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Project No. 700

3 April, 2002
LTR-NRC-02-14

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
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Rockville, Maryland 20852-2738

SUBJECT: EVALUATION OF TRANSIT-TIME AND CROSS-CORRELATION ULTRASONIC FLOW MEASUREMENT EXPERIENCE WITH NUCLEAR PLANT FEEDWATER FLOW MEASUREMENT

[Enclosure 1-P Contains Westinghouse Proprietary Class 2 Material]

References:
1. Letter, C. R. Hastings (Caldon) to J. A. Zwolinski (NRC), "Caldon Engineering Report: ER-262, Effects of Velocity profile Changes Measured In-Plant on Feedwater Flow Measurement Systems", January 10, 2002
2. CENPD-397-P-A, Rev. 01, "Improved Flow Measurement Accuracy Using CROSSFLOW Ultrasonic Flow Measurement Technology", May 2000
3. Letter, S. A. Richards (NRC) to I. C. Rickard (ABB-CE), Acceptance for Referencing of CENPD-397-P, Revision-01-P, 'Improved Flow Measurement Accuracy Using CROSSFLOW Ultrasonic Flow Measurement Technology' (TAC No. MA6452)", March 20, 2000

It has come to our attention that Caldon, Inc. submitted an informational engineering report No. ER-262 (Reference 1) to the Nuclear Regulatory Commission (NRC) regarding ultrasonic feedwater flow measurement technology. Caldon states that the purpose of the report was to discuss the effects of velocity profile changes measured in-plant on feedwater flow measurement systems using Caldon's LEFM Check and LEFM CheckPlus ultrasonic flow measurement systems and to provide "...new information that could affect the design bases for these instruments". According to the Caldon report, fluid velocity profiles are very dynamic and flow swirl can vary as much as 10% and more of the axial velocity measurement in these systems, which in turn can impact feedwater flow measurement accuracy.

In this report, Caldon did not limit their technical evaluation to their own product line or their own area of expertise (i.e., transit-time ultrasonic flow measurement) but went on to comment about what effects these issues might have on cross-correlation ultrasonic flow measurement technology. ER-262 notes that "Obviously, any external system in service for the determination of calorimetric power should be evaluated in light of this new data." Since Westinghouse Electric Company LLC (WEC) and its partner Advanced Measurement and Analysis Group, Inc. (AMAG) are the suppliers of CROSSFLOW Ultrasonic Flow Measurement Systems, which is used in support of Appendix K power uprates throughout the nuclear industry, our technical experts have completed a review of ER-262 to determine whether there is validity to Caldon's new concerns which would be pertinent to the performance of CROSSFLOW. WCAP-15689-P, "Evaluation of Transit-Time and Cross-Correlation Ultrasonic Flow Measurement Experience With Nuclear Plant Feedwater Flow Measurement"; copies of which are attached herewith for vour information and use, documents the results of our review. In summary, WEC/AMAG have

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determined that the conclusions presented in ER-262 regarding cross-correlation technology *ARE NOT* applicable to CROSSFLOW and that the CROSSFLOW technology *IS NOT* subject to the specific technical issues associated with Caldon's transit-time flowmeter as documented in their report.

The NRC has reviewed and approved the CROSSFLOW Ultrasonic Flow Measurement System (References 2 and 3); which is based on cross-correlation ultrasonic flow measurement technology. The Safety Evaluation Report (SER) issued on March 20, 2000 continues to be valid and appropriate based on the following conclusions which are discussed in detail in WCAP-15689-P.

- The CROSSFLOW cross-correlation based ultrasonic flowmeter is not as sensitive to flow perturbations as clamp-on transit-time flowmeters. The reason for the lower sensitivity is that the cross-correlation technology only tracks the axial velocity component of the fluid, while the transit-time technology is impacted by all of the velocity components including not only the axial, but the radial and tangential components as well. If swirl were to occur as hypothesized in ER-262, a cross-correlation flowmeter will behave in a predictable manner, while transit-time measurements may be biased high, low or remain unaffected, depending on how the radial and tangential velocity components interact with the ultrasonic beams that are used to measure the fluid velocity. Although abrupt changes in "swirl" have never been encountered in our operating experience, if it were to occur, the CROSSFLOW software would detect the change and alert the operator, and in all cases the shift would be only in the conservative direction.

- The inherent limitations of model testing should be considered for all types of calibrations including calibrations that compensate for manufacturing tolerance of a multi-path choral spool piece. WEC/AMAG have elected to use in-situ calibrations whenever there is a question about the velocity profile being fully developed at the flowmeter installation location. This approach allows the calibration to be performed under operating conditions, which eliminates any need for most laboratory calibrations. The accuracy of the CROSSFLOW meter can, therefore, easily be shown to be outstanding under operating plant conditions.

- Caldon's conclusions are based on its operating experience with transit-time technology and the limited information that is available in the public domain regarding cross-correlation technology; some of which has since been found to be in error. Due to the proprietary restrictions necessary to provide the continued commercial protection of CROSSFLOW, most flow measurement experts, in general, are not in a fully informed position to provide objective technical evaluations and public presentations or reports that accurately reflect the state-of-the-art in cross-correlation technology. It is, therefore, understandable why some flow engineers and transit-time specialists with limited knowledge of cross-correlation technology, assume that all clamp-on flowmeters are subject to similar reliability and performance issues. This is simply *NOT* the case. One example of the problem with drawing conclusions from old information is illustrated by the attached letter AMAG recently received from Dr. David Zobin of Ontario Power Generation (OPG). Dr. David Zobin (OPG) notes, in part of his greater input that:

  > "The Caldon report specifically referenced a 1992 paper[1] by Jim Sherin, and myself and concluded that *'the sensitivity of a cross correlation meter to the axial*

velocity profile may be somewhat greater than that of an externally mounted transit time meter.'

Dr. Zobin goes on to point out that while the Caldon quote is correct as a snapshot in time (circa 1992), it is incorrect as a current interpretation of the state-of-the-art as it has evolved since that time. Dr. Zobin writes,

"Originally it was believed that the flow profile strongly depends on the fluid velocity. The statement was based on the best fit to the laboratory test data collected in 1990. *This conclusion turned out to be erroneous* (emphasis added) since the observed dependence is later proved to be due to the test loop characteristic behavior and not due to any flow profile changes."

- Both the clamp-on LEFM and the multi-path chordal systems are subject to similar issues with the electronics and ultrasonic transducer technology. While design improvements have likely been implemented over the years, utilities have continued to experience non-conservative drift or transducer failures that have led to overpower events. With CROSSFLOW's proven and unique technology, to date there have been no reliability problems in either ultrasonic transducers or the associated electronics. The permanent transducers are designed to perform indefinitely and thus far have never experienced a design or operating failure.

WEC has determined that the information contained in WCAP-15689-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.

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

for Ian C. Rickard
Licensing Project Manager
Windsor Nuclear Licensing

Enclosure(s): As stated

xc: w/Enclosures
I. Ahmed (NRC)
J. S. Cushing (NRC)
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Enclosure 3 to LTR-NRC-02-14

WESTINGHOUSE ELECTRIC COMPANY LLC

WCAP-15689-NP

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