FPL Energy Duane Arnold, LLC
3277 DAEC Road
Palo, Iowa 52324

FPLEnergy.

Duane Arnold Energy Center

February 14, 2007

NG-07-0143
10 CFR 50.55a(b)(2)(xxiv)

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

Duane Arnold Energy Center
Docket No: 50-331
Op. License No: DPR-49

Subject: Request for Relief from the ASME Section XI Code to Allow Use of the Provisions of Appendix VIII, Article VIII-4000, in the Evaluation of Changes in Maximum Cable Length for In-Service Inspection Examination Equipment at the Duane Arnold Energy Center

References: 1) Letter, L. Raghavan (USNRC) to G. Van Middlesworth (FPL Energy), "Duane Arnold Energy Center – Third 10-Year Interval Inservice Inspection Program Plan Request for Relief to Extend the Third 10 Year Inservice Inspection Interval for the Examination of Welds VLA001 VLA002 (TAC# MC7979)," dated April 4, 2006 (ML060400405)

2) Letter, G. Van Middlesworth (NMC) to L. Raghavan (USNRC), "Request to Extend the Third 10-year Inservice Inspection (ISI) Interval for Reactor Vessel Welds VLA-001 and VLA-002," NG-05-0388, dated July 14, 2005 (ML052070659)

In Reference 1, the NRC granted FPL Energy Duane Arnold relief from the ASME Code, Section XI, pursuant to 10 CFR 50.55a(a)(3)(ii), to extend the inspection of two Duane Arnold Energy Center (DAEC) Reactor Pressure Vessel (RPV) welds (VLA-001 and VLA-002) due to be performed in the 3rd 10-year In-Service Inspection (ISI) interval to the next refuel outage (RFO20). RFO20 began on February 4, 2007. The DAEC is currently in the 4th 10-year ISI interval, which began on November 1, 2006.

As part of our preparation for an inspection of the current DAEC ISI program, we received several written questions from an inspector from the NRC Region III

A047

office. The questions raised issues with respect to the adequacy of qualification of the procedure being used to conduct the deferred weld examinations noted above. Specifically, the current equipment configuration (coaxial cable sizes and lengths and associated number of connections) is different from that in the ISI vendor's documentation of the as-tested/as-qualified configuration.

Our review of the issue has identified that this request for relief to use Appendix VIII, Article VIII-4000 is appropriate to clearly justify our use of the cable configuration currently on-site, since the code of record for the 3rd ISI interval at the DAEC (1989 Edition with no addenda) does not expressly authorize an equivalence evaluation of alternative cable configurations from the as-tested configuration. In addition, because a similar equipment configuration was used to conduct the RPV weld examinations performed during RFO19, relief is also requested retroactively for the examinations of those welds (VLB-A001, VLB-A002, VLC-B001, VLC-B002, VLD-B001, VLD-B002, and VCB-C005).

NRC approval of the requested relief is needed by February 23, 2007, the scheduled start date for conducting the ASME Class I leaktest of the RPV. The RPV cannot be pressurized until the DAEC is in compliance with the Code or has been granted relief.

Attachment A provides FPL Energy Duane Arnold's request for relief. Attachment B provides the IHI Southwest Technologies Inc. (ISwT) Technical Evaluation Regarding Alternate Cable Configuration Used for Reactor Vessel Shell Weld Examinations from the Inside Surface at Duane Arnold Energy Center.

There is no practical alternative to the requested relief. The examination of the RPV welds previously conducted during RFO19 was not deferred to this RFO, as it was believed at the time of the previous relief request (Reference 2), that the exams had been conducted in accordance with the Code. Requiring the re-performance of the examinations during the current RFO would be outside the DAEC 3rd 10-year interval.

This letter contains no new commitments nor revises any previous commitments.

Any questions regarding this matter should be referred to Steve Catron at (319) 851-7234.

Gary Van Middlesworth
Site Vice President, Duane Arnold Energy Center

Attachments: A. Request for Relief from the ASME Section XI Code to Allow Use of the Provisions of Appendix VIII, Article VIII-4000, in the Evaluation of Changes in Maximum Cable Length for In-Service Inspection Examination Equipment at the Duane Arnold Energy Center

B. Technical Evaluation Regarding Alternate Cable Configuration Used for Reactor Vessel Shell Weld Examinations from the Inside Surface at Duane Arnold Energy Center

CC: Administrator, Region III, USNRC
Project Manager, DAEC, USNRC
Resident Inspector, DAEC, USNRC

Request for Relief from the ASME Section XI Code to Allow Use of the Provisions of Appendix VIII, Article VIII-4000, in the Evaluation of Changes in Maximum Cable Length for In-Service Inspection Examination Equipment at the Duane Arnold Energy Center

Request for Relief from the ASME Section XI Code to Allow Use of the Provisions of Appendix VIII, Article VIII-4000, in the Evaluation of Changes in Maximum Cable Length for In-Service Inspection Examination Equipment at the Duane Arnold Energy Center

1. ASME Code Component(s) Affected

Code Class:	1
References:	Appendix VIII, Articles VIII-2000, VIII-4000, and Supplement 1 10 CFR 50.55a(b)(2)(xxiv)
Examination Category:	B-A
Item Number:	B1.12, B1.30
Description:	Relief to use the provisions of Appendix VIII, Article VIII-4000 for evaluation of changes to maximum cable length as an essential variable as an alternative to the requirements of Appendix VIII, paragraph VIII-3140.
Component Numbers:	VLA-A001, VLA-A002, VLB-A001, VLB-A002, VLC-B001, VLC-B002, VLD-B001, VLD-B002, and VCB-C005

2. Applicable Code Edition and Addenda

The Duane Arnold Energy Center 3rd Interval examinations will be performed per the requirements of the American Society of Mechanical Engineers (ASME) Section XI, 1989 Edition no addenda. Appendix VIII of ASME Section XI was implemented using the 1995 Edition with the 1996 Addenda as modified per 10 CFR 50.55a(b)(2)(xv).

3. Applicable Code Requirement

Appendix VIII, paragraph VIII-2100(d)(3) requires that the examination procedure shall specify the search unit cable type, maximum length, and maximum number of connectors as essential variables.

Appendix VIII, paragraph VIII-3140 requires when a change in an examination procedure causes an essential variable to exceed a qualified range, the examination procedure shall be re-qualified for the revised range.

4. Reason for Request

The IHI Southwest Technologies Inc. (ISwT) Ultrasonic Examination Procedures (ISwT-PDI-AUT1 and ISwT-PDI-AUT2) included the following essential variables for the cables that were used in the performance demonstration:

Cable Type	Maximum Length	Number of Connectors
RG58	1018 feet	13
RG174	80 feet	

IHI Southwest Technologies Inc. has changed the essential variables for the cables in the procedure (ISwT-PDI-AUT1) to the following:

Cable Type	Maximum Length	Number of Connectors
RG58	1350 feet	20
RG174	230 feet	
Micro cable	5 feet	

FPL Energy Duane Arnold used the following cables at the DAEC when performing the examinations of the above mentioned welds in the 2005 refueling outage:

Refueling Outage 19 (2005)		
Cable Type	Maximum Length	Number of Connectors
RG174	230 feet	6
Micro cable	5 feet	

FPL Energy Duane Arnold plans to use the following cables at the DAEC when performing the examinations of the above mentioned welds in the 2007 refueling outage:

Refueling Outage 20 (2007)		
Cable Type	Maximum Length	Number of Connectors
RG174	230 feet	6

As shown in the tables above, the maximum length of cable that was used in 2005 and is planned to be used in 2007 is greater than that demonstrated for cable type RG174. However, for the over-all system configuration, the length of cable is shorter.

5. Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(a)(3)(i), the following alternative is requested on the basis that the proposed alternative provides an acceptable level of quality and safety.

Appendix VIII, Article VIII-4000 allows procedure modifications, including substitution and/or replacement of major system components (pulsers, receivers, and search units), as well as introducing alternate methods of system calibration without re-qualification.

FPL Energy Duane Arnold requests retroactively the use of Appendix VIII, Article VIII-4000 for Refueling Outage 19 (2005) to allow the use of cable type RG174 with a maximum length of 230 feet and 5 feet of Micro Cable with 6 connectors in lieu of the 1018 feet of RG58 cable and 80 feet of RG174 with a total of 13 connectors without re-qualification of ISwT reactor vessel procedures ISwT-PDI-AUT1 and ISwT-PDI-AUT2 which is presently required by Appendix VIII, paragraph VIII-3140. FPL Energy Duane Arnold also requests the use of Appendix VIII, Article VIII-4000 to allow the use of cable type RG174 with a maximum length of 230 feet and 6 connectors for Refueling Outage 20 (2007).

In 1995, ISwT (then Southwest Research Institute) qualified ISwT-PDI-AUT1 and ISwT-PDI-AUT2 Revision 0 procedures for inside surface examination of pressurized water reactor vessel shell welds. These procedures do not utilize a basic calibration block to establish system sensitivity. Instead system sensitivity is established based on material noise observed on the actual component being examined. This technique eliminates any variations in sensitivity that could be incurred if the calibration block material was not identical to the vessel material. Another unique aspect of these procedures is that they do not rely on amplitude measurement to discriminate flaws from non-relevant reflectors. As long as the indication has at least a 2:1 signal to noise ratio and has flaw image display characteristics, the indication is evaluated as a flaw. Because of these unique aspects, the impact of cable configuration on these procedures is minimized. Instead system sensitivity is established based on material noise observed on the actual component being examined. Thus, provided an acceptable signal to noise ratio can be obtained, the change in cable configuration has no appreciable affect on the system capability to detect flaws.

In 2001, ISwT began using a scanner whose size and function were capable of accessing the inside surface of welds in a Boiling Water Reactor (BWR) vessel. Because of the small size and restricted areas of operation in a BWR annulus, the type of search unit cable used for the initial procedure qualifications for ISwT-PDI-AUT1 and ISwT-PDI-AUT2 Revision 0 in 1995 was not feasible for use with this tool.

With exception of DC resistance values, the cable types RG174, RG58, and Micro Cable are electrically equivalent. The rated nominal impedance and capacitance values for these cable types are equivalent. The DC resistance values for the RG174 and Micro Cable are higher per unit length, but the calculated change in resistance has a negligible effect on signal presentation and signal to noise ratio.

ISwT performed a system equivalency comparison between the PDI essential variable cable configuration and the cable configuration listed in the new procedure for BWR vessels. The comparison used a "worst case" BWR cable configuration that could be necessary if the data acquisition system was physically located outside of the reactor building. This "worst case" configuration consisted of 1,350 feet of RG58, plus 230 feet of RG174, plus 5 feet of Micro Cable, with 20 connectors. The results of the comparison can be found in Attachment B. The equivalency demonstration was performed in accordance with Appendix VIII, Supplement 1, with the exception that a steel reference block was used in lieu of the glass block recommended in Supplement 1. All aspects of the procedure were held constant and the system center frequency and bandwidth were measured for both cable configurations and each type of probe specified in the procedures. The comparison identified that the center frequency and bandwidth of the total system were within the acceptance criteria contained in Appendix VIII. The measurements were within the acceptance criteria of Section VIII-4110(h)(4) for systems with bandwidths greater than 30%. The total cable length actually used for DAEC examinations (235 feet in 2005 and 230 feet in 2007) is significantly less than the total cable length originally qualified (1098 feet).

In addition, an empirical cable demonstration was performed at the DAEC which demonstrated signal amplitude is slightly improved when using the typical BWR cable configuration (235 feet) compared to the original cable configuration and that signal to noise ratios are relatively consistent between either cable configuration.

Based on the above discussion, allowing the cable configuration change without re-qualification similar to the substitution and/or replacement of major system components as allowed by Appendix VIII, Article VIII-4000, provides an acceptable level of quality and safety.

6. Duration of Proposed Alternative

This alternative will be used for the remainder of the DAEC third ten-year interval and the entire fourth ten year interval. The current ten-year interval for the DAEC is the fourth interval, however Reference 1 extended the third 10-year inservice inspection (ISI) interval for reactor vessel welds VLA-A001 and VLA-A002 to the end of refueling outage 20. This relief is also requested to be retroactive to the third ten-year interval for welds VLB-A001, VLB-A002, VLC-B001, VLC-B002, VLD-B001, VLD-B002, and VCB-C005 inspected during Refueling Outage 19.

7. References

1. Letter, L. Raghavan (USNRC) to G. Van Middlesworth (FPL Energy), "Duane Arnold Energy Center – Third 10-Year Interval Inservice Inspection Program Plan Request for Relief to Extend the Third 10 Year Inservice Inspection Interval for the Examination of Welds VLA001 VLA002 (TAC# MC7979)," dated April 4, 2006 (ML060400405).

ATTACHMENT B

Technical Evaluation Regarding Alternate Cable Configuration Used for Reactor Vessel Shell Weld Examinations from the Inside Surface at Duane Arnold Energy Center

28 pages follow

IHI Southwest Technologies, Inc.

6766 Culebra
San Antonio, Texas 78238

Tel: (210) 256-4100
Fax: (210) 521-2311

February 13, 2007

Mr. Gary Park
FPL Energy
Duane Arnold Energy Center
3313 DAEC Road
Palo, Iowa 52324

Subject: Technical Evaluation Regarding Alternate Cable Configuration Used for Reactor Vessel Shell Weld Examinations from the inside surface at Duane Arnold Energy Center

Reference: FPL Energy Purchase Order No. K114303

Dear Mr. Park:

Based on questions identified by a Region III USNRC inspector regarding the acceptability of the IHI Southwest Technologies (ISwT) procedures, and Duane Arnold Energy Center's (DAEC) request for a technical evaluation in response to those questions, I am pleased to offer this evaluation and supporting documentation.

At the heart of the issue is a change in the cable configuration that is listed as an essential variable in ISwT's procedures, made to allow the use of a new scanner specifically designed to improve examination coverage on Boiling Water Reactor (BWR) vessel shell welds. This scanner design allows examination coverage of some BWR vessel welds that are normally not accessible for examination. Even in cases where examination access is available from the outside of the vessel, this scanner allows a significant reduction in radiation exposures by avoiding personnel entrances into high radiation areas in the BWR drywell.

Attachment 1 contains a discussion of the events to date relative to these issues. Attachment 2 contains a summary of a cable electrical evaluation performed by ISwT in 2001. Attachment 3 addresses a system equivalency demonstration performed by ISwT in 2001 using guidance from Appendix VIII, Supplement 1. Attachment 4 contains a summary of an empirical cable comparison performed by ISwT at DAEC along with supporting data.

Based on a review of the evaluations and demonstrations performed by IHI Southwest Technologies (ISwT) as further described and documented in the attachments to this letter, ISwT's position is that the inspection procedures previously used at DAEC RFO19, and that are also planned for use during RFO20, are not only technically equivalent to the procedures that were initially qualified under the Performance Demonstration Initiative (PDI) Program in 1995, but that the changes to the cable configurations were made in a manner consistent with the intent of ASME Section XI, Appendix VIII.

Sincerely,

Grady Lagleder
President
IHI Southwest Technologies

Attachment 1
Discussion

Background

IHI Southwest Technologies (formerly the NDE Services Department of Southwest Research Institute or SwRI) has been performing Automated Ultrasonic Examinations of Reactor Pressure Vessels since approximately 1970. ISwT provides these services for both Pressurized Water Reactors (PWR) and Boiling Water Reactors (BWR).

In the late 1980s, ASME Section XI began development of Appendix VIII "Performance Demonstration for Ultrasonic Examination Systems", which was published in the 1989 Addenda. In the early 1990s the industry formed the Performance Demonstration Initiative (PDI) for the purpose of implementing the Appendix VIII requirements.

Initial Procedure Qualification

In 1995, ISwT (then SwRI) qualified a set of procedures for inside surface examination of reactor vessel shell welds. These procedures were designed to function with ISwT's PWR vessel inspection system and the open access available when performing PWR vessel inspections with the core barrel removed. ISwT's procedures were unique in several ways. They do not utilize a basic calibration block to establish system sensitivity. Instead system sensitivity is established based on material noise observed on the actual component being examined. This eliminated any variations in sensitivity that could be incurred if the calibration block material was not identical to the vessel material. Another unique aspect of these procedures is that they do not rely on amplitude measurement to discriminate flaws from non-relevant reflectors. As long as the indication has at least a 2:1 signal to noise ratio and has flaw image display characteristics, the indication is evaluated as a flaw. Because of these unique aspects, the impact of cable configuration on these procedures is minimized. In fact, during ISwT's initial procedure qualification activity, an argument was presented to not consider this information essential, since, within typical operating situations, cable length and configuration will not have a significant affect on inspection results when using these procedures. Although the PDA conducting the qualification agreed with ISwT's position from a technical viewpoint, it was determined that cable configuration must be identified in the procedure as an essential variable simply because it was listed as an essential variable in Appendix VIII. The cable configuration used for this initial qualification was 1,018 feet of RG58, plus 80 feet of RG174, with 13 connectors.

Adaptation to AIRIS Scanner for BWR Vessel Examinations

In 2001, in response to the need for increased examination coverage of BWR reactor vessel welds, particularly those where outside surface inspection access was not available, ISwT introduced a new scanner that, due to it's size and function, could access the weld inside surface

in the very limited-access annulus regions between the BWR vessel shell and the core shroud. This tool not only had potential for increasing inspection coverage, but would also significantly reduce radiation exposure to personnel because the examinations would be conducted from the refuel floor instead of inside the drywell. Because of the small size and restricted areas of operation in a BWR annulus, the type of search unit cable used for the initial procedure qualifications in 1995 was not feasible for use with this tool. Other aspects of the previously qualified procedures were determined to be applicable and ISwT proceeded to adapt the previously qualified procedures to this tool.

Justification for Cable Modifications

Because of the time and expense associated with a reactor vessel procedure qualification (ISwT's initial automated vessel procedure qualification took over 3 months and cost approximately $1,000,000), and since it was strongly believed that the necessary cable reconfiguration would not have a detrimental affect on the performance of these procedures, ISwT investigated opportunities to make this procedure change without a complete procedure re-qualification. ISwT reviewed the Appendix VIII requirements, consulted with PDI personnel, consulted with in-house engineering personnel, and proceeded to perform several demonstrations and evaluations in lieu of undertaking a complete procedure re-qualification, believing the process to be in compliance with the intent of Appendix VIII.

Appendix VIII, Article VIII-4000 allows procedure modifications, including substitution and/or replacement of major system components (pulsers, receivers, and search units), as well as introducing alternate methods of system calibration without re-qualification. ISwT felt at that time, and still does, that it was ASME's intent to allow minor modifications to systems and procedures without re-qualification if a suitable technical evaluation or system equivalency demonstration can be performed.

Prior to performing an equivalency demonstration, ISwT performed an electrical evaluation of the cable types intended for use. With exception of DC resistance values, the cable types used by ISwT are electrically equivalent. This evaluation is addressed in more detail in Attachment 2.

In 2001, ISwT performed a system equivalency demonstration using a PWR cable configuration and a 'worst case' BWR cable configuration that would be necessary if the data acquisition system was physically located outside of the reactor building. The PWR cable configuration was slightly shorter than the originally qualified cable length (65 feet less), which bounded the intended comparison. The BWR 'worst case' configuration consisted of 1,350 feet of RG58, plus 230 feet of RG174, plus 5 feet of micro coaxial cable, with 20 connectors. Although this 'worst case' cable configuration was never actually used in the field, it provided information that helped substantiate ISwT's claims during the original 1995 procedure qualification that cable configuration is not truly an "essential" variable when using these types of procedures. The equivalency demonstration was performed using guidance from Appendix VIII, Supplement 1, with the exception that a steel reference block was used in lieu of the glass block recommended in Supplement 1 and a contact setup was used in lieu of the immersion setup. Other aspects of the qualified procedure were held constant and the system center frequency and bandwidth were

measured for both cable configurations and each type of probe specified in the procedures. The measurements were within the equivalency criteria of VIII-4110 for systems with bandwidths greater than 30% (as documented in the original procedure and as measured again for this comparison). The results of this equivalency comparison are included as Attachment 3.

Empirical Comparison Performed in 2007

In addition to the measures taken in 2001, ISwT also performed an empirical comparison of the three cable configurations using the entire ultrasonic system at Duane Arnold Energy Center (DAEC). Reference signals from each type of search unit were compared with each of the cable configurations (original qualification, DAEC RFO19, and DAEC RFO20) and all three configurations were shown to be within 2dB. Slightly less system gain was required to bring the reference signal to 80% full screen height when using the RFO19 and RFO20 cable configurations. A-scan presentations for each cable configuration indicate no significant degradation in signal to noise ratio. The results of this comparison are described in more detail in Attachment 4.

Summary

Based on the following key points, ISwT's position is that the cable configuration change required for adaptation to the AIRIS scanner will not have a detrimental effect on the quality of examinations performed using the AIRIS scanner and that the process used by ISwT to justify the substitution of an alternate cable configuration was not in violation of Code intent.

1) The impedance and capacitance values for the substituted cable are equivalent.
2) Even though the DC resistance values for the substituted cable are different, the increase in resistance has a negligible effect on procedure performance due to the equipment used, the methods used for setting system sensitivity, and the methods used for flaw discrimination.
3) The system equivalency comparison performed using guidance from Appendix VIII, Supplement 1 demonstrated that the center frequency and bandwidth of the total system with the 'worst case' cable configuration were still within the system equivalency criteria contained in Appendix VIII.
4) The empirical cable comparison performed at DAEC shows that signal to noise ratios are very similar and that overall system sensitivity is within 2 dB with either cable configuration, again showing that cable configuration changes (within practical limits) are not a significant issue.
5) The total cable length actually used by ISwT at DAEC and for all previous BWR examinations (235') is less than the cable length originally qualified.
6) The total number of connectors actually used by ISwT at DAEC and for all previous BWR examinations (6-8) is less than the number of connectors originally qualified.
7) Discussions with various industry experts in 2001, and again in 2007, verify that it was not the intent of Appendix VIII to limit the use of Supplement 1 system equivalency demonstrations to Pulsers, Receivers, and Search Units.

Attachment 2
ISwT Cable Electrical Evaluation

Prior to initiating the cable modifications for the AIRIS scanner, ISwT performed an evaluation of the specifications for the different types of cables used by ISwT. Each of the three cable types used (RG-58, RG-174, and the special small diameter micro cable) is a co-axial insulated cable consisting of a braided shield surrounding a stranded core. The physical characteristics of these cable types (outside diameter, insulation thickness, shield configuration, etc.) is different for each, but that alone should have no impact on the inspection results.

1) The primary value of concern with respect to ultrasonic testing signal transmission is typically considered to be impedance. The nominal impedance of all three cable types used by ISwT is equal at 50 ohms.

2) Besides impedance, the next cable characteristic with potential to affect signal quality is the capacitance, which is related not only to the cross section of the conductors, but also to the design and spatial relationships between the core and the braid. Typically, signal loss increases as capacitance increases. Capacitance is expressed in values of pico-farads per foot. The RG-58 and RG-174 cable types used by ISwT have the same capacitance at 30.8 pF/ft. The smaller micro cable used at the AIRIS tool is a special design with a capacitance value of approximately 27 pF/ft. So in this case, the smaller cable has even less capacitance than the larger diameter RG-58 and RG-174 cables.

   Using these values, the total capacitance of the cable configuration used for ISwT's PDI qualification (excluding connectors) is approximately 32,500 pF. The total capacitance of the AIRIS cable configuration for the DAEC examinations (excluding connectors) is approximately 5,600 pF. Based on these calculations it can be seen that the shorter lengths of cable used in the AIRIS configuration have less total capacitance than the cable configuration used for the qualification activity.

3) Another value that can influence signal amplitude is DC resistance. Increases in resistance can reduce signal amplitude. The resistance value for RG174 is 97 ohms per 1000 feet and the resistance value for RG58 is 10.8 ohms per 1000 feet. Therefore an approximation of the total resistance for the original cable configuration (1018' RG58 plus 80' RG174, excluding connectors) is 18.76 ohms. The approximate resistance of the typical AIRIS cable configuration (230' RG174, excluding connectors) is 22.31 ohms plus the value of the 5' of micro cable for which nominal resistance values are not available, but are considered insignificant due to the short length used.

   One of the features of the ISwT procedures is that system gain is established based upon material noise in the examination component. Therefore, differences in cable configuration (within practical limits) are compensated when adjusting the total system gain on the component.

Based on this evaluation, ISwT was confident that the differences in cable type would have no adverse affect on the procedure performance.

FULL TECHNICAL SPECS

Tech Data

For more information please call 1-800-BELDEN-1

8216 Coax - 50 Ohm Transmission & Computer Cables

RG Type	# Coax	AWG	# Strands	Type
174/U	1	26	(7x34)	BCCS - Bare Copper Covered Steel

Insulation	Shield	Jacket
PE - Polyethylene	Tinned Copper Braid Shield	PVC - Polyvinyl Chloride

Nominal OD (in.)	Insulation Thickness (in.)	Jacket Thickness (in.)	Nominal Capacitance (pF/ft)	Nominal Conductor DCR (/M')	Nominal Velocity of Propagation (%)	Nominal Impedance (ohms)
.1100	.02100	.0165	30.800	97.000	66.0	50.0

Putup		
Feet	Meters	Ship Weight (Lb)
100	30.480	0.9000
1000	304.80	9.0000
500	152.40	4.5000

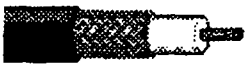
Description

Coaxial, Brilliance, RG-174/U Type, 26 AWG, stranded (7x34) bare copper covered steel, polyethylene, tinned copper braid, 90% shield coverage, PVC jacket, UL Style 1354, 30V, 60 deg.C. May contain -0/+10% - multipiece (max. 3 pieces, min. length 100').

Disclaimer: Great effort is made to ensure the accuracy of the information presented, but errors or omissions may occur. This listing of information is presented as a courtesy and does not ensure that a product with these specifications is available. Specification and availability should be confirmed with a call to our sales representative or to Customer Service. Have a question? Call us at 1-800-BELDEN-1 or send us a comment

FULL TECHNICAL SPECS

Tech Data



For more information please call 1-800-BELDEN-1

8262 Coax - MIL-C-17G QPL Cables

RG Type	# Coax	AWG	# Strands	Type
58C/U	1	20	(19x.0071)	TC - Tinned Copper

Insulation	Shield	Jacket
PE - Polyethylene	Braid	PVCNC - Polyvinyl Chloride Non-Contaminating

Nominal OD (in.)	Insulation Thickness (in.)	Jacket Thickness (in.)	Nominal Capacitance (pF/ft)	Nominal Conductor DCR (/M')	Nominal Velocity of Propagation (%)	Nominal Impedance (ohms)
.1950	.04000	.0270	30.800	10.800	66.0	50.0

Putup		
Feet	Meters	Ship Weight (Lb)
U1000	304.80	27.000
U500	152.40	13.500
1000	304.80	27.000
500	152.40	13.500

Description

Coaxial, 50 ohm coax, M17/155-00001 (RG-58 C/U - Non SWR swept version of RG-58), 20 AWG, stranded (19x33) tinned copper, polyethylene, tinned copper braid, 95% shield coverage, non-contaminating PVC jacket, 85 deg.C.

Disclaimer: Great effort is made to ensure the accuracy of the information presented, but errors or omissions may occur. This listing of information is presented as a courtesy and does not ensure that a product with these specifications is available. Specification and availability should be confirmed with a call to our sales representative or to Customer Service. Have a question? Call us at 1-800-BELDEN-1 or send us a comment

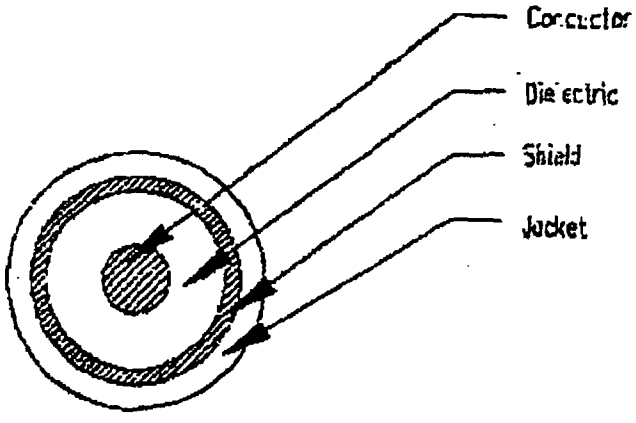
VICTOR Wire & Cable Corp.

3601 Holdrege Avenue • Los Angeles, CA 90016 tel. (310) 842-9933 • fax (310) 559-4167

VWC - 7227 Special 50 Ohm Micro Cable Specifications

Description: 50 Ohm Micro coaxial cable with Black Polyethylene Jacket.

Conductor:	28 AWG (19/36) Silver Plated Copper
Core Insulation:	V132 Polyethylene nominal O.D. .032"
Shield:	38 AWG Silver Plated Copper braid 95% coverage (nom. O.D. .050")
Jacket:	.013" +/- .002" wall extruded Black Polyethylene
Cable O.D.:	.064" +/- .005
Nom. Impedance:	50 ohms
Nom. Vel of Prop.:	79% nom.
Nom Capacitance:	27 pf / ft



CABLE ASSEMBLY

Conductors:	10 each VWC - 7227 planetary laid
Shielding	Overall braid shielded 36 AWG Tinned Copper
Cable Jacket	Extruded black PVC .025" wall. nom O.D. .333"
Put-ups	1000' nominal reels.

Attachment 3
ISwT System Equivalency Demonstration

After consulting with various technical experts and ASME personnel involved with the development of Appendix VIII, ISwT elected to also perform a system equivalency comparison using guidance from Appendix VIII, Supplement 1. ISwT's comparison test was generally compliant with Supplement 1, however a standard UT reference block was used in lieu of the recommended 'glass block' and a contact setup was used in lieu of the immersion test setup. Essentially a full system setup and calibration was performed in accordance with procedure requirements with the addition of a spectrum analyzer to measure system output. A reference signal appropriate for each transducer type was obtained using the UT reference block and frequency/bandwidth measurements were obtained for each transducer/cable combination. No changes in system configuration were allowed, except for the cable configurations selected for comparison.

The Supplement 1 equivalency comparison was incorporated into Appendix VIII for the purpose of allowing procedure modifications without procedure re-qualification as long as the examination system performance is shown to be equivalent. Based on a variety of studies, center frequency and bandwidth have been shown to be valid measurements of system performance, primarily relying on the fact that flaw detection capability is largely dependent on frequency. The results of this comparison showed that the total system performance was within established Appendix VIII equivalency guidelines of +/- 10% for center frequency and bandwidth for systems with bandwidths equal to or greater than 30%.

Additional documentation is included on the following pages.

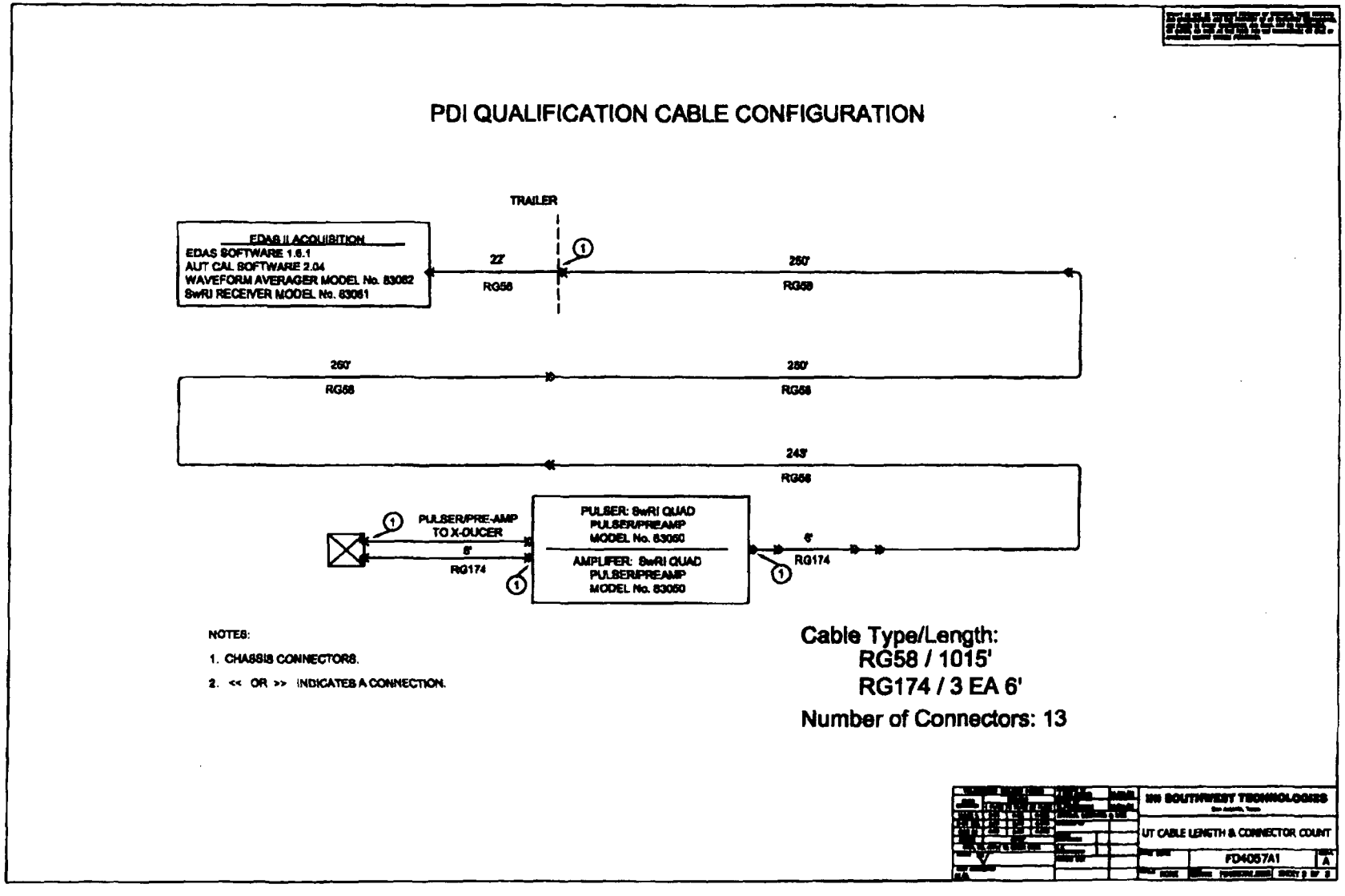


Figure 1. Original Cable Configuration

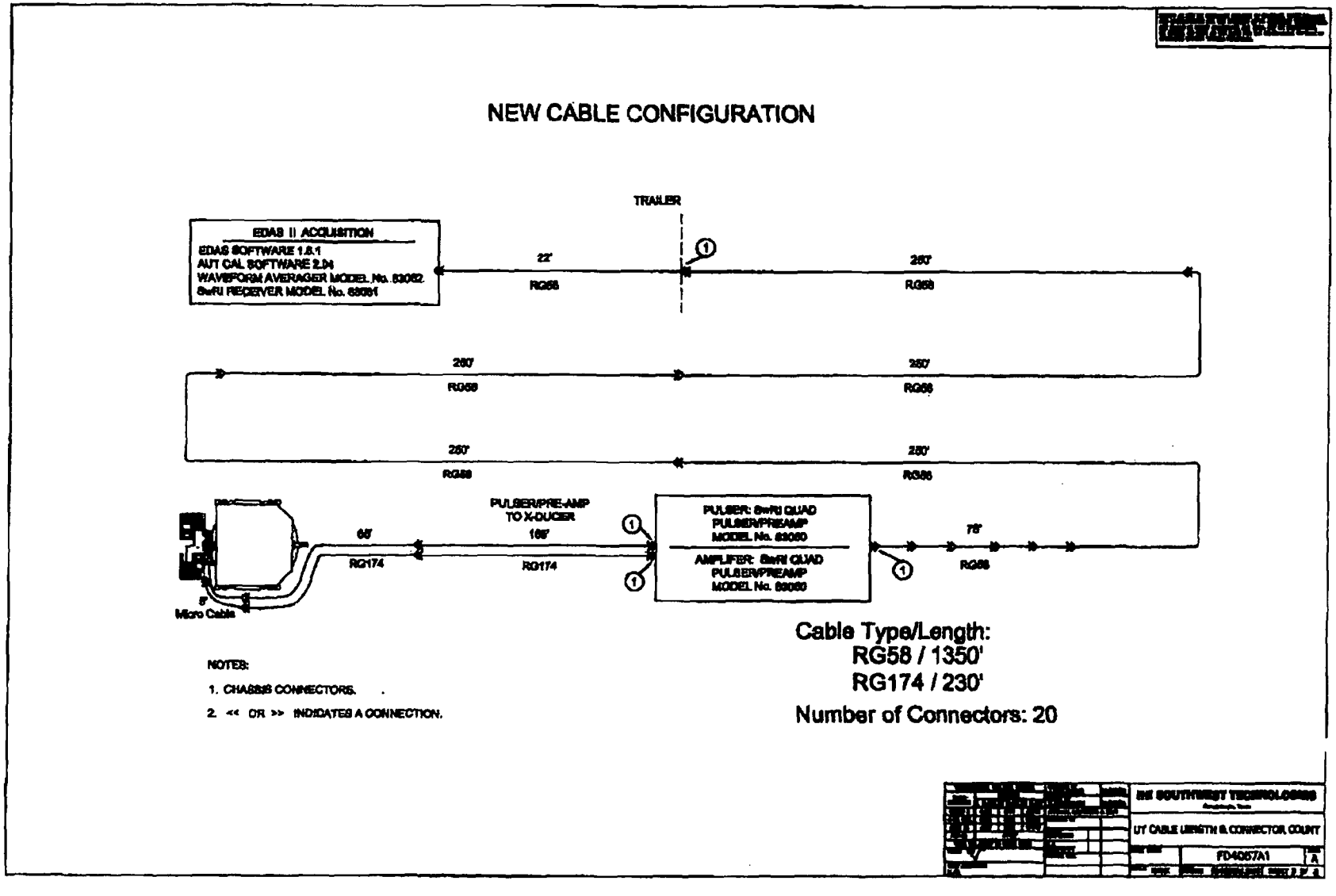


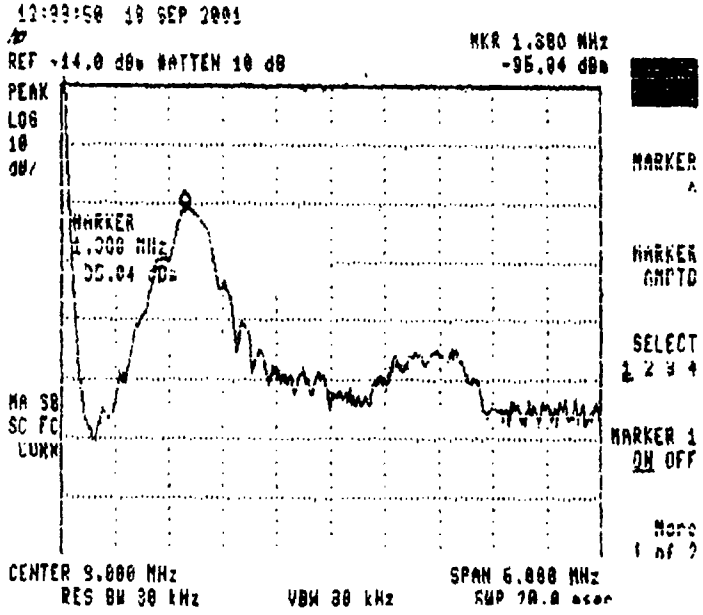
Figure 2. New Cable Configuration

TRANSDUCER TYPE	PDI QUALIFIED CABLE CONFIGU-RATION	NEW CABLE CONFIGU-RATION	PDI QUALIFIED CABLE CONFIGU-RATION	NEW CABLE CONFIGU-RATION	PDI QUALIFIED CABLE CONFIGU-RATION	NEW CABLE CONFIGU-RATION	PDI QUALIFIED CABLE CONFIGU-RATION	NEW CABLE CONFIGU-RATION
SERIAL NUMBER	Duplex 45° K-5626	Duplex 45° K-5626	SLIC -35 4722	SLIC -35 4722	SLIC -40 4724	SLIC - 40 4724	SLIC -40D K9102	SLIC -40D K9102
FREQUENCY (Mhz)	1.5	1.5	2.25	2.25	3.0	3.0	2.0	2.0
F_L	1.200	1.200	1.680	1.800	1.995	2.055	1.980	1.845
F_C	1.425	1.380	2.235	2.325	2.370	2.520	2.310	2.250
U_U	1.650	1.600	2.760	2.850	2.805	2.995	2.805	2.610
BANDWIDTH	31.57%	28.98%	48.32	45.16	34.17	36.45	35.71	34.00
TOLERANCE	28.42% 34.72%		43.46 53.15		30.76 37.58		32.14 39.28	

Table 1. Summary of Results

Transducer Type 45° Duplex
Transducer Serial No. K-5626
Frequency: 1.4 mhz

Qualified Cable Configuration

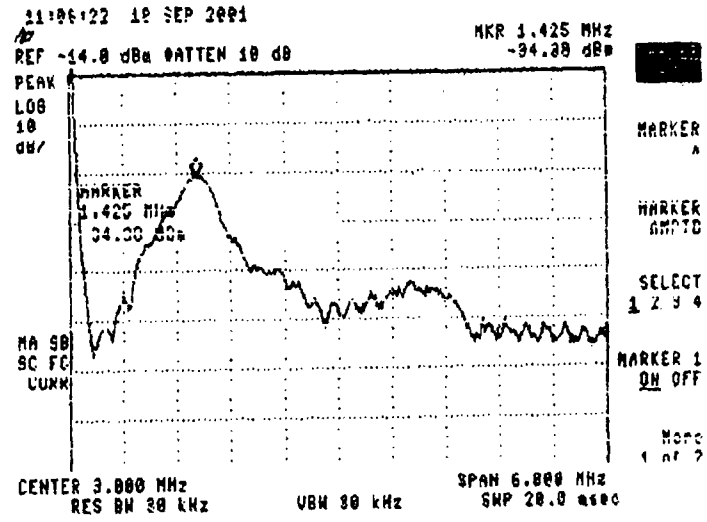


Cable Length/Type: 1015'/Rg-58,18'/Rg-174
Connectors: 13

Frequency (mhz) Results

Low	Center	Upper	Bandwidth	Tolerance
1.200	1.425	1.650	31.57%	28.42%-34.72%

Extended Cable Configuration



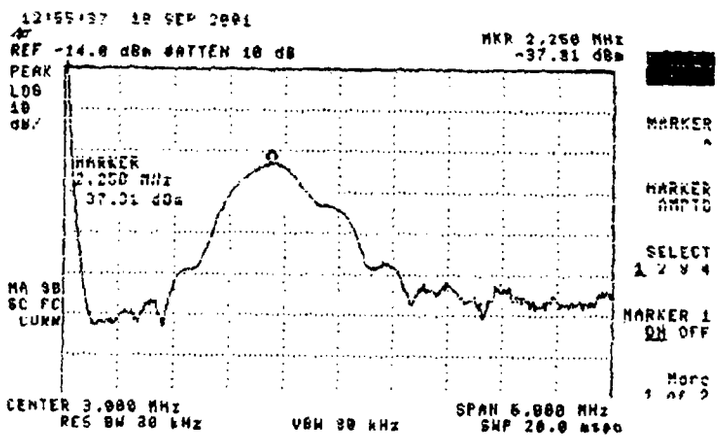
Cable Length/Type: 1350'/Rg-58, 230'/Rg-174, 5' Micro
Connectors: 20

Frequency (mhz) Results

Low	Center	Upper	Bandwidth	Acceptable
1.200	1.380	1.600	28.98%	OK

Transducer Type SLIC-40D
Transducer Serial No. K-9102
Frequency: 2.0 mhz

Qualified Cable Configuration

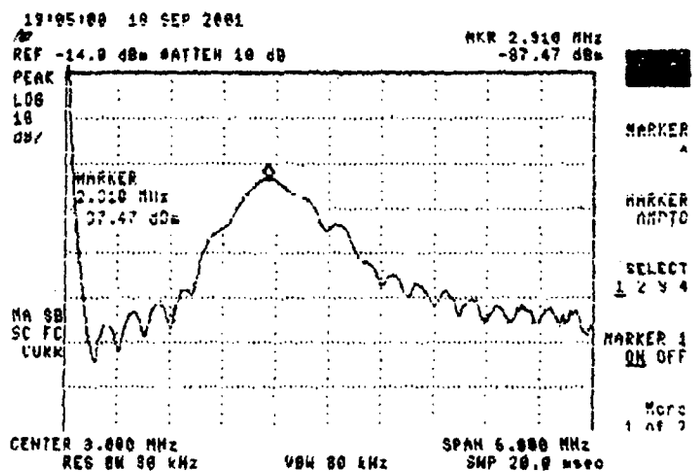


Cable Length/Type: 1015'/Rg-58, 6'/Rg-174
Connectors: 13

Frequency (mhz) Results

Low	Center	Upper	Bandwidth	Tolerance
1.980	2.310	2.805	35.71%	32.14%-39.28%

Extended Cable Configuration

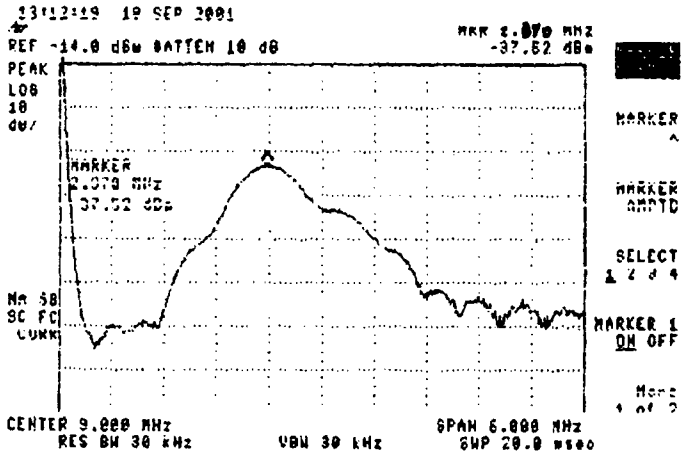


Cable Length/Type: 1350'/Rg-58, 230'/Rg-174, 5' Micro
Connectors: 20

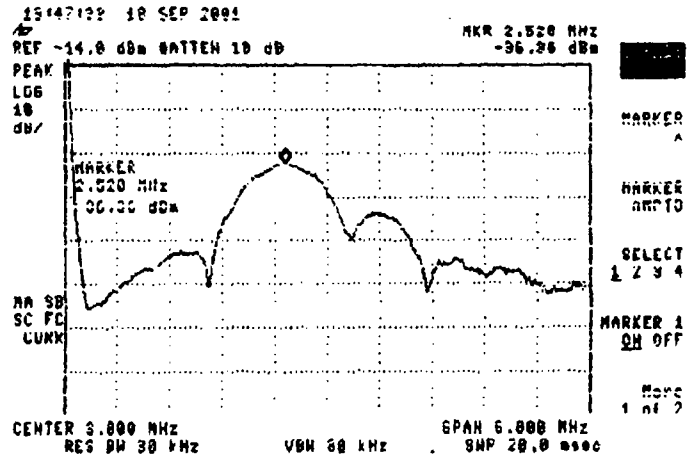
Frequency (mhz) Results

Low	Center	Upper	Bandwidth	Acceptable
1.845	2.250	2.610	34.00	OK

Transducer Type SLIC-40
Transducer Serial No. 4724
Frequency: 3.0 mhz



Extended Cable Configuration



Cable Length/Type: 1015'/Rg-58, 6'/Rg-174
Connectors: 13

Frequency (mhz) Results

Low	Center	Upper	Bandwidth	Tolerance
1.995	2.370	2.805	34.17%	30.76%-37.58%

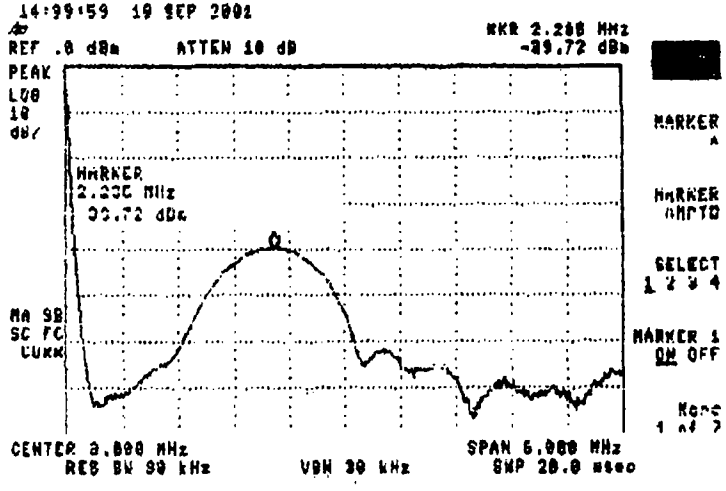
Cable Length/Type: 1350'/Rg-58, 230'/Rg-174, 5' Micro
Connectors: 20

Frequency (mhz) Results

Low	Center	Upper	Bandwidth	Acceptable
2.0555	2.520	2.995	36.45	OK

Transducer Type SLIC-35
Transducer Serial No. 4722
Frequency: 2.25 mhz

Qualified Cable Configuration

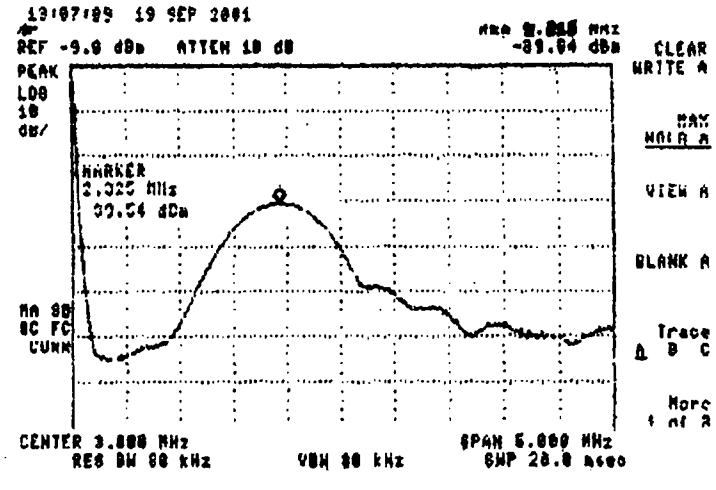


Cable Length/Type: 1015'/Rg-58, 6'/Rg-174
Connectors: 13

Frequency (mhz) Results

Low	Center	Upper	Bandwidth	Tolerance
1.680	2.235	2.760	48.32%	43.46%-53.15%

Extended Cable Configuration



Cable Length/Type: 1350'/Rg-58, 230'/Rg-174, 5' Micro
Connectors: 20

Frequency (mhz) Results

Low	Center	Upper	Bandwidth	Acceptable
1.800	2.325	2.850	45.16%	OK

Attachment 4
ISwT Empirical Cable Comparison at DAEC

While onsite at DAEC, ISwT conducted an empirical ultrasonic cable comparison using the entire system in an effort to establish equivalency between the three cable configurations:

a) The cable configuration to be used for DAEC RFO20, (230' RG174)
b) The cable configuration used for DAEC RFO19, (230' RG174, 5'micro cable), and
c) The original cable configuration used for procedure qualification in 1995 (1018' RG58, 80' RG174).

This comparison was performed for both types of search units (SLIC40 and Duplex55) with each cable configuration using the same calibration block reflector for each measurement. The key measurement parameter recorded was the system gain required to bring the calibration reflector to 80% of full screen height with the three different cable configurations.

The table below summarizes those measurements and indicates that:

1) In each case, less gain was required to bring the signals to 80% of full screen height when using either of the two shorter cable configurations than was needed with the longer cable configuration, indicating that signal amplitude is slightly higher when using the shorter BWR cable configurations
2) The differences between the cable configurations used for RFO19 and RFO20 are less than 1 dB, indicating that the micro cable has a negligible affect on the signal
3) There is less than 2dB difference between any of the cable configurations, indicating that the differences are not only within standard ultrasonic amplitude calibration tolerances, but that cable configuration differences are not significant when using the ISwT system.

Configuration Description	Configuration ID on Calibration Records	SLIC40 System Gain Required	Duplex55 System Gain Required
a) DAEC RFO20	1	7.6	34.1
b) DAEC RFO19	2	7.2	34.4
c) Original Qualification	4	7.8	35.5

Calibration records are attached documenting this comparison. It should be noted that 4 cable configurations are referenced in these records. Upon review of the initial records a discrepancy in the conduct of the test was noted for cable configuration 3, so the configuration was corrected and the measurements were repeated and noted on separate data sheets as cable configuration 4. Both 3 & 4 consisted of the same original cable length, but the sequence of the cables was not correct for configuration 3.

Data acquisition system printouts are also included to document this comparison for configurations 1, 2, & 4. From these printouts, A-scan presentations indicate reasonable consistency in signal to noise ratio for each of the three cable configurations

ISwT AUTOMATED INSTRUMENT CALIBRATION DATA RECORD

Project No.	Site:	EDAS Software Rev.:	File Name:	Sheet No.:
06-0455	Duane Arnold Energy Center	1.6.2	DEA-03-2	08cable40

Calibrator (Signature)	SNT Level:	Date (Day-Mo-Yr)	Time: (24 Hr. Clock)	Procedure No. ISwT-PDI-AUT1
[signature]	III	10-Feb-07	2110	Revision: 0 Chg. 0 ICN:1 & 2

Remote Pulser Preamp		EDAS II Channel Board			Calibration Block(s)	
Frame Select	1-2	Channel No.:	2	N/A	Basic Calibration Block:	70389-1
Rep Rate	2	Board Serial No.:	175599	N/A	Auxiliary Calibration Block:	N/A
Pulser Gain	35	Search Unit			Reference Calibration Block:	SwRI-IIW-24
Can No.	002	Brand/ Size	SwRI / .375 x 1.00	N/A	Pyrometer S/N: 78700030	Cal. Block Temp. °F: 84
Instrument Settings		Serial No.	K9107	N/A	Cable	
TCG (On/Off)	On	Frequency (MHz)	2.00	N/A		
Avg. (On/Off)	On	Nominal Angle	SLIC 40	N/A		
No. of Avgs.	8	Measured Angle	N/A	N/A		

Cable	Length	Type
N/A	N/A	N/A
Pulsr/Pre	N/A	RG/174
Exam	N/A	RG/174
Device	N/A	Micro/cable
Total	N/A	

Search Unit Orientation: TWD ☐ AWY ☐ UP ☐ DN ☐ CW ☐ CCW ☐

Gate Start	0.00	Calibration Parameters		
Gate Range	3.50			
Cal. Marker 1	0.25			
Cal. Marker 2	3.25			
DIG Rate (MHz)	25			
Compaction	6			
Units	Inches			
No. Samples	247			
DAC Ref. Level	80			
Signal Mode	Video			
Cal. Method	Depth in Metal			

	Signal Amplitude	dB Difference	Signal Screen Distance
1	83	-0.32	0.37
2	35	7.18	1.27
3	11	17.23	2.27
4	9	18.98	3.30
5			
6			
7			

No. of Cons.: N/A Couplant: DI-Water

Remarks: Linearity Sheet # 010003

Set calibration hole @ 80% FSH (depth of 1.25")

Cable configuration 1 - Exam 1-40 Base gain 7.6 dB

Cable configuration 2 - Exam 2-40 Base gain 7.2 dB

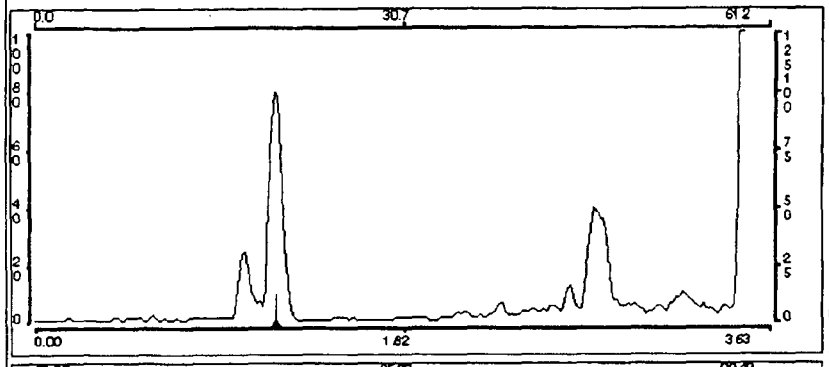
~~Cable configuration 3 - Exam 3-40 Base gain 11.7 dB~~ [signature] 10FEB07

AMP Mode	% FSH	Mode:	Reflectors:
Filter Freq.	2.25		Notches ☐ Holes ☑
Base Gain	see remarks	Longitudinal ☑	Axial ☐ Circ. ☐
TCG Clock Freq.	800	Shear ☐	Notch dB N/A
Ref. Amp. %FSH	80		1/4t Hole dB N/A

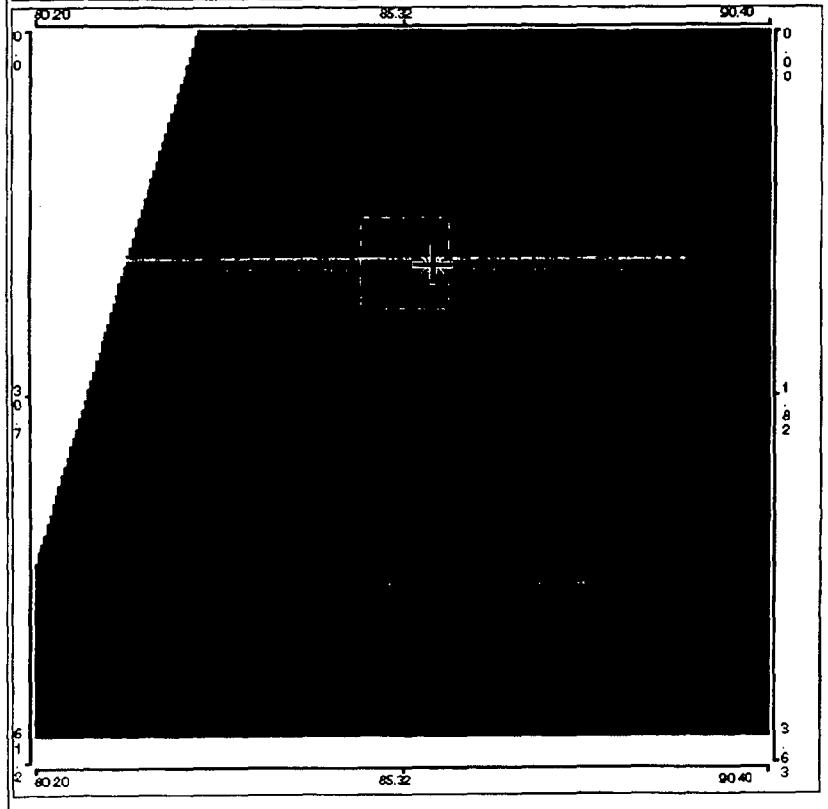
Reviewed By: [signature] SNT Level: III Date: 10 Feb 2007

ISwT Form No. UT-08 (Rev 11/99) Front

EDAS B-Scan Display - Channel 2, Refracted Angle 40-, Exam Number 1-40



1	SCAN NO.
83.18	INC. AXIS
85.72	SCAN AXIS
19.7	TIME
1.17	MATERIAL DEPTH
80	% SCREEN HEIGHT
100	% DAC



B-SCAN CONTROL OPTIONS

Next B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 79.52

Upper 100.56

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc. 83.18

Scan 80.20

EDAS Feature Analysis - Channel 2

ASME Analysis

Select Reference Point

Point 1 Point 2

Inc. Axis Location
Surface Location
Scan Axis Location
Depth In Material
Time
% DAC
Separation

Lower	Upper	
1	4	Scan No. Limits
83.18	85.92	Inc. Axis Limits
2.74		Length

Select Maximum Point

100	% DAC
83.18	Inc. Axis Location
86.68	Surface Location
85.72	Scan Axis Location
1.17	Depth In Material
19.7	Time

Comments

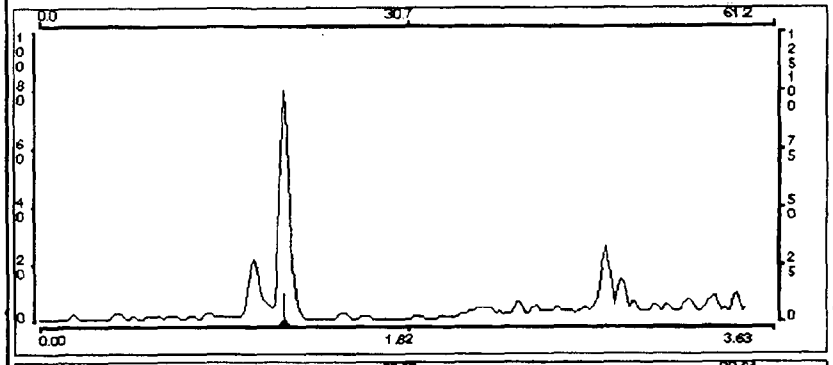
: SLIC-40, Cable Config. 1

:

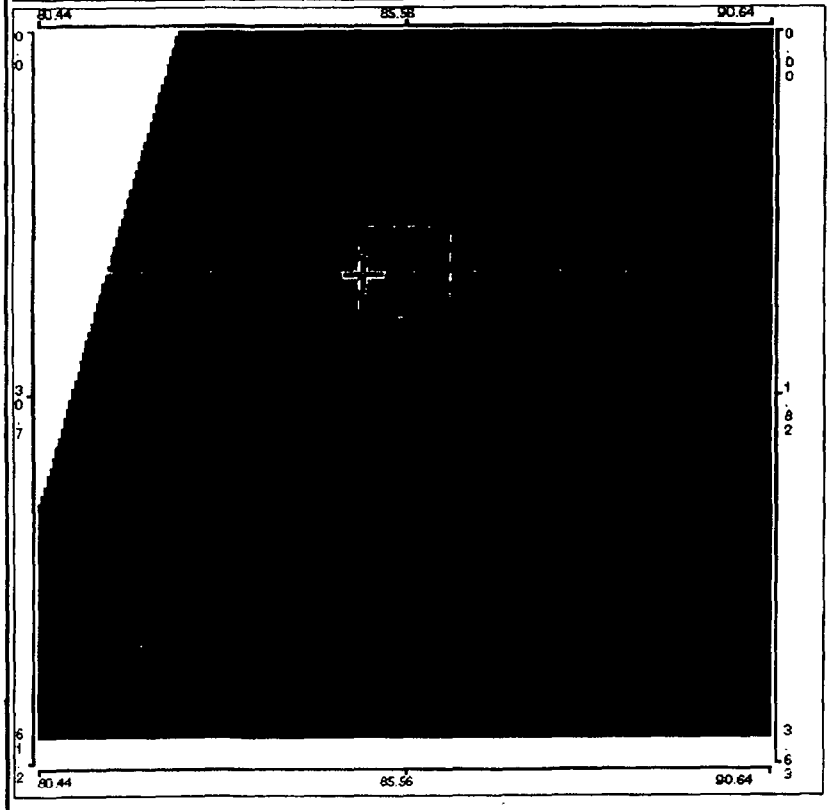
:

:

EDAS B-Scan Display - Channel 2, Refracted Angle 40-, Exam Number 2-40



4	SCAN NO.
85.88	INC. AXIS
84.96	SCAN AXIS
20.6	TIME
1.22	MATERIAL DEPTH
80	% SCREEN HEIGHT
100	% DAC



B-SCAN CONTROL OPTIONS

Previous B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 79.52

Upper 100.56

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc. 85.88

Scan 80.44

EDAS Feature Analysis - Channel 2

ASME Analysis

Select Reference Point

Point 1 Point 2

		Inc. Axis Location
		Surface Location
		Scan Axis Location
		Depth In Material
		Time
		% DAC
		Separation

Lower	Upper	
1	4	Scan No. Limits
83.18	85.88	Inc. Axis Limits
2.70		Length

Select Maximum Point

100	% DAC
85.88	Inc. Axis Location
86.00	Surface Location
84.96	Scan Axis Location
1.22	Depth In Material
20.6	Time

Comments

: SLIC-40, Cable Config. 2

:

:

:

ISwT AUTOMATED INSTRUMENT CALIBRATION DATA RECORD

Project No.	Site:	EDAS Software Rev.:	File Name:	Sheet No.:
06-0455	Duane Arnold Energy Center	1.6.2	DAE-03-2	08cable40-1

Calibrator (Signature)	SNT Level:	Date (Day-Mo-Yr)	Time: (24 Hr. Clock)	Procedure No. ISwT-PDI-AUT1
	III	11-Feb-07	1320	Revision: 0 Chg. 0 ICN:1 & 2

Remote Pulser Preamp		EDAS II Channel Board			Calibration Block(s)	
Frame Select	1-2	Channel No.:	2	N/A	Basic Calibration Block:	70389-1
Rep Rate	2	Board Serial No.:	175599	N/A	Auxiliary Calibration Block:	N/A
Pulser Gain	35	Search Unit			Reference Calibration Block:	SwRI-IIW-24
Can No.	002	Brand/ Size	SwRI / .375 x 1.00	N/A	Pyrometer S/N: 78700031	Cal. Block Temp. °F: 84
Instrument Settings		Serial No.	K9107	N/A	Cable	
TCG (On/Off)	On	Frequency (MHz)	2.00	N/A		
Avg. (On/Off)	On	Nominal Angle	SLIC40	N/A		
No. of Avgs.	8	Measured Angle	n/a	N/A		

Cable	Length	Type
N/A	N/A	N/A
Pulsr/Pre	N/A	RG/174
Exam	N/A	RG/174
Device	N/A	Micro/cable
Total	N/A	

Search Unit Orientation: TWD ☐ AWY ☐ UP ☐ DN ☐ CW ☐ CCW ☐

Gate Start	0.00
Gate Range	3.50
Cal. Marker 1	0.25
Cal. Marker 2	3.25
DIG Rate (MHz)	25
Compaction	6
Units	Inches
No. Samples	247
DAC Ref. Level	80
Signal Mode	Video
Cal. Method	Depth
AMP Mode	% FSH
Filter Freq.	2.25
Base Gain	see remarks
TCG Clock Freq.	800
Ref. Amp. %FSH	80

Calibration Parameters

	Signal Amplitude	dB Difference	Signal Screen Distance
1	83	-0.32	0.37
2	35	7.18	1.27
3	11	17.23	2.27
4	9	18.98	3.30
5			
6			
7			

Mode: Longitudinal ☐ Shear ☑

Reflectors: Notches ☐ Holes ☑ Axial ☐ Circ. ☐ Notch dB N/A 1/4t Hole dB N/A

No. of Cons.: n/a Couplant: DI-Water

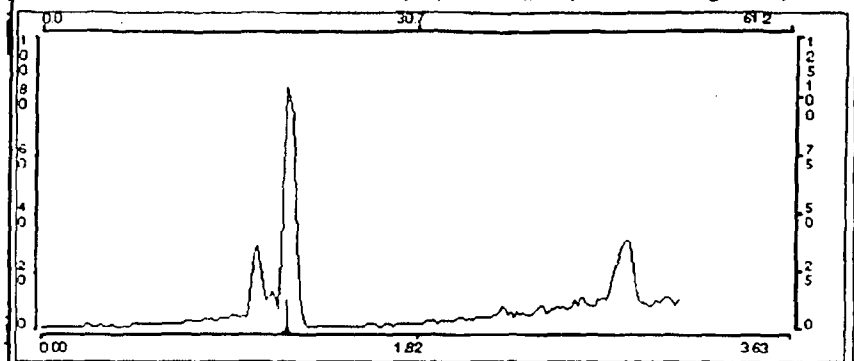
Remarks: Linearity Sheet # 010003

Cable configuration 4 - Exam 4-40 Base Gain 7.8 dB

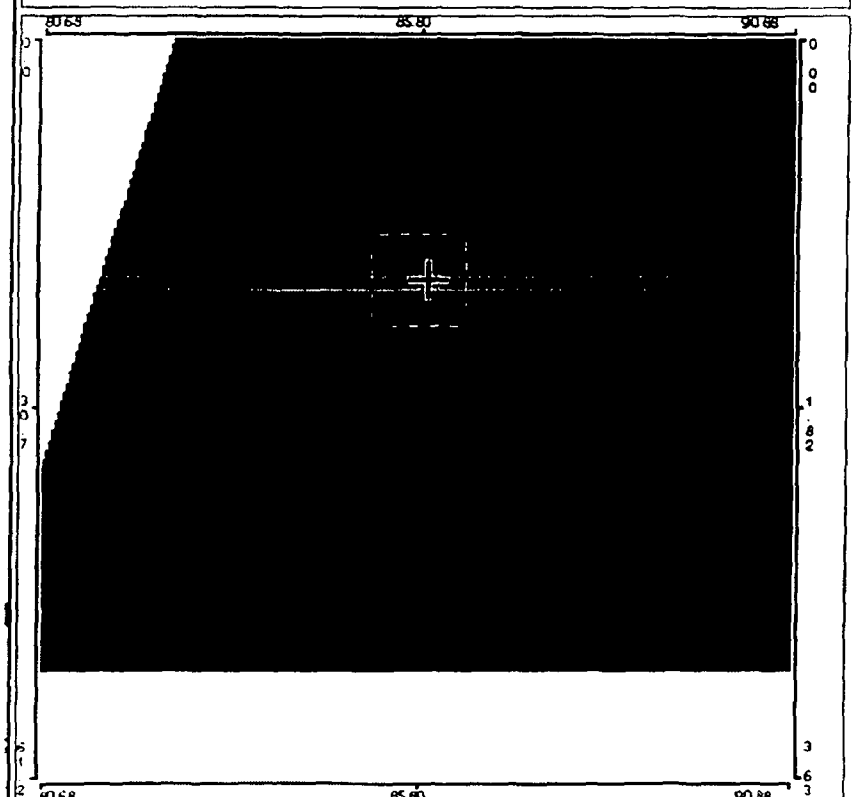
Reviewed By: SNT Level: III Date: 12 Feb 2007

ISwT Form No. UT-08 (Rev 11/99) Front

EDAS B-Scan Display – Channel 2, Refracted Angle 40–, Exam Number 40LngEDAS



3	SCAN NO
84.79	INC AXIS
85.92	SCAN AXIS
20.2	TIME
1.19	MATERIAL DEPTH
83	% SCREEN HEIGHT
103	% DAC



B-SCAN CONTROL OPTIONS

Next B-Scan

Previous B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 79.84

Upper 100.88

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc. 84.79

Scan 80.68

EDAS Feature Analysis – Channel 2

ASME Analysis

Select Reference Point

Point 1 Point 2

	Inc. Axis Location
	Surface Location
	Scan Axis Location
	Depth In Material
	Time
	% DAC
	Separation

Lower	Upper	
1	6	Scan No. Limits
83.18	87.30	Inc. Axis Limits
4.12		Length

Select Maximum Point

103	% DAC
84.79	Inc. Axis Location
86.92	Surface Location
85.92	Scan Axis Location
1.19	Depth In Material
20.2	Time

Comments

: SLIC-40, cable config. 4

:

:

:

ISwT AUTOMATED INSTRUMENT CALIBRATION DATA RECORD

Project No.	Site:	EDAS Software Rev.:	File Name:	Sheet No.:
06-0455	Duane Arnold Energy Center	1.6.2	DAE-03-2	08cable55

Calibrator (Signature)	SNT Level:	Date (Day-Mo-Yr)	Time: (24 Hr. Clock)	Procedure No. ISwT-PDI-AUT1
[signature]	III	10-Feb-07	2155	Revision: 0 Chg. 0 ICN:1 & 2

Remote Pulser Preamp		EDAS II Channel Board			Calibration Block(s)	
Frame Select	1-2	Channel No.:	1	N/A	Basic Calibration Block:	70187-2
Rep Rate	2	Board Serial No.:	175598	N/A	Auxiliary Calibration Block:	N/A
Pulser Gain	35	Search Unit			Reference Calibration Block:	SwRI-IIW-24
Can No.	002	Brand/ Size	SwRI / 1.625 x 2.25	N/A	Pyrometer S/N: 78700030	Cal. Block Temp. °F: 84
Instrument Settings		Serial No.	B3533	N/A	Cable	
TCG (On/Off)	On	Frequency (MHz)	1.50	N/A		
Avg. (On/Off)	On	Nominal Angle	55	N/A		
No. of Avgs.	8	Measured Angle	55	N/A		

Cable	Length	Type
N/A	N/A	N/A
Pulsr/Pre	N/A	RG/174
Exam	N/A	RG/174
Device	N/A	Micro/cable
Total	N/A	

Search Unit Orientation: TWD ☐ AWY ☐ UP ☐ DN ☐ CW ☐ CCW ☐

Gate Start	0.00
Gate Range	16.00
Cal. Marker 1	3.49
Cal. Marker 2	13.95
DIG Rate (MHz)	12.5
Compaction	8
Units	Inches
No. Samples	419
DAC Ref. Level	80
Signal Mode	Video
Cal. Method	Metal Path
AMP Mode	% FSH
Filter Freq.	1.4
Base Gain	see remarks
TCG Clock Freq.	800
Ref. Amp. %FSH	80

Calibration Parameters

	Signal Amplitude	dB Difference	Signal Screen Distance
1	79	-0.11	3.47
2	57	2.94	6.98
3	38	6.47	10.42
4	25	10.10	13.93
5			
6			
7			

Mode: Longitudinal ☐ Shear ☑

Reflectors: Notches ☐ Holes ☑ Axial ☐ Circ. ☐

Notch dB N/A

1/4t Hole dB N/A

No. of Cons.: N/A Couplant: Di-Water

Remarks: Linearity Sheet # 010001

Set calibration hole @ 80% FSH (depth of 4.0")

Cable configuration 1 - Exam 1-55 Base gain 34.1 dB

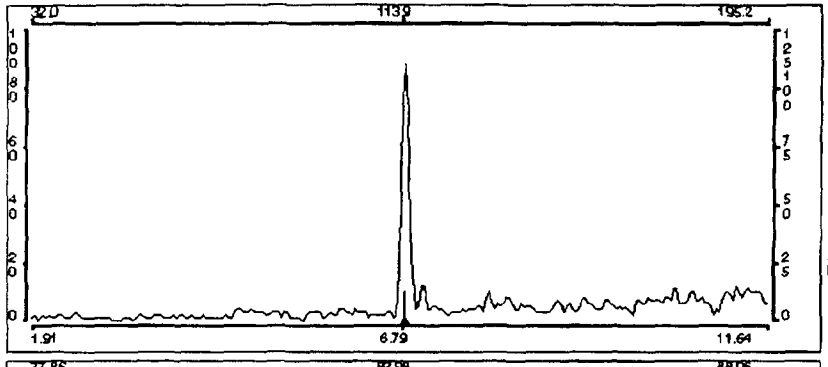
Cable configuration 2 - Exam 2-55 Base gain 34.4 dB

~~Cable configuration 3 - Exam 3-55 Base gain 37.1 dB~~ 10 FEB 07

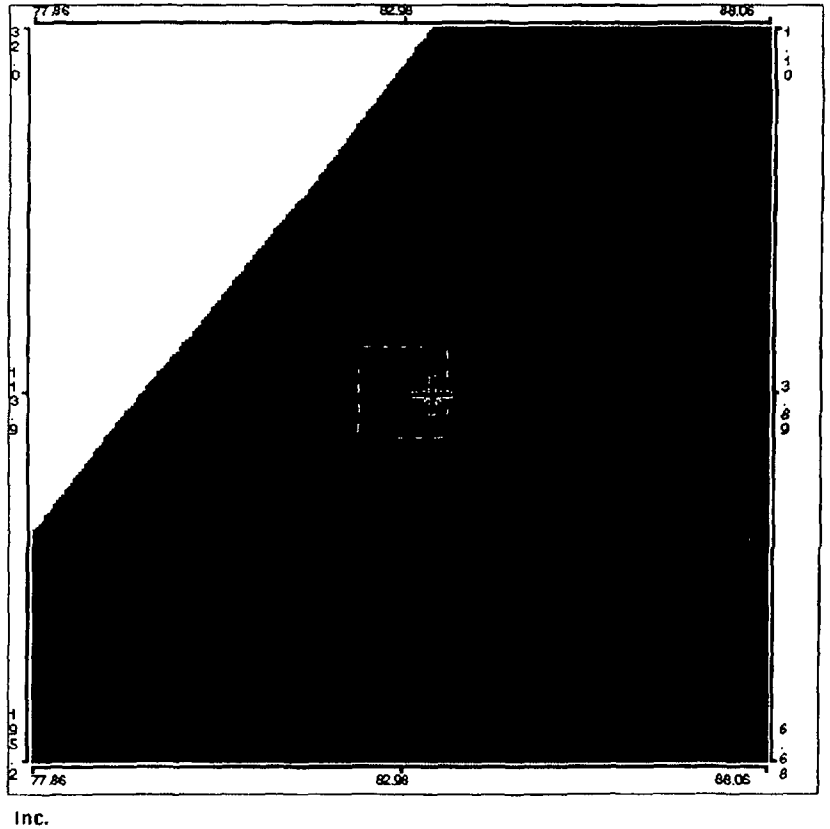
Reviewed By: [signature] SNT Level: III Date: 10 Feb 2007

ISwT Form No. UT-08 (Rev 11/99) Front

EDAS B-Scan Display – Channel 1, Refracted Angle 55–, Exam Number 1–55



1	SCAN NO.
83.18	INC. AXIS
83.38	SCAN AXIS
114.6	TIME
6.83	METAL PATH
3.92	MATERIAL DEPTH
88	% SCREEN HEIGHT
110	% DAC



B-SCAN CONTROL OPTIONS

Next B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 71.86

Upper 92.90

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc.	83.18
Scan	77.86
Depth	1.10

EDAS Feature Analysis – Channel 1

ASME Analysis

Select Reference Point

Point 1 Point 2

	Inc. Axis Location
	Surface Location
	Scan Axis Location
	Metal Path
	Time
	% DAC
	Depth In Material
	Separation

Lower	Upper	
1	4	Scan No. Limits
83.18	85.90	Inc. Axis Limits
2.72		Length

Select Maximum Point

110	% DAC
83.18	Inc. Axis Location
88.98	Surface Location
83.38	Scan Axis Location
6.83	Metal Path
114.6	Time
3.92	Depth In Material

Comments

: 55-deg., Cable Config. 1

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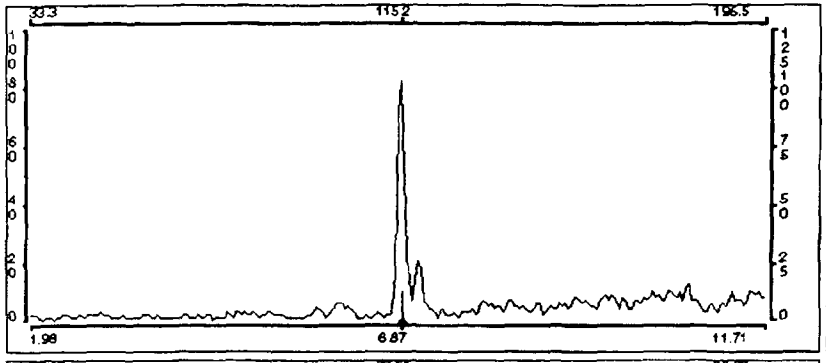
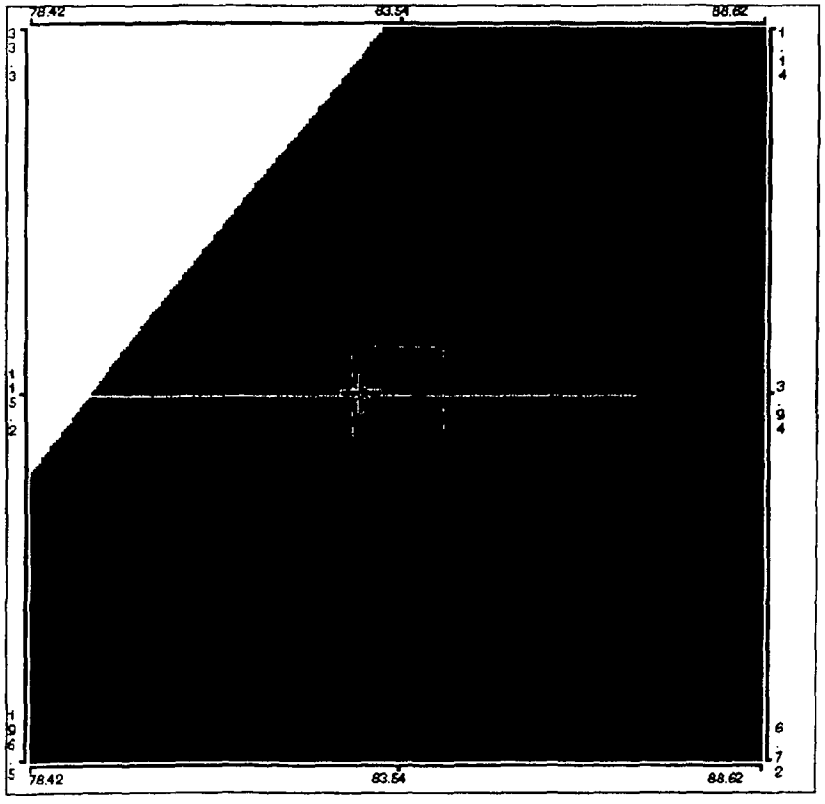
EDAS B-Scan Display - Channel 1, Refracted Angle 55-, Exam Number 2-55



1	SCAN NO.
83.18	INC. AXIS
83.02	SCAN AXIS
115.2	TIME
6.87	METAL PATH
3.94	MATERIAL DEPTH
82	% SCREEN HEIGHT
103	% DAC



B-SCAN CONTROL OPTIONS

Next B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 71.86

Upper 92.90

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc.	83.18
Scan	78.42
Depth	1.14

EDAS Feature Analysis - Channel 1

ASME Analysis

Select Reference Point

Point 1 Point 2

Inc. Axis Location
Surface Location
Scan Axis Location
Metal Path
Time
% DAC
Depth In Material
Separation

Lower	Upper	
1	4	Scan No. Limits
83.18	85.90	Inc. Axis Limits
2.72		Length

Select Maximum Point

103	% DAC
83.18	Inc. Axis Location
88.66	Surface Location
83.02	Scan Axis Location
6.87	Metal Path
115.2	Time
3.94	Depth In Material

Comments

: 55-deg. Cable Config. 2

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ISwT AUTOMATED INSTRUMENT CALIBRATION DATA RECORD

Project No.	Site:	EDAS Software Rev.:	File Name:	Sheet No.:
06-0455	Duane Arnold Energy Center	1.6.2	DEA-03-2	08cable55-1

Calibrator (Signature)	SNT Level:	Date (Day-Mo-Yr)	Time: (24 Hr. Clock)	Procedure No. ISwT-PDI-AUT1
[signature]	III	11-Feb-07	1310	Revision: 0 Chg. 0 ICN:1 & 2

Remote Pulser Preamp		EDAS II Channel Board			Calibration Block(s)	
Frame Select	1-2	Channel No.:	1	N/A	Basic Calibration Block:	70187-2
Rep Rate	2	Board Serial No.:	175598	N/A	Auxiliary Calibration Block:	N/A
Pulser Gain	35	Search Unit			Reference Calibration Block:	SwRI-IIW-24
Can No.	002	Brand/ Size	SwRI / 1.625 x 2.25	N/A	Pyrometer S/N: 78700031	Cal. Block Temp. °F: 84
Instrument Settings		Serial No.	B3533	N/A	Cable	
TCG (On/Off)	On	Frequency (MHz)	1.50	N/A		
Avg. (On/Off)	On	Nominal Angle	55	N/A		
No. of Avgs.	8	Measured Angle	55	N/A		

Cable	Length	Type
N/A	N/A	N/A
Pulsr/Pre	N/A	RG/174
Exam	N/A	RG/174
Device	N/A	Micro/cable
Total	N/A	

Search Unit Orientation: TWD ☐ AWY ☐ UP ☐ DN ☐ CW ☐ CCW ☐

Gate Start	0.00
Gate Range	16.00
Cal. Marker 1	3.49
Cal. Marker 2	13.95
DIG Rate (MHz)	12.5
Compaction	8
Units	Inches
No. Samples	419
DAC Ref. Level	80
Signal Mode	Video
Cal. Method	Metal Path
AMP Mode	% FSH
Filter Freq.	1.4
Base Gain	see remarks
TCG Clock Freq.	800
Ref. Amp. %FSH	80

Calibration Parameters

	Signal Amplitude	dB Difference	Signal Screen Distance
1	79	-0.11	3.47
2	57	2.94	6.98
3	38	6.47	10.42
4	25	10.10	13.93
5			
6			
7			

Mode: Longitudinal ☐ Shear ☑

Reflectors: Notches ☐ Holes ☑ Axial ☐ Circ. ☐ Notch dB N/A 1/4t Hole dB N/A

No. of Cons.: N/A Couplant: DI-Water

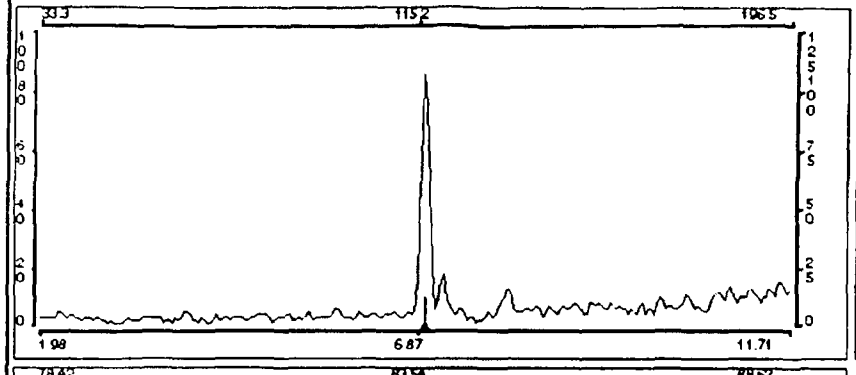
Remarks: Linearity Sheet # 010001

Cable configuration 4 - Exam 4-55 Base Gain 35.5 dB

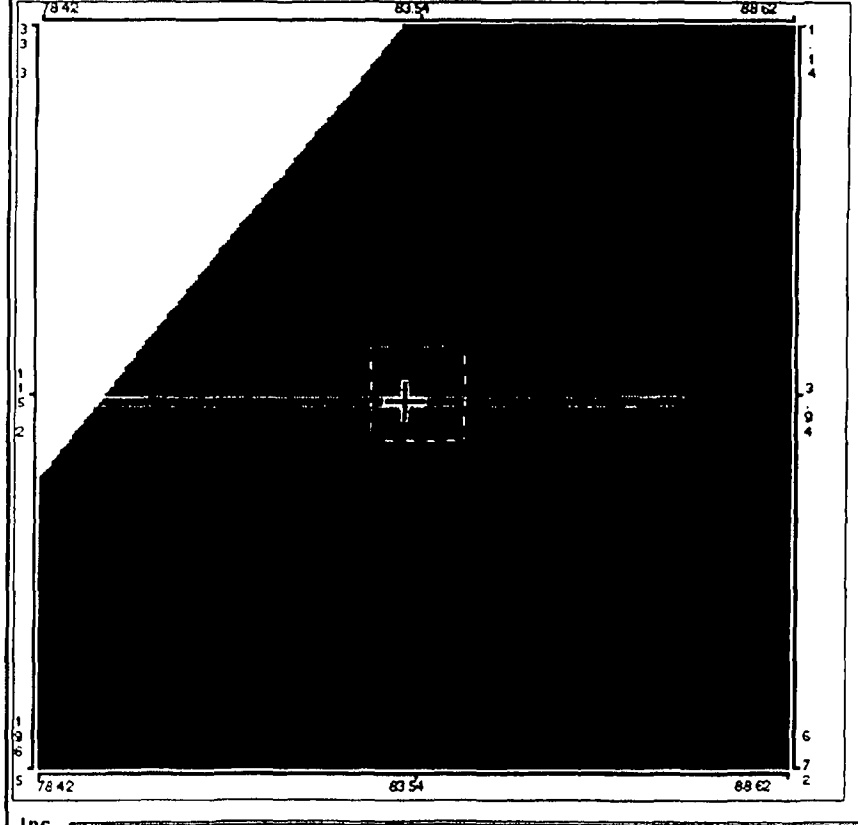
Reviewed By: [signature] SNT Level: III Date: 12 Feb. 2007

ISwT Form No. UT-08 (Rev 11/99) Front

EDAS B-Scan Display - Channel 1, Refracted Angle 55-, Exam Number 55LngEDAS



5	SCAN NO
86.37	INC AXIS
83.34	SCAN AXIS
116.5	TIME
6.94	METAL PATH
3.98	MATERIAL DEPTH
86	% SCREEN HEIGHT
107	% DAC



B-SCAN CONTROL OPTIONS

Previous B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 71.86

Upper 92.90

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc. 86.37

Scan 78.42

Depth 1.14

EDAS Feature Analysis - Channel 1

ASME Analysis

Select Reference Point

Point 1 Point 2

Inc. Axis Location
Surface Location
Scan Axis Location
Metal Path
Time
% DAC
Depth In Material
Separation

Lower	Upper	
1	5	Scan No. Limits
83.18	86.37	Inc. Axis Limits
3.19		Length

Select Maximum Point

107	% DAC
86.37	Inc. Axis Location
89.02	Surface Location
83.34	Scan Axis Location
6.94	Metal Path
116.5	Time
3.98	Depth In Material

Comments

: 55-deg. cable config. 4
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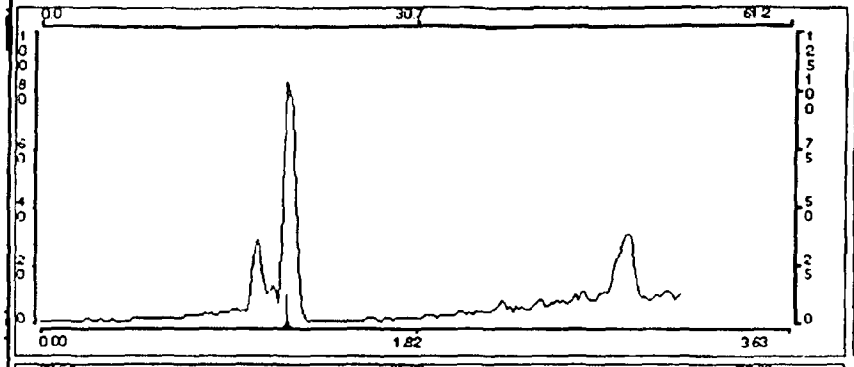
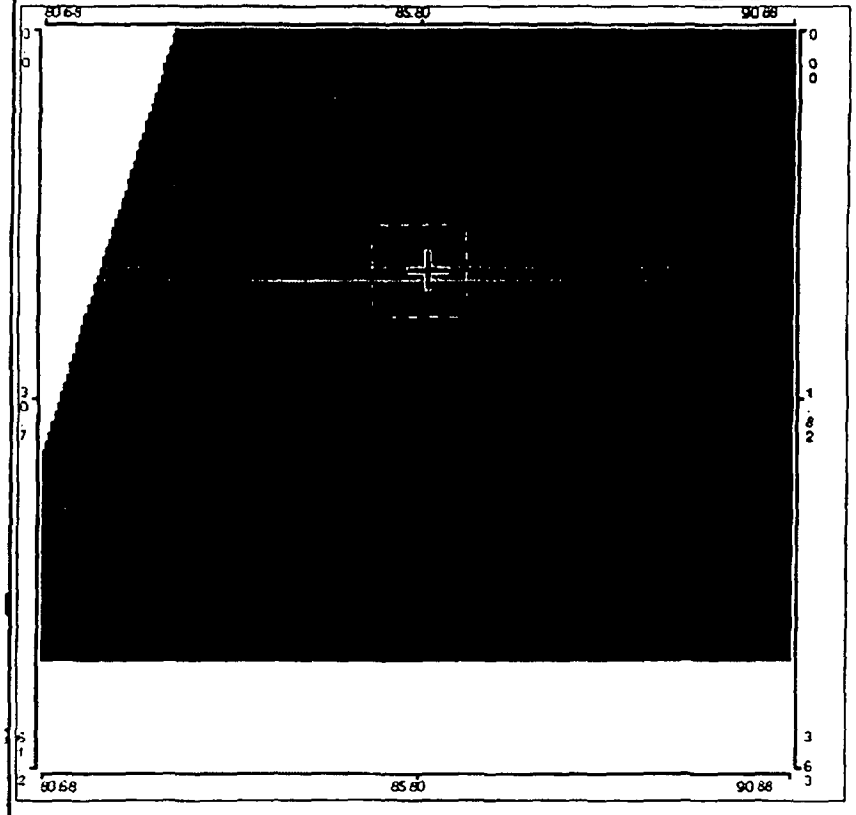
EDAS B-Scan Display – Channel 2, Refracted Angle 40–, Exam Number 40LngEDAS



3	SCAN NO
84.79	INC. AXIS
85.92	SCAN AXIS
20.2	TIME
1.19	MATERIAL DEPTH
83	% SCREEN HEIGHT
103	% DAC



B-SCAN CONTROL OPTIONS

Next B-Scan

Previous B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 79.84

Upper 100.88

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc. 84.79

Scan 80.68

EDAS Feature Analysis – Channel 2

ASME Analysis

Select Reference Point

Point 1 Point 2

Inc. Axis Location
Surface Location
Scan Axis Location
Depth In Material
Time
% DAC
Separation

Lower	Upper	
1	6	Scan No. Limits
83.18	87.30	Inc. Axis Limits
4.12		Length

Select Maximum Point

103	% DAC
84.79	Inc. Axis Location
86.92	Surface Location
85.92	Scan Axis Location
1.19	Depth In Material
20.2	Time

Comments

: SLIC-40, cable config. 4

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ISwT AUTOMATED INSTRUMENT CALIBRATION DATA RECORD

Project No.	Site:	EDAS Software Rev.:	File Name:	Sheet No.:
06-0455	Duane Arnold Energy Center	1.6.2	DAE-03-2	08cable55

Calibrator (Signature)	SNT Level:	Date (Day-Mo-Yr)	Time: (24 Hr. Clock)	Procedure No. ISwT-PDI-AUT1
[signature]	III	10-Feb-07	2155	Revision: 0 Chg. 0 ICN:1 & 2

Remote Pulser Preamp		EDAS II Channel Board			Calibration Block(s)	
Frame Select	1-2	Channel No.:	1	N/A	Basic Calibration Block:	70187-2
Rep Rate	2	Board Serial No.:	175598	N/A	Auxiliary Calibration Block:	N/A
Pulser Gain	35	Search Unit			Reference Calibration Block:	SwRI-IIW-24
Can No.	002	Brand/ Size	SwRI / 1.625 x 2.25	N/A	Pyrometer S/N: 78700030	Cal. Block Temp. °F: 84
Instrument Settings		Serial No.	B3533	N/A	Cable	
TCG (On/Off)	On	Frequency (MHz)	1.50	N/A		
Avg. (On/Off)	On	Nominal Angle	55	N/A		
No. of Avgs.	8	Measured Angle	55	N/A		
Gate Start	0.00					
Gate Range	16.00					
Cal. Marker 1	3.49					
Cal. Marker 2	13.95					
DIG Rate (MHz)	12.5					
Compaction	8					
Units	Inches					
No. Samples	419					
DAC Ref. Level	80					
Signal Mode	Video					
Cal. Method	Metal Path					
AMP Mode	% FSH					
Filter Freq.	1.4					
Base Gain	see remarks					
TCG Clock Freq.	800					
Ref. Amp. %FSH	80					

Cable	Length	Type
N/A	N/A	N/A
Pulsr/Pre	N/A	RG/174
Exam	N/A	RG/174
Device	N/A	Micro/cable
Total	N/A	

Search Unit Orientation: TWD ☐ AWY ☐ UP ☐ DN ☐ CW ☐ CCW ☐

No. of Cons.: N/A Couplant: DI-Water

Remarks: Linearity Sheet # 010001

Set calibration hole @ 80% FSH (depth of 4.0")

Cable configuration 1 - Exam 1-55 Base gain 34.1 dB

Cable configuration 2 - Exam 2-55 Base gain 34.4 dB

~~Cable configuration 3 - Exam 3-55 Base gain 37.1 dB~~ [initials] 10 FEB 07

Calibration Parameters

	Signal Amplitude	dB Difference	Signal Screen Distance
1	79	-0.11	3.47
2	57	2.94	6.98
3	38	6.47	10.42
4	25	10.10	13.93
5			
6			
7			

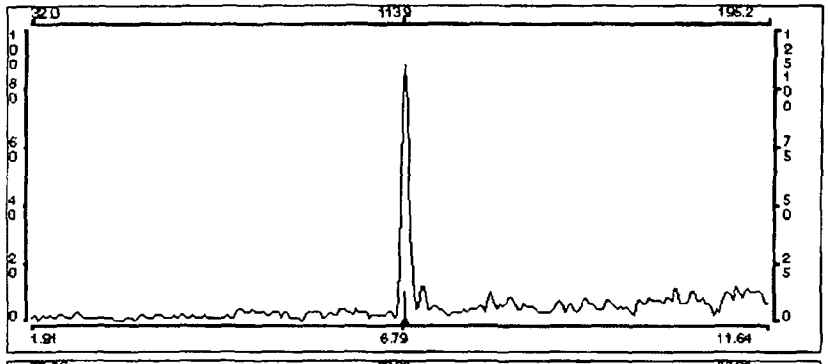
Mode: Longitudinal ☐ Shear ☑

Reflectors: Notches ☐ Holes ☑ Axial ☐ Circ. ☐ Notch dB N/A 1/4t Hole dB N/A

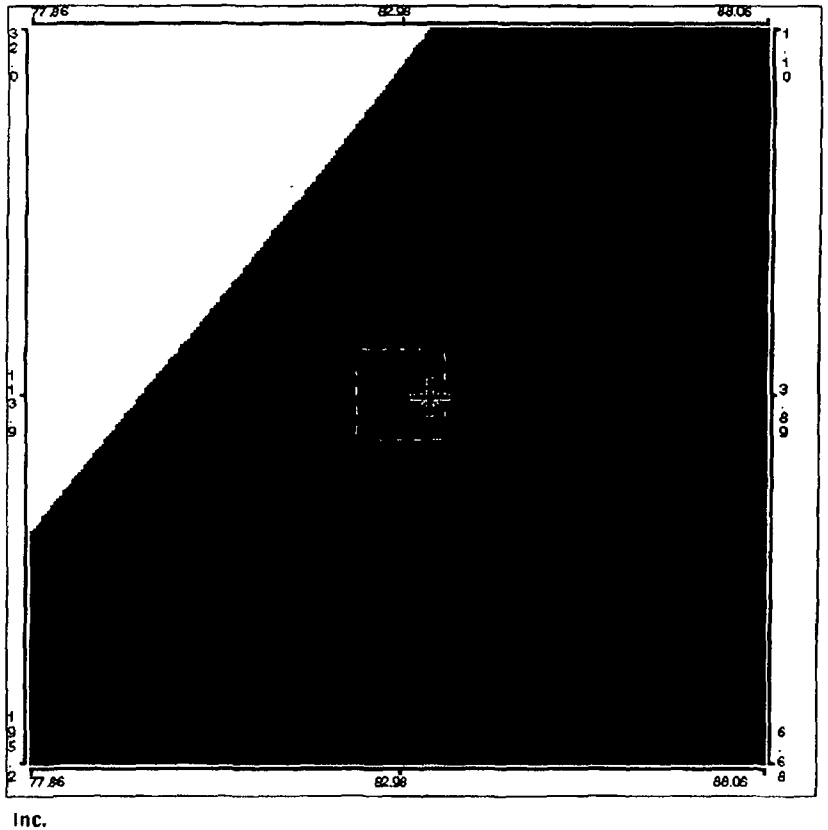
Reviewed By: [signature] SNT Level: III Date: 10 Feb 2007

ISwT Form No. UT-08 (Rev 11/99) Front

EDAS B-Scan Display – Channel 1, Refracted Angle 55–, Exam Number 1–55



1	SCAN NO.
83.18	INC. AXIS
83.38	SCAN AXIS
114.6	TIME
6.83	METAL PATH
3.92	MATERIAL DEPTH
88	% SCREEN HEIGHT
110	% DAC



B-SCAN CONTROL OPTIONS

Next B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 71.86

Upper 92.90

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc.	83.18
Scan	77.86
Depth	1.10

EDAS Feature Analysis – Channel 1

ASME Analysis

Select Reference Point

Point 1 Point 2

Inc. Axis Location
Surface Location
Scan Axis Location
Metal Path
Time
% DAC
Depth In Material
Separation

Lower	Upper	
1	4	Scan No. Limits
83.18	85.90	Inc. Axis Limits
2.72		Length

Select Maximum Point

110	% DAC
83.18	Inc. Axis Location
88.98	Surface Location
83.38	Scan Axis Location
6.83	Metal Path
114.6	Time
3.92	Depth In Material

Comments

: 55-deg., Cable Config. 1

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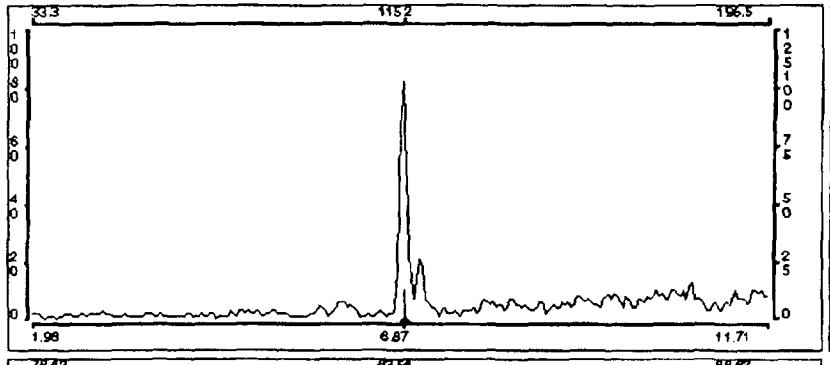
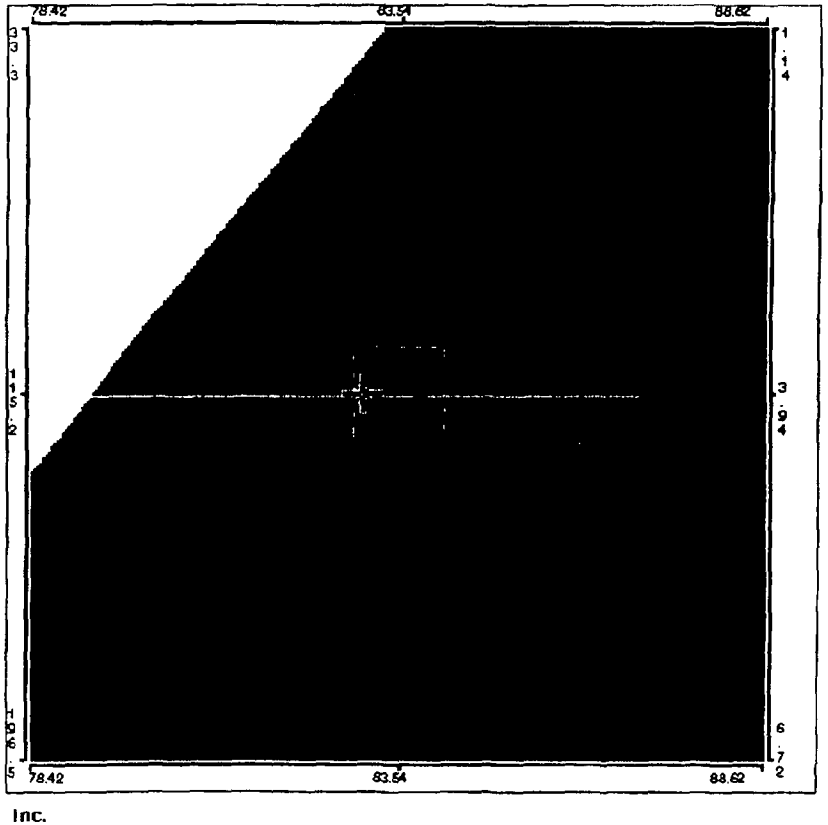
EDAS B-Scan Display - Channel 1, Refracted Angle 55-, Exam Number 2-55



1	SCAN NO.
83.18	INC. AXIS
83.02	SCAN AXIS
115.2	TIME
6.87	METAL PATH
3.94	MATERIAL DEPTH
82	% SCREEN HEIGHT
103	% DAC



B-SCAN CONTROL OPTIONS

Next B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 71.86

Upper 92.90

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc.	83.18
Scan	78.42
Depth	1.14

EDAS Feature Analysis - Channel 1

ASME Analysis

Select Reference Point

Point 1 Point 2

Inc. Axis Location
Surface Location
Scan Axis Location
Metal Path
Time
% DAC
Depth In Material
Separation

Lower	Upper	
1	4	Scan No. Limits
83.18	85.90	Inc. Axis Limits
2.72		Length

Select Maximum Point

103	% DAC
83.18	Inc. Axis Location
88.66	Surface Location
83.02	Scan Axis Location
6.87	Metal Path
115.2	Time
3.94	Depth In Material

Comments

: 55-deg. Cable Config. 2

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ISwT AUTOMATED INSTRUMENT CALIBRATION DATA RECORD

Project No.	Site:	EDAS Software Rev.:	File Name:	Sheet No.:
06-0455	Duane Arnold Energy Center	1.6.2	DEA-03-2	08cable55-1

Calibrator (Signature)	SNT Level:	Date (Day-Mo-Yr)	Time: (24 Hr. Clock)	Procedure No. ISwT-PDI-AUT1
	III	11-Feb-07	1310	Revision: 0 Chg. 0 ICN:1 & 2

Remote Pulser Preamp		EDAS II Channel Board			Calibration Block(s)	
Frame Select	1-2	Channel No.:	1	N/A	Basic Calibration Block:	70187-2
Rep Rate	2	Board Serial No.:	175598	N/A	Auxiliary Calibration Block:	N/A
Pulser Gain	35	Search Unit			Reference Calibration Block:	SwRI-IIW-24
Can No.	002	Brand/ Size	SwRI / 1.625 x 2.25	N/A	Pyrometer S/N: 78700031	Cal. Block Temp. °F: 84
Instrument Settings		Serial No.	B3533	N/A	Cable	
TCG (On/Off)	On	Frequency (MHz)	1.50	N/A		
Avg. (On/Off)	On	Nominal Angle	55	N/A		
No. of Avgs.	8	Measured Angle	55	N/A		

Cable	Length	Type
N/A	N/A	N/A
Pulsr/Pre	N/A	RG/174
Exam	N/A	RG/174
Device	N/A	Micro/cable
Total	N/A	

Search Unit Orientation: TWD ☐ AWY ☐ UP ☐ DN ☐ CW ☐ CCW ☐

Gate Start	0.00
Gate Range	16.00
Cal. Marker 1	3.49
Cal. Marker 2	13.95
DIG Rate (MHz)	12.5
Compaction	8
Units	Inches
No. Samples	419
DAC Ref. Level	80
Signal Mode	Video
Cal. Method	Metal Path
AMP Mode	% FSH
Filter Freq.	1.4
Base Gain	see remarks
TCG Clock Freq.	800
Ref. Amp. %FSH	80

Calibration Parameters

	Signal Amplitude	dB Difference	Signal Screen Distance
1	79	-0.11	3.47
2	57	2.94	6.98
3	38	6.47	10.42
4	25	10.10	13.93
5			
6			
7			

Mode: Longitudinal ☐ Shear ☑

Reflectors: Notches ☐ Holes ☑ Axial ☐ Circ. ☐

Notch dB N/A

1/4t Hole dB N/A

No. of Cons.: N/A Couplant: DI-Water

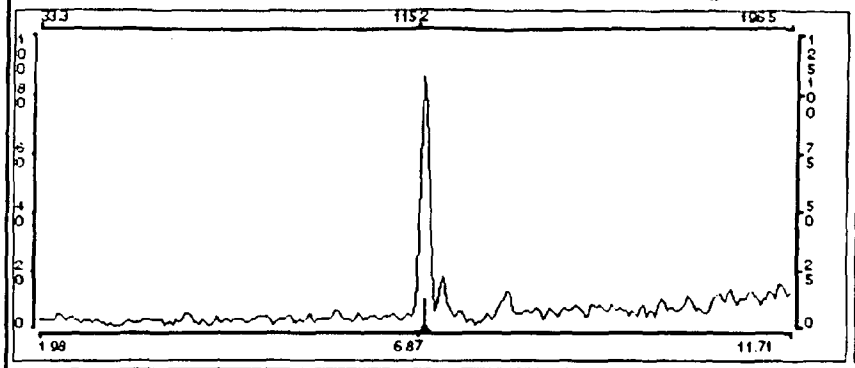
Remarks: Linearity Sheet # 010001

Cable configuration 4 - Exam 4-55 Base Gain 35.5 dB

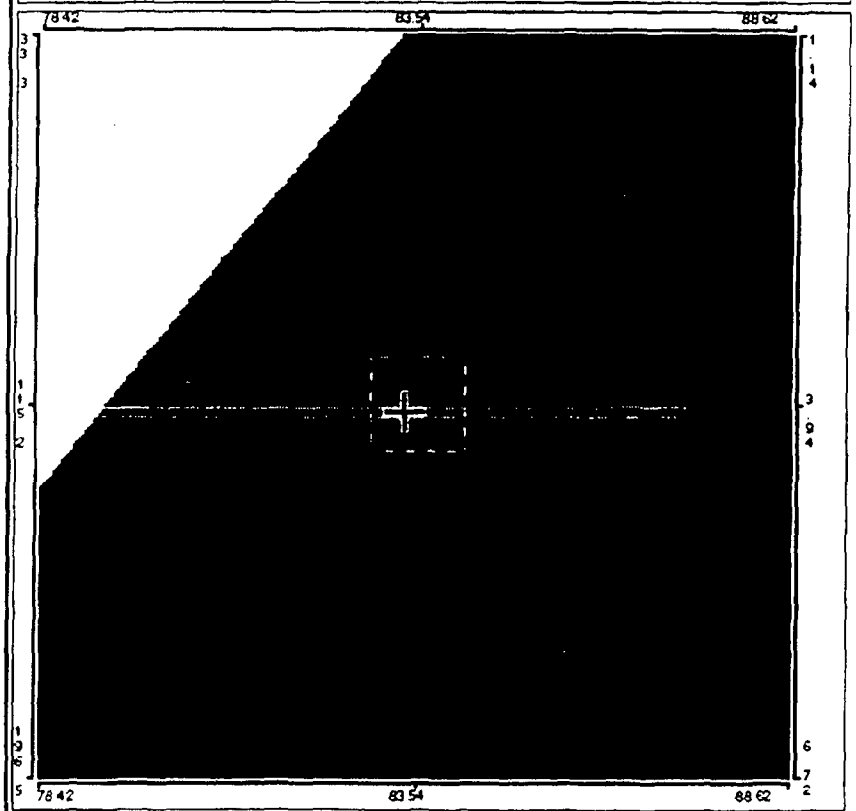
Reviewed By: SNT Level: III Date: 12 Feb. 2007

ISwT Form No. UT-08 (Rev 11/99) Front

EDAS B-Scan Display - Channel 1, Refracted Angle 55-, Exam Number 55LngEDAS



5	SCAN NO
86.37	INC AXIS
83.34	SCAN AXIS
116.5	TIME
6.94	METAL PATH
3.98	MATERIAL DEPTH
86	% SCREEN HEIGHT
107	% DAC



B-SCAN CONTROL OPTIONS

Previous B-Scan

A-SCAN CONTROL OPTIONS

Compressed Display

Replay Off

Direction Forward

Speed

Select Scan Axis

Lower 71.86

Upper 92.90

GEOMETRY OPTIONS

Mode Off

FEATURE ANALYSIS OPTIONS

Analyze Cursor Box

Inc. 86.37

Scan 78.42

Depth 1.14

EDAS Feature Analysis - Channel 1

ASME Analysis

Select Reference Point

Point 1 Point 2

Inc. Axis Location
Surface Location
Scan Axis Location
Metal Path
Time
% DAC
Depth In Material
Separation

Lower	Upper	
1	5	Scan No. Limits
83.18	86.37	Inc. Axis Limits
3.19		Length

Select Maximum Point

107	% DAC
86.37	Inc. Axis Location
89.02	Surface Location
83.34	Scan Axis Location
6.94	Metal Path
116.5	Time
3.98	Depth In Material

Comments

: 55-deg. cable config. 4

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