NPSD EASTERN TERRITORY

LIMERICK UNIT 2

AND DISSIMILAR METAL WELDS IN PIPING SYSTEMS

UT-AUSTENITIC-M Rev. 6 PAGE 1 of 29

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STATEMENT OF INTENDED USE

Approved for use at Limerick Generating Station
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1.0 SCOPE

1.1 General

1.1.1 This procedure defines the methods, equipment, and requirements for manual contact ultrasonic examination of austenitic, dissmilar metal, and ferritic welds and base material to stress corrosion cracking (SCC) sensitivity. This procedure is in accordance with ASME XI paragraph IWA-2240.

1.1.2 The requirements are limited to full penetration butt welds and adjacent base metal in piping systems and safe ends having nominal wall thickness from 0.2 inches to 6 inches, using straight beam and angle beam techniques.

1.1.3 Examinations shall be performed from the outside surface of the component(s).

2.0 REFERENCES

2.1 American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, 1980 Edition with Addenda through Winter 1981.

2.1.1 Section V, Nondestructive Examination

2.1.2 Section XI, Rules For Inservice Inspection of Nuclear Power Plant Components.

2.2 General Electric Company Procedures

2.2.1 Procedure for Qualification and Certification of Nondestructive Examination Personnel, AP-GQUA-277 or equivalent, which meets the requirements of the American Society for Nondestructive Testing (ASNT) Recommended Practice, SNT-TC-1A, 1980 Edition.

2.2.2 "UT-Evaluation", Procedure for Evaluation of Ultrasonic Examination Data.

2.3 Bechtel Procedures

2.3.1 Bechtel Construction Procedure, "CP-W-4", Procedure for Preservice Inspection of Nuclear Piping Systems.

3.0 PERSONNEL REQUIREMENTS

3.1 Personnel performing the examination shall include at least one person certified to a Level II. Qualification and Certification shall be in accordance with a written practice prepared in accordance with SNT-TC-1A. A Level I individual shall not independently evaluate or accept the results of the examination. Subcontractor personnel shall be obtained from an approved vendor.

3.2 Personnel evaluating the results of the ultrasonic examinations shall be certified to Level II minimum in accordance with SNT-TC-1A.

3.3 Personnel performing examinations and evaluations in accordance with this procedure shall receive an indoctrination of its contents. This indoctrination shall be documented and included in the final records package.

4.0 EQUIPMENT

4.1 Ultrasonic Instrument

4.1.1 The ultrasonic instrument shall be of the pulse echo type, and shall be equipped with a calibrated fine gain or attenuator control stepped in increments of 2dB or less.

4.2 Search Units

4.2.1 Angle beam examination shall be performed using single element transmit-receiver or dual element pitch-catch type search units having a nominal frequency from 1 to 5.0 MHz. Other frequencies may be used to obtain adequate penetration or resolution. For direct contact scanning, the search units should be 3/8 inch round or square for piping under 10 inches in diameter and should not exceed 1/2 inch round or square for larger diameter piping. For focused contact search units, the focal length shall be designed for the application.

4.2.2 Search units with contoured contact wedges may be used to aid ultrasonic coupling. Examinations shall be performed with the same search units and wedges used to establish system calibration.

4.2.3 Wedges shall be used that will produce angle beams at a nominal angle of 45° $\pm$ 3° in the examination medium. The actual beam paths to be utilized for the weld examinations shall be determined using the widest point of the weld crown and the thinnest wall section, to assure complete coverage.

4.2.4 A straight beam examination for base metal and weld metal shall be performed using single element transmit/receiver or dual element pitch/catch type search units with a nominal frequency from 1 to 5.0 MHZ. Other frequencies may be used to obtain adequate penetration/resolution. Adequate size and configuration to accommodate pipe diameter, weld crown size, mismatch or other restricting factors should be used.

NOTE: Transducers/Wedges of other sizes, angles, mode of propogation, or frequencies may be used where required by material characteristics, geometric configuration or for the evaluation of indications, with approval of the cognizant Level III. This approval may be documented during Level III review of the examination records.

4.3 Coaxial cables of any convenient length and number of connectors may be used for examination. The length and type of cable used shall be recorded on the Calibration Data Sheet. The cable(s)length used to establish system calibration shall be used to perform the examination(s).

4.4 When the remote master/slave system is employed, the CRT (slave unit used as an aid for the person scanning) may be of any type that will produce video display. It shall not contain any independent controls that could alter the performance parameters or calibration of the master instrument being monitored by the Level II examiner.

4.5 An IIW-2, or other calibration block simulator may be used for calibration checks, provided the the response is correlated with the DAC curve. Correlation shall be documented on the Calibration Data Sheet.

4.6 Basic Calibration Blocks

4.6.1 Material - The basic calibration blocks shall be made from material of the same nominal diameter and nominal wall thickness or pipe schedule as the pipe to be examined.

4.6.1.1 Material Specification

4.6.1.1.1 The calibration blocks shall be fabricated from one of the materials specified for the piping being joined by the weld.

4.6.1.1.2 Where the examination is to be performed from only one side of the joint, the calibration block material shall be of the same specification as the material on that side of the joint.

4.6.1.1.3 If material of the same specification is not available, material of similar chemical analysis, tensile properties, and metallurgical structure may be used, with PECO approval.

4.6.2 Surface Finish - The finish on the surfaces of the block shall be representative of the surface finish of the piping.

4.6.3 Retention Control and Responsibility - Basic calibration blocks shall be furnished by PECO.

4.7 Couplant

4.7.1 USP grade glycerine, D.I. water, or ULTRAGEL II shall be used for calibration and examinations. The couplant used during calibration(s) shall be used to perform the examination(s).

4.7.2 Couplants shall be certified for total sulfur and halogen content in accordance with ASTM D-129-64 and D-808-63. The total residual halogens and sulfur shall not exceed 250 PPM.

4.7.3 Other couplants which meet the above specification may be used with PECO approval.

4.8 Surface Contour Gauges

4.8.1 Contour gauges shall be used to determine the OD weld contour as specified herein.

5.0 CALIBRATION

5.1 Instrument Linearity Verifications

5.1.1 This calibration shall include the verification of screen height linearity and amplitude control linearity as described below. These checks shall be performed at the beginning of each shift.

5.1.2 Screen Height Linearity - To verify the ability of the instrument to meet the linearity requirement, position an angle beam search unit so that echoes can be observed from any two reflectors in a calibration block. Adjust the search unit position to give a 2 to 1 ratio of amplitudes between the two echoes, with the larger set at 80% of full screen height (FSH). Without moving the search unit, adjust instrument gain to successively set the larger echo from 100% to 20% FSH, in 10% increments (or 2 dB steps if a fine control is not available), and read the amplitude of the smaller signal at each setting. The readings must be 50% of the larger amplitude, within 5% of FSH. The setting and reading must be estimated to the nearest 1% of FSH. Alternatively, a straight beam search unit may be used on any calibration block that will provide the signal correlations.

5.1.3 Amplitude Control Linearity - To verify the accuracy of the amplitude control in the ultrasonic instrument, position a search unit so that an echo from one reflector in a calibration block is peaked on the screen. With the increases and decreases in gain shown below, the echo amplitude must fall within the specified limits. Convenient reflectors from any calibration block may be used with angle or straight beam search units. The settings and readings must be estimated to the nearest 1% of FSH.

Indication set at % of full screen	dB control change [1]	Indication limits % of full screen
80%	- 6 dB	32 to 48%
80%	-12 dB	16 to 24%
40%	+ 6 dB	64 to 96%
20%	+12 dB	64 to 96%

1 Minus denotes decrease in amplitude; plus denotes increase.

5.2 System Calibration

5.2.1 A system calibration shall be performed at the beginning of each shift, prior to use of the system in the thickness range being examined.

5.2.2 Calibration shall include the complete examination system. A change in search units, shoes, couplants, instruments, or any other part of the system (including operators) shall require a calibration check. The original calibration shall be performed on the applicable basic calibration block. Calibration checks may be performed on either the basic calibration block or a calibration block simulator, but they must include a check of the complete system.

5.2.3 The calibration block temperature shall be within 25°F of the temperature of the component to be examined. Thermometer SN and the temperature(s) shall be documented on the applicable Data Sheet(s).

5.3 General Requirements For Calibration

5.3.1 Obtain the angle beam path required in 6.3.3 on the sweep display. Variables such as weld preparation, weld crown width, or physical interference may preclude obtaining coverage of the examination volume with a 1/2 V examination from two sides as shown in Figure 2. If these variables are such that the dimension A of Figure 1 is greater than:

.93t for θ = 45°
1.19t for θ = 52°
1.60t for θ = 60°
2.50t for θ = 70°

the beam path shall be increased at least 1/2 V. Alternatively, the interference may be eliminated by one or more of the following:

1) reducing the dimension of the wedge edge to beam entry point;
2) reducing search unit size;
3) increasing the beam angle;
4) conditioning the weld surface;

5.3.2 Examinations may be performed using a 1/2 V path calibration when the "A" dimension requirements of paragraph 5.3.1 can be obtained. When the requirements of 5.3.1 can not be met, other methods described in the "Angle Beam Calibration" and "Angle Beam Examination" sections of this procedure may be used.

5.3.3 Determination of beam index - Position the angle beam search unit on an IIW-2 block or equivalent so that the beam is directed toward the appropriate radius surface. Move the transducer parallel to the sides of the block until a maximum echo is obtained from the reflecting radius. The beam index point is now above the centerline of the radius, as scribed on the applicable block. Place a mark on the side of the wedge to identify the index point.

5.3.4 Determination of beam angle - Place the angle beam transducer on the IIW-2 block or equivalent and obtain a peak signal amplitude from the 2 inch diameter hole. Read the refracted beam angle from the side of the block using the angle which corresponds with the beam index point.

5.3.5 Sweep calibration - Position the search unit on the IIW, DSC, Rompus block, or equivalent and maximize the responses from the radius reflectors. Using the sweep and delay controls, position these responses on the CRT to read the desired linear sound path in inches. Position the reflectors on the CRT to allow for a sound path of at least 1 V to be observed when calibrating for 1/2 V, 1 1/2 V's to be observed when calibrating for a Full V examination, and 2 V's to be observed when calibrating for a 1 1/2 V examination.

5.4 1/2 V Path Calibration (Unrestricted Access)

5.4.1 The maximum calibration indications shall be obtained with the sound beam oriented essentially perpendicular to the axis of the calibration reflector. The centerline of the search unit shall be at least 3/4 inch from the nearest side of the block. Rotation of the beam into a corner formed by the reflector and the side of the block may produce a higher amplitude signal at a longer beam path. This beam path shall not be used for calibration.

5.4.2 Position the search unit on the applicable basic calibration block. Using the drilled holes, obtain the maximum amplitude response from the reflector exhibiting the highest amplitude from the following positions, 3/8, 5/8, or 7/8 V path, and set its amplitude to 80% FSH. Without changing the gain, maximize the responses from the remaining V path positions. When the calibration block contains only a 1/2t hole, calibrate using the 2/8 and 6/8 V paths.

5.4.3 Connect these points with a smooth line and extend this curve horizontally from the 3/8 (or 2/8) V path response to the initial pulse. Extrapolate the line from the 7/8 (or 6/8) V path response to either the right hand side of the CRT or to the base line, whichever comes first.

5.4.4 Establish primary reference sensitivity be setting the response from the applicable ID notch equal to the DAC at that location.
Record the sweep postitions and amplitudes of the calibration reflectors on the Calibration Data Sheet. Measurements shall be recorded to the nearest .1" of metal path.

NOTE: Depending on joint configuration, Primary Reference Sensitivity may require an adjustment to provide acoustic equivalency. See Paragraph 5.8 for the A.E. requirements on welds without access restrictions.

5.5 Full V Path Calibration (When Access is Restricted to One Side Only)

5.5.1 When examining welds where access is restricted to scanning from one side of the weld, the following calibration technique shall be used.

5.5.2 Position the search unit on the basic calibration block and obtain a peaked signal amplitude from the applicable ID Notch. Set the response to 80% FSH. Without changing gain obtain a peaked signal amplitude from the OD Notch. Mark the amplitudes and positions of the responses on the CRT.

5.5.3 Connect these points with a smooth line and extend the curve horizontally from the 4/8 V path response to the initial pulse. Extrapolate the line from the 8/8 V path response to either the right hand side of the CRT or to the base line, whichever comes first. The gain used to establish the distance amplitude correction (DAC) curve, when adjusted to provide * acoustic equivalency per 5.9 is the primary reference sensitivity. Mark the position of the reflectors on the CRT and record instrument settings and screen positions on the calibration data sheet. Measurements shall be recorded to the nearest 0.1" of metal path.

* When an acoustic Equivalency determination can not be performed due to OD Configuration, nonparallel surfaces, etc., reference sensitivity shall be established by increasing the gain determined in paragraph 5.5.2 by 6 dBs (2X). Scanning and recording sensitivity shall be per paragraph 6.3.2.2.

5.5.4 Calibration for supplemental examination (Restricted access).

5.5.4.1 When required by the cognizant Level III, Full V path examinations may be supplemented with a refracted longitudinal wave scan when the weld being examined can only be examined from one side. Calibration for the supplemental examination shall be performed as follows.

1) A suitable calibration block shall be used to calibrate the UT instrument search unit combination for a sweep range of 1 1/2T minimum.

2) Position the search unit on the applicable basic calibration block. Obtain a peaked signal amplitude from the applicable I.D. notch. Set the response to 80% FSH.

3) Record the sweep position and amplitude on the Calibration Data Sheet. Measurements shall be recorded to the nearest 0.1" of metal path.

4) Scanning gain and recording level shall be in accordance with paragraph 6.3.2.2.

5.6 1-1/2 V Path Calibration

5.6.1 Using the appropriate notches, construct a DAC from the 4/8, 8/8, and 12/8 ID, OD, ID, nodal positions. Adjust the response from the 4/8 node ID notch to 80% FSH. Mark this point on the CRT. Maximize the response from the remaining notches and mark their response on the CRT, establishing a DAC. Record the amplitude, and the sweep position or metal path to each reflector on the Calibration Data Sheet. Measurements shall be recorded to the nearest .1" of metal path.

5.7 Establishment of a Secondary DAC Curve

5.7.1 If any point on a DAC curve (5.4.3, 5.5.3, or 5.6.1) falls below 20% FSH, a a secondary DAC shall be constructed as follows.

1) Determine the dB change necessary to increase the 20% FSH amplitude to 80% FSH, and increase the gain this amount.

2) The new 80% FSH point is used to extend the DAC to cover the remaining sweep distance.

3) The secondary DAC shall be marked on the CRT. The DAC and the dB change shall be recorded on the Calibration Data Sheet. Measurements shall be recorded to the nearest 0.1" of metal path.

4) The secondary DAC shall be the primary reference sensitivity for the portion of the sweep range it represents.

5.8 Acoustic Equvalency Determination (For unrestricted access)

5.8.1 For the fitting side of welds between pipe and fittings, with unrestricted scanning access to both sides of the weld, the primary reference sensitivity established in paragraph 5.4.4 shall be adjusted as necessary to obtain acoustic equivalency. Acoustic equivalency may be established for any examination volume as an aid to data evaluation if deemed necessary by the Level III responsible for the examination.

5.8.2 The following steps shall be performed to determine the gain adjustment (if any) necessary to establish equivalency in examination sensitivity between the fitting base material examined and the basic calibration block. These steps may be performed with any equipment capable of through transmission operation.

1) Adjust the screen to display a minimum of a full V path.

2) Position the search units in the * axial direction on the OD surface of the calibration block and maximize the full V return signal.

3) Adjust the sensitivity controls to produce a return signal amplitude of 80 percent FSH.

4) Record this sensitivity on the Calibration Data Sheet.

5) Using the same equipment, position the search units in the * axial direction on the OD surface and project the sound beam through the base material of the fitting.

6) Using the sensitivty recorded in step 4 above, maximize the return signal after a full V through the fitting.

7) If the amplitude of the return signal is not 80 percent FSH, change the sensitivity to bring the signal amplitude to 80 percent FSH. Note the sensitivity adjustment.

8) Perform steps 5-7 in three locations approximately 120° apart, on the fitting side of the weld being examined.

9) Determine the average dB change for the fitting side of the weld. Primary reference sensitivity may then be adjusted, provided the adjustment does not exceed 4 dB's. If the adjustment exceeds 4dB's of cannot be determined due to configuration (i.e. nonparallel surfaces). Notify the G.E. Level III prior to performing the examination.

10) Note the adjusted primary reference sensitivity on the Examination Data Sheet. When no adjustment is necessary, enter 0db on the data sheet.

11) The adjusted primary reference sensitivity shall be used during the recording of indications.

* Circumferential Direction may be used upon aproval from the cognizant Level III.

5.9 Acoustic Equivalency Determination (For Restricted Access)

5.9.1 For welds that are restricted to scanning from one side only, the primary reference sensitivity established in 5.5 shall be adjusted as necessary to obtain acoustic equivalency.

5.9.2 The following steps shall be performed to determine the gain adjustment (if any) necessary to establish equivalency in examination sensitivity between the welds examined with restricted access and the calibration block. These steps may be performed with any equipment capable of through transmission operation.

1) Adjust the screen to display a minimum of a full V path.

2) Position the search units in the axial direction on on the OD surface of the calibration block and maximize the full V return signal.

3) Adjust the sensitivity controls to produce a return signal amplitude of 80 percent FSH.

4) Record this sensitivity on the Calibration Data Sheet

5) Using the same equipment, position the search units on the OD surface and project the sound beam toward the restricted side through the weld being examined.

6) Using the sensitivity recorded in step 4 above, maximize the return signal after a full V through the weld.

7) If the amplitude of the return signal is not 80 percent FSH, change the sensitivity to bring the signal amplitude to 80 percent FSH. Note the sensitivity adjustment.

8) Perform steps 5-7 in three locations approximately 120° apart, through the weld being examined.

5.9.2 con't

9) Determine the average dB change for the weld. Primary reference sensitivity may then be adjusted, provided the adjustment does not exceed 6 dBs. If the adjustment exceeds 6 dBs or cannot be determined due to configuration (i.e. Nonparallel surfaces) notify the GE Level III prior to performing the examination.

10) Note the adjusted primary reference sensitivity on the Examination Data Sheet. When no adjustment is necessary, enter 0db on the data sheet.

11) The adjusted primary reference sensitivity shall be used for the recording of indications from the weld centerline to the edge of the examination volume on the restricted side.

5.10 Straight Beam 0° Calibration

5.10.1 Position the search unit on the basic calibration block applicable to the weld being examined using the drilled holes, obtain a signal from a 3/4t hole. Adjust the peak signal amplitude to be a minimum of 75 percent of FSH. This point represents primary reference sensitivity for the 0° L wave examination of the weld and required volume. Record this data on the Calibration Data Sheet along with the location of the back reflection and the amplitude and position of the 1/4t hole response (if detected).

NOTE: If no 3/4t hole is present, a 1/2t hole may be used.

5.11 Recording of Calibration Data.

5.11.1 Record all instrument settings and DAC points on the Ultrasonic Calibration Data sheet (Exhibit A). Calibration measurements shall be recorded to the nearest .1" of metal path.

5.12 Calibration Verification

5.12.1 A system calibration check, which is the verification of the instrument sensitivity and sweep range calibration, shall be performed.

a) at the start and finish of each series of examinations;

b) at intervals not to exceed 4 hrs;

c) with any change in examination personnel or system;

5.12.2 Corrective Actions

5.12.2.1 If any point on the DAC curve has decreased 20% or 2 dB of its amplitude, all data sheets since the last acceptable calibration check shall be marked void. A new calibration shall be made and recorded and the voided examination areas shall be reexamined.

5.12.2.2 If any point on the DAC curve has increased more than 20% or 2 dB of its amplitude, recorded indications taken since the last valid calibration or calibration check shall be reexamined with the correct calibration and their values changed on the data sheets.

5.12.2.3 If any point on the DAC curve has moved on the sweep line more than 10% of the sweep division reading, correct the sweep range calibration and note the correction in the examination record. If recordable reflectors are noted on the data sheets, those data sheets shall be voided, a new calibration shall be recorded, and the examination areas shall be reexamined.

6.0 EXAMINATION

6.1 Surface Conditions

6.1.1 The examination surface should be free of irregularities, loose material, or coatings which interfere with ultrasonic wave transmission.

6.1.2 Surface preparation, cleaning operations, and marking of the reference system are not within the scope of this procedure.

6.2 Examination Volume

6.2.1 Circumferential Welds

6.2.1.1 The minimum examination volume shall be the *inner 1/3 of the weld and base material (*1/3t) extended to a vertical line drawn 1/4" from the fusion line at each toe of the weld (Figure 2). Wherever feasible, the examination for Class 1 welds should be expanded to include essentially the full wall thickness extended to a vertical line drawn 1/2" from the fusion line at each toe of the weld.

6.2.2 Longitudinal Welds

6.2.2.1 Longitudinal welds shall be examined, when required. Class 1 longitudinal seams shall be examined for at least 1 foot from the intersection with the edge of the circumferential weld. Class 2 longitudinal seams shall be examined for at least 2 1/2t from the intersection with the edge of the circumferential weld. Preservice examination of Class 1 welds shall include 100% of the weld length.

6.2.2.2 The minimum examination volume shall be the *inner 1/3 of the weld and base material (*1/3t) extended to a vertical line drawn 1/4" from the fusion line at each toe of the weld. Wherever feasible, the examination for Class 1 welds should be expanded to include essentially the full wall thickness extended to 1/2" from the fusion line at each toe of the weld.

*Note: For Class 1 and Class 2 welds included in the "No Break" boundaries shown as Code Category + in Specification P-505 (ie. BJ+ or BF+), the examination volume shall be increased to t.

6.2.3 Restricted Examinations

6.2.3.1 Examination restrictions or limitations shall be noted on the Examination Data Sheet.

6 Scanning

6.3.1 Scans to be Performed

6.3.1.1 A straight beam (0°) examination shall be performed to detect conditions that could interfere with the required angle beam examinations.

6.3.1.2 Angle beam examination for detection of indications both parallel and transverse to the weld shall be performed.

6.3.1.3 The scans shall be identified as shown in Figure 3.

6.3.2 Angle Beam Scanning Sensitivity/Speed/Overlap

6.3.2.1 The scanning sensitivity for welds with unrestricted access and acoustic equivalency established per 5.8 or 5.9 should be at least *14dB above the primary reference sensitivity. Scans may be performed at levels lower than 14dB above reference sensitivity when noise level requires a reduction in gain. It is intended that the inside surface noise level during both 1/2 V and full V scanning be an average of 5% FSH. Scanning sensitivity must be no less than 2X reference sensitivity adjusted for acoustic equivalency if applicable. The scanning sensitivity used shall be documented on the Examination Data Sheet(s).

*The above scanning sensitivity may not be adequate in some highly attenuative materials. In these situations the gain shall be adjusted so the average inside surface noise is an average 5% FSH.

6.3.2.2 Where accoustic equivalency cannot be determined or when examining welds with access restricted to scanning from one side, a supplemental scan may be required in addition to the full V examination. The examination, if performed, shall be performed as follows.

1) Instrument gain shall be increased until either a 5%-10% FSH ID noise level is achieved or until front surface noise begins to obscure the inner 1/2t of wall thickness, whichever comes first.

2) The volume shall be scanned at the gain established above.

3) All indications with a signal to noise (s/n) ratio of 2 or greater shall be recorded . (i.e. Noise level = 10% FSH, recording level is 20% FSH)

4) Indications from ID roll need not be recorded unless in the opinion of the examiner an unusual condition is being observed.

5) The instrument gain used during scanning shall be recorded on the appropriate calibration and examination data sheets.

6.3.2.3 The scanning speed during examination shall not exceed 3" per second.

6.3.2.4 Scanning shall be performed so that the minimum scan overlap is at least 10% of the transducer transmitting piezoelectric element.

6.3.3 Angle Beam Scan

6.3.3.1 To detect discontinuities which are essentially parallel to the weld, the search unit shall be placed on the contact surface with the beam directed at about 90° to the weld and manipulated laterally and longitudinally with a minimum of 10° oscillation so that the sound beam passes through the required examination volume. The examination shall be performed from both sides of the weld (1/2 V) where possible or from one side of the weld as a minimum with a beam path long enough to examine the required volume in 2 beam directions.

6.3.3.2 To detect discontinuities which are essentially transverse to the weld, the skew angles for various pipe wall thicknesses are as shown on Exhibit D. The examination shall be performed on the required volume (Figure 2) with 1/2 V scanning in 2 directions where configuration permits. Other skew angles may be used if in the opinion of the Level III more meaningful data can be obtained.

△6 6.3.3.3 For welds where access is restricted scanning from one side only, an additional skew angle of approximately 45° ±10° shall be used. This shall be used to aid in the detection of discontinuities which are essentially parallel to the weld, and discontinuities which are essentially transverse to the weld, and to detect discontinuities which are oriented at angles other than transverse or parallel to the weld.

6.3.4 Straight Beam (0°) Scanning Sensitivity/Speed/Overlap

6.3.4.1 0° scanning sensitivity should be at least 2X primary reference sensitivity. In thin material (~ .700) it may not be possible to scan at 2X due to front surface noise obscuring the near portion of the pipe wall. In such cases, sensitivity may be reduced to assure coverage of the maximum portion of the pipe wall. In no case shall scanning be performed at less than reference sensitivity. The sensitivity used shall be recorded on the Examination Data Sheet(s).

6.3.4.2 Scanning speed during examination shall not exceed 3" per second.

6.3.4.3 Scanning shall be performed so that the minimum overlap is 10% of the transducer transmitting piezoelectric element.

6.3.5 Straight Beam (0°) Scanning

6.3.5.1 The 0° examination shall be performed on both the weld and required volume (Figure 2) and the base material through which the angle beams must pass.

6.4 Investigation of Indications

6.4.1 If, during the examinations the Level II believes that indications are caused by cracks, lacks of fusion, or lacks of penetration, they shall be noted on the Examination Data Sheet(s) regardless of amplitude.

6.5 OD WELD CONTOUR

6.5.1 Contour gages shall be used to establish the OD weld contour in 4 approximately equally spaced locations around the weld. In addition, the OD contour shall be taken at the location of each indication recorded during the scans referenced in 6.3.2. and 6.3.4. The contour of the weld shall be traced as follows: At the position of maximum amplitude along each indication the general OD contour of the weld and component surface shall be profiled by applying a pin gage to the weld and/or component surface. The pin gage contour measurement shall be continuous along the area to be profiled. The OD profile shall cover the weld and sufficient base metal to extend 1 inch beyond the search unit position, where possible. Outside diameter profiles shall be conducted by placing the pin gage on the OD surface of the weld and adjacent component material and applying pressure to obtain a contour. One tooth of the pin gage shall be raised when profiling to identify the weld centerline. After forming the contour and establishing the elevated gage tooth reference, this section of the OD contour shall be traced from the pin gage and the process repeated until the area has been completely profiled.The above contours and corresponding thickness readings shall be recorded on the Weld Thickness Profile sheet (Exhibit B).

7.0 DATA RECORDING

7.1 Recording Of Angle Beam Data

7.1.1 Non-Geometric Indications

Any indication in excess of 20% of DAC in austenitic type materials or 50% of DAC in ferritic type materials, located in the weld and required volume, shall be recorded in accordance with paragraph 7.1.1.1 and 7.1.1.3. DAC levels shall be adjusted for acoustic equivalency if applicable.

7.1.1.1 The amplitude, and the search unit position (W),search unit location (L), the beam direction, the sweep reading to the reflector (SW),at the peak amplitude,and reflector end points shall be recorded to *20% DAC. Reflector amplitude is either :1) *20% of DAC for relectors that equal or exceed 20% of DAC or 2) *20% of DAC and 100% of DAC for reflectors that equal or exceed 100% DAC.

7.1.1.2 Any indication suspected to be a crack, lack of fusion or incomplete penetration shall be recorded regardless of amplitude. All indications recorded per the above requirements shall be investigated to the extent necessary to determine the shape, identity, and location of the reflector. L & W measurements shall be recorded in inches to the nearest .1".

7.1.1.3 When indications are detected on the restricted side of a weld scanned in accordance with paragraph 6.3.2.2, they shall be recorded regardless of amplitude. Data shall be recorded at scanning sensitivity. Indications from ID roll need not be recorded unless, in the opinon of the examiner, an unusual condition is being observed. All indications detected shall also be compared to the primary reference sensitivity established in Paragraph 5.5.3. Indications that have amplitudes equal to or exceeding 100% DAC shall be recorded to both the 100% and 20% DAC end points. Indications that have amplitudes between 20% and 100% DAC shall be recorded to the 20% DAC end points only.

7.1.1.4 For the supplemental examination required by paragraph 6.3.2.2, data shall be recorded per 7.1.1.1 and 7.1.1.2 except that the reflector end points are the points at which the S/N ratio is below 2:1.

7.1.2 Geometric and Metallurgical Indications

7.1.2.1 Any Indication is excess of 20% DAC shall be recorded in accordance with 7.1.2.2.

7.1.2.2 Record the peak amplitude, the transducer position (W max), transducer location (L max), the sound beam direction (1 thru 4) the sweep reading (SW max) to the reflector, at the peak amplitude point only. Record the transducer positions and locations parallel to the reflector,at the end points (L1-L2), at which the signal drops below *20% DAC. "L" and "W" measurements shall be recorded to the nearest .1".

7.1.2.3 Indications from ID and OD geometry may be recorded once per paragraph 7.1.2.2 provided the operator periodically checks the transducer position and sweep readings at the peak amplitudes. The operator shall record on the examination data sheet the extent to which the indications occur (i.e.Intermittent 360°,or "Intermittent 0" to 32").

* NOTE 20% DAC becomes 50% DAC for ferritic type mateials.

7.2 Recording of Straight Beam (0°) Data

7.2.1 Base Material Indications

Record on the data sheet all areas of base material which exhibit a total loss of back reflection. In addition, record all areas where intermediate reflector(s) with signal amplitudes equal to or greater than the remaining back reflection appear. If numerous overlapping indications of lesser amplitudes exist which in the opinion of the Level II could prevent a meaningful angle beam examination they shall be documented. These indications shall be recorded using the back reflection sensitivity established in 5.9.1.

7.2.2 Indications Within the Weld and Required Volume

7.2.2.1 The search unit postion (W), search unit location (L) the sweep reading to the reflector (SW) at the peak amplitude point and reflector end points shall be recorded to *20% DAC. *20% of DAC or 20% of DAC and 100% of DAC for reflectors that equal or exceed 100% of DAC.

7.2.2.2 Any indication suspected to be a crack, lack of fusion or incomplete penetration shall be recorded regardless of amplitude. All indications recorded per the above requirements shall be investigated to the extent necessary to determine the shape, identity, and location of the reflector. L&W measurements shall be recorded in inches to the nearest .1".

7.3 Determination of "L" and "W" measurements

7.3.1 "L" and "W" measurements shall be determined in accordance with the conventions shown in Figure 5 for both circumferential and longitudinal weld seams.

7.4 Record any interference(s) to scanning and dimensions of the area not scanned on the applicable data sheet(s).

8.0 REPORTS AND RECORDS

8.1 Minimum Information Requirements

8.1.1 Examination records shall include, but not necessarily be limited to the following:

8.1.2 Calibration Data Sheet (Exhibit A)

a) calibration sheet identification and date and time period of calibration.
b) name(s) of examination personnel
c) examination procedure number and revision
d) basic calibration block identification
e) ultrasonic instrument identification and serial number
f) Beam angle, couplant, and mode of wave propagation in the material
g) orientation of search unit with respect to the pipe (longitudinal or circumferential)
h) search unit identification - frequency, size, Manufacturer, and serial number
i) reviewers signature, level and date
identification, if used
j) search unit cable type, and length
k) times of initial calibration and subsequent and final calibration checks.
l) instrument settings, amplitudes, and sweep postitions used to establish primary reference sensitivity.
m) thermometer serial number and required calibration block temperatures
n) reviewers signature, level and date

8.1.3 Examination Data Sheet (Exhibit C)

a) data sheet identity and examination date and time period of the examinations
b) name(s) and ASNT Level(s) of examination personnel
c) examination procedure and revision
d) applicable calbration sheet identity
e) surface from which the examination is conducted
f) weld identification
g) record of indications or of volume free of indications
h) volume scanned, and scan limitations, if any
i) reviewers signature, level and date
j) search unit position and location for recorded indications
k) thermometer serial numbers and examination surface temperatures
l) acoustic equvalency adjustment where necessary or 0db when applicable

8.2 The format of exhibits are subject to change as may be required. The technical content of forms used shall contain as a minimum that shown on the exhibits.

9.0 Data Evaluation

9.1 Ultasonic data shall be evaluated, by a GE Level III, in accordance with GE procedure "UT-Evaluation".

9.2 Evaluated data shall be forwarded in accordance with contract and QA. Manual Requirements, for final disposition.

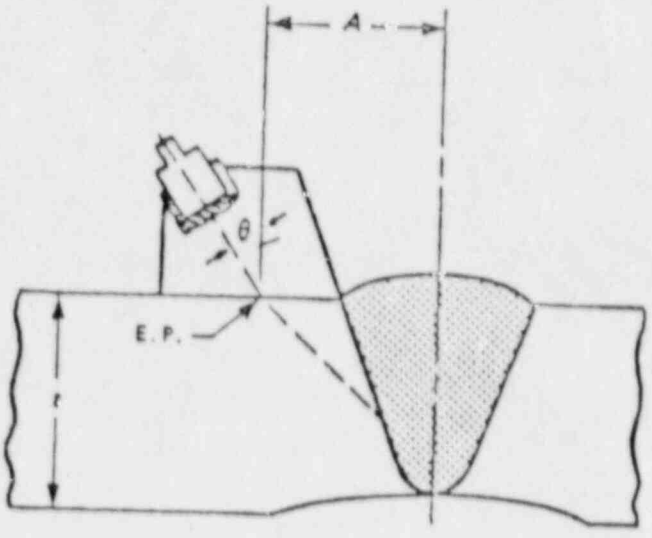


FIGURE 1

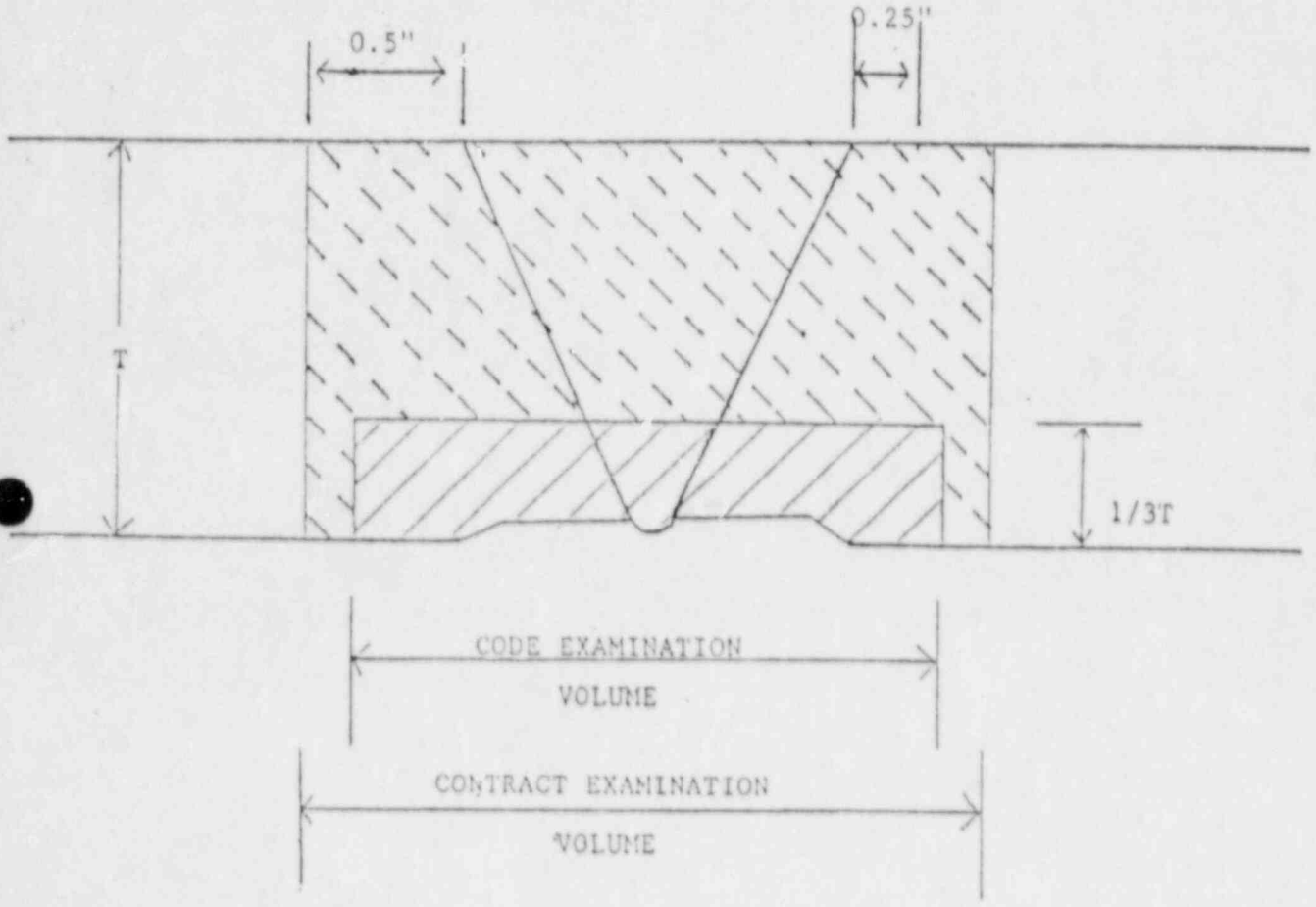

0.5"
0.25"
T
1/3T
CODE EXAMINATION
VOLUME
CONTRACT EXAMINATION
VOLUME

FIGURE 2

GENERAL ELECTRIC | ULTRASONIC CALIBRATION DATA SHEET

PROJECT

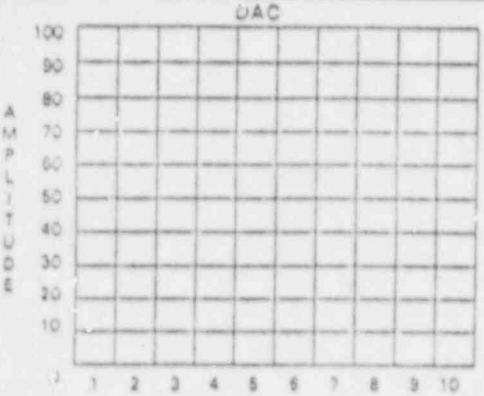
CALIBRATION SHEET No. _____
DATA SHEET(s) _____

PROCEDURE No. _____
REV. _____
INSTRUMENT _____
TYPE/MODEL _____
S/N _____

TRANSDUCER _____ S/N _____
TYPE _____
SIZE _____ FREQ. _____
WEDGE No. _____ ANGLE _____
CABLE TYPE/LENGTH _____

CALIBRATION BLOCK No. _____
TEMP. _____
TYPE OF EXAMINATION:
☐ SHEAR ☐ RL ☐ OTHER _____
COUPLANT _____
BATCH No. _____

DAC



X = AXIAL CAL.
O = CIRC. CAL.

SCALE RANGE: 0-" "

INSTRUMENT SETTINGS

FREQUENCY _____ MHZ _____
GAIN ... COARSE _____ FINE _____ AXIAL
COARSE _____ FINE _____ CIRC.
DELAY _____
SWEEP/MAT'L CAL _____
FILTER ☐ OFF ☐ ON ☐ FIXED
DAMPING ☐ OFF ☐ FIXED ☐ OTHER _____
REJECT ☐ OFF ☐ ON
REP RATE ☐ FIXED ☐ OTHER _____
RANGE _____
JACK ... ☐ R ... ☐ T

REFLECTOR TYPE
☐ NOTCH ☐ RADIUS
☐ SDH
☐ OTHER _____

FIELD SIMULATOR
TYPE _____ ID No. _____

	NEAR REFLECTOR	FAR REFLECTOR
MAXIMUM % AMP		
SWEEP/METAL PATH		

CALIBRATION VERIFICATION

INITIAL CALIBRATION TIME			
CALIBRATION VERIFICATION TIME(S)			
FINAL CALIBRATION VERIFICATION TIME		dB CHANGE FOR ACOUSTIC DIFFERENCE	
LAST DATA SHEET			

☐ HOLES
☐ NOTCHES

BEAM SPREAD

TRAILING RAY				MAXIMUM AMP.		LEADING RAY			
20% FSH		40% FSH		80% FSH		40% FSH		20% FSH	
W	SW	W	SW	W	SW	W	SW	W	SW

EXAMINED BY
LEVEL _____ DATE _____
RECORDED BY
LEVEL _____

REVIEWED BY
LEVEL _____ DATE _____

☐ REVIEWED BY ☐ APPROVED BY
_____ DATE _____

☐ SUPPLEMENTAL DATA ATTACHED Page # of

EXHIBIT A - CALIBRATION DATA SHEET

GENERAL ELECTRIC

GENERAL ELECTRIC

WALL THICKNESS PROFILE SHEET

SHEET NO.

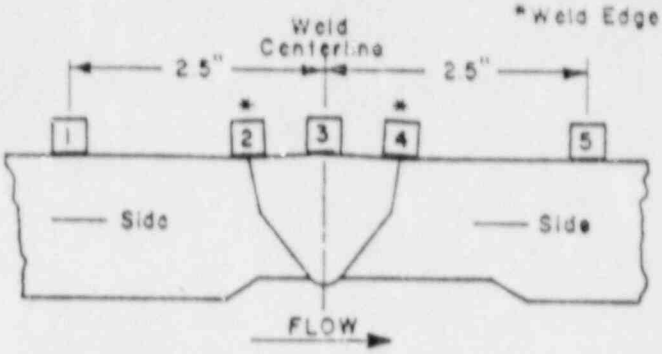
PROJECT:
Limerick Unit #2 PSI

SYSTEM _____ WELD NO. _____

UT Examination Data Sheet No. _____

Record Thickness Measurement As Indicate, Including Weld Width, Edge-To-Edge At 0°

Position	0°	90°	180°	270°
1				
2				
3				
4				
5				



CROWN HEIGHT: _____ DIAMETER _____

CROWN WIDTH _____ WELD LENGTH _____

MINIMUM DETECTED THICKNESS _____ X, Y LOCATION _____

EXAMINED BY _____ DATE _____

REVIEWED BY _____ DATE _____

☐REVIEWED ☐APPROVED _____ DATE _____

PAGE _____ OF _____

EXHIBIT B - WELD THICKNESS PROFILE SHEET

GENERAL ELECTRIC | ULTRASONIC EXAMINATION DATA SHEET

PROJECT

CAL SHEET NO _____ SHEET NO _____

PROCEDURE _____ REV NO _____

WELD NO _____
SYSTEM _____
MATERIAL TYPE _____
TEMPERATURE WITHIN 25°F OF CAL BLOCK
☐ YES
☐ NO
SCAN SENS _____ dB
L_D: _____
W_D: _____

EXAMINATIONS

1 ANGLE BEAM NORMAL
2 ANGLE BEAM ALONG WELD
a CLOCKWISE
b COUNTER CLOCKWISE
IDENTITY

3 ANGLE BEAM ALONG WELD
a CLOCKWISE
b COUNTER CLOCKWISE
IDENTITY

4 ANGLE BEAM NORMAL
5 BASE METAL L-WAVE
6 WELD METAL L-WAVE

	PERFORMED		INDICATION	
	YES	NO	YES	NO
1				
2				
a				
b				

INDICATION NO	L (in) FROM REF			W (in) FROM REF			MAX AMP % DAC	SWEEP READING			EXAM 1-6	SCANNING MODE
	L_1	L_{MAX}	L_2	W_1	W_{MAX}	W_2		SW_1	SW_{MAX}	SW_2		

COMMENTS

INDICATOR NO _____
REFER TO FLAW INDICATION EVALUATION REPORT NO _____
EVALUATED BY _____
LEVEL _____ DATE _____

Examined by _____
Level _____ Date _____
Recorded by _____
Level _____

Reviewed by _____
Level _____ Date _____

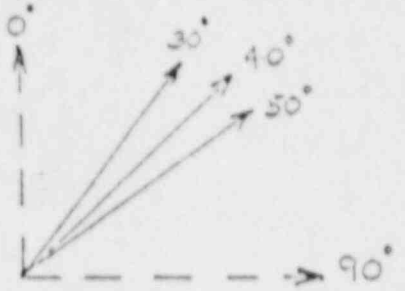
☐ SUPPLEMENTAL DATA ATTACHED

☐ Reviewed by ☐ Approved by _____
Date _____

Page _____ of _____

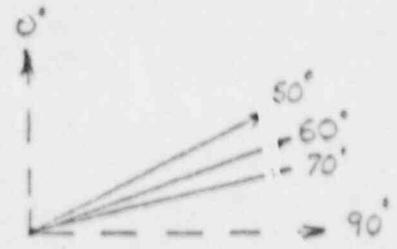
EXHIBIT C - EXAMINATION DATA SHEET

I. FOR NOMINAL WALL THICKNESSES ≥ 1.0"



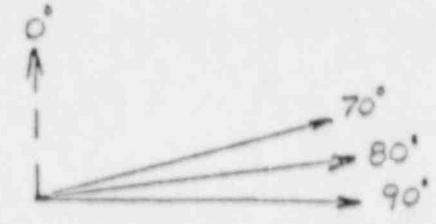
SKEW ANGLE OF 40°; MINIMUM OSCILLATION ANGLE OF ± 10° IN CLOCKWISE AND COUNTERCLOCKWISE DIRECTIONS.

II. FOR NOMINAL WALL THICKNESSES < 1" to .8"



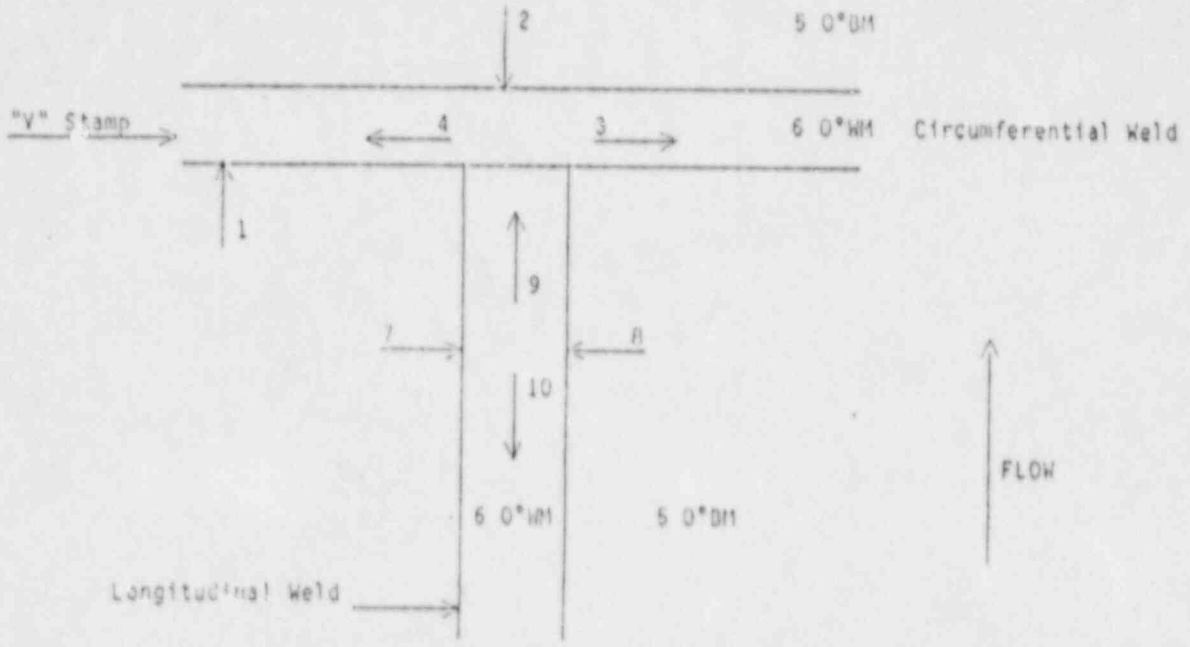
SKEW ANGLE OF 60°; MINIMUM OSCILLATION ANGLE OF ± 10° IN CLOCKWISE AND COUNTERCLOCKWISE DIRECTIONS.

III. FOR NOMINAL WALL THICKNESSES < .8"



SKEW ANGLE OF 80°; MINIMUM OSCILLATION ANGLE OF ± 10° IN CLOCKWISE AND COUNTERCLOCKWISE DIRECTIONS.

EXHIBIT D



Scan #1 Beam directed downstream and perpendicular to the weld (W/F)

Scan #2 Beam directed upstream and perpendicular to the weld (A/F)

Scan #3 Beam directed parallel to the weld in the direction of the "V"stamp (W/V)

Scan #4 Beam directed parallel to the weld against the direction of the "V"stamp (A/V)

Scan #5 0° examination of the Base Material through which angle beams must pass (BM)

Scan #6 0° examination of the Weld and Required Volume (WM)

Scan #7 Beam directed perpendicular to the weld in the direction of the "V"stamp (W/V)

Scan #8 Beam directed perpendicular to the weld against the direction of the "V"stamp (A/V)

Scan #9 Beam directed downstream and parallel to the weld (W/F)

Scan #10 Beam directed upstream and parallel to the weld (A/F)

FIGURE 3

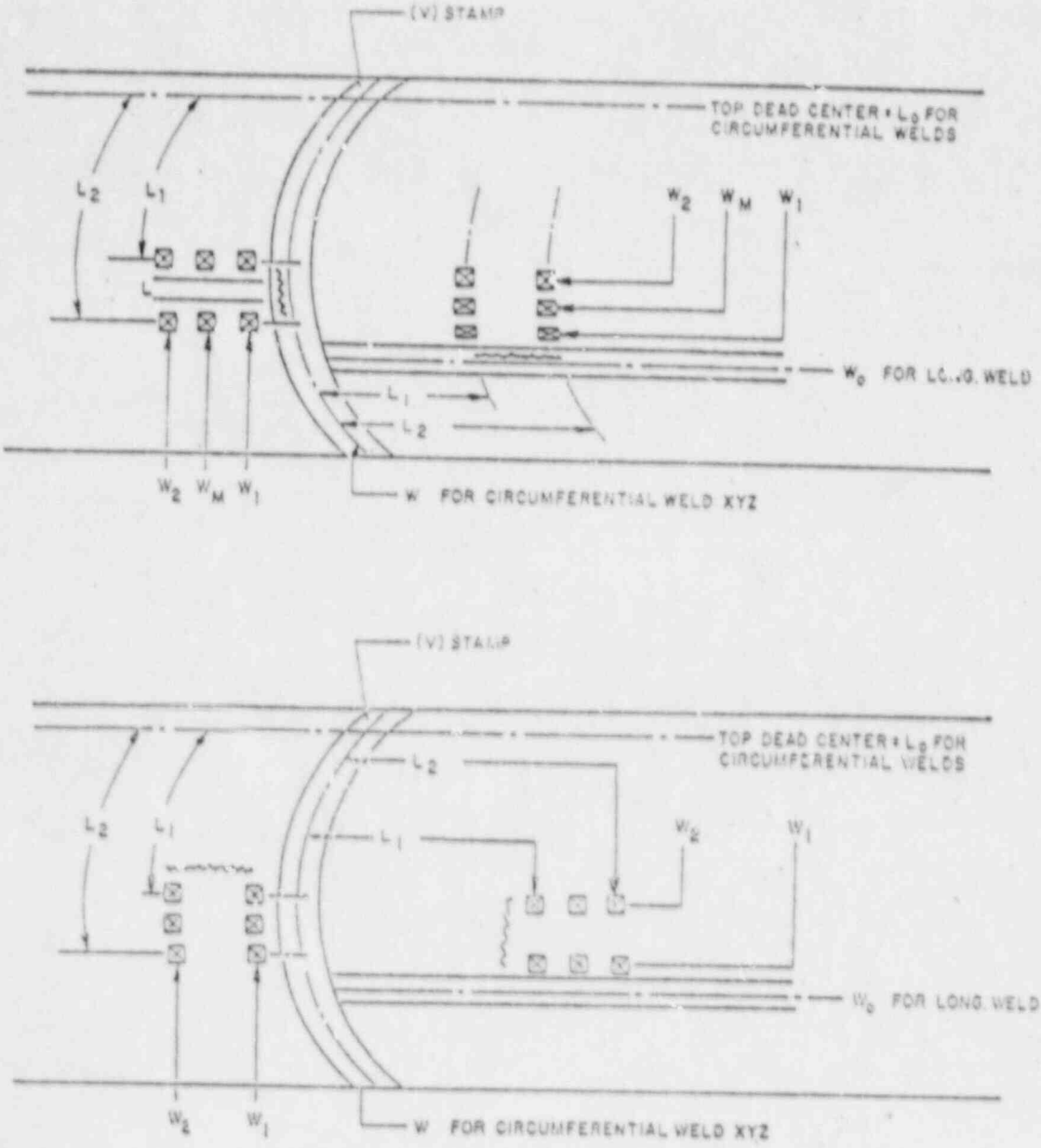

(V) STAMP
TOP DEAD CENTER + L_0 FOR CIRCUMFERENTIAL WELDS
L_2
L_1
W_2
W_M
W_1
W_0 FOR LONG. WELD
W FOR CIRCUMFERENTIAL WELD XYZ
(V) STAMP
TOP DEAD CENTER + L_0 FOR CIRCUMFERENTIAL WELDS
W_0 FOR LONG. WELD
W FOR CIRCUMFERENTIAL WELD XYZ

FIGURE 4

GENERAL ELECTRIC | INSTRUMENT LINEARITY DATA RECORD

Client _____ Serial No.: _____

Site _____ Date _____

Mfg. & Model: _____

SCREEN HEIGHT LINEARITY		
% FSH LARGER SIGNAL	% FSH SMALLER SIGNAL*	
	ACTUAL	LIMITS
100		45-55
90		40-50
80		35-45
70		30-40
60		25-35
50		20-30
40		15-25
30		10-20
20		5-15

* The Smaller Signal must be 50% of the Larger Signal within 5% of FSH.

SCREEN HEIGHT LINEARITY		
% FSH LARGER SIGNAL	% FSH SMALLER SIGNAL*	
	ACTUAL	LIMITS
100		45-55
90		40-50
80		35-45
70		30-40
60		25-35
50		20-30
40		15-25
30		10-20
20		5-15

* The Smaller Signal must be 50% of the Larger Signal within 5% of FSH.

AMPLITUDE CONTROL LINEARITY			
INDICATION SET AT % OF FULL SCREEN	DB CONTROL CHANGE*	INDICATION AT FSH	
		ACTUAL	LIMITS
80%	+ 6 DB		32-48
80%	+ 12 DB		16-34
40%	+ 6 DB		64-96
20%	+ 12 DB		64-96

* Minus denotes decrease in amplitude plus denotes increase in amplitude

AMPLITUDE CONTROL LINEARITY			
INDICATION SET AT % OF FULL SCREEN	DB CONTROL CHANGE*	INDICATION AT FSH	
		ACTUAL	LIMITS
80%	- 6 DB		32-48
80%	- 12 DB		16-34
40%	+ 6 DB		64-96
20%	+ 12 DB		64-96

*Minus denotes decrease in amplitude plus denotes increase in amplitude

HORIZONTAL LINEARITY

WITHIN LIMITS

☐ YES ☐ NO

HORIZONTAL LINEARITY

WITHIN LIMITS

☐ YES ☐ NO

EQUIPMENT DATA FOR LINEARITY CHECKS

Block Identification: _____

Transducer Data:

Serial No.: _____ Size _____

Beam Angle: _____ Freq.: _____

Shoe No.: _____ Cable No.: _____

Performed by: _____

Level: _____ Date _____

Reviewed by: _____

Level: _____ Date: _____

EQUIPMENT DATA FOR LINEARITY CHECKS

Block Identification: _____

Transducer Data:

Serial No.: _____ Size: _____

Beam Angle: _____ Freq.: _____

Shoe No.: _____ Cable No.: _____

Performed by: _____

Level: _____ Date: _____

Reviewed by: _____

Level: _____ Date: _____

EXHIBIT E