Westinghouse

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Project No. 700

17 July, 2002
LTR-NRC-02-36

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2738

SUBJECT: WESTINGHOUSE RESPONSE TO NRC RAIS REGARDING WCAP-15689-P
[ENCLOSURE 1-P CONTAINS WESTINGHOUSE PROPRIETARY CLASS 2 INFORMATION]

References: Letter, I. C. Rickard (Westinghouse) to U.S. NRC Document Control Desk, "Evaluation of Transit-Time and Cross-Correlation Ultrasonic Flow Measurement Experience With Nuclear Plant Feedwater Flow Measurement", March 14 10, 2002

On March 14, 2002, Westinghouse Electric Company LLC (Westinghouse) submitted WCAP-15689-P, "Evaluation of Transit-Time and Cross-Correlation Ultrasonic Flow Measurement Experience With Nuclear Plant Feedwater Flow Measurement" to the Nuclear Regulatory Commission (NRC) for information (Reference). Review of WCAP-15689-P has identified the need for the NRC to Request Additional Information (RAI). The RAI was communicated to Westinghouse verbally in a telephone conference call with the NRC reviewer, Mr. Iqbal Ahmed. Provided herewith (Enclosure 1-P) are the Westinghouse and Advanced Measurement and Analysis Group (AMAG) responses to the NRC RAIs.

At the NRC's request, Westinghouse/AMAG reconsidered the proprietary classification of certain material contained in WCAP-15689-P and has determined that some but no all material can be downgraded to a non-proprietary status. The RAI responses reflect the reclassification, however, Westinghouse has determined that other information contained in Enclosure1-P is proprietary in nature. Consequently, it is requested that the information contained therein be withheld from public disclosure in accordance with the provisions of 10 CFR 2.790 and that copies provided herewith be appropriately safeguarded. The reasons for the classification of this information as proprietary are delineated in the affidavit provided in Enclosure 2. Enclosure 3 provides a non-proprietary version of the information. Westinghouse will follow-up this submittal with a revision to both WCAP-15689-P and WCAP-15689-NP to bring their proprietary markings into alignment with the proprietary information reclassification performed and reflected in the RAI responses. The revised topical reports will be submitted to the NRC under separate cover.

If you have any questions regarding this matter, please do not hesitate to call Chuck Molnar of my staff at (860) 731-6286 or Chip French of our technical staff at (860) 731-6711.

Very truly yours,
Westinghouse Electric Company LLC

Ian C. Rickard
Licensing Project Manager
Windsor Nuclear Licensing

Enclosure(s): As stated

xc: w/Enclosures

I. Ahmed (NRC)
G. S. Shukla (NRC)
E. C. Marinos (NRC)

WESTINGHOUSE ELECTRIC COMPANY LLC

WESTINGHOUSE PROPRIETARY AFFIDAVIT FOR RESPONSE TO NRC RAIs REGARDING WCAP-15689-P

Proprietary Affidavit

I, Ian C. Rickard, depose and say that I am the Licensing Project Manager, Windsor Nuclear Licensing, of Westinghouse Electric Company LLC (WEC), 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 WEC 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 documents have been appropriately designated as proprietary, is contained in the following:

Enclosure 1-P to LTR-NRC-02-36, "Westinghouse Response to NRC RAIs Regarding WCAP-15689-P", July, 2002

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

i. The information sought to be withheld from public disclosure is owned and has been held in confidence by WEC. It consists of information concerning the technical basis and implementation of the CROSSFLOW Ultrasonic Flow Measurement System.

ii. The information consists of test data or other similar data for the design, development and implementation of the CROSSFLOW Ultrasonic Flow Measurement System, the application of which results in substantial competitive advantage to WEC.

iii. The information is of a type customarily held in confidence by WEC and not customarily disclosed to the public.

iv. 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.

v. 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.

vi. Public disclosure of the information is likely to cause substantial harm to the competitive position of WEC because:

   a. A similar product is manufactured and sold by major competitors of WEC.

   b. WEC invested substantial funds and engineering resources in the development of this information. A competitor would have to undergo similar expense in generating equivalent information.

   c. The information consists of the technical basis and implementation of the CROSSFLOW Ultrasonic Flow Measurement System, the application 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 WEC, take marketing or other actions to improve their product's position or impair the position of WEC's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.

   d. In pricing WEC's products and services, significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included. The ability of WEC's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.

   e. Use of the information by competitors in the international marketplace would increase their ability to market a competing product, reducing the costs associated with their technology development.

[signature]

Ian C. Rickard
Licensing Project Manager
Westinghouse Electric Company LLC

Sworn to before me this 17th day of July, 2002

[signature]

Notary Public
My commission expires: May 31, 2003

Enclosure 3 to LTR-NRC-02-36

WESTINGHOUSE ELECTRIC COMPANY LLC

WESTINGHOUSE NON-PROPRIETARY RESPONSE TO NRC RAIs REGARDING WCAP-15689-P

JULY, 2002

Nuclear Regulatory Commission RAIs Regarding WCAP-15689-P

Question No. 1

With respect to WCAP-15689-NP, Page ii, last paragraph:

a) How does WEC/AMAG perform an in-situ calibration?

b) How do we establish the fully developed flow location?

Response

1a) If there is a question concerning whether or not the flow can be accurately measured, an in-situ calibration can be used to answer this question. A second CROSSFLOW meter is installed at an alternative location, where it is known that an accurate measurement can be obtained. The readings from the two meters can be compared. If there is no difference, the flow measurements at the preferred CROSSFLOW meter installation are also accurate and no additional action is required. However, if there is a difference in the meter readings, the reading from the second CROSSFLOW meter can be used to determine a flow profile correction factor for the meter installed at the preferred location.

Westinghouse/AMAG prefer to use in-situ calibration instead of laboratory calibrations whenever it is feasible. The clamp-on characteristic of the CROSSFLOW meter provides for an economical and flexible in-situ calibration. In-situ calibrations provide an accurate VPCF for non-standard piping configurations and remove uncertainties and/or questions associated with extrapolation of a low Re number laboratory calibration to an operating plant environment.

1b) Fully developed flow conditions can be identified in several ways. For example, high temperature laboratory tests have been run in the past, which demonstrate that under plant operating conditions, the flow is fully developed for 15 or more diameters downstream of a 90° elbow. Multiple installations at different axial locations and different orientations about the pipe can also be used if necessary to further determine the condition of the flow. Finally, hydraulic laboratory tests can also be used to determine the number of diameters downstream of a flow disturbance that the flow becomes fully developed.

Validation of this process is demonstrated in WCAP-15689-P, Table 1. Over the years, WEC/AMAG have undertaken comparisons, where the utility believed that plant instrumentation was accurate. For example, one such comparison was performed immediately after an ASME venturi and flow straightener test section had been returned from being calibrated at the Alden Research Laboratory. Table 1 provides the data from not only this test, but also others on different piping configurations. The fact that the average difference between the cross-correlation and plant flow instrumentation in Table 1 is only 0.04%, confirms not only the accuracy of the ultrasonic flowmeters used in these tests, but also that the plant instrumentation was accurate at the time of the tests. Furthermore, the fact that the two independent means of measuring the same flow (ultrasonic and differential pressure instruments) provide close agreement, each with their own unique uncertainties, is strong evidence that both instruments are measuring the flow correctly.

This type of comparison is the ultimate confirmation of a meter's ability to accurately measure flow, where the accuracy of the meter is demonstrated under actual field conditions. This standard provides a higher degree of confidence than laboratory tests and eliminates the uncertainties encountered when extrapolating laboratory calibrations to field conditions.

Question No. 2

With respect to WCAP-15689-NP, Page 6, Section 2.4, 2nd paragraph and Figure 2:

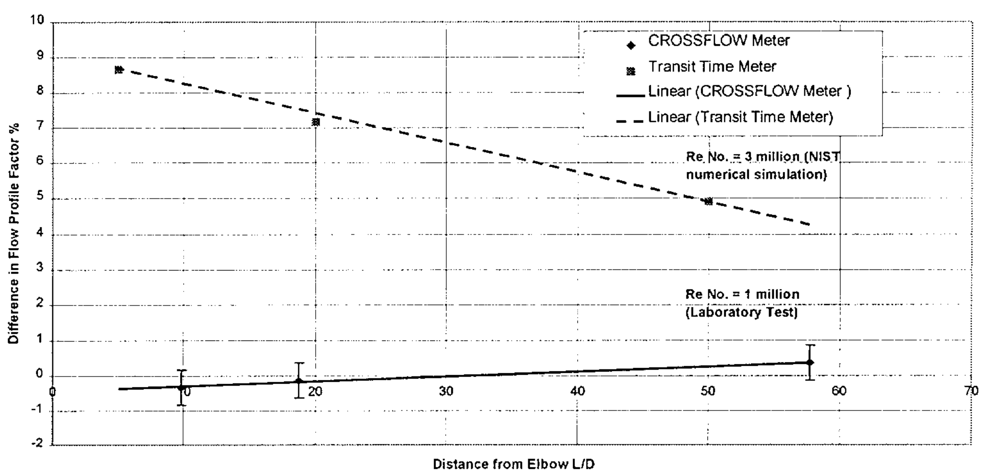
> This figure is marked proprietary in its entirety, however, the corresponding discussion of the figure is non-proprietary. Please provide a non-proprietary version of the figure, if possible, to facilitate writing of the NRC's ER-262 evaluation report which will be in the public domain. Additionally, the lines drawn on the figure are indistinguishable from one another since the figure is not in color. Use of different line types would facilitate understanding the figural presentation.

Response

The proprietary classification of Figure 2 has been removed so that the figure can be referenced in the NRC evaluation report. To facilitate the presentation, the sensitivity curve for the transit-time meter has been replaced by a dashed line to delineate it from the corresponding curve for the CROSSFLOW meter. The revised figure is shown below and has been downgraded from its former proprietary status to facilitate NRC use.

Figure 2

Difference in Flow Profile Factor Between Vertical and Horizontal Oriented Transducers Downstream of Elbow for CROSSFLOW and Transit time meter



Question No. 3

With respect to WCAP-15689-NP, Page 6, last sentence:

c) What caused the non-symmetry in the velocity profile?

d) What does symmetry mean?

Response

3a) Due to the large number of pipe diameters required for the flow to reach fully developed flow conditions, the NIST laboratory attempted to reduce the number of diameters by introducing specially prepared perforated plates upstream of the test section that were intended to facilitate the development of the velocity profile. It was learned after the tests, these perforated plates were not been completely successful in achieving a fully developed velocity profile.

As a result, when the readings were taken with the transit-time and cross-correlation meters assuming fully developed flow, the accuracy of the transit-time meters were affected more than the cross-correlation meter, since the cross-correlation meter was less sensitive to distortion in the velocity profile.

3b) Symmetry refers to the shape of the velocity profile. For a symmetrical profile, the shape of the profile is independent of the tangential position. For example, if a flow profile is symmetrical, the profile will appear to be the same in both the horizontal and vertical planes.

Question No. 4

With respect to WCAP-15689-P, Page 7, 2nd paragraph, 1st sentence, also on Page 14, Section 3.1, 2nd sentence and with respect to CENPD-397-P, Page 2-2, Section 2.2.2, paragraph starting just below Equation 2-6:

Explain the apparent discrepancy between the radial and axial component statements in the two topical reports.

Response

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Question No. 5

With respect to WCAP-15689-NP, Page 2, last sentence on page:

What is meant by "velocity profile" in this sentence?

Response

The velocity profile is normally thought of as a set of velocity vectors that form a certain distribution across the pipe cross-section. For fully developed turbulent flow, velocity profile is represented as a set of axial velocity vectors that form a well-known distribution across the diameter of the pipe. This distribution depends only on distance from pipe axis and is typically approximated by a logarithmic curve. However, when a flow disturbance occurs, additional velocity components are superimposed on the profile, that may include both radial and tangential vectors.

For the transit-time technology, these radial and tangential components may add or subtract from the chordal velocities that are being measured by the meter. This results in an apparent shift in the velocity of fluid, which may be different for the inner and outer chordal measurements. When this occurs, an alarm may be triggered, indicating that the flow measurements may no longer be valid.

Question No. 6

With respect to WCAP-15689-P, Page 8, Section 2.4, middle of last paragraph:

What is meant by "...if the signal were to degrade..."?

Response

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Question No. 7

With respect to WCAP-15689-P, Page 20, Figure 4, explain what this figure is meant to demonstrate.

Response

Figure 4 compares flow measurements at a plant by both the CROSSFLOW meter and the plant's venturi. The significant disturbance in the flow measurement was caused by a plant down-power event. The figure is provided to demonstrate CROSSFLOW's ability to accurately track the perturbation throughout the duration of the event.

Question No. 8

With respect to WCAP-15689-NP, Page 11, 2nd paragraph:

c) Was this feature described in CENPD-397-P-A?

d) What is pipe swirl?

Response

c) No. This software feature is typically employed in those installations where CROSSFLOW is tied to the Plant Computer. This feature alerts the operator to a potential problem with the CROSSFLOW measurement, which requires investigation prior to using it for venturi calibration.

d) Pipe swirl refers to the presence of a tangential velocity component within the fluid, where the fluid rotates about the central axis of the pipe. If the swirl is not symmetrical, it will also introduce a radial velocity component. For the transit-time technology, these components may either add or subtract from the axial component, resulting in a potentially unpredictable response that may indicate that the flow is either increasing or decreasing. However, for the cross-correlation technology, the imposition of radial and tangential velocity components will only reduce the correlation between the upstream and downstream phase shift patterns near the surface of pipe. As a result, the meter will tend to track the fluid velocities near the central region of the pipe resulting in a conservatively higher mass flow.

Question No. 9

With respect to WCAP-15689-NP, Page 19, Figure 3, shows several gradations within the individual participants meter responses.

Response

The gradations within the individual participant's responses are a demonstration of the meter's repeatability. For each meter, measurements were made for three (3) Reynolds numbers (shown as the vertical separations for each meter). The meter was then removed from the test section and then reinstalled on the pipe and another set of measurements taken. This process was repeated four (4) times as shown in Figure 3, leading to the four (4) gradations for each RE measurement (seen as the horizontal separations).

Nuclear Regulatory Commission RAIs Regarding WCAP-15689-P

Question No. 10

Regarding the Zobin letter+ provided in Appendix B to WCAP-15689-NP, on Page 2, Item d of General Comments, provide a clearer explanation of the discussion therein.

+ Dr. D. Zobin (OPG) to Y. Gurevich (AMAG), "Comments on Caldon Report – ERL (sic) 262", February 28, 2002

Response

Item d makes the point that the value of the velocity profile correction factor (VPCF) for a cross-correlation meter approaches the value for fully developed flow at distances from an upstream disturbance which are shorter than other tests provided for transit-time technology. To arrive at this conclusion, Dr. Zobin compared test data obtained in OPG's high temperature laboratory, plant data from feedwater installations in Canada downstream of a single 90^0 elbow using cross-correlation technology, and results published by Caldon[1] of experiments with a similar 90^0 elbow in Alden Laboratory using transit time technology.

The test data from the cross-correlation meter shows that at the length of approximately 15L/D downstream of the elbow, the VPCF has the same value as for long straight pipe. The transit time test data shows that even on a distance of 30L/D downstream of the elbow the VPCF deviates from its value for long straight pipe by 1% - 2%.

The verification of the cross-correlation test data is provided by the substantial CROSSFLOW independent field validation discussed in response to Question 1(b). Westinghouse is not aware of any similar independent field validation of the transit-time laboratory test data at actual plant operating conditions.

(1) D. E. Mazzola (MPR Associates) and D. R. Augenstein (Caldon), "Hydraulic Testing of External Mount Ultrasonic Flow", presented at the EPRI Nuclear Plant Performance Improvement Seminar, Albuquerque, NM, August 23-24, 1995

Question No. 11

Regarding the Zobin letter+ provided in Appendix B to WCAP-15689-NP, on Page 3, the 2nd paragraph and Item 4.4 of the Conclusions section, the discussions seem to conflict with one another, explain in further detail.

+ Dr. D. Zobin (OPG) to Y. Gurevich (AMAG), "Comments on Caldon Report – ERL (sic) 262", February 28, 2002

Response

As noted in Dr. Zobin's letter, Ontario Power Generation (OPG) originally believed that the velocity profile correction factor (VPCF) was strongly dependent on the fluid velocity. It was later confirmed during in-plant testing at Point Lepreau that this assumption was not correct. The Point Lepreau tests demonstrated that the VPCF was only a function of the Reynolds number as shown in CENPD-397-P-A Revision 01, Section 4.1, Equation 4-3.

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