Exelon Generation
Braidwood Generating Station
35100 South Route 53, Suite 84
Braceville, IL 60407-9619
Tel 815-458-2801

www.exeloncorp.com

Exelon Nuclear

March 27, 2001
BW010033

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Unit 1
Facility Operating License No. NPF-72
NRC Docket Nos. STN 50-456

Subject: Steam Generator Tube Inspection Report from Braidwood Unit 1 Refueling Outage Inspections

Pursuant to Item b of Braidwood Station Technical Specification 5.6.9, "Steam Generator (SG) Tube Inspection Reports," we are submitting the steam generator (SG) inspection results for Braidwood Station Unit 1, Cycle 8 Refueling Outage. This outage was the first inservice inspection of the SGs after SG replacement, which occurred during the previous refueling outage (i.e., Braidwood Station Unit 1, Cycle 7). Technical Specification 5.6.9.b requires the results of the SG tube inservice inspection be submitted to the NRC within 12 months following completion of the inspection. This report includes the number and extent of tubes inspected, location and percentage of wall thickness penetration for each indication of an imperfection, and identification of tubes plugged or repaired. The Braidwood Station Unit 1, Cycle 8 Refueling Outage SG inspections and repairs were completed on March 31, 2000.

The attached report is also being submitted in accordance with Section 4.0 of Nuclear Energy Institute (NEI) 97-06, "Steam Generator Program Guidelines".

Please direct any questions regarding this submittal to A. Ferko, Braidwood Regulatory Assurance Manager, (815) 458-2801 ext.2980.

Respectfully,

James D. von Suskil
Site Vice President
Braidwood Station

Attachment: Steam Generator Eddy Current Inspection Report (A1R08)

cc: Regional Administrator - NRC Region III
NRC Senior Resident Inspector - Braidwood Station
Office of Nuclear Facility Safety - Illinois Department of Nuclear Safety

A001

EXELON

BRAIDWOOD STATION UNIT 1

STEAM GENERATOR EDDY CURRENT INSPECTION REPORT

CYCLE 8 REFUELING OUTAGE (A1R08)

MARCH 2000

Documentation Completed Date: 3/12/01

Table of Contents

1.0 INTRODUCTION

Braidwood 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 feedring 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 7.

In compliance with Braidwood Station Technical Specification (TS) 5.5.9, "Steam Generator Tube Surveillance Program," and American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section XI 1989 Edition, IWB 2500-1, Examination Category B-Q, Item B16.20, SG eddy current examinations were performed during the Braidwood Station Unit 1 Cycle 8 refueling outage (A1R08). In addition, the inspections were performed consistent with the Electric Power Research Institute (EPRI) "PWR Steam Generator Examination Guidelines: Revision 5" and Nuclear Energy Institute NEI 97-06, "Steam Generator Program Guidelines." The inspections were conducted from March 22, 2000 through March 31, 2000 by Westinghouse Electric Co. Ltd. The following inspections were performed during this outage.

- 100% Full Length Bobbin Coil in all 4 SGs.
- Diagnostic Plus-Point Inspections based on Bobbin Coil Results.

2.0 SUMMARY

The guidance in Revision 5 of the EPRI PWR Steam Generator Examination Guidelines (i.e., EPRI Guidelines) was used during this inspection. A degradation assessment was performed prior to the inspection to ensure the proper EPRI Appendix H, "Performance Demonstration for Eddy Current Examination," qualified inspection techniques were used to detect any existing and potential modes of degradation. Each technique was evaluated to ensure that the detection and sizing capabilities are applicable to the Braidwood 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, "Qualification of Nondestructive Examination Personnel for Analysis of NDE Data," of the EPRI Guidelines (i.e., Qualified Data Analyst (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 inspection of the SGs, one tube was plugged due a minor indication of wear indication in the Fan Bar region. The wear was measured as less than 10% Through Wall (TW) which is well below the TS 40% TW repair limit. The tube was conservatively removed from service by mechanical tube plugging. The results of this inspection were classified as inspection category C-1 pursuant to Technical Specification 5.5.9.c, "Inspection Results Classification." There were no scanning limitations during the eddy current examinations. Table 2.1 provides the total tube

plugging history and equivalent plugging levels to-date for the Braidwood Station Unit 1 SGs:

Table 2.1
Equivalent Tube Plugging Level

	SG A	SG B	SG C	SG D	Total
Tubes Previously Plugged*	1	2	0	0	3
Tubes Plugged in A1R08	1	0	0	0	1
Total Tubes Plugged	2	2	0	0	4
Total Tubes Plugged (%)	0.003%	0.003%	0%	0%	0.015%

* 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." Commonwealth Edison (ComEd) Company procedures Special Process Procedures Manual (SPPM) NDT-E-2, "Multifrequency Eddy Current Data Acquisition of Steam generator Tubing at Braidwood and Byron Nuclear Stations," Revision 3 and SPPM NDT-E-3, "Evaluation of Eddy current Data for Steam generator tubing at Braidwood and Byron Nuclear Stations," Revision 2 were used for the data acquisition and analysis.

3.1.2 The examinations, equipment and personnel were in compliance with the requirements of ComEd and Westinghouse Quality Assurance Programs for Inservice Inspection, Braidwood Station Technical Specification 5.5.9, 1989 Edition of ASME B&PV Code Sections XI, "Rules for Inservice Inspection of Nuclear power Plant Components," and V, "Nondestructive Examination," Revision 5 of the EPRI PWR SG Examination Guidelines and NEI 97-06, Steam Generator Program Guidelines, Revision 0.

3.1.3 Certification packages for examiners, data analysts and equipment are available at Braidwood 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 R/D Tech Inc. TC6700 Remote Data Acquisition Units (RDAUs) with Westinghouse ANSER computer software was used to acquire the eddy current data. Analysis was performed with Westinghouse ANSER Release 2000.1.0.1 computer software. Secondary analysis was performed with CoreStar Eddyvision 32 Release 4.1 computer software.

3.1.5 The bobbin coil examinations of the SGs were performed with Westinghouse 0.560 inch diameter long life probes.

3.1.6 The rotating coil examinations were performed with Zetec 0.560 inch or 0.520 inch diameter three coil plus-point 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.

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 and Article IV-2000 of ASME Section XI, 1989 Edition.

3.2.3 All eddy current data analysts were qualified in accordance with EPRI Appendix G for Qualified Data Analysts (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 Westinghouse and sub-contractors. An independent company, CoreStar International, performed the secondary analysis. Primary and Secondary analysis was performed by an automated data screening analysis system as described in Section 6.3 of the EPRI PWR Steam Generator Examination Guidelines, Revision 5. Each 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 Guidelines, 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, that all essential variables were set in accordance with the applicable Examination Technique Specification Sheet (ETSS) and to

provide a data quality check of acquired data. The Independent Level III QDA 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 Braidwood Station Unit 1 SGs.

4.1 Examination Techniques

4.1.1 All inservice tubes 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 for tubes in row 10 and higher and 24 inches per second in rows 1 through 9. 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, and a 650/320 kHz differential mix.

4.1.2 Diagnostic examinations were planned for non-quantifiable indications and hot leg dents/dings greater than 5.0 volts that may be detected by the bobbin coil examination. The diagnostic examinations were to utilize a plus-point probe as described in Section 3.1.6. Axial probe inspection speed was 0.5 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 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 eddy current calibration standards used for the bobbin coil and plus-point inspections met the requirements of Section 6.2.7 of the EPRI PWR Steam Generator Examination Guidelines, Revision 5 and Sections V and XI of the ASME B&PV Code, 1989 Edition.

4.1.4 The SG eddy current examination techniques used during this inspection were equivalent to the EPRI Appendix H techniques listed in Table 4.1. Each technique was evaluated and determined to be applicable to the site conditions.

Table 4.1
EPRI Appendix H Techniques

EPRI Technique ETSS	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

4.2 Steam Generator Inspection Scope

4.2.1 100% of the tubes in all 4 SGs were inspected full length (tube end to tube end) with a bobbin coil probe as described in Section 4.1.1 above.

4.2.2 Diagnostic examinations were planned for non-quantifiable indications and hot leg dents/dings greater than 5.0 volts that were detected by the bobbin coil examination. These special examinations are performed with the three coil plus-point probe described in Section 4.1.2 above. A total of 7 indications were inspected due to non-quantifiable signals detected during the bobbin coil inspection. See Section 5.1 for further detail. No hot leg dents or dings greater than 5.0 volts by the bobbin coil technique were detected.

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 Westinghouse 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. L. Malabanan the Hartford Steam Boiler Inspection and Insurance Company of Hartford Connecticut, Chicago Branch, 2443 Warrenville Road, Suite 500, Lisle, Illinois 60532-9871.

5.0 EXAMINATION RESULTS

5.1 Eddy Current Inspection

Full length bobbin coil examination was performed on 100% of the tubes in all 4 SGs. One tube in steam generator 1A showed signs of minor Fan Bar wear (< 10% TW) and was conservatively removed from service by mechanical tube plugging. Diagnostic plus-point examination was performed on SG tubes that contained non-quantifiable bobbin coil signals located in six tubes and the one Fan Bar indication discussed above (see Table 5.1). Except for the tube containing the minor Fan Bar wear the remaining plus-point examinations 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
A	35	22	DFI	NDF	5C + 7.83"
A	39	26	DFI	NDF	1C + 10.34"
A	87	54	DSI	VOL*	F-5 + 1.24"
B	102	47	ADI	NDF	7C + 7.26"
B	101	60	ADI	NDF	TSH + 19.14"
B	30	81	ADI	NDF	TSC + 17.98"
C	119	70	ADI	NDF	5H + 14.51"

* Fan Bar Indication Removed from Service

ADI – Absolute Drift Indication
DFI – Differential Freespan Indication
DSI – Distorted Support Plate Indication
NDF- No Degradation Found
VOL – Volumetric Indication
TSH – Tube Sheet Hot Leg
TSC – Tube Sheet Cold Leg
5H – Hot Leg Lattice Grid
F-5 – Fan Bar Number 5
1C, 5C, 7C – Cold Leg Lattice Grid

6.0 REPAIR SUMMARY

Repairs were conducted in accordance with ASME Section XI, 1989 Edition. All repairs were performed using Inconel-690 mechanical tube plugs. All repairs were performed in accordance with Westinghouse approved procedures. No tube sleeving was performed.

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 8 or during plant shutdown for refueling outage A1R08.

7.1 Condition Monitoring/Operational Assessment

The only tube degradation detected during A1R08 was one indication of minor (< 10% TW) Fan Bar wear. A condition monitoring assessment was performed in accordance with the EPRI Steam Generator Integrity Assessment Guidelines which demonstrated that all structural and leakage integrity requirements were met. Therefore, SG structural and leakage performance criteria were maintained within the original design limits for the previous operational period. The only mode of degradation found to date in the industry with similarly designed replacement SGs has been mechanical wear associated with fan bars and lattice grids. The industry experience with this damage mechanism demonstrates that there is a high probability of detection for small wear flaws (i.e., <=10% Through Wall) and that the growths rates are also small (i.e., <5% Through Wall/cycle).

An operational assessment was performed in accordance with the EPRI Steam Generator Integrity Assessment Guidelines. The results of this assessment show that all structural and leakage integrity requirements are predicted to be met after two cycles of operation. Therefore, this results in an acceptable operational assessment.

8.0 DOCUMENTATION

All original SG eddy current optical disks have been provided to Exelon and are maintained at Braidwood Station. The final data sheets and pertinent SG tube sheet plots are contained in the Westinghouse Final Outage Report for Braidwood Station Unit 1, A1R08, and are also maintained at Braidwood Station.

9.0 TABLES/FIGURES/ATTACHMENTS

Table A.1	Data Analysis Personnel Certifications
Table A.2	Data Acquisition Personnel Certifications
Figure A.1	Babcock & Wilcox Replacement Steam Generator Braidwood Unit 1 Configuration
Figure A.2	Braidwood Station Unit 1 Steam Generator Tubesheet Configuration

TABLE A.1
DATA ANALYSIS PERSONNEL CERTIFICATIONS

Name	Company	Level	QDA (Y/N)
Akre, MG	Anatec	IIA	Y
Brack, MT	Anatec	III	Y
Caperello, MM	Anatec	IIA	Y
Deveau, DC	Anatec	IIA	Y
Emery, RS	Anatec	IIA	Y
Griffith, TE	Anatec	IIA	Y
Himmelspach, RJ	Anatec	III	Y
Hodnett, SR	Anatec	IIA	Y
Kang, JH	Anatec	III	Y
Kerson, CJ	Anatec	IIA	Y
Lancaster, ME	Anatec	IIA	Y
Linney, TJ, Jr	Anatec	IIA	Y
Madison, BF	Anatec	IIA	Y
Maestas, RR	Anatec	III	Y
McKenzie, JH	Anatec	IIA	Y
Roberts, CJ	Anatec	IIA	Y
Schaefer, S	Anatec	III	Y
Steele, BG	Anatec	IIA	Y
Tan, JM	Anatec	IIA	Y
Tessier, HA	Anatec	IIA	Y
Benefield, C	Verner & James	III	Y
Coradi, MD	CoreStar	III	Y
DeLaPintiere, LM	Anatec	III	Y
Ethridge, GJ	NDET	IIIA	Y
Gardner, CL	Anatec	III	Y
Howe, DW	Anatec	III	Y
Maben, DE	Anatec	III	Y
Pierini, GP	Westinghouse	III	Y
Popovich, RA	Westinghouse	III	Y
Raper, LJ	Anatec	III	Y
Rogers, GF	Quantum	III	Y
Wadzinski, DJ	Anatec	III	Y
Bowler, SR	CoreStar	IIA	Y
Bowser, GC	CoreStar	III	Y
Butcher, S	Verner & James	IIA	Y
Causby, GW	CoreStar	IIA	Y
Croyle, RJ	CoreStar	III	Y
Hill, JW	Verner & James	IIIA	Y
Hover, LD	Verner & James	IIIA	Y

TABLE A.1
DATA ANALYSIS PERSONNEL CERTIFICATIONS
(Continued)

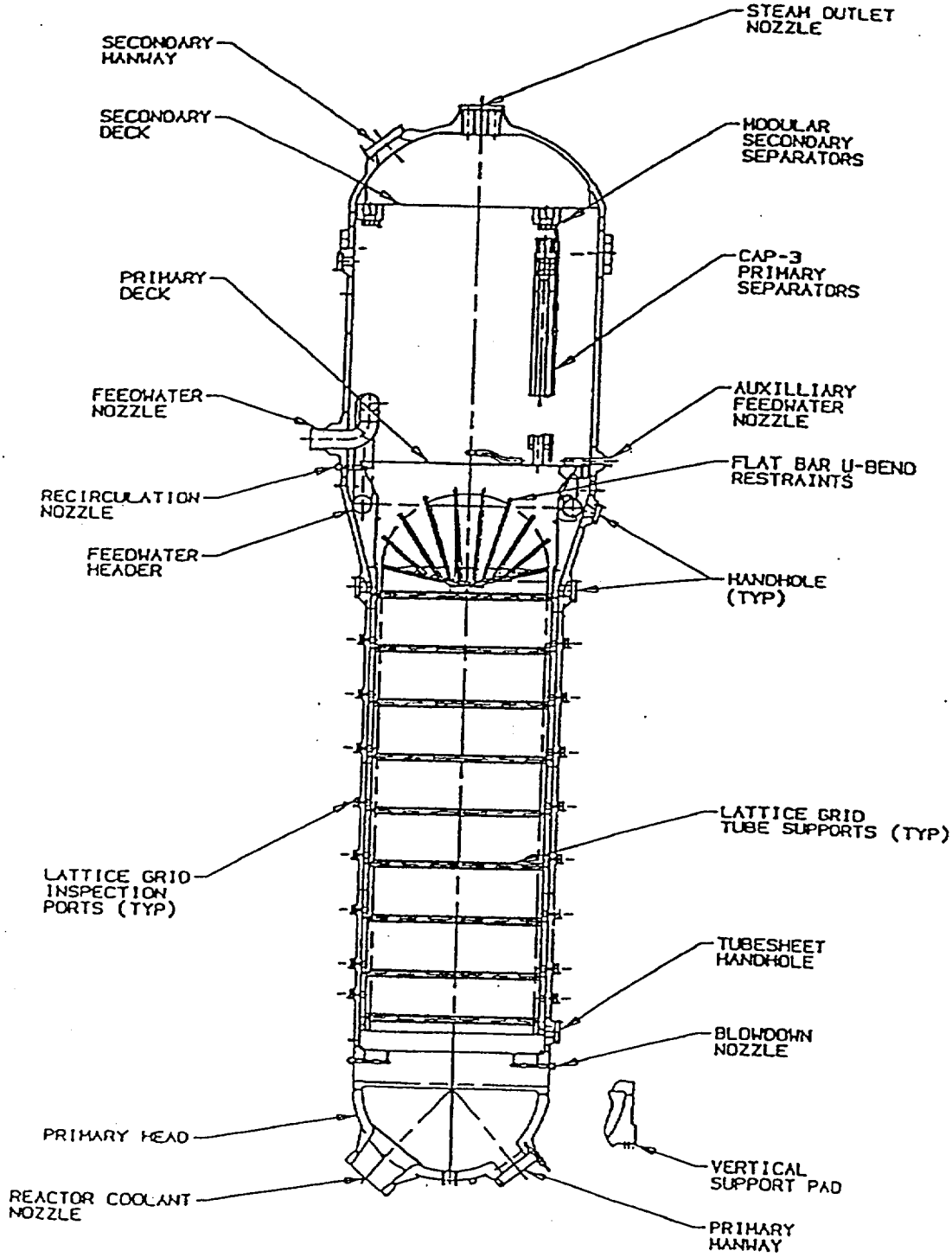
Name	Company	Level	QDA (Y/N)
Ignethron, GJ	Verner & James	IIA	Y
Martin, AP	CoreStar	IIA	Y
McChesney, WD	CoreStar	III	Y
McLeod, EJ	Verner & James	IIA	Y
Miller, HN	CoreStar	IIA	Y
Mullan, WA	Verner & James	IIA	Y
Paine, RJ	Verner & James	IIA	Y
Palmer, RK	Verner & James	IIIA	Y
Pessek, SG	Verner & James	IIA	Y
Robertson, RR	CoreStar	IIA	Y
Salls, YJ	Verner & James	IIA	Y
Salton, JR	Verner & James	IIA	Y
Shepard, JD	CoreStar	IIA	Y
Smith, JS	CoreStar	IIA	Y
Spake, CD	CoreStar	III	Y
T hompson, VA	CoreStar	IIA	Y
Thulien, TA	CoreStar	IIA	Y
Traves, DJ	CoreStar	IIA	Y
Turner, DG	CoreStar	IIA	Y
Visconti, CG	CoreStar	IIA	Y
Webb, JF	Verner & James	IIIA	Y

TABLE A.2
DATA ACQUISITION PERSONNEL CERTIFICATIONS

Name	Company.	Level	QDA (Y/N)
Bradley, GD	Westinghouse	II	N
Burkholder, RS	Westinghouse	II	N
Dawson, FD	Westinghouse	II	N
Derby, KL	Anatec	II	N
Douglas, BA	Westinghouse	II	N
Estel, JW	Westinghouse	II	N
Evering, DP	Westinghouse	II	N
Frye, PC	Zetec	IIA	Y
Gallagher, DR	Westinghouse	I	N
Gamache, EM	Zetec	I	N
Glenn, WD	Westinghouse	II	N
Hazlett, W	Westinghouse	II	N
Horvath, JI	Westinghouse	II	N
Mardell, DM	Westinghouse	II	N
Miller, GW	Westinghouse	II	N
Moorhead, GC	Westinghouse	II	N
Reif, DL	Westinghouse	II	N
Schachte, DM	Westinghouse	II	N
Schwering, RS	CoreStar	II	N
Scott, AW	Westinghouse	II	N
Scott, KL	Westinghouse	II	N
Sekeras, CJ	Westinghouse	II	N
Young, JA	Westinghouse	II	N

FIGURE A.1

General Configuration



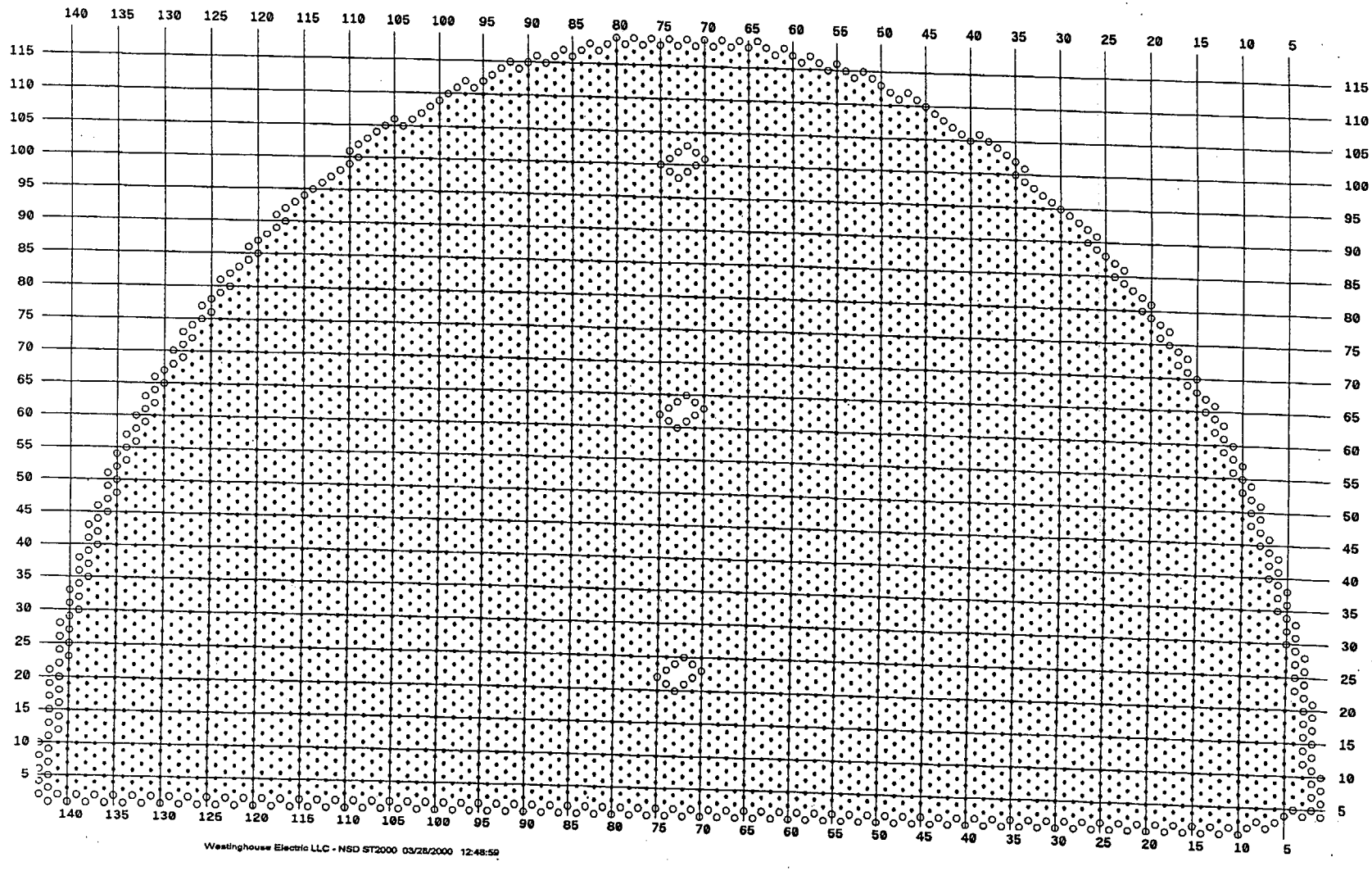

140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5
115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5
Westinghouse Electric LLC - NSD ST2000 03/28/2000 12:48:59

FIGURE A.2