From: Mark King - NRR
To: Vincent Gaddy - RIV
Date: Thu, Jun 22, 2006 11:31 AM
Subject: Re: Leading Edge Flow Measurement (LEFM) OpE search info

Thanks for the good references Jack.

Vince,
The Morning report certainly provides information and lists some references that should be looked at by the inspectors in regards to these type of devices. The information is associated with the Westinghouse's version (Crossflow) while Caldon uses the Leading Edge Flow Measurement Device (LEFM). Per the morning report references the Information provided by Westinghouse included:
1) Technical Bulletin, "CROSSFLOW Ultrasonic Flow Measurement System Signal Issues" - TB-03-6, Date: 09/05/2003 **(ADAMS # ML032521438) - ATTACHED**

2) Nuclear Safety Advisory Letter, "CROSSFLOW Ultrasonic Flow Measurement System Flow Signal Interference Issues" - NSAL-03-12, Date: 12/05/2003 **(ADAMS # ML033421289) - Attached**

3) Technical Bulletin, "Information Regarding Recent CROSSFLOW Ultrasonic Flow Measurement System Performance Observations" - TB-04-4, Date: 02/12/2004 (ADAMS # - not available as of release date for this Morning Report) - **[not attached, I did a quick ADAMS search but didn't find it. If you feel you need this let me know and I'll hunt it down (or the resident inspectors can asked the licensees for it)**

The slides briefing slides that Jack mentioned are available at the following link:
http://nrr10.nrc.gov/rorp/potentialoverpowerissue.pdf
I've also **attached** them to this e-mail.

Good luck inspecting.
Thanks for reviewing and using OpE.
Mark

>>> Jack Foster 6/22/2006 10:04 AM >>>
Vince,

I also did a Morning Roprt regarding a similar issue for Byon/Braidwood - see attached. I believe I also did an ET Briefing on this subject.

Jack

Jack

>>> Mark King 06/22/2006 9:55 AM >>>
Vince,
RE: your request for OpE on LEFM

See attached files - these should be active pdf files. Which means the links should take you to the document and you can also refine your searches right in the pdf file yourself. Call me if you have questions about doing additional searches.

From left to right the attached files are:

1) LEFM INPO SEE-IN search pdf file [2 hits]- click links in the files to view

A-94

2) Leading Edge Flow google search of nrc.gov pdf file [41 hits]

3) LEFM Caldon_.01 pdf file - attached (has list of plants that were doing uprates)

4) LEFM Caldon trade journal pdf file - attached (good general background on the technology)

5) LEFM NRC entire public web browser search pdf file [20 hits]

6) Note: I could locate any "findings" in the dynamic web page that referenced "leading edge or LEFM", but did find an example overpower violation from Byron site that may be of interest:
Barrier Integrity 03/31/2005 BYRO Green *SCWE: N *HP: N *PIR: Y
Docket/Status: 05000454 (C) , 05000455 (C)

(PIM) **EXCEEDING 100% LICENSED POWER FOLLOWING THE IMPLEMENTATION OF THE ULTRASONIC FEEDWATER FLOW MEASURING INSTRUMENTS.**
A finding of very low safety significance and an associated NCV for operating in excess of the licensed thermal power limits was self-revealed. Specifically, it was determined that for periods between May 2000 and August 2003, the installed feedwater ultrasonic flow measurement instruments provided non-conservative data to the reactor power calculation which resulted in power operation greater than the licensed maximum thermal power output of 3586.6 megawatts thermal (100 percent power). Unit 1 operated with a maximum power level of 102.62 percent. Unit 2 operated with a maximum power level of 101.88 percent. This finding was related to the cross-cutting area of Problem Identification and Resolution (evaluation) because the licensee missed several opportunities to determine that an over power condition existed. This finding was more than minor because it affected the Barrier Integrity Cornerstone objective of providing reasonable assurance that the physical design barrier of fuel cladding protect the public from radionuclide releases caused by accidents or events, and was associated with the attribute of design control (core design analysis). The finding was of very low safety significance because of the fuel cladding barrier was no degraded. (SEE -Section 4OA5.3)

BYRON IR: 2005003 - pdf file of the full report is attached -(SEE -Section 4OA5.3)

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7) Also note the LEFM Caldon web page is available by clicking the link below:
http://www.caldon.net/nuclear/check.cfm
and note: you can link to their literature which is extensive (scroll down to the nuclear portion, includes user manuals etc. that can be viewed by clicking the links - don't order) from the above link or go directly to that page a the link below:
http://www.caldon.net/nuclear/literature.cfm

Hope this helps, call me if you have questions or I can be of further assistance.
Mark

Mark King
Reactor Systems Engineer
NRR/ADRO/DIRS/IOEB
Operating Experience Branch
301-415-1150

CC: Jack Foster

Westinghouse Electric Company

Technical Bulletin

An advisory of a recent technical development pertaining to the installation or operation of Westinghouse-supplied nuclear plant equipment. Recipients should evaluate the information and recommendation, and initiate action where appropriate.
P.O. Box 355, Pittsburgh, PA 15230

Subject: CROSSFLOW Ultrasonic Flow Measurement System Signal Issues		Number: TB-03-6
System(s): CROSSFLOW Ultrasonic Flow Measurement System		Date: 09/05/2003
Affected Plants: All CROSSFLOW Users		S.O.:
References:	Affects Safety Related Equipment: Yes ☐ No ☒	Page: 1 of 4

BACKGROUND

The CROSSFLOW Ultrasonic Flow Measurement System technology and methodology is documented in CENPD-397-P-A, Rev. 01 and was approved by the NRC on March 20, 2000, for improved feedwater flow measurement accuracy. By employing CROSSFLOW ultrasonic flow measurement technology a plant can recapture lost power due to venturi inaccuracy or, subject to NRC approval, can increase the thermal output of a nuclear power plant by taking credit for the reduction in the uncertainty of the secondary heat balance measurement (i.e., an Appendix K or Measurement Uncertainty Recapture power uprate).

As a result of an investigation of apparent performance inconsistencies at a utility employing CROSSFLOW at two stations, Westinghouse Electric Company LLC (Westinghouse) and its CROSSFLOW partner the Advanced Measurement Analysis Group, Inc. (AMAG) have recently identified a potential for contamination of the signals used to determine feedwater flowrate. Specifically, it appears that plant equipment proximate to a CROSSFLOW installation has the potential to cause signal contamination that could lead to an incorrect and potentially non-conservative determination of the venturi flow correction factor (C_f).

This Technical Bulletin discusses the status of the aforementioned signal contamination issue. The discussion also provides information about operational indicators that can be used to identify the possible presence of signal contamination in operating units.

Additional Information, if required, may be obtained from the originator. Telephone (860) 731-6707

Originator:(s)

Rhonda O. Doney
Plant Systems

C. M. Molnar
Regulatory Compliance and Plant Licensing

Approved:

H. A. Sepp, Manager
Regulatory Compliance and Plant Licensing

DISCUSSION

The CROSSFLOW Ultrasonic Flow Measurement System technology was implemented by a utility in 1999 at two stations, each with similar units. In this particular application, the CROSSFLOW system was utilized as a calibration tool to correct the venturis in order to recover megawatts lost due to venturi inaccuracy issues. The venturis were periodically checked at the stations and the venturi flow correction factors (C_f's) were updated using a set of portable CROSSFLOW system electronics that were shared by the stations for this purpose.

Based on observed C_f values, Westinghouse/AMAG recommended that the utility use the CROSSFLOW system to collect additional continuous operational data. This data would allow trending information and provide for a more in depth evaluation. The bulk of this data was collected over the past months and provided to Westinghouse/AMAG for evaluation. To gain further insight, an additional CROSSFLOW bracket assembly was recently installed on the feedwater common header at one of the units. The goal of this activity was to compare the total flow in the feedwater common header to the sum of the flows in the four individual feedwater lines at the Unit's 5.0% uprated power condition (this uprate was implemented after the original CROSSFLOW installation) and to collect continuous data during coast down into a planned refueling outage. Based on these data collection activities, and the supporting plant operating data provided by the utility, initial results indicated that the difference between the sum of the CROSSFLOW measurements in the four feedwater lines and the flow measurement in the common header was outside acceptable statistical limits.

Additional review of current and past collected information on one of the units indicated that the C_f for the four individual feedwater lines had exhibited unexpected changes. In addition, C_f appeared to vary as a function of power, which is not consistent with expected behavior for the CROSSFLOW system. Additional inspection also indicated that the individual feedwater line flow measurements were not linear with respect to the venturi output, which is also an atypical behavior.

Continued Westinghouse/AMAG review and evaluation led to a preliminary conclusion that the inconsistent measurements in the four feedwater lines were being driven by a variable affecting the flow information signal (i.e., the calculated time delay) measured by CROSSFLOW electronics. Using frequency spectrum analysis, the variability in the time delay measurement was determined to be the result of signal contamination.

A review of the remaining CROSSFLOW installations at the two stations also indicated the presence of signal contamination on several, but not all, of the individual feedwater line measurements. The contamination was absent from the two installed feedwater common header locations.

Westinghouse/AMAG are currently performing a root cause evaluation to provide a basis for fully quantifying the effects of signal contamination and designing an effective barrier to identify and prevent adverse impact on the determination of C_f in the future. Signal contamination can act as a bias, either positive or negative, to affect the measured results. At this time, it appears that equipment proximate to a CROSSFLOW installation has the potential to cause signal contamination that can lead to an incorrect and potentially non-conservative determination of C_f. A sufficiently non-conservative C_f could lead to a non-conservative correction to the operating power level which could in turn potentially result in a plant exceeding its licensed power level.

At this time, Westinghouse/AMAG believe this situation is unique to the affected plants and plant specific hardware and, therefore, is not a generic CROSSFLOW performance issue. This conclusion is based on the consistent performance of other CROSSFLOW systems and their associated C_f's, and on an ongoing review of archived CROSSFLOW installation information, which includes frequency spectrum data records. The Westinghouse/AMAG review to date has not identified similar signal contamination or inconsistent C_f behavior in other CROSSFLOW installations.

Westinghouse/AMAG have identified the following criteria associated with identification of signal contamination. Additional guidance and more detail will be provided as the root cause analysis activities proceed.

For Plants Using CROSSFLOW As A Periodic Calibration Tool:

- The C_f should be a reasonably constant value without unexpected changes between calibrations (i.e., typically less than ~0.3%) unless these changes can be attributable to specific plant changes such as fouling or de-fouling events. The actual threshold for reasonable changes to C_f is a plant specific value based on the unique installation features and performance of the plant.
    - o The C_f at the affected plants exhibited significant changes (up to ~1%) between the periodic calibrations.
- Signal contamination can be identified using frequency spectrum analysis to look for signal consistency across various frequency ranges. A frequency spectrum analysis is typically performed during initial installation but is not re-verified following changes to plant hardware. In the future, this analysis should be re-verified following changes to plant hardware or a major power uprate.
    - o Data from the affected plant indicated the presence of signal contamination. This contamination was detected following a 5% power uprate. It is not clear at this time whether the contamination existed prior to the power uprate.

For Plants Using CROSSFLOW In A Continuous Monitoring Mode:

- Same as above for periodic calibration plus,
- Individual feedwater line flow measurements should be reasonably linear with respect to venturi output.
    - o In two of the plants at the affected stations, individual feedwater line flow measurements were not linear with respect to venturi output.
- The C_f is independent of reactor power level and should not vary significantly as a plant increases or decreases power (between ~80% and 100%). For plants with in-situ line calibration the expected change in C_f is based on plant specific calculations.
    - o Data from the affected plants showed the C_f to be varying significantly with power changes (~1%).

RECOMMENDED ACTIONS

1. At this time, no changes to currently certified CROSSFLOW installations are deemed necessary.
2. CROSSFLOW users should continue to be alert to the built-in system alarms, which can detect anomalous input signals and changes in C_f. Users should determine the cause of the alarm and whether any further action is required.
3. The validity of the CROSSFLOW Ultrasonic Flow Measurement System original installation certification should be reconfirmed if a utility modifies hardware in the proximity of a CROSSFLOW installation or implements a power uprate greater than the typical Appendix K type (typically ~1.5% - 1.7%).
4. If atypical CROSSFLOW system performance is identified or suspected in consideration of the criteria discussed above, Westinghouse/AMAG should be contacted for operational/investigatory guidance.

FUTURE ACTIONS

- Westinghouse/AMAG will complete the root cause analysis and communicate the detailed technical results to the CROSSFLOW User community.
- Westinghouse/AMAG will update the User's Manual to include technical criteria for identifying potential contamination issues associated with plant hardware changes.
- Westinghouse/AMAG will evaluate the viability of procedural changes to formally obtain and document the frequency spectrum analysis as part of the Quality Assured baseline plant data records.
- If baseline plant data records are currently unavailable, Westinghouse/AMAG will perform a frequency spectrum analysis to establish these records for future use.
- Westinghouse/AMAG will evaluate the viability of modifying CROSSFLOW electronics and associated software with the goal of protecting against the effects of potential signal contamination.

Nuclear Safety Advisory Letter

Westinghouse Electric Company

This is a notification of a recently identified potential safety issue pertaining to basic components supplied by Westinghouse. This information is being provided so that you can conduct a review of this issue to determine if any action is required.

P.O. Box 355, Pittsburgh, PA 15230

Subject: **CROSSFLOW Ultrasonic Flow Measurement System Flow Signal Interference Issues**	Number: **NSAL-03-12**
Basic Component: CROSSFLOW Ultrasonic Flow Measurement System	Date: 12/05/2003
Affected Plants: See attached list	
Substantial Safety Hazard or Failure to Comply Pursuant to 10 CFR 21.21(a)	Yes ☐ No ☒
Transfer of Information Pursuant to 10 CFR 21.21(b)	Yes ☐
Advisory Information Pursuant to 10 CFR 21.21(d)(2)	Yes ☐
References: See attached list.	

SUMMARY

The CROSSFLOW Ultrasonic Flow Measurement System is used to calibrate the feedwater flow measurement instrumentation (e.g., venturi flow meter) at nuclear power plants. The CROSSFLOW technology and methodology is documented in CENPD-397-P-A, Rev. 01 (Reference 1) and was approved by the Nuclear Regulatory Commission (NRC) on March 20, 2000 (Reference 2), for improved feedwater flow measurement accuracy. By employing CROSSFLOW, a plant can recapture lost power due to feedwater flow instrumentation inaccuracies and/or, subject to NRC approval, can increase plant thermal output by taking credit for the reduction in the uncertainty of the secondary heat balance measurement (i.e., an Appendix K or measurement uncertainty recapture power uprate).

This NSAL discusses the status of a flow signal interference issue that has the potential to adversely affect the feedwater flow measurement. The signal interference (contamination) issue was previously discussed in Technical Bulletin, TB-03-6, "CROSSFLOW Ultrasonic Flow Measurement System Signal Issues" (Reference 3). The following discussion also provides operational guidance that should be used to ensure that the CROSSFLOW system is properly implemented and performs within acceptable limits, and therefore, that the system will provide flow measurement accuracy consistent with its plant specific application.

Additional information, if required, may be obtained from Rhonda Doney. Telephone (860) 731-6707.

Originator:(s)

C. M. Molnar
Regulatory Compliance and Plant Licensing

R. O. Doney
Plant Systems

Approved:

J. S. Galembush, Acting Manager
Regulatory Compliance and Plant Licensing

ISSUE DESCRIPTION

As a result of an investigation of CROSSFLOW performance at the Byron and Braidwood nuclear power stations, Westinghouse Electric Company LLC (Westinghouse) and its CROSSFLOW partner the Advanced Measurement Analysis Group, Inc. (AMAG) identified a potential interference (contamination) of the flow signals used to determine feedwater flow rate. Specifically, it appears that plant mechanical equipment in the feedwater system in combination with the unique plant specific acoustic response characteristics of the piping system has the potential to cause flow signal interference that can lead to an incorrect and potentially non-conservative determination of the venturi flow correction factor, C_f.

The presence of flow signal interference or correlated noise can result in a bias (shift) in the CROSSFLOW time-delay measurement. The interference can either increase or decrease the true time-delay measurement, which is the time that it takes for the eddies within the fluid to pass between the two ultrasonic beams. When the time-delay is biased high, the flow measurement is biased low (non-conservative direction with respect to assessment of plant power level) and when the time-delay is biased low, the flow measurement is biased high (conservative direction with respect to assessment of plant power level).

TECHNICAL EVALUATION

This issue has undergone extensive scrutiny. All users should continue to ensure their application stays within its plant specific CROSSFLOW operation acceptance limits. The following paragraphs provide further information and guidance on various aspects of CROSSFLOW operation that will assure systems continue to perform as expected and intended.

Correction of Plant Flow Instrumentation or Venturi Flow Correction Factor (C_f)

The correction factor, C_f, is defined as the ratio of the CROSSFLOW determined flow value (F_{UFM}) to the corresponding venturi determined flow value (F_V) for the same time period (i.e., $C_f = F_{UFM}/F_V$). Since C_f is the ratio of F_{UFM} and F_V, a fluctuation in C_f can result from either 1) a change in the CROSSFLOW system, which manifests itself as a change in F_{UFM} or, 2) a change in plant conditions, which manifest themselves as a change in F_V. If the fluctuation in plant flow, F_V, is low (which is typical), there is little or no contribution to C_f fluctuation from the plant. In this situation, C_f varies primarily as a function of F_{UFM} which is expected to be less than a buffered average of ~±0.3%, although the explicit value is plant specific. CROSSFLOW software monitors the acceptability of both C_f and F_{UFM} and identifies when the system is generating a measurement that does not meet the plant specific acceptance limits specified in the measurement uncertainty calculation. Consequently, if F_{UFM} is operating within expected limits, and C_f is varying beyond the plant specific acceptance limit, the variation is originating not from CROSSFLOW but from a change in plant conditions. For example, it could be an early indication of changing plant conditions such as plant instrumentation drift, fouling, etc. The plant specific limits on C_f variation are set by the Utility which identifies what actions are required if the calculated C_f is outside acceptance limits.

For a given installation, the overall integrity of the CROSSFLOW generated F_{UFM} is monitored by collecting adequate data points to satisfy the required plant specific uncertainty limit as documented in the associated CROSSFLOW measurement uncertainty calculation. This measurement varies as a function of the normal fluctuation in measured time delay, which is a function of the inherently random nature of the turbulent flow. An unexplained increase in the standard deviation or rejection rate of the collected data could be a precursor to an issue that has the potential to affect F_{UFM}. The expected fluctuation in the F_{UFM} buffered value is based on plant specific flow measurement characteristics and is typically less than ~±0.3%.

CROSSFLOW Initial Installation Procedure

At the time of CROSSFLOW system initial installation, a frequency spectrum analysis is now performed to ensure that the system is free of plant specific signal interference. Once the integrity of the signal is verified, variations in the time-delay readings caused by flow fluctuations are recorded. This information is used to establish plant specific uncertainty limits for F_{UFM}. Therefore, as long as F_{UFM} remains within acceptance limits, the uncertainty analysis used to establish the overall accuracy of the CROSSFLOW meter is bounded.

CROSSFLOW Normal Operation (Manual and Automatic Modes)

Based on the installation baseline information, each Utility should review their current operating procedures for monitoring F_{UFM}, and C_f, to ensure that they appropriately identify when these limits are being approached or exceeded. If these limits are exceeded, procedures should be available to determine if the value of C_f is valid (i.e., is acceptable for use), by using other corroborating plant parameters or plant specific operating history.

Further, since the CROSSFLOW system was designed to improve feedwater flow measurement accuracy and thereby recover only modest amounts of power (e.g., as associated with venturi fouling), if the cumulative change in C_f ever equals or exceeds the plant specific upper or lower maximum operational limits, the CROSSFLOW system should be taken out-of-service or a power penalty applied until the cause of the excursion is identified and addressed. The upper and lower maximum operational limits, which are established by the Utility, are based on plant specific historical instrumentation drift and fouling characteristics.

In addition, evaluations of C_f acceptability should be performed if the following plant conditions occur:

- Plant power uprates are implemented.

- Feedwater system modifications are made that have the potential to affect the flow characteristics at the CROSSFLOW meter location (e.g., changes in feedwater regulating valve internals, piping modifications, steam generator replacement, etc.).

- A variation in C_f that is outside the established plant specific acceptance limits and which cannot be attributed to a known change in plant conditions (e.g., a fouling or defouling event).

In each case, it should be confirmed that changes such as these have not introduced signal interference with the CROSSFLOW system. This can be done by performing a frequency spectrum analysis. If a potential interference issue is identified, the CROSSFLOW system should be taken out-of-service or a power penalty applied until the affect of the interference is addressed.

Point-In-Time Calibration

Occasionally, utilities have requested that Westinghouse/AMAG perform an independent CROSSFLOW feedwater flow measurement for the purpose of a point-in-time venturi calibration. That is, there is no permanent CROSSFLOW meter installation in the plant. Westinghouse/AMAG bring in the necessary CROSSFLOW equipment, determine the appropriate venturi flow correction factor (C_f) and then remove the equipment following the point-in-time calibration. Since CROSSFLOW is not actively monitoring flow conditions which could impact the continued acceptability of the C_f, it is the responsibility of the Utility to have procedures in place to ensure that continued use of the C_f is justified. This procedure should outline the required steps to be followed to ensure that any change in the C_f will be identified and the appropriate actions taken to preclude an overpower condition as a result of unjustified changes. Because CROSSFLOW is not actively monitoring flow conditions, it is necessary for the Utility to rely on other plant parameters to detect a change and to adjust the C_f, if warranted, for the feedwater venturi flow.

CROSSFLOW Manual Operation

When the CROSSFLOW system is continuously operating in the manual mode, C_f is calculated by taking the average of a number of CROSSFLOW readings and dividing it by the average of the corresponding venturi readings over the same time period. The collected CROSSFLOW data with nominal input temperature and pressure should be corrected for the actual plant average temperature and pressure for the data collection period. The resulting C_f is then entered into the plant computer, where subsequent venturi readings are multiplied by this C_f prior to being used in the core thermal power calculation. The appropriate number of readings in manual mode is a function of plant specific flow characteristics. Guidelines for data collection are documented in the plant specific CROSSFLOW measurement uncertainty calculation provided to each user.

CROSSFLOW Automatic Operation

When the CROSSFLOW system is continuously operating and is interfaced with the plant computer, C_f is continually generated by taking the ratio of the instantaneous CROSSFLOW readings and dividing them by the corresponding venturi readings to calculate an instantaneous correction factor. In this mode of operation, the instantaneous C_f is entered into a moving average buffer and the value of the moving average buffer is then passed to the plant computer. Checks are made to ensure that the accuracy of F_{UFM} is better than or equal to the accuracy of the meter as defined by the plant specific quality assured uncertainty calculation. This ensures for example, that the justification for the Appendix K power uprate through improved feedwater flow measurement accuracy remains valid. In the Automatic mode there are several checks in the process of monitoring F_{UFM}, and calculating the C_f, with associated alarms. Further details about the checks that monitor the communication stream with the plant computer and the algorithm used for calculating C_f and associated alarms are provided in the plant specific Software Requirements Specification documents prepared jointly by Westinghouse/AMAG and the Utility.

SAFETY SIGNIFICANCE

Westinghouse has determined that this issue does not represent a substantial safety hazard. Evaluations of safety analyses for which Westinghouse holds the analysis of record (AOR) were performed for the overpower condition at Byron Units 1 and 2 and Braidwood Unit 2. The overall conclusion was that the applicable regulatory acceptance criteria were met for all of the UFSAR Chapters 6 and 15 events evaluated. Considering the margins available in the system designs and safety analyses, had the CROSSFLOW signal contamination gone undetected, and the plant continued to operate at the same overpower condition, it is expected that the applicable regulatory acceptance criteria would continue to be met.

Regarding generic aspects of this issue, CROSSFLOW is not expected to produce power uprates that reach into the Stretch Power range and certainly not into the Extended Power uprate range. Power increases using CROSSFLOW have been less than 3%; when combining recovery of lost power (e.g., due to venturi inaccuracies) with an Appendix K power uprate. A power increase of this magnitude does not approach the percent increase associated with a Stretch Power uprate (~7%), consequently, it is unlikely to significantly challenge NSSS systems, structures and components. Further, CROSSFLOW operation does not result in automatic power increases. Operator intervention and appropriate licensee procedural controls are required prior to plant power level being changed.

In consideration of the above, while a condition that results in overpower operation violates the operating license, there is reasonable assurance of safe operation with respect to the CROSSFLOW signal interference issue. Thus, even if uncorrected, the condition does not represent a substantial safety hazard.

NRC AWARENESS

The NRC is aware of this issue. Exelon filed two Licensee Event Reports (References 4 and 5) regarding exceeding licensed power levels and also had a meeting with NRC Region 3 staff on September 18, 2003. Additionally, Westinghouse held a telephone conference call with NRC Headquarters staff members on August 28, 2003 to informally advise them of the signal contamination issue. The NRC was also informally provided a list of CROSSFLOW users and a copy of Westinghouse Technical Bulletin TB-03-6 (Reference 3). Finally, a meeting was held between Westinghouse, AMAG, Exelon, and the NRC on September 26, 2003 at NRC headquarters in which the NRC staff was briefed in detail about the signal contamination issue. In addition, Westinghouse responded to NRC requests for additional information that arose during the course of the meeting. One of the actions from this meeting was that Westinghouse provide more specific CROSSFLOW system operational guidance, with respect to the signal contamination issue, in an NSAL distributed to all CROSSFLOW users. This guidance is provided below and will be incorporated along with other operational guidance in an upcoming revision to the CROSSFLOW Users Manual.

RECOMMENDED ACTIONS

The following actions are recommended in order to maintain system uncertainty certification.

1. Westinghouse/AMAG recommends that CROSSFLOW system operators attend and complete the training course provided with the CROSSFLOW installation. Additional training can be provided upon request. This action ensures that personnel operating the system will be certified by Westinghouse/AMAG as having a comprehensive understanding of CROSSFLOW functionality, including acceptable ranges of operation and what actions should be taken if system performance deviates from acceptable norms.

2. Going forward, Westinghouse/AMAG will perform a baseline frequency spectrum analysis at the time of installation. This baseline frequency spectrum analysis will be provided to Utility customers and also retained by Westinghouse as a quality record along with other installation parameters. This action ensures that the system is free of interference and provides a record for comparison to potential future frequency spectrum analyses. Westinghouse/AMAG have completed a review of frequency spectrum records, or have obtained new records, for all Utilities currently using CROSSFLOW to adjust plant power. No other plants were found to be affected by the signal interference issue.

3. Westinghouse/AMAG recommends that the performance of the CROSSFLOW system be re-evaluated whenever a modification is made to the feedwater system that has the potential to affect the flow characteristics and/or a power uprate is implemented. This action ensures that interference is not unknowingly introduced which could adversely affect subsequent CROSSFLOW performance.

4. CROSSFLOW system users should continue to ensure their application stays within its plant specific acceptance limits using the guidance provided in the Technical Evaluation above and the information (e.g. Users manual, uncertainty calculations, etc) provided with the CROSSFLOW system. Utilities should also verify that operating procedures have been updated to reflect these recommendations.

REFERENCES

1. CENPD-397-P-A, Rev. 01, "Improved Flow Measurement Accuracy Using CROSSFLOW Ultrasonic Flow Measurement Technology", May 2000

2. Letter, S. A. Richards (NRC) to I. C. Rickard (ABB-CE), "Acceptance for Referencing of CENPD-397-P, Rev. 01-P, 'Improved Flow Measurement Accuracy Using CROSSFLOW Ultrasonic Flow Measurement Technology' (TAC No. MA6452)", March 20, 2000

3. TB-03-6, "CROSSFLOW Ultrasonic Flow Measurement System Signal Issues", September 5, 2003

4. Letter, M. J. Pacilio (Exelon/Braidwood) to USNRC Document Control Desk, "Submittal of Licensee Event Report Number 2003-002-00, 'Licensed Maximum Power Level Exceeded Due to Inaccuracies in Feedwater Ultrasonic Flow Measurements Caused by Signal Noise Contamination'", BW030080, September 30, 2003

5. Letter, S. E. Kuczynski (Exelon/Byron) to USNRC Document Control Desk, "Licensee Event Report (LER) 454-2003-003-00, 'Licensed Maximum Power Level Exceeded Due to Inaccuracies in Feedwater Ultrasonic Flow Measurements Caused by Signal Noise Contamination'", Byron 2003-0092, September 29, 2003

CROSSFLOW Installation Summary - U.S.	
Braidwood Units 1 & 2	Hope Creek Unit 1
Byron Units 1 & 2	Kewaunee
Calvert Cliffs Units 1 & 2	La Salle Units 1 & 2
Clinton	Monticello
Diablo Canyon Units 1 & 2	Palisades
Dresden Units 2 & 3	Pilgrim
Duane Arnold	Salem Units 1 & 2
Fermi	San Onofre Units 2 & 3
Ft. Calhoun	South Texas Units 1 & 2
Hatch Units 1 & 2	Vermont Yankee

CROSSFLOW Installation Summary - International Units
Brazil
Angra Unit 1
Japan
Genkai Units 1 - 4
Sendai Units 1 & 2
Spain
Almaraz Units 1 & 2
Sweden
Ringhals Unit 3