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Our ref: AW-03-1703
September 15, 2003

**APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE**

Subject: Westinghouse CROSSFLOW Presentation to NRC Staff (Proprietary), September 2003

Westinghouse hereby transmits presentation slides to be used in a forthcoming informational meeting with the staff. Portions of this presentation contain proprietary information for which withholding from public disclosure is requested. Affidavit AW-03-1703, signed by Westinghouse Electric Company LLC, the owner of the information, sets forth the basis on which the proprietary information is requested to be withheld from public disclosure by the Commission and addresses the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

For identification purposes and in conformance with the requirements of 10 CFR 2.790, Westinghouse has enclosed within brackets the proprietary information contained within the subject presentation. The justification for claiming the information designated as proprietary is indicated by means of superscript letters immediately following the brackets. These superscript designators refer to the types of information Westinghouse customarily holds in confidence as identified in Sections (4)(ii)(a) through (4)(ii)(f) of the enclosed affidavit.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, AW-03-1703, and should be addressed to the undersigned.

Very truly yours,

A handwritten signature in black ink, appearing to read "Ian C. Rickard".

Ian C. Rickard
Licensing Project Manager
Regulatory Compliance and Plant Licensing

Enclosure

cc: B. J. Benney / NRR

bcc: H. A. Sepp (ECE 4-7A)
C. B. Brinkman, (Rockville, MD 20852)
R. O. Doney (Windsor)
RCPL Administrative Aide (ECE 4-7A)

AFFIDAVIT

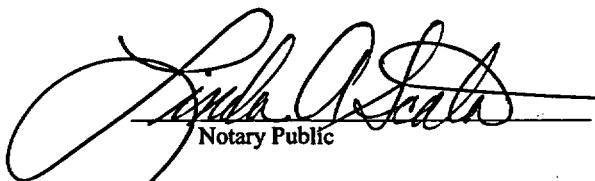
STATE OF CONNECTICUT)
) ss: WINDSOR, CT
COUNTY OF HARTFORD)

Before me, the undersigned authority, personally appeared Ian C. Rickard, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC ("Westinghouse"), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:



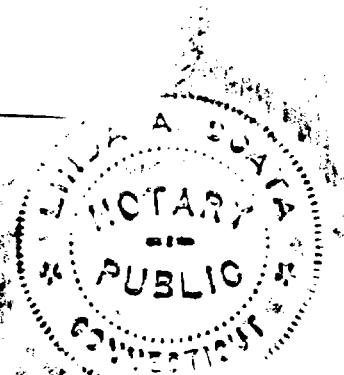
Ian C. Rickard,
Licensing Project Manager
Regulatory Compliance and Plant Licensing

Sworn to and subscribed before me
this 15th day of September 2003.



Notary Public

My commission expires May 31, 2008.



- (1) I, Ian C. Rickard, depose and say that I am the Licensing Project Manager, Regulatory Compliance and Plant Licensing, in Nuclear Services, Westinghouse Electric Company LLC ("Westinghouse"), and as such I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Electric Company LLC.
- (2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.
- (3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Electric Company LLC in designating information as a trade secret, privileged or as confidential commercial or financial information.
- (4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.
 - (i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.
 - (ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

- (a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.
- (b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.
- (c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

- (d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.
 - (e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.
 - (f) It contains patentable ideas, for which patent protection may be desirable.
- (iii) There are sound policy reasons behind the Westinghouse system for classification of proprietary information, which include the following:
- (a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.
 - (b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.
 - (c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.
 - (d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.
 - (e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.
 - (f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.
- (iv) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.790, it is to be received in confidence by the Commission.
- (v) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.
- (vi) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in the presentation materials designated as "CROSSFLOW Signal Contamination: Root Cause and Corrective Actions" dated September 2003.

This information is part of that which will enable Westinghouse to describe the application of the CROSSFLOW ultrasonic flow measurement systems to nuclear plants, and in particular to support utilities in the application of such, including:

- (a) The identification of important phenomena relevant to the application of CROSSFLOW,
- (b) An assessment of flow measurement signals obtained from CROSSFLOW,
- (c) The continued qualification of CROSSFLOW to plant applications.

Further this information has substantial commercial value as follows:

- (a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.
- (b) Westinghouse can sell support and defense of CROSSFLOW.
- (c) The information requested to be withheld reveals the distinguishing aspects of a methodology that was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar advanced nuclear power plant designs and to provide licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence as identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal.

COPYRIGHT NOTICE

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

NP - Master

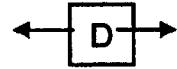
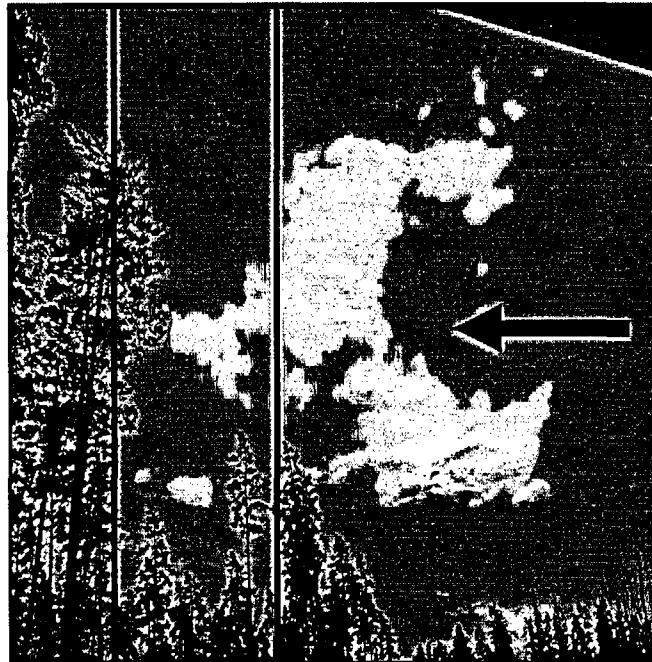
CROSSFLOW Signal Contamination Root Cause and Corrective Actions

September, 2003

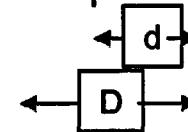
Agenda

- Introduction
- Overview of CROSSFLOW Technology
- Characteristics and Detection of Noise Contamination
- Overview of EXELON CROSSFLOW Application
- Discovery of Signal Contamination
- Technical Root Cause Analysis
- Organizational Root Cause Analysis
- Safety Implications
- Extent of Condition
- Recommended/Ongoing Actions
- Overall Conclusions

Example of Turbulence Propagation – Clouds (Fast)

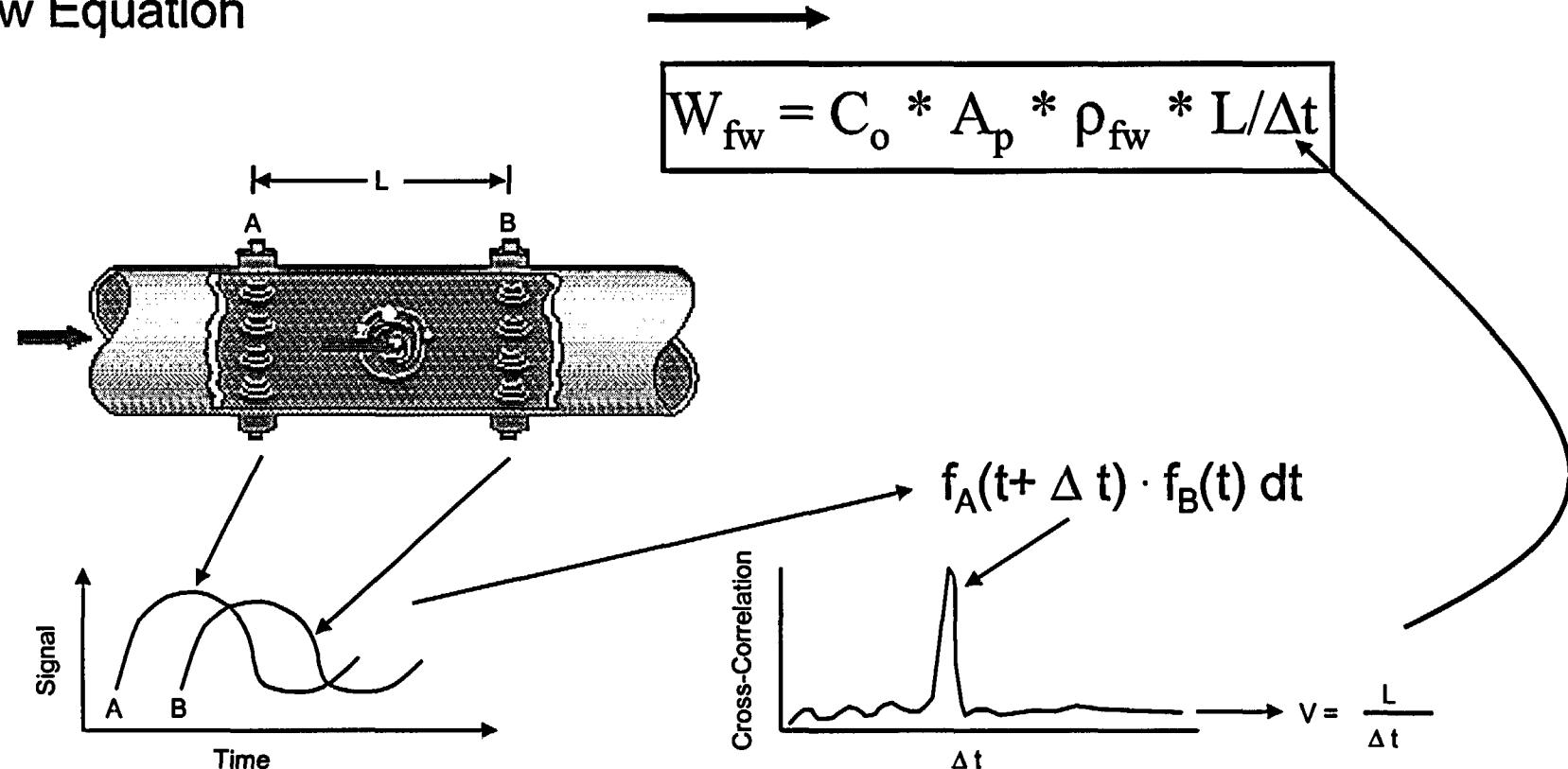


D = Original position of cloud at time T_0
d = distance traveled by cloud after ΔT



CROSSFLOW – Measures Flow Directly

- CROSSFLOW captures the signature at A and B and calculates the travel time, Δt .
- Flow Equation



CLOSED Portion of Meeting

Amaq

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Slide No. 5



Detection of Noise Contamination

- CROSSFLOW recognized that in real world piping systems, noise exists.



Characteristics of Noise Contamination



Characteristics of Noise Contamination



Characteristics of Noise Contamination



Characteristics of Noise Contamination



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EXELON CROSSFLOW Application

- CROSSFLOW bracket assemblies were installed at Byron and Braidwood sites in 1999.
 - Brackets were installed on the four feedwater branch lines at each unit.
 - C_f's are periodically updated to recover lost megawatts due to venturi inaccuracies.
- CROSSFLOW installation was not part of a power measurement uncertainty recapture uprate (i.e., Appendix K).

Discovery of Signal Contamination

- EXELON inquired why Byron was recovering more megawatts than Braidwood (history documented in Response to RAIs RS-03-149).
- In February 2002, Westinghouse/AMAG were requested to verify the flow at Byron Unit 1 by installing a CROSSFLOW bracket assembly on the feedwater common header in order to compare the results with the sum of the flow in the four individual lines.
- March results (at 92% power) were at the upper end of acceptable statistical limits.
 - Installation and operational criteria verified including piping geometry, transducers, cables, software, and test procedures.
 - Westinghouse/AMAG did not check for noise contamination.
 - Test concluded CROSSFLOW measured flow per design and was properly implemented.
- It was recommended that continuous data be collected on Byron.
 - Initial review of the collected data from Byron Unit 1 individual lines did not indicate any C_f anomalies (Summer 2003).
 - Test plans were developed to obtain common header data for comparison to the individual feedwater lines for all four units.

Discovery of Signal Contamination

- Data from a common header bracket on the Byron Unit 1 was obtained in late August, 2003.

- A frequency spectrum analysis was performed which identified signal contamination on all four Byron Unit 1 feedwater lines. The common header was free of contamination.
- EXELON was informed of the condition and removed the CROSSFLOW correction factors from all four lines and returned to the uncorrected venturi output.

Discovery of Signal Contamination

- Following the Byron Unit 1 test, frequency spectrum analyses of the feedwater lines at Byron Unit 2 and Braidwood Units 1 and 2 were performed.
 - Based on identified signal contamination and vendor recommendations both Byron 2 and Braidwood 2 reduced power.
- Review of additional plant data determined that past C_f 's:
 - varied uncharacteristically between periodic calibrations (~1%)
 - did not vary linearly with respect to uncorrected venturi output
 - varied as a function of plant power level
- This data, along with the frequency spectrum analysis, led Westinghouse/AMAG to suspect that the contamination could be a function of plant power and somehow tied to plant specific equipment/configuration.

Technical Root Cause Analysis

- EXELON sponsored a Technical RCA Team
 - Included technical representatives from EXELON, Westinghouse/AMAG
 - The challenge was to determine the source and magnitude of the signal contamination.
- All piping systems experience resonant response when a driver occurs to excite the system at its natural acoustic frequencies.
 - A location where large pressure changes occur can serve to create a driver (e.g., FW regulating valves).
- The Team developed a model of the piping system and components.
 - Textbook methods were used to forecast the expected frequency response and acoustic impedance for different excitation modes.
- The actual acoustic resonance of the system was then measured using a dynamic pressure data collection process.
- AMAG was able to simulate the frequency response and determine the resulting effect on C_f .

Technical Root Cause Analysis

- The feedwater piping can be modeled as a closed or open-ended system, and will have fundamental acoustic modes characterized by the following relationship for a closed system:

$$f = \frac{c \times i}{4 \times L}$$

Note: For an open-ended system
divide by 2.

Where

- c= sound speed, fps
- L= length of pipe
- f= frequency
- and i=1,3,...n

Technical Root Cause Analysis

- The feedwater piping acoustic frequencies were calculated.

a, c

Technical Root Cause Analysis



- For the Byron Unit 2 configuration (example), the program was run using the following inputs:
 - Flow rate = 4E6 lbm/hr
 - Pipe Diameter = 13.362 inches (16 inch Sch 120)
 - Darcy Friction Factor = 0.013
 - Speed of Sound = 4600 fps

Technical Root Cause Analysis

a, c

Technical Root Cause

Acoustic Impedance for Byron 2A



a, b, c

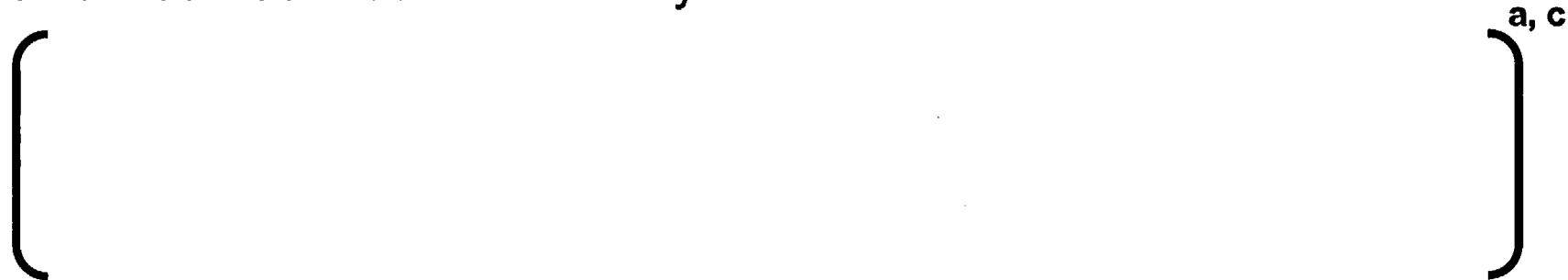
A_{mag}

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Technical Root Cause Analysis

- Dynamic pressure measurements were taken on September 9, 2003 on all four feedwater lines on Byron Unit 2.



Technical Root Cause Analysis

Pressure Data

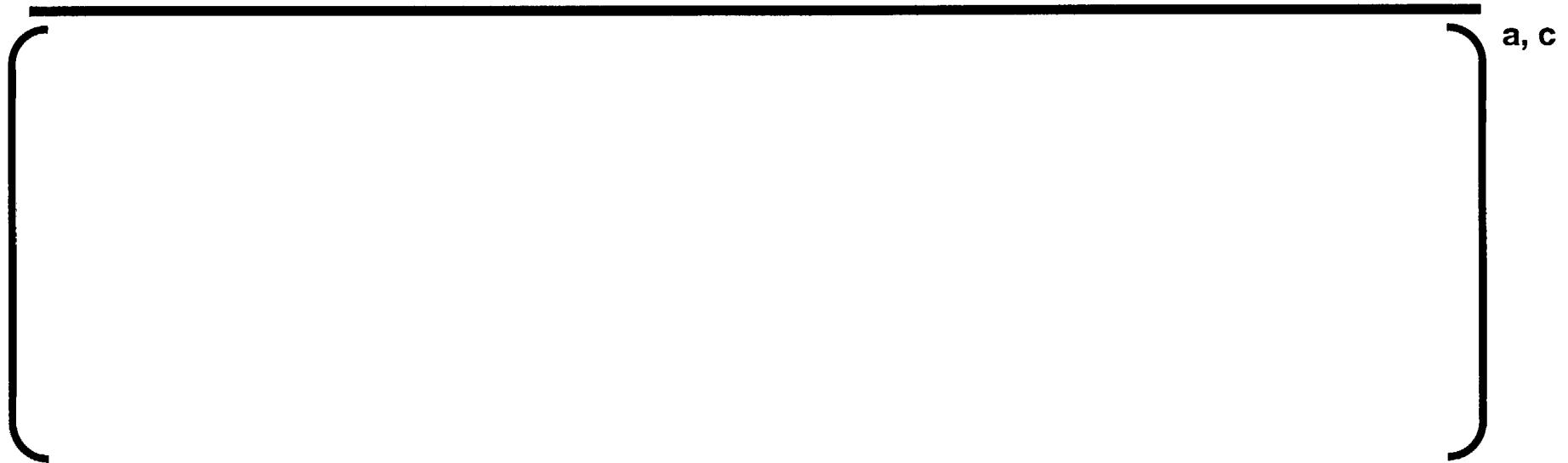


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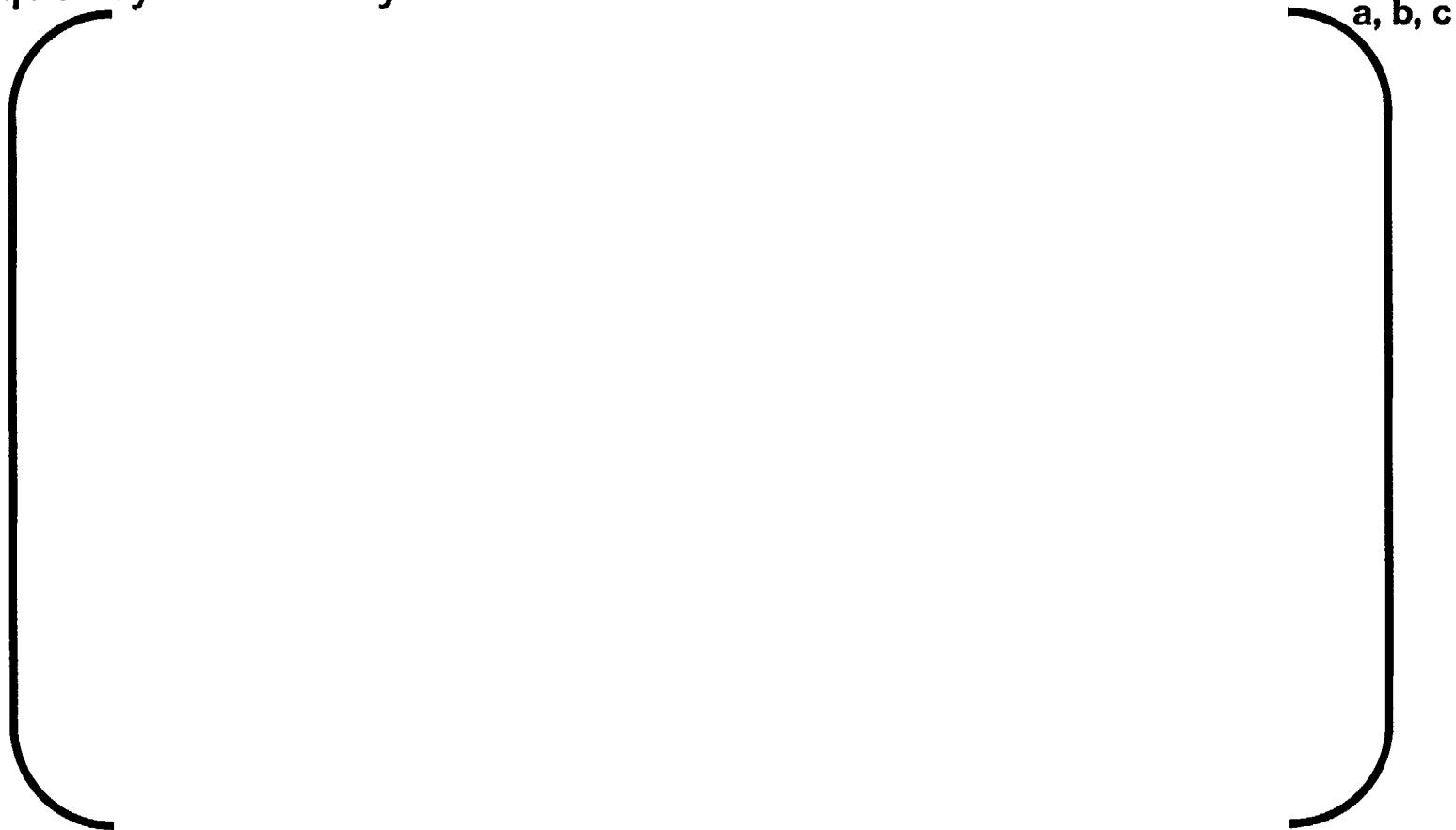
Technical Root Cause Analysis



a, c

Technical Root Cause Analysis

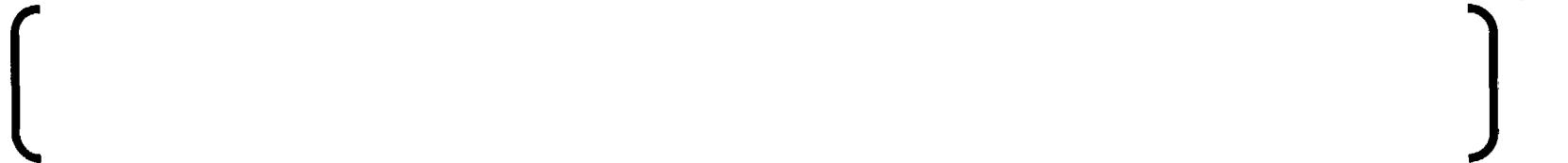
- Frequency scan of Byron 2A



Technical Root Cause Analysis

- Conclusion:

- The potential resonant frequencies were predicted using several theoretical methods.
- Dynamic pressure measurements and frequency spectrum measurements taken on Byron Unit 2 support the existence of low frequency resonant system response.
- There is good agreement between approximate theoretical methods and actual plant response.



Technical Root Cause Analysis

- AMAG Simulation:



Characteristics of Noise Contamination



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Technical Root Cause Analysis

- Conclusions:

a, c

Technical Root Cause Analysis

- EXELON/AMAG also developed additional data regarding the common header locations. From these activities it was conclude that:



Organizational Root Cause Analysis

- Preliminary conclusions and lessons learned:



a, c

- Additional organizational investigations and lessons learned are being developed.

Safety Implications

- Westinghouse has initiated its Part 21 evaluation process.
 - Investigation is ongoing and will be complete within the 60-day window.
 - NRC already informed:
 - EXELON via three LERs and meeting with Region 3 NRC staff.
 - Westinghouse telephone call, list of CROSSFLOW Users and Technical Bulletin TB-03-6, “CROSSFLOW Ultrasonic Flow Measurement System Signal Issues”, Sept. 5, 2003.
- An evaluation is ongoing and is being performed with conservative assumptions that envelope historical power levels.
 - Results to date indicate applicable safety analysis acceptance criteria were met.

Extent of Condition

- For CROSSFLOW Owners that utilize CROSSFLOW as a periodic calibration tool:
 - C_f should be relatively constant ($<\sim 0.3\%$) unless changes can be attributable to plant specific changes (e.g. fouling/defouling events).
 - Precursors to a changing condition (signal symmetry, standard deviation, rejection rate etc.) are manually recorded and trended.
- For CROSSFLOW Owners that utilize continuous monitoring:
 - C_f should be relatively constant ($<\sim 0.3\%$) unless changes can be attributable to plant specific changes (e.g. fouling/defouling events).
 - Precursors to a changing condition (signal symmetry, standard deviation, rejection rate etc.) are flagged or alarmed.
- For utilities that tie into the plant computer, unexpected changes in C_f will drive CROSSFLOW to automatically roll the C_f back to 1.0. (i.e. CROSSFLOW takes itself out of service).

Extent of Condition

- To determine Extent of Condition for CROSSFLOW Users, the following factors were examined:



Extent of Condition

- No other instance of signal contamination or suspect feedwater flow measurement has been identified to date.
 - Most plants meet the applicable criteria and measurements are confirmed valid.
 - Many plant evaluations are complete and meet applicable criteria, but permanent frequency spectrum records will be collected.
 - Several plant evaluations are in progress.

Recommended/Ongoing Actions

- At this time, no changes to currently certified installations are deemed necessary.
- 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.
 - If atypical CROSSFLOW system performance is identified or suspected in consideration of the criteria discussed above and cannot be explained, Westinghouse/AMAG should be contacted for operational guidance.
- The validity of the CROSSFLOW 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 (~1.5% - 1.7%).
 - Such revalidation should include a frequency spectrum analysis.
 - If atypical CROSSFLOW system performance is identified or suspected in consideration of the criteria discussed above and cannot be explained, Westinghouse/AMAG should be contacted for operational guidance.

Short and Long Term Corrective Actions

- Short Term:

- Westinghouse/AMAG will update the User's Manual to include additional technical guidance/criteria for identification of future potential contamination.
- Westinghouse/AMAG will prepare a procedure to formally obtain and document the frequency spectrum analysis as part of the Quality Assured installation 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.

- Long Term:



Overall Conclusions

- The presence of sufficient acoustic signal contamination has the potential to adversely affect the CROSSFLOW feedwater flow measurement.
 - Prior to the Byron/Braidwood experience, signal contamination of this type had not been encountered.
- Currently, the signal contamination experience appears to be limited to the Byron/Braidwood sites.
 - Data for other CROSSFLOW installations has not revealed the presence of signal contamination or suspect flow measurements to date.
- CROSSFLOW Users have been informed via Westinghouse Technical Bulletin TB-03-6
- Westinghouse/AMAG will update CROSSFLOW training, installation procedures and User Manual.
- Industry training and update will be provided at January CROSSFLOW Users Meeting.

[]^{a, c}