Are other models affected?

BAW-10168 (RSG plants) and BAW-10192 (OTSG plants)

A. Individual loop modeling and noding.

1. What is changed?
2. Where is it described?
3. What is affected?
4. If intra-loop modeling and/or noding is changed, provide the justification.

B. Downcomer noding changes.

1. What is changed?

2. Where is it described?

3. What is affected?

4. Are the correlations changed? Should they be?

5. Where is the justification?

6. Do all downcomer nodes communicate with metal heat sources?

7. Is the noding consistent with the intent of 10 CFR Part 50, Appendix K?

C. Lower head/plenum axial and circumferential noding and modeling changes.

1. Does the lower head/plenum communicate with metal heat sources?

2. Show that the RELAP noding is detailed enough to properly represent phenomenological behavior.

3. Justify the correlations used.

4. What are the effects?

D. Dissolution of nitrogen.

1. How is it used?

2. How is it modeled?

3. What is the effect?

4. How is it justified?

E. Mechanistic break flow.

1. How is it modeled?

2. How is this treatment consistent with 10 CFR Part 50, Appendix K, modeling?

3. Have all heat sources been considered?

4. Are containment conditions calculated with an approved methodology with approved heat sinks, etc.?

5. What is basis?

F. Core nodes: modeling change.

1. Identify new thermal-hydraulic models and how they are used to replace empirical models.

2. Give bases.

3. What are the effects on other models?

4. Justify the conservatism.

G. NEWQUEN tuning vs. experiments.

1. Is the test data prototypic? How is it scaled?

2. What is the uncertainty?

3. Is biasing properly quantified? Is the bias case specific?

4. Are the effects monotonic?

SOME SPECIFIC QUESTIONS

1. Please provide the PCT results from a full break spectrum for the large break LOCA and compare the results to the break spectrum PCTs from your approved evaluation model. Perform the break spectrum calculations at a range of containment backpressures that are representative of all containment types.

2. Perform a sensitivity calculation showing the effect of the dissolved nitrogen model. Include accumulator flow rates in the calculation comparisons.

3. Provide time history plots of the steam and liquid break mass flow rates for both sides of the break.

4. Provide time history plots of the downcomer pressures (in the volumes to which the cold legs are attached) and containment pressure.

5. Provide information about how the loss coefficients were selected at the junctions between the downcomer and lower plenum/lower head regions and between the downcomer and cold legs.

6. Perform a nodalization sensitivity study of the downcomer axial nodalization. Perform the sensitivity calculations at a range of containment backpressures that are representative of all containment types.

7. Provide a discussion of the number and type of flow restrictions that determine CCFL between the top of the core and the upper plenum in the plants and compare them to the restrictions in the experiments used to determine and assess the CCFL model.

8. In the plant model, the slope of the hot leg near the steam generator inlet plenum was artificially changed in order to be consistent with the horizontal to vertical flow map transition in RELAP5. This distorts the gravitational force on the water running back into the hot leg. Alternatively, the transition angle in RELAP5 could have been changed and preserved the gravitational force on the water. Provide an assessment of the error introduced by your modeling choice.

**HOT BUNDLE PEAKING BASED ON STEADY STATE AVERAGE RADIAL PEAKING WITHIN HOT BUNDLE**

1. State the changes made to the evaluation model (EM) in question.

2. Provide calculational results from the current EM.

3. Provide calculational results from the proposed EM.

4. Provide comparison of the results of the two models, pointing out advantages and disadvantages between the two models.

5. Review changes in context of regulatory requirements of 10 CFR Part 50, Appendix K.

<u>GENERAL COMMENTS AND QUESTIONS</u>

1. The information provided lacks sufficient detail, clarity, and justification for the NRC staff to evaluate.

2. Are the changes compatible in approach and effect with pre-existing (unchanged) parts of the methodology?

3. Are phenomena modeled consistently throughout the EM?

4. Is the approach taken using RELAP consistent and in keeping with the guidance in 10 CFR Part 50, Appendix K?

5. Are the phenomena well enough known to be quantified, bounded, or estimated, including a conservatively quantified and bounded uncertainty?

6. Where is the data cited? Is the data sufficient and is the data consistent with the way it is used?

7. Where sensitivity studies are performed, is the spectrum itself actual or conservative? Can suitability determinations of validity be made?

8. Because of the large impact of the changes, the effect of each individual change on PCT should be estimated (where possible).