ABB

March 8, 2000
LD-2000-0015

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: **Response to Request for Additional Information Regarding CENPD-392-P (Contains Proprietary Information)**

Reference: 1. Letter, J. S. Cushing (NRC) to I. C. Rickard (ABB), "Request for Additional Information (RAI) Regarding CENPD-392-P...," January 13, 2000

2. Letter, I. C. Rickard (ABB) to Document Control Desk, "Transmittal for NRC Staff Review of CENPD-392-P, "10x10 SVEA Fuel Critical Power Experiments and CPR Correlations: SVEA-96," LD-99-031, May 28, 1999

The purpose of this letter is to provide proprietary and non-proprietary responses to the Request for Additional Information, Reference 1, concerning topical report CENPD-392-P. ABB CENP Nuclear Power Inc., (ABB CENP) submitted this report for staff review via Reference 2.

The enclosed RAI responses are formatted as Appendix D of CENPD-392-P. Following completion of the staff review and issuance of its safety evaluation, ABB CENP will incorporate these responses and any other updates determined to be necessary in the approved "-A" version of the report in accordance with the guidelines in NUREG-0390.

Information contained in the Enclosure has been determined by ABB CENP to be proprietary in nature. It is requested that this information be withheld from public disclosure in accordance with the provisions of 10 CFR 2.790 and be appropriately safeguarded. The reasons for the classification of this information as proprietary are delineated in the enclosed affidavit.

Please feel free to contact Virgil Paggen of my staff at 860-285-4700 or me if you have any questions.

Sincerely,

Virgil Paggen for

Ian C. Rickard, Director
Nuclear Licensing

Enclosures: As Stated
copy: J. S. Cushing (OWFN, 4 D7)
A. C. Attard (OWFN, 10 B3)

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Appendix D - ABB CENP Responses to the NRC Request For Additional Information

The NRC request for additional information is in the form of nine questions, Reference D-3. In these responses, each NRC question is repeated followed by the ABB CENP response.

This information will be incorporated as Appendix D in the approved version of CENPD-392.

D1. NRC Question Number 1

On page 27 of the submittal, the last sentence of the first paragraph states that not all the data points were obtained at precisely the target condition. Please clarify.

Response

The intent of showing the experimental data trends in Figures 3.11 through 3.24 is to demonstrate that the SVEA-96 critical power database is physically realistic and consistent with similar measurements for other assembly designs. For example, Figure 3.11 demonstrates that for a given axial power shape and an approximately constant radial power distribution, inlet subcooling, and system pressure, the critical power [.] The statement that "not all the data points were obtained at precisely the target condition" reflects the fact that the radial power distribution, inlet subcooling, and system pressure were not exactly equal to the target values in each experimental data point. This situation introduces a minor spread in the experimental data points. The ABBD1.0 predictions were calculated at the target conditions.

To illustrate the statement "since not all the data points were obtained at precisely the target condition," consider Figure 3.11 as an example. In this figure, the target conditions for the test cases are: [ ] However, the actual test cases were [ ] as shown in the following table.]

These small deviations in the experimental conditions introduce some spread in the measured points. It should be noted that the correlation development and validation are performed for the [ ]

D2. NRC Question Number 2

Please explain why full bundle data is not considered necessary to confirm (validate) sub-bundle mismatch factor accuracies and full bundle correlation predictions.

Response

The method for treating sub-bundle power mismatch in ABBD1.0 has been successfully applied to ABB watercross designs in the past. The method used for ABBD1.0 was also utilized for the XL-S96 CPR correlation described in Reference D-1 as well as the ABBD2.0 CPR correlation described in Reference D-2. The method was justified on physical grounds in Reference D-1. [

.] In Reference D-2, this method was qualified by comparison with test data. Specifically, the predictions of the ABBD2.0 CPR correlation were compared with CPR test data obtained with a 96-rod SVEA-96+ test assembly.

For ABBD1.0, full bundle data are not considered necessary to confirm (validate) the sub-bundle mismatch factor method for establishing full bundle correlation predictions for the following reasons:

1. The methodology used to establish the mismatch factor for ABBD1.0 is the same as that used for XL-S96 in Reference D-1 and ABBD2.0 in Reference D-2. The actual mismatch factor established by this methodology is specific to the ABBD1.0 correlation and reflects the actual SVEA-96 characteristics.
2. The radial configuration of the sub-bundles and integral water cross channel are [

]
3. Experience with the mismatch factor methodology indicates [

]

D3. NRC Question Number 3

Please provide additional information regarding the equation (on page 72) for calculating the sub-bundle power, FSUBS, (i.e., where does the value of the total bundle power come from)?

Response

In a reload design application, the nuclear design lattice code is used to calculate the rod power distributions for each bundle. The relative sub-bundle power, $FSUB_s$, is then calculated as:

$$FSUB_s = \frac{4 \times power\ for\ subbundle\ "s"}{total\ bundle\ power}$$

Power for sub-bundle "s" is given by the sum of the 24 rod powers in sub-bundle "s," where "s" refers to sub-bundle 1, 2, 3 or 4. The total bundle power equals the sum of the 96 rod powers in the full bundle.

A typical example of the relative rod power distribution for the full bundle is shown below:

[

]

The sub-bundle powers and the values of $FSUB_s$ are then calculated as follows:

[

]

D4. NRC Question Number 4

Is Figure 5.2 representative of all the data, i.e., evaluation and validation data?

Response

Yes, Figure 5.2 includes all of the SVEA-96 data points, including both evaluation and validation data.

D5. NRC Question Number 5

Please explain the scattering of data in Figure 5.4 through 5.8.

Response

The points in Figures 5.4 through 5.8 for which the magnitude of the prediction error is relatively large have been investigated to establish any correlation with process parameter (e.g. pressure, flow, etc.), axial power distribution, or test rod location. Figures D5-1 through D5-10 are plots of the data for which the magnitude of the prediction errors are greater than [ ]. Figures D5-1 through D5-6 show the data for which the magnitude of the prediction errors are greater than [ ] Figures D5-7 through D5-10 show the prediction errors as a function of the [ ] The following conclusions are based on the data in Figures D5-1 through D5-10:

1. Figures D5-1 through D5-6 do not show any [

   ]

2. Figures D5-7 through D5-10 indicate that [

   ] However, these heater rods do not appear to consistently give anomalous results. Therefore, it is concluded that any [ ]

3. Experience with dryout testing has indicated that thermocouples [

   ]

D6. NRC Question Number 6

In Chapter 6, Section 6.1, page 114; please provide clarification (additional information) for the 3rd and 4th paragraphs.

Response

CPR correlations such as ABBD1.0, ABBD2.0 (Reference D-2), and XL-S96 (Reference D-1) typically used for monitoring the dryout behavior of fuel in commercial power reactors are correlated to describe well-established steady-state thermal-hydraulic conditions. As discussed in Section 6.1, an application of these correlations is the calculation of the change in CPR during a postulated transient. The correlation can be used for steady-state equilibrium CPR predictions in any code which reliably predicts those conditions. Therefore, the application of the correlation is straight forward for transients whose time dependence is sufficiently slow to justify their description as a series of steady-state conditions. The Rod Withdrawal Error and Loss of Feedwater Heating Anticipated Operational Occurrences are examples of "Slow Transients."

"Fast" transients, however, occur sufficiently rapidly that the hydraulic conditions during the event are not in thermal-hydraulic equilibrium. The pressurization transients caused by closure of the main steam line are generally the limiting fast transients in U.S. reactors and can be initiated, for example, by a turbine trip or a generator load rejection. Since CPR correlations typically used in the industry, such as ABBD1.0, predict dryout for equilibrium thermal-hydraulic conditions, it is not *a priori* clear that the correlation will necessarily accurately predict the change in assembly CPR during a fast transient. [

]

The important factors determining the capability of a fast transient analysis code package to conservatively predict transient CPR performance using a given CPR correlation are the form of the CPR correlation and the methodology with which the CPR correlation is evaluated. Therefore, the system dynamic code used to calculate delta-CPR during a transient, the CPR correlation, and the manner in which the correlation is to be evaluated in design calculations should be compared with transient experimental data as an integrated package. For a given transient code and application methodology, the details of the assembly design are not of primary importance for the conservative prediction of delta-CPR if the form of the correlation is not changed, and the CPR correlation used adequately describes the steady-state CPR performance of the assembly. The important consideration in the transient application is whether or not the change in CPR is conservatively predicted during the transient.

[

]

The comparisons of the ABBD1.0 predictions with the five SVEA-96 data points described in Section 6.3 provide a second, independent confirmation of the conclusion that the ABBD1.0 CPR correlation in conjunction with the BISON-SLAVE hot channel code using the same strategy for evaluating the correlation will provide conservative delta-CPR values during a fast transient. As discussed in Section 6.4, the results of these comparisons for SVEA-96 are very consistent with results in Section 6 of Reference D-2 for SVEA-96+. This conclusion was intended to be the primary message in paragraph 4 of Section 6.1.

D7. NRC Question Number 7

Please provide additional technical justification as to why 5 data points constitute an "adequate" data base for validating the ABBD1.0 correlation in a transient mode.

Response

In light of Response D6 above demonstrating that the transient test comparisons in Reference D-2 for [

]

Furthermore, all of our comparisons between the predictions of critical quality-boiling length correlations for 10x10 SVEA fuel in conjunction with the BISON-SLAVE code using the same strategy for selecting correlation inputs with transient test data have confirmed the conservative nature of the predictions. [

] Therefore, transient validation based on one of the ABBD-versions of CPR correlation and its associated measurements has proven to be applicable to all the ABBD-versions of CPR correlation.

In summary, the comparison for ABBD1.0 based on the 5 data points in Section 6.3 represents confirmation of a method of calculating delta-CPR which has been demonstrated for a much broader data base.

D8. NRC Question Number 8

In Table 6.3, what is the difference between the Initial and the Minimum columns?

Response

Table 6.3 shows the transient CPR results for the five flow reduction events calculated by ABBD1.0 in the BISON-SLAVE code simulations of the events. The "Initial" column provides the CPR predicted by the code at the initiation of the transient (time = 0.0 sec). The "Minimum" column provides the minimum CPR predicted in the BISON-SLAVE simulation of the event at any time during the transient.

D9. NRC Question Number 9

Regarding mis-rotation of sub-bundles, please comment on the possibility of misloading/orienting a sub-bundle while preparing a full bundle during a fuel reload situation.

Response

[

]

Positive controls during the sub-bundle channeling operation preclude the possibility of loading the fresh sub-bundles incorrectly if they are delivered to the site in the correct orientation. [

] Accordingly, the manufacturing facility processes and site inspection procedures have been further strengthened to include:

4. [

]

5. [
]

6. The procedure for the QC inspection of the BWR assemblies at the manufacturing facility has been modified to require an independent verification [
]

4. The fuel receipt inspection at the utility site requires the specific verification of proper location of all sub-bundles.

With these strengthened manufacturing and inspection procedures, it is judged that the probability of mis-orientation of the sub-bundles in the channel is less likely than other postulated BWR accident scenarios.

REFERENCES

D-1. "SVEA-96 Critical Power Experiments on a Full Scale 24-Rod Sub-bundle," ABB Report UR-210-P-A (proprietary), UR-210-NP-A (non-proprietary), October 1993.

D-2. "10x10 SVEA Fuel Critical Power Experiments and CPR Correlation: SVEA-96+," CENPD-389-P-A, September 1999.

D-3. Letter, NRC to I. C. Rickard (ABB-CE), "Request for Additional Information (RAI) Regarding CENPD-392-P, 10x10 SVEA Fuel Critical Power Experiments and CPR Correlation: SVEA-96," January 13, 2000.

D-4. Letter, I. C. Rickard (ABB-CE) to J. S. Cushing (NRC), "Transmittal of Meeting Slides concerning ABB Fuel Performance Update and Licensing Plans for Year 2000 (Proprietary Information)," February 11, 2000.

D-5. CENPD-390-P. "The Advanced PHOENIX and POLCA Codes for Nuclear Design of Boiling Water Reactors," April, 1999.

Information presented in Appendix D, Figures D5-1 through D5-10 is proprietary.
The following non-proprietary (title only) information replaces these figures.

Figure D5-1 Prediction Error Vs. Mass Flux (for cases with error > 5%)	*Figure D5-6 Prediction Error Vs. Annular Boiling Length (for cases with error > 5%)*
Figure D5-2 Prediction Error Vs. Outlet Pressure (for cases with error > 5%)	*Figure D5-7 Prediction Error Vs. Dry Rod Number (for cases with error > 5%)*
Figure D5-3 Prediction Error Vs. Inlet Subcooling (for cases with error > 5%)	*Figure D5-8 Prediction Error Vs. Dry Rod Number (for cases with cosine axial power shape)*
Figure D5-4 Prediction Error Vs. R-factor (for cases with error > 5%)	*Figure D5-9 Prediction Error Vs. Dry Rod Number (for cases with bottom-peaked axial power shape)*
Figure D5-5 Prediction Error Vs. Boiling Length (for cases with error > 5%)	*Figure D5-10 Prediction Error Vs. Dry Rod Number (for cases with top-peaked axial power shape)*

I, Ian C. Rickard, depose and say that I am the Director, Nuclear Licensing, of ABB C-E Nuclear Power, Inc. (ABB), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and described below. I am submitting this affidavit in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations for withholding this information.

I have personal knowledge of the criteria and procedures utilized by ABB in designating information as a trade secret, privileged, or as confidential commercial or financial information. The information for which proprietary treatment is sought, and which document has been appropriately designated as proprietary, is contained in the following:

- *"Response to NRC RAIs for topical report CENPD-392-P, 3/03/2000*

Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, included in the above referenced document, should be withheld.

1. The information sought to be withheld from public disclosure is owned and has been held in confidence by ABB. It consists of experimental results, technical data, and CHF correlations applicable to ABB-designed fuel.
2. The information consists of summary data or other similar data concerning a process, method or component, the application of which results in substantial competitive advantage to ABB.
3. The information is of a type customarily held in confidence by ABB and not customarily disclosed to the public.
4. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.
5. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.
6. Public disclosure of the information is likely to cause substantial harm to the competitive position of ABB because:
   a. A similar product is manufactured and sold by major competitors of ABB.
   b. Development of this information by ABB required hundreds of thousands of dollars and thousands of manhours of effort. A competitor would have to undergo similar expense in generating equivalent information.
   c. The information consists of technical data and qualification information for ABB-supplied products, the possession of which provides a competitive economic advantage. The availability of such information to competitors would enable them to design their product to better compete with ABB, take marketing or other actions to improve their product's position or impair the position of ABB's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.
   d. In pricing ABB's products and services, significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included. The ability of ABB's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.

Sworn to before me this
3rd day of March, 2000

Catherine P. McCarthy
Notary Public
My commission expires: 1/31/03

I. C. Rickard
Ian C. Rickard
Director, Nuclear Licensing