

Byron and Braidwood

Recent Potential Over Power Issues

November 19, 2003

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AA-2

Background

- Initial testing of the CROSSFLOW Ultrasonic Flow Measurement (UFM) System at Byron and Braidwood was completed in late 1998 and early 1999. The instruments were implemented for use at Braidwood in June 1999 and at Byron in May 2000.
- The CROSSFLOW instrumentation at Byron and Braidwood, like many other plants, is used for venturi measurement correction. Note: Byron and Braidwood use this system for venturi calibration and verification, not for measurement uncertainty recapture.

Background

- During the last week of August, Exelon, in response to a difference in thermal power between Byron Unit 1 and Braidwood Unit 1, added additional instrumentation to Byron Unit 1 and began continuous monitoring of feed flow instruments to verify accuracy of UFM system.
- On 8/29/03 Byron reported to the NRC (EN 40117) that results of the continuous monitoring and additional instrumentation indicated that there were signal abnormalities or contaminations associated with the UFM System.

Background

- There were inconsistencies in the UFM signals on all four loops for Byron Unit 1 and one loop for Byron Unit 2 and therefore they subsequently reduced power. Sum of the loops was not equal to the total at the manifold.
- From analysis, it was determined that Byron Units 1 and 2 had potentially exceed their licensed thermal power limit by approximately 1.5% and 0.33%, respectively.
- As a result of the recent over power issues at Byron, Braidwood investigated both Units 1 and 2.

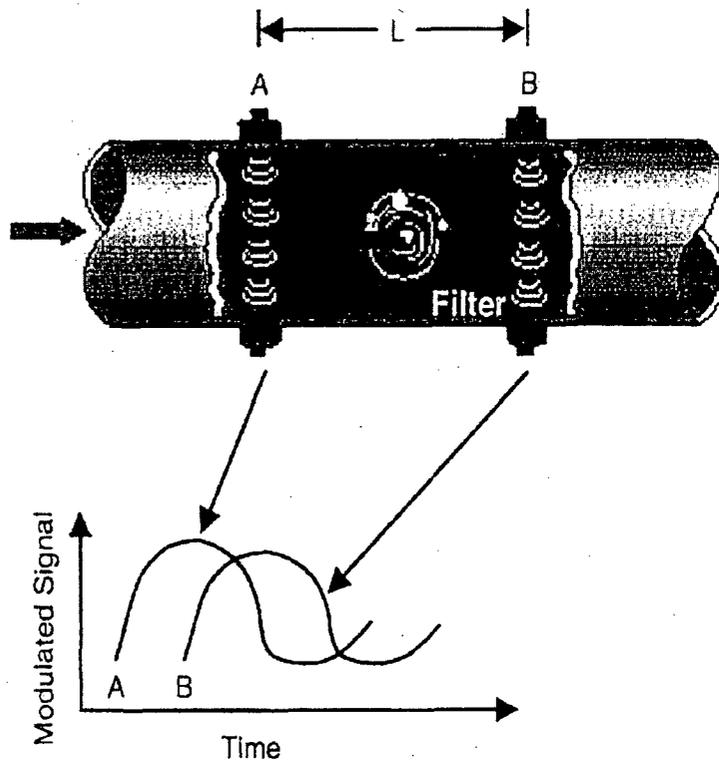
Background

- On 8/31/03, the investigation revealed that Braidwood Unit 2 (EN 40123) had potentially exceed their licensed thermal power limit by approximately 0.39%.
- The power level for all affected units was reduced to less than 100% consistent with the feedwater flow as measured directly by the associated venturi.

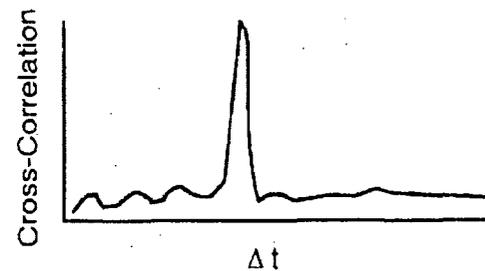
Cross-Correlation Process

- Cross-Correlation measures the velocity of eddies within the fluid using a non-intrusive transducer mounted externally on existing piping.
- For this process, an ultrasonic beam is modulated by the eddies that are present in the flowing liquid.
- As the modulated signal is processed, a random signal, which is the signature of the flowing eddies, is obtained.
- The modulated signals from the upstream and downstream transducers are displaced in time by the time that it takes for the eddies to pass between the two transducer sets.

Cross-Correlation Process

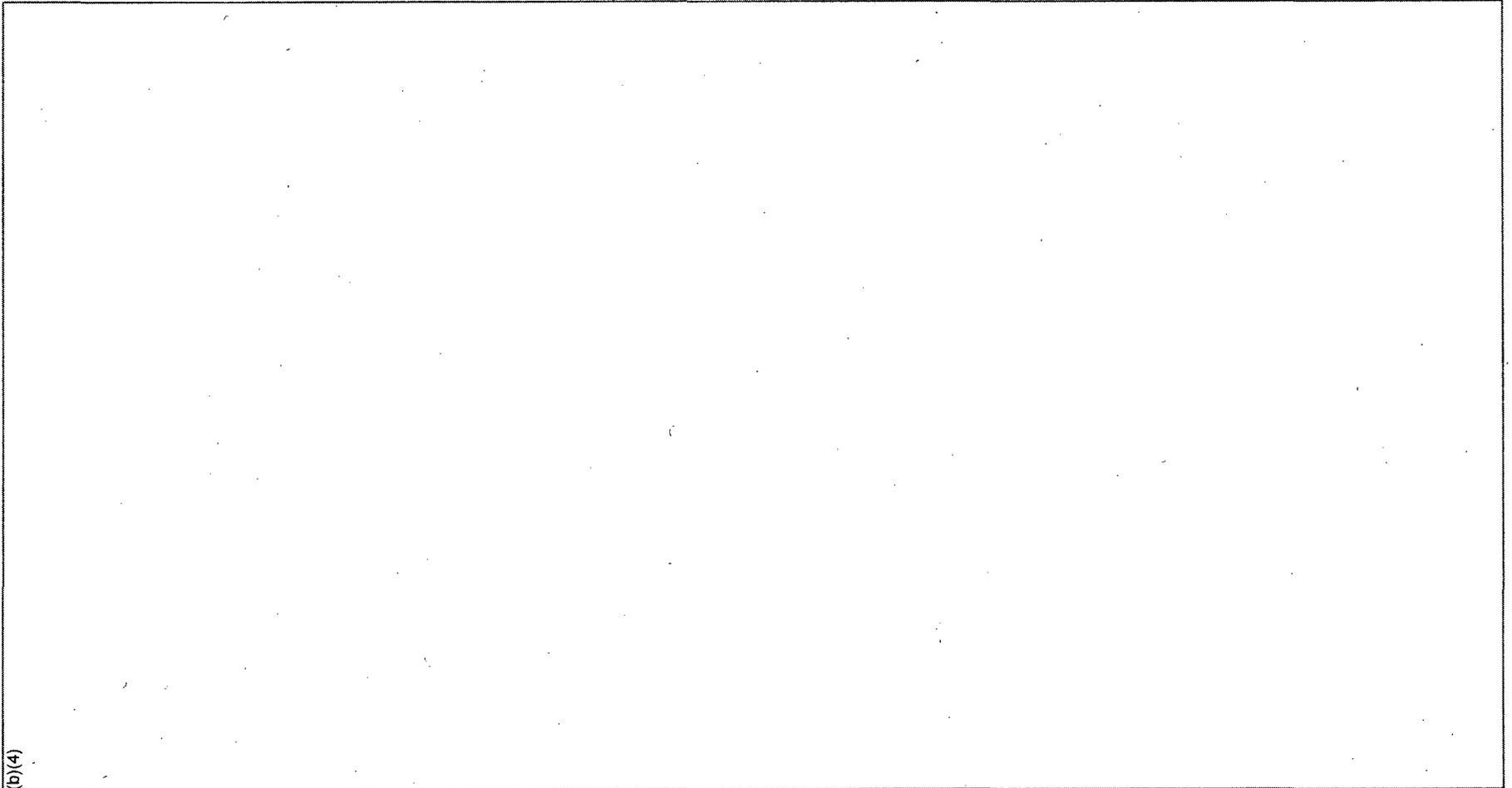


$$\int f_A(t + \Delta t) \cdot f_B(t) dt$$



$$\text{Velocity} = \frac{L}{\Delta t}$$

Typical Transducer/Bracket Hardware



(b)(4)

Possible Root Cause

- From the Byron draft root cause report of 9/26/03, the root cause for both Byron and Braidwood UFM events was noise contamination of the ultrasonic signal.
- The cause of this contamination was determined to be acoustic resonant response of the feedwater piping system.
- Feedwater flow pressure pulses occurred at frequencies which caused the UFM's to indicate lower than actual feedwater flowrates resulting in a non-conservative calorimetric result.

Other Similar Event

- River Bend reported (EN 39835) on 5/10/03 that they may have exceeded rated thermal power (RTP) during previous operating cycles. This observation was based on data analysis following testing of their installed feedwater ultrasonic flow meter (CALDON TRANSIT-TIME).
- Licensee determined that the thermal power was exceeded by up to 0.7% in previous cycles. The licensee determined that the primary root cause (LER 50-458/03-005-00) was due to incorrect pipe wall smoothness following initial installation which caused changes in velocity profiles.
- Corrective Action - Replaced older version of UFMs with newer and more accurate version – Developed computer points for best statistical estimate of core thermal power.

Risk/Safety Impact

- Safety Impact - negligible in that the margin to operating limits was sufficient to accommodate the potential over power.
 - Not Safety Related System - Excore and RPS provide safety related function in over power conditions.
 - Not Risk Significant – within deterministic and parameter limits (operating limits - design limits) and no “Initiating Event.”

Communications

- Two 50.72 Event Notification Reports (40117 - 8/29/03 and 40123 – 8/31/03) - Two 50.73 LERs. Byron (LER 03-003-00 ML032810527) and Braidwood (LER 03-002-00 ML032810226).
- Westinghouse Technical Bulletin “CROSSFLOW Ultrasonic Flow Measurement System Signal Issues” TB-03-6 (9/05/03).
- Byron Root Cause Report 9/26/03. (Draft – not on docket)
- CENPD-397-P-A Rev 1 – “Improved Flow Measurement Accuracy Using Crossflow Ultrasonic Flow Measurement Technology” May 2000.
- NRR to provide applicable Information Notice to Industry.

Potential Generic Implications

- (b)(4) plants using this configuration from Westinghouse/AMAG ((b)(4) plants in the US and (b)(4) plants internationally).
- Westinghouse/AMAG has stated that they believe this situation is not completely unique to Byron and Braidwood and is applicable to other plants utilizing this ultrasonic system.
- Ongoing review of archived installation data has not identified similar signal contamination at other installations.

NRC Regulatory Aspects

- Part 21 - Westinghouse/AMAG have evaluated this issue and determined it applicable to other plants – LERs from both Byron/Braidwood - NSAL to be released in November (J. Foster - R. Doney).
- Emergent International Issues - Unsolicited correspondence providing public information to international stakeholders (M. Cullingford).
- Westinghouse/Westinghouse Owners Group (B. Benney & D. Holland). Ongoing discussions with NRC staff.
- Research – Providing technical consulting on Flowmeter issues including CROSSFLOW to NRR staff. Possible future anticipatory research in this area (S. Arndt).

Conclusions

- Broad effects associated with potential over power issues, but because of the narrow band relating to correction factors associated with thermal power, it is considered less significant on the safety/risk scale.
- Important issue relative to economics and compliance for the vendor/licensee.
- The NRC staff will continue to monitor both US and worldwide experience with over power issues and evaluate the need for additional generic regulatory action based on future operational events.