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

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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.
    - 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.
    - 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.
    - 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.
    - 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.