

Commonwealth Edison Company (ComEd)  
BYRON STATION UNIT 1  
4450 N. German Church Road  
Byron, IL 61010

COMMERCIAL OPERATION: 09/16/85

STEAM GENERATOR EDDY CURRENT INSPECTION REPORT

CYCLE 9 REFUELING OUTAGE (B1R09)

APRIL 1999

ComEd  
P.O. Box 767  
Chicago, IL 60690

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## 1.0 INTRODUCTION

Byron Station Unit 1 operates with four Babcock & Wilcox Replacement Steam Generators (SGs) in the four loop pressurized water reactor system. The SGs each contain 6633 thermally treated Inconel-690 U-tubes that have a nominal diameter of 0.6875 inches and a nominal thickness of 0.040 inches. The tubes are supported by stainless steel lattice grid structures and fan bars. The tubes are hydraulically expanded into the full depth of the tubesheet. Main Feedwater enters the SGs above the tube bundle through a feeding and J-tubes. The SG configuration is shown in Figures A.1 and A.2. The replacement SGs were installed at the end of Cycle 8 and Byron Station Unit 1 operated one cycle using these SGs prior to this inservice inspection described in this report. During the Byron Station Unit 1 Cycle 9 refueling Outage (B1R09) the first inservice inspection of the replacement SGs was performed.

In compliance with Byron Station Technical Specification 5.5.9, "Steam Generator Tube Surveillance Program" and ASME Section XI, IWB 2500-1, Examination Category B-Q, Item B16.20, 1989 Edition, SG eddy current examinations were performed during the Byron Station Unit 1 Cycle 9 refueling outage (B1R09). In addition, the inspections were performed consistent with Revision 5 of the EPRI PWR Steam Generator Examination Guidelines and NEI 97-06, "Steam Generator Program Guidelines". The inspections were conducted from April 3 through April 9, 1999 by Framatome Technologies, Inc. (FTI). The following inspections were performed during this outage:

- 100% Full Length Bobbin Coil in SGs B, C, and D
- Diagnostic Plus-Point Inspections based on Bobbin Coil Results
- 100% Visual Inspection of installed welded plugs (2 in SG C)
- Visual Inspection of Secondary Side Tubesheet in All SGs
- Visual Inspection of Upper Bundle and Feeding Region in SG D

## 2.0 SUMMARY

The guidance in Revision 5 of the EPRI PWR Steam Generator Examination Guidelines (EPRI Guidelines) was used during this inspection. A degradation assessment was performed prior to the inspection to ensure the proper EPRI Appendix H qualified inspection techniques were used to detect any existing (none) and potential modes of degradation. Each technique was evaluated to ensure that the detection and sizing capabilities are applicable to the Byron Station Unit 1 site specific condition in accordance with Section 6.2.4 of the EPRI Guidelines. All data analysts were qualified to Appendix G of the EPRI Guidelines (QDA). All data analyst and acquisition personnel satisfactorily completed site specific training and testing. An independent QDA process control review was employed to randomly sample the data to ensure that the analysis resolution process was properly performed and that the field calls were properly reported. An analysis feedback process was implemented that required the data analysts to review their missed calls and overcalls on a daily basis.

As a result of the eddy current and visual inspections of the SGs, no degradation was found in the tubing or internal components. There were no scanning limitations during the eddy current examinations. No tubes were repaired. Table 2.1 provides the total tube plugging history and equivalent plugging levels to-date for the Byron Unit 1 SGs:



**Table 2.1**  
**Equivalent Tube Plugging Level**

	<b>SG A</b>	<b>SG B</b>	<b>SG C</b>	<b>SG D</b>	<b>Total</b>
<b>Tubes Previously Plugged*</b>	0	0	1	0	1
<b>Tubes Plugged in B1R09</b>	0	0	0	0	0
<b>Total Tubes Plugged</b>	0	0	1	0	1
<b>Total Tubes Plugged (%)</b>	0%	0%	0.015%	0%	0.004%

\* Tubes plugged at factory during vessel fabrication.

### **3.0 CERTIFICATIONS**

#### **3.1 Procedures/Examinations/Equipment**

- 3.1.1 The examination and evaluation procedures used during the SG eddy current inspection were approved by personnel qualified to Level III in accordance with the 1984 Edition of SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing". ComEd procedures SPPM NDT-E-2, Revision 2 and SPPM NDT-E-3, Revision 1 were used for the data acquisition and analysis.
- 3.1.2 The examinations, equipment and personnel were in compliance with the requirements of the ComEd and FTI Quality Assurance Programs for Inservice Inspection, Byron Station Technical Specification 5.5.9, 1989 Edition of ASME Boiler and Pressure Vessel Code Sections XI and V, Revision 5 of the EPRI PWR SG Examination Guidelines and NEI 97-06.
- 3.1.3 Certification packages for examiners, data analysts and equipment are available at Byron Station. Tables A.1 and A.2 list all personnel who performed, supervised or evaluated the data during this SG inservice inspection.
- 3.1.4 Zetec MIZ-30 Remote Data Acquisition Units (RDAUs) with EddyNet 98 Version 5.16 computer software was used to acquire the eddy current data. Analysis was performed with EddyNet 98 Version 5.16 computer software.
- 3.1.5 The bobbin coil examinations of the SGs were performed with Zetec 0.560 inch diameter M/ULC 3/8 36p Tuned probes.
- 3.1.6 The rotating coil examinations in the straight tubing were planned to be performed with Zetec 0.560 inch diameter plus-point Delta Probe Head 0.115/PP/s80 probes. The coils within this probe were a 0.115 inch diameter pancake coil, a shielded 0.080 inch diameter mid-range pancake coil and a standard mid-range plus-point coil. No diagnostic examinations in the straight tubing were required.
- 3.1.7 The rotating coil examination in the U-bend region of the SG tubing were performed with a Zetec 0.560 inch diameter FH/PH standard mid-range plus-point probe.

#### **3.2 Personnel**

- 3.2.1 The personnel who performed the SG eddy current inspections were qualified to Level I and Level II certification in accordance with the 1984 Edition of SNT-TC-1A. The Level I personnel performed the inspections under the direct supervision of Level II personnel.



- 3.2.2 The personnel who performed the SG eddy current data analysis were qualified to a minimum of Level II, with special analysis training (i.e., Level IIA) in accordance with the 1984 Edition of SNT-TC-1A.
- 3.2.3 All eddy current data analysts were qualified in accordance with EPRI Appendix G for QDAs. In addition, all data analysts were trained and tested in accordance with a site specific performance demonstration program in both the bobbin coil and plus-point inspection data analysis. Resolution analysts were also trained and tested specifically for the performance of data resolution. All analysts were required to achieve a score of 80% or greater on both the written and practical examinations prior to analyzing data.
- 3.2.4 All SG eddy current data acquisition personnel were trained and tested in accordance with a site specific performance demonstration program. The data acquisition operators were required to achieve a written test score of 80% or greater prior to acquiring data.
- 3.2.5 The SG eddy current analysis was subject to two independent analyses. Primary analysis of all data was performed by FTI and Rockridge Technologies, Inc. The following inspection agencies were subcontracted by FTI: Tecnom, Verner & James and Master-Lee. An independent company, Zetec, performed the secondary analysis. Secondary analysis was performed by an automated data screening analysis system. The system was required to successfully pass the site specific performance demonstration practical examination prior to analyzing field data.
- 3.2.6 An independent SG eddy current Level III QDA was employed to serve as a process control reviewer, in accordance with EPRI Guideline Section 6.3.3.4, to randomly sample the data to ensure the resolution process was properly performed and that the field calls were properly reported. The Independent Level III QDA also provided data acquisition oversight to ensure that the data collection process was in compliance with appropriate procedures and all essential variables were set in accordance with the applicable Examination Technique Specification sheet (ETSS). The Independent Level III QDA was employed by a third inspection company, ANATEC, and reported directly to the ComEd Level III inspector.

#### **4.0 EXAMINATION TECHNIQUES AND EXAMINATION SCOPE**

All SG eddy current examination techniques used were qualified in accordance with Appendix H of the EPRI PWR SG Examination Guidelines. Each examination technique was evaluated to be applicable to the tubing and conditions of the Byron Station Unit 1 SGs.

##### **4.1 Examination Techniques**

- 4.1.1 All inservice tubes in SGs B, C and D were inspected full length utilizing a bobbin coil probe described in Section 3.1.5 of this report. Nominal probe inspection speed was 40 inches per second. Sufficient sampling rates were used to maintain a minimum digitizing rate of 30 samples per inch. The bobbin probes were operated in both the differential and absolute modes at frequencies of 650 kHz, 320kHz, 160 kHz, and 35 kHz. The following suppression mixes were used to enhance the inspection: 650/160 kHz differential mix, 320/160 kHz absolute mix, 650/320/160 kHz differential mix, and a 650/320 kHz differential mix.

- 4.1.2 Diagnostic examinations were performed on non-quantifiable indications and hot leg dents/dings greater than 5.0 volts that were detected by the bobbin coil examination. The diagnostic examinations were performed using a plus-point probe as described in Section 3.1.6 and Section 3.1.7. Axial probe inspection speed was 0.6 inches per second for straight tubing and 0.15 inches per second for U-bend region of the tubing and dents/dings. Sample rates and rotation speeds were used to maintain a minimum of digitizing rate of 30 samples per inch (i.e., 25 samples per inch for the axial direction and 30 samples per inch for the circumferential direction). The rotating probes were operated in the absolute test mode at frequencies of 300 kHz, 200kHz, 100 kHz and 20 kHz. In addition to the four base frequencies, three process channels were used to display axial indications in the positive trace.
- 4.1.3 The SG eddy current examination techniques used during this inspection were equivalent to the EPRI Appendix H techniques listed in Table 4.1 of this report. Each technique was evaluated and determined to be applicable to the site conditions.

**Table 4.1**  
**EPRI Appendix H Techniques**

EPRI Technique ETSC	Probe	Description
96004	Bobbin	Fan Bar/Lattice Grid/Foreign Object Wear and Free Span Flaws
96910	Plus-Point	Foreign Object Wear/Free Span Flaws
96509	Plus-Point	Dents/Dings – Primary Water Stress Corrosion Cracking (PWSCC)
96703	Plus-Point	Dents/Dings – PWSCC sizing
96402	Plus-Point	Dents/Dings – Outer Diameter Stress Corrosion Cracking (ODSCC)
96010	Bobbin	Manufacturing Burnish Marks
96006	Bobbin	Tubesheet Expanded Region, excluding expansion transition

## 4.2 Exceptions to EPRI PWR Steam Generator Examination Guidelines

As stated in Section 1.1 of the EPRI PWR SG Examination Guidelines, "Utilities may be able to deviate from specific requirements of this document by providing a documented technical justification for each deviation or through the application of performance-based criteria and risk-based methodologies." Below are instances where technical justifications were provided to take exception to specific guideline requirements.

- 4.2.1 Section 3.4.1 of the referenced EPRI Guidelines requires that 20% of the active SG tube population be inspected from tube end to tube end with an EPRI Appendix H qualified technique. Technical justification was completed and documented to exempt the 20% examination of the top of the tubesheet expansion transition and low row U-bends with a plus-point probe during B1R09 (i.e., the first outage following SG replacement).
- 4.2.2 Section 3.3.1 of the referenced EPRI Guidelines requires that a 100% full length inspection with a general purpose probe be performed on all SGs during the first outage following SG replacement. Technical justification was completed and documented to exempt eddy current inspections in SG "A" during B1R09.



#### 4.3 Recording of Examination Data

Results of the SG eddy current data analysis were recorded on optical disks. The data was then loaded into a Zetec SG eddy current data management system. The system was used to track the completion of the examinations and was used to generate the final SG eddy current report summaries.

#### 4.4 Witness and Verification of Examination

SG eddy current inspections were witnessed and/or verified by the Authorized Nuclear Inservice Inspectors, Mr. Jeff Hendricks and Mr. Duane Oakley of the Hartford Steam Boiler Inspection and Insurance Company of Hartford Connecticut, Chicago Branch, 2443 Warrenville Road, Suite 500, Lisle, Illinois 60532-9371.

ASME Form NIS-1, "Owners Report for Inservice Inspections", is contained in Figure B.1.

### 5.0 EXAMINATION RESULTS

#### 5.1 Eddy Current Inspection

Full length bobbin coil examination was performed on 100% of the tubes in SGs "B", "C" and "D". No indication of tube degradation was found in any SG tube. Diagnostic plus-point examination was performed on SG tubes that contained non-quantifiable bobbin coil signals located in the U-bend region of seven tubes (see Table 5.1). The plus-point examination confirmed that the tubes did not contain any tube degradation.

Table 5.1  
Diagnostic Plus-Point Inspection

SG	Row	Column	Bobbin Result	Plus-Point Result	Location
B	112	51	NQI	NDF	FB6 +3.11 to +84.9
C	4	123	DFI	NDF	FB1 +13.93
C	12	69	DFI	NDF	FB1 +29.5
C	14	73	DFI	NDF	FB6 +6.28
D	15	102	DFI	NDF	FB1 +5.36
D	15	104	DFI	NDF	FB1 +5.46
D	20	19	DFI	NDF	FB1 +6.36

(NQI - Non-Quantifiable Indication; DFI - Differential Freespan Indication;  
NDF- No Degradation Found; FB - Fan Bar)

#### 5.2 Weld Plug Inspection

The Byron Station Unit 1 replacement SGs have one tube that is removed from service and is plugged with an Inconel-690 welded plug at each tube end. This tube, tube 34-129 in SG "C", was plugged during initial vessel fabrication. Both welded plugs were visually inspected during this outage. The inspection was performed by a Level II VT-1 qualified inspector using the ComEd VT-1 visual inspection procedure.

No indications or degradation was found in either of the welded plugs.



### **5.3 Secondary Side Visual Inspection**

Visual inspection of the secondary side of the SGs were performed in the following regions:

- Top of the tubesheet in each SG
- Top Lattice Grid in SG "D"
- Feeding/J-Tube Region in SG "D"

The top of the tubesheet inspections encompassed the outer tube annulus, tube free divider lane and two inner bundle passes on each of the hot and cold leg sides of the SG.

The top lattice grid/upper bundle inspection encompassed inspection of the lattice grid, lattice grid support rim, lattice grid acorn nuts, acorn nut tack welds, U-bend region tube surfaces, in-bundle tube surfaces, and general condition of areas surrounding the 8 inch diameter handhole where access was gained.

The feeding and J-tube inspection encompassed inspection of the feedwater header outside and inside surfaces, two J-tubes, J-Tube/Header welds and general condition of areas surrounding the 6 inch diameter handhole where access was gained.

No observations of degradation were found during the visual inspections described above.

### **6.0 REPAIR SUMMARY**

Since the SG eddy current and visual examinations resulted in no tube or component degradation, no tubes were plugged or repaired.

### **7.0 TUBE INTEGRITY ASSESSMENT SUMMARY**

SG tube integrity assessments were performed to demonstrate that SG performance met the required structural integrity and leakage requirements for the previous operating period (i.e., condition monitoring) and for the next operating period (i.e., operational assessment).

There was no primary to secondary leakage detected during Cycle 9 or during plant shutdown for refueling outage B1R09.

#### **7.1 Condition Monitoring/Operational Assessment**

Since no degradation was found in the SG tubes, plugs or internal components during the SG inspections, there is no impact to any structural or leakage performance criteria. Therefore, SG structural and leakage performance criteria were maintained within the original design limits. This results in an acceptable condition monitoring and operational assessment.

### **8.0 DOCUMENTATION**

All original SG eddy current optical disks have been provided to ComEd and are maintained at Byron Station. The final data sheets and pertinent SG tube sheet plots are contained in the FTI Final Outage Report for Byron Station Unit 1, B1R09, and is also maintained at Byron Station.

## 9.0 TABLES/FIGURES/ATTACHMENTS

Table A.1	Data Acquisition Personnel Certification
Table A.2	Data Analysis Personnel Certification
Figure A.1	Babcock & Wilcox Replacement Steam Generator Configuration
Figure A.2	Byron Station Unit 1 Steam Generator Tubesheet Configuration
Figure B.1	ASME Form NIS-1, "Owners Report for Inservice Inspection"

**TABLE A.1**  
**DATA ACQUISITION PERSONNEL CERTIFICATIONS**

<b>Name</b>	<b>Company</b>	<b>Level</b>	<b>QDA (Y/N)</b>
Abendanio, H	FTI	II	N
Ashford, GS	FTI	II	N
Bautista, MR	FTI	II	N
Camacho, E	FTI	II	N
Daley, SA	FTI	I	N
Gardner, EL	FTI	II	N
Gardner, JL	FTI	II	N
Gomez, AJ	FTI	II	N
Goodwin, MD	FTI	II	N
Greenquist, GJ	FTI	II	N
Gresham, BG	FTI	IIA	Y
Knox, BL	FTI	IIA	Y
Leach, CA	FTI	I	N
Lutz, RE	FTI	I	N
Markham, JH	FTI	II	N
Martin, AC	FTI	IIA	Y
Maxwell, JF	FTI	II	N
McMillan, WP	FTI	IIA	Y
Munsterman, JW	FTI	I	N
Mutschler, TL	FTI	II	N
Nelson, MA	FTI	II	N
Stromer, RG	FTI	I	N
Taylor, SC	FTI	IIA	Y
Ward, ET	FTI	II	N
Welsh, JP	FTI	I	N
Wright, JA	FTI	II	N



**TABLE A.2**  
**DATA ANALYSIS PERSONNEL CERTIFICATIONS**

Name	Company	Level	QDA (Y/N)
Alspaugh, KS	Zetec	IIIA	Y
Bjerke, DA	Zetec	IIA	Y
Boudreaux, WM	FTI	III	Y
Bridgforth, WD	FTI	IIA	Y
Bryant, DN	FTI	IIA	Y
Cochaud, A	FTI	III	Y
Colado, LE	FTI	IIA	Y
Cox, JE	Zetec	IIIA	Y
Crittenden, JG	Zetec	IIIA	Y
Darst, DR	Zetec	IIIA	Y
Deddens, JC	FTI	IIA	Y
Dlabik, AJ	Master-Lee	IIIA	Y
Farenbaugh, NJ	Zetec	IIIA	Y
Frye, PC	Zetec	IIA	Y
Fuse, K	Zetec	IIA	Y
Garcia, AM	Tecnatom	IIA	Y
Hayashi, T	Zetec	IIA	Y
Hower, SL	Zetec	IIIA	Y
Jimenez, LP	Tecnatom	IIA	Y
Johnson, KL	FTI	IIA	Y
Komatsu, K	Zetec	IIA	Y
Korkowski, EM	FTI	III	Y
Kovalesky, TL	FTI	IIA	Y
Lee, RE	FTI	IIA	Y
Loer, MS	FTI	IIA	Y
Lucier, LJ	Zetec	IIIA	Y
Mathison, CM	Zetec	IIIA	Y
McLeod, E	Verner&James	IIA	Y
Merriam, SP	Zetec	IIIA	Y
Merriman, RH	FTI	III	Y
Nakano, H	Zetec	IIA	Y
Navratil, GL	FTI	III	Y
Oliver, JC	FTI	IIA	Y
Paine, RJ	FTI	IIA	Y
Palmer, RK	Verner & James	IIA	Y
Popkirov, I	Tecnatom	III	Y
Porras, PD	Tecnatom	III	Y
Ribaric, TA	FTI	III	Y
Richards, TA	FTI	III	Y
Shepherd, MD	FTI	IIA	Y
Shields, GK	FTI	IIA	Y
Silus, GK	Zetec	IIIA	Y
Singh, MT	Anatec	III	Y
Spencer, JL	Verner & James	IIIA	Y
Terhaar, MA	Zetec	IIA	Y
Tommarello, DJ	M-L	IIIA	Y
Toral, MD	Tecnatom	IIA	Y
Villanueva, LF	Tecnatom	III	Y
Vollmer, RA	Zetec	IIIA	Y

FIGURE A.1

Babcock & Wilcox Replacement Steam Generator  
Byron Unit 1 Configuration

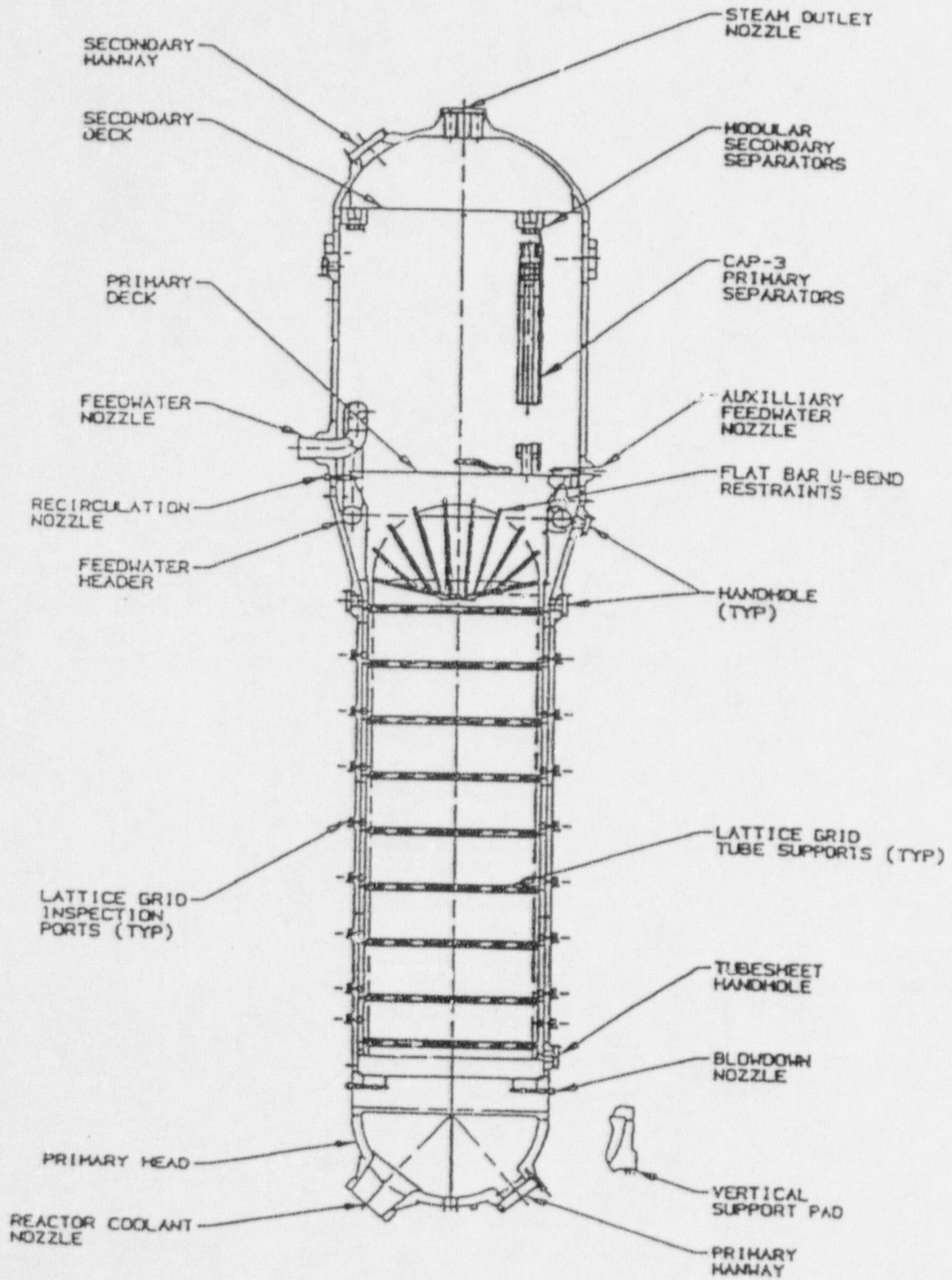
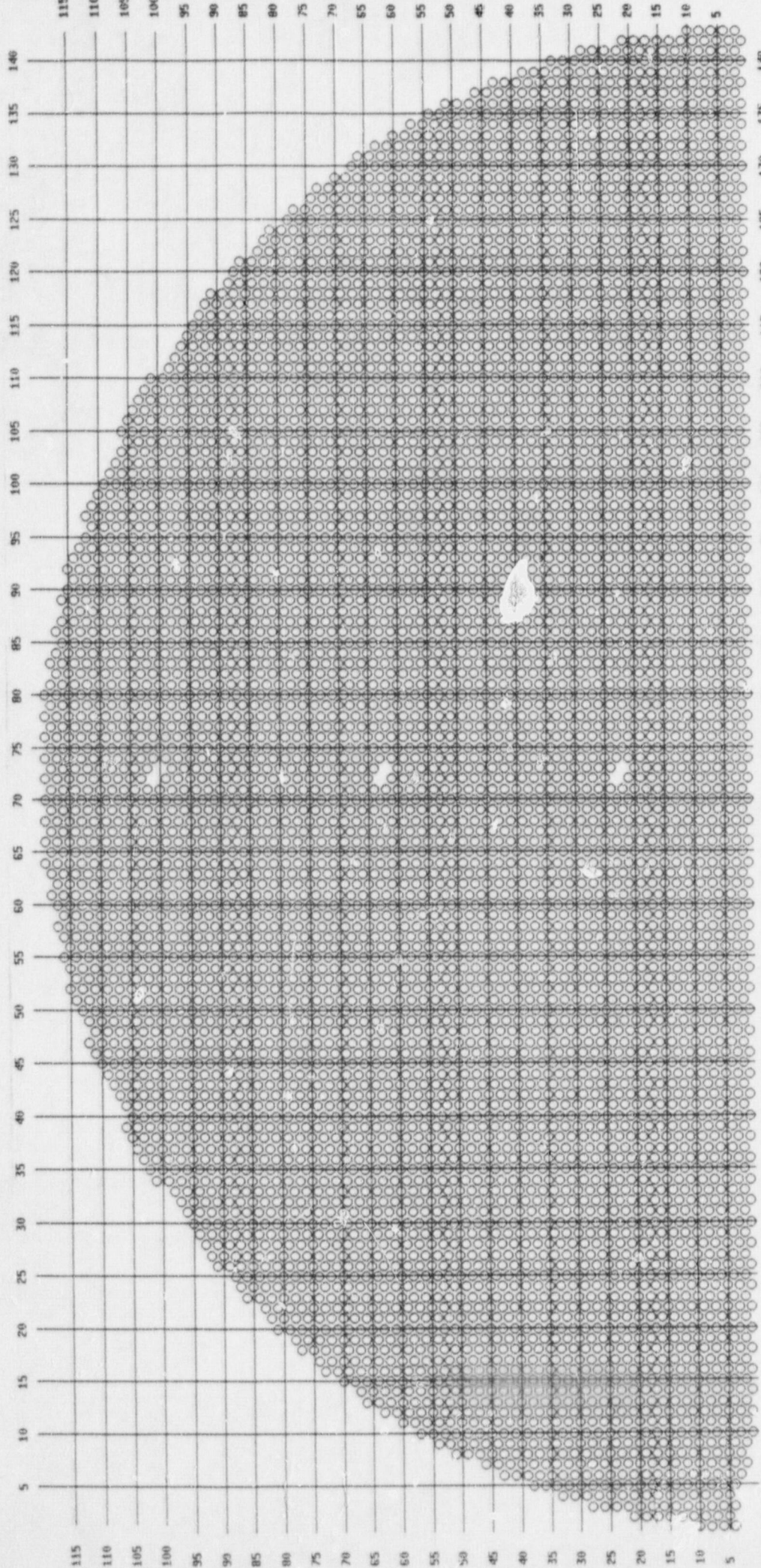




FIGURE A.2

BYRON UNIT 1 STEAM GENERATOR  
TUBESHEET CONFIGURATION (TYPICAL)



MANWAY Database: BYRON1\_SGA\_0399\_B1R09 Model: 7720 INLET NOZZLE

Character	Extent	Total	% of Total
○ Default Tube		6633	100.00
○ Default Stay		6	



1. Owner: Commonwealth Edison Company (ComEd) P.O. Box 767, Chicago, Illinois 60690  
(Name and Address of Owner)

2. Plant: Byron Station 4450 N. German Church Rd., Byron, Illinois 61010  
(Name and Address of Plant)

3. Plant Unit: One (1)

4. Owner Certificate of Authorization (if required): N/A

5. Commercial Service Date: 09/16/85

6. National Board Number for Unit: N-198

7. Components Inspected: Steam Generator Eddy Current Inspection

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FORM NIS-1 (Back)

8. Examination Dates 4/3/99 to 4/9/99 9. Inspection Interval from 6/30/96 to 9/16/05
10. Abstract of Examinations. Include a list of examinations and a statement concerning status of work required for current interval.

Refer to the Attached Steam Generator Eddy Current Report

11. Abstract of Conditions Noted

Refer to the Attached Steam Generator Eddy Current Report

12. Abstract of Corrective Measures Recommended and Taken

Refer to the Attached Steam Generator Eddy Current Report

We certify that the statements made in this report are correct and the examinations and corrective measures taken conform to the rules of the ASME Code, Section XI.

Certificate of Authorization No. (if applicable) Not Applicable Expiration Date Not Applicable

Date July 8 19 99 Signed For ComEd By [Signature]  
Owner

CERTIFICATE OF INSERVICE INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and the State or Province of ILL. and employed by HSB I & E Co of Hartford, CT have inspected the components described in this Owner's Report during the period 4/3/99 to 4/9/99, and state that to the best of my knowledge and belief, the Owner has performed examinations and taken corrective measures described in this Owner's Report in accordance with the requirements of the ASME Code, Section XI.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the examinations and corrective measures described in this Owner's Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or loss of any kind arising from or connected with this inspection.

[Signature]  
Inspector's Signature

Commissions ILL-1254  
National Board, State, Province, and Endorsements

Date July 8, 19 99