UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket No. 50-454-OLA
	)	50-455-OLA
(Byron Station, Units 1 and 2)	)	

TESTIMONY OF JOHN C. BLOMGREN CONCERNING STEAM GENERATOR TUBE INTEGRITY (BYRON STATION WATER CHEMISTRY, EDDY CURRENT TESTING AND LOOSE PARTS CONTROL PROGRAMS AND COMMONWEALTH EDISON'S COMMITMENT FOR THE BYRON STATION CONCERNING THE FLOW-INDUCED VIBRATION PHENOMENON AND THE TUBE PLUGGING CRITERION)

Submitted on behalf of
the Applicant, Commonwealth Edison
Company in Response to DAARE/SAFE
Contention 9c and League Contention 22

February 25, 1983

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SUMMARY

The testimony of Mr. John C. Blomgren addresses various measures that will be employed at the Byron Station with respect to the steam generator tube degradation issue. After qualifying himself as an expert, Mr. Blomgren indicates that the applicable Westinghouse all volatile treatment (AVT) water chemistry AVT guidelines described in Dr. Wootten's testimony have been adopted for use at Byron Station. In addition, Mr. Blomgren testifies that the Westinghouse guidelines have been modified in some respects based on the guidelines recommended by the Steam Generator Owners' Group.

Mr. Blomgren also details the loose parts control program and the eddy current testing program, based on NRC Regulatory Guides 1.133 and 1.83 respectively, that will be employed at the Byron Station. Mr. Blomgren's testimony commits Commonwealth Edison Company to (i) the use of a 40% tube plugging criterion at Byron Station, and (ii) a limitation of 70% of full power on the operation of Byron Station in the event that startup and operation occur prior to the installation of the modification to the steam generators required to minimize the effects of flow induced vibration.

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Q.1. State your name, address and present occupation.

A.1. My name is John C. Blomgren. My business address is P.O. Box 767, Chicago, Illinois 60690. My present position is Special Projects, Group Leader within the Technical Services Nuclear Department of Commonwealth Edison Company.

Q.2. State your educational background.

A.2. I graduated in 1969 with a B.S. Degree in Chemistry from Aurora College, Aurora, Illinois. I received a M.S. Degree in Nuclear Engineering from Pennsylvania State University in March 1972.

Q.3. State your professional work experience.

A.3. In 1971, I was assigned to Zion Station as a Technical Staff Engineer. My responsibilities included preoperational testing and system startup for Zion Units 1 and 2. I was assigned as Supervisor of the Zion Chemistry Laboratory in late 1971. I was assigned as Zion Rad/Chem Supervisor in Mid-1974 with responsibility for station chemistry and health physics. In 1978, I was assigned to the Nuclear Station Division Staff in the Technical Services - Nuclear Department. My responsibilities since 1978 have included the management of projects related to the improvement of nuclear unit availability by improvements in PWR steam generator water chemistry.

In June 1982, I was assigned the responsibility for coordinating the efforts of a Westinghouse-Edison Working Group for the improvement of steam generator availability at Zion Station. This responsibility included the development of recommendations for the improvement of station water chemistry through improvement of operations and plant modifications. One of these recommendations is to develop a corporate Steam Generator Water Chemistry Control Program.

Q.4. What is the purpose of your testimony?

A.4. My testimony addresses Rockford League of Women Voters Contention 22 and DAARE/SAFE Contention 9c. Dr. M.J. Wootten's testimony addresses the history and development of water chemistry guidelines and recommendations made by Westinghouse for the control of steam generator secondary side water chemistry. My testimony addresses the implementation of these guidelines and others at Byron Station. My testimony also addresses the measures to be implemented at Byron Station with respect to eddy current testing, loose parts control, flow induced vibration and the tube plugging criterion.

Q.5. What steam generator water chemistry guidelines are being implemented at the Byron Station?

A.5. The Westinghouse guidelines regarding water chemistry have been implemented in the design and construction of Byron Station as appropriate. The current Westinghouse chemistry controls as modified to incorporate elements of the Steam Generator

Owners' Group - Secondary Water Chemistry Guidelines, have been used as the basis for the Byron Station Secondary Chemistry Monitoring Program.

Q.6. Please explain how the Westinghouse guidelines have been implemented at Byron.

A.6. These guidelines have been implemented as follows:

Recommendation - The guideline chemistry conditions should be achieved prior to unit loading and maintained during power changes.

This recommendation has been incorporated in the Byron Secondary Chemistry Monitoring Program. To improve the unit startup water chemistry, a cleanup demineralizer system has been installed. The condensate and feedwater cleanup demineralizer will provide the plant with an efficient system to clean up the condensate and feedwater systems on startup. Guideline chemistry conditions will be achieved prior to unit loading through the use of this system.

Recommendation - Any source of contamination should be identified and the source corrected. No operation is allowed with locatable contaminant ingress.

Recommendation - Continuous monitoring of the chemistry of the steam generator blowdown is essential. Measured values should be compared to theoretical values in order to identify whether or not excess alkalinity or acidity is present.

The Byron Secondary Chemistry Monitoring program contains the following elements to locate, respond to and correct contaminant ingress:

1. An on-line chemistry monitoring system.
2. A backup analytical laboratory sampling and evaluation program; and
3. A specific chemical control corrective action plan.

The continuous on-line chemistry monitoring system provides a prompt method for identifying contaminant ingress. After a contaminant has been identified in the secondary system, corrective action will be taken to minimize the effects of that contaminant in the steam generator. Corrective action includes reduced power operation or unit shutdown until the source of the contaminant is corrected.

Recommendation - Dissolved oxygen at the condensate pump discharge should be less than 10 ppb, this minimizes the inventory of corrosion product transported to the steam generator.

The chemical control limit for oxygen in the condensate pump discharge is 10 ppb as stated in the Byron Secondary Chemistry Monitoring Program.

Recommendation - Copper bearing alloys be eliminated from the secondary system to permit greater flexibility and optimization in chemistry control.

Recommendation - Main condenser integrity be upgraded to minimize the ingress of impurities in the condensate to improve the reliability of the steam generators and turbine.

These guidelines have been implemented as follows:

a. Corrosion resistant materials, such as stainless steel have been used for condenser, feedwater heater and moisture separator reheater tubing.

b. Copper alloys have been eliminated from the steam, condensate and feedwater systems of the plant.

The elimination of copper alloys and the installation of corrosion resistant tubing in the feedwater system, will significantly reduce sludge deposits in the steam generators. This in turn will reduce corrosion adjacent to sludge deposits and permit greater flexibility and optimization of chemical control. The use of stainless steel tubing in the condenser will decrease contaminant ingress because of improved condenser tube integrity.

Recommendation - If a condensate polishing system is installed, it must be carefully controlled and properly operated in order to optimize the quality of the treated condensate.

Byron Station does not have a full-flow condensate polishing system. Therefore, this recommendation does not apply.

Q.7. What is the Steam Generator Owners' Group?

A.7. The Steam Generator Owners' Group (SGOG) was established in 1977 by a group of utilities for the purpose of conducting research in the areas of steam generator design, operation and water chemistry control. The SGOG uses the facilities of the Electric Power Research Institute (EPRI), but is separately funded. The SGOG has issued Secondary Water Chemistry Guidelines, developed for the SGOG by a committee of utility and vendor and water chemistry experts. These guidelines have also been issued, with identical content, by EPRI.

Commonwealth Edison Company has been a member of the SGOG since its inception. I have actively participated on behalf of Commonwealth Edison in the activities of the Owners' Group. My participation has included membership on the Technical Advisory Committee, the Chemical Cleaning Subcommittee and the Secondary Water Chemistry Guidelines Committee.

Q.8. How do the Steam Generator Owners' Group Guidelines relate do the Westinghouse guidelines referred to in Dr. Wootten's testimony?

A.8. The Steam Generator Owners' Group Secondary Water Chemistry Guidelines are an expansion of the Westinghouse guidelines described in Dr. Wootten's testimony.

The SGOG Guidelines incorporate more restrictive water chemistry controls than the Westinghouse guidelines and include a staged corrective action plan. In addition to the more restrictive water chemistry controls, the SGOG Guidelines include recommendations for data management and surveillance, analytical methods. The SGOG guidelines include a recommendation that specific management responsibilities regarding secondary water chemistry control be assigned from the plant chemist to senior corporate management.

Q.9. What elements of the SGCG Guidelines have been implemented at Byron?

A.9. The Byron Station Chemistry Monitoring Program incorporates the following elements from the SGOG Guidelines:

- The more restrictive SGOG water chemical controls have been included. These controls are coupled with the corrective action plan to require prompt station response to a chemistry excursion before unit shutdown is required.
- The staged corrective action plan has been included. Based upon the level and duration of contaminant ingress, this plan requires specific corrective actions, including staged reductions in power.
- A data management and surveillance program is defined. This program provides for prompt identification of negative trends or inconsistencies in chemical control data.
- An analytical program is in place to supplement and verify the continuous on-line chemistry monitoring system data.

Although not specifically included in the Byron Chemistry Monitoring Program, the statement of management responsibilities recommended in the SGOG Guidelines is being addressed in a Commonwealth Edison corporate PWR Secondary Water Chemistry Control Program.

Q.10. What other actions have been taken by Commonwealth Edison to monitor steam generator tube integrity?

A.10. The condition of the Byron steam generators will be periodically monitored through an eddy current inspection program (Attachment A). Eddy current inspections will be performed according to the provisions of the Byron Technical Specifications. The results of these periodic inspections will be compared to the 100% pre-service baseline examination that has been completed at Byron. This comparison provides an ongoing evaluation of the steam generator tubing condition and allows for steam generator maintenance prior to primary to secondary leakage.

The eddy current inspection program described in Attachment A is the minimum inspection that will be conducted. Based upon the inspection results at similar plants, the first Byron in-service inspection will be a minimum of 3% of the steam generator tubes. Additional tubes may be added to the inspection to evaluate potential tube degradation mechanisms pertinent to the Byron Model D steam generators.

As in the past, we intend to upgrade our eddy current inspection techniques and equipment as technology advances to provide Commonwealth Edison with the utmost sensitivity available for evaluation of the condition of the Byron steam generators. In addition to the eddy current inspection program, Byron station will implement a loose parts control program.

Q.11. Please describe the loose parts control program for Byron Station.

A.11. Byron Station has a two part approach for the control of loose parts in the secondary side of the steam generators. The first is to control materials and tools used in the steam generators during maintenance and inspection. These controls are set forth in tool and material inventory control procedures. The second portion of the program is to use the installed Loose Parts Monitoring System (LPMS) to promptly identify loose parts in the steam generator.

Q.12. Please describe the tool and material inventory control procedures.

A.12. Procedures are being written that require tools and materials entering the secondary side of the steam generators to be inventoried and accounted for prior to return to operation. Typically this will be done by checklists and logs. For example, a tool taken into the steam generator will be logged in and then must be logged out and accounted for prior to unit operation.

In addition, hold points are required in maintenance procedures for cleanliness inspections. The final hold point will be after all work is complete and immediately prior to closing the system. This inspection will be done by the Quality Control group which is a separate group from those actually performing work in the steam generators.

Q.13. Please describe the LPMS.

A.13. The Byron Station Loose Parts Monitoring System, as required by NRC Staff Regulatory Guide 1.133, is a monitoring, alarm and diagnostics system that provides real-time information to the operator on a variety of mechanical vibration phenomena that may occur in the reactor coolant system. This system includes two sensors on the secondary side of each steam generator. These sensors listen for noise generated by loose parts. Analysis of the wave forms, frequency, amplitude and timing between sensors gives an indication of the location of a loose part and an indication of the energy with which the part is striking the steam generator internals.

Q.14. How does the LPMS discriminate between noises normally present in the system and loose parts?

A.14. During the plant start-up background sound spectra are obtained at several power levels. Start-up background spectra at 100% power will be compared to new background spectra obtained every six months. The most recent background spectra is compared with the suspected loose part spectra. Analysis of the differences among spectra will yield the impact energy of the loose part.

Q.15. How is it determined that a loose part is present in the secondary side of a steam generator?

A.15. This can be done in two ways. First, the LPMS has an audio listening feature. This feature will be used to routinely listen to those sensors on the secondary side of the steam generators. Second, a computer designed into the system can be used to discriminate between normal system noise and that generated by a loose part.

The audio listening feature will be used to monitor noises in the steam generator at least one per week. If a loose part is suspected, the noise spectra can be recorded and analyzed by either the spectra analysis described above or the computer can be used for analysis purposes. These procedures will be embodied in a document entitled "Byron Technical Staff Surveillance Procedures."

Q.16. How sensitive is the LPMS for detecting loose parts?

A.16. The Byron LPMS will be calibrated and its sensitivity determined during the unit start-up testing. This calibration is done by actually hitting the outside of the system at various locations with a known mass and measuring the sensor response. Reg. Guide 1.133 requires that a 1.25 lb. metallic part impacting with a kinetic energy of 0.5 ft./lb. be detected if it is within 3 feet of the detector. Based upon experience with a similar system at the Zion Station the Byron system should be able to meet this requirement.

Q.17. What action is taken if a loose part is detected in the secondary side of a steam generator?

A.17. Upon confirmation of a loose part in the steam generator tube bundle, the unit would be shut down and inspected and the loose part removed.

Q.18. Have you read Mr. Timmons' testimony in this case on the subject of the flow-induced vibration phenomenon?

A.18. Yes.

Q.19. Does Commonwealth Edison intend to modify the Byron Station steam generators to minimize tube wear due to flow-induced vibration?

A.19. Yes. Commonwealth Edison will conduct a review of the steam generator modifications as proposed by Westinghouse. Based upon the results of this review, Commonwealth Edison will install the necessary modifications in the Byron Station steam generators.

Q.20. When will the modifications to the steam generators at Byron Station be installed?

A.20. Commonwealth Edison Company intends to install the necessary steam generator modifications at the earliest opportunity after engineering, testing, review and approval are completed. The Company presently intends that this be completed prior to unit operation.

Q.21. Does Commonwealth Edison intend to operate Byron Station at full-power if operation occurs prior to the time the modification is installed in the steam generators?

A.21. No. Commonwealth Edison does not intend to operate the Byron Station at power levels greater than 70% if the modifications to the steam generators have not been installed prior to start-up.

Q.22. What criterion will be used for tube plugging at Byron?

A.22. The tube plugging criterion to be used at Byron is a 40% through wall eddy current indication. This is an industry standard and is appropriate for Byron as indicated in Dr. Patel's testimony.

STEAM GENERATORS

LIMITING CONDITION FOR OPERATION

3.4.5 Each steam generator in a non-isolated reactor loop shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With one or more steam generators in non-isolated reactor coolant loops inoperable, restore the inoperable generator(s) to OPERABLE status prior to increasing T_{avg} above 200° F.

SURVEILLANCE REQUIREMENTS

4.4.5.0 Each steam generator shall be demonstrated OPERABLE by performance of the following augmented inservice inspection program and the requirement of Specification 4.0.5.

4.4.5.1 Steam Generator Sample Selection and Inspection - Each steam generator shall be determined OPERABLE during shutdown by selecting and inspecting at least the minimum number of steam generators specified in Table 4.4-1.

4.4.5.2 Steam Generator Tube Sample Selection and Inspection - The steam generator tube minimum sample size, inspection result classification, and the corresponding action required shall be as specified in Table 4.4-2. The inservice inspection of steam generator tubes shall be performed at the frequencies specified in Specification 4.4.5.3 and the inspected tubes shall be verified acceptable per the acceptance criteria of Specification 4.4.5.4. The tubes selected for each inservice inspection shall include at least 3% of the total number of tubes in all steam generators; the tubes selected for these inspections shall be selected on a random basis except:

a. Where experience in similar plants with similar water chemistry indicates critical areas to be inspected, then at least 50% of the tubes inspected shall be from these critical areas.

b. The first inservice inspection (subsequent to the preservice inspection) of each steam generator shall include:

   1. All nonplugged tubes that previously had detectable wall penetrations (>20%), and

   2. Tubes in those areas where experience has indicated potential problems.

3. A tube inspection (pursuant to Specification 4.4.5.4.a.8) shall be performed on each selected tube. If any selected tube does not permit the passage of the eddy current probe for a tube inspection, this shall be recorded and an adjacent tube shall be selected and subjected to a tube inspection.

c. The tubes selected as the second and third samples (if required by Table 4.4-2) during each inservice inspection may be subjected to a partial tube inspection provided:

1. The tubes selected for these samples include the tubes from those areas at the tube sheet array where tubes with imperfections were previously found.

2. The inspections include those portions of the tubes where imperfections were previously found.

The results of each sample inspection shall be classified into one of the following three categories:

Category	Inspection Results
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.
C-2	One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.
C-3	More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

Note: In all inspections, previously degraded tubes must exhibit significant (>10%) further wall penetrations to be included in the above percentage calculations.

4.4.5.3 Inspection Frequencies - The above required inservice inspections of steam generator tubes shall be performed at the following frequencies:

a. The first inservice inspection shall be performed after 6 Effective Full Power Months but within 24 calendar months of initial criticality. Subsequent inservice inspections shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection. If two consecutive inspections following service under AVT conditions, not including the preservice inspection, result in all inspection results falling into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval may be extended to a maximum of once per 40 months.

b. If the results of the inservice inspection of a steam generator conducted in accordance with Table 4.4-2 at 40 month intervals fall into Category C-3, the inspection frequency shall be increased to at least once per 20 months. The increase in inspection frequency shall apply until the subsequent inspections satisfy the criteria of Specification 4.4.5.3.a; the interval may then be extended to a maximum of once per 40 months.

c. Additional, unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.4-2 during the shutdown subsequent to any of the following conditions occurring at operating pressure and temperature resulting in the blowdown of the affected system:

1. Primary-to-secondary tubes leaks (not including leaks originating from tube-to-tube sheet welds) in excess of the limits of Specification 3.4.6.2,

2. A seismic occurrence greater than the Operating Basis Earthquake,

3. A loss-of-coolant accident requiring actuation of the engineered safeguards, or

4. A main steamline or feedwater line break.

4.4.5.4 <u>Acceptance Criteria</u>

a. As used in this Specification:

1. <u>Imperfection</u> means an exception to the dimensions, finish or contour of a tube from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections.

2. Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube.

3. Degraded Tube means a tube containing imperfections ≥20% of the nominal wall thickness caused by degradation.

4. % Degradation means the percentage of the tube wall thickness affected or removed by degradation.

5. Defect means an imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective.

6. Plugging Limit means the imperfection depth at or beyond the tube shall be removed from service because it may become unserviceable prior to the next inspection and is equal to 40% of the nominal tube wall thickness (60% tube wall thickness remaining).

7. Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break as specified in 4.4.5.3.c, above.

8. Tube Inspection means an inspection of the steam generator tube from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg.

b. The steam generator shall be determined OPERABLE after completing the corresponding actions (plug all tubes exceeding the plugging limit and all tubes containing through-wall cracks) required by Table 4.4-2.

4.4.5.5 Reports

a. Following each inservice inspection of steam generator tubes, the number of tubes plugged in each steam generator shall be reported to the Commission within 15 days.

b. The complete results of the steam generator tube inservice inspection shall be included in the Annual Operating Report for the period in which this inspection was completed. This report shall include:

1. Number and extent of tubes inspected.

2. Location and percent of wall-thickness penetration for each indication of an imperfection.

3. Identification of tubes plugged.

c. Results of steam generator tube inspections which fall into Category C-3 and require prompt notification of the Commission shall be reported pursuant to Specification 6.6 prior to resumption of plant operation. The written followup of this report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

TABLE 4.4-1

MINIMUM NUMBER OF STEAM GENERATORS TO BE INSPECTED DURING INSERVICE INSPECTION

	PRESERVICE INSPECTION
First Inservice Inspection	
Without Preservice Inspection	Four
With Preservice Inspection	Two
Second and Subsequent Inservice Inspections	
Without Preservice Inspection	One[1]
With Preservice Inspection	One[2]

Table notation:

1. The inservice inspection may be limited to one steam generator on a rotating schedule encompassing 12% of the tubes if the results of the first or previous inspections indicate that all steam generators are performing in a like manner. Note that under some circumstances, the operating conditions in one or more steam generators may be found to be more severe than those in other steam generators. Under such circumstances the sample sequence shall be modified to inspect the most severe conditions.

2. Each of the other two steam generators not inspected during the first inservice inspections shall be inspected during the second and third inspections. The fourth and subsequent inspections shall follow the instructions described in 1 above.

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TESTIMONY OF NILRATAN PAUL
CONCERNING STEAM GENERATOR
TUBE INTEGRITY
(PRE-SERVICE INSPECTION)

Submitted on behalf of
the Applicant, Commonwealth Edison
Company in Response to DAARE/SAFE
Contention 9c and League Contention 22

February 25, 1983