1985
EDDY CURRENT EXAMINATION MANUAL FOR HOUSTON LIGHTING AND POWER COMPANY

South Texas Project
Unit 1

Location: Eight miles west of Wadsworth, Texas

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CONTENTS

A. Code Examination - 100% of all tubes in each generator except those which have been plugged during the fabrication stage. Each tube will be examined from tube-end to tube-end in accordance with technical procedure ISI-441 using the MIZ-18 data acquisition equipment.

B. Augmented Examination of Expansion Area - An augmented examination will be performed on those tubes identified in Section 4 of this manual in accordance with technical procedure ISI-442 using MIZ-18 data acquisition equipment.

C. Loose Parts - An examination will be performed in accordance with ISI-441 on the Row 1 tubes, outer periphery tubes and tubes adjacent to the T-slot area for the detection of loose parts

2. Requirements

The examinations described above shall be performed in accordance with the following requirements:

- ASME Boiler and Pressure Vessel Code Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components", 1980 Edition with addenda through the Winter 1981, Subsections IWA and IWB and Appendix IV.

1.0 INTRODUCTION

This manual describes the methods by which the Special Products and Integrated Field Services' (SPIS) organization of the Babcock & Wilcox Company (B&W) will perform the eddy current examinations of the South Texas Project located eight miles west of Wadsworth, Texas for the Houston Lighting and Power Company. This manual serves as the examination plan as required by Nuclear Regulatory Commission. This manual contains the following:

(1) Technical procedures which define the method and techniques used to perform the examinations

(2) Supplier Engineering Document Transmittal forms indicating acceptance of the technical procedures

(3) List of tubes containing expansions in the preheater region in each generator

(4) Drawings of the calibration standards and tube expansion mockup assembly and details

(5) List of previously used procedures

1. Scope of Examination

The preservice examination of the tubes in each steam generator (A, B, C & D) will be performed as defined below.

- o ASME Boiler and Pressure Vessel Code Nuclear Components Code Case N-401, "Eddy Current Examination - Section XI, Division 1".

- o Article 8, Appendix 1 of ASME Boiler and Pressure Vessel Code Section V, "Nondestructive Examination", 1980 Edition with addenda through the Winter 1981.

- o Plant technical specification

3. Tube Numbering:

Steam generator tubes are numbered as follows: Row 1/Column 1 tube is the tube directly adjacent to the divider plate and furthermost from the manway as illustrated in technical procedure ISI-441.

This manual was prepared for Houston Lighting and Power Company by Babcock & Wilcox under reference number 647-0009.

2.0 PROCEDURES

This section contains the technical procedures pertinent to the preservice examinations to be performed at HL&P's South Texas Project, Unit 1.

Technical Procedures

The appropriate technical procedures compiled in this section are listed below:

NUMBER	TITLE	REVISION
ISI-441	Technical Procedure for the Multifrequency Eddy Current Examination of RSG Tubing in E2 Steam Generators Using the MIZ-18	0
ISI-460	Technical Procedure for the Evaluation of Eddy Current Data of Nuclear Grade Steam Generator Tubing	11
ISI-462	Technical Procedure for the Evaluation of Eddy Current Data for Debris, Sludge and Secondary Side Loose Parts in Steam Generators	3

SUBJECT: TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	Enclosure 1 to ISI-441362 Rev. 0 PAQ-441-1

1. SCOPE: This procedure shall govern the multifrequency eddy current examination (ET) of recirculating steam generator (RSG) tubing in accordance with the requirements up to and including the 1980 Edition of the ASME Boiler and Pressure Vessel Code Section XI with the Addenda through the Winter 1981, the Nuclear Regulatory Commission Reg. Guide 1.83 of July 1975, and ASME Code Case N-401 (ISI 83-28).

   The tubing and calibration standards are made of Inconel 600 and have a nominal OD dimension of .750 inch and a nominal wall of .043 inch.

2. EXAMINER QUALIFICATION:

   2.1 Examiner: The examiner shall be qualified to a minimum of Level II in accordance with B&W Procedure ISI-24. The Level II shall be responsible for the quality of the examination data and shall review the calibrations performed for acceptance.

   2.2 Assistant: The assistant shall be qualified to at least Trainee or Level I Limited in accordance with the Babcock & Wilcox Procedure ISI-24. The assistant shall not independently evaluate or accept the results of the examination. The assistant shall perform the examination in accordance with this procedure under the guidance of an examiner defined in 2.1. When the examination is performed by a Trainee, the Level II or Level III shall observe the performance of the examination to ensure that the requirements of this procedure are met.

   2.3 Data Analyst: The data analyst shall be qualified to a minimum of Level IIA in accordance with B&W Procedure ISI-24 and shall have received specific training for the evaluation of data from nonferromagnetic tubing.

3. SURFACE PREPARATION: All tubes to be examined shall be as free of obstructions, dirt, and scale or other extraneous matter that could obscure tube openings or otherwise interfere with the examination as is practical.

4. EQUIPMENT: The Eddy Current Data Acquisition equipment shall be certified, when applicable, in accordance with ISI-80.

4.1 Eddy Current Instruments:

4.1.1 HP 9836 Computer.

4.1.2 GPIO Card.

4.1.3 MIZ-18 to HPIB interface.

4.1.4 MIZ-18 Remote Acquisition Unit.

4.1.5 MIZ-18 Acquisition Software.

4.1.6 Associated cables and connectors.

4.1.7 Equivalent equipment can be used if compatible.

4.2 Magnetic Tape Recording Equipment:

4.2.1 Zetec HCD-75Z Data Cartridge Recorder

4.2.2 "Formatted" Scotch brand DC 600 HC data cartridges or equivalent.

4.3 Zetec MIZ-18 "Digital Data Acquisition Instruction Book", Revision 1 dated June 21, 1984. Other subsequent revision shall be used as they become available or are applicable.

4.4 Strip Chart Recorder:

4.4.1 No external strip chart recorder shall be used. A presentation of the horizontal and vertical components are displayed and retrievable in hard copy printouts on a priority basis. Generation of a strip chart for any portion of a specific examination can be generated at any time in the future.

4.4.2 ASME Code Case N-401 (ISI 83-28) was passed by the Main Committee of the ASME Boiler and Pressure

Vessel Code Committee on November 4, 1983 and approved by the ASME Council.

4.5 Graphics Printer: (Optional)

4.6 Probes:

4.6.1 Annular differential straight body probe with a nominal diameter of .620 inch, nominal coil widths of .060 inch, and nominal coil separation of .060 inch.

4.6.2 Other probe designs and diameters may be used for supplemental information. If other designs or diameters are used, the type and size shall be recorded on the respective calibration sheet.

4.6.3 Maximum total probe extension cable lengths are defined in Figure 3.

4.7 Probe Driver: Zetec Model 2-D, B&W Pinch Wheel, or equivalent with or without take up reel.

4.8 Probe Alignment Device:

4.8.1 For baseline examinations, the probe may be positioned either manually or with a manipulator (and template if applicable).

4.8.2 For inservice examinations, the probe must be positioned with a remotely operated manipulator (and template if applicable).

4.9 Calibration Standards: The eddy current calibration standards shall contain at least but, not be limited to, the following artificial discontinuities:

4.9.1 Flat bottom holes drilled from the outer diameter with the following nominal dimensions.

Quantity	Depth	Diameter
1	100%	.052"
1	80%	.078"

Quantity	Depth	Diameter
1	60%	.109"
1	40%	.187"
4 at 90°	20%	.187"

4.9.2 Circumferential grooves on the identified surface with the following nominal dimensions:

Surface	Quantity	Depth	Width
OD	1 at 360°	10%	.125"
OD	1 at 360°	20%	.5"
ID	1 at 360°	20%	.062"

4.9.3 The calibration standard shall incorporate a tube support plate sample (TSP). For the ASME standards, the TSP shall be located in a defect-free area of the tube so that interfering signals do not result.

4.9.4 Other designs or additional artifical flaw indications are permissible in the same or different calibration standards provided that adequate separation (one inch minimum) exists between flaws and the "as built" drawings are available for data acquisition and data analysis of eddy current data.

4.10 DECIDE Computer: The DECIDE program is a Data Base Management system used for tracking and trending the status of the inspection. It can be run on any IBM-PC compatible computer system. Its use is optional to hand written data forms or the MIZ-18 generated tube list.

5. AREA OF INTEREST: The examination shall include the full length of the tube unless specified differently by the owner prior to the initiation of the inspection.

5.1 The tube support plates (TSP) shall be numbered as shown in Figure 1.

5.2 The tubes shall be identified by row and column number in accordance with Figure 2, with row 1 column 1 adjacent to the nozzle and opposite the manway, next to the divider plate.

6. INITIAL SETUP AND INTERCONNECTIONS OF EQUIPMENT: (Refer to Figure 3).

6.1 Connect the GPIO interface card on the HP 9836 to the HCD-75Z Data Cartridge Recorder with a 50-pin GPIO cable.

6.2 Connect the HPIB Interface on the HP 9836 to the HPIB/MIZ-18 interface with a GPIB cable.

6.3 Connect the HPIB/MIZ-18 Interface to the MIZ-18 Remote Unit with the desired lengths of MIZ-18 Remote Cables. The IEEE-488 connector at the lower right corner of the MIZ-18 Remote Unit should be used.

6.4 An appropriate MIZ-18 Probe Adaptor Cable connected to the Probe connector on the MIZ-18 Remote is used to adapt to standard test probe configurations. If a differential coil arrangement is to be used, such as a standard bobbin coil, then the test probe must be connected to the MIZ-18 with either:

A. The MIZ-18 Probe Adaptor (1 Amphenol, 4-Pin); or
B. The MIZ-18 Probe Adaptor (2 Amphenol, 4-Pin).

6.4.1 If only differential data is desired, then the 1 Amphenol, 4-pin adaptor (A) can be used without requiring a reference probe. The coil channel selected in the configuration mode for this type of test should be coil 1.

6.4.2 Should absolute data be desired with this type coil arrangement, the 2 Amphenol, 4-pin adaptor (B) should be used. In this case, a reference probe MUST be connected to the REFERENCE connector of the 4-pin Amphenol adaptor, and placed in a reference standard. Differential data is then available on coil channel 1 and absolute data is available on coil channel 5.

6.4.3 Check the Interface Select Code Switch on the installed GPIO card, which is the 5 part rocker switch located in the upper left quadrant of the board. (See Figure 4). The select code should be set to 12 by closing (setting to 1) rocker switches 2 and 3 with switches 0,1 and 4 open (set to 0).

6.5 If used, the 2671G Printer should be connected to either the HP 9836 or the HPIB/MIZ-18 Interface with a GPIB cable.

7.0 LOADING THE ACQUISITION SOFTWARE:

7.1 Load the MIZ-18 Data Acquisition floppy disk in the right disk drive of the computer. (This disk shall not be "write protected"). System can be booted up by turning the power "on" or "off & on".

7.2 Insert a blank data cartridge with the protect arrow pointing away from the "SAFE" position. The system will automatically position and load the data recorder which takes approximately 90 seconds.

7.3 Enter the month, day, year, hours, minutes and seconds with the appropriate soft keys. When complete press "Set Clock".

7.4 Return to test mode by pressing "TEST" key.

7.5 Press "Summary" key to produce the Summary Sheet. The appropriate information shall be entered by pressing "Type Data" and then typing the information. All entries exhibited on the summary shall be completed.

7.6 When complete with the Summary sheet press "Done". This will enter the data on the magnetic tape and return the system to the "Test" mode.

7.7 Press the "Configuration" soft-key to display the configuration screen. (Refer to Figure 5).

7.7.1 Set up the configuration as shown in Figure 5 by following the steps below:

7.7.2 Select one of the 16 configuration by number that can be changed by pressing the NEXT.# and/or PREV.# soft-keys. This is necessary because once this configuration has been changed, the new configuration will be written to the system disk.

7.7.3 Select the frequency desired for the #1 frequency time slot in the sequential array by rotating the knob until the desired frequency is displayed.

7.7.4 All frequencies have an allowable tolerance of ± 10 kHz.

7.7.5 Using the "DOWN" soft-key, move the white square to the #2, #3, and #4 frequency time slots and select the desired frequencies.

7.7.6 Using the "DOWN","UP", "LEFT" and "RIGHT" soft-keys, position the white square in the appropriate coil boxes that are to be excited with each frequency. The "TOGGLE" soft-key will set the coil to be excited or not excited. For each frequency time slot, and using the bobbin type probe with a reference probe also connected, the position corresponding to coil 1 represents differential data and the coil 5 position represents absolute data.

7.7.7 If a new name is required, press the "NEW.NAME" soft-key and using the keyboard, type in the new name in the space provided. The "NEW NAME" shall reflect the procedure and revision in use.

7.7.8 If desired, the number of data samples per second can be changed. Press the "PTS/SEC" soft-key and enter the numerical value desired using the keyboard. The range is from 10 samples/second to 400 samples/second. For most applications this value will be the default value of 400 samples/second.

7.7.9 Once the configuration has been established as desired, press the "CONFIGURE" soft-key. The system

will, if any changes have been made, store the configuration on disk and return the system to the test mode.

7.7.10 Other configurations than those described above may be implemented upon prior approval of the B&W Level III.

7.8 Select the strip chart channels desired using the "L.STRIP+" and "R.STRIP+" soft-keys. Operators may select these at their discretion.

7.9 Select the lissajous channel desired using the "CHANNEL+" or "CHANNEL-" soft-keys. Operators may select this at their discretion.

7.10 Move to the utility mode by pressing "TEST" while holding the shift key and with shift key still depressed, press the "REVIEW" soft-key.

7.10.1 Press the "SETUP" soft-key to select the setup mode.

7.10.1.1 If a printer is being used during data acquisition press the "2671G ON" soft-key.

7.10.1.2 Select the tube and generator labeling system to be used by selecting the appropriate soft keys. For OTSG's, this numbering shall be "SG" for the steam generator title and "ROW" and "COL" for the tube titles.

7.10.1.3 Return to the utility mode by pressing the "UTILITY" soft key.

7.10.2 Press the "DISK UTIL" soft-key and insert a blank disk in the left disk drive.

7.10.2.1 Press the "INIT DISK" soft-key in the shifted mode to initialize a data disk for power failure backup.

NOTE: Refer to Section 13 for instructions on recovering from keyboard lockup or power failure.

7.10.2.2 When initialization is complete (approximately 2 minutes) press the "INDEX BKUP" soft-key and read message on screen to ensure "Backup Enabled".

7.10.2.3 If the data cartridge was successfully ended by using the "END TAPE" soft key, the back up disk may be re-used on the next data cartridge by pressing the "CLR INDX" soft key in the shifted mode. This will erase the backup tube list for the cartridge that has just been ended.

7.10.2.4 Return to the utility mode by pressing the "UTILITY" soft key.

7.11 Return to the test mode by pressing the "UTILITY" soft key while holding the shift key.

8.0 ACQUIRING DATA

8.1 Turn the MIZ-18 tester on by pressing the "MIZ-18. ON" soft-key.

8.2 With a test probe in a section of calibration standard known to be free of defects, press the "CONTINUE" key on the keyboard to null the data being displayed and notice the long strip charts scrolling from top to bottom of the screen.

8.3 While viewing channel #1 withdraw the test probe through the calibration standard until all artificial flaws are displayed.

8.4 Press the MIZ-18 OFF soft-key to turn the tester off.

8.5 With the knob, move the cursor down the long strip chart. The lissajous display will change as the knob is turned and

the expanded strip charts will show that section of data being displayed in the lissajous section of the display screen.

NOTE: No data will be displayed in the long strip charts on the left portion of the display.

8.6 Press the "SPAN/ROT" softkey to enter the span/rotation mode.

8.6.1 Press the "REFRESH" soft key to display data in the long strip chart widows .

8.6.2 Position the cursor to that section of data that shows the 100% through wall flaw in the lissajous display.

8.6.3 Press the "SET ROT" soft key to enter the rotation setting mode.

8.6.3.1 With the knob, rotate the signal from the 100% through wall hole such that the signal is parallel to the 40 degree line drawn on the screen and with the initial excursion being down and to the right. The expanded strip charts should show the vertical (left) and horizontal (right) channels having the earliest in time data (i.e., the lower part of the display) initially moving apart.

8.6.3.2 All channels can be set to the desired display rotation by pressing either the "CHANNEL-" or "CHANNEL+" soft keys to display the same data segment for each channel.

8.6.3.3 For the differential channels 1,3,and 5 set the rotation (phase) such that the response from the 100% through wall hole is 40° (± 5 degrees) from the horizontal and the signals go down first. See Figure 6.

8.6.3.4 For the 10 kHz differential, channel 7 , set the phase so that the response to the TSP sample goes horizontal and to the left first as the probe is pulled. See Figure 8A.

8.6.3.5 For the absolute channels 2, 4 and 6, set the "Rotation" so that the response from the 100% through wall hole is approximately 220° degrees (± 5 degrees) as shown in Figure 7 when pulling the probe.

8.6.3.6 For the 10 kHz absolute, channel 8, set the phase so that the response to the TSP goes down and is 90° peak to peak as shown in Figure 8B.

8.6.4 Press the "SET SPAN" soft key to enter the signal span setting mode.

8.6.4.1 With the knob adjust the size of the signal being displayed to the desired level.

NOTE: It may be necessary to return to the SPAN/ROT mode to select another signal for setting SPANS such as a tube support plate signal. The combination of these soft key modes should be used to set the signal display desired for each channel.

8.6.4.2 All channels can be set to the desired span setting by pressing either the "CHANNEL-" or "CHANNEL+" soft-keys.

8.6.4.3 Set the "SPAN" for the differential channels 1, 3 and 5 so that the signal response from the 100% through wall hole is at approximately 4 divisions on the display. See Figure 6.

8.6.4.4 Set the span for the 10 kHz differential, channel 7, so that the response to the TSP

is 6 divisions vertically as shown in Figure 8A.

8.6.4.5 Adjust the "SPAN" on channels 2,4,and 6 to produce at least a two division signal, from the 100% through wall hole. See Figure 7.

8.6.4.6 Set the span for the 10 kHz absolute, channel 8, such that the response to the TSP is between 3 and 4 divisions vertically, as shown in Figure 8B.

8.6.4.7 Pressing the "TO.DISK" soft-key stores ALL SPAN and ROTATION values as part of this configuration on the acquisition software disk. This can be used to recover from an inadvertent error should it be necessary. Once stored on disk, the SPAN and ROTATION values will automatically be set when this configuration is used to establish the acquisition parameters.

8.7 Press "Test" to return to the test mode.

8.8 Press the "Summary" soft-key.

8.9 Press "Update" to update the summary with frequency, Span, rotation and coil data.

8.10 Press "Type Data" followed by "Done". This will rewrite the updated summary to the tape.

8.11 Any message can be typed by going to the "message" function. Press "Type Data" to enter a message and "Done" to store message on tape. (i.e.: Start of Standard test" is a sample message).

9. SYSTEM RECORDING: Upon completion of the span and rotation settings record the calibration on the data cartridge as follows:

9.1 Press "MIZ-18 On".

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INSERVICE INSPECTION PROCEDURE

UBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

9.2 Enter the steam generator identification stipulated by the customer. Enter Row/Column as 999 & 999 to identify the data as calibration data.

9.3 Press the "Run" key on keyboard and wait for screen command of "Tape On - Writing Verified".

9.4 Withdraw the test probe through the calibration standard and broached support plate sample at a speed not to exceed 14 inches/sec. and record the responses on the magnetic tape.

9.5 Press "Pause" on the keyboard to stop tape recorder. Note recorder will stop a few seconds later and the MIZ-18 remains on.

9.6 Repeat steps 9.3 through 9.5 to repeat the calibration recording.

9.7 Calibration shall include the complete ET examination system. Any change of test probe, extension cables, ET instrument, recording instruments, or any other parts of the examination system shall be cause for recalibration.

9.8 The system calibration shall be verified and the results of the test standard recorded at:

9.8.1 The beginning and end of each data cartridge and at interva s not to exceed four hours.

9.8.2 Calibration shall be performed at any time malfunctioning is suspected and after any malfunctions have been corrected.

9.8.3 Prior to changing any equipment (if possible).

9.8.4 The conclusion of an inspection as a final calibration.

9.9 If the equipment is found to be out of calibration as defined in this procedure, it shall be recalibrated. The data analyst shall determine which tubes, if any, shall be reinspected.

JBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

NOTE: Using the MIZ-18 system, the only real indication that the system is out of calibration is an error message identifying the channel affected, the horizontal or vertical component and the range of the signal in terms of full scale. An example of this is "Ch 4Y - 89% full scale". This message occurs when the balance (CONT) key is pressed. Additionally, the centerline between the long strip charts will become very broad in the region where the system is out of calibration.

9.10 In the event that calibrations cannot be performed because of building evacuations, etc., a calibration shall be made upon reentry and will suffice as the fourth hour calibration.

9.11 The calibration performed above does not actually change the phase and gain of the probe and instrument. The setup is to assist the operator in determining if all systems are working properly during the data acquisition phase. The data analyst shall also review the calibration data to ascertain if proper voltages are obtained.

10. SCANNING REQUIREMENTS:

10.1 The direction of scanning and recording shall be during retraction of the probe. The inlet or outlet from which the probe was inserted shall be identified on the applicable data sheet.

10.2 The speed of scanning during data recording shall not exceed 14 inches/sec. unless prior approval from a B&W ET Level III is granted.

11. PROBE SPEED VERIFICATION: The reverse (retraction) speed of the probe driver shall be verified whenever the eddy current system is calibrated.

11.1 Insert the eddy current probe into the straight length portion of a steam generator tube.

UBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

11.2 Retract the eddy current probe at the normal inspection speed through the length of tube while recording the signal on the MIZ-18 display.

11.3 The horizontal hash marks between the L. Strip and R. Strip charts are 1 second intervals. Use these to determine probe velocity between two points of known dimension, e.g. support plate to support plate.

12. POSITION VERIFICATION:

12.1 The ability of the probe positioner to locate specific tubes shall be verified visually and recorded upon installation and before relocating or removing the fixture.

12.2 If tube identity verification reveals that an error has occurred in the recording of probe location and resolution of actual tubes run is not possible, then all tubes examined since the previous verification of location shall be reexamined.

12.3 Corrections to any tube identity shall be made using the message routine following the completion of the tube run.

13. RECOVERY FROM POWER FAILURE OR KEYBOARD LOCKUP:

NOTE: If the Disk backup was properly enabled, it is the prefered routine for recovery. If it was not, follow the steps outlined in Section 13.2 for recovery.

13.1 Using the Index Backup from disk:

13.1.1 Cycle the "On-Off" switch with the data acquisition software disk in the right disk drive to re-boot the system.

13.1.2 Re-set the clock, month, day and year using the appropriate soft-keys.

13.1.3 Return to the test mode by pressing the "TEST" soft-key.

13.1.4 Press the "TEST" soft-key with the shift key to enter the review mode then press "REVIEW" soft-key with the shift key to enter the utility mode.

13.1.5 Press the "DISK UTIL" soft-key.

13.1.6 Press the "DISK INDX" soft-key to obtain the index (TLIST) from the disk and store to the computer memory.

13.1.7 Press the "INDX BKUP" soft-key to enable the backup routine. This is necessary after re-booting the system as the disabled mode is the default condition.

13.1.8 Press the "UTILITY" soft-key once by itself then again while pressing the shift key to return to the test mode.

13.1.9 Press the "TEST" soft-key while pressing the shift key to enter the review mode.

13.1.10 Press the "SUMMARY" soft key and verify the summary contains the correct information.

13.1.11 Press the "TLIST" soft-key to obtain the list of tube entries that have been recorded to the tape.

13.1.12 Using the knob scroll the list of tubes to place the next to last tube entry adjacent to the find tube arrow.

13.1.13 Press the "FIND TUBE" soft-key and the recorder will move to the selected tube and display the eddy current data on the screen.

NOTE: Before displaying the data for the selected tube, the message "CONFIG CHANGE-RUN TO CONTINUE" may be displayed. Simply press the RUN key to change the configuration and display the tube.

13.1.14 Press the "REVIEW" soft-key once by itself and then again while holding the shift key to return to the utility mode.

13.1.15 Press the "UTILITY" soft-key while holding the shift key to return to the test mode.

13.1.16 Begin testing again by first verifying the calibration setup and then re-running the last tube inspected before the power failure or keyboard lockup.

13.2 If the backup disk utility was not enabled, recovery can be accomplished by creating a new index using the "TAPE UTIL".

13.2.1 Follow steps 13.1.3 and 13.1.4 to enter the utility mode after re-booting the system and setting the clock.

13.2.2 Press the "TAPE UTIL" soft-key.

13.2.3 Press the "NEW INDX" soft-key to start a search of the data cartridge for the tube numbers that are recorded on the cartridge. This will create a new TLIST in the memory of the computer and to the disk, if now enabled.

13.2.4 When the search is complete the message "DONE" will appear on the display. Follow steps 13.1.8 through 13.1.16 to continue testing.

14. RECORDING CRITERIA:

14.1 All data from the tube examinations shall be recorded on digital data cartridges.

14.2 In the test mode with the MIZ-18 on, insert the test probe into the tube to be tested.

14.3. Identify the tube number using the appropriate soft-keys with the MIZ-18 on.

14.4 Press the "RUN" key to initiate the data recording and withdraw the probe while recording the data. When the probe has exited the tube, wait two seconds, then press the "PAUSE" key to stop data recording, otherwise some of the data will not get written onto the cassette tape.

NOTE: It is not necessary to turn the MIZ-18 off between tube runs.

14.5 Repeat steps 14.2 through 14.4 until all desired tubes are tested or the data cartridge becomes full.

14.6 Each data cartridge shall contain the following information as a minimum in the summary section:

14.6.1 Name of Owner

14.6.2 Plant site

14.6.3 Heat exchanger identification

14.6.4 Date of examination

14.6.5 Tape number

14.6.6 Examination direction (from inlet or outlet)

14.6.7 Data base or identification number of the calibration standard.

14.6.8 Operator's personal identification number (PIN) and certification level.

14.6.9 Nominal operating frequencies/test type (abs. or diff.).

14.6.10 Cable type and characterisitics, e.g. coax.

14.6.11 Lengths of probe and extension cables.

14.6.12 Size and type of probe(s).

14.6.13 Probe manufacturer's name and probe description or part number.

14.6.14 Data base or serial number of the data acquisition equipment. (i.e.: computer, interface unit, MIZ-18 remote unit, data recorder).

14.7 There is only one summary written to any data cartridge. Any changes affecting information within a summary already written to the data cartridge shall be made using the message routine. An alternate method is to end the current data cartridge and install a new one with the new summary information.

14.8 When a data cartridge is full, press the "TAPE RCDR" soft-key to enter this mode.

14.9 Press the "END TAPE" soft-key in the shifted mode to write an "end of data" message to the data cartridge and to update the tape header with the list of tubes and messages that have been recorded to this data cartridge.

14.10 The tape will atuomatically unload, which takes about 90 seconds, and the solenoid will sound a release allowing the tape to be removed.

14.11 Remove the data cartridge and turn the write protect device to the "SAFE" position to prevent accidental overwrite of the data.

14.12 Calibration sheets and data sheets shall be completed for all tubes examined if the MIZ-12 system is used. DECIDE printouts may be used instead of data sheets. All calibration sheets, data sheets, and DECIDE printouts where applicable shall be reviewed, signed, and dated by a Level II.

15. DATA EVALUATION: Data shall be evaluated in accordance with ISI-460 for ASME calibrations and ISI-462 for sludge or debris as required.

16. REPORTING CRITERIA: All reportable indications shall be reported to the owner on at least a 24 hour basis. Only reportable indications shall be listed in the final report. Customer reporting requirements shall supercede this procedure.

16.1 All reportable indications equal to or greater than 20% through wall shall be reported.

16.2 All detectable tube dings/dents known to obstruct probe passage shall be reported.

16.3 Any additional condition(s) that the data analyst deems necessary to report shall be reported.

BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

UBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

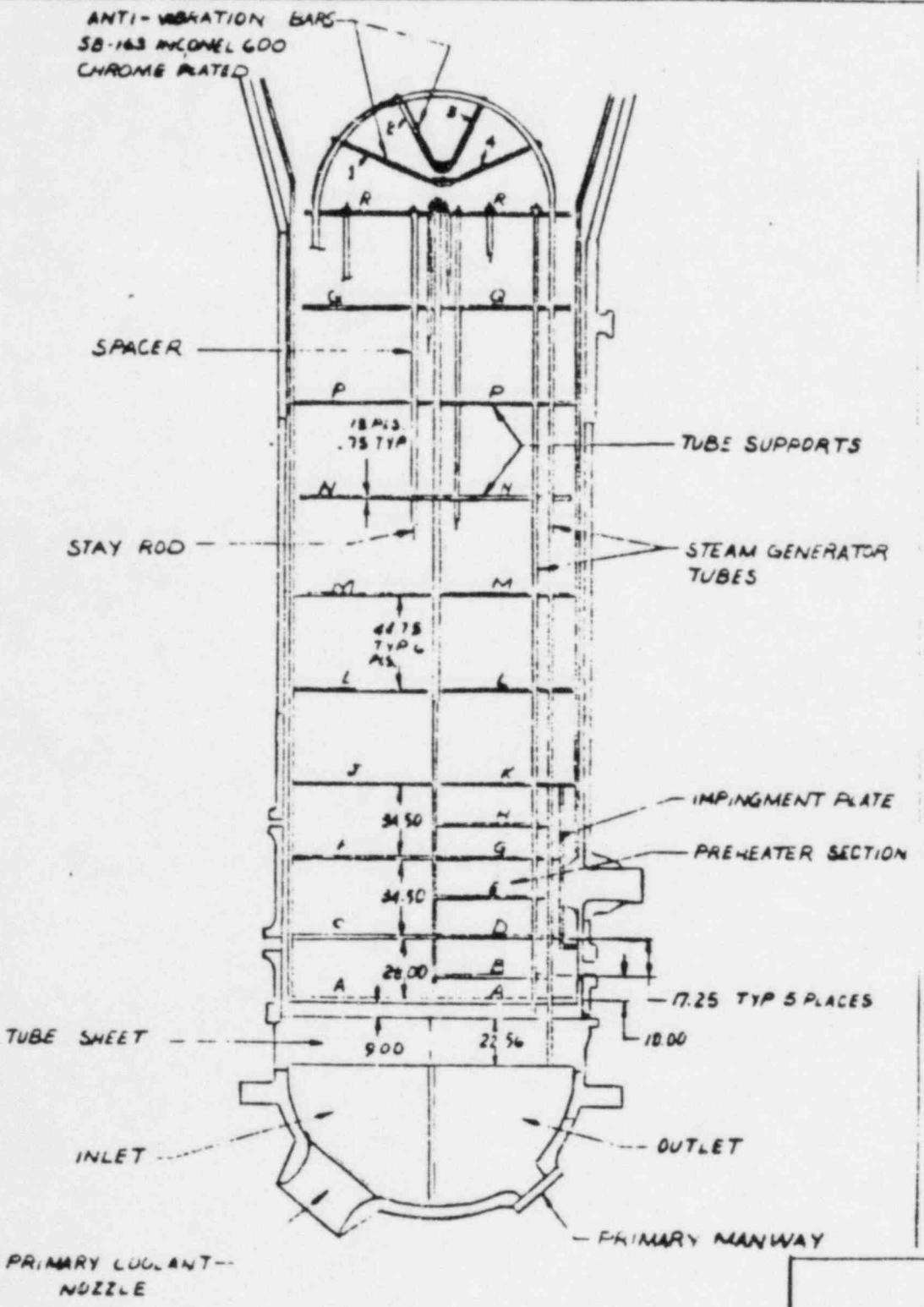

FIGURE 1 - TUBE SUPPORT PLATE LOCATION AND NUMBERING SEQUENCE FOR E2 RSG's.

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INSERVICE INSPECTION PROCEDURE

UBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

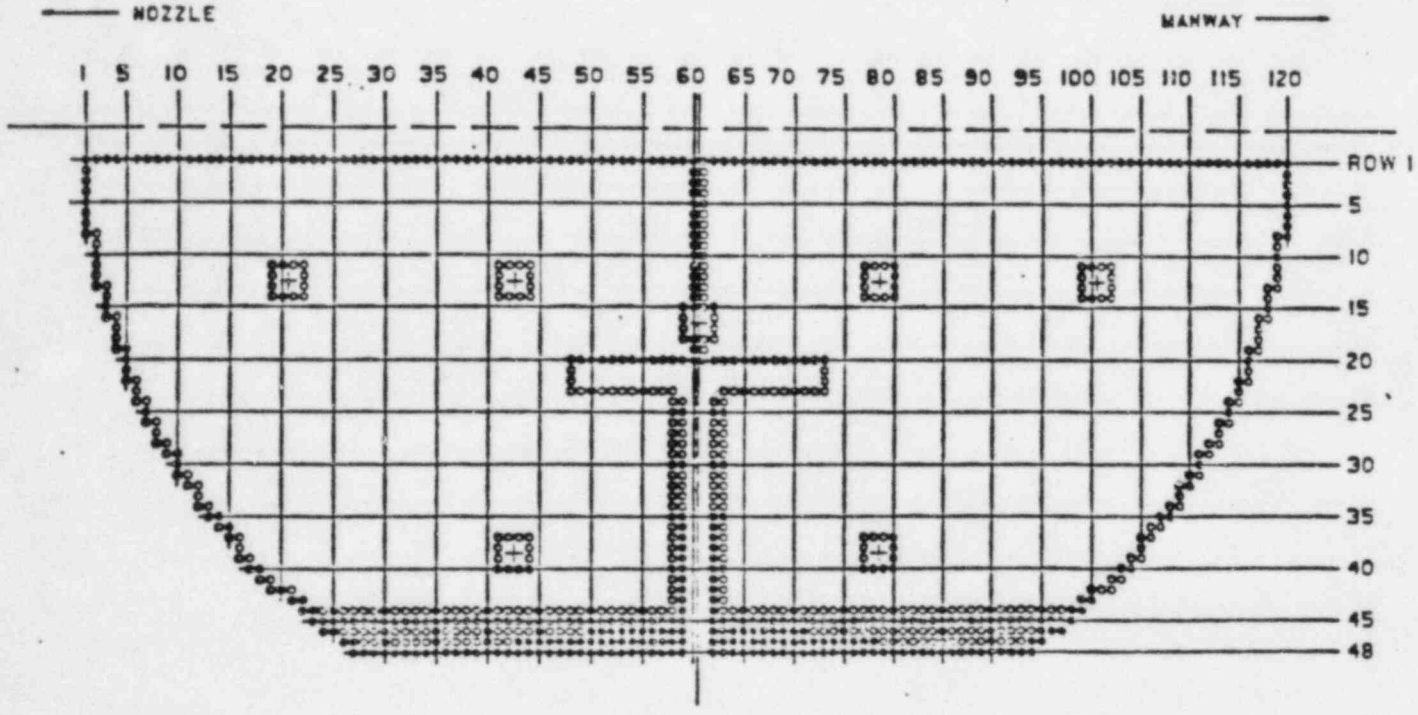

FIGURE 2 - TYPICAL MODEL E2 TUBE SHEET MAP

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INSERVICE INSPECTION PROCEDURE

SUBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

MIZ-18 INTERCONNECTION SCHEMATIC

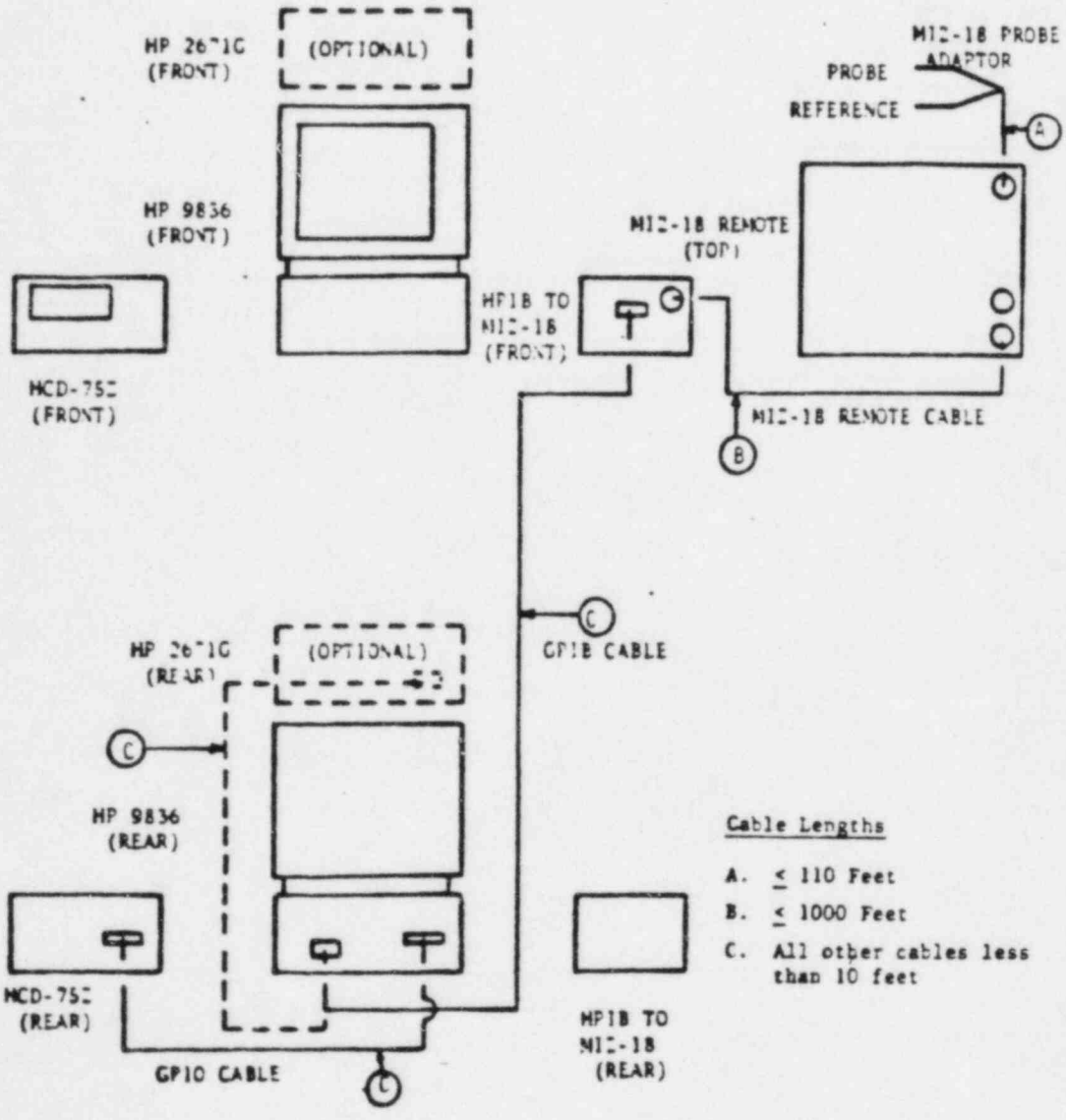

FIGURE 3 - MIZ-18 EQUIPMENT INTERCONNECTIONS

UBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

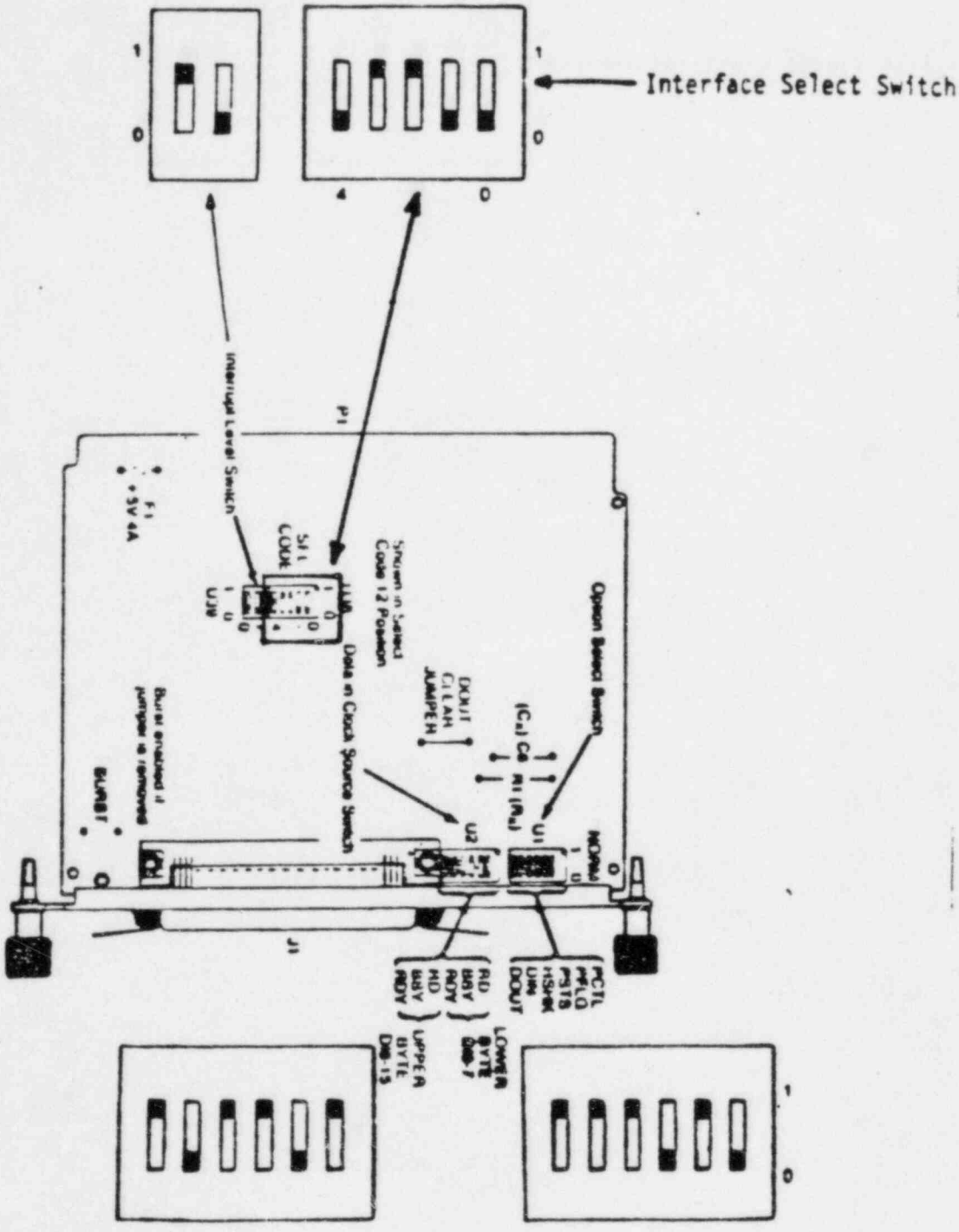

FIGURE 4 - DIAGRAM SHOWING POSITION OF INTERFACE SELECT SWITCHES ON GP10 CARD AND THEIR PROPER CONFIGURATION (DARK AREA INDICATES THE ROCKER SWITCH IS IN THE DOWN POSITION)

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INSERVICE INSPECTION PROCEDURE

SUBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

MIZ-18 CONFIGURATION

NUMBER: 0
NAME--: ISI-441 R0
SAMPLES per SEC: 400

FREQUENCY SEQUENCE		PROBE CHANNEL SELECT							
#	FREQUENCY	COIL 1	COIL 2	COIL 3	COIL 4	COIL 5	COIL 6	COIL 7	COIL 8
1	400 kHz	■				■			
2	200 kHz	■				■			
3	100 kHz	■				■			
4	10 kHz	■				■			

FIGURE 5 - CONFIGURATION SETUP (NAME SHALL REFLECT PROCEDURE AND REVISION IN USE).

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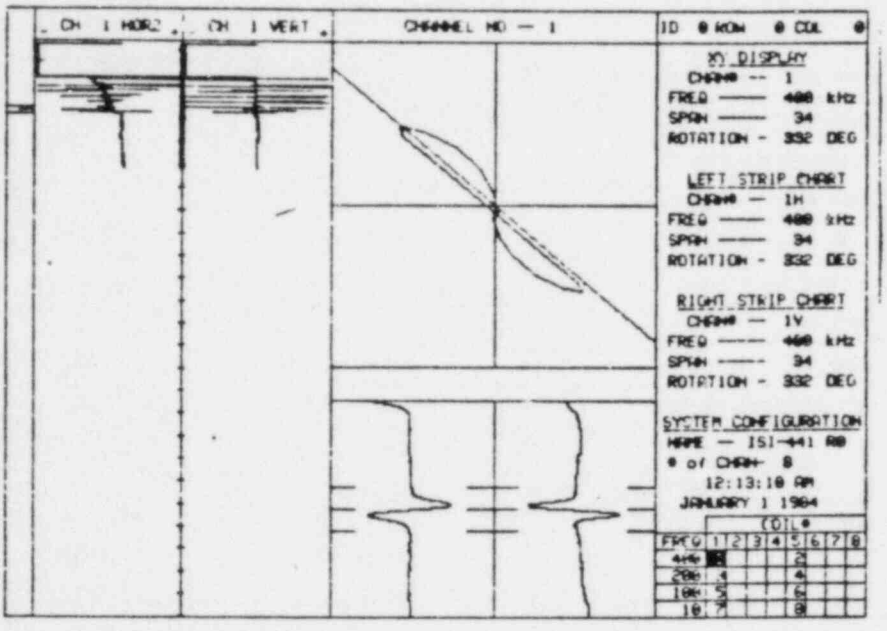
INSERVICE INSPECTION PROCEDURE

JBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0



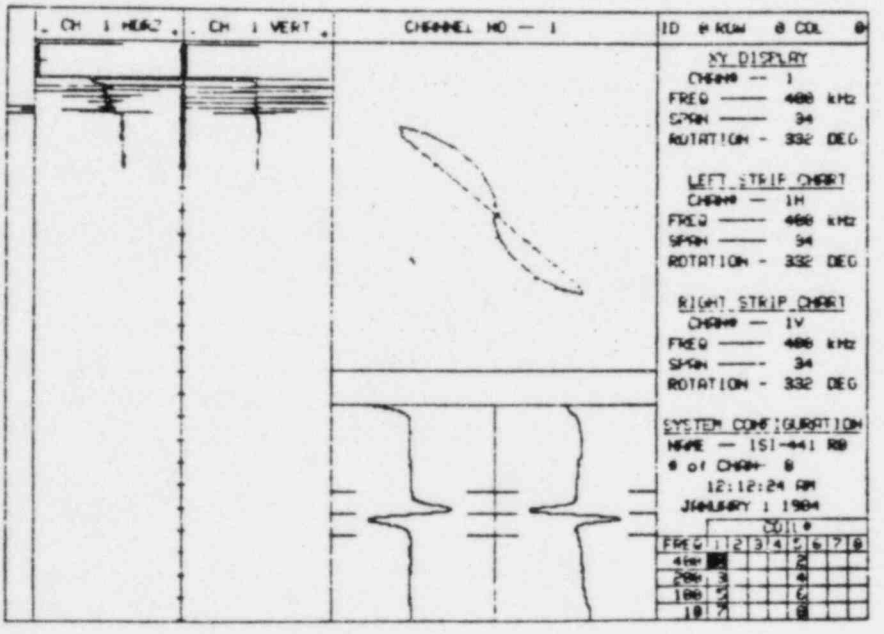


FIGURE 6 - TYPICAL SPAN AND ROTATION SETTINGS FOR DIFFERENTIAL CHANNELS 1,3, AND 5

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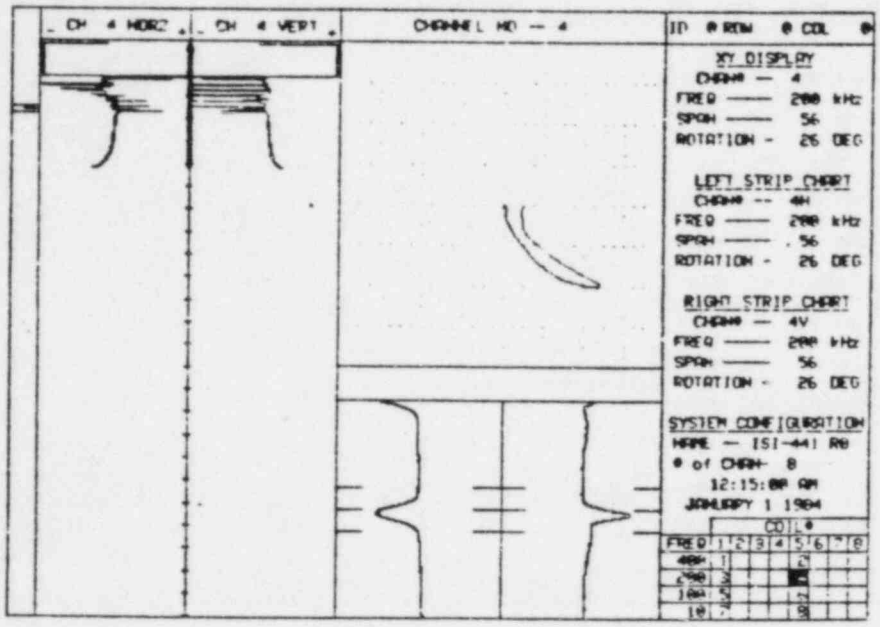
INSERVICE INSPECTION PROCEDURE

UBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0



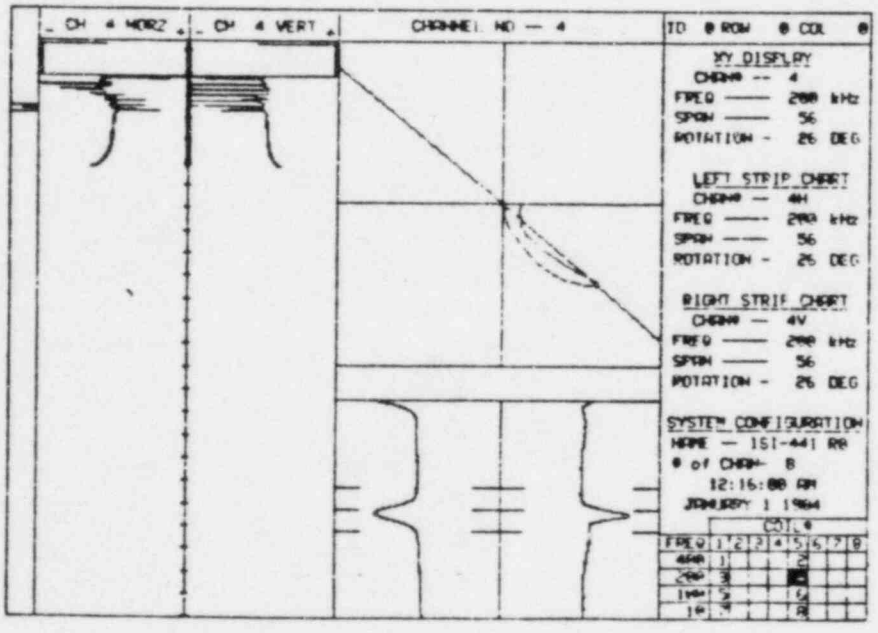


FIGURE 7 - TYPICAL SPAN AND ROTATION SETTINGS FOR ABSLUTE CHANNELS 2, 4 AND 6

UBJECT:	TECHNICAL PROCEDURE FOR THE MULTIFREQUENCY EDDY CURRENT EXAMINATION OF RSG TUBING IN E2 STEAM GENERATORS USING THE MIZ-18	ISI-441 Rev. 0

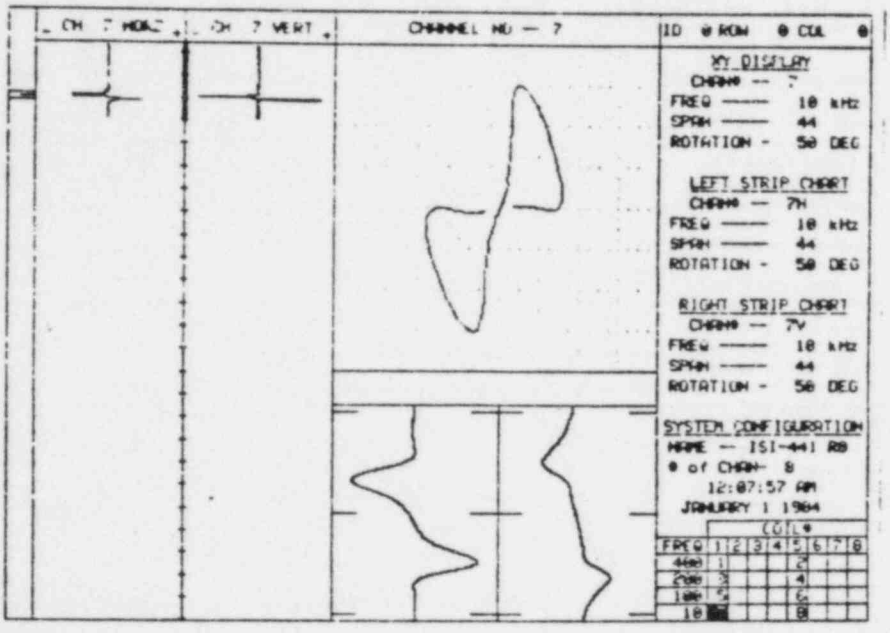


FIGURE 8A - CORRECT RESPONSE TO TSP AT 10 KHZ DIFFERENTIAL (CHANNEL 7)

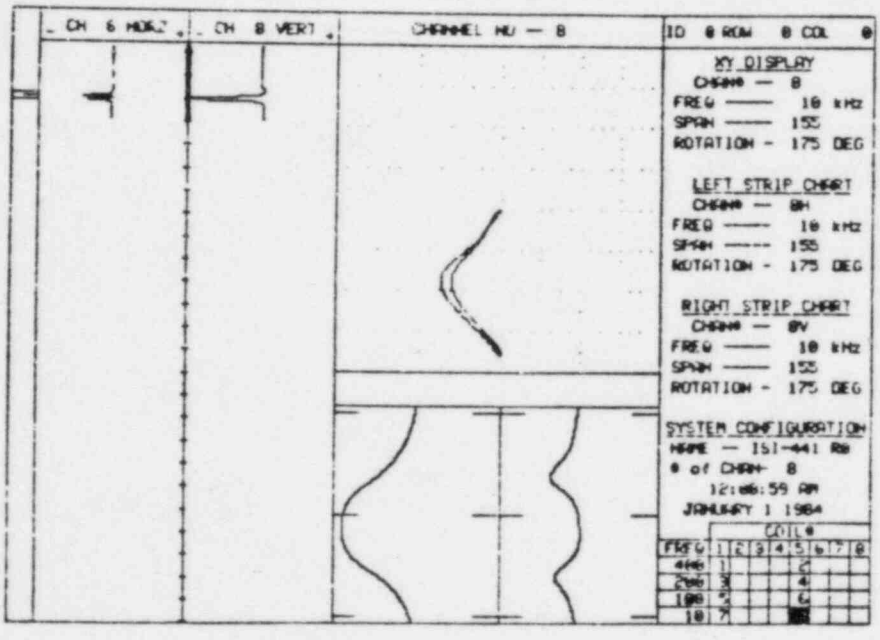


FIGURE 8B - CORRECT RESPONSE TO TSP AT 10 KHZ ABSOLUTE (CHANNEL 8)

SUBJECT: TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA OF NUCLEAR GRADE STEAM GENERATOR TUBING	Procedure No. ISI-460, Rev. 11 PQ No.: PQ-460-1

1. SCOPE: This procedure shall govern the evaluation and reporting of eddy current data from nonferromagnetic steam generator tubing.

2. DATA ANALYST QUALIFICATIONS: The Data Analyst shall be qualified to a minimum of Level IIA in accordance with Babcock & Wilcox Company Administrative Procedure ISI-24. The analyst shall have also received specific training for the evaluation of data from nonferromagnetic tubing. The analyst shall evaluate the data and report the results of the examination.

3. EQUIPMENT: The following equipment is considered acceptable but not required for use in the evaluation of the data. This typically consists of multifrequency generators, storage scopes, strip chart recorders, magnetic tape recorders, the Computerized Eddy Current Analysis System (CECA), and the Zetec DDA-4 (Digital Data Analyzer). The DECIDE system (Direct Eddy Current Inspection Data Entry) may be utilized to assist in the record keeping of the results. All equipment used shall be certified, when applicable, in accordance with ISI-80.

4. AREA OF INTEREST: The evaluation of data shall include all information recorded on magnetic tapes and strip charts per the requirements of the operating procedure in use or as specified by the customer.

5. EVALUATION OF DATA: The 400 kHz data shall normally be considered the primary scanning frequency in conjunction with the TSP suppresion mix displayed by one of the vertical strip charts.

   5.1 The evaluation shall be conducted by viewing the data from the magnetic tape recording for each tube to locate any abnormal signal indications and review of the data for indications identified during the acquisition of the data. Strip charts shall be used to provide supplemental information as needed. 11

5.2 Once the indication has been detected, all respective frequencies and mixes shall be displayed on the CRT for further evaluation. | 11

5.3 Analysis: All indications analyzed will be classified in accordance with Table I and recorded.

5.3.1 When the signal of interest is not interfered with by the edge effects of tube support, tube sheet, or anti-vibration bar signals, then the indication, if tube wall loss, can be classified with the data available.

5.3.2 When the signal of interest is interfered with, then one of the following techniques may be used to further define the tube wall loss.

5.3.2.1 Computer Analysis
5.3.2.2 Multifrequency
5.3.2.3 Multiparameter
5.3.2.4 Special Probes
5.3.2.5 Magnetic Saturation
5.3.2.6 Other

6. SIGNAL FORMATION: Determine the direction in which the signal being evaluated forms. | 11

6.1 The indication shall normally represent tube wall degradation (metal loss) if the evaluated signal begins down (negative) first.

6.2 The indication shall normally represent no degradation (no metal loss) of tube wall if the evaluated signal begins up (positive) first.

6.3 Paragraphs 6.1 and 6.2 are predicated on the fact that the calibration technique requires defect signals to go down first.

6.4 Any indication representing tube wall loss shall be evaluated with other frequencies, whenever practical, to make sure that the indication responds consistently as a defect.

7. SIGNAL TO NOISE RATIO: For all signal indications which represent a percent wall penetration, the signal to noise ratio (S/N) shall be determined. The method used to determine the signal to noise ratio is illustrated in Figure 1.

7.1 For indications with a S/N < 1.5, only the location and type of defect (if possible) shall be recorded with an accompanying note of "S/N" in the "% TWD" column.

7.2 For indications with a S/N > 1.5, the location, type, and percent through wall dimension shall be recorded.

8. PHASE ANGLE MEASUREMENT:

8.1 Determination of the phase angle of all indications representing tube wall degradation shall be made providing the S/N is greater than 1.5. The phase angle shall be determined in accordance with Figure 2.

8.2 When determining the phase angle of an indication, proper selection of the points used to determine the angle are very important (See Figure 3).

8.2.1 When indications cross over and have a significant straight line between peak to peak points (similar to the calibration signals), the angle will be determined by the straight line portion.

8.2.2 When indications deviate from calibration hole signal responses or do not cross over, the phase angle shall generally be determined from peak to peak amplitude points.

8.3 The phase angle measurement shall be compared to the relevant calibration curve to determine the percent through wall and originating surface.

8.4 An oscillograph of all indications representing tube wall loss of 20% or greater shall be made.

8.5 All information about the tube and defect will accomodate the oscillograph. This includes tube number, defect location, steam generator, date of examination, the phase angle assigned in degrees, the percent through wall, and the system response number from which the percent through wall was derived. The data analyst shall sign and date the oscillograph page. 11

9. CALIBRATION SYSTEM RESPONSE:

9.1 Establish the applicable OD or ID system response calibration curves for the technique used for any indication representing tube wall degradation.

9.2 The system response should be constructed from the calibration performed immediately prior to the indication being evaluated. However, the calibration performed immediately after the indication may be used if nothing in the system was changed before the calibration. 11

9.3 The system responses used shall be numbered in sequence and the information recorded on an appropriate calibration sheet.

9.4 The "as built" calibration drawings shall be used to determine the actual percent through wall of the artificial discontinuities, and these percentages shall be used to construct the system response curve.

The phase angle of the artificial discontinuities in the calibration standard will be determined using a protractor if the phase angle of the discontinuities in the steam generator tubing is going to be determined using a protractor.

The phase angle of the artificial discontinuities in the calibration standard will be determined using the DDA-4 if the phase angle of the discontinuities in the steam generator tubing is going to be determined using the DDA-4.

In either case, the calibration system response curve will be plotted manually on the appropriate calibration system response form. If any of these responses are distorted or have been interfered with in any way, they may be omitted or others used with the approval of a B&W Level III ET.

10. AXIAL LOCATION: Indications representing wall loss with a S/N > 1.5 and 20% or greater through wall dimension shall have the axial location determined by referring to known structures, i.e., tube supports, tube sheets, or anti-vibration bars.

10.1 Determine from drawings or customer information the actual distances between support members.

10.2 To determine the axial location of an indication from a known reference point (tube sheets, tube supports or anti-vibration bars), a strip chart recording may be generated at a speed of at least 25 mm/sec which includes the indication and the bounding support members with the manual method, or if the DDA-4 is used during the analysis, the axial location can be determined by following the preprogrammed routine of the DDA-4. The routine shall be set up on the tube in which the indication is located. 11

10.3 Either the vertical or horizontal channel may be used to determine axial distance to the nearest inch. Selection of the channel giving the maximum amplitudes shall be used.

10.4 The direction of probe scanning must be factored into the determination of indication location with respect to the

support member. The direction of probe scanning will change the calculations of axial location.

10.5 Reference Figures 4 and 5 for examples of calculating defect locations with the manual method for given probe scan directions in a once through steam generator (OTSG) or a recirculating steam generator (RSG).

11. REEXAMINATIONS: All tubes to be rerun as a result of the data analysis shall be identified by the Data Analyst. When this request is made, the Analyst shall make the notation "TBR" (to be rerun) in the remarks column.

11.1 Any information listed for a tube with "TBR" is preliminary and the final analysis will appear later in the data when the tube is rerun.

11.2 All tubes without the "TBR" designation shall be considered as final calls.

12. CONFIRMATION: Confirmation examinations of tubes scheduled to be plugged or pulled are usually made after the completion of the entire eddy current examination. The primary purpose of the confirmation examinations is to verify the tube identity of any tube to be removed from service (plugging or pulling). Another purpose that the confirmation run can fulfill is to help determine if defects are actively progressing in depth during the inspection outage. The confirmation process may be eliminated or additional tubes may be selected for confirmation per customer request.

12.1 When the purpose of the confirmation examination is to verify tube identity, this can be completed by comparing the original oscillographs to the signals observed on the eddy current CRT scope. A separate magnetic tape can be generated during the confirmation examinations if requested by the customer.

12.1.1 For all tubes verified, the Level II shall write "confirmed" in the remarks column and no other analysis is required in this case.

12.1.2 In the event that a particular indication does not confirm the tube location, resolution is needed.

12.1.3 If the tube is not verified, the correct tube number shall be noted and all previous data shall be corrected accordingly.

12.2 When the purpose of the confirmation is also to determine if the flaws have grown during the outage, an analysis of the confirmation eddy current data is necessary. For the purpose of determining flaw growth, the following procedure assumes that a + 10% error band exists in the eddy current technique and this must be factored into the analysis when determining if flaws are actively growing. The following analysis technique shall be implemented on the confirmation run to determine if additional tube degradation has occurred.

12.2.1 The preconfirmation final call (percent through wall) shall be referred to as (X). The confirmation initial analysis shall be referred to as (Y). The final confirmation analysis shall be referred to as (Z).

12.2.2 When (Y) has a value less than (X) or up to (X + 10%), the value to be reported as the final confirmation (Z) will be the same as (X).

12.2.3 When (Y) is greater than (X + 10%), (Z) shall be equal to (Y - 10%). For example, if (X) was 35% and (Y) was 50%, (Z) would be 40% and could be construed to mean that the defect grew from 35% to 40%.

13. MAINTENANCE OF DATA: The Data Analyst shall be responsible for magnetic tapes, strip charts, oscillographs and other records once in his possession.

13.1 The Analyst shall notify the Group Leader of reexaminations required on a daily basis.

13.2 Upon completion of the examination, or more frequently if required, the Analyst shall provide a data record of all examined and evaluated tubes to the Group Leader for distribution.

13.3 When the data is to be submitted by telecopy, an appropriate transmittal form shall be used to log data transmitted. This sheet shall also be telecopied to the receiving party with the appropriate data.

13.4 The data analyst shall be identified for each tube analyzed on the applicable data sheet. | 11

14. RECORDING CRITERIA: All signal indications evaluated to be one of the indication designations listed in Table I shall be recorded by the appropriate method. Customer recording requirements shall supercede this procedure.

15. REPORTING CRITERIA: All reportable indications shall be reported to the owner on at least a 24 hour basis. Only reportable indications shall be listed in the final report. Customer reporting requirements shall supercede this procedure.

15.1 All recordable indications evaluated to be equal to or greater than 20% through wall shall be reported.

15.2 All detectable tube dings/dents known to obstruct probe passage shall be reported.

15.3 Any additional condition(s) that the data analyst deems necessary to report shall be reported.

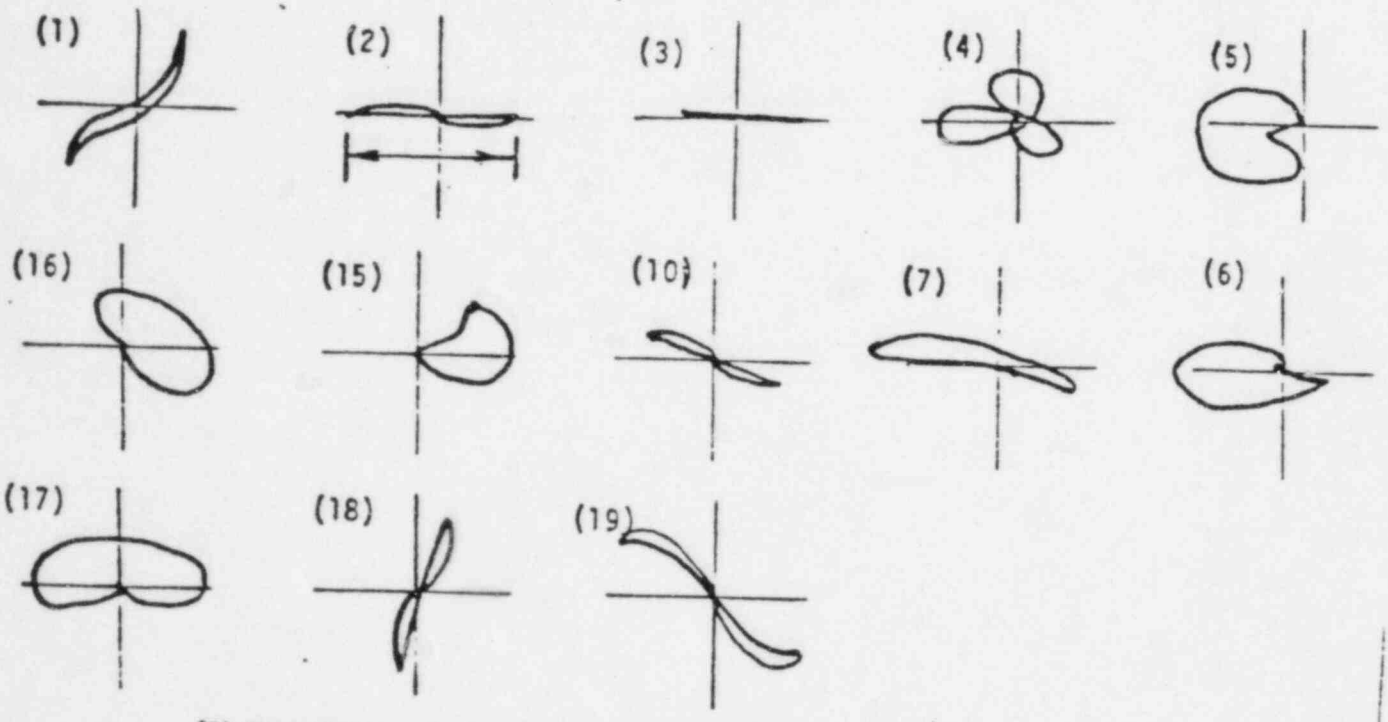
BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

SUBJECT:	Procedure No.
TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA OF NUCLEAR GRADE STEAM GENERATOR TUBING	ISI-460, Rev. 11

TABLE I

INDICATION DESIGNATIONS

(1) OD Long. Crack
(2) Ding
(3) Chatter
(4) Loops *
(5) LTS-1 *
(6) LTS-2 *
(7) LTS-B *
(8) Misc.
(9) Special Tubes
(10) ID Indication
(11) OD Wear-Thinning
(12) Plugged
(13) Removed
(14) Stabilized
(15) UTS C_1 *
(16) UTS C_2 *
(17) UTS C_3 *
(18) OD Indication
(19) ID Long. Crack
(20) Permeability
(21) RSG Distorted TS or TSP



(2) Dings/Dents - Categorized as small (0 to 2 volts), medium (2 to 4 volts), large (4 to 8 volts), and extra large (8 volts or more) from horizontal amplitude.

(4) Loops - Structural response from support plate overlap (manway area)

(8) Miscellaneous - Any indication other than 1-7 or 9-20.

(9) Special Tubes - Sleeved tubes, etc.

(11) O.D. Wear Thinning - O.D. longitudinal defect occurring at a support member.

(12) Plugged Tube - Explosively plugged.

(13) Removed Tube - No indication.

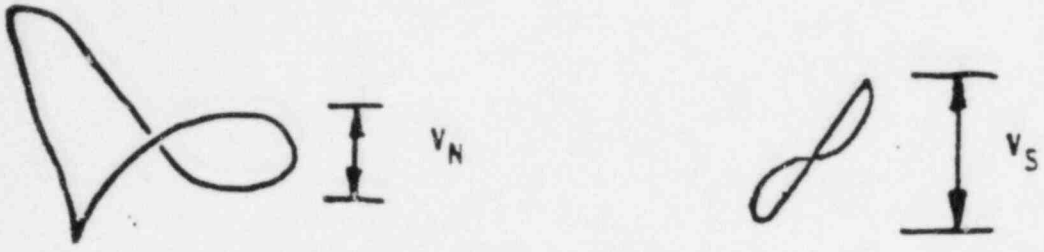
(14) Stabilized Tube - Welded nail plug.

(20) Permeability - Can appear as an ID or OD defect or noise.

* Applicable to once through steam generators only.

BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

UBJECT:	TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA OF NUCLEAR GRADE STEAM GENERATOR TUBING	Procedure No. ISI-460, Rev. 11

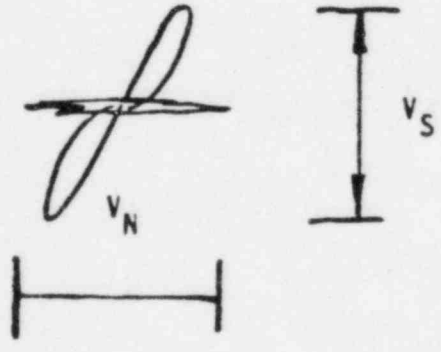


Composite Signal

Analyzed Signal

$$S/N = \frac{V_S}{V_N}$$

a) Determining S/N ratio for multiparameter and computerized analysis of indication interfered with by the edges of tube support plates or tube sheets.



$$S/N = \frac{V_S}{V_N}$$

b) Determining S/N ratio for indications occurring at locations other than as defined in (a) above.

Figure 1. Determining the S/N Ratio of Indications

BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

OBJECT:	TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA OF NUCLEAR GRADE STEAM GENERATOR TUBING	Procedure No. ISI-460, Rev. 11

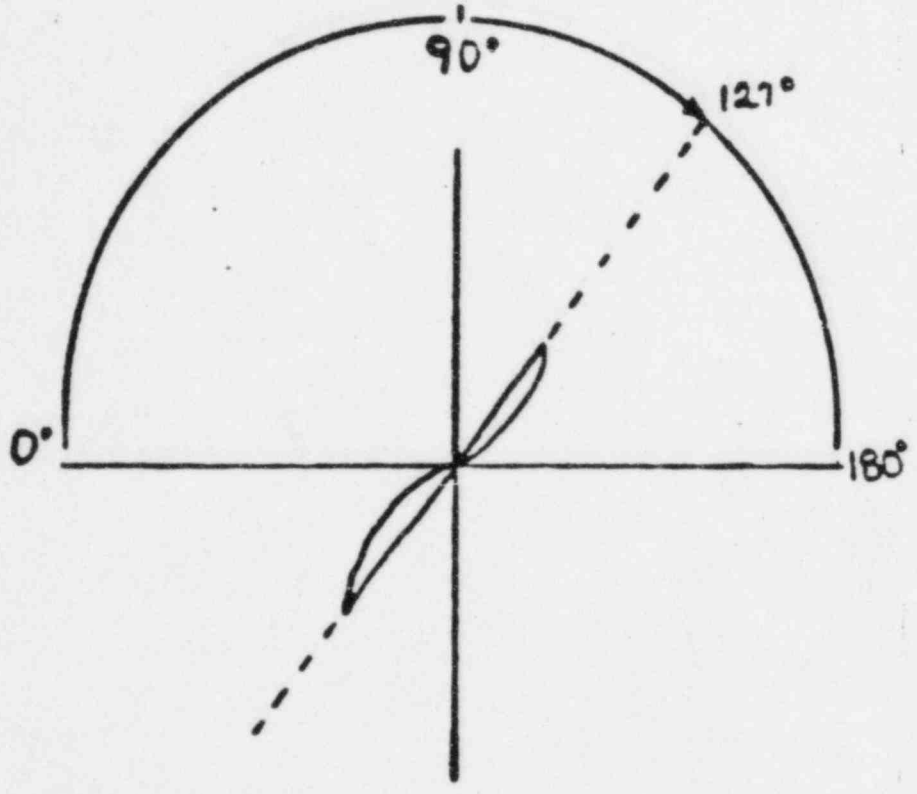


Figure 2. Phase Angle Measurement Convention

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INSERVICE INSPECTION PROCEDURE

SUBJECT:	TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA OF NUCLEAR GRADE STEAM GENERATOR TUBING	Procedure No. ISI-460, Rev. 11

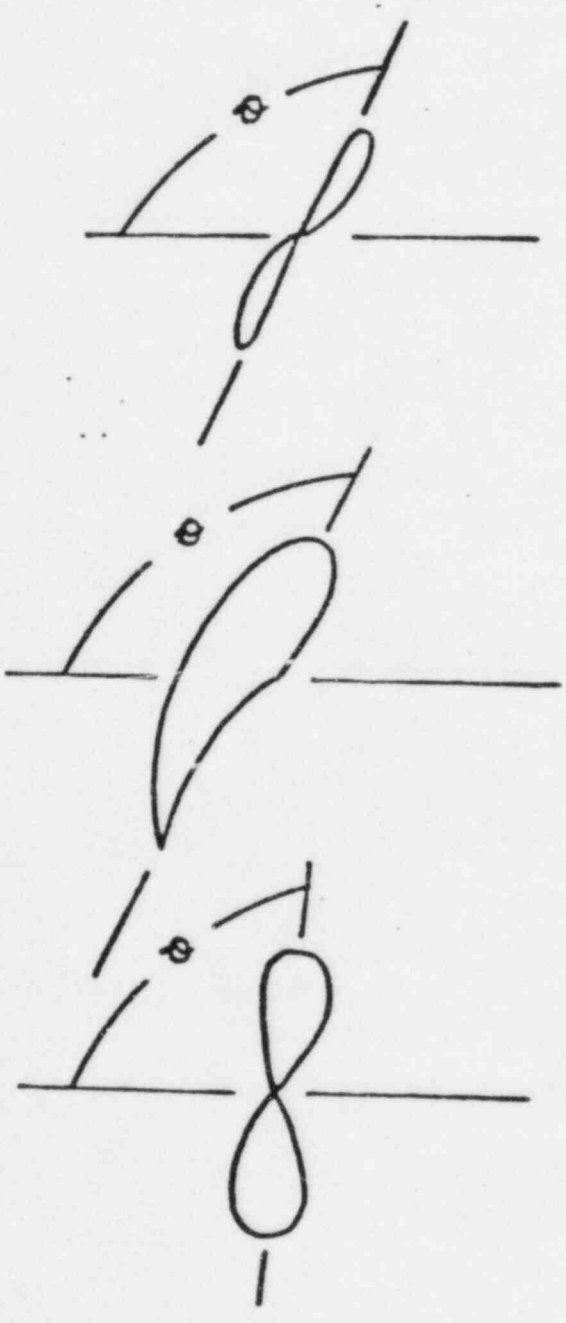
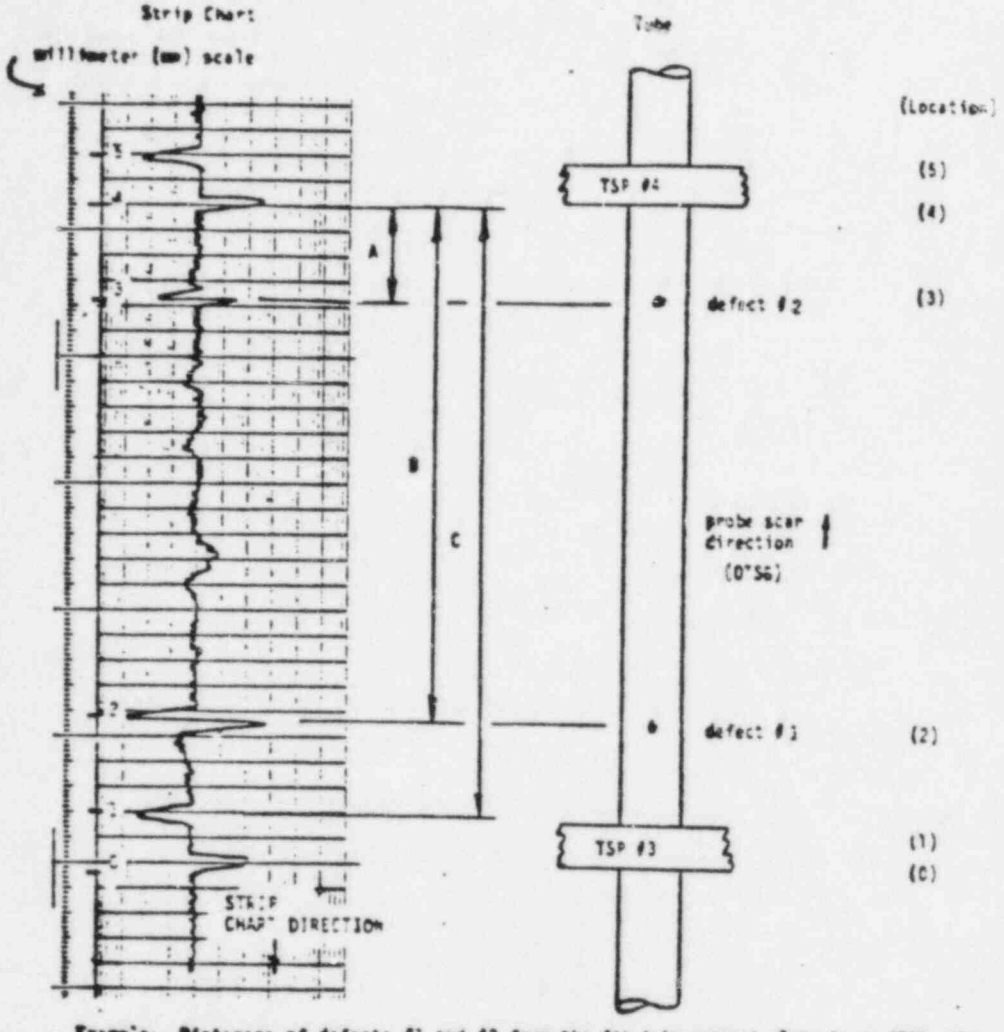


Figure 3. Typical Assignment of Phase Angles

SUBJECT:	TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA OF NUCLEAR GRADE STEAM GENERATOR TUBING	Procedure No. ISI-460, Rev. 11



Example: Distances of defects #1 and #2 from the 4th tube support plate in an 0°SG tube.

Strip Chart Values

(4-3) = B = 19 mm (defect #2)
(4-2) = B = 101 mm (defect #1)
(4-1) = C = 120 mm (TSP to TSP)

Known Physical Dimensions

Distance between TSP #3 and TSP #4 is 40 inches.*

* actual distance may vary

Calculations

defect #1 distance from 4th TSP = $\frac{B}{C} \times 40^{\circ} = \frac{101}{120} \times 40 = 34^{\circ}$

(reported on data sheet as 4 - 33.6")

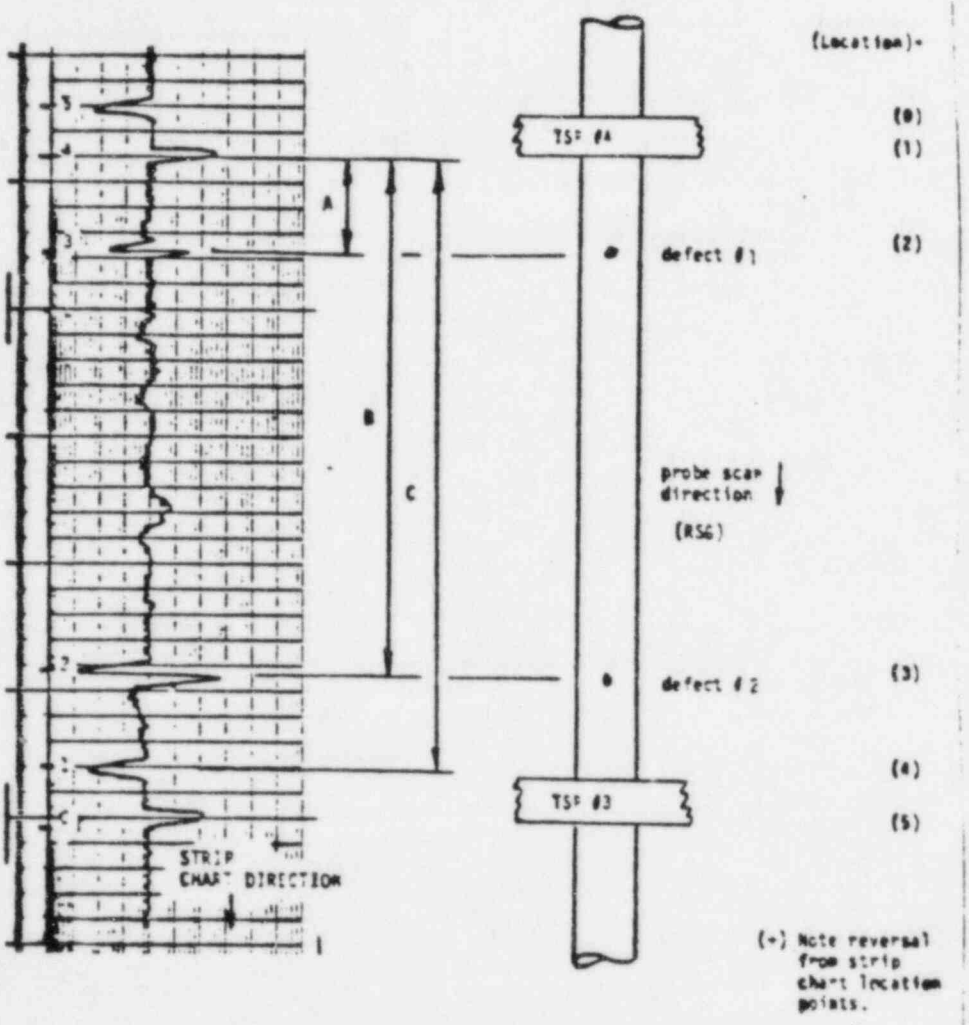
defect #2 distance from 4th TSP = $\frac{B}{C} \times 40^{\circ} = \frac{19}{120} \times 40 = 6^{\circ}$

(reported on data sheet as 4 - 6.3")

Figure 4. Typical Calculation of Defect Axial Location in Once Through Steam Generators

BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

JBJECT:	TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA OF NUCLEAR GRADE STEAM GENERATOR TUBING	Procedure No. ISI-460, Rev. 11



Example: Distances of defects #1 and #2 from the 4th tube support in an RSG tube.

Strip Chart Values

(4-3) = A = 19 mm (defect #1)
(4-2) = B = 101 mm (defect #2)
(4-1) = C = 120 mm (TSP to TSP)

Known Physical Dimensions

Distance between TSP #3 and TSP #4 is 40 inches.*

* Actual distance may vary.

Calculations

defect #1 distance from 4th TSP = $\frac{A}{C} \times 40" = \frac{19}{120} \times 40" = 6"$
(reported on data sheet as 4 - 6")

defect #2 distance from 4th TSP = $\frac{B}{C} \times 40" = \frac{101}{120} \times 40" = 34"$
(reported on data sheet as 4 - 34")

Figure 5. Typical Calculation of Defect Axial Location in Recirculating Steam Generators

SUBJECT: TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA FOR DEBRIS, SLUDGE AND SECONDARY SIDE LOOSE PARTS IN STEAM GENERATORS	ISI-462, Rev. 3 PQ No.: 462-1

1. SCOPE: This procedure shall govern the evaluation and reporting of eddy current data for the determination of debris, sludge and secondary side loose parts in steam generators. This evaluation is provided for information only.

2. DATA ANALYST QUALIFICATIONS: The data analyst shall be qualified to a minimum of Level II in accordance with Babcock & Wilcox Company Administrative Procedure ISI-24. The analyst shall have also received specific training for the evaluation of data from nonferromagnetic tubing. The analyst shall evaluate the data and report the results of the examination.

3. EQUIPMENT: The following equipment is considered acceptable for sludge and debris evaluation and shall be utilized in one of the following combinations. This equipment shall be certified when applicable in accordance with ISI-80.

   3.1 MIZ-12 Multifrequency Data: Option 1

      3.1.1 Storage Scope

      3.1.2 Hewlett Packard 3968AZ series eight channel tape recorder with voice log capability or equivalent.

      3.1.3 Hewlett Packard 7402A with 17402 inserts, or Soltec 8K29, or equivalent.

   3.2 MIZ-12 Multifrequency Data: Option 2

      3.2.1 Hewlett Packard 3968AZ series eight channel tape recorder with voice log capability or equivalent.

      3.2.2 Zetec DDA-4 (Digital Data Analyzer) with Edition 12 software and A/D converter

   3.3 MIZ-18 Multifrequency Data:

      3.3.1 Data Cartridge Tape Recorder

      3.3.2 Zetec DDA-4 (Digital Data Analyzer) with Edition 18 software.

BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

SUBJECT: TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA FOR DEBRIS, SLUDGE AND SECONDARY SIDE LOOSE PARTS IN STEAM GENERATORS	ISI-462, Rev. 3

4. DEFINITIONS: The term "debris" shall be used to identify magnetite on the secondary side of steam generator tubes in the area of the tube support plates or the free span area of the tube. The term "sludge" shall be used to identify magnetite accumulated on the secondary face of the tubesheet. The term "secondary side loose parts" refers to any eddy current signal attributed to foreign material, other than sludge or debris that is not normally associated with the steam generator secondary side design.

5. AREA OF INTEREST: The evaluation of data shall concentrate primarily on the intersections of the tube with the tube support plates and tubesheets for debris and sludge evaluations and tube free span regions for loose parts unless otherwise specified by the customer.

6. DEBRIS EVALUATION:

6.1 Reference the operating procedure used to detect debris.

6.2 Playback the appropriate channels of magnetic tape data through the storage oscilloscope or the DDA-4 for presentation of the appropriate signal.

6.3 The storage oscilloscope, if used, shall be viewed at 1 volt/division. The DDA-4 shall be viewed with a span setting such that the tube support plate signal fills 80% of the screen height.

6.4 The location and classification of debris analyzed will be determined in accordance with Figures 1 and 2 and reported on an appropriate data sheet.

6.5 The debris signals shall be quantified as small, medium, or large according to the approximate voltage of the signals beyond that exhibited by the "mock-up" TSP calibration standard as illustrated in Figure 2.

6.6 Knowledge of the probe scanning direction (insertion or retraction) during acquisition of the data is essential to properly locate the debris signal with respect to the tube support plate, e.g. upper, middle, lower (Figure 1).

6.7 Variations in support plate material, probes, and exact debris chemistry in a steam generator will cause some deviations in signal patterns.

7. SLUDGE EVALUATION:

7.1 Reference the operating procedure used to detect the sludge.

7.2 Playback the appropriate channels from the magnetic tape data for presentation on the CRT and strip chart recorder if used. The DDA-4 electronic strip chart may also be used.

7.3 Figure 3 illustrates the eddy current signal strip chart responses from both a clean tubesheet secondary face and from sludge accumulation on a tubesheet.

7.4 Determine the actual tube support plate thickness in steam generator (specifically the first tube support up from the tubesheet). This dimension shall be used to calculate the sludge depth. Typical support plate thickness ranges are 0.62" to 1.5".

7.5 Determine probe direction during data acquisition.

7.6 Record the signals from the support plate used as a thickness reference and the tubesheet on the strip chart recorder at a speed of at least 25 millimeters per second similar to that shown in Figure 3. Higher speeds will provide more resolution if needed.

7.7 If the DDA-4 is used, record the signal from the support plate and the tubesheet on the DDA-4 oscilloscope. Determine the values for d_1 and d_2 in Figure 4 per the DDA-4 Operating Manual.

7.8 Draw the values on the strip chart as shown in Figure 4. (Note that polarity of the strip chart recorder is arbitrary).

7.9 Sludge depth is determined by multiplying the support plate thickness times the ratio of (d_1/d_2).

7.10 Sludge depth data shall be recorded on an appropriate data sheet.

8. SECONDARY SIDE LOOSE PARTS: Note: Loose parts can be attributed to materials left in the steam generator during the fabrication process as well as pieces of broken tube support plate. As such the formation of the eddy current signal can be highly variable. To be detected the loose part must be a conductor.

8.1 Reference the operating procedure used to detect sludge and debris.

8.2 Play back the horizontal (H) and vertical (V) components of the low frequency channel on the CRT and strip chart recorder, if used. The DDA-4 electronic strip chart may also be used.

8.3 While monitoring the data for sludge and debris any eddy current indications observed which are not attributable to sludge and/or debris deposits shall be thoroughly investigated (i.e., other frequencies) as a possible loose part.

8.4 Indications which can not be resolved as typical of the normal secondary side design shall be identified on the debris data sheet and reported to the customer as a suspected loose part.

8.5 The reporting of suspected loose parts shall include the approximate axial location of the condition, as well as the tube number and steam generator.

8.6 It is recommended that the suspected loose part condition be evaluated, when possible, using secondary side visual inspection.

9. DATA REVIEW: All data sheets shall be reviewed for completeness and accuracy following the evaluation and reporting of data by the Analyst. This review shall be done by another Level II or III individual.

BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

SUBJECT: TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA FOR DEBRIS, SLUDGE AND SECONDARY SIDE LOOSE PARTS IN STEAM GENERATORS	ISI-462, Rev. 3

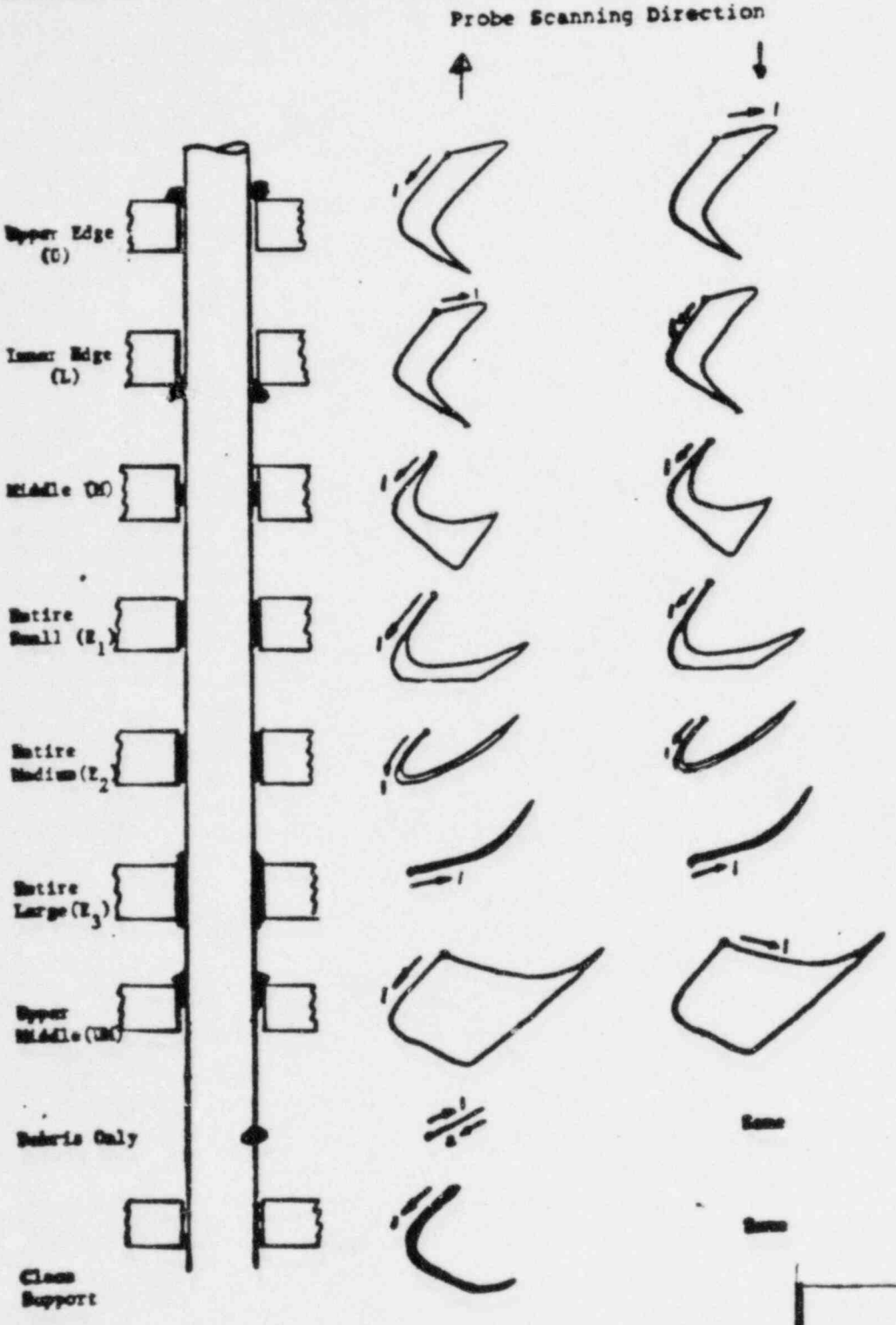


Figure 1. Debris Location and Classification.

SUBJECT: TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA FOR DEBRIS, SLUDGE AND SECONDARY SIDE LOOSE PARTS IN STEAM GENERATORS	ISI-462, Rev. 3

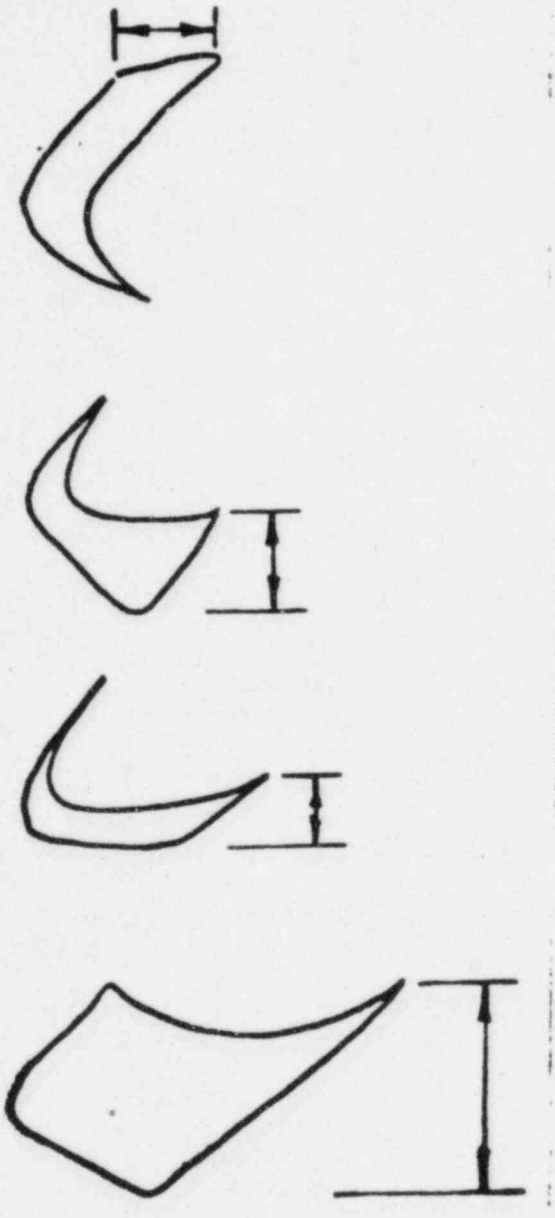


Figure 2. Typical Debris Signal Sizing Technique

Approximate Sizing Technique

Small is 0 to 1 volt beyond that exhibited by the TSP Standard.
Medium is 1 to 2 volts beyond that exhibited by the TSP Standard.
Large is greater than 2 volts beyond that exhibited by the TSP Standard.

BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

SUBJECT: TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA FOR DEBRIS, SLUDGE AND SECONDARY SIDE LOOSE PARTS IN STEAM GENERATORS	ISI-462, Rev. 3

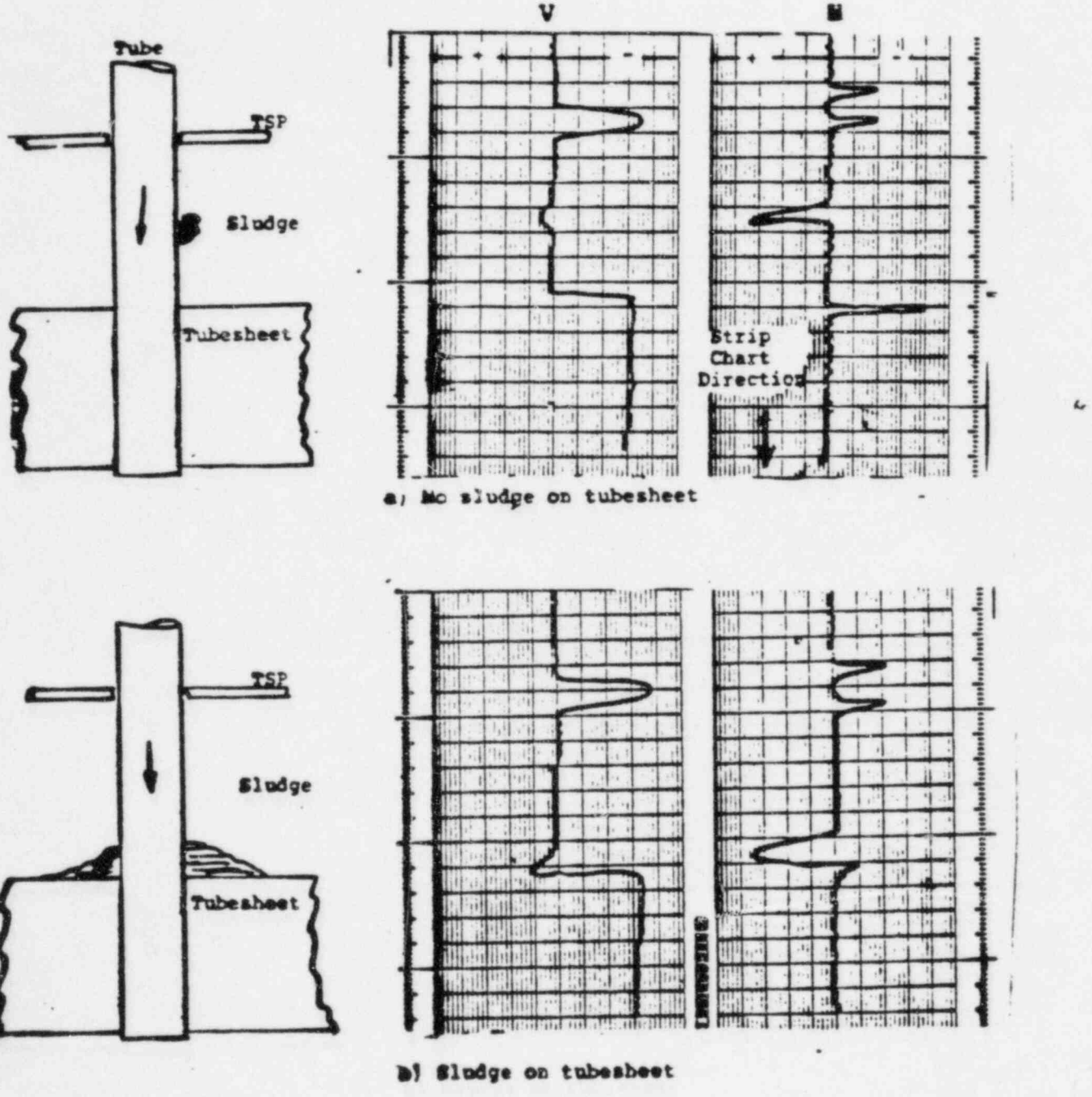
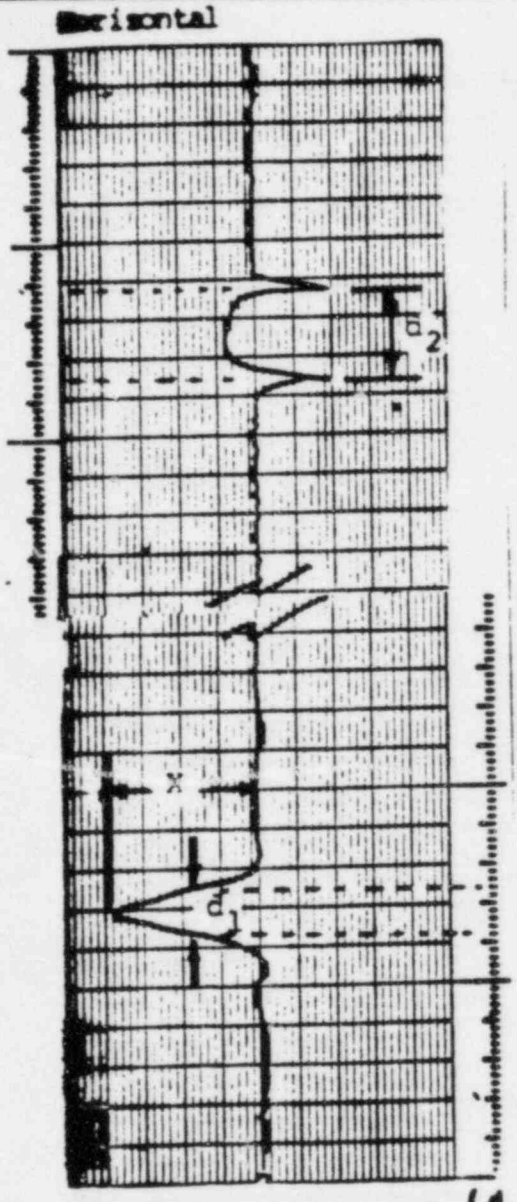


Figure 3. Typical Strip Chart Responses from Sludge and TSP

BABCOCK & WILCOX
INSERVICE INSPECTION PROCEDURE

SUBJECT: TECHNICAL PROCEDURE FOR THE EVALUATION OF EDDY CURRENT DATA FOR DEBRIS, SLUDGE AND SECONDARY SIDE LOOSE PARTS IN STEAM GENERATORS	ISI-462, Rev. 3



d_1 measured at $\frac{X}{2}$ amplitude

sludge depth = (TSP thickness) $\frac{(d_1)}{(d_2)}$

Figure 4. Typical Strip Chart Analysis for Sludge Depth

3.0 CUSTOMER APPROVALS

The supplier engineering document transmittal forms located in this section indicate HL&P's acceptance of the referenced B&W technical procedures and drawings for use during the preservice eddy current examinations at STP-1.

SUPPLIER ENGINEERING DOCUMENT TRANSMITTAL

TO: B&W
SUPPLIER

DATE July 18, 1985

ADDRESS
3110 Odd Fellows Road
Lynchburg, VA 24501

DOCUMENT STATUS CODES:
1 WORK MAY PROCEED
2 REVISE AND RESUBMIT, WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED.
3 REVISE AND RESUBMIT, WORK MAY NOT PROCEED.
4 REVIEW NOT REQUIRED, WORK MAY PROCEED.
7 IN FORMATION ONLY

REQUIRED ACTION BY SUPPLIER:
a. RESUBMIT BY (DATE) _____
b. SHOW SUPPLIER ENGINEERING DOCUMENT LOG NUMBER ON TRANSMITTALS.

FROM:
HOUSTON LIGHTING & POWER CO.
SOUTH TEXAS PROJECT
P.O. BOX 1700
HOUSTON, TEXAS 77001

ATTENTION: _____

IMPORTANT
PERMISSION TO PROCEED DOES NOT CONSTITUTE ACCEPTANCE OR APPORVAL OF DESIGN DETAILS, CALCULATIONS ANALYSES, TEST METHODS, OR MATERIALS DEVELOPED OR SELECTED BY THE SUPPLIER AND DOES NOT RELIEVE SUPPLIER FROM FULL COMPLIANCE WITH CONTRACTURAL OBLIGATIONS.

PURCHASE ORDER NO. ST-300171

ENCLOSED IS ONE (1) COPY OF THE FOLLOWING DOCUMENTS:

SUPPLIER DOCUMENT NO.	SH	REV	DOCUMENT TITLE	FOR HL&P USE ONLY: SUPPLIER ENGINEERING DOCUMENT LOG NO.	STATUS
1) 1157654A	1	0	Cal Standard	300171-00025-A-7E	2
2) 1157191D	1	1	Tube Expansion Mockup Assembly and Details	300171-00026-B-7E	2
3) ISI-441	28	0	Technical Procedure for the multifrequency eddy current examination of RSG tubing in F2 steam generators using the MIZ-18	300171-00027-A-7E	2
4) ISI-460	14	1	Technical Procedure for the evaluation of eddy current data of nuclear grade steam generator tubing	300171-00028-A-7E	2

BY RM 00831

SIGNED Jim Haning for drawings DATE 7-26-85 SIGNED DW Renner DATE 7-18-85
HL&P SUPPLIER
Jim Haning for procedures 8-2-85

ATTACHMENT

HL&P Comments on
B&W Drawing 1157654A
"Cal. Standard"

COMMENT NO.	COMMENTS
1	The tolerance of the .780" ID ring should be +.001" or - .003".
2	The tolerance of the tube OD should be +.004" or - .006".
3	The tolerance of the 10% TWL OD notch should ±.0009" in depth.
4	The drawing must be approved and issued final before it is used for fabrication.

ATTACHMENT

HL&P Comments on Procedure ISI-441 Rev.0

"Technical Procedure for the Multifrequency Eddy Current Examination of RSG Tubing in E2 Steam Generators Using the MIZ-18."

Comment No.	Comments
1	The procedure must be approved by B&W before use.
2	In Paragraph 4.6.1, "strainght" should be "straight".
3	In Paragraph 4.6.3, "Figure 1" should be "Figure 3".
4	Figure 1 should be included before use.
5	The nominal wall in Paragraph 1 should be ".043 inch".
6	The location of Row 1 Col 1 should be clarified in the text of 5.2.

ATTACHMENT
HL&P Comment On
Procedure ISI-460 Rev. 11

"Technical Procedure for the Evaluation of Eddy Current Data of Nuclear Grade Steam Generator Tubing"

COMMENT NO.	COMMENTS
1	Delete the evaluation option of 5.2 and use the provisions of 5.1 for PSI.
2	The procedure should be approved by B&W before use.

SUPPLIER ENGINEERING DOCUMENT TRANSMITTAL

SHEET 2 OF 4

TO:
SUPPLIER

DATE 8-5-85

ADDRESS
Babcock & Wilcox
3110 Odd Fellows Road
Lynchburg, VA 24501

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1 WORK MAY PROCEED
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SOUTH TEXAS PROJECT
P.O. BOX 1700
HOUSTON, TEXAS 77001

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PURCHASE ORDER NO. 300171

ENCLOSED IS ONE (1) COPY OF THE FOLLOWING DOCUMENTS:

SUPPLIER DOCUMENT NO.	SH	REV	DOCUMENT TITLE	FOR HL&P USE ONLY: SUPPLIER ENGINEERING DOCUMENT LOG NO.	STATUS
			Technical Procedure for the Evaluation of Eddy Current Data for Dilbris, Budge & Secondary Side Loose Parts in Steam Generators	300171-00029-A-7E	2

ST-HM-00831

SIGNED Jim Haney (HL&P) DATE 8-13-85 SIGNED DW Renny (SUPPLIER) DATE 8-5-85

ATTACHMENT

HL&P Comments on
B&W Procedure ISI-462, Rev. 3

"Technical Procedure for the Evaluation of Eddy Current Data for Debris, Sludge and Secondary Side Loose Parts in Steam Generators."

Comment No.	Comments
1	In section 3, it should be stated that the listed equipment or its equivalent is required.

Supplier Engineering Document Log No. 300171-00029A-TE

IMPORTANT

Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligations

DATE RECEIVED 8-5-85

STAT USED BY HL&P 2

DOCUMENT STATUS

1 ☐ APPROVED FOR USE/ WORK MAY PROCEED.

2 ☒ APPROVED FOR USE AS NOTED/REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO INCORPORATION OF CORRECTION INDICATED.

3 ☐ NOT APPROVED/REVISE AND RESUBMIT. WORK MAY NOT PROCEED.

4 ☐ SPECIAL _____

SIGNED Jim Hanning

DATE 8-13-85

SOUTH TEXAS PROJECT

ST-RM-0147 (05/85)

RECEIVED

AUG 5 1985

[illegible]

SUPPLIER ENGINEERING DOCUMENT TRANSMITTAL

TO: SUPPLIER

DATE Aug 6, 1985

ADDRESS
Babcock & Wilcox
3.10 Odd Fellows Rd
Lynchburg, Va.
24501

DOCUMENT STATUS CODES:
1 WORK MAY PROCEED
2 REVISE AND RESUBMIT, WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED.
3 REVISE AND RESUBMIT, WORK MAY NOT PROCEED.
4 REVIEW NOT REQUIRED, WORK MAY PROCEED.
7 INFORMATION ONLY

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a. RESUBMIT BY (DATE) _____
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HOUSTON LIGHTING & POWER CO.
SOUTH TEXAS PROJECT
P.O. BOX 1700
HOUSTON, TEXAS 77001

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PURCHASE ORDER NO. 300171

ENCLOSED IS ONE (1) COPY OF THE FOLLOWING DOCUMENTS:

SUPPLIER DOCUMENT NO.	SH	REV	DOCUMENT TITLE	FOR HL&P USE ONLY: SUPPLIER ENGINEERING DOCUMENT LOG NO.	STATUS
1157191 D		2	TUBE EXPANSION MOCKUP ASSEMBLY AND DETAILS	300171-00026-C-7E	1

SIGNED Jim Hansing (HL&P) DATE 8-9-85 SIGNED DN Renner (SUPPLIER) DATE 8/16/85

4.0 LISTING OF TUBES CONTAINING EXPANSIONS

This section contains a list of tubes in each of the four steam generators which contain expansions in the preheater region.

The expansions exist in the B and D tube support plates of the 160 tubes in each of the four steam generators. In addition, expansions exist in the G and K tube support plates (as well as B and D TSP's) of all the tubes in Row 48 of steam generator C. Tubes R47C52, R48C70, R48C80, and R47C94 in steam generator D have been removed from service by plugging and can not be examined.

TUBES CONTAINING EXPANSIONS

Row	Columns
36	59, 62
37	59, 62
38	59, 62
39	59, 62
40	59, 62
41	59, 62
42	59, 62
43	21, 22, 59, 62, 99, 100
44	22, 23, 59, 62, 98, 99
45	23, 58, 59, 62, 63, 98
46	24, 25, 50-59, 62-71, 96, 97
47	26, 27, 43-59, 62-78, 94, 95
48	27-59, 62-94

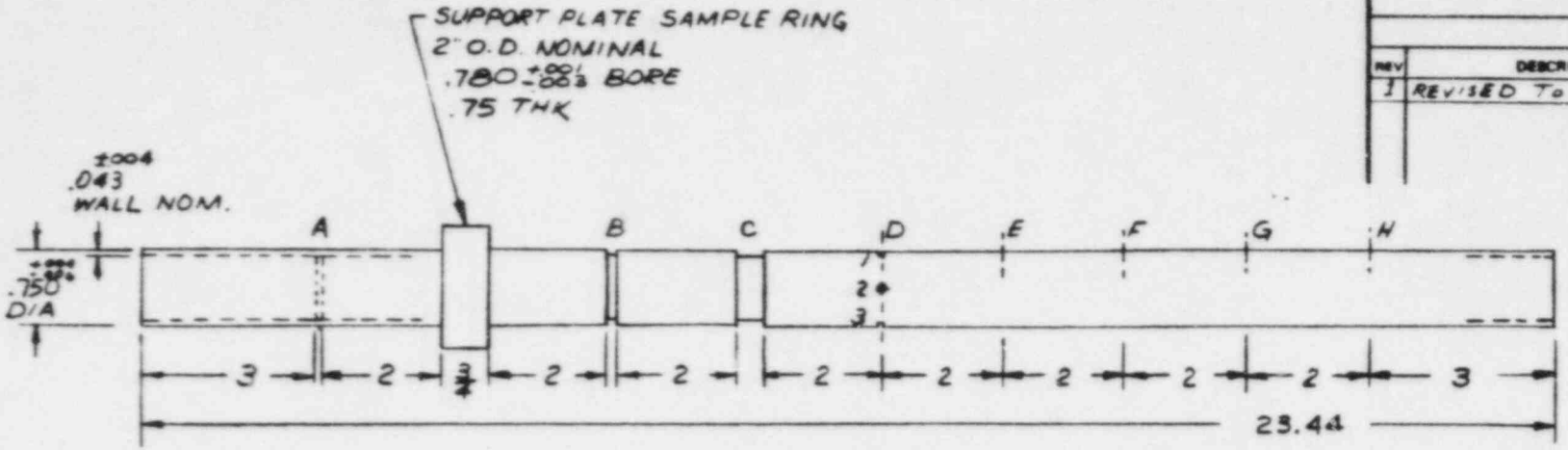
5.0 DRAWINGS

Included in this section are drawings of the calibration standards to be used during performance of the eddy current examinations (drawing numbers 1157654B-0 and 1157789B-0) and a drawing depicting the tube expansion mockup assembly and details (drawing no. 1157191D-2).

ON 2HQ

Babcock & Wilcox
a McDermott company

REVISIONS			
REV	DESCRIPTION	DATE	APPROVAL
1	REVISED TO AS BUILT	8/20/8	DLE RJB



MACHINING REQD	I.D. NOTCH	O.D. NOTCH	O.D. NOTCH	4 HOLES 90° APART				HOLE	HOLE	HOLE	HOLE
LOCATION	A	B	C	D-1	D-2	D-3	D-4	E	F	G	H
WIDTH OR DIA	.072	.140	.515	.188	.188	.188	.188	.188	.110	.079	.052
DEPTH	.068 AVG	.004 AVG	.0082 AVG	.0081	.0081	.0075	.0083	.0165	.024	.032	THRU
* % THRU	15.4	9.0	18.6	18.4	18.4	17.0	18.8	37.5	60	72.7	100
				AVERAGE 18.1							

TUBE MATL - INCONEL 600 (SB 163)
SUPPORT PLATE MATL - A-285 GRADE C

TOL. ±.01 EXCEPT AS NOTED

CUSTOMER : HOUSTON POW & LIGHT
SITE : STPEG-1
CONTRACT NO: 647-0009-00-13
DATABASE NO: 49127

* % THRU WALLS CALCULATED ON THE MEASURED WALL THICKNESS. WALL THICKNESS MEASURED .044.

DRAWN BY	CHECKED BY	APPD BY	APPD BY
D.R.D.		D.P.W.	M.J.B.

CAL. STANDARD

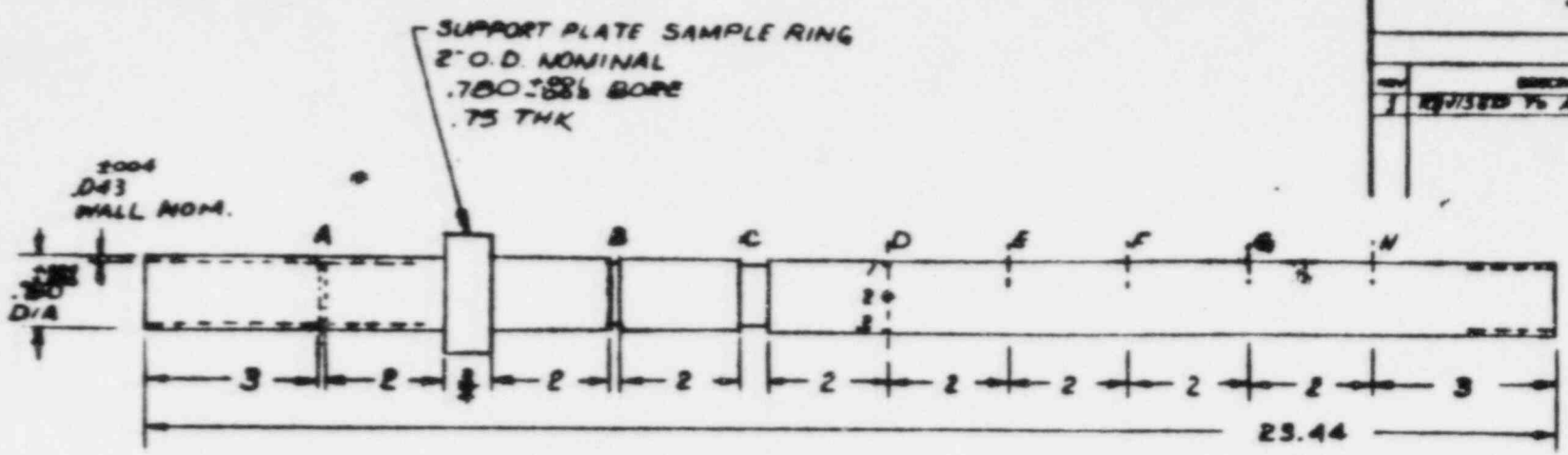
SCALE NONE DATE 8/20/85
DWG NO 115765 4 B-1

FG 108785

Babcock & Wilcox

REVISIONS

NO	DESCRIPTION	DATE	APPROVAL
1	REVISED % AS BUILT		



MACHINING REQ'D	I.D. NOTCH	O.D. NOTCH	O.D. NOTCH	4 HOLES 90° APART				HOLE	HOLE	HOLE	HOLE
LOCATION	A	B	C	D-1	D-2	D-3	D-4	E	F	G	N
WIDTH OR DIA	.075	.160	.515	.188	.188	.188	.18	.188	.110	.079	.953
DEPTH	.0053 MIN	.0038 MIN	.0084 MIN	.0081	.0091	.0086	.0087	.0149	.034	.033	THRU
% THRU	12.6	8.6	19.0	18.4	20.6	19.5	19.7	33.8	59.0	75.0	100
				AVERAGE 19.5							

TUBE MATL - INCONEL 600 (SB 167)
SUPPORT PLATE MATL - A-285 GRADE C

TOL. ±.01 EXCEPT AS NOTED

CUSTOMER : HOUSTON POW. & LIGHT
SITE : STP EG-1
CONTRACT NO: 647-0009-00-13
DATABASE NO: 49128

* % THRU WALLS CALCULATED ON THE MEASURED WALL THICKNESS. WALL THICKNESS MEASURED .044

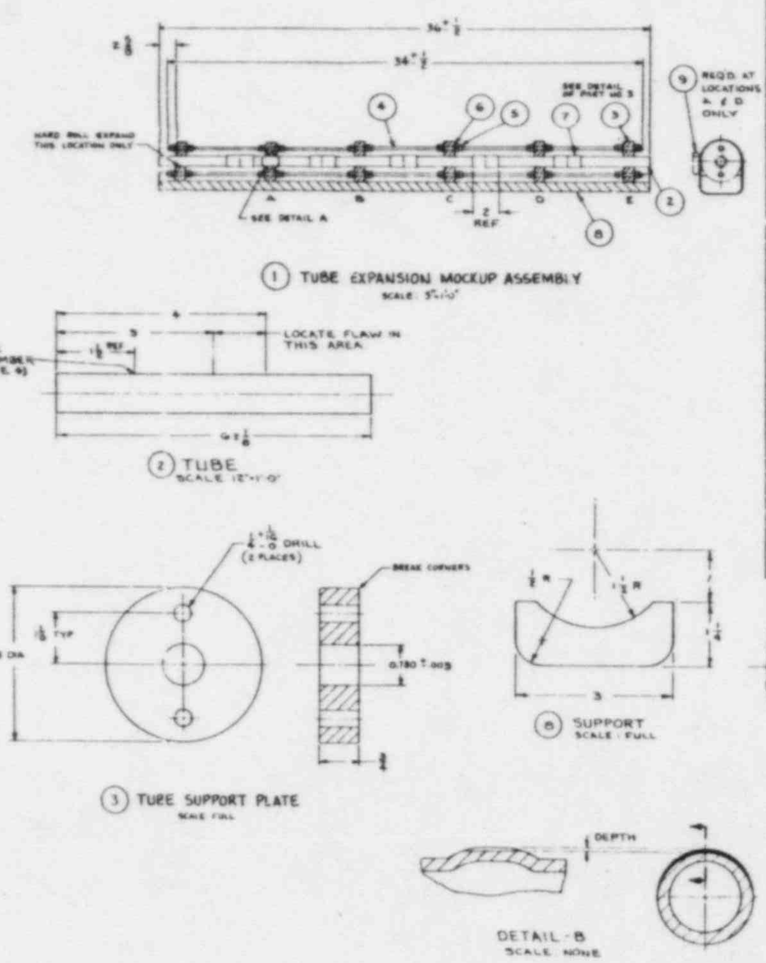
CAL. STANDARD

Enclosure
ST-HL-AE-1362
Page 71 of 74

APPENDIX A

This appendix contains the following procedure which will be used for performance of the eddy current examination of the expanded region of the steam generator tubing.

Number	Title	Revision
ISI-442	Technical Procedure for the Examination of the Expanded Region of the Steam Generator Tubing (To be issued at a later date)	0



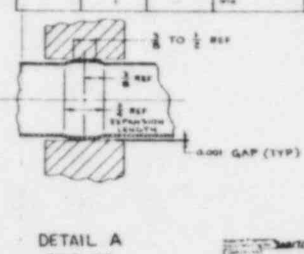
(1) TUBE EXPANSION MOCKUP ASSEMBLY
SCALE: 3"=1'-0"

(2) TUBE
SCALE 12"=1'-0"

(3) TUBE SUPPORT PLATE
SCALE FULL

(8) SUPPORT
SCALE: FULL

DETAIL-B
SCALE: NONE



DETAIL A
SCALE: NONE

TABLE 1. TUBE FLAWS

ASSEMBLY SERIAL NO.	TUBE SUPPORT PLATE LOCATION	FLAW LOCATION (NOTE 2)	FLAW DESCRIPTION	FLAW WIDTH	FLAW DEPTH
1	A	—	NONE	—	—
	B	[illegible]	4 FLAT BOTTOM HOLES 90° APART	3/16 DIA x .010	(20%) .009 ± .002
	C	[illegible]	1 FLAT BOTTOM HOLE	3/16 DIA x .010	(40%) .017 ± .003
	D	[illegible]	1 FLAT BOTTOM HOLE	7/64 DIA x .010	(60%) .026 ± .002
	E	THRU	1 THRU WALL HOLE	.052 DIA x .010	THRU WALL
2	A	—	NONE	—	—
	B	[illegible]	1/4 AXIAL NOTCH x 1/32	.010 x .005	(20%) .009 ± .002
	C	[illegible]	180° CIRCUM NOTCH x 5°	.010 x .005	(20%) .009 ± .002
	D	[illegible]	1/4 AXIAL NOTCH x 1/32	.010 x .005	(20%) .009 ± .002
	E	[illegible]	180° CIRCUM NOTCH x 5°	.010 x .005	(20%) .009 ± .002
3	A	—	NONE	—	—
	B	[illegible]	1/4 AXIAL NOTCH x 1/32	.010 x .005	(20%) .009 ± .002
	C	[illegible]	1/4 AXIAL NOTCH x 1/32	.010 x .005	(40%) .017 ± .005
	D	[illegible]	1/4 AXIAL NOTCH x 1/32	.010 x .005	(60%) .026 ± .005
	E	10°	1/4 AXIAL NOTCH x 1/32	.010 x .005	(20%) .009 ± .002
4	A	—	NONE	—	—
	B	—	NONE	—	—
	C	—	NONE	—	—
	D	[illegible]	180° TAPERED WEAR (DETAIL B)	VARIABLE	(20%) .009 ± .002
	E	[illegible]	180° TAPERED WEAR (DETAIL B)	VARIABLE	(40%) .017 ± .005
5	A	—	NONE	—	—
	B	[illegible]	360° CIRCUM NOTCH x 5°	.010 x .005	(20%) .009 ± .002
	C	[illegible]	180° CIRCUM NOTCH x 5°	.010 x .005	(40%) .017 ± .005
	D	[illegible]	180° CIRCUM NOTCH x 5°	.010 x .005	(60%) .026 ± .005
	E	10°	180° CIRCUM NOTCH x 5°	.010 x .005	(20%) .009 ± .002
6	A	—	NONE	—	—
	B	—	NONE	—	—
	C	—	NONE	—	—
	D	—	NONE	—	—
	E	—	NONE	—	—

REVISIONS

REV	DESCRIPTION	DATE	APPROVAL
1	REV NOTE 1, ADDED NOTES 2, 3 & TABLE I, REV PT NO 2 & 3	7-[illegible] 85	[illegible]
	REV GAP DIM IN DETAIL A, ADDED DETAIL-B, REV TOL ON PT NO 3, ADDED COUPLINGS AND TUBE SUPPORT PLATE LOCATIONS AND REV DIM IN ASSY		
2	ADD PARTS #[illegible] ADD TOL TO [illegible] DIM [illegible] REF TO [illegible] DIM [illegible] REF DIM [illegible]	8-[illegible] 85	[illegible]
	TOLS ON DIMS [illegible] D-G [illegible] REVISED NOTE 1		

BILL OF MATERIAL

ITEM NO.	QTY	DWG NO.	DESCRIPTION	MAT'L SPEC
1	—	1157191D	TUBE EXPANSION MOCKUP ASSEMBLY	—
2	6	1157191D	TUBE 0.750 O.D. x .045 WALL	SB-163 SEE NOTE 1
3	6	1157191D	TUBE SUPPORT PLATE	A-285 GRC
4	2	1157191D	TIE ROD, 1/4-20 UNC THREADED	COMM'L
5	48	1157191D	HEX NUT, 1/4-20 UNC	COMM'L
6	24	1157191D	WASHER, 1/4	COMM'L
7	5	1157191D	COUPLING, 1½ HEAT SHRINK TUBE WITH MELT LINER	POLYOLEFIN PLASTIC
8	1	1157191D	SUPPORT 36" LONG	WOOD (FIR)
9	2	1157191D	HOSE CLAMP 3 3/4 I.D.	COMM'L

NOTES:

1. MACHINE FLAWS IN TUBES PER TABLE 1 PRIOR TO TUBE EXPANSION, EXCEPT WEAR FLAWS OF DETAIL B ARE MACHINED AFTER TUBE EXPANSION.
2. LOCATE DETAIL A EXPANSION [illegible] CENTERED AT THE CENTER OF THE EXPANSION, EXCEPT THAT FLAW LOCATION MARKED [illegible] ARE CENTERED 5/16" FROM THE CENTER OF THE EXPANSION.
3. [illegible]
4. EACH TUBE [illegible] SHALL BE IDENTIFIED BY AN [illegible] SERIAL NUMBER CONSISTING OF ASSEMBLY NUMBER AND TUBE SUPPORT PLATE LOCATION PER TABLE 1.

TOLERANCES UNLESS OTHERWISE SPECIFIED
ALL TOLERANCE DEFINITIONS PER ANSI Y14.5 1973
ALL DIMENSIONS ARE FOR PART TEMPERATURE OF 68°F

	UP TO 6 INCL	OVER 6 TO 12 INCL	OVER 12 TO 24 INCL	OVER 24 TO 48 INCL	OVER 48 TO 96 INCL	OVER 96
DECIMAL DIMENSIONS	±.005	±.005	±.005	±.010	±.015	[illegible]
FRAC DIM MACH	±1/64	±1/32	±1/32	±1/16	±1/16	±1/8
FRAC DIM UNMACH	±1/16	±1/16	±1/16	±1/8	±1/8	±3/16
DIM FOR BURNING	±1/16	±1/8	±1/8	±1/8	±1/8	±3/16
FLATNESS	.001 IN. OF SURFACE UP TO .025 MAX			BREAK CORNERS 1/64 X 45° MIN OR CHAMFER		
PERPENDICULARITY	.002 IN. OF SURFACE UP TO .030 MAX					
CONCENTRICITY	[illegible]					
ANGULARITY	[illegible]			CHAMFER ± 5°		

ALL MACHINED SURFACES TO HAVE 250 RMS FINISH UNLESS OTHERWISE NOTED

DRAWN: [illegible] 8-[illegible]-85

TUBE EXPANSION MOCKUP ASSEMBLY AND DETAILS

SCALE: AS NOTED

1157191 | D | 2

6.0 PREVIOUSLY USED PROCEDURE LISTING

Included in this section is a list of procedures which were previously used during the nondestructive examinations. These procedures have either been replaced or deleted and are listed for reference purposes. The originals are kept on permanent file within Babcock & Wilcox and are available upon request.

NUMBER	TITLE	REVISION