Los Alamos NATIONAL LABORATORY EST.1943

Blue Sheet
Engineering Division

DCN:

This Blue Sheet applies to:
☒ Individual Policy/Procedure Listed Below

LANL review date: 12/3/08

Policy/Procedure No:	**Rev. No.:**	**Date:**
# KSL – UT – AWS D1.1-06 Ultrasonic Inspection of Demand Critical Welds - 16-30-013	0	5/25/06

Manual, Policy or Procedure Title:

AWS D1.1-06 Ultrasonic Inspection of Demand Critical Welds - 16-30-013

Reason for Revision (if complete revision is checked above)
Roll over of SSS contractor activities and work to LANL/LANS

Documents listed above will be reviewed and conformed to by:
All personnel qualified to perform Ultrasonic Examination of Demand Critical welding & related fabrications for acceptance.

Description of Change:

1.0 Purpose – Modify – "KSL Personnel" to "inspection personnel"

2.0 Scope – No Changes

3.0 Definitions – – No Changes

4.0 Responsibilities – Delete "Quality Control\"

Add -

"UT Inspection personnel shall be qualified and certified in accordance with ESM, Chapter 13 – Welding & Joining, Volume 1, GWS 1-11 Attachment 3, Qualification and Certification of NDE Personnel.

5.0 Methodology –

Delete -

5.1.1 Personnel shall be qualified and certified to the latest approved revisions of Procedure 16-30-001- Nondestructive Examination (NDE) Personnel Qualification and Certification.
KSL Procedure 16-30-001, "Nondestructive Examination (NDE) personnel Qualification and Certification" is in compliance with the guidelines provided in the American Society for Non Destructive Testing recommended practice SNT-TC-1A (2001 Edition).

6.0 Records – No Changes

7.0 References – No Changes

KSL Procedures/Work Instructions

Add –

ESM, Chapter 13 – Welding & Joining, Volume 1, GWS 1-11 Attachment 3, Qualification and Certification of NDE Personnel.

Implementation Support Document ISD 330-5.0 – Special Processes

8.0 Attachment – No Change

Date Revision Required: **12/1/10**

Changes as marked

Reviewed by:

___Kelly Bingham_____ Date: ___12-9-08____

LANL Welding Program Administrator

Approved by:

____Signature on File_____ Date: 3/31/09____ ____ Signature on File____ Date: 3/31/09____

ES - DE Group Leader ES - DE Division Leader

MSS Policy/Procedures Review Team please forward original Blue Sheet to Luci Chavez upon approval

AWS D1.1-06 ULTRASONIC INSPECTION OF DEMAND CRITICAL WELDS

16-30-013

IMPLEMENTATION

Affected Personnel: QUALITY CONTROL PERSONNEL PERFORMING ULTRASONIC INSPECTION OF DEMAND CRITICAL WELDS

Training Determination: Required Reading

Procedure Owner: PERFORMANCE ASSURANCE

Effective Date: 6/30/2008	**Next Revision Date:** 6/30/2010
Procedure Level: Division	**Revision Number:** 0

DOCUMENT MODIFICATION HISTORY

Rev No.	Description of Modification
0	New Procedure

DOCUMENT REVIEW AND APPROVAL

Function	Name	Position Title	Date	Signature
Prepared and Approved by	Thomas Bentley	QC Supervisor \ NDE UT Level III	6/26/08	Signature on File
	John Salazar	Technical Writer	6/30/08	Signature on File
Quality Review and Approval by	Richard D. Maestas	Manager, Performance Assurance	6/26/08	Signature on File
Reviewed and Approved by	Richard Bingham	QC Manager \ NDE UT Level III	6/26/08	Signature on File
Final Approval by	John Merhege	Deputy General Manager	6/27/08	Signature on File

TABLE OF CONTENTS

1.0 PURPOSE

To provide written instruction for the Ultrasonic Examination of base metal and welded components by qualified and certified KSL personnel.

2.0 SCOPE

This written ultrasonic testing procedure contains the elements set forth in Section 6, Part F and paragraph S3 of Annex S of the American Welding Society Standard D1.1 -06 Structural Welding Code-Steel and the applicable requirements of AWS D1.1-04 Section 6, Part F and paragraph K3 of Annex K

It meets the requirements of Structural Welding Code-Steel- Seismic Supplement , AWS D1.8, American Welding Society, 2005 Edition section 7.10 and the requirements of AISC 341-05 Seismic Provisions for Structural Steel Buildings.

This procedure describes the methods to be used for the performance of Ultrasonic Examination of Groove Welds and Heat affected zones between the thicknesses of 5/16 inch and 8 inches inclusive. The types of weld joint configurations to be examined include:

- V-Groove, Single and Double Beveled Groove, Single and Double J, and Single and Double U Groove Butt Joints.
- V-Groove, Single and Double Beveled Groove, Single and Double J, and Single and Double U Groove “T”- Joints.
- V-Groove, Single and Double Beveled Groove, Single and Double J, and Single and Double U Groove Corner Joints.
- Fillet Welds.

This procedure is not to be used for testing of tube-to-tube, T, Y, or K connections.

Material less 5/16” or greater than shall utilize the procedure outlined in Annex S.

Acceptance criteria are based on n AWS D1.1-06 Table 6.2 for Statically Loaded Non-Tubular Connections and AWS D1.1-06 Table 6.3 for Cyclically Loaded Non-Tubular Connections.

3.0 DEFINITIONS/ACRONYMS

ASNT – American Society of Non-Destructive Testing

AWS – American Welding Society

AISC – American Institute of Steel Construction

UT – Ultrasonic testing

IIW – International Institute of Welding

NDE – Non-destructive examination

dB – Decibel

4.0 RESPONSIBILITIES

Quality Control \ NDE UT Technicians are required to follow the requirements listed in this procedure when performing Ultrasonic flaw detection per AWS D1.1 of Demand Critical Welds.

5.0 METHODOLOGY

NOTE:	**References in this document with an asterisk preceding figure or a paragraph number refers to the actual paragraph in the AWS D1.1-06 code book. Example (see *Fig 6.20 or * 6.30.3)**

5.1 PROCEDURAL STEPS

1. Personnel Qualifications

   - Personnel shall be qualified and certified to the latest approved revisions of KSL Procedure 16-30-001- Nondestructive Examination (NDE) Personnel Qualification and Certification.
   - KSL Procedure 16-30-001, “Nondestructive Examination (NDE) personnel Qualification and Certification” is in compliance with the guidelines provided in the American Society for Non Destructive Testing recommended practice SNT-TC-1A (2001 Edition).
   - The qualification of UT operators shall include a specific and practical examination based on the requirements of AWS D1.1-06 and AWS D1.8-05.

2. Responsibilities

   a. NDE Level III

      - An NDE Level III individual shall be capable of establishing techniques and procedures; interpreting codes, standards, specifications, and procedures; and designing the particular test methods, techniques, and procedures to be used. The NDE Level III shall be responsible for the NDE operations for which qualified and to which assigned, and shall be capable of interpreting and evaluating results in terms of existing codes, standards, and specifications. The NDE Level III shall have sufficient practical background in applicable materials, fabrication and product technology to establish techniques and to assist in establishing acceptance criteria where none are otherwise available. The NDE Level III shall have general familiarity with other appropriate NDE methods, and shall be qualified to train and examine NDE Level I and Level II personnel for certification.

   b. NDE LEVEL II

      - An NDE Level II individual shall be qualified to set up and calibrate equipment and to interpret and evaluate results with respect to the applicable codes, standards, and specifications. The NDE Level II shall be thoroughly familiar with the scope and limitations of the methods for which the individual is qualified and shall exercise assigned responsibility for the on-the-job training and guidance of trainees and NDE Level I Personnel. The NDE Level II shall be able to prepare written instructions and to organize and report the results of nondestructive tests.

   c. NDE LEVEL I

      - An NDE Level I individual shall be qualified to properly perform specific calibrations, specific tests, and specific evaluations for acceptance or rejection determinations according to written instructions and to record results. The NDE Level I shall receive

the necessary instructions or supervision from a certified NDE Level II or Level III individual.

5.2 EQUIPMENT QUALIFICATION

5.2.1 Ultrasonic Instruments

1. The ultrasonic test instrument shall be the pulse echo type suitable for use with transducers oscillating at frequencies between 1 and 6 MHz The display shall be an “a” scan rectified video trace.
2. The horizontal linearity of the test instrument shall be qualified over the full sound path distance to be used in testing in conformance with paragraph *6.30.1.
3. Test instruments shall include internal stabilization so that after warm-up no variation in response greater than +/- 1dB occurs with supply voltage change of 15% nominal or, in the case of a battery, throughout the charge operating life. There shall be an alarm or meter to signal a drop in battery voltage prior to instrument shutoff due to battery exhaustion.
4. The test instrument shall have a calibrated gain control (attenuator) adjustable in discrete 1or 2 dB steps over a range of at least 60 dB. The accuracy of the gain control settings shall be within plus or minus 1 dB. The procedure for qualification shall be as described in paragraphs*6.24.2 and *6.30.2.
5. The dynamic range of the instrument’s display shall be such that a difference of 1 dB of amplitude can be easily detected.
6. Specific Ultrasonic Test Instrument information includes:

Manufacturer:	***Krautkramer***
Model:	USN 60
Serial Numbers:	00RJY6, 00W3RT

Manufacturer:	***Krautkramer***
Model:	USN 52L
Serial Numbers:	602719, 602922, 602861

5.2.2 Ultrasonic Search Units (Transducers)

Straight beam (Longitudinal Wave) Search Units- Straight beam search unit transducers shall have an active area of not less than ½ square inch nor more than 1 square in. The transducer shall be round or square. Transducer shall be capable of resolving the 3 reflections as described in paragraph *6.29.1.3

Angle Beam Search Units-Angle Beam search units shall consist of a transducer and an angle wedge. The unit may be comprised two separate elements or may be an integral unit.

The transducer frequency shall be between 2 and 2.5 MHz, inclusive.

The transducer crystal shall be square or rectangular in shape and may be from 5/8 in. to 1 in. in width and from 5/8 to 13/16 in. in height (see *Fig 6.20).

The maximum ratio of width to height shall be 1.2 to 1.0, and the minimum width to height ratio shall be 1.0 to 1.0.

The search unit shall produce a sound beam in the material being tested within plus or minus 2°degrees of the proper angles: 70, 60, or 45 degrees as described in paragraph *6.29.2.2.

Each search unit shall be marked clearly to indicate the frequency of the transducer, nominal angle of refraction, and index point. The index point location procedure is described in paragraph *6.29.2.1.

Maximum allowable internal reflections from the search unit shall be as described in paragraph *6.24.3.

The dimensions of the search unit shall be such that the distance from the leading edge of the search unit to the index line shall not exceed 1 in.

Specific Ultrasonic search unit information includes:

Angle Beam Search Unit:

Manufacturer: ***KB-AEROTECH***

Model: Gamma

Size & Frequency: 2.25Mhz/3/4”x 3/4”, 5/8”x 5/8”,3/4”x 5/8”

Serial Numbers: H24425, M17774, D15769, J14415, J20417, J06431, G21443, G21442

Straight Beam Search unit:

Manufacturer: ***AEROTECH***

Model: Gamma

Size & Frequency: 2.25 MHz/1”Diameter

Serial Number: H23444 (SP), M16306 (SP), G14412 (SP), C14793

Manufacturer: ***Automation Industries***

Model: GN57A7014

Size & Frequency: 2.25 MHz/1”Diameter

Serial Numbers: J85015, J85012, I850219

5.2.3 Reference Standards

The International Institute of Welding (IIW) ultrasonic reference block, shown in Figure *6.20, shall be the standard used for both distance and sensitivity calibration. Other portable reference blocks may be used, provided the reference level sensitivity for the instrument/search unit combination shall be adjusted to be equivalent of that achieved with the IIW Block (see *Annex H for examples).

The use of a ‘corner’ reflector for calibration purposes is prohibited.

The combination of search unit and instrument shall resolve three holes in the RC resolution reference test block, as shown in *Figure 6.23. The search unit position is described in paragraph *6.29.2.5. The resolution shall be evaluated with the instrument controls set at

normal test settings and with indications from the holes brought to mid-screen height. Resolution shall be sufficient to distinguish at least the peaks of indications from the three holes. Use of the RC resolution reference block for calibration shall be prohibited. Each combination of instrument search unit (shoe and transducer) shall be checked prior to its initial use. This equipment verification shall be done initially with search unit and ultrasonic test unit combination. The verification need not be done again provided documentation is maintained that the records the following items:

- Ultrasonic test instruments make, model, and serial number.
- Search unit's manufacturer, type, size, angle, and serial number.
- Date of verification and technicians name. **Attachment 1**

5.2.4 Calibration Qualification

The horizontal linearity of the test instrument shall be re-qualified after each 40 hours of instrument use in each of the distance ranges that the instrument will be used. The qualification procedure shall be in accordance with paragraph *6.30.1 and or Annex H. **Attachment 2**

The instrument's gain control (attenuator) shall meet the requirements of paragraph*6.22.4 and shall be checked for correct calibration at two month intervals in conformance with *6.30.2. Alternative methods may be used for calibrated gain control (attenuator) qualification if proven at least equivalent with paragraph *6.30.2 **Attachment 5**

Maximum internal reflections from each search unit shall be verified at a maximum time interval of 40 hours of instrument use in conformance with paragraph *6.30.3. **Attachment 3**

With the use of an approved calibration block, each angle beam search unit shall be checked after each eight hours of use to determine that the contact face is flat, that the sound entry point is correct, and that the beam angle is within the permitted plus or minus 2 degree tolerance in conformance with paragraphs *6.29.2.1 and *6.29.2.2. Search units, which do not meet these requirements, shall be corrected or replaced. (If in use more than eight hours the verify at each eight hour interval)

5.2.5 Couplant

A couplant material shall be used between the search unit and the test material. The couplant shall be either glycerin or cellulose gum and water mixture of a suitable consistency. A wetting agent may be added if needed. Light machine oil may be used for couplant on calibration blocks.

The couplant used for ultrasonic test inspection may be one of the following or equivalent:

- SONOTECH ECHOGEL Grade 20
- KRAUTKRAMMER XL

When required, couplant shall be removed after examination is completed.

The couplant used for calibration should be the same as to be used for the test.

5.3 SURFACE PREPARATION

Contact Surfaces

- All surfaces to which a search unit is applied shall be free of weld spatter, dirt, grease, oil (other than that used as a couplant), paint, loose scale, and any roughness that would

interfere with the free movement of the search unit or impair the transmission of ultrasonic vibrations.

Weld Surfaces

- The weld surface shall be finished so they cannot mask or be confused with reflections from defects, and should merge smoothly into the surfaces of the adjacent base materials.

Transfer Surface Correction Methods

- For precise sensitivity standardization, transfer correction should be performed. This will ensure that the differences in acoustical properties, scanning surfaces and part shape between the calibration standard and the calibration block are utilized when performing the standard sensitivity calibration. Transfer correction values should be determined before examination and when material type, shape, thickness and scanning surfaces vary such that different values exceeding +/- 25% of the original values are expected. The transfer correction values should be determined per the procedure in *Figure S.4.

5.4 INSTRUMENT CALIBRATION

5.4.1 Straight Beam (Longitudinal Mode) Calibration

Distance Calibration

- Set the transducer in position G on the IIW block, position H on the DC block, or position M on the DCS block Figure*6.26 and or *Figure H-1.
- Adjust instrument to produce indications at 1”, 2”, 3”, 4”, etc. on the display.
- The horizontal sweep shall be adjusted for distance calibration to present the equivalent of at least two plate thicknesses on the display.

Amplitude

- Set the transducer in position G on the IIW block, position H on the DC block, or position M on the DSC black *Figure 6.26 and or *FigureH-1.
- Adjust the gain until the maximized indication from first back reflection attains 50 to 75% screen height.

Resolution

- Set the transducer in position F on the IIW block. *Figure 6.26
- Transducer and instrument should resolve all three distances.

5.4.2 Shear Wave Mode (Transverse) Calibration

Index Point

- Set the transducer in position D on the IIW block, position J or L on the DSC block, or I on the DC block. *Figure 6.26 and or *Figure H-1.
- Move the transducer until the signal from the radius is maximized. The point on the transducer which aligns with the radius line on the calibration block is the point of sound entry.

Transducer Angle

- Set the transducer in position B on IIW block for angles 40 degrees through 60 degrees. *Figure 6.26.
- Set the transducer in position C on IIW block for angles 60 degrees through 70 degrees. *Figure 6.26.
- Set the transducer in position K on DSC block for 45 degrees through 70 degrees. *Figure H-1
- Set the transducer in position N on SC block for 70 degree angle O for 45 degree, and P for 60 degree. *Figure H-1

Distance Calibration

- Set the transducer in position D on the IIW block (any angle). *Figure 6.26
- Adjust the instrument to attain indications at 4 in. and 9 in. on the instrument display using Type 1 IIW block.
- Set the transducer in position J or L on the DSC block (any angle). *Figure H-1.
- Adjust the instrument to attain indications at 1 in., 5 in. and 9 in. on the instrument display in the J position.
- Adjust the instrument to attain indications at 3 in. and 7 in. on the instrument display in the L position.
- Set the transducer in position I on the DC block (any angle). *Figure H-1
- Adjust the instrument to attain indications a 1 in., 2 in., 3 in., 4 in., etc., on the instrument display.

Amplitude or Sensitivity Calibration

- (Method -1) Set the transducer in position A on the IIW block (any angle) *Figure 6.26.
- Adjust the maximized signal from the 0.06 in. hole to attain a horizontal reference-line height indication (see *Annex H, H2.4 for alternative method).
- (Method -2) Set the transducer in position L on the DSC block (any angle) *Figure H-1.
- Adjust the maximized signal from the 1/32 in. slot to attain a horizontal reference line height indication.
- (Method -3) Set the transducer on the SC block position N for 70 degree angle, position O for 45 degree angle, or position P for 60 degree angle.
- Adjust the maximized signal from the 1/16 in. hole to attain a horizontal reference line height indication.
- The decibel reading obtained in Methods 1, 2, or 3 shall be used as the “Reference Level” “b” reading on the Test Report sheet *(Attachment 4) in conformance with *6.23.1

Resolution

- Set the transducer on resolution reference RC block position Q for 70 degree angle; position R for 60 degree angle, or position S for 45 degree angle. *Figure 6.26

- Transducer and instrument shall resolve the three test holes, at least to the extent of distinguishing the peaks of the indications from the three holes.

Approach Distance of Search Unit

- The minimum allowable distance between the toe of the search unit and the edge of the IIW block shall be as follows (see *Figure 6.21):
  - For 70 degree transducer: X = 2 in.
  - For 60 degree transducer: X= 1-7/16
  - For 45 degree transducer: X= 1 in.

5.5 EXTENT OF TESTING

The entire base metal through which ultrasound must travel to test the weld shall be tested for laminar reflectors using a straight beam search unit conforming to the requirements of paragraph *6.2.1. If any area of the base metal exhibits total loss of back reflection or an indication equal to or greater than the original back reflection height is located in a position that will interfere with the normal weld scanning procedure, its size, location, and depth from the A face shall be determined and reported on the ultrasonic test report and an alternate weld scanning procedure shall be used.

The reflector size evaluation procedure shall be in conformance with paragraph *6.31.1.

If part of a weld is inaccessible to testing in accordance with the requirements of *Table 6.7 due to laminar content, the testing shall be conducted using one or more of the following alternate procedures as necessary to attain full weld coverage:

- Grind the surface(s) flush in conformance with *5.24.4.1.
- Test from Faces “A” and “B.”
- Use other search unit angles.

Welds shall be tested using and angle beam search unit conforming to the requirements of paragraph *6.2.2 with the instrument calibrated in accordance with paragraph 8.2 using the angles as shown in *Table 6.7. Following calibration and during testing, the only instrument adjustment permitted is the sensitivity level adjustment with the calibrated gain control (attenuator). The reject (clipping or suppression) control shall be turned off. Sensitivity shall be increased from the reference level for weld scanning in accordance with the *Table 6.2 or 6.3, as applicable.

5.6 TESTING PROCEDURES

5.6.1 Weld Marking (Index Marking)

An “X” line for discontinuity location shall be marked on the test face of the weldment in a direction parallel to the weld axis. The location distance perpendicular to the weld axis is based on the dimensional figures on the detail drawing and usually falls on the centerline of butt joint welds, and always falls on the near face of the connecting member of T and corner joint welds (the face opposite Face C)

A “Y” accompanied with a weld identification number shall be clearly marked on the base metal adjacent to the weld that is ultrasonically tested. This marking is used for the following purposes:

- Weld Identification
- Identification of Face A
- Distance measurements and direction (+ or -) from the X Line.
- Location measurements from the weld ends or edges.

Testing Angle

- The required testing angle and test face shall be in accordance with *Table 6.7.

Scanning Patterns *(See Figure 6.24)

- Longitudinal Discontinuities
  - Scanning Movement A- Rotation angle a = 10 degrees.
  - Scanning Movement B- Scanning distance b shall be such that the section of the weld being tested is covered.
  - Scanning Movement C- Progression distance c shall be approximately one-half the transducer width, Note: Movements A, B, and C are combined into one scanning pattern.

Transverse Discontinuities

- Ground Welds. Scanning pattern D shall be used when welds are ground flush.
- Un-ground Welds. Scanning pattern E shall be used when weld reinforcement is not ground flush.
- Scanning angle e = 15 degrees max.

Electroslag or Electrogas Welds

- (Additional Scanning Pattern) – Scanning Pattern E.
- Search unit rotation angle e between 45 and 60 degrees.

NOTE:	**The scanning pattern shall be such that the full weld section is covered.**

Calibration for Testing

- All calibrations and tests shall be made with the reject (clipping or suppression) control turned off.
- Calibration for sensitivity and horizontal sweep (distance) shall be made by the ultrasonic operator just prior to and at the location of the testing of each weld,
- Re-calibration shall be made after a change of operators, each 30 minutes maximum time interval, or when the electrical circuitry is disturbed in any way, which includes the following: Attachment 6

- Transducer change
- Battery change
- Electrical outlet change
- Coaxial cable change
- Power outage (failure)

Straight Beam Calibration

- Calibration for straight beam testing of base metal shall be made with the search unit applier to Face A of the base metal and performed as follows:
  - The horizontal sweep shall be adjusted for distance calibration to present the equivalent of at least two plate thicknesses on the instrument display.
  - The sensitivity shall be adjusted at a location free of indications so that the first back reflection from the far side of the plate will be 50% to 75% of full screen height.

Angle Beam Calibration

- Calibration for angle beam testing shall be performed as follows:
  - The horizontal sweep shall be adjusted to represent the actual sound path distance by using acceptable distance calibration blocks shown in *Figure 6.22 and or H-1. The distance calibration shall be made using either the 5 in. scale or the 10 in. scale on the instrument display, whichever is appropriate, unless joint configuration or thickness prevents full examination of the weld at either of these settings, in which case, the distance calibration shall be made using 15 in. or 20 in. scale as required.

NOTE:	**The horizontal location of all screen indications is based on the location at which the left side of the trace reflection breaks the horizontal base line.**

Zero Reference Level

- The zero reference level sensitivity used for discontinuity evaluation (“b” on the ultrasonic test report, Attachment 4) shall be attained by adjusting the calibrated gain control (attenuator) of the discontinuity detector, so that a maximized horizontal trace deflection (adjusted to horizontal reference line height with calibrated gain control “attenuator” results on the display, in conformance with *6.29.2.4).

5.7 SCANNING LEVELS

When inspecting weldments, angle beam scanning is done at decibel levels, which exceed the reference sensitivity level. The required scanning levels are as follows:

Statically Loaded Non-tubular Connections

Scanning Levels

Sound Path in inches	Above zero reference, dB
to 2 ½	14
> than 2 ½ to 5	19
> than 5 to 10	29
> than 10 to 15	39

*This column refers to sound path distance: **NOT** material thickness.

Cyclically Loaded Non-tubular Connections

Scanning Levels

Sound Path* in inches	Above zero reference, dB
to 2 ½	20
> than 2 ½ to 5	25
> than 5 to 10	35
> than 10 to 15	39

* This column refers to sound path distance **NOT** material thickness.

5.8 INDICATION EVALUATION

All butt joint welds shall be tested from each side of the weld axis. Corner and T-joint welds shall be tested using the applicable scanning pattern or patterns shown in *Figure 6.24 as necessary to detect both longitudinal and transverse discontinuities. It is intended that, as a minimum, all welds be tested by passing sound through the entire volume of the weld and the heat-affected zone in two crossing directions, wherever practical.

The zero reference level sensitivity used for flaw evaluation (“b” on the ultrasonic test report) is attained by adjusting the calibrated gain control or attenuator of the flaw detector so that a maximized horizontal reference level trace deflection results on the display screen,

When scanning and a discontinuity indication appears on the screen, the maximum attainable amplitude from the discontinuity shall be obtained.

- The indication's amplitude shall then be decreased by adjusting the calibrated gain control or attenuator to the reference level amplitude. The discontinuity's reading at reference level amplitude shall be recorded as the "Indication Level, a" for calculating the "Indication Rating, "d", as shown on the test report. (Attachment 4).

The "Attenuation Factor, c" on the test report is attained by subtraction 1 in form the sound path distance and multiplying the remainder by two. This factor shall be rounded out to the nearest dB value. Fractional values less than ½ dB or greater increased to the higher level.

- The 'Transfer Correction Factor, e" should be added or subtracted as required per *annex S6.3

The " Indication Rating, "d" in the Ultrasonic Report, Attachment 4, represents the algebraic difference in decibels between the indication level and the reference level with correction for attenuation as indicated in the following expressions:

- Instruments with gain in dB:
  - a-b-c- = d
  - Transfer Correction Factor applied to indication rating
  - d +/- e = corrected indication ratting "d"
- The length of flaws shall be determined in conformance 5.8.1 (Angle beam testing).

Each weld discontinuity shall be accepted or rejected on the basis of its indication rating and its length, in accordance with *Table 6.2 for Statically Loaded Non-tubular Connections or *Table 6.3 Cyclically Loaded Non-tubular Connections, whichever is applicable. Only those discontinuities which are rejectable need to be recorded on the test report, except that for welds designed in the contract documents as being "Fracture Critical", acceptable ratings that are within 6 dB inclusive, of the minimum rejectable rating shall be recorded on the test report.

Each rejectable discontinuity shall be indicated on the weld by a mark directly over the discontinuity for its entire length. The depth from the surface and indication rating shall be noted on nearby base metal.

Welds found unacceptable by ultrasonic testing shall be repaired by methods permitted by paragraph * 5.26. Repaired areas shall be retested ultrasonically with results tabulated on the original form (if available) or additional report form.

Evaluation of retested repaired weld areas must be tabulated on a new line on the report form. If the original report form is used, an R1, R2…Rn shall prefix the indication number. If additional report forms are used, The R number shall prefix the report number.

5.8.1 Flaw size Evaluation

Straight Beam (Longitudinal) Testing

- The size of lamellar discontinuities is not always easily determined especially those that are smaller than the transducer size. When the discontinuity is larger than the transducer, a full loss of back reflection will occur and a 6 dB loss of amplitude and measurement to the centerline of the transducer is usually reliable for determining flaw edges. However, the approximate size evaluation of those reflectors, which are smaller than the transducer, must be made by beginning outside of the discontinuity and moving the transducer toward the area of discontinuity until an indication on the instrument

display begins to form. The leading edge of the search unit at this point is indicative of the edge of the discontinuity.

Angle Beam (shear) Testing

- The following procedure shall be used to determine the length of flaws which have dB ratings more serious than for Class D indications. The length of such a discontinuity as entered under “Discontinuity Length” on the test report shall be determined by measuring the distance between the center line of the transducer locations where a 6 dB (50%) drop in sound amplitude below the rating for the applicable discontinuity classification.
- The rejectable length of discontinuities that have variable dB ratings more serious than Class D indications, and separations less than the search unit width, shall be determined as follows:
  - Find the location where the most serious indication occurs and note the indication level.
  - Classify this level as being a Class B, C, flaws. Class A flaws are rejectable regardless of length and will be evaluated for length only.
  - Adjust the calibrated gain control or attenuator to the most serious Class D level.
  - Move the search unit from the point of most serious indication level (both directions) until the indication decays to a reference level trace deflection height.
  - Mark the trailing edge locations of the search unit on the test material.
  - The distance between these marks is the indication length at Class C, B, or A amplitude levels.
  - If this distance exceeds the allowable length of a Class C flaw, the indication is rejectable at this length.
  - If this length is equal to or less than the allowable Class C flaw length, further evaluation is necessary as follows.
    - Adjust the calibrated gain control or attenuator to the most serious Class C level.
    - Move the search unit toward the point of the most serious indication level until the indication height reaches reference level trace deflection height.
    - Mark the location of the leading edge of the search unit on the test material.
    - The distance between these marks is the indication length at Class B or A amplitude level(s).
    - If this length exceeds the allowable length of a Class B flaw, the indication is rejectable at this length.
    - If this length is equal to or less than the allowable Class B flaw length, further evaluation is necessary.
    - If the flaw classification is Class B, C, or D the indication is acceptable.
    - If the flaw classification is Class A, determine the length.
    - Adjust the calibrated gain control or attenuator to the most serious Class A level.

- Move the search unit further toward the most serious indication found until the indication height reaches a reference level trace deflection height.
- Mark the location of the leading edge of the search unit.
- The distance between these points is the length of indication as a Class A flaw.

5.9 EXTENT OF EXAMINATION

Weld joints requiring ultrasonic testing by specification shall be tested for their full length unless partial or spot testing is specified.

When partial testing is specified, the location and lengths of welds or categories of welds to be tested shall be clearly designated in the contract documents.

When spot testing is specified, the number of spots in each designated category of weld or the number of spot tests required to be made in a stated length of weld shall be included in information furnished to the bidders. Each spot test shall cover at least 4 in. of the weld length. When spot testing reveals indications of rejectable discontinuities, the extent of those discontinuities shall be explored and two additional spots in the same weld joint shall be tested. If indication of flaws requiring repair are revealed in either of the two spots, the entire length of weld in that welded joint shall be tested ultrasonically.

5.10 VERIFYING ACCURACY OF THE COMPLETED EXAMINATION

Verifying accuracy of the completed ultrasonic weld examination, when required, shall be achieved by at least one of the following methods:

- The preferred method is to investigate the accuracy of the completed ultrasonic weld examination by incremental removal of the identified flaw area by gouging or back gouging. If required by contract, customer witnessing or photo documentation are options for a permanent record of ultrasonic examination accuracy verification. Other method options include:
  - Re-inspection using the ultrasonic examination method by others (audit inspections).
  - Re-inspection using other NDT methods for weld examination.
  - Machroetch specimen.
  - Other visual techniques as may be approved by the engineer.

5.11 WRITTEN ULTRASONIC EXAMINATION PROCEDURE MOCK-UP TESTING

The written procedure shall be qualified by testing mock-up welds, which represent the production welds to be examined. Agreement of Ultrasonic procedure qualification on mock-up welds will be negotiated prior to commencing inspection work. If this item is not considered for negotiation, qualification of this written procedure will be performed by default to mock-up testing option 1.

Mock-up Testing- Option 1

- Ultrasonic testing shall be performed according to this ultrasonic examination procedure. This procedure shall be qualified using mock-ups having 1/16 inch diameter side drilled holes similar to those found in AWS D1.1 Structural Welding Code- Steel Annex S, Figure S-3.

Mock-up Testing-Option 2

- The mock-up welds shall be sectioned, properly examined and documented to prove satisfactory performance of the procedure. The procedure and all qualifying data shall be approved by an individual who has been certified Level III in UT by testing in conformance with ASNT SNT-TC-1A and who is further qualified by experience in examination of the specific types of weld joints to be examined.

6.0 RECORDS

The ultrasonic report shall contain, but is not limited to, the following:

- Weld Identification
- Material Thickness
- Transducer Angle
- Indication Level
- Reference Level
- Attenuation Factor
- Indication Rating
- Discontinuity Length
- Sound Path Distance
- Depth from Surface “A”
- Distance from X
- Distance from Y
- Discontinuity Evaluation
- Record of Any Verification Inspection that are performed
- Date of Test
- Inspector’s Signatures

7.0 REFERENCES

Client specifications or governing authority ASNT-SNT-TC-1A, 2001 edition

- Structural Welding Code-Steel, AWS D1.1, American Welding Society, 2004 Edition.
- Structural Welding Code-Steel, AWS D1.1, American Welding Society, 2006 Edition.
- Structural Welding Code-Steel- Seismic Supplement , AWS D1.8, American Welding Society, 2005 Edition.
- Seismic Provisions for Structural Steel Buildings, AISC 341-2005

8.0 ATTACHMENTS

Attachment 1 – AWS D1.1- UT Resolution Verification Form

Attachment 2 – Horizontal linearity Procedure Checklist Form

Attachment 3 – Internal Reflection Procedure Form

Attachment 4 – AWS D1.1, UT Printable Form

Attachment 5 – AWS Amplitude Linearity Calibration Form

Attachment 6 – 30 minute calibration verification check

AWS D1.1- UT Resolution Verification

Instrument: Reference Block Sn#:

Sn#:

Transducer	Wedge	Accept / Reject	Technician	Date

Horizontal Linearity Procedure Checklist

1. Set up the instrument for double the maximum range of angle beam inspection to be used.
    a. Example: 10” shear wave range would require a 20” range for this procedure.
2. A straight beam search unit shall be coupled meeting the requirements of *6.22.6 to the IIW or DS block in Position G, T, or U (see *Figure 6.26) as necessary to attain five back reflections in the qualification range being certified (see *Figure 6.26).
3. The first and fifth back reflection shall be adjusted to their proper locations with use of the distance calibration and zero delay adjustments.
4. Each indication shall be adjusted to reference level with the gain or attenuation control for horizontal location examination.
5. Each intermediate trace deflection location shall be correct within 2% of the screen width.

Instrument	Transducer	Angle Beam Range	Straight Beam Range	Intermediate Indications Acceptable	NDE Tech	Date	Time

Internal Reflection Procedure

1. Calibrate the equipment in conformance with *6.25.5
2. Remove the search unit from the calibration block without changing any other equipment adjustments.
3. Increase the calibrated gain or attenuation 20 dB more sensitive than the reference level.
4. The screen area beyond 1/2 inch sound path and above reference level shall be free of any indications.

Instrument Sn#	Transducer	Wedge	Reference Level	Accept / Reject	NDE Tech	Date.

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Report of AWS Ultrasonic Examination of welds

Project _____ **Work Order Number** _____ **Drawing Number** _____

Material Thickness _____ **Weld Joint AWS** _____ **Welding Process** _____

Quality Requirement Code _____ **Section** _____ **Page** ____ **Of** ____

	Location of weld Station Number ect.	Indication number	Transducer angle	Leg	Indication level	Referance level	Attenuation Factor	transfer correction	Indication Rating	Sound Path	Surface Distance	Depth of Indication	Indication Length	Distance from X	Distance From Y	Accept	Reject	Welders Stamp	Remarks
1		1																	
2		2																	
3		3																	
4		4																	
5		5																	
6		6																	
7		7																	
8		8																	
9		9																	
10		10																	

Calibration Block Used

Instrument Serial Number _____ **Calibration date** _____

Transducer Serial Number _____ **Frequency** _____

Wedge Serial Number _____

IIW Type SN. _____ **Range** ____ **Inspected BY** _____ **Level** ____ **Date** _____

DSC Block _____ **Range** ____ **Reviewed By** _____ **Date** _____

AWS Amplitude Linearity Calibration Form
Serial number

NO.	a dB READING	b % SCALE	c CORRECTED READING	d dB ERROR	e COLLECTIVE ERROR
1			#DIV/0!	#DIV/0!	
2			#DIV/0!	#DIV/0!	
3			#DIV/0!	#DIV/0!	
4			#DIV/0!	#DIV/0!	
5			#DIV/0!	#DIV/0!	
6			#DIV/0!	#DIV/0!	
7			#DIV/0!	#DIV/0!	
8			#DIV/0!	#DIV/0!	
9			#DIV/0!	#DIV/0!	
10			#DIV/0!	#DIV/0!	
11			#DIV/0!	#DIV/0!	
12			#DIV/0!	#DIV/0!	

Average #DIV/0!

Total Error

Total Range Qualified

Calibration Date
Calibrated By
File number
BRAND KROUTKRAMER USN 60
SERIAL No

Transducer

30 Minute Calibration Verification Checklist

Time	Index point	Angle	Distance	Reference level	Transducer change	Power change	Insp Initials	Date