Mr. Ian C. Rickard, Director
Nuclear Licensing
ABB Combustion Engineering Nuclear Operations
Post Office Box 500
2000 Day Hill Road
Windsor, Connecticut 06095-0500

November 19, 1999

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING CENPD-397-P, "IMPROVED FLOW MEASUREMENT ACCURACY USING CROSSFLOW ULTRASONIC FLOW MEASUREMENT TECHNOLOGY" (TAC NO. MA6452)

Dear Mr. Rickard:

CENPD-397-P, "Improved Flow Measurement Accuracy Using Crossflow Ultrasonic Flow Measurement Technology" was submitted for staff review by ABB Combustion Engineering (ABB-CE) letter LD-99-047 dated August 23, 1999. As a result of the review, the staff has determined that additional information is needed to complete the review. The information needed is detailed in the enclosure.

The enclosed request was discussed with Mr. Molnar of your staff on November 9, 1999. A mutually agreeable target date of November 24, 1999, was established for responding to the RAI. If circumstances result in the need to revise the target date, please call me at your earliest opportunity at (301) 415-1424.

Sincerely,

/s/
Jack Cushing, Project Manager, Section 2
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 692

Enclosure: Request for Additional Information

cc w/encl: See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 19, 1999

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ABB Combustion Engineering Nuclear Operations
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REQUEST FOR ADDITIONAL INFORMATION

CENPD-397-P, "IMPROVED FLOW MEASUREMENT ACCURACY USING

CROSSFLOW ULTRASONIC FLOW MEASUREMENT TECHNOLOGY"

1. Figure 2-2 compares the plot of the velocity profile correction factor (VPCF) vs. Reynolds number to experimental results. The topical report claim of high confidence in the extension of the VPCF to high Reynolds number is supported by limited data. Provide additional data for high Reynolds numbers plotted in Figure 2-2, or provide additional basis for the topical report claim.

2. The topical report associates Equations 2-15 and 2-19 with Reference 2-1 (Schlichting), yet the equations do not appear in the same form in the Schlichting reference. Provide the basis for the equations using a derivation traceable to something in Schlichting or some other source.

3. Summarize the detailed analysis mentioned in Section 2.3 supporting Equation 2-22 for r^*_t and provide the reference(s) containing the supporting analysis.

4. Section 3.4.1 discusses the intended application of the Crossflow system. The Crossflow output is not to be directly used as input to the calorimetric calculation of thermal power, but to provide data to adjust the venturi flowmeter flow coefficient. What uncertainty components are introduced in the calibration of the venturi measurement from the Crossflow data? How are venturi-related uncertainties accounted for in power measurement in order to support a reduced (i.e., less than 2 percent) margin? Provide supporting details.

5. How were the values of measured C_o given in Table 4-1 determined (appears to be inverse of Equation 4-9)? What measurement or supporting experimental information is represented by V* in the table?

6. Equation 4-6 should be the inverse of Equation 4-3, but Equation 4-6 appears to be missing the V_a term. If the omission is confirmed, provide corrections to the equations and other material in the topical report that follow from Equation 4-6.

7. Explain the apparent disparity among the curves and plant data depicted in Figures 2-2, 4-1, and 4-2.

8. Provide Reference 4-2.

9. What is the effect of corrosion products on the ultrasonic measurement of inside pipe diameter discussed in Section 5.4.1 of the topical report? Discuss how operating procedures or plant specific data should be used to demonstrate that the measured value of pipe inner diameter remains valid for operation of the Crossflow system.

10. Explain why sensor angular orientation relative to the flow disturbance is not a factor in determining the pipe configuration correction factor (Equation 5-24)?

11. Error analysis and uncertainty calculation based on square root sum-of-the-squares methods discussed in Section 5 must use contributors that are random, normally distributed, and independent. Explain how, for a specific installation, that each of the terms in Equation 5-34 can be assured to meet the randomness, distribution, and independence requirements. For example, explain how independence of the profile correction factor and feedwater density error terms is assured if each error involves measurement of feedwater temperature using the same instrumentation.

12. Explain the basis for the flow disturbance factor (ΔC) in Equation 5-24.

13. How does the internal time delay check mentioned in Sections 3.3.5 and 5.8 confirm the values input to Equation 5-29 (the time delay confidence interval)? Explain how the terms on the right side of Equation 5-29 are independent.

14. Section 2.2.2 defines cross-correlation as a "mathematical process for determining the displacement in time between similar curves." Explain Equations 2-9 and 2-10 graphically identifying the similar curves. Are the two signals A(t) and B(t+τ) through two different eddies or through the same eddy traveling between station A and station B?

15. The asterisk (*) in Equation 2-12 indicates the complex conjugate of a function. What does * mean in Equations 2-15, 2-18, 2-22, and $\tau=\tau^*$ in Section 2.2.2.

16. Section 3.2.4.5 states that the Crossflow software includes data filtration criteria, yet not all of the criteria are explained.

17. Section 3.2.4.6 states that the "cumulative cross-correlation function is the result of the summation of all instantaneous cross-correlation functions that are processed in each data acquisition cycle over a user specified average size." What is a data acquisition cycle and what is the basis for specifying an average size.

18. Section 4.2 states that a limited amount of data has been collected from several plants where the accuracy of the in-plant flow instrumentation was independently confirmed at Alden Research Laboratory (ARL). It is understood that the plant data are all for 25 million or higher Reynolds numbers whereas the ARL tests were limited to a lower Reynolds number shown on Figure 2-2. Explain how the plant data with high Reynolds numbers were confirmed at ARL and how Figures 2-2 and 4-1 curves were developed without sufficient data needed to perform a regression analysis.

19. In Section 5.6.1, definition of Cp indicates that VPCF is affected by the upstream piping configuration/disturbance other than an elbow. Has the ABB report provided methodology for calculating PCCF.

20. Section 5.8 indicates that a random normally distributed uncertainty is procedurally controlled and periodically verified by an internal time delay check. On what basis did AMAG assign this uncertainty value to the Crossflow UFM instrumentation? Explain the control procedure and verification method and the guideline if the assigned uncertainty is exceeded.

21. Table 5-1 shows uncertainty of measured and calculated parameters at various power plants. What is the reason for such a wide range of difference in the minimum and maximum values? Did the plants follow other methodologies than those outlined in Sections 5.5, 5.7, and 5.8 for the measurement uncertainties of the respective parameters.

22. What is the confidence level of repeatability and reproducibility of ARL test results? Explain how extrapolation for higher Reynolds numbers is performed and how its uncertainty is bounded by the AMAG assigned uncertainty value.

23. What is the indication of the Crossflow UFM instrumentation failure and what actions are recommended?