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ComEd

November 1, 1996

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

Subject: Baidwood Unit 1 Fall 1996 Mid-Cycle Steam Generator Inspection - Appendix H Compliance

Reference: (1) Harold Gene Stanley letter to Document Control Desk, October 23, 1996, "Comparison of Eddy Current Data Acquisition Equipment Braidwood Nuclear Power Station, Unit 1 Facility Operating License NPF-72 NRC Docket Number 50-456"

In Reference (1), Commonwealth Edison discussed the comparison of the TC 6700 Eddy Current Tester to the MIZ-30A. This comparison was conducted in accordance with the requirements of Electric Power Research Institute Document NP-6201, Appendix H, and documented in Westinghouse transmittal CCE-96-197, "Documentation of Appendix H Compliance and Equivalency Calculation Note DDM-96-009." This report shows that the TC 6700 is equivalent to or better than the MIZ-30A which was used at Byron during Byron's Unit 1 Spring 1996 refueling outage.

Reference (1) committed to providing a copy of this report to the Nuclear Regulatory Commission at a later date due to the proprietary nature of the document. Westinghouse has since determined that Calculation Note DDM-96-009 is not proprietary. This letter transmits a copy of Calculation Note DDM-96-009 in accordance with the commitment in Reference (1).

If you have any questions concerning this correspondence please, contact Douglas Huston at (815) 458-2801 extension 2511.

Sincerely,

Harold Gene Stanley
Site Vice-President
Braidwood Generating Station

Attachment

cc: R. R. Assa, Braidwood Project Manager - NRR
M. D. Lynch, Senior Project Manager - NRR
C. J. Phillips, Senior Resident Inspector - Braidwood
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Box 355
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CCE-96-210
October 24, 1996

Mr. J. R. Meister
ComEd
Braidwood Nuclear Station
Rural Route #1, Box 84
Braceville, IL 60407

ComEd
Braidwood Unit 1
Mid-Cycle SG Inspection - Appendix H Compliance

Reference: Westinghouse letter CCE-96-197, dated 9/16/96, to Mr. Harry Smith of ComEd

Dear Mr. Meister:

Please find attached sections of Calculation Note DDM-96-009, "Documentation of Appendix H Compliance and Equivalency," for your review. The Typical Examination Technique Specification Sheet covers the type of inspection that will be applied to Braidwood.

Per your request we have reviewed the attached sections of DDM-96-009 (previously provided to ComEd per Reference above) and they are provided as non-proprietary for ComEd's use.

If you have any questions or require further information on this matter, please contact me.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

James M Bennecicky for

B. S. Humphries, Manager
ComEd Project
Operating Plant Programs

Attachment

cc: H. L. Smith/Downers Grove
L. B. Alexander/Braidwood
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1.0 PURPOSE

The Electric Power Research Institute (EPRI) Document NP-6201, Appendix H - *Performance Demonstration for Eddy Current Examination* documents the performance of various eddy current techniques to detect and size indications. In some cases, the test parameters used were not prototypic of those used in the field or the sample sizes were too small to demonstrate a technique without supplementing the data. Where the supplementing of data was done, it was only for a specific system set-up. This Calculation Note is to document the compliance of various eddy current testing configurations to EPRI's Appendix H. The equivalency of various techniques where certain essential variables have been changed will also be documented. The testing program documented herein is designed to span a range of essential variables matching those used in the course of conventional field eddy current testing. Conclusions as to the applicability of various test configurations are drawn based on the test results. Work performed for this Calc Note was done in accordance with STD-QP-1996-7702, Rev. 0. The data provided herein is meant to supplement that which is provided in EPRI's documentation.

2.0 SCOPE

The test program described in this document defines, in detail, the essential variables which are being examined. These include the tester configuration, the coil type, the type of extension cabling, and the length of the extension cabling used. The scope of the program includes the performance of impedance sweeps for each coil with a variety of lengths and types of extension cabling. This documents the effect of the cabling on the operating point of the probe. Testing of the probes on samples with known defect depths and morphologies is used to document the comparative ability of the coils to detect various types of indications given the range of changes in the essential variables. The parameters being varied for each coil type include the type of tester and its operating parameters (drive and gain, if configurable), the type of cabling (characteristics to be defined by nominal capacitance and impedance), and the length of the extension cabling used for the test. The data obtained are reduced and analyzed in order to define the acceptable range of these essential variables.

3.0 BACKGROUND

3.1 Industry Requirements

As an industry, nuclear utilities have endorsed EPRI's Appendix H as the method for qualification of the eddy current techniques used for the examination of steam generator tubing. EPRI provided the original documentation of the applicability of bobbin and rotating pancake coils to the detection and sizing of various damage mechanisms. As new techniques became available, they have been qualified by either EPRI, the utilities, or the vendors. EPRI has documented some of the qualifications. Most utilities have committed to the regulatory body to use EPRI's Appendix H qualified techniques. For this reason, it is important that Westinghouse, as a service vendor, understands the applicability of the techniques to be used with respect to EPRI's Appendix H. This understanding must include what limitations exist with respect to the essential variables.

3.2 Industry Documentation

The majority of Appendix H related documentation resides with EPRI and is published as part of NP-6201. Appendix H does not require that EPRI be the qualifier of all techniques and, like other industry documents, states that the vendor or utility are responsible for their own program. An analysis of the techniques documented by EPRI was recently performed by Westinghouse. This analysis broke down the documentation so as to allow for a clearer understanding of what the acceptable range of essential variables (frequency, cable length, cable type, coil type, etc.) was for each damage mechanism.

The parameterized tables showed that there were several gaps in the documentation with respect to how eddy current testing is performed in the field. The deficiencies in the documentation include the extension cable lengths used, tester equivalency for some applications, cable types, and some qualifications which were approved by an industry peer review and were then 'dis-qualified' when the application to various mechanisms was re-parameterized by EPRI. This document seeks to fill in many of the gaps in this documentation by applying the

concept of demonstrated equivalency in a manner consistent with EPRI's Appendix H. This report also includes some direct qualifications of techniques which are not included in the EPRI document.

EPRI was requested by Westinghouse to supply interpretations to a small number of questions regarding the application of Appendix H (see Appendix J of this document). EPRI has stated that the interpretation of the document is up to the industry and the vendors. This report documents Westinghouse's position on these and other Appendix H related issues.

4.0 TEST MATRIX

4.1 Impedance Sweeps

Impedance sweeps were performed for all coils using the extension lengths as defined in Table 4-1. The coil was placed in an Inconel 600 tube for the performance of this test. The sweeps were performed over a frequency range of 10 kHz through 1000 kHz in 1 kHz steps. The impedance data were recorded and the resonance point noted for each test.

Three types of extension cabling were used for the impedance sweeps. For the bobbin probes, RG-174U and the Zetec 'low loss' cabling were tested. For the RPC probes, Westinghouse RPC extensions and Zetec 'low loss' cables were used. As a reference, the nominal characteristics of each cable type are listed in Table 4-2.

Table 4-1. Impedance sweep test matrix.

Probe	0 ft	60 ft	110 ft	120 ft	50 ft ('Low Loss')	100 ft ('Low Loss')
MULC Bobbin	X	X	X	X	X	X
LLMC Bobbin	X	X	X	X	X	X
115 mil MR. Pancake	X	X	X		X	X
80 mil MR. Pancake	X	X	X		X	X
80 mil HF Pancake	X	X	X		X	X
Plus Point	X	X	X		X	X
Axially Wound Coil	X	X	X		X	X
Cicumferentially Wound Coil	X	X	X		X	X

Table 4-2. Extension cable characteristics

Cable Type	Characteristic Impedance	Characteristic Capacitance
RG-174U Extension	50 Ω	30.5 ± 1.5 pf/ft
Westinghouse RPC Extension	50 Ω	26.0± 2.5 pf/ft
Zetec 'Low Loss' Extension	80 Ω	17.5 pf/ft (nom.)

4.2 System Equivalency

The eddy current system is defined as the combination of tester, cabling and probes. Two systems are considered to be equivalent when their scaled responses for a range of signals are equal (within expected eddy current measurement error as defined in Reference 5). Also, the ability to detect the smaller signals must be shown to not change significantly with the addition of cabling. To achieve this, a variety of samples were used to provide signals which range from marginally detectable to very large. A sampling of these over the full range of amplitude responses were selected for comparison. This concept of equivalency was applied using the bobbin probes. The technique sheets for each system and the range of the essential variables used are included in the Appendices.

NRC Generic Letter 95-05 defines the acceptance criteria used for the manufacture of probes used for alternate repair criteria. Probes must be manufactured to a 10% tolerance based on response to a defect standard. The acceptance criteria for determining the equivalency of a system shall be defined based upon the scaled average response of the system using a single probe. The amplitude response of the first run of a given standard defect was used to scale the probe response to a given value (see the Technique Sheets for detail). The next six runs of each sample defect were then averaged. The basis for comparison was the test run using a MIZ-18A with a bobbin probe and no extension cabling. The remainder of the tests were performed to demonstrate qualification based upon system equivalency. The test matrix used is defined in Table 4-3.

Table 4-3. System equivalency test matrix.

Probe and Tester	0 ft	110 ft	Excitation
LLMC MIZ-18A	X	X	Default (not adjustable)
LLMC TC6700		X	1.9 Vp at 38 dB
LLMC MIZ-30A		X	12V at 1x

Table 4-4. Probe/cable equivalency test matrix

Probe and Tester	0 ft	60 ft	120 ft	100 ft. ('Low Loss)
MULC TC6700	X	X	X	X
LLMC TC6700	X	X	X	

The Zetec MULC probe was tested to show equivalence of response to the Echoram LLMC probe (Table 4-4). Both the RG-174 and Zetec 'low loss' cabling were tested. The 'low loss' cabling is a lower noise (lower capacitance) cabling than the standard Zetec RPC extension cabling and RG-174. As this cabling is commonly used with the MIZ-30A, its equivalency must also be demonstrated.

4.3 Direct Qualification

For the rotating probes, it was decided that a more direct qualification needed to be performed. The coils were all tested over a wide frequency range in order to better determine the suitability of a given frequency/coil combination to the detection of PWSCC and ODSCC simulations and to make sure that the range of frequencies commonly used in the field were evaluated. The system set-up matrix for rotating coils is shown in Table 4-5. The Technique Sheets for these tests can be found in the appropriate Appendices.

Table 4-5. Rotating coil test matrix.

Coil and Tester	**0 ft**	**60 ft**	**110 ft**	**50 ft ('Low Loss')**	**100 ft. ('Low Loss)**
115 mil MR MIZ-18A	X	X	X		
115 mil MR TC6700	X		X	X	X
115 mil MR MIZ-30A	X		X		
80 mil MR MIZ-18A	X	X	X		

Table 4-5. Rotating coil test matrix (cont.).

Coil and Tester	0 ft	60 ft	110 ft	50 ft ('Low Loss')	100 ft. ('Low Loss)
80 mil MR TC6700	X		X	X	X
80 mil MR MIZ-30A	X		X		
80 mil HF MIZ-18A	X	X	X		
80 mil HF TC6700	X		X	X	X
80 mil HF MIZ-30A	X		X		
Plus Point MIZ-18A	X	X	X		
Plus Point TC6700	X		X	X	X
Plus Point MIZ-30A	X		X		
Axially Wound MIZ-18A	X	X	X		
Axially Wound TC6700	X		X	X	X
Axially Wound MIZ-30A	X		X		
Circ. Wound MIZ-18A	X	X	X		
Circ. Wound TC6700	X		X	X	X
Circ. Wound MIZ-30A	X		X		

5.0 TEST METHODOLOGY

5.1 Bobbin Testing

Bobbin testing was performed on both 0.750" OD x 0.043" wall and 0.875" x 0.050" wall Inconel 600 tubing. The test samples used are identified on the data sheets, and drawings are included in Appendix K. All testing was performed such that the minimum digitization rate was 30 samples per inch of probe travel. Each tube tested had approximately 18" of tubing attached to each end in order to ensure that the probe speed was consistent by the time the probe reached that sample and that there was no 'probe whip' as the probe exited the sample.

Each sample was tested a total of six times. The probe speed was controlled using a Zetec 4D probe pusher and an SM-10 robotic control box. Between tests, the sample was rotated about the tube axis in order to minimize any bias which might be attributed to the orientation (set) of the probe's push tube.

5.1.1 MIZ-18A

The MIZ-18A has fixed drive voltage and gain. The drive voltage is 11 Vpp and the total instrument gain is 28 dB. As all of the early Appendix H qualifications documented by EPRI were performed using this instrument, this shall be considered to be the minimum setting for any instrument. This does not mean that the drive and gain of an adjustable instrument must match these, but that the end result of the drive and gain combination must be the same.

Equivalency can be calculated based on drive voltage and instrument gain, but detectability must be maintained. For example: if the gain on the TC6700 is set to 35 dB, the minimum drive voltage required to achieve an equivalent response is approximately 5 Vpp (2.5 Vp).

5.1.2 TC6700

The TC6700 allows for adjustment of both the drive voltage and the gain of the instrument. The drive voltage is adjustable over a range of .05 Vp through 10 Vp (20 Vpp) using the ANSER software. The minimum total instrument gain is dependent upon the probe interface module (PIM) used. Testing was performed using a PIM-04 and a PIM-04W. The minimum instrument gain with a PIM-04 is 38 dB. The PIM-04W has 9 dB less gain than a PIM-04 and reduces the minimum system gain to 29 dB. The gain can be adjusted upward by as much as 16 dB from the minimum in 1 dB increments.

Testing with the TC6700 was performed at or slightly above the settings needed to be equivalent to the MIZ-18A. Some data were collected at greater settings in order to demonstrate the scaled equivalency of the settings and establish the validity of an operating range.

5.1.3 MIZ-30A

The MIZ-30A allows for adjustment of both the drive voltage and the gain of the instrument. The drive voltage is adjustable over a range of 11 Vpp through 16 Vpp (8 Vp) using the EddyNet software. The minimum total instrument gain is 28 dB. The gain can be adjusted upward by as much as about 24 dB from the minimum by using multiplying factors (x2., x4, x8, and x16).

Testing with the MIZ-30A was performed at the setting which is equivalent to the MIZ-18A (11 Vpp x1), and at 12 Vpp x1. This was done settings in order to demonstrate the scaled equivalency of the settings.

5.2 Rotating Probe Testing

For general applications, testing was performed on 0.875" x 0.050" and 0.750" x 0.043" wall Inconel 600 tubing. The test samples used are identified on the data sheets, and drawings are included in Appendix K. All testing was performed such that the minimum digitization rate was 30 samples per inch of helical probe travel.

Since the probes tested were all surface riding, each undeformed sample was required to be tested only once. Samples with dents or expansions were initially examined in both directions in order to determine the effect of the position of the defect relative to the direction of test for the test parameters used. A variety of probe translation and rotation speeds were used in order to better determine any practical limitations related to deformed regions. For base testing, all three test instruments were utilized. For the speed range testing only one instrument was used based on equivalency of signal response. The probe speed was controlled using a Zetec 4D probe pusher and an SM-10 robotic control box.

5.3 Direct Qualification

All rotating coils were tested by means of direct qualification on each system. While this is perhaps redundant with respect to that which was already documented in Appendix H, it was considered best to have all systems and variables tested on a consistent set of samples. Drawings for the samples used for this qualification have been included in Appendix K. The technique and data sheets for each of the coils are in Appendices E through H. The acceptance criteria for a technique is 80% POD at 90% confidence.

6.0 RESULTS

6.1 Impedance Sweeps

The impedance sweeps for all the coils and cabling cited in Table 4-1 are contained in Appendix A. While these sweeps do not, by themselves, constitute a qualification of the system, they do define the range of probe and cable characteristics which can be related to the other data acquired. By defining these ranges, the acceptability of different cables to be used with these coils can be evaluated by whether or not the coil/cable impedance sweep lies within the established range. It also helps in defining what effect a typical incremental cable addition would have on the operating point of the probe. For example, the difference between the characteristic behavior of the LLMC Bobbin (Figure A-1) with 110 feet and 120 feet of RG-174 can be seen to be quite small. Thus, the effect of adding or subtracting 10 feet of cable can be seen to be small.

The most noticeable differences in the impedance sweeps for the bobbin probes are between the LLMC and MULC using Zetec 'low loss' cable. The secondary resonance peaks for the MULC are related largely to the wiring of the probe. It is also possible that this behavior is related to the characteristics of the low loss cable in combination with the wiring of the probe. The LLMC probe does not experience this aberration due to differences in the cable construction (long life conduit) and the wiring of the probe.

The plots for the rotating coils show very little difference in the behavior of the mid-range coils (pancakes, plus point and oriented coils) for 60 feet of Westinghouse extension (50 Ω and 26 pf/ft) and 50 feet of Zetec low loss extension (80 Ω and 26 pf/ft). There is a small difference for these coils between 110 feet of Westinghouse extension and 100 feet of Zetec low loss cabling. For the high frequency pancake, these differences are small.

6.2 System Equivalency

System equivalency was demonstrated using a 610 LLMC probe. The system configurations used for this comparison were listed in Table 4-3. The responses of the systems were compared for a range of signals from a variety of samples. These signals ranged from < 0.25 Vpp to over 100 Vpp. The data showed that the scaled responses of the systems were found to be equivalent. It should be noted that the settings of the TC6700 and MIZ-30A were not exactly equivalent in terms of end instrument gain. The MIZ-18A operates at 11 Vpp and 28 dB gain. The TC6700 setting used (1.9 Vp and 38 dB) is equivalent to approximately 1 Vpp greater excitation than the MIZ-18A and is equivalent to the MIZ-30A setting of 12 V and 1x. The results of this testing are tabulated in Appendices B, C and D.

Table 6-1 summarizes a range of responses based on using a 100 ft long 610-LLMC probe with 110 feet of RG-174 extension cabling. Using the ±10% criteria, a range of acceptability is provided. The basis for the test was the response of the MIZ-18A. All data presented are based upon the average results for multiple tests of each sample with the probe. The data for the TC6700 and MIZ-30A a display responses equivalent to that of the MIZ-18A within expected eddy current error.

Table 6-1. System equivalency responses. All measurements on the AVB and ASV standards were made using a mix channel (except for support ring) and are in volts. The measurements from X-001-93 were made using the prime differential frequency.

Sample	Flaw	-10% ≤ Basis ≤ +10%	TC6700	MIZ-30A
AV-006-91	52%	3.94 ≤ 4.38 ≤ 4.82	4.39	4.38
	40%	2.31 ≤ 2.57 ≤ 2.83	2.57	2.54
	33%	1.68 ≤ 1.87 ≤ 2.06	1.86	1.86
	21%	0.75 ≤ 0.83 ≤ 0.91	0.86	0.82
ASV-A-003-93	ID Groove	62.36 ≤ 69.29 ≤ 76.22	68.44	67.95
	Support Ring	5.29 ≤ 5.88 ≤ 6.47	5.77	5.96
	100%	5.39 ≤ 5.99 ≤ 6.59	5.98	5.89
	80%	5.26 ≤ 5.85 ≤ 6.44	5.72	5.89
	60%	4.51 ≤ 5.01 ≤ 5.51	4.81	5.04
	40%	2.71 ≤ 3.01 ≤ 3.31	3.03	3.05
	20%	2.47 ≤ 2.75 ≤ 3.03	2.81	2.79
	OD Groove	5.26 ≤ 5.85 ≤ 6.44	6.05	5.91
	100% (probe wear)	5.31 ≤ 5.90 ≤ 6.49	5.99	5.83
	100% (probe wear)	5.26 ≤ 5.84 ≤ 6.42	5.62	5.74
	100% (probe wear)	5.40 ≤ 6.01 ≤ 6.60	5.89	5.97
	100% (probe wear)	5.49 ≤ 6.10 ≤ 6.71	6.29	6.15
	Dent	49.6 ≤ 55.11 ≤ 60.62	55.04	54.26
X-001-93	7 mil dent	181.39 ≤ 201.54 ≤ 221.69	202.34	205.04
	3 mil Dent	88.68 ≤ 98.53 ≤ 108.38	97.40	98.25
	40% OD Groove	54.45 ≤ 60.50 ≤ 66.55	59.40	61.14
	63 % Circ. Notch	0.32 ≤ 0.36 ≤ 0.40	0.36	0.39
	40 % Circ. Notch	0.16 ≤ 0.18 ≤ 0.20	0.17	0.16
	21 % Circ. Notch	NDD (no detection)	NDD	NDD
	40 % Oblique Notch	0.51 ≤ 0.57 ≤ 0.63	0.55	0.55
	19 % Oblique Notch	0.08 ≤ 0.09 ≤ 0.10	0.09	0.10
	63 % Axial Notch	1.60 ≤ 1.78 ≤ 1.96	1.78	1.80
	40 % Axial Notch	0.70 ≤ 0.78 ≤ 0.86	0.75	0.77
	21 % Axial Notch	0.15 ≤ 0.17 ≤ 0.19	0.16	0.17
	37 % ID Axial. Notch	2.49 ≤ 2.77 ≤ 3.05	2.75	2.79
	37 % ID Circ. Notch	0.95 ≤ 1.06 ≤ 1.17	1.02	1.04

6.3 Bobbin Probe Equivalency

The equivalency of the probe responses with various lengths and types of cabling were verified using the test matrix from Table 4-4. The results are tabulated in Appendices B, C and D, and are summarized in Table 6-2. For all baseline responses greater than 0.2 Vpp, the response of the two probes (LLMC and MULC) and the various lengths/types of cabling were found to be equivalent within the ±10% criteria of STD-QP-1996-7702, Rev. 0. The lowest amplitude signals were detectable with any configuration, but the variance in the data was greater than ±10% (these are highlighted in Table 6-2). This is not uncommon for small amplitude signals. For this table, the basis was a 720-LLMC probe with no extension. All test were performed on the TC6700. The LLMC and MULC probes were tested with up to 120 feet of RG-174 extension cabling. The MULC was also tested using 100 feet of Zetec low loss cabling.

Table 6-2. Comparison of bobbin probe responses with various cabling. Measurements are in volts from the mix channel (except for support signal).

Sample	Flaw	-10% ≤ Basis ≤ +10%	LLMC w/ 60 ft RG-174	LLMC w/ 120 ft RG-174	MULC w/ no extension	MULC w/ 60 ft RG-174	MULC w/ 120 ft RG-174	MULC w/ 100 ft Low Loss Ext.
AVDB-019-96	IDG	51.40 ≤ 57.11 ≤ 62.82	57.98	57.17	59.49	58.13	58.09	58.69
	ODG	4.89 ≤ 5.43 ≤ 5.97	5.48	5.44	5.66	5.62	5.71	5.52
	100	4.72 ≤ 5.24 ≤ 5.76	5.28	5.29	5.37	5.29	5.24	5.29
	60	2.97 ≤ 3.30 ≤ 3.63	3.37	3.32	3.35	3.28	3.33	3.38
	40	2.74 ≤ 3.04 ≤ 3.34	3.11	3.06	3.02	3.01	3.05	3.11
	20	2.45 ≤ 2.72 ≤ 2.99	2.77	2.73	2.74	2.73	2.78	2.77
	100	5.29 ≤ 5.88 ≤ 6.47	6.05	5.88	5.99	5.84	5.86	6.05
	100	5.23 ≤ 5.81 ≤ 6.39	6.11	6.02	6.18	5.99	5.84	6.15
	100	5.37 ≤ 5.97 ≤ 6.57	5.96	6.01	6.23	6.15	5.9	5.93
	100	5.34 ≤ 5.93 ≤ 6.52	5.93	5.98	6.00	6.01	6.08	5.89
	DNT	50.75 ≤ 56.39 ≤ 62.03	57.24	57.17	55.05	54.23	54.01	57.53
	TSP	6.39 ≤ 7.10 ≤ 7.81	7.27	7.24	6.98	6.88	6.83	7.27
	AV20	0.64 ≤ 0.71 ≤ 0.78	0.73	0.70	0.70	0.69	0.70	0.72
	AV40	2.52 ≤ 2.80 ≤ 3.08	2.87	2.82	2.66	2.68	2.69	2.86
AE-002-93	20	0.50 ≤ 0.56 ≤ 0.62	0.56	0.59	0.57	0.58	0.59	0.56
	40	1.61 ≤ 1.79 ≤ 1.97	1.84	1.81	1.82	1.81	1.81	1.83
	60	2.88 ≤ 3.20 ≤ 3.52	3.30	3.28	3.20	3.19	3.19	3.28
	80	3.38 ≤ 3.76 ≤ 4.14	3.81	3.76	3.69	3.65	3.60	3.77
	100	98.89 ≤ 109.88 ≤ 120.87	111.15	110.53	101.57	99.77	98.98	110.98
AE-003-93	20	6.87 ≤ 7.63 ≤ 8.39	7.75	7.81	7.50	7.43	7.41	7.87
	40	11.94 ≤ 13.27 ≤ 14.60	13.47	13.50	12.95	12.86	12.8	13.53
	60	11.12 ≤ 12.36 ≤ 13.60	12.57	12.57	12.20	11.93	11.9	12.66
	80	8.58 ≤ 9.53 ≤ 10.48	9.40	9.36	8.92	8.77	8.8	9.47
AE-005-93	20	0.13 ≤ 0.15 ≤ 0.17	0.16	0.19	0.20	0.17	0.19	0.13
	40	0.38 ≤ 0.42 ≤ 0.46	0.44	0.45	0.45	0.45	0.45	0.44
	60	1.41 ≤ 1.57 ≤ 1.73	1.64	1.59	1.55	1.58	1.55	1.62
	80	4.03 ≤ 4.48 ≤ 4.93	4.69	4.57	4.42	4.42	4.38	4.62
	100	81.86 ≤ 90.96 ≤ 100.06	93.96	92.34	84.89	83.98	83.55	93.14

6.4 Rotating Coil Qualification

6.4.1 80 mil MR Pancake

The 80 mil mid-range pancake coil was tested on a variety of samples with EDM notches on the ID and OD of the tube. [illegible] samples included a range of straight lengths, expansion transitions and dents (both symmetric and asym[illegible] The sample configurations are supplied in Appendix K. The results of the testing are tabulated in Appen[illegible] E.

The POD's for ID and OD indications were calculated at 90% confidence individually for all test frequencies and for var[illegible]s actual depth ranges (for example ≥ 60%, ≥50%, etc.) for the various extension and tester combinations using a binomial distribution. The results for all indications ≥20% are tabulated in this section (Table 6-3). Those values which failed the acceptance criteria of a POD ≥ 0.80 at 90% confidence are highlighted. For a more complete breakdown, refer to Appendix E.

Table 6-3. POD's at 90% confidence for the 80 mil MR pancake coil for EDM notches of depth ≥ 20% of the tube wall.

Tester	Cable	Flaw Type	600 kHz	500 kHz	400 kHz	300 kHz	200 kHz	100 kHz
MIZ-18A	None	OD	.71	.77	.95	.95	.95	.95
MIZ-18A	None	ID	.94	.94	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 60 ft.	OD	.75	.77	.95	.95	.95	.95
MIZ-18A	26 pf/ft - 60 ft.	ID	.94	.94	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 110 ft.	OD	.77	.77	.95	.95	.95	.95
MIZ-18A	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94
TC6700	None	OD	.88	.93	.95	.95	.95	.95
TC6700	None	ID	.94	.94	.94	.94	.94	.94
TC6700	26 pf/ft - 110 ft.	OD	.75	.95	.95	.95	.95	.93
TC6700	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94
TC6700	17.5 pf/ft - 50 ft.	OD	.62	.70	.94	.94	.90	.90
TC6700	17.5 pf/ft - 50 ft.	ID	.93	.93	.93	.93	.93	.93
TC6700	17.5 pf/ft - 100 ft.	OD	.59	.81	.90	.90	.90	.90
TC6700	17.5 pf/ft - 100 ft.	ID	.93	.93	.93	.93	.93	.93
MIZ-30A	None	OD	.79	.93	.95	.95	.95	.95
MIZ-30A	None	ID	.94	.94	.94	.94	.94	.94
MIZ-30A	26 pf/ft - 110 ft.	OD	.79	.93	.95	.95	.95	.95
MIZ-30A	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94

6.4.2 115 mil MR Pancake

The 115 mil mid-range pancake coil was tested on a variety of samples with EDM notches on the ID and OD of the tube. The samples included a range of straight lengths, expansion transitions and dents (both symmetric and asymmetric). The sample configurations are supplied in Appendix K. The results of the testing are tabulated in Appendix F.

The POD's for ID and OD indications were calculated at 90% confidence individually for all test frequencies and for various actual depth ranges (for example ≥ 60%, ≥50%, etc.) for the various extension and tester combinations using a binomial distribution. The results for all indications ≥20% are tabulated in this section (Table 6-4). Those values which failed the acceptance criteria of a POD ≥ 0.80 at 90% confidence are highlighted. For a more complete breakdown, refer to Appendix F.

Table 6-4. POD's at 90% confidence for the 115 mil MR pancake coil for EDM notches of depth ≥ 20% of the tube wall.

Tester	Cable	Flaw Type	600 kHz	500 kHz	400 kHz	300 kHz	200 kHz	100 kHz
MIZ-18A	None	OD	.77	.79	.95	.95	.95	.95
MIZ-18A	None	ID	.94	.94	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 60 ft.	OD	.77	.93	.95	.95	.95	.95
MIZ-18A	26 pf/ft - 60 ft.	ID	.94	.94	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 110 ft.	OD	.77	.93	.95	.95	.95	.95
MIZ-18A	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94
TC6700	None	OD	.79	.95	.95	.95	.95	.95
TC6700	None	ID	.94	.94	.94	.94	.94	.94
TC6700	26 pf/ft - 110 ft.	OD	.79	.81	.95	.95	.95	.93
TC6700	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94
TC6700	17.5 pf/ft - 50 ft.	OD	.70	.87	.90	.90	.90	.90
TC6700	17.5 pf/ft - 50 ft.	ID	.93	.93	.93	.93	.93	.93
TC6700	17.5 pf/ft - 100 ft.	OD	.62	.87	.90	.90	.90	.90
TC6700	17.5 pf/ft - 100 ft.	ID	.93	.93	.93	.93	.93	.93
MIZ-30A	None	OD	.81	.95	.95	.95	.95	.95
MIZ-30A	None	ID	.94	.94	.94	.94	.94	.94
MIZ-30A	26 pf/ft - 110 ft.	OD	.81	.95	.95	.95	.95	.95
MIZ-30A	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94

6.4.3 80 mil HF Pancake

The 80 mil high frequency pancake coil was tested on a variety of samples with EDM notches on the ID and OD of the tube. The samples included a range of straight lengths, expansion transitions and dents (both symmetric and asymmetric). The sample configurations are supplied in Appendix K. The results of the testing are tabulated in Appendix G.

The POD's for ID and OD indications were calculated at 90% confidence individually for all test frequencies and for various actual depth ranges (for example ≥ 60%, ≥50%, etc.) for the various extension and tester combinations using a binomial distribution. The results for all indications ≥20% are tabulated in this section (Table 6-5). Those values which failed the acceptance criteria of a POD ≥ 0.80 at 90% confidence are highlighted. For a more complete breakdown, refer to Appendix G.

Table 6-5. POD's at 90% confidence for the 80 mil HF pancake coil for EDM notches of depth ≥ 20% of the tube wall.

Tester	Cable	Flaw Type	600 kHz	500 kHz	400 kHz	300 kHz	200 kHz	100 kHz
MIZ-18A	None	OD	.77	.79	.95	.95	.81	.77
MIZ-18A	None	ID	.94	.94	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 60 ft.	OD	.77	.79	.95	.95	.81	.81
MIZ-18A	26 pf/ft - 60 ft.	ID	.94	.94	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 110 ft.	OD	.77	.79	.95	.95	.81	.79
MIZ-18A	26 pf/ft - 110 ft.	ID	[illegible]	.94	.94	.94	.94	.94
TC6700	None	OD	.75	.79	.81	.81	.81	.81
TC6700	None	ID	.94	.94	.94	.94	.94	.94
TC6700	26 pf/ft - 110 ft.	OD	.77	.79	.81	.81	.81	.81
TC6700	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94
TC6700	17.5 pf/ft - 50 ft.	OD	.64	.70	.90	.90	.72	.70
TC6700	17.5 pf/ft - 50 ft.	ID	.93	.93	.93	.93	.93	.93
TC6700	17.5 pf/ft - 100 ft.	OD	.57	.67	.90	.90	.72	.70
TC6700	17.5 pf/ft - 100 ft.	ID	.93	.93	.93	.93	.93	.93
MIZ-30A	None	OD	.79	.93	.95	.95	.95	.79
MIZ-30A	None	ID	.94	.94	.94	.94	.94	.94
MIZ-30A	26 pf/ft - 110 ft.	OD	.79	.95	.95	.95	.95	.93
MIZ-30A	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94

6.4.4 Axially Sensitive Coil

The axially sensitive coil was tested on a variety of samples with EDM notches on the ID and OD of the tube. The samples included a range of straight lengths, expansion transitions and dents (both symmetric and asymmetric). The sample configurations are supplied in Appendix K. The results of the testing are tabulated in Appendix H. For the purposes of the qualification of this coil, only axial and oblique notches were considered. While there is some ability to detect larger circumferential indications, this coil was designed to be primarily sensitive to axial indications.

The POD's for ID and OD indications were calculated at 90% confidence individually for all test frequencies and for various actual depth ranges (for example ≥ 60%, ≥50%, etc.) for the various extension and tester combinations using a binomial distribution. The results for all indications ≥20% are tabulated in this section (Table 6-6). Those values which failed the acceptance criteria of a POD ≥ 0.80 at 90% confidence are highlighted. For a more complete breakdown, refer to Appendix H.

Table 6-6. POD's at 90% confidence for the axially sensitive coil for EDM notches of depth ≥ 20% of the tube wall.

Tester	Cable	Flaw Type	600 kHz	500 kHz	400 kHz	300 kHz	200 kHz	100 kHz
MIZ-18A	None	OD	.63	.68	.94	.94	.94	.94
MIZ-18A	None	ID	.91	.91	.91	.91	.91	.91
MIZ-18A	26 pf/ft - 60 ft.	OD	.68	.71	.94	.94	.94	.90
MIZ-18A	26 pf/ft - 60 ft.	ID	.91	.91	.91	.91	.91	.91
MIZ-18A	26 pf/ft - 110 ft.	OD	.68	.71	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 110 ft.	ID	.91	.91	.91	.91	.91	.91
TC6700	None	OD	.86	.94	.94	.94	.94	.94
TC6700	None	ID	.91	.91	.91	.91	.91	.75
TC6700	26 pf/ft - 110 ft.	OD	.68	.71	.94	.94	.94	.74
TC6700	26 pf/ft - 110 ft.	ID	.91	.91	.91	.91	.91	.75
TC6700	17.5 pf/ft - 50 ft.	OD	.64	.92	.92	.92	.92	.92
TC6700	17.5 pf/ft - 50 ft.	ID	.90	.90	.90	.90	.90	.72
TC6700	17.5 pf/ft - 100 ft.	OD	.61	.83	.92	.92	.92	.92
TC6700	17.5 pf/ft - 100 ft.	ID	.90	.90	.90	.90	.90	.90
MIZ-30A	None	OD	.74	.94	.94	.94	.94	.90
MIZ-30A	None	ID	.91	.91	.91	.91	.91	.91
MIZ-30A	26 pf/ft - 110 ft.	OD	.74	.95	.94	.94	.94	.94
MIZ-30A	26 pf/ft - 110 ft.	ID	.91	.91	.91	.91	.91	.91

6.4.5 Circumferentially Sensitive Coil

The circumferentially sensitive coil was tested on a variety of samples with EDM notches on the ID and OD of the tube. The samples included a range of straight lengths, expansion transitions and dents (both symmetric and asymmetric). The sample configurations are supplied in Appendix K. The results of the testing are tabulated in Appendix H. For the purposes of the qualification of this coil, only circumferential and oblique notches were considered. While there is some ability to detect larger axial indications, this coil was designed to be primarily sensitive to circumferential indications. Due to a connector difference to accommodate the low loss cable, only a .720" diameter motor unit was available when the testing was being performed. The 0.750" diameter tubing could not be tested. This resulted in an inadequate sample size of appropriately oriented flaws for calculating the POD for this coil with that cable.

The POD's for ID and OD indications were calculated at 90% confidence individually for all test frequencies and for various actual depth ranges (for example ≥ 60%, ≥50%, etc.) for the various extension and tester combinations using a binomial distribution. The results for all indications ≥20% are tabulated in this section (Table 6-7). Those values which failed the acceptance criteria of a POD ≥ 0.80 at 90% confidence are highlighted. For a more complete breakdown, refer to Appendix H.

Table 6-7. POD's at 90% confidence for the circumferentially sensitive coil for EDM notches of depth ≥ 20% of the tube wall. N/A denotes that the sample size was insufficient. This was due to not having a motor unit with the appropriate connector for both tube sizes used for the other tests.

Tester	Cable	Flaw Type	600 kHz	500 kHz	400 kHz	300 kHz	200 kHz	100 kHz
MIZ-18A	None	OD	.73	.80	.87	.87	.87	.87
MIZ-18A	None	ID	.83	.83	.83	.83	.83	.83
MIZ-18A	26 pf/ft - 60 ft.	OD	.73	.80	.87	.87	.87	.87
MIZ-18A	26 pf/ft - 60 ft.	ID	.83	.83	.83	.83	.83	.83
MIZ-18A	26 pf/ft - 110 ft.	OD	.80	.80	.87	.87	.87	.87
MIZ-18A	26 pf/ft - 110 ft.	ID	.83	.83	.83	.83	.83	.83
TC6700	None	OD	.80	.80	.87	.87	.87	.87
TC6700	None	ID	.83	.83	.83	.83	.83	.83
TC6700	26 pf/ft - 110 ft.	OD	.73	.80	.87	.87	.87	.87
TC6700	26 pf/ft - 110 ft.	ID	.83	.83	.83	.83	.83	.83
TC6700	17.5 pf/ft - 50 ft.	OD	N/A	N/A	N/A	N/A	N/A	N/A
TC6700	17.5 pf/ft - 50 ft.	ID	N/A	N/A	N/A	N/A	N/A	N/A
TC6700	17.5 pf/ft - 100 ft.	OD	N/A	N/A	N/A	N/A	N/A	N/A
TC6700	17.5 pf/ft - 100 ft.	ID	N/A	N/A	N/A	N/A	N/A	N/A
MIZ-30A	None	OD	.80	.80	.87	.87	.87	.87
MIZ-30A	None	ID	.83	.83	.83	.83	.83	.83
MIZ-30A	26 pf/ft - 110 ft.	OD	.80	.80	.87	.87	.87	.87
MIZ-30A	26 pf/ft - 110 ft.	ID	.83	.83	.83	.83	.83	.83

6.4.6 Plus Point Coil

The plus point coil was tested on a variety of samples with EDM notches on the ID and OD of the tube. The samples included a range of straight lengths, expansion transitions and dents (both symmetric and asymmetric). The sample configurations are supplied in Appendix K. The results of the testing are tabulated in Appendix I.

The POD's for ID and OD indications were calculated at 90% confidence individually for all test frequencies and for various actual depth ranges (for example ≥ 60%, ≥50%, etc.) for the various extension and tester combinations using a binomial distribution. The results for all indications ≥20% are tabulated in this section (Table 6-8). Those values which failed the acceptance criteria of a POD ≥ 0.80 at 90% confidence are highlighted. For a more complete breakdown, refer to Appendix I.

Table 6-8. POD's at 90% confidence for the plus point coil for EDM notches of depth ≥ 20% of the tube wall.

Tester	Cable	Flaw Type	600 kHz	500 kHz	400 kHz	300 kHz	200 kHz	100 kHz
MIZ-18A	None	OD	.71	.77	.95	.95	.95	.95
MIZ-18A	None	ID	.94	.94	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 60 ft.	OD	.73	.73	.95	.95	.95	.95
MIZ-18A	26 pf/ft - 60 ft.	ID	.94	.94	.94	.94	.94	.94
MIZ-18A	26 pf/ft - 110 ft.	OD	.71	.69	.95	.95	.95	.95
MIZ-18A	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94
TC6700	None	OD	.67	.81	.95	.95	.95	.95
TC6700	None	ID	.94	.94	.94	.94	.94	.94
TC6700	26 pf/ft - 110 ft.	OD	.64	.69	.81	.95	.95	.93
TC6700	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94
TC6700	17.5 pf/ft.- 50 ft.	OD	.70	.70	.94	.94	.94	.94
TC6700	17.5 pf/ft - 50 ft.	ID	.93	.93	.93	.93	.93	.93
TC6700	17.5 pf/ft - 100 ft.	OD	.62	.75	.94	.94	.94	.94
TC6700	17.5 pf/ft - 100 ft.	ID	.93	.93	.93	.93	.93	.93
MIZ-30A	None	OD	.75	.79	.95	.95	.95	.95
MIZ-30A	None	ID	.94	.94	.94	.94	.94	.94
MIZ-30A	26 pf/ft - 110 ft.	OD	.73	.79	.95	.95	.95	.95
MIZ-30A	26 pf/ft - 110 ft.	ID	.94	.94	.94	.94	.94	.94

7.0 CONCLUSIONS

7.1 System Equivalency

The system equivalency, based upon equivalency of response (Section 6.2), has been demonstrated. Given a consistent scaling practice, differences in instrument gain are not a factor so long as a minimum value is defined upon which to base an equivalent setting. This conclusion can be derived from the variety of settings used for this work and the documentation in Appendix H of EPRI Guideline NP-6201. Such minimum settings would typically be derived from the original qualification of a technique, or they could be demonstrated. For impedance testing of steam generator tubing, the minimum standard is taken to be the MIZ-18A (the basis for most of the Appendix H qualifications). Instrument settings which can be demonstrated, by calculation or testing, to meet or exceed this minimum criterion of total gain are considered to be equivalent. A sampling is provided in Table 7-1. NOTE: The drive voltages for the TC6700 are set by Vp rather than Vpp.

Table 7-1. TC6700 and MIZ-30A minimum equivalency settings (MIZ-18A basis).

MIZ-18A (basis)	TC6700 with PIM-04	TC6700 with PIM-04W	MIZ-30A
11 Vpp at 28 dB	1.8 Vp (3.6 Vpp) at 38 dB	2.5 Vp (5.0 Vpp) at 35 dB	11 Vpp at 1x

7.2 Bobbin Probes

The data presented in Section 6.3 support the equivalence of the response of the LLMC and MULC bobbin probes. There are three data points which exhibit deviation from the ±10% criteria. This is not unexpected given the fairly wide deviation experienced for a single tester/cable/probe combination. In all cases, the flaw on the sample was detectable. As both the LLMC and MULC, as well as the BPRMS (see Reference 6 for qualification information), are used for alternate repair criteria measurements and are subject to a manufacturing acceptance criteria (see Reference 7), it was expected that the criteria set forth in STD-QP-1996-7702 were met. The deviations are noted and deemed to be acceptable. Also, the impedance sweeps of the two probes with and without cabling show similar characteristics, thus defining a range of acceptability for the probe/cable combination.

7.3 Cabling

The impedance sweeps along with the demonstrations show that the Zetec 'low loss' cable does not have characteristics which are significantly different than those of the Westinghouse RPC extension cabling. Both cables are considered to be 'low loss' and can be used in an equivalent manner for rotating probe applications. The Zetec 'low loss' cable has exhibited a different characteristic than RG-174 when used with a bobbin probe. This is evidenced in a lesser degree of shift in the resonance point when compared to RG-174. However, the testing performed has demonstrated that both types of cable provide equivalent scaled response when used (Sections 6.2 and 6.3; Appendices B, C and D). Once again, the impedance sweeps recorded can be used to bracket a range of acceptable probe/cable response and either cable can be used with the system.

7.4 Rotating Coils

The tabulations in Section 6.4 and Appendices E through I show the applicability of the rotating coils by frequency and whether the flaw is ID or OD originated. In general terms, for OD indications it is best to use mid-range coils at frequencies ≤ 400 kHz. For ID indications, all coils meet the 80% POD at 90% confidence. However, the axially sensitive coil did not meet that criteria at 100 kHz in all cases. Table 7-2 provides some general guidance for the applicability of the coils on any of the testers using up to the maximum cable length specified in Tables 6-3 through 6-8. There may be individual cases where a particular coil/cable/tester/frequency combination performed better in testing, but the table represents what met the POD criteria in all cases. The testing with the low loss cable was limited due to not having a 0.610" diameter motor unit available. However, the system equivalency will allow the extension of the Westinghouse extension cable results to the Zetec low loss cable on the basis of demonstrated

equivalency (see Section 6.1 and Appendix A). Since the samples tested included dents, expansions and straight lengths, the applicability of the qualification testing extends to all regions of the tube.

Table 7-2. Applicability of rotating coils.

Coil Type	OD Indications	ID Indications
80 mil MR	100 kHz - 400 kHz	100 kHz - 600 kHz
115 mil MR	100 kHz - 400 kHz	100 kHz - 600 kHz
80 mil HF	300 kHz - 400 kHz (Not recommended for detection, but may be used to help confirm an indication)	100 kHz - 600 kHz
Axial Coil	200 kHz - 400 kHz	200 kHz - 600 kHz
Circ. Coil	100 kHz - 400 kHz	100 kHz - 600 kHz
Plus Point	100 kHz - 400 kHz	100 kHz - 600 kHz

When applying any of these techniques, the analyst must always consider the best usage of a coil for a given indication. The information provided by this testing should be useful in determining how the information from one coil should relate to that from another.

8.0 WESTINGHOUSE POSITIONS AND RECOMMENDATIONS

8.1 System Setup and Equivalency

The configuration of the TC6700 and MIZ-30A testers should be set-up such that the minimum total system gain is directly comparable to that of a MIZ-18A (see Table 7-1). Settings which exceed that of a MIZ-18A are acceptable as long as a consistent means of scaling the response of the system is being invoked (e.g. setting a defect response to a given amplitude). The only restriction should be that the system parameters should be set such that the largest expected response (typically a dent) does not saturate the system.

Additional back end gain on the instrument does not increase signal to noise ratio, it amplifies both signal and noise. The only exception to this would be if additional filtering were done in the instrument. While this is possible on some instruments, it is not generally recommended because of the possibility of losing infonnation in the signal which may be related to a degraded tube condition. In general, additional filtering of the data should be performed at the analysis workstation so both raw and filtered responses may be compared directly. If additional filtering is to be used at the tester, it must be demonstrated that the filtering does not adversely affect the ability to detect signals related to degradation.

Probes of the same coil type which exhibit similar impedance behavior and scaled responses are equivalent. This was demonstrated for the Westinghouse long life conduit. Though the conduit's cable design differs from that of RG-174, the design of the probe as a unit exhibits responses which are equivalent to that of a bobbin on RG-174. This principle also applies to the addition of extension cabling.

Cable characteristics go beyond capacitive reactance. A cable with a lower characteristic capacitance should, in principle, reduce cable related noise. However, the impedance of the cable also affects the response of the probe/cable system (as evidenced in the impedance sweeps). The matching of the cable impedance to those of the tester and probe are important to the performance of the system as well. The performance or the higher capacitance Westinghouse RPC extension cable as compared to the Zetec 'low loss' cable showed marginal differences in the response of the probe and extension as a unit. While the 'low loss' cable may be a dramatic improvement over the previous Zetec RPC extension (low loss would be a comparative term), it does not offer substantial benefit over the use of Westinghouse's cabling. Either cable type may be applied to RPC testing.

8.2 Applicability of Techniques

Though the qualification data cited in this Calc Note was not run through slip rings, there is very little or no expected influence of the slip rings on the performance of the probe. This has been the general observation in the field where slip rings are both used and by-passed. This is due to the fact that there is very little cable length in a slip ring and, therefore, there is very little or no effect on the impedance characteristics of the system. Based on Westinghouse's experience, the slip rings are not considered to be an essential variable of the system.

None of the qualifications were performed on Inconel 690 tubing. It is Westinghouse's opinion that the qualification of a technique for a given damage mechanism on Inconel 600 is also applicable to Inconel 690. This is due to the fact that the nominal material characteristics which affect the eddy current response of the material (conductivity and permeability) are very similar between the two alloys. This similarity is such that the same frequencies are typically applied for equivalent wall thickness of each alloy.

In general all techniques should be applicable if the code requirement of 30 data points per inch of probe travel is met. This is an essential variable. This has been tested by Westinghouse for bobbin probe speeds up to 48 inches per second and RPC rotational speeds up to 1200 RPM (see Reference 8). However, probe speed should not be adjusted upward without verification testing. The reason for this has to do with the response of the eddy current system (probe, cable and tester) as a whole, not just with the possible digitization rate. It is possible for an indication which is detected at a slower probe speed to be distorted or go undetected at a high probe speed. Thus, the system response must be verified for equivalence to established parameters prior to using probe speeds greater

than those already qualified. This may be done in the lab, but it is best to verify the response on known signals in the steam generator.

8.3 Ranges of Application

Techniques may be applied over the entire range of qualified frequencies. For probes which have operating points which are affected by the body size (typically bobbin probes) and are designed for an impedance behavior which is scaled to the wall thickness of the tube (i.e. increase or decrease in resonant frequency), the applicable frequencies may also be scaled outside of those documented in the technique sheets. For example, if the bobbin probe was only tested on 0.050" wall tubing and had a resonant frequency of about 400 kHz in Inconel, a bobbin probe could be used in 0.043" wall Inconel if it had appropriate characteristics at 550 kHz. The test frequency, in this case, scales with the wall thickness and the probe characteristics with the probe diameter.

Normally, such scaling of frequencies occurs most often in the application of bobbin probes. It may be used with rotating coils, but detectability outside of the qualified frequency range should be verified. This is because the coil's dimensions and, therefore, its operating characteristics do not change. It is possible that the response of the coil at a higher frequency may be inadequate even though the wall thickness of the tubing may indicate the use of a higher frequency.

9.0 DOCUMENTATION OF QA NOTIFICATION, DEVIATIONS AND COMMENTS, AND CERTIFICATION OF QUALIFICATION

APPENDICES

Appendix A - Impedance Sweeps

Figure A-1 Impedance Sweep for 720 LLMC Probe

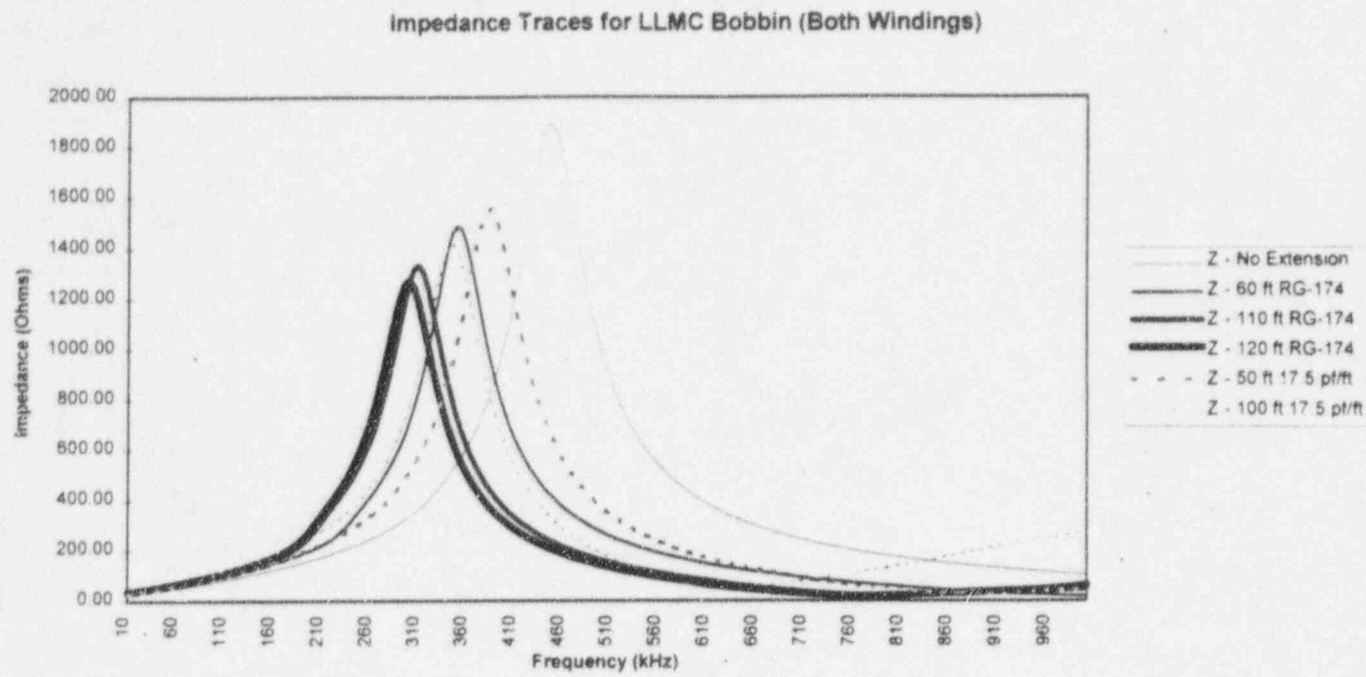


Figure A-2 Impedance Sweep for 720 MULC Probe

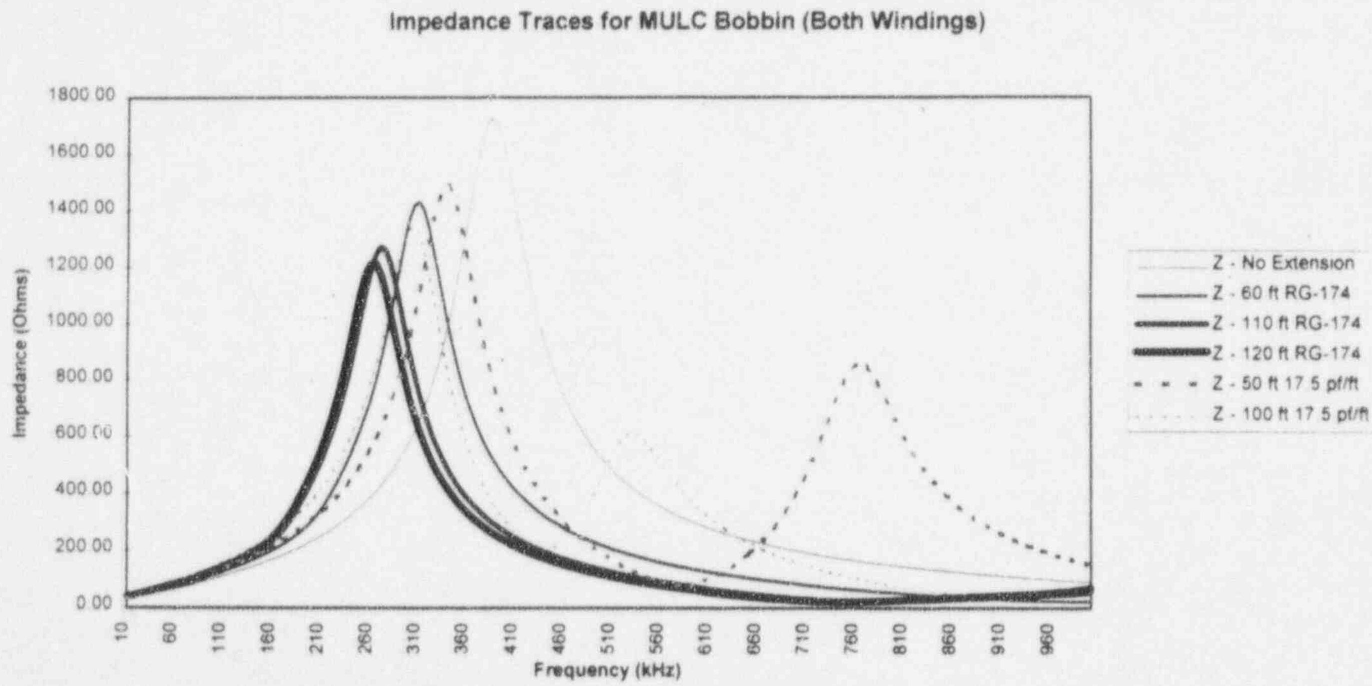


Figure A-3 Impedance Sweep for 80 mil MR Pancake Coil

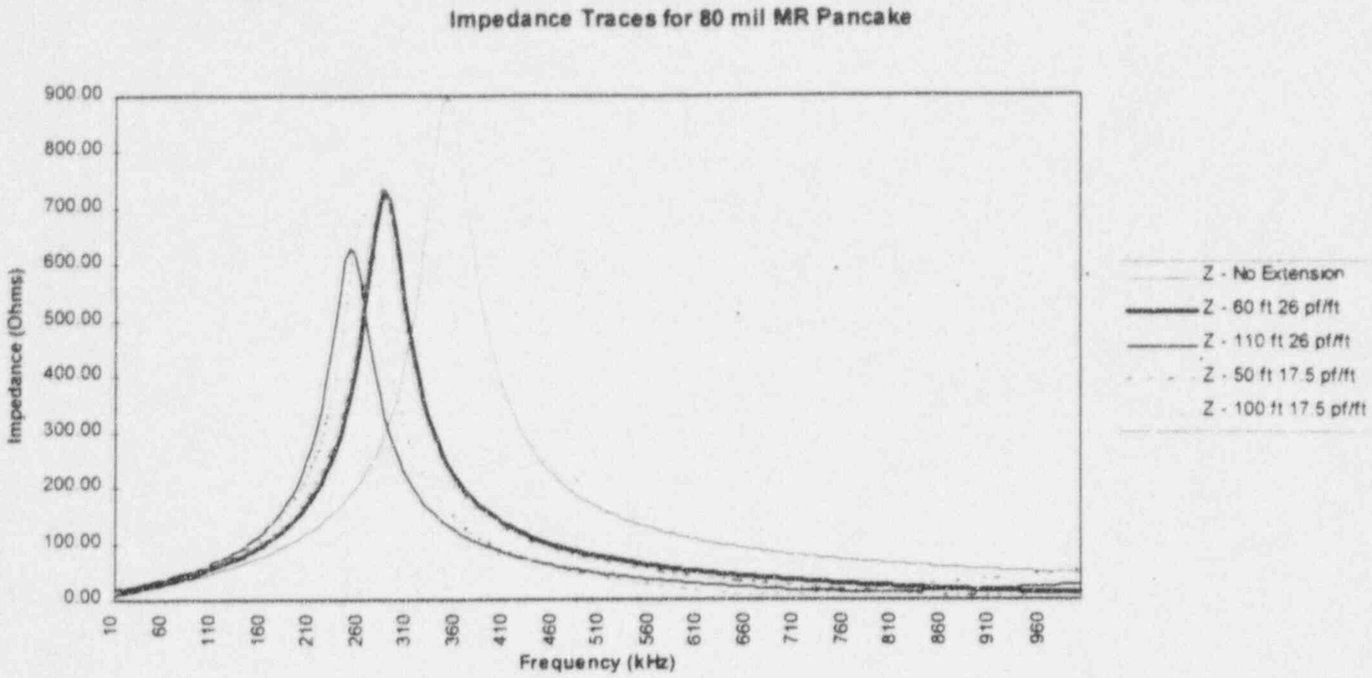


Figure A-4 Impedance Sweep for 115 mil MR Pancake Coil

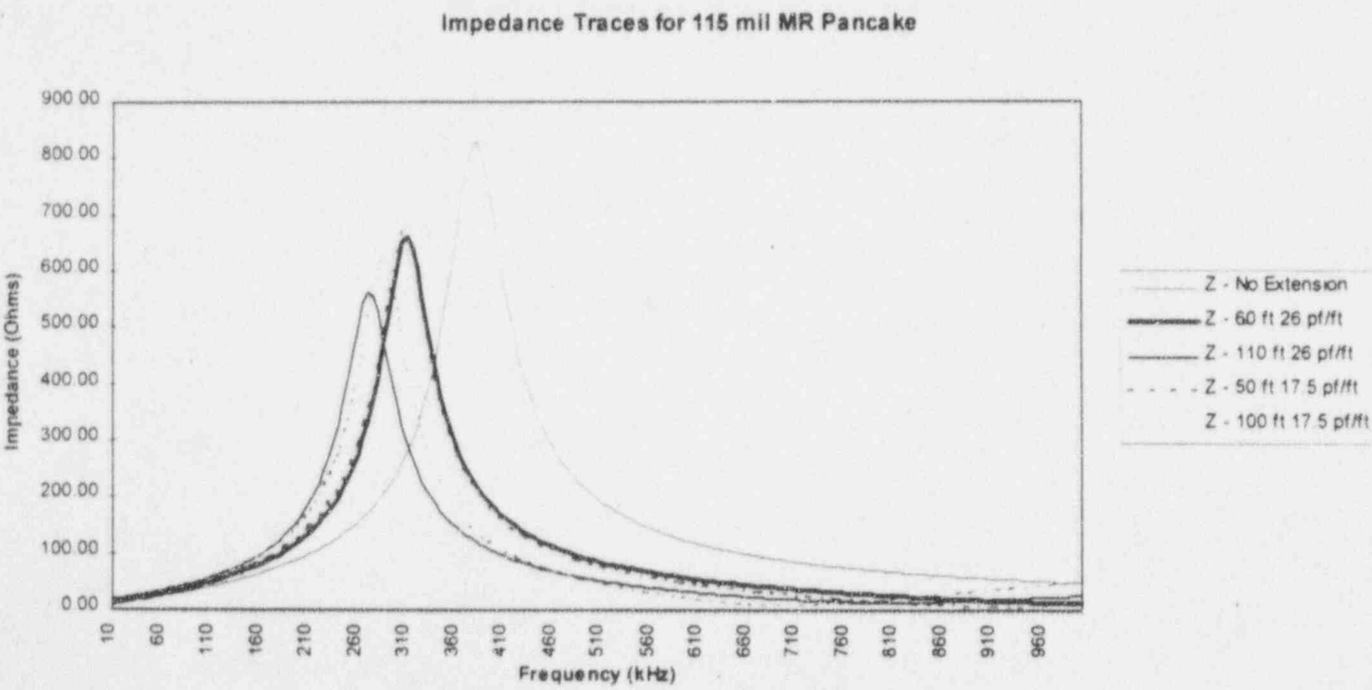


Figure A-5 Impedance Sweep for 80 mil HF Pancake Coil

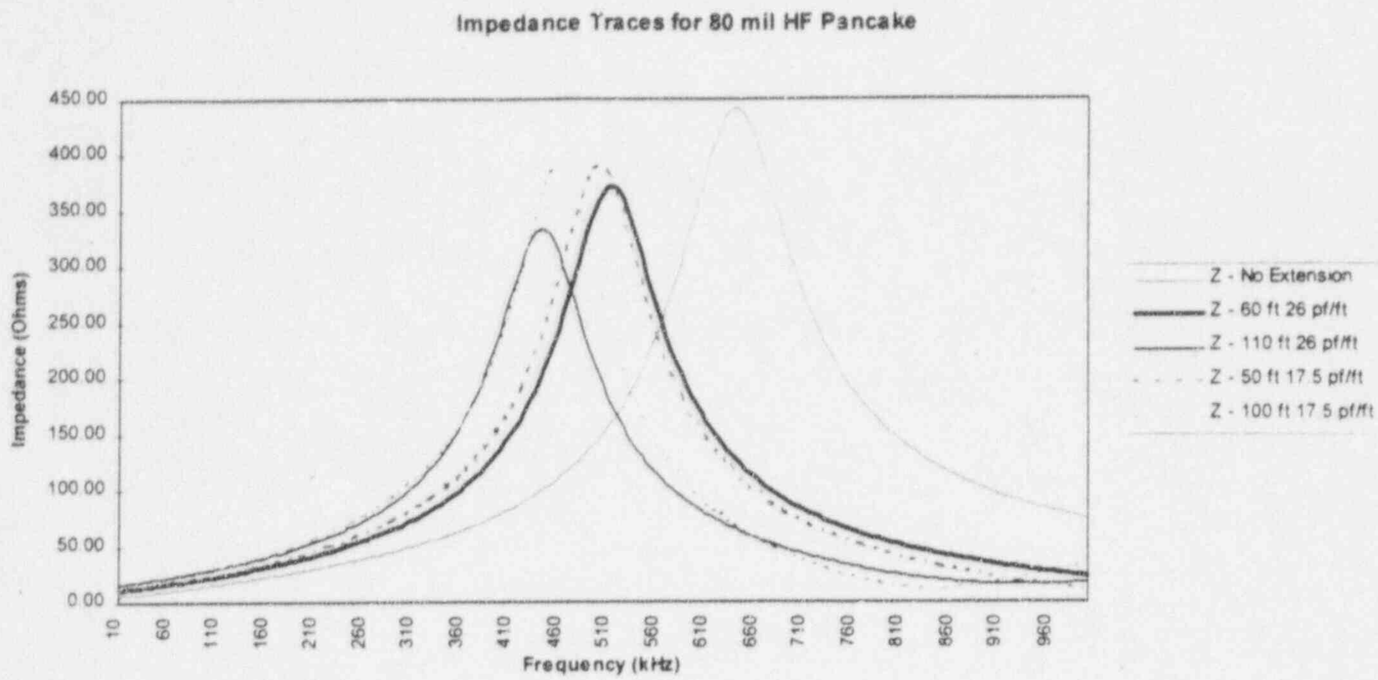


Figure A-6 Impedance Sweep for Axially Sensitive Coil

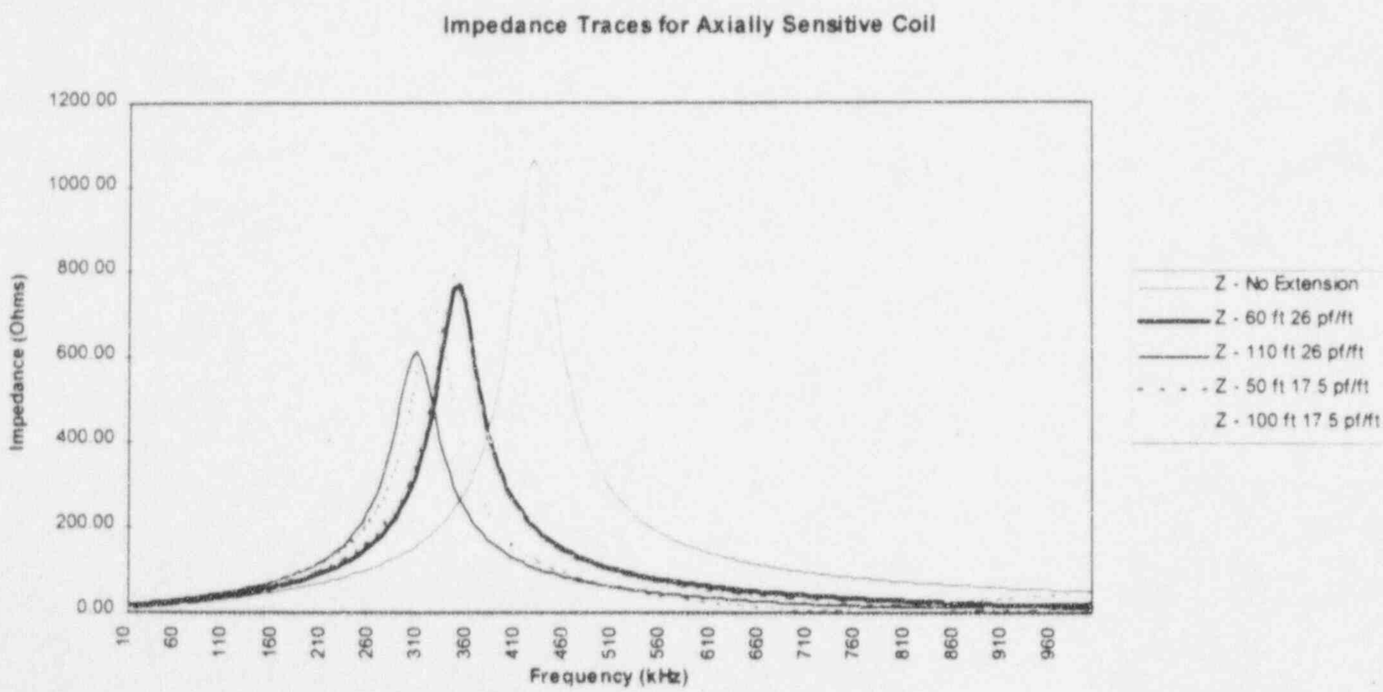


Figure A-7 Impedance Sweep for Circumferentially Sensitive Coil

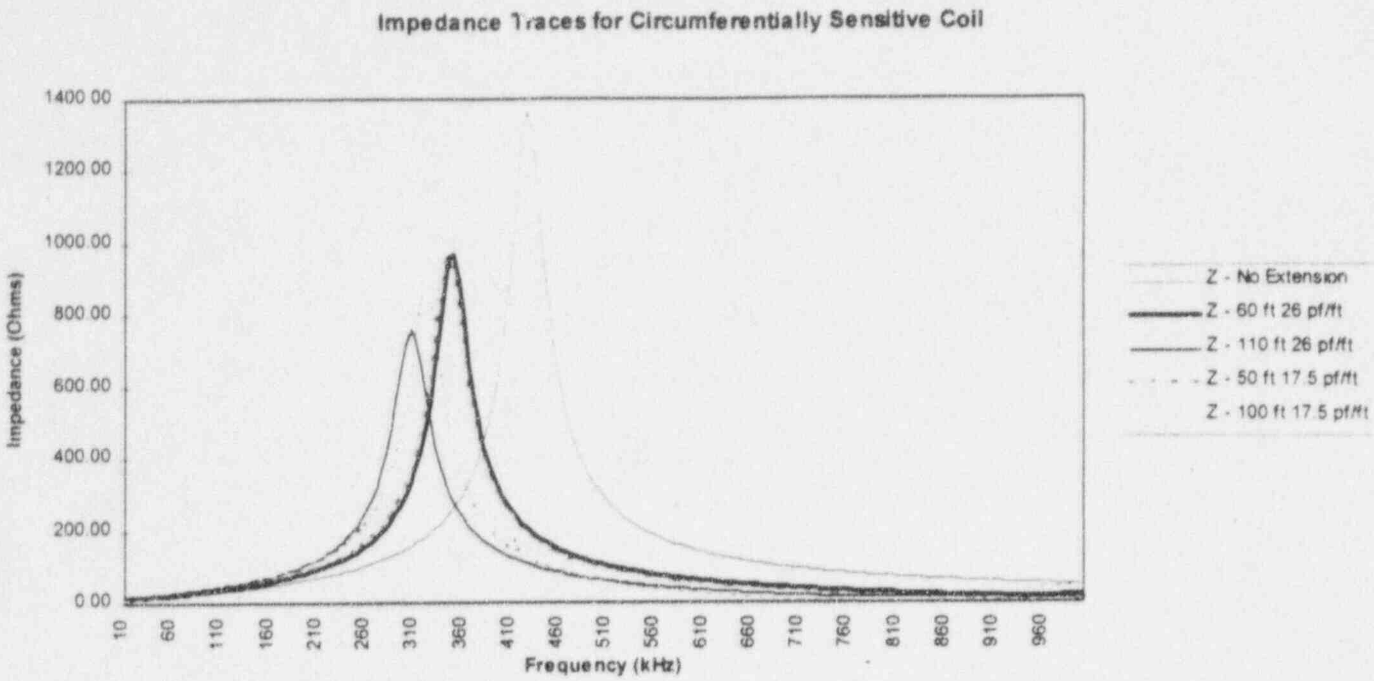
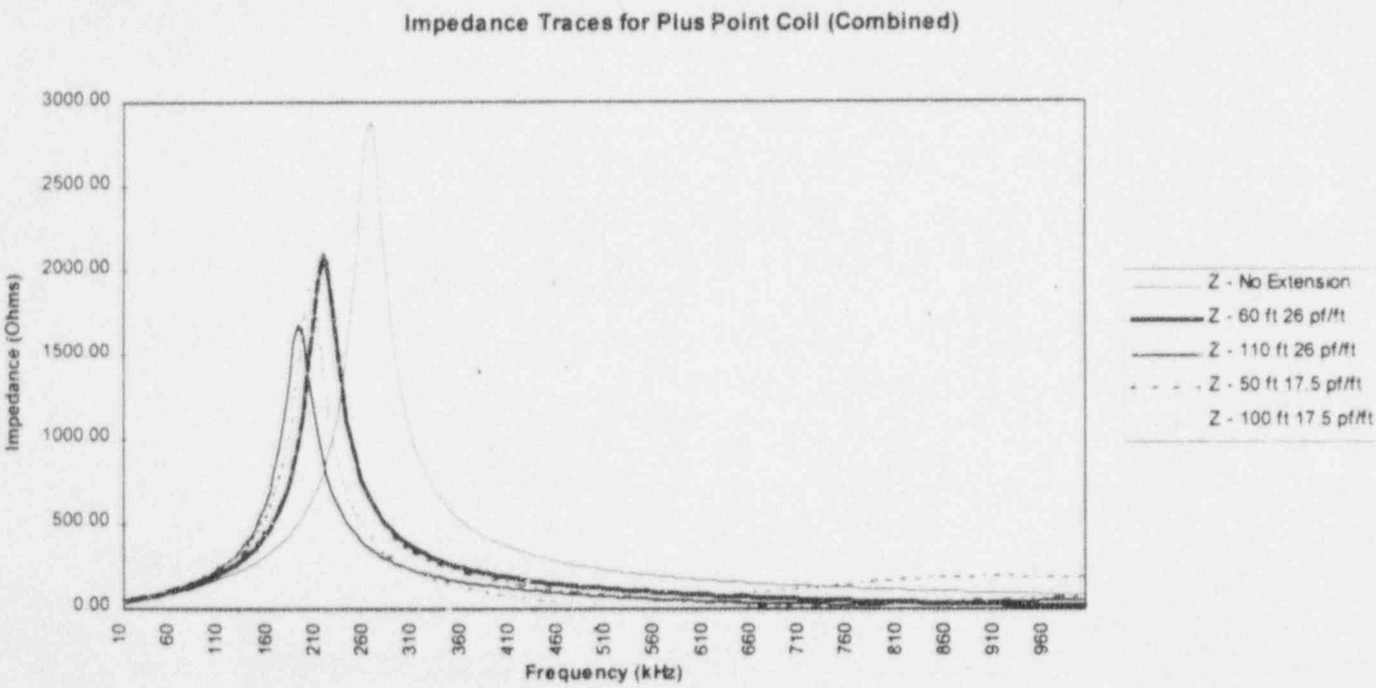


Figure A-8 Impedance Sweep for Plus Point Coil



Typical Examination Technique Specification Sheet		
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TUBING		
Material: Tube: Inconel 600	OD: Tube: .875", .750"	Wall: Tube: .050", .043"
EXAMINATION SCOPE		
Test Application: PWSCC and ODSCC in expansions, and dented and non-dented intersections		
ACQUISITION TECHNIQUE		
Bobbin Probe ______ Rotating Probe __X__ Other ______		

DATA ACQUISTION	
Instrument	**Probe**
Manufacturer: Zetec	Manufacturer: Zetec
Model: MIZ-18A, or equivalent	Diameter: .720", .620"
Acquisition System Software	Model: 115/+Pt/80S MRPC (80 mil nid-range coil)
Manufacturer: Westinghouse	Probe Cable Length: 610 MRPC/52MU, 50'
Description/Title: ANSER™	**Analog Probe Extension**
Version/Revision: 8.0, or equivalent	Manufacturer: Westinghouse Length: 0', 60', 110' (26 pf/ft nom.)
Frequencies/Coil Excitation Modes (see attached)	
Data Recording Equipment	
Manufacturer: Hewlett Packard	Model: HP650A (or equivalent)

Signature [signature] Date 1/26/96

Typical Examination Technique Specification Sheet

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DIGITIZATION RATE, SCAN DIRECTION AND SCAN PATTERN	
Cecco/Bobbin Probe	Rotating Probe
Digitizing Rate Min (DR)*: N/A	Digitizing Rate Min (DR)†: 30/inch
Sample Rate Min (SR): N/A	Sample Rate Min (SR): 400/second
Probe Speed Max (PS): N/A	Withdrawal Speed Max (WS): 0.2 inch/second
Scan Direction: Axial	Rotation Speed Max (RPM): 300 RPM
* Note: Digitizing rate applies only in the axial direction SR= DR X PS	† Note: Digitizing rate applies in both the circumferential and axial directions: for the circumferential direction. DR= 19.09 X SR / RPM / tube diameter
DATA ANALYSIS	
Instrument	**Analysis System Software**
Manufacturer: Hewlett Packard	Manufacturer: Westinghouse
Model: HP433, or equivalent	Description/Title: ANSER™
	Version/Revision: 8.0, or equivalent
ANALYSIS SETTINGS	
Span Setting: Adjust span such that 40% EDM is approximately 1/2 screen height.	
Phase Rotation: 100% EDM at ~20°; probe motion horizontal	
Calibration Std: EDM Notch	
Calibration Curve: N/A	
Voltage Setting: Voltage set for the 100% EDM on the standard to 20 V_{pp} on 300 kHz; store to all channels.	
Mixing Frequencies: N/A	
Filtering: N/A	

Signature [signature] Date 4/26/96

Typical Examination Technique Specification Sheet

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DONE

TESTER: MIZ18A | NO ROBOT | D4 PUSHER | INIT D4

TRAN ON | RPC YES | 5 TICKS | 300 RPM | CAL 03:45 | MIN FREE=5 MB

RUN REVERSE | SM-10 BOX | TENSIONER OFF | ACQUIRE OFF | TESTER NO

NUMBER: 1

SAMPLE RATE: 400

NAME: PPQUAL1

FREQUENCY SEQUENCE	COIL 1	COIL 2	COIL 3	COIL 4	COIL 5	COIL 6	COIL 7	COIL 8
FREQUENCY	115			TRG	+PT		80H	
600 Khz								
500 Khz								
400 Khz								
300 Khz				TRG				

Signature [signature]

Date 4/26/96

Typical Examination Technique Specification Sheet

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[illegible] CONFIGURATION MENU

DONE

TESTER: MIZ18A | NO ROBOT | D4 PUSHER | INIT D4

TRAN ON | RPC YES | 5 TICKS | 300 RPM | CAL 03:45 | MIN FREE=5 MB

RUN REVERSE | SM-10 BOX | TENSIONER OFF | ACQUIRE OFF | TESTER NO

NUMBER: 1

NAME: PPQUAL2

SAMPLE RATE: 400

FREQUENCY SEQUENCE	COIL 1	COIL 2	COIL 3	COIL 4	COIL 5	COIL 6	COIL 7	COIL 8
FREQUENCY	115			TRG	+PT		80H	
300 Khz								
200 Khz				TRG				
100 Khz								
10 Khz								

Signature [illegible] Date 4/26/96

Typical Examination Technique Specification Sheet

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Analysis Guidelines:

Set-up per DAT-GYD-001, Rev. 6 and DAT-GYD-005, Rev. 1
Measure signal amplitudes as Vpp for all signals.

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TECHNIQUE PERFORMANCE

Description	POD at ≥ 30% TW (90% CL)	Sizing RMSE, % TW
600 kHz	See Attached Worksheets	N/A
500 kHz	See Attached Worksheets	N/A
400 kHz	See Attached Worksheets	N/A
300 kHz	See Attached Worksheets	N/A
200 kHz	See Attached Worksheets	N/A
100 kHz	See Attached Worksheets	N/A

Signature [signature] Date 4/26/96

Sample ID	% TW	Wall	Orientation	Length	Geometry	800kHz	500Khz	400Khz	300Khz	200Khz	100Khz		
5251-G01	49	ID	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1	Note 1 = detection	
	50	ID	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1	0 = no detection	
	39	ID	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	58	ID	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G03	41	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	83	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	55	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
5251-G06	49	OD	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	88	OD	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	40	OD	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	81	OD	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G07	44	OD	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	69	OD	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	OD	Circumferential	25"	40 mil Ovalized Dent	0	0	1	1	1	1		
	80	OD	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	61	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	56	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
CP-001-82	41	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	39	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
ARXM-60	19	OD	Circumferential	25"	Expansion	0	0	0	0	0	0		
	17	OD	Axial	25"	Expansion	0	1	1	1	1	1		
	42	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	38	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	62	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	58	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	81	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	74	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	38	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	33	ID	Axial	25"	Expansion	1	1	1	1	1	1		
	46	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	44	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	46	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	52	ID	Axial	25"	Expansion	1	1	1	1	1	1		
	50	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	55	OD	Axial	25"	Expansion	1	1	1	1	1	1		
AE-A-002-93	100	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	81	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	82	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	20	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
AE-A-003-93	75	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	38	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		

	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1
	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1
AE A-004-93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1
AE A-005-93	100	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	80	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	80	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	38	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	21	OD	Axial	0.68"	Straight Tubing	0	0	1	1	1	1
AE A-006-93	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	40	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	20	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
AE-A-007-93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1
X-001-93	83	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1
	60	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1
	21	OD	Circumferential	0.25"	Straight Tubing	0	1	1	1	1	1
	40	OD	Oblique	0.25"	Straight Tubing	0	1	1	1	1	1
	19	OD	Oblique	0.25"	Straight Tubing	0	0	1	1	1	0
	83	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1
	60	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1
	21	OD	Axial	0.25"	Straight Tubing	0	1	1	1	1	1
	37	ID	Axial	0.25"	Straight Tubing	1	1	1	1	1	1
	37	ID	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1
X-002-95	60	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	57	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	40	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	40	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	79	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	100	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	19	OD	Axial	0.50"	Straight Tubing	0	1	1	1	1	1
	19	OD	Circumferential	0.50"	Straight Tubing	0	0	0	0	0	0
	100	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	81	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	80	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	40	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	40	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	71	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
Total of	61	OD	Indications	Detected=		48	50	59	59	59	58
Total of	40	ID	Indications	Detected=		40	40	40	40	40	40
Total of	24	OD	Indications>=60%	Detected=		24	24	24	24	24	24
Total of	7	ID	Indications>=60%	Detected=		7	7	7	7	7	7
Total of	27	OD	Indications>=50%	Detected=		27	27	27	27	27	27
Total of	14	ID	Indications>=50%	Detected=		14	14	14	14	14	14
Total of	44	OD	Indications>=40%	Detected=		42	43	44	44	44	44
Total of	25	ID	Indications>=40%	Detected=		25	25	25	25	25	25
Total of	47	OD	Indications>=30%	Detected=		46	46	47	47	47	47
Total of	34	ID	Indications>=30%	Detected=		34	34	34	34	34	34
Total of	56	OD	Indications>=20%	Detected=		45	48	56	56	56	56
Total of	38	ID	Indications>=20%	Detected=		38	38	38	38	38	38
Total of	61	OD	Indications	POD=	@ 90% Confidence	0.88	0.74	0.91	0.91	0.91	0.99
Total of	40	ID	Indications	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94
Total of	24	OD	Indications>=60%	POD=	@ 90% Confidence	0.90	0.90	0.90	0.90	0.90	0.90
Total of	7	ID	Indications>=60%	POD=	@ 90% Confidence	N/A	N/A	N/A	N/A	N/A	N/A
Total of	27	OD	Indications>=50%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91
Total of	14	ID	Indications>=50%	POD=	@ 90% Confidence	0.84	0.84	0.84	0.84	0.84	0.84
Total of	44	OD	Indications>=40%	POD=	@ 90% Confidence	0.89	0.91	0.94	0.94	0.94	0.94
Total of	25	ID	Indications>=40%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91
Total of	47	OD	Indications>=30%	POD=	@ 90% Confidence	0.89	0.91	0.95	0.95	0.95	0.95
Total of	34	ID	Indications>=30%	POD=	@ 90% Confidence	0.83	0.83	0.93	0.93	0.92	0.93
Total of	56	OD	Indications>=20%	POD=	@ 90% Confidence	0.71	0.77	0.95	0.95	0.95	0.95
Total of	35	ID	Indications>=20%	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94

Sample ID	% TW	Wall	Orientation	Length	Geometry	800kHz	500Khz	400Khz	300Khz	200Khz	100Khz		
5251-G01	49	ID	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	Note 1 = detection	
	69	ID	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	0 = no detection	
	39	ID	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	58	ID	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G03	41	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	63	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	55	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
5251-G05	49	OD	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	68	OD	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	40	OD	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	61	OD	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G07	44	OD	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	66	OD	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	OD	Circumferential	.25"	40 mil Ovalized Dent	0	0	1	1	1	1		
	80	OD	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	81	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	56	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
CP-001-92	41	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	39	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
ARXM 60	19	OD	Circumferential	.25"	Expansion	0	0	0	0	0	0		
	17	OD	Axial	.25"	Expansion	0	1	1	1	1	1		
	42	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	38	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	62	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	56	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	81	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	74	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	38	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	33	ID	Axial	.25"	Expansion	1	1	1	1	1	1		
	46	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	44	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	48	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	52	ID	Axial	.25"	Expansion	1	1	1	1	1	1		
	50	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	55	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
AE-A-002-93	100	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	61	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	62	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	20	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
AE-A-003-93	75	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	38	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		

	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
AE A 004 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
AE A 005 93	100	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	60	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	38	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	0.68"	Straight Tubing	0	0	1	1	1	1		
AE A 006 93	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
AE A 007 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
X-001-93	63	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Circumferential	0.25"	Straight Tubing	0	0	1	1	1	1		
	40	OD	Oblique	0.25"	Straight Tubing	1	1	1	1	1	1		
	19	OD	Oblique	0.25"	Straight Tubing	0	0	1	1	1	1		
	63	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	0.25"	Straight Tubing	0	0	1	1	1	1		
	37	ID	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
X-002 95	80	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	79	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	100	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	19	OD	Axial	0.50"	Straight Tubing	0	0	1	1	1	1		
	19	OD	Circumferential	0.50"	Straight Tubing	0	0	0	0	0	0		
	100	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	81	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	71	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
Total of	61	OD	Indications	Detected=		46	47	59	59	59	59		
Total of	40	ID	Indications	Detected=		40	40	40	40	40	40		
Total of	24	OD	Indications>=60%	Detected=		24	24	24	24	24	24		
Total of	7	ID	Indications>=60%	Detected=		7	7	7	7	7	7		
Total of	27	OD	Indications>=50%	Detected=		27	27	27	27	27	27		
Total of	14	ID	Indications>=50%	Detected=		14	14	14	14	14	14		
Total of	44	OD	Indications>=40%	Detected=		43	43	44	44	44	44		
Total of	25	ID	Indications>=40%	Detected=		25	25	25	25	25	25		
Total of	47	OD	Indications>=30%	Detected=		46	46	47	47	47	47		
Total of	34	ID	Indications>=30%	Detected=		34	34	34	34	34	34		
Total of	56	OD	Indications>=20%	Detected=		46	46	56	56	56	56		
Total of	38	ID	Indications>=20%	Detected=		38	38	38	38	38	38		
Total of	61	OD	Indications	POD=	@ 90% Confidence	0.66	0.66	0.91	0.91	0.91	0.91		
Total of	40	ID	Indications	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94		
Total of	24	OD	Indications>=60%	POD=	@ 90% Confidence	0.90	0.90	0.90	0.90	0.90	0.90		
Total of	7	ID	Indications>=60%	POD=	@ 90% Confidence	N/A	N/A	N/A	N/A	N/A	N/A		
Total of	27	OD	Indications>=50%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91		
Total of	14	ID	Indications>=50%	POD=	@ 90% Confidence	0.84	0.84	0.84	0.84	0.84	0.84		
Total of	44	OD	Indications>=40%	POD=	@ 90% Confidence	0.91	0.91	0.94	0.94	0.94	0.94		
Total of	25	ID	Indications>=40%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91		
Total of	47	OD	Indications>=30%	POD=	@ 90% Confidence	0.91	0.91	0.95	0.95	0.95	0.95		
Total of	34	ID	Indications>=30%	POD=	@ 90% Confidence	0.93	0.93	0.93	0.93	0.93	0.93		
Total of	56	OD	Indications>=20%	POD=	@ 90% Confidence	0.73	0.73	0.95	0.95	0.95	0.95		
Total of	38	ID	Indications>=20%	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94		

Sample ID	% TW	Wall	Orientation	Length	Geometry	800kHz	500Khz	400Khz	300Khz	200Khz	100Khz		
5251-G01	49	ID	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	Note 1 = detection	
	69	ID	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	0 = no detection	
	39	ID	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	58	ID	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G03	41	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	63	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	55	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
5251-G05	49	OD	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	68	OD	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	40	OD	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	61	OD	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G07	44	OD	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	69	OD	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	OD	Circumferential	.25"	40 mil Ovalized Dent	0	0	1	1	1	1		
	80	OD	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	61	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	56	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
CP-001 92	41	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	39	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
ARXM 60	19	OD	Circumferential	.25"	Expansion	0	0	0	0	0	0		
	17	OD	Axial	.25"	Expansion	0	1	1	1	1	1		
	42	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	38	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	82	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	56	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	81	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	74	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	38	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	33	ID	Axial	.25"	Expansion	1	1	1	1	1	1		
	46	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	44	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	48	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	52	ID	Axial	.25"	Expansion	1	1	1	1	1	1		
	50	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	55	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
AE-A-002 93	100	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	81	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	82	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1.25"	Straight Tubing	0	1	1	1	1	1		
	40	OD	Axial	1.25"	Straight Tubing	0	1	1	1	1	1		
	40	OD	Axial	1.25"	Straight Tubing	0	1	1	1	1	1		
	41	OD	Axial	1.25"	Straight Tubing	0	1	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
	20	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1		
AE-A-003 93	75	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	38	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		

	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1
	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1
AE A 004 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1
AE A 005 93	100	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	80	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	60	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	39	OD	Axial	0.68"	Straight Tubing	0	1	1	1	1	1
	21	OD	Axial	0.68"	Straight Tubing	0	0	1	1	1	1
AE A 006 93	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	61	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	40	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
	20	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1
AE A 007 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1
X-001-93	63	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1
	40	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1
	21	OD	Circumferential	0.25"	Straight Tubing	0	0	1	1	1	1
	40	OD	Oblique	0.25"	Straight Tubing	0	0	1	1	1	1
	19	OD	Oblique	0.25"	Straight Tubing	0	0	0	1	1	1
	63	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1
	40	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1
	21	OD	Axial	0.25"	Straight Tubing	0	0	1	1	1	1
	37	ID	Axial	0.25"	Straight Tubing	1	1	1	1	1	1
	37	ID	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1
X-002 95	80	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	57	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	40	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	40	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	79	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	100	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1
	19	OD	Axial	0.50"	Straight Tubing	0	0	1	1	1	1
	19	OD	Circumferential	0.50"	Straight Tubing	0	0	0	0	0	0
	100	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	81	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	60	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	40	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	40	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
	71	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1
Total of	61	OD	Indications	Detected=		45	45	58	59	59	59
Total of	40	ID	Indications	Detected=		40	40	40	40	40	40
Total of	24	OD	Indications>=60%	Detected=		24	24	24	24	24	24
Total of	7	ID	Indications>=60%	Detected=		7	7	7	7	7	7
Total of	27	OD	Indications>=50%	Detected=		27	27	27	27	27	27
Total of	14	ID	Indications>=50%	Detected=		14	14	14	14	14	14
Total of	44	OD	Indications>=40%	Detected=		42	42	4[illegible]	44	44	44
Total of	25	ID	Indications>=40%	Detected=		25	25	25	25	25	25
Total of	47	OD	Indications>=30%	Detected=		46	44	47	47	47	47
Total of	34	ID	Indications>=30%	Detected=		34	34	34	34	34	34
Total of	58	OD	Indications>=20%	Detected=		45	44	56	56	56	56
Total of	38	ID	Indications>=20%	Detected=		38	38	38	38	38	38
Total of	61	OD	Indications	POD=	@ 90% Confidence	0.84	0.84	0.91	0.91	0.91	0.91
Total of	40	ID	Indications	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94
Total of	24	OD	Indications>=60%	POD=	@ 90% Confidence	0.90	0.90	0.90	0.90	0.90	0.90
Total of	7	ID	Indications>=60%	POD=	@ 90% Confidence	N/A	N/A	N/A	N/A	N/A	N/A
Total of	27	OD	Indications>=50%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91
Total of	14	ID	Indications>=50%	POD=	@ 90% Confidence	0.84	0.84	0.84	0.84	0.84	0.84
Total of	44	OD	Indications>=40%	POD=	@ 90% Confidence	0.88	0.88	0.94	0.94	0.94	0.94
Total of	25	ID	Indications>=40%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91
Total of	47	OD	Indications>=30%	POD=	@ 90% Confidence	0.86	0.86	0.95	0.95	0.95	0.95
Total of	34	ID	Indications>=30%	POD=	@ 90% Confidence	0.83	0.83	0.93	0.93	0.93	0.93
Total of	58	OD	Indications>=20%	POD=	@ 90% Confidence	0.71	0.66	0.95	0.95	0.95	0.95
Total of	38	ID	Indications>=20%	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94

Typical Examination Technique Specification Sheet		
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TUBING		
Material: Tube: Inconel 600	OD: Tube: .875", .750"	Wall: Tube: .050", .043"
EXAMINATION SCOPE		
Test Application: PWSCC and ODSCC in expansions, and dented and non-dented intersections		
ACQUISITION TECHNIQUE		
Bobbin Probe ______	Rotating Probe ___X___	Other ______

DATA ACQUISTION	
Instrument	**Probe**
Manufacturer: Tecrad	Manufacturer: Zetec
Model: TC6700	Diameter: .720", .620"
Acquisition System Software	Model: 115/+Pt/80S MRPC (80 mil nid-range coil)
Manufacturer: Westinghouse	Probe Cable Length: 610 MRPC/52MU, 50'
Description/Title: ANSER™	**Analog Probe Extension**
Version/Revision: 8.0, or equivalent	Manufacturer: Westinghouse; Zetec Length: 0', 110' (26 pf/ft nom.); 50', 100' (17.5 pf/ft nom.)
Frequencies/Coil Excitation Modes (see attached)	
Data Recording Equipment	
Manufacturer: Hewlett Packard	Model: HP650A (or equivalent)

Signature [signature] Date 4/26/96

Typical Examination Technique Specification Sheet

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DIGITIZATION RATE, SCAN DIRECTION AND SCAN PATTERN	
Cecco/Bobbin Probe	Rotating Probe
Digitizing Rate Min (DR)*: N/A	Digitizing Rate Min (DR)†: 30/inch
Sample Rate Min (SR): N/A	Sample Rate Min (SR): 400/second
Probe Speed Max (PS): N/A	Withdrawal Speed Max (WS): 0.2 inch/second
Scan Direction: Axial	Rotation Speed Max (RPM): 300 RPM
* Note: Digitizing rate applies only in the axial direction SR= DR X PS	† Note: Digitizing rate applies in both the circumferential and axial directions: for the circumferential direction. DR= 19.09 X SR / RPM / tube diameter
DATA ANALYSIS	
Instrument	**Analysis System Software**
Manufacturer: Hewlett Packard	Manufacturer: Westinghouse
Model: HP433, or equivalent	Description/Title: ANSER™
	Version/Revision: 8.0, or equivalent
ANALYSIS SETTINGS	
Span Setting: Adjust span such that 40% EDM is approximately 1/2 screen height.	
Phase Rotation: 100% EDM at ~20°; probe motion horizontal	
Calibration Std: EDM Notch	
Calibration Curve: N/A	
Voltage Setting: Voltage set for the 100% EDM on the standard to 20 V_{pp} on 300 kHz; store to all channels.	
Mixing Frequencies: N/A	
Filtering: N/A	

Signature [signature] Date 4/26/96

Typical Examination Technique Specification Sheet

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Configuration File: /115-+PT-080HF-QUAL

Version: 0.016 created Sun Mar 10 07:39:40 1996

Acquisition Rate:	400 Hz	Frequencies	
Current Source:	0 Volts	F1	600.00 kHz
Acquisition Type:	INTERNAL	F2	500.00 kHz
Interpolation:	ON	F3	400.00 kHz
Demodulation Type:	REAL_IMAG	F4	300.00 kHz
Frequency Accuracy:	2.00 %	F5	200.00 kHz
Num Frequencies:	6	F6	100.00 kHz
Num Contexts:	6		

	C1	C2	C3	C4	C5	C6
GEN 1 is NORMAL	F1 3.0V	F2 3.0V	F3 3.0V	F4 3.0V	F5 3.0V	F6 3.0V
GEN 2 is NORMAL						
GEN 3 is OFF						
GEN 4 is OFF						

Demod Signal 1

TRN	CH	ISw	DSw	Gn	F1	F2	F3	F4	F5	F6
1	1	1	1	35	600.00	500.00	400.00	300.00	200.00	100.00
1	2	1	2	38						
1	3	1	1	38						
1	4	4	1	35				300.00		
2	1	1	1	35	600.00	500.00	400.00	300.00	200.00	100.00
2	2	1	1	38						
2	3	3	1	35	600.00	500.00	400.00	300.00	200.00	100.00
2	4	1	6	38						
3	1	1	1	38						
3	2	2	1	38						
3	3	3	1	38						
3	4	4	1	38						
4	1	1	1	38						
4	2	1	2	38						
4	3	1	3	38						
4	4	1	6	38						

Signature [signature] Date 4/26/96

Typical Examination Technique Specification Sheet

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RPC TRIGGER CHAN = 19

CHAN	Freq	Type	TRN	ch	DSw	ISw	Ctx	Gn	Filt	Parm
1	600.00	115	1	1	1	1	1	35	NONE	0
2	500.00	115	1	1	1	1	2	35	NONE	0
3	400.00	115	1	1	1	1	3	35	NONE	0
4	300.00	115	1	1	1	1	4	35	NONE	0
5	200.00	115	1	1	1	1	5	35	NONE	0
6	100.00	115	1	1	1	1	6	35	NONE	0
7	600.00	+PT	2	1	1	1	1	35	NONE	0
8	500.00	+PT	2	1	1	1	2	35	NONE	0
9	400.00	+PT	2	1	1	1	3	35	NONE	0
10	300.00	+PT	2	1	1	1	4	35	NONE	0
11	200.00	+PT	2	1	1	1	5	35	NONE	0
12	100.00	+PT	2	1	1	1	6	35	NONE	0
13	600.00	80H	2	3	1	3	1	35	NONE	0
14	500.00	80H	2	3	1	3	2	35	NONE	0
15	400.00	80H	2	3	1	3	3	35	NONE	0
16	300.00	80H	2	3	1	3	4	35	NONE	0
17	200.00	80H	2	3	1	3	5	35	NONE	0
18	100.00	80H	2	3	1	3	6	35	NONE	0
19	300.00	TRG	1	4	1	4	4	35	NONE	0

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Typical Examination Technique Specification Sheet

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Configuration File: /LOW-LOSS+PT-1

Version: 0.030 created Mon Apr 1 19:35:09 1996

Acquisition Rate:	400 Hz	Frequencies		
Current Source:	0 Volts		F1	600.00 kHz
Acquisition Type:	INTERNAL		F2	500.00 kHz
Interpolation:	ON		F3	400.00 kHz
Demodulation Type:	REAL_IMAG		F4	300.00 kHz
Frequency Accuracy:	2.00 %			
Num Frequencies:	4			
Num Contexts:	2			

	C1		C2	
GEN 1 is NORMAL	F1	3.0V	F2	3.0V
	F3	3.0V	F4	3.0V
GEN 2 is NORMAL	F2	3.0V	F1	3.0V
	F4	3.0V	F3	3.0V
GEN 3 is OFF				
GEN 4 is OFF				

	C1	C2
Demod Signal 1	F1	F2
Demod Signal 2	F3	F4
Demod Signal 3	F2	F1
Demod Signal 5	F4	F3

TRN	CH	ISw	DSw	Gn		
1	1	2	3	35	500.00	600.00
1	2	2	5	35	300.00	400.00
1	3	1	1	35	600.00	500.00
1	4	1	2	35	400.00	300.00
2	1	2	1	35		
2	2	2	2	47		300.00
2	3	1	1	35	600.00	500.00
2	4	1	2	35	400.00	300.00
3	1	1	1	38		
3	2	2	1	38		
3	3	3	1	38		
3	4	4	1	38		
4	1	1	1	38		
4	2	1	2	38		
4	3	1	3	38		
4	4	1	6	38		

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Typical Examination Technique Specification Sheet

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RPC TRIGGER CHAN = 13

CHAN	Freq	Type	TRN	ch	DSw	ISw	Ctx	Gn	Filt	Parm
1	600.00	115	1	3	1	1	1	35	NONE	0
2	500.00	115	1	3	1	1	2	35	NONE	0
3	400.00	115	1	4	2	1	1	35	NONE	0
4	300.00	115	1	4	2	1	2	35	NONE	0
5	600.00	+PT	1	1	3	2	2	35	NONE	0
6	500.00	+PT	1	1	3	2	1	35	NONE	0
7	400.00	+PT	1	2	5	2	2	35	NONE	0
8	300.00	+PT	1	2	5	2	1	35	NONE	0
9	600.00	80H	2	3	1	1	1	35	NONE	0
10	500.00	80H	2	3	1	1	2	35	NONE	0
11	400.00	80H	2	4	2	1	1	35	NONE	0
12	300.00	80H	2	4	2	1	2	35	NONE	0
13	300.00	TRG	2	2	2	2	2	38	NONE	0

Signature [signature] Date 4/21/96

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Configuration File:   /LOW-LOSS+PT-2

Version:   0.031 created Mon Apr  1 19:44:24 1996

Acquisition Rate:        400 Hz                    Frequencies
Current Source:            0 Volts                      F1  400.00 kHz
Acquisition Type:        INTERNAL                       F2  300.00 kHz
Interpolation:            ON                            F3  200.00 kHz
Demodulation Type:       REAL_IMAG                      F4  100.00 kHz
Frequency Accuracy:     2.00 %
Num Frequencies:           4
Num Contexts:              2

                          C1         C2

GEN 1 is NORMAL       F1  3.0V  F2  3.0V
                      F3  3.0V  F4  3.0V
GEN 2 is NORMAL       F2  3.0V  F1  3.0V
                      F4  3.0V  F3  3.0V
GEN 3 is OFF
GEN 4 is OFF

Demod Signal 1          F1         F2
Demod Signal 2          F3         F4
Demod Signal 3          F2         F1
Demod Signal 5          F4         F3
```

TRN	CH	ISw	DSw	Gn		
1	1	2	3	35	300.00	400.00
1	2	2	5	35	100.00	200.00
1	3	1	1	35	400.00	300.00
1	4	1	2	35	200.00	100.00
2	1	2	1	35		
2	2	2	2	38	200.00	
2	3	1	1	35	400.00	300.00
2	4	1	2	35	200.00	100.00
3	1	1	1	38		
3	2	2	1	38		
3	3	3	1	38		
3	4	4	1	38		
4	1	1	1	38		
4	2	1	2	38		
4	3	1	3	38		
4	4	1	6	38		

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Typical Examination Technique Specification Sheet

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RPC TRIGGER CHAN = 13

CHAN	Freq	Type	TRN	ch	DSw	ISw	Ctx	Gn	Filt	Parm
1	400.00	115	1	3	1	1	1	35	NONE	0
2	300.00	115	1	3	1	1	2	35	NONE	0
3	200.00	115	1	4	2	1	1	35	NONE	0
4	100.00	115	1	4	2	1	2	35	NONE	0
5	400.00	+PT	1	1	3	2	2	35	NONE	0
6	300.00	+PT	1	1	3	2	1	35	NONE	0
7	200.00	+PT	1	2	5	2	2	35	NONE	0
8	100.00	+PT	1	2	5	2	1	35	NONE	0
9	400.00	80H	2	3	1	1	1	35	NONE	0
10	300.00	80H	2	3	1	1	2	35	NONE	0
11	200.00	80H	2	4	2	1	1	35	NONE	0
12	100.00	80H	2	4	2	1	2	35	NONE	0
13	200.00	TRG	2	2	2	2	1	38	NONE	0

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Typical Examination Technique Specification Sheet

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Analysis Guidelines:

Set-up per DAT-GYD-001, Rev. 6 and DAT-GYD-005, Rev. 1
Measure signal amplitudes as Vpp for all signals.

TECHNIQUE PERFORMANCE

Description	POD at ≥ 30% TW (90% CL)	Sizing RMSE, % TW
600 kHz	See Attached Worksheets	N/A
500 kHz	See Attached Worksheets	N/A
400 kHz	See Attached Worksheets	N/A
300 kHz	See Attached Worksheets	N/A
200 kHz	See Attached Worksheets	N/A
100 kHz	See Attached Worksheets	N/A

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Sample ID	% TW	Wall	Orientation	Length	Geometry	600kHz	500Khz	400Khz	300Khz	200Khz	100Khz		
5251-G01	49	ID	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1	Note 1 = detection	
	69	ID	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1	0 = no detection	
	39	ID	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	58	ID	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G03	41	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	63	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	55	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
5251-G05	49	OD	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	66	OD	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	40	OD	Circumferential	25"	40 mil Symmetric Dent	0	1	1	1	1	1		
	61	OD	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G07	44	OD	Axial	25"	40 mil Ovalized Dent	0	1	1	1	1	1		
	60	OD	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	OD	Circumferential	25"	40 mil Ovalized Dent	0	1	1	1	1	1		
	60	OD	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	81	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	56	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
CP-001-82	41	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	39	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
ARXM-60	19	OD	Circumferential	25"	Expansion	0	0	0	0	0	0		
	17	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	42	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	38	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	62	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	56	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	81	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	74	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	38	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	33	ID	Axial	25"	Expansion	1	1	1	1	1	1		
	48	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	44	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	48	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	52	ID	Axial	25"	Expansion	1	1	1	1	1	1		
	50	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	55	OD	Axial	25"	Expansion	1	1	1	1	1	1		
AE-A-002-93	100	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	81	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	82	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	20	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
AE-A-003-93	75	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	38	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		

	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
AE A 004 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
AE A 005 93	100	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	60	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	38	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	0.68"	Straight Tubing	0	1	1	1	1	1		
AE A 006 93	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	61	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
AE A 007 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
X-001-93	63	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Circumferential	0.25"	Straight Tubing	0	1	1	1	1	1		
	60	OD	Oblique	0.25"	Straight Tubing	0	1	1	1	1	1		
	19	OD	Oblique	0.25"	Straight Tubing	0	0	1	1	1	1		
	83	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	0.25"	Straight Tubing	0	1	1	1	1	1		
	37	ID	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
X-002 95	80	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	79	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	100	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	19	OD	Axial	0.50"	Straight Tubing	0	1	1	1	1	1		
	19	OD	Circumferential	0.50"	Straight Tubing	0	0	0	0	0	0		
	100	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	81	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	60	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	71	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
Total of	61	OD	Indications	Detected=		44	52	59	59	59	59		
Total of	40	ID	Indications	Detected=		40	40	40	40	40	40		
Total of	24	OD	Indications>=60%	Detected=		24	24	24	24	24	24		
Total of	7	ID	Indications>=60%	Detected=		7	7	7	7	7	7		
Total of	27	OD	Indications>=50%	Detected=		27	27	27	27	27	27		
Total of	14	ID	Indications>=50%	Detected=		14	14	14	14	14	14		
Total of	44	OD	Indications>=40%	Detected=		40	44	44	44	44	44		
Total of	25	ID	Indications>=40%	Detected=		25	25	25	25	25	25		
Total of	47	OD	Indications>=30%	Detected=		43	47	47	47	47	47		
Total of	34	ID	Indications>=30%	Detected=		34	34	34	34	34	34		
Total of	58	OD	Indications>=20%	Detected=		43	50	58	58	58	58		
Total of	38	ID	Indications>=20%	Detected=		38	38	38	38	38	38		
Total of	61	OD	Indications	POD=	@ 90% Confidence	0.63	0.77	0.91	0.91	0.91	0.91		
Total of	40	ID	Indications	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94		
Total of	24	OD	Indications>=60%	POD=	@ 90% Confidence	0.90	0.90	0.90	0.90	0.90	0.90		
Total of	7	ID	Indications>=60%	POD=	@ 90% Confidence	N/A	N/A	N/A	N/A	N/A	N/A		
Total of	27	OD	Indications>=50%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91		
Total of	14	ID	Indications>=50%	POD=	@ 90% Confidence	0.84	0.84	0.84	0.84	0.84	0.84		
Total of	44	OD	Indications>=40%	POD=	@ 90% Confidence	0.82	0.94	0.94	0.94	0.94	0.94		
Total of	25	ID	Indications>=40%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91		
Total of	47	OD	Indications>=30%	POD=	@ 90% Confidence	0.83	0.95	0.95	0.95	0.95	0.95		
Total of	34	ID	Indications>=30%	POD=	@ 90% Confidence	0.93	0.93	0.93	0.93	0.93	0.93		
Total of	58	OD	Indications>=20%	POD=	@ 90% Confidence	[illegible]	0.81	0.95	0.95	0.95	0.95		
Total of	38	ID	Indications>=20%	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94		

+Pt 110

Sample ID	% TW	Wall	Orientation	Length	Geometry	600kHz	500Khz	400Khz	300Khz	205Khz	100Khz		
5251-G01	49	ID	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	Note: 1 = detection	
	69	ID	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	0 = no detection	
	39	ID	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	58	ID	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G03	41	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	63	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	55	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
5251-G06	49	OD	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	66	OD	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	40	OD	Circumferential	.25"	40 mil Symmetric Dent	0	1	1	1	1	1		
	61	OD	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G07	44	OD	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	69	OD	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	OD	Circumferential	.25"	40 mil Ovalized Dent	0	1	1	1	1	1		
	60	OD	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	61	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	56	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1		
CP-001-82	41	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	39	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
ARXM-80	19	OD	Circumferential	.25"	Expansion	0	0	0	0	0	0		
	17	OD	Axial	.25"	Expansion	0	0	0	1	1	1		
	42	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	38	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	62	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	56	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	81	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	74	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	38	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	33	ID	Axial	.25"	Expansion	1	1	1	1	1	1		
	46	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	44	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	48	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1		
	52	ID	Axial	.25"	Expansion	1	1	1	1	1	1		
	50	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
	55	OD	Axial	.25"	Expansion	1	1	1	1	1	1		
AE-A-002-93	100	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	61	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	62	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	0	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	0	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	0	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	0	1	1	1		
	21	OD	Axial	1.25"	Straight Tubing	0	0	0	1	1	1		
	20	OD	Axial	1.25"	Straight Tubing	0	0	0	1	1	1		
AE-A-003-93	75	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	38	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		

	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
AE A-004 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
AE A-005 93	100	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	60	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	38	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	0.68"	Straight Tubing	0	0	1	1	1	1		
AE A-006-93	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	61	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
AE-A-007-93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
X-001-93	63	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Circumferential	0.25"	Straight Tubing	0	0	1	1	1	1		
	40	OD	Oblique	0.25"	Straight Tubing	0	0	1	1	1	1		
	19	OD	Oblique	0.25"	Straight Tubing	0	0	0	1	1	1		
	63	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	0.25"	Straight Tubing	0	0	1	1	1	1		
	37	ID	Axial	0.25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Circumferential	0.25"	Straight Tubing	1	1	1	1	1	1		
X-002-95	80	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	79	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	100	OD	Axial	0.50"	Straight Tubing	1	1	1	1	1	1		
	19	OD	Axial	0.50"	Straight Tubing	0	1	1	1	1	1		
	19	OD	Circumferential	0.50"	Straight Tubing	0	0	0	0	0	0		
	100	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	81	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	60	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
	71	ID	Circumferential	0.50"	Straight Tubing	1	1	1	1	1	1		
Total of	61	OD	Indications	Detected=		44	47	51	58	58	58		
Total of	40	ID	Indications	Detected=		40	40	40	40	40	40		
Total of	24	OD	Indications>=60%	Detected=		24	24	24	24	24	24		
Total of	7	ID	Indications>=60%	Detected=		7	7	7	7	7	7		
Total of	27	OD	Indications>=50%	Detected=		27	27	27	27	27	27		
Total of	14	ID	Indications>=50%	Detected=		14	14	14	14	14	14		
Total of	44	OD	Indications>=40%	Detected=		41	43	44	44	44	44		
Total of	25	ID	Indications>=40%	Detected=		25	25	25	25	25	25		
Total of	47	OD	Indications>=30%	Detected=		44	46	47	47	47	47		
Total of	34	ID	Indications>=30%	Detected=		34	34	34	34	34	34		
Total of	58	OD	Indications>=20%	Detected=		44	46	50	56	56	56		
Total of	38	ID	Indications>=20%	Detected=		38	38	38	38	38	38		
Total of	61	OD	Indications	POD=	@ 90% Confidence	0.83	0.88	0.75	0.91	0.91	0.91		
Total of	40	ID	Indications	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94		
Total of	24	OD	Indications>=60%	POD=	@ 90% Confidence	0.90	0.90	0.90	0.90	0.90	0.90		
Total of	7	ID	Indications>=60%	POD=	@ 90% Confidence	N/A	N/A	N/A	N/A	N/A	N/A		
Total of	27	OD	Indications>=50%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91		
Total of	14	ID	Indications>=50%	POD=	@ 90% Confidence	0.84	0.84	0.84	0.84	0.84	0.84		
Total of	44	OD	Indications>=40%	POD=	@ 90% Confidence	0.85	0.91	0.94	0.94	0.94	0.94		
Total of	25	ID	Indications>=40%	POD=	@ 90% Confidence	0.91	0.91	0.91	0.91	0.91	0.91		
Total of	47	OD	Indications>=30%	POD=	@ 90% Confidence	0.88	0.91	0.95	0.95	0.95	0.95		
Total of	34	ID	Indications>=30%	POD=	@ 90% Confidence	0.93	0.93	0.93	0.93	0.93	0.93		
Total of	58	OD	Indications>=20%	POD=	@ 90% Confidence	0.84	0.88	0.81	0.95	0.95	0.95		
Total of	38	ID	Indications>=20%	POD=	@ 90% Confidence	0.94	0.94	0.94	0.94	0.94	0.94		

Sample ID	% TW	Wall	Orientation	Length	Geometry	600Khz	500Khz	400Khz	300Khz	200Khz	100Khz	
5251-G01	49	ID	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	Note: 1 = detection
	69	ID	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	0 = no detection
	39	ID	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	
	58	ID	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	
5251-G03	41	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	63	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	42	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	55	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
5251-G06	49	OD	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	
	66	OD	Axial	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	
	40	OD	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	
	81	OD	Circumferential	.25"	40 mil Symmetric Dent	1	1	1	1	1	1	
5251-G07	44	OD	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	69	OD	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	40	OD	Circumferential	.25"	40 mil Ovalized Dent	0	0	1	1	1	1	
	80	OD	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	42	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	81	ID	Axial	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	40	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
	56	ID	Circumferential	.25"	40 mil Ovalized Dent	1	1	1	1	1	1	
CP-001-92	41	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	39	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	41	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	41	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1	
ARXM 60	19	OD	Circumferential	.25"	Expansion	0	0	0	1	1	1	
	17	OD	Axial	.25"	Expansion	0	0	0	1	1	1	
	42	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	38	OD	Axial	.25"	Expansion	1	1	1	1	1	1	
	62	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	56	OD	Axial	.25"	Expansion	1	1	1	1	1	1	
	81	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	74	OD	Axial	.25"	Expansion	1	1	1	1	1	1	
	38	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	33	ID	Axial	.25"	Expansion	1	1	1	1	1	1	
	48	OD	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	44	OD	Axial	.25"	Expansion	1	1	1	1	1	1	
	48	ID	Circumferential	.25"	Expansion	1	1	1	1	1	1	
	52	ID	Axial	.25"	Expansion	1	1	1	1	1	1	
	50	OD	Axial	.25"	Expansion	1	1	1	1	1	1	
	55	OD	Axial	.25"	Expansion	1	1	1	1	1	1	
AE-A-002-93	100	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	80	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	61	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	62	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	41	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	40	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	40	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	41	OD	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1	
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1	
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1	
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1	
	21	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1	
	20	OD	Axial	1.25"	Straight Tubing	0	0	1	1	1	1	
AE-A-003-93	75	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	57	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	57	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	38	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	37	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	
	20	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1	

	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
AE A 004 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
AE A 005 93	100	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	60	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	38	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	0.68"	Straight Tubing	0	0	1	1	1	1		
AE A 006 93	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	61	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
AE A 007 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
X-001-93	63	OD	Circumferential	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Circumferential	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	21	OD	Circumferential	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Oblique	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	19	OD	Oblique	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	63	OD	Axial	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Axial	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	21	OD	Axial	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	37	ID	Axial	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	37	ID	Circumferential	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
X-002-95	80	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	57	ID	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	ID	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	79	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	100	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	19	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	19	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	100	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	81	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	60	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	ID	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	71	ID	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
Total of	43	OD	Indications	Detected=		33	33	41	43	43	43		
Total of	34	ID	Indications	Detected=		34	34	34	34	34	34		
Total of	16	OD	Indications>=60%	Detected=		16	16	16	16	16	16		
Total of	6	ID	Indications>=60%	Detected=		6	6	6	6	6	6		
Total of	19	OD	Indications>=50%	Detected=		19	19	19	19	19	19		
Total of	12	ID	Indications>=50%	Detected=		12	12	12	12	12	12		
Total of	31	OD	Indications>=40%	Detected=		30	30	31	31	31	31		
Total of	21	ID	Indications>=40%	Detected=		21	21	21	21	21	21		
Total of	34	OD	Indications>=30%	Detected=		33	33	34	34	34	34		
Total of	28	ID	Indications>=30%	Detected=		28	28	28	28	28	28		
Total of	41	OD	Indications>=20%	Detected=		33	[illegible]	41	41	41	41		
Total of	32	ID	Indications>=20%	Detected=		32	32	32	32	32	32		
Total of	43	OD	Indications	POD=	@ 90% Confidence	0.88	0.88	0.88	0.94	0.94	0.94		
Total of	34	ID	Indications	POD=	@ 90% Confidence	0.93	0.93	0.93	0.93	0.93	0.93		
Total of	16	OD	Indications>=60%	POD=	@ 90% Confidence	0.86	0.86	0.86	0.86	0.86	0.86		
Total of	6	ID	Indications>=60%	POD=	@ 90% Confidence	N/A	N/A	N/A	N/A	N/A	N/A		
Total of	19	OD	Indications>=50%	POD=	@ 90% Confidence	0.88	0.88	0.88	0.88	0.88	0.88		
Total of	12	ID	Indications>=50%	POD=	@ 90% Confidence	0.84	0.84	0.84	0.84	0.84	0.84		
Total of	31	OD	Indications>=40%	POD=	@ 90% Confidence	0.88	0.88	0.92	0.92	0.92	0.92		
Total of	21	ID	Indications>=40%	POD=	@ 90% Confidence	0.89	0.89	0.89	0.89	0.89	0.89		
Total of	34	OD	Indications>=30%	POD=	@ 90% Confidence	0.89	0.89	0.93	0.93	0.93	0.93		
Total of	28	ID	Indications>=30%	POD=	@ 90% Confidence	0.92	0.92	0.92	0.92	0.92	0.92		
Total of	41	OD	Indications>=20%	POD=	@ 90% Confidence	0.70	0.70	0.94	0.94	0.94	0.94		
Total of	32	ID	Indications>=20%	POD=	@ 90% Confidence	0.93	0.93	0.93	0.93	0.93	0.93		

Sample ID	% TW	Wall	Orientation	Length	Geometry	600kHz	500Khz	400Khz	300Khz	200Khz	100Khz		
5251-G01	49	ID	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1	Note 1 = detection	
	69	ID	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1	0 = no detection	
	39	ID	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	58	ID	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G03	41	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	63	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	55	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
5251-G05	49	OD	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	68	OD	Axial	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
	40	OD	Circumferential	25"	40 mil Symmetric Dent	0	1	1	1	1	1		
	61	OD	Circumferential	25"	40 mil Symmetric Dent	1	1	1	1	1	1		
5251-G07	44	OD	Axial	25"	40 mil Ovalized Dent	0	1	1	1	1	1		
	69	OD	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	OD	Circumferential	25"	40 mil Ovalized Dent	0	1	1	1	1	1		
	80	OD	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	42	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	61	ID	Axial	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	40	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
	56	ID	Circumferential	25"	40 mil Ovalized Dent	1	1	1	1	1	1		
CP-001-92	41	OD	Circumferential	25"	Expansion	0	1	1	1	1	1		
	39	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	41	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
ARXM 60	19	OD	Circumferential	25"	Expansion	0	0	0	0	1	1		
	17	OD	Axial	25"	Expansion	0	0	1	1	1	1		
	42	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	38	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	82	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	56	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	81	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	74	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	38	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	33	ID	Axial	25"	Expansion	1	1	1	1	1	1		
	48	OD	Circumferential	25"	Expansion	1	1	1	1	1	1		
	44	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	48	ID	Circumferential	25"	Expansion	1	1	1	1	1	1		
	52	ID	Axial	25"	Expansion	1	1	1	1	1	1		
	50	OD	Axial	25"	Expansion	1	1	1	1	1	1		
	55	OD	Axial	25"	Expansion	1	1	1	1	1	1		
AE-A-002-93	100	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	61	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	62	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	40	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	41	OD	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	21	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
	20	OD	Axial	1 25"	Straight Tubing	0	0	1	1	1	1		
AE-A-003-93	75	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	57	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	38	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	37	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	1 25"	Straight Tubing	1	1	1	1	1	1		

	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
	19	ID	Axial	1.25"	Straight Tubing	1	1	1	1	1	1		
AE A 004 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
AE A 005 93	100	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	80	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	60	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	38	OD	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	21	OD	Axial	0.68"	Straight Tubing	0	1	1	1	1	1		
AE A 006 93	81	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	61	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	40	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
	20	ID	Axial	0.68"	Straight Tubing	1	1	1	1	1	1		
AE A 007 93	100	OD	Axial	Various	Straight Tubing	1	1	1	1	1	1		
X-001-93	63	OD	Circumferential	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Circumferential	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	21	OD	Circumferential	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Oblique	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	19	OD	Oblique	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	63	OD	Axial	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Axial	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	21	OD	Axial	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	37	ID	Axial	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	37	ID	Circumferential	0.25"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
X 002 95	60	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	57	ID	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	ID	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	79	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	100	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	19	OD	Axial	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	19	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	100	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	81	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	60	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	OD	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	40	ID	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
	71	ID	Circumferential	0.50"	Straight Tubing	N/A	N/A	N/A	N/A	N/A	N/A		
Total of	43	OD	Indications	Detected=		30	35	42	42	43	43		
Total of	34	ID	Indications	Detected=		34	34	34	34	34	34		
Total of	18	OD	Indications>=60%	Detected=		18	18	18	18	18	18		
Total of	6	ID	Indications>=60%	Detected=		6	6	6	6	6	6		
Total of	19	OD	Indications>=50%	Detected=		16	19	19	19	19	19		
Total of	12	ID	Indications>=50%	Detected=		12	12	12	12	12	12		
Total of	31	OD	Indications>=40%	Detected=		27	31	31	31	31	31		
Total of	21	ID	Indications>=40%	Detected=		21	21	21	21	21	21		
Total of	34	OD	Indications>=30%	Detected=		30	34	34	34	34	34		
Total of	28	ID	Indications>=30%	Detected=		28	28	28	28	28	28		
Total of	41	OD	Indications>=20%	Detected=		30	35	41	41	41	41		
Total of	32	ID	Indications>=20%	Detected=		32	32	32	32	32	32		
Total of	43	OD	Indications	POD=	@ 90% Confidence	0.56	0.71	0.91	0.91	0.94	0.94		
Total of	34	ID	Indications	POD=	@ 90% Confidence	0.93	0.93	0.93	0.93	0.93	0.93		
Total of	18	OD	Indications>=60%	POD=	@ 90% Confidence	0.86	0.86	0.86	0.86	0.86	0.86		
Total of	6	ID	Indications>=60%	POD=	@ 90% Confidence	N/A	N/A	N/A	N/A	N/A	N/A		
Total of	19	OD	Indications>=50%	POD=	@ 90% Confidence	0.88	0.88	0.88	0.88	0.88	0.88		
Total of	12	ID	Indications>=50%	POD=	@ 90% Confidence	0.84	0.84	0.84	0.84	0.84	0.84		
Total of	31	OD	Indications>=40%	POD=	@ 90% Confidence	0.78	0.92	0.92	0.92	0.92	0.92		
Total of	21	ID	Indications>=40%	POD=	@ 90% Confidence	0.89	0.89	0.89	0.89	0.89	0.89		
Total of	34	OD	Indications>=30%	POD=	@ 90% Confidence	0.77	0.93	0.93	0.93	0.93	0.93		
Total of	28	ID	Indications>=30%	POD=	@ 90% Confidence	0.82	0.82	0.92	0.92	0.92	0.92		
Total of	41	OD	Indications>=20%	POD=	@ 90% Confidence	0.82	0.78	0.94	0.94	0.94	0.94		
Total of	32	ID	Indications>=20%	POD=	@ 90% Confidence	0.93	0.93	0.93	0.93	0.93	0.93		