



PII-MUT

Manual Ultrasonic Examination

PNDT-UT

Revision 04

Prepared By:

Brandon Champion – Chief Operations Officer, NDT Level III

Reviewed By:

William Mustin – Director of Advanced Services, NDT Level III

Approved By:

Oscar Gonzales – VP Quality & Corporate RSO, ASNT NDT Level III #201657

Signatures on file – available upon request

Prime Inspections Inc.

1621 Primewest Parkway, Katy, TX 77449
(870) 291-1991



Prime Inspections Inc.

1621 Primewest Parkway, Katy, TX 77449
(870) 291-1991



Revision / Change Summary

Revision/Change	No.	Date	Description
Initial	0	4/1/2020	Original Issue
Revision	01	8/1/2021	Code Review and Administrative Changes
Revision	02	1/1/2024	Code Review
Revision	03	1/1/2026	Code Review
Revision	04	9/6/2026	Complete rewrite to ASME Section V 2025 Edition Articles 4, 5, and 23 for UT technique; Article 14 for calibration blocks; added API 1104 21st Edition Section 12 acceptance criteria for ultrasonic testing of welds; added ASME Section V Article 23 for thickness measurement; updated personnel qualifications per SNT-TC-1A 2020 Edition; expanded equipment, calibration, examination, evaluation, and acceptance criteria sections; added definitions and abbreviations; added safety section; expanded appendices

Prime Inspections Inc.

1621 Primewest Parkway, Katy, TX 77449
(870) 291-1991

Table of Contents

- 1.0 SCOPE
- 2.0 REFERENCED DOCUMENTS
- 3.0 DEFINITIONS AND ABBREVIATIONS
- 4.0 RESPONSIBILITY
- 5.0 PERSONNEL QUALIFICATIONS
- 6.0 EQUIPMENT AND MATERIALS
- 7.0 INSTRUMENT LINEARITY AND PERFORMANCE
- 8.0 TRANSDUCERS AND SEARCH UNITS
- 9.0 COUPLANT
- 10.0 CALIBRATION BLOCKS
- 11.0 BLOCK CURVATURE AND SURFACE CONDITIONS
- 12.0 CALIBRATION AND VERIFICATION
- 13.0 EXAMINATION
- 14.0 EVALUATION
- 15.0 ACCEPTANCE STANDARDS
- 16.0 POST-EXAMINATION CLEANING
- 17.0 PROCEDURE QUALIFICATION
- 18.0 RECORDS
- 19.0 SAFETY

TABLE T-421 – Requirements of an Ultrasonic Examination Procedure

APPENDICES

- Appendix I – Straight Beam Inspection of Nozzle Weld Fusion Zones
- Appendix II – Layout of Vessel Reference Points
- Appendix III – API 1104 Section 12 Acceptance Criteria for UT of Welds
- Appendix IV – Ultrasonic Examination Report Form Template
- Appendix V – Ultrasonic Calibration Record Form Template

1.0 SCOPE

1.1 This procedure describes the requirements to be implemented by Prime Inspections Inc. when performing Manual Ultrasonic Examinations (MUT) on full penetration welds ranging in thickness from 0.2 in. (5 mm) to 5 in. (125 mm) using the manual contact technique in ferritic wrought and cast material, and in ferritic pipe. Use of this procedure for other thicknesses requires a technique approved by the responsible UT Level III and training of the personnel using the technique. This procedure may be used on austenitic and high alloy welds provided the requirements addressed in paragraph 13.9.3(c) are met.

1.2 When the reference 2.6 QW-142 or QW-143 option applies to use RT or UT for the examination of welder or welder operator qualification test assemblies, UT may be conducted on test welds in material $\frac{1}{2}$ in. (13 mm) thick or greater.

1.3 This procedure is the basic procedure for reference 2.1. Appendix I provides the technique requirements when examination of either the nozzle side weld fusion zone and/or adjacent parent metal is specified by the referencing Code Section. Other techniques, as described in the Mandatory Appendices of reference 2.1, will be addressed as attachments to this procedure or a separate procedure will be developed and approved, as needed.

1.4 This procedure is not intended to be used in lieu of radiographic examination when radiographic examination is required by the referencing Code section.

1.5 This procedure is not approved for the reference 2.3 Division 2 examination of Submerged Arc Welds in 2 $\frac{1}{4}$ Cr-1Mo- $\frac{1}{4}$ V vessels which require specialized UT techniques.

1.6 Acceptance criteria for ultrasonic testing of welds shall be in accordance with API 1104 21st Edition Section 12 where the referencing code, contract, or customer specification requires compliance with API 1104. The acceptance criteria of API 1104 Section 12 shall apply to pipeline girth welds and related facilities welds when specified by the referencing document.

1.7 Ultrasonic examination techniques herein comply with ASME Section V Article 4 (Methods of Ultrasonic Examination), Article 5 (Methods for UT of Welds), and Article 23 (Methods for Thickness Measurement). Calibration blocks shall be in accordance with ASME Section V Article 14 (Calibration Blocks).

2.0 REFERENCED DOCUMENTS

2.1 The following documents are referenced in this procedure. Current editions apply unless otherwise noted. Where a referenced document contains requirements that conflict with this procedure, the referencing code or contract specification shall govern.

2.2 Codes and Standards

2.2.1 ASME BPVC Section V, Nondestructive Examination, 2025 Edition, Article 4 – Methods of Ultrasonic Examination

2.2.2 ASME BPVC Section V, Nondestructive Examination, 2025 Edition, Article 5 – Methods for Ultrasonic Examination of Welds

2.2.3 ASME BPVC Section V, Nondestructive Examination, 2025 Edition, Article 14 – Calibration Blocks for Ultrasonic Examination

2.2.4 ASME BPVC Section V, Nondestructive Examination, 2025 Edition, Article 23 – Methods for Thickness Measurement

2.2.5 ASME BPVC Section I, Power Boilers, 2025 Edition

2.2.6 ASME BPVC Section VIII, Pressure Vessels, Divisions 1 and 2, 2025 Edition

2.2.7 ASME B31.1, Power Piping, 2024 Edition

2.2.8 ASME B31.3, Process Piping, 2024 Edition

2.2.9 ASME B31.8, Gas Transmission and Distribution Piping Systems, 2025 Edition

2.2.10 ASME BPVC Section IX, Welding and Brazing Qualification, 2025 Edition

2.2.11 API 1104, Welding of Pipelines and Related Facilities, 21st Edition, Section 12 – Ultrasonic Testing of Welds

2.2.12 ASNT SNT-TC-1A, Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing, 2020 Edition

2.2.13 ASNT CP-189, Certification for Nondestructive Testing Personnel, Current Edition

2.2.14 NAS 410, Certification of Nondestructive Test Personnel, Revision 5

2.2.15 ASTM E317, Standard Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Examination Instruments and Systems

2.2.16 ASTM E1316, Standard Terminology for Nondestructive Examinations

2.2.17 ASTM E1324, Standard Guide for Ultrasonic Examination of Welds

2.2.18 ASTM E587, Standard Practice for Ultrasonic Examination of Standard Steel Bars and Billets

2.2.19 ISO 17640, Non-destructive testing of welds – Ultrasonic testing of joints, metallic, for acceptance criteria

2.2.20 ISO 11666, Non-destructive testing of welds – Ultrasonic testing of welds – Acceptance levels

2.3 Company Documents

2.3.1 PII-WP-1, Written Practice for the Qualification and Certification of NDE Personnel, Current Revision

2.3.2 Prime Inspections Inc. Safety Manual, Current Revision

2.3.3 Prime Inspections Inc. Record Retention Policy, Current Revision

3.0 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

3.1.1 Ultrasonic Examination (UT): A nondestructive examination method that uses high-frequency sound energy to conduct examinations and measurements on materials and components.

3.1.2 Manual Ultrasonic Examination (MUT): Ultrasonic examination performed by an examiner who manually manipulates the search unit over the examination surface without the use of automated or semi-automated scanning equipment.

3.1.3 A-Scan: A display of signal amplitude versus time or distance in which the horizontal axis represents distance or time and the vertical axis represents signal amplitude.

3.1.4 Pulse-Echo: An ultrasonic examination technique in which a single transducer is used to both transmit and receive ultrasonic energy.

3.1.5 DAC (Distance Amplitude Correction): A correction curve used to account for signal amplitude loss as a function of sound path distance.

3.1.6 FSH (Full Screen Height): The maximum vertical display range of the A-scan presentation.

3.1.7 Primary Reference Level: The gain setting at which the primary reference reflector response is set to $80\% \pm 5\%$ of FSH.

3.1.8 Search Unit (Transducer): An electromechanical device that converts electrical energy into ultrasonic energy and vice versa.

3.1.9 Contact Wedge: A plastic or epoxy material shaped to introduce ultrasonic energy into the test material at a specific refracted angle.

3.1.10 IIW Block: International Institute of Welding calibration block, used for verifying search unit exit point, beam angle, and sweep range.

3.1.11 Transfer Correction: A correction applied to account for differences in acoustic properties between the calibration block and the component being examined.

3.1.12 Calibration Block: A reference standard containing known reflectors used to establish or verify instrument calibration.

3.1.13 Geometric Indication: An ultrasonic indication resulting from component geometry rather than a flaw, such as reflections from counterbores, root geometry, or internal attachments.

3.1.14 Relevant Indication: An ultrasonic indication exceeding the acceptance level that is determined to be from a flaw and not from component geometry or metallurgical conditions.

3.1.15 Vee-Path: The sound path of an angle beam in the material from the entry point to the reflecting surface and back to the entry surface, or a portion thereof.

3.1.16 Refracted Angle: The angle of the ultrasonic beam within the test material, measured from the normal to the entry surface, resulting from mode conversion at the wedge-to-material interface.

3.1.17 P-Number: A classification of base metals for procedure qualification per ASME Section IX, used to group materials with similar welding characteristics.

3.1.18 Straight Beam: An ultrasonic beam propagated perpendicular to the entry surface using a normal (0°) refracted angle.

3.1.19 Angle Beam: An ultrasonic beam propagated at a refracted angle to the entry surface, typically 45° , 60° , or 70° shear wave.

3.1.20 Remaining Back Reflection: The backwall signal amplitude after subtracting the signal loss attributed to reflectors in the sound path.

3.2 Abbreviations

- 3.2.1 UT – Ultrasonic Testing / Examination
- 3.2.2 MUT – Manual Ultrasonic Testing / Examination
- 3.2.3 RT – Radiographic Testing / Examination
- 3.2.4 PT – Penetrant Testing / Examination
- 3.2.5 MT – Magnetic Particle Testing / Examination
- 3.2.6 VT – Visual Testing / Examination
- 3.2.7 DAC – Distance Amplitude Correction
- 3.2.8 FSH – Full Screen Height
- 3.2.9 IIW – International Institute of Welding
- 3.2.10 SNR – Signal-to-Noise Ratio
- 3.2.11 JHA – Job Hazard Analysis
- 3.2.12 NDE / NDT – Nondestructive Examination / Testing
- 3.2.13 ASNT – American Society for Nondestructive Testing
- 3.2.14 SNT-TC-1A – ASNT Recommended Practice for Personnel Qualification
- 3.2.15 PII – Prime Inspections Inc.
- 3.2.16 PNDT – Prime Nondestructive Testing Procedure Number
- 3.2.17 ID – Inside Diameter
- 3.2.18 OD – Outside Diameter
- 3.2.19 CW – Clockwise
- 3.2.20 CCW – Counter-Clockwise

4.0 RESPONSIBILITY

4.1 The Quality Manager of Prime Inspections Inc. is responsible for the preparation, review, approval, and control of this procedure. The designated NDT Level III is responsible for the technical review and approval of this procedure.

4.2 Level III, Level II, and Level I examiners are responsible for implementing the requirements of this procedure. Level III and Level II examiners are responsible for the supervision of Level I examiners and trainees.

4.3 The Quality Manager is responsible for monitoring compliance with this procedure.

4.4 Technicians are responsible for complying with this procedure and completing all required records and reports. At any time while performing work under this procedure, should it become evident that the requirements herein cannot be met, the technician shall immediately contact the supervisor or lead technician for resolution.

4.5 Technicians shall ensure that the item being inspected receives 100% inspection of all accessible areas within the inspection zone. Accessible areas are defined as those where all test parameters can be applied in accordance with the NDE procedure and the results properly viewed for interpretation and evaluation. Inspection zone areas that are found to be inaccessible shall be recorded in the report.

4.6 Prior to beginning work, all personnel shall read, understand, and follow the requirements of the applicable Job Hazard Analysis (JHA). In addition, personnel shall observe and follow all site-specific safety requirements.

4.7 Should there be a question or a clarification needed regarding any safety requirement, the supervisor, lead technician, or facility representative shall be contacted for resolution before beginning or resuming work.

4.8 The designated Level III shall be responsible for the qualification of examination techniques for austenitic and high nickel alloy welds per paragraph 13.9.3(c), including the selection of weld mockups and reference reflectors.

4.9 It shall be the responsibility of the Customer to determine applicable codes, standards, and acceptance criteria unless otherwise specified in the contract or purchase order.

5.0 PERSONNEL QUALIFICATIONS

5.1 Technicians performing evaluations under this procedure shall be certified to Level II or possess a current PCN Level II and shall be certified in accordance with reference 2.12 (SNT-TC-1A, 2020 Edition) and PII-WP-1. API qualifications such as QUTE, or ASNT ISQ are also acceptable.

5.2 Personnel may also be qualified and certified to other certification schemes such as CP-189 or NAS 410 Revision 5, depending on customer requirements.

5.3 Personnel performing UT examinations shall be trained and qualified in the specific equipment, techniques, and software used under this procedure. Training records shall be maintained in accordance with PII-WP-1.

5.4 Near-vision acuity shall be verified annually in accordance with SNT-TC-1A. Personnel shall be capable of reading Jaeger No. 1 (or equivalent) at a minimum distance of 12 inches (300 mm).

5.5 Color vision shall be verified annually. Personnel shall be capable of distinguishing and differentiating the colors used in the ultrasonic method as applicable.

5.6 Level I examiners and trainees shall work under the direct supervision of a Level II or Level III examiner. Level I personnel shall not independently evaluate or report indications without review and approval by a Level II or III.

5.7 Personnel shall be knowledgeable of the applicable acceptance criteria specified by the referencing Code Section, contract, or customer specification prior to performing examinations.

6.0 EQUIPMENT AND MATERIALS

6.1 Instrument

6.1.1 The instrument shall be a pulse-echo type with an A-scan display capable of operating at frequencies over a range of at least 1 MHz to 5 MHz. Instruments shall be equipped with a stepped gain control in units of 2.0 dB or less.

6.1.2 The instrument damping control may be used if it does not reduce the sensitivity of the examination. The reject control shall be in the "off" position unless it can be demonstrated that it does not affect the linearity of the examination.

6.1.3 Each instrument shall be calibrated and shall display a valid calibration tag. The calibration tag shall identify the instrument, calibration date, due date, and calibration traceability.

6.1.4 Digital instruments shall have the capability to record calibration data, examination parameters, and signal displays. Analog instruments shall have sufficient screen size for accurate amplitude and distance measurements.

6.2 Couplant

6.2.1 A high-quality couplant material such as Ultragel, Echogel, Sonoglide, Pyrogel, or equivalent shall be used when performing ultrasonic calibrations and examinations in accordance with this procedure. The couplant material used for examinations shall be the same as used for calibration.

6.2.2 Note: Ensure the couplant is compatible with the specimen's temperature and material chemistry.

6.2.3 Couplants and additives shall be certified as follows:

(a) Couplants/additives used on nickel-based alloys shall not contain more than 250 ppm of sulfur.

(b) Couplants/additives used on austenitic stainless steel or titanium shall not contain more than 250 ppm of halides (chlorides plus fluorides).

6.2.4 Deionized water, when used, shall be supplied as agreed upon with the customer.

6.2.5 Couplant Material Safety Data Sheets (SDS) shall be maintained on file and shall be available to personnel and the customer upon request.

6.3 Calibration Blocks

6.3.1 Calibration blocks shall be fabricated in accordance with ASME Section V Article 14. The block type, configuration, and reflectors shall be appropriate for the examination being performed.

6.3.2 Reflectors (side drilled holes, flat bottom holes, notches, etc.) shall be used to establish the primary reference response for the equipment.

6.3.3 An alternative reflector(s) may be used provided that the alternative reflector produces a sensitivity equal to or greater than the specified reflector (e.g., side drilled holes in lieu of notches, flat bottom holes in lieu of side drilled holes).

6.3.4 Calibration blocks shall be identified with a unique serial number and shall be traceable to the material specification and heat lot.

6.4 Reference Standards

6.4.1 IIW (International Institute of Welding) blocks or equivalent shall be used for verifying search unit exit point, beam angle, and sweep range calibration.

6.4.2 DSC (Distance/Sensitivity Calibration) blocks or DC blocks of the appropriate P-number material may be used for distance and sensitivity calibration.

6.5 Measurement and Recording Devices

6.5.1 Calibrated rulers, calipers, and measuring devices shall be used for marking weld locations and measuring indication lengths and positions.

6.5.2 Thermometers or surface temperature measurement devices shall be used to verify the temperature of the calibration block and the component surface.

6.6 Markers and Layout Tools

6.6.1 Permanent markers, paint markers, or low-stress stamps shall be used for layout of vessel reference points per Appendix II. Vibratooling may be used if specified and supplied by the Manufacturer or Owner. Markings applied after final stress relief shall not be any deeper than 3/64 in. (1.2 mm).

6.6.2 Layout tools shall include flexible measuring tapes suitable for curved surfaces, protractors for angular layout, and markers for identification of reference points.

7.0 INSTRUMENT LINEARITY AND PERFORMANCE

7.1 Screen Height Linearity

7.1.1 Screen height linearity and amplitude control linearity shall be checked at intervals not to exceed three months for analog-type instruments and one year for digital-type instruments, or prior to first use thereafter.

7.2 Screen Height Linearity Procedure

7.2.1 Screen height linearity shall be performed in accordance with reference 2.1, which complies with ASME Section V Article 4 Mandatory Appendix I. The procedure verifies that the instrument can accurately display signal amplitudes across the full screen height.

7.3 Amplitude Control Linearity

7.3.1 Amplitude control linearity shall be performed in accordance with reference 2.1, which complies with ASME Section V Article 4 Mandatory Appendix II. This verifies the accuracy of the gain control in 2 dB or finer increments across the full gain range.

7.4 Instrument Performance

7.4.1 Instrument performance shall be evaluated in accordance with reference 2.1 and ASTM E317. Performance verification shall include checks for vertical limit, horizontal linearity, and signal-to-noise ratio capability.

7.5 ASME B31.1 Instrument Requirements

7.5.1 The instruments used to perform the examination, when ASME B31.1 is the applicable code, shall be capable of recording the UT data to facilitate the analysis by a third party and for the repeatability of subsequent examinations, should they be required.

Note: The above is not applicable to manual instruments. Where physical obstructions prevent the use of systems capable of recording the UT data, manual UT may be used with the customer's approval.

8.0 TRANSDUCERS AND SEARCH UNITS

8.1 General Requirements

8.1.1 Search units shall have a nominal frequency of 1 to 5 MHz; however, other frequencies may be used to ensure adequate penetration, better resolution, or for evaluation purposes. Contoured contact wedges may be used to aid ultrasonic coupling.

8.1.2 Transducer size shall range from ¼ in. (6 mm) up to 1.0 in. (25 mm) in diameter or 1.0 square inch maximum (625 square mm maximum).

8.2 Contact Wedges

8.2.1 Search unit wedges shall be fabricated to introduce the required refracted angle in the material examined. The exit point of the sound beam and the actual refracted beam angle of angle beam search units shall be determined using an IIW block, or equivalent. The exit point of the sound beam shall be marked on the search unit wedge.

8.2.1.1 Examinations performed on a curved component having a diameter less than 14 in. (350 mm) (at the examination surface) shall be performed using a contoured wedge to ensure sufficient ultrasonic coupling is achieved and to limit any potential rocking of the search unit as it is moved along the circumference of the component.

8.2.2 Search units shall be contoured as required by the following equation:

Where:

A = length of search unit footprint during circumferential scanning or the width when scanning in the axial direction, in. (mm)

D = the component diameter at inspection surface (ID/OD), in. (mm)

Note: The footprint is defined as the physical dimension of the search unit in the curved direction of the component.

8.2.3 The search unit contoured dimension shall be selected from the tables below and shall be determined using the same component dimension from which the examination is being performed (ID or OD).

Maximum Contour for Examinations Performed from the OD:

Actual Component OD, in. (mm)	Allowable Increase in Contour Diameter Over Component OD, in. (mm)
< 4.0 (< 100)	< 1 (< 25)
≥ 4.0 to 10 (≥ 100 to 250)	< 2 (< 50)
> 10 (> 250)	< 4 (< 100)

Minimum Contour for Examinations Performed from the ID:

Actual Component OD, in. (mm)	Allowable Increase in Contour Diameter Over Component OD, in. (mm)
< 4.0 (< 100)	< 1 (< 25)
≥ 4.0 to 10 (≥ 100 to 250)	< 2 (< 50)
> 10 (> 250)	< 4 (< 100)

8.3 Weld Metal Overlay Cladding – Search Unit

8.3.1 Dual element, straight beam search units using an angled pitch-catch technique shall be used. The included angle between the search unit's elements shall be such that the effective focal spot distance is centered in the area of interest.

8.4 High Temperature Examinations

8.4.1 At temperatures exceeding 200° F (93° C), special search units and/or high temperature wedges may be required. High-temperature couplant compatible with the specimen temperature and chemistry shall be used.

9.0 COUPLANT

9.1 General Requirements

9.1.1 A high-quality couplant material such as Ultragel, Echogel, Sonoglide, Pyrogel, or equivalent shall be used when performing ultrasonic calibrations and examinations in accordance with this procedure. The couplant material used for examinations shall be the same as used for calibration.

9.1.2 The couplant shall be compatible with the specimen temperature. At elevated temperatures, high-temperature couplant shall be used and calibration shall be performed at a temperature within 25° F (14° C) of the component temperature.

9.2 Material Compatibility Requirements

9.2.1 Couplants and additives shall be certified as follows:

- (a) Couplants/additives used on nickel-based alloys shall not contain more than 250 ppm of sulfur.
- (b) Couplants/additives used on austenitic stainless steel or titanium shall not contain more than 250 ppm of halides (chlorides plus fluorides).

9.3 Deionized Water

9.3.1 Deionized water, when used as a couplant, shall be supplied as agreed upon with the customer. Deionized water is typically used for immersion techniques or for examination of components at ambient temperature.

9.4 Documentation

9.4.1 The type and brand of couplant used for each examination shall be documented on the Ultrasonic Calibration Record. The couplant lot or batch number shall be traceable to the manufacturer's certification of contaminant levels.

10.0 CALIBRATION BLOCKS

10.1 General

10.1.1 Calibration blocks shall be fabricated in accordance with ASME Section V Article 14. The block material, reflectors, and configuration shall be appropriate for the examination being performed and the component being examined.

10.2 Material

10.2.1 Similar Metal Welds: The material from which the block is fabricated shall be of the same product form and material specification or equivalent P-number grouping as one of the materials being examined. For the purposes of this paragraph, P-Nos. 1, 3, 4, 5A through 5C, and 15A through 15F materials are considered equivalent.

10.2.2 Dissimilar Metal Welds: The material selection shall be based on the side of the weld from which the examination will be conducted. If the examination is to be conducted from both sides, calibration reflectors shall be provided in both materials.

10.2.3 Transfer Correction: When the block material is not of the same product form or has not received the same heat treatment, it may be used provided it meets all other block requirements and a transfer correction for acoustical differences is used. Transfer correction shall be determined by noting the difference between the signal response, using the same transducers and wedges to be used in the examination, received from either:

10.2.3.1 The corresponding reference reflector (same type and dimensions) in the basic calibration block and in the component to be examined, or

10.2.3.2 Two search units positioned in the same orientation on the basic calibration block and component to be examined.

10.2.3.3 The examination sensitivity shall be adjusted for the difference.

10.3 Block Quality

10.3.1 Prior to fabrication, the calibration block material shall be completely examined with a straight beam search unit. Areas that contain an indication exceeding the remaining back reflection shall be excluded from the beam paths required to reach the various calibration reflectors.

10.4 Cladding

10.4.1 When the component material is clad, the block shall be clad by the same welding procedure as the production part. Where the automatic method is impractical, deposition of clad shall be by the manual method. It is desirable to have component materials which have been clad before the drop-outs or prolongations are removed.

10.5 Heat Treatment

10.5.1 The calibration block shall receive at least the minimum tempering treatment required by the material specification for the type and grade. If the calibration block contains welds other than cladding, and the component weld at the time of the examination has been heat treated, the block shall receive the same heat treatment.

10.6 Surface Finish

10.6.1 The finish on the scanning surfaces of the block shall be representative of the scanning surface finishes on the component to be examined.

10.7 Temperature

10.7.1 The temperature of the calibration block during calibration, examination, and verifications shall be within 25° F (14° C) of the component's temperature. The temperature of the calibration block shall be

recorded on the instrument calibration record, at the initial calibration and at each subsequent verification.

10.7.2 The surface temperature of the component to be examined shall be taken prior to performing an examination. The temperature shall be recorded on the applicable examination record. If the component is at ambient temperature, no measurement is necessary and may be recorded as ambient. Alternatively, the calibration block(s) may be placed on the component for a sufficient length of time to allow for temperature stabilization.

11.0 BLOCK CURVATURE AND SURFACE CONDITIONS

11.1 Material with Diameters Greater Than 20 in. (500 mm)

11.1.1 For examinations in materials where the examination surface diameter is greater than 20 in. (500 mm), a block of essentially the same curvature, or alternatively, a flat basic calibration block, may be used.

11.2 Materials with Diameters 20 in. (500 mm) and Less

11.2.1 For examinations in materials where the examination surface diameter is equal to or less than 20 in. (500 mm), a curved block shall be used. Except where otherwise stated in this procedure, a single curved basic calibration block may be used for examinations in the range of curvature from 0.9 to 1.5 times the basic calibration block diameter.

11.2.2 Example: An 8 in. (200 mm) diameter block may be used to calibrate for examinations on surfaces in the range of curvature from 7.2 in. (180 mm) to 12 in. (300 mm).

11.2.3 The curvature range from 0.94 in. (23.5 mm) to 20 in. (500 mm) diameter requires six (6) block curvatures as indicated in Figure T-434.1.7.2, for any thickness range.

11.3 Non-Piping Calibration Blocks

11.3.1 The basic calibration block configuration, thickness (T), and reflectors shall be as shown in Figure T-434.2.1 per ASME Section V Article 14. The block size and reflector locations shall be adequate to perform calibrations for the beam angles and distance range(s) to be used.

11.4 Piping Calibration Blocks

11.4.1 The basic calibration block configuration and reflectors shall be as shown in Figure T-434.3-1 or the alternate calibration block shown in Figure T-434.3-2 per ASME Section V Article 14. The basic calibration block curvature shall be in accordance with paragraph 11.2. The thickness T shall be $\pm 25\%$ of the nominal thickness of the component to be examined. The block size and reflector locations shall be adequate to perform calibration for the beam angles and distance range(s) to be used.

11.5 Surface Condition

11.5.1 The contact surface shall be uniform and free of loose scale and paint, weld spatter, surface irregularities, or foreign matter that might interfere with free movement of the search unit or impair the transmission of ultrasound.

11.5.2 When surface conditions cannot be improved to permit adequate coupling, the condition shall be noted on the examination report and the extent of restricted examination shall be documented.

12.0 CALIBRATION AND VERIFICATION

12.1 General Calibration Requirements

12.1.1 All ultrasonic calibrations shall be completed prior to the start of examination. Each calibration shall be performed from the surface (clad or unclad) corresponding to the surface of the component from which the examination will be performed.

12.1.2 The same couplant to be used during the examination shall be used for calibration.

12.1.3 The same contact wedges to be used during the examination shall be used for calibration.

12.1.4 Any instrument control which affects instrument linearity (i.e., filters, reject, or clipping) shall be in the same position for calibration, calibration checks, instrument linearity checks, and examination.

12.1.5 The temperature of the calibration block and the examination surfaces shall be within 25° F (14° C).

12.1.6 Sweep range and Distance Amplitude Correction (DAC) shall be performed as required by Section 13.0.

12.1.7 All spaces on the instrument calibration record shall be filled in completely.

12.1.8 No point on the DAC curve shall be less than 20% of Full Screen Height (FSH). When any portion of the DAC curve will fall below 20% FSH, a split DAC shall be used. The first calibration reflector of the second DAC shall start at $80 \pm 5\%$ FSH. When reflector signal-to-noise ratio precludes effective indication evaluation and characterization, a split DAC should not be used. (See reference 2.1 Nonmandatory Appendix Q for an example).

12.2 Verification Requirements

12.2.1 Sweep range calibration shall be verified on the IIW block, or equivalent, and DAC curve calibration (if applicable) shall be verified on the appropriate basic calibration block:

12.2.1.1 At the start of a series of examinations.

12.2.1.2 With any substitution of search unit cable.

12.2.1.3 With any substitution utilizing the same type of power source; e.g., a change from one direct current to another direct current source.

12.2.1.4 At least every four (4) hours during the examination.

12.2.1.5 At the finish of a series of examinations.

12.2.1.6 Whenever the validity of the calibration is in doubt.

Note: Verification/check times must be documented and are part of the examination record.

12.3 Calibration Changes

12.3.1 If any distance range point has moved on the sweep line by more than 10% of the sweep reading or 5% of full sweep, whichever is greater, correct the distance range calibration and note the correction on the examination record. All recorded indications since the last valid calibration shall be reexamined with the corrected calibration, and values changed on the data sheets or re-recorded.

12.3.2 If any sensitivity setting has changed by more than 20% or 2 dB of its amplitude, correct the sensitivity calibration and note the correction on the examination record.

12.3.2.1 For a decrease in sensitivity, void all data sheets since the last valid calibration verification and reexamine the area covered by the voided data sheets.

12.3.2.2 For an increase in sensitivity, all recorded indications since the last valid calibration shall be reexamined and values changed on the data sheets or re-recorded.

12.3.3 When it is determined that the instrument is not functioning properly during any check/calibration, all material examined since the last valid check/calibration shall be re-examined.

12.4 Recalibration

12.4.1 Substitution of any of the following shall be cause for recalibration:

12.4.1.1 Search unit transducer or wedge.

12.4.1.2 Search unit cable.

12.4.1.3 Ultrasonic instrument.

12.4.1.4 Examination personnel.

12.4.1.5 Couplant.

12.4.1.6 Change in type of power source; e.g., a change from alternating to direct current.

13.0 EXAMINATION

13.1 Transfer Correction

13.1.1 Unless otherwise specified by customer requirements, purchase order, contract, or code requirements, the transfer correction method shall not be used if the requirements in paragraph 10.6 are maintained.

13.2 Scanning

13.2.1 The manual scanning technique using no scanner equipment will be used. Each pass of the search unit shall overlap a minimum of 10% of the search unit piezoelectric element dimension perpendicular to the scan direction.

13.2.2 The pulse repetition rate shall be small enough to assure that a signal from a reflector located at the maximum distance in the examination volume will arrive back at the search unit before the next pulse is placed on the transducer.

13.2.3 The search unit movement rate (scanning speed) shall not exceed 2 in. (50 mm) per second.

13.2.4 For Distance Amplitude Techniques, the scanning shall be at a gain setting at least 6 dB higher than the primary reference level (+14 dB is recommended), and evaluation shall be at the reference level gain setting.

13.2.5 For Non-Distance Amplitude Techniques, the scanning shall be at a gain setting appropriate for the configuration being examined and shall be capable of detecting the calibration reflector(s) at the maximum scanning speed.

13.3 Examination Area

13.3.1 The area(s) to be examined shall be in accordance with code, standard, or customer instructions for the inspection required. As a minimum, this shall include the required volume of weld adjacent base material for a distance of 0.5 in. (12 mm) or 1/4T, whichever is greater.

13.3.2 When UT of either the nozzle side weld fusion zone and/or adjacent parent metal is specified by the referencing Code Section, the examination is to be performed in accordance with Appendix I.

13.4 Weld Examinations

13.4.1 The weld identification and location(s) shall be recorded on a weld map or identification plan. Reference points shall be applied using a permanent marker. A sample layout system is included in Appendix II. Different layout systems and marking methods may be used with the Owner's approval.

13.4.2 The adjacent base metal through which the angle beam will travel shall be scanned with a straight beam search unit to detect reflectors that might limit the ability of the angle beam to examine the weld volume.

13.4.2.1 Reflectors producing echoes having amplitude equal to or greater than the remaining back reflection shall be investigated to determine the relative size (area) of the reflector. In order to determine the boundaries of the reflector, obtain a back reflection signal from an indication-free area and adjust the instrument gain control until this signal is at $80\% \pm 5\%$ FSH. Slowly scan the area and establish the boundary of the indication when the amplitude is equal to the remaining back reflection. If total loss of back reflection accompanies the intermediate echo, the area of total loss of back reflection shall be recorded on the appropriate examination record.

13.4.2.2 Laminar reflectors shall be marked on the part for reference during angle beam examination and the technique shall be modified such that the maximum feasible volume is examined.

13.5 Product Classifications

13.5.1 Welds in ferritic wrought and cast materials.

13.5.2 Welds in ferritic pipe.

13.5.3 Austenitic and high nickel alloy welds may be examined with this procedure provided the examination technique (including calibration) is qualified by a Level III using weld mockups with reference reflectors. This qualification will be documented on the Ultrasonic Examination Report and maintained on file. The weld mockups, technique(s), and qualification records shall be accessible to the Level II examiner when performing each material joint configuration and material change. Under no circumstances shall examinations be performed on joint configurations that have not been qualified under this procedure. The use of a previously qualified mockup to examine a mockup with a variation to the configuration or to the material previously qualified requires Level III approval.

13.6 Calibration Recording

13.6.1 Calibrations and verifications shall be recorded. Additionally, a position calibration and/or echo amplitude measurement from the surface notch in the basic calibration block may be required by the referencing Code Section.

13.7 Beam Angles

13.7.1 Nominal shear wave beam angles shall be 45°, 60°, or 70°. The search unit and beam angles selected shall be appropriate for the configuration being examined and shall be capable of detecting the calibration reflectors over the required angle beam path. Shear waves shall be used for ferritic welds. Austenitic and high nickel alloy welds may require the use of refracted longitudinal and/or low frequency shear waves with a technique qualified by the Level III.

13.8 Screen Distance and Range

13.8.1 The screen distance chosen shall be the shortest applicable size to include at least 1/8 vee-path beyond the anticipated examination range.

13.8.2 Set up the appropriate examination range by observing the radius signals produced from the reference block (IIW, DSC, or DC block of the appropriate P-number material).

13.9 Non-Piping Calibration

13.9.1 Position the search unit on the Non-Piping Calibration Block shown in Figure T-434.2.1 to obtain maximum response from the calibration holes. The hole that produces the highest amplitude within or adjacent to the sound path range used for examination shall be used as the primary reference reflector.

Hole	Angle Beam Vee-Path Positions
1/4T	1/8 (1st leg), 7/8 (2nd leg), 9/8 (3rd leg)
1/2T	2/8 (1st leg), 6/8 (2nd leg), 10/8 (3rd leg)
3/4T	3/8 (1st leg), 5/8 (2nd leg), 11/8 (3rd leg)

13.9.2 Position the search unit on the basic calibration block to obtain maximum response from the primary reference reflector, then adjust the gain to establish a primary reference response at 80% ± 5% FSH. Establish this amplitude on the screen. Except for scanning, the gain control shall not be adjusted once the primary reference response has been established.

13.9.3 Obtain a maximum response from the remaining vee-path positions (minimum of two required), establish on screen, and join all amplitude points with a smooth, curved line. If any calibration hole produces a response less than 20% FSH, an additional DAC curve shall be constructed for the remaining sound path range. If two curves are established on the same screen, the reference gain settings for each curve shall also be established on screen.

13.9.4 With the instrument gain set at the primary reference level, position the search unit for maximum amplitude from the square notch on the opposite surface. Establish the signal amplitude on the screen. The

signal shall be considered when evaluating reflectors at the opposite surface.

13.9.5 When an electronic distance-amplitude correction device is used, the primary reference responses from the basic calibration block shall be equalized over the distance range to be employed in the examination. The response equalization line shall be at a screen height of 40% to 80% FSH.

13.9.6 In cases of single-sided access welds, the calibration block shown in Figure T-434.2.1 may not provide the necessary sound path distances to the reference reflectors to provide distance-amplitude correction (DAC) that will fully cover the area of interest for the straight beam technique. In these cases, a second calibration block is required whose thickness (T) and reference reflector locations are based on the sound path distance that provides for coverage of the area of interest.

13.10 Piping Calibration

13.10.1 Calibration with Notches

13.10.1.1 A sensitivity calibration using the applicable surface notches (axial and circumferential) of the Piping Calibration Block shown in Figure T-434.3-1 is required for angle beam examination of welds in ferritic pipe. The angle beam shall be directed toward the notch that yields the maximum response.

13.10.1.2 The gain control shall be set so that this response is $80\% \pm 5\%$ of FSH. This shall be the primary reference level. The search unit shall then be manipulated, without changing instrument settings, to obtain the maximum responses from the calibration reflectors at the distance increments necessary to generate a three-point DAC curve. Separate calibrations shall be established for both the axial and circumferential notches. These calibrations shall establish both the distance range calibration and the distance amplitude correction.

13.10.2 Calibration with Side-Drilled Holes

13.10.2.1 A sensitivity calibration using the applicable side-drilled holes (axial and circumferential) of the Piping Calibration Block shown in Figure T-434.3-2 is required for angle beam examination of welds in ferritic pipe. The angle beam shall be directed toward the side-drilled hole that yields the maximum response.

13.10.2.2 The gain control shall be set so that this response is $80\% \pm 5\%$ of FSH. This shall be the primary reference level. The search unit shall then be manipulated, without changing instrument settings, to obtain the maximum responses from the calibration reflectors at the distance increments necessary to generate a 3T DAC curve, where T is the thickness of the calibration block. Next, position the search unit for the maximum response for the surface notch positions and mark the positions on the screen for consideration when evaluating surface reflectors.

13.10.2.3 Separate calibrations shall be established for both the axial and circumferential notches. These calibrations shall establish both the distance range calibration and the distance amplitude correction.

Note: Circumferential scan calibrations on the axial notches or axial side-drilled holes are limited to FULL-V only (2-point DAC).

13.10.3 DAC Exception

13.10.3.1 DAC is not required where the exam is limited to one-half ($1/2$) V-path in a material less than 1.0 in. (25 mm) thick. The amplitude level from a single calibration reflector shall be used.

13.10.4 Alternative Angle Beam Calibration

13.10.4.1 When a vessel or other component is made with a thickness of $\frac{1}{2}$ in. (12 mm) or less and a diameter equal to or less than 20 in. (500 mm), the angle beam systems calibrations for distance-amplitude techniques may be performed using the requirements of paragraph 13.10.1 with calibration blocks that conform to Figure T-434.3-1 or Figure T-434.3-2.

13.11 Examination Coverage

13.11.1 Reflectors oriented parallel to the weld seam:

13.11.1.1 The angle beam shall be oriented approximately perpendicular to the weld axis from both sides of the weld (i.e., from two directions) on the same surface when possible. The search unit shall be manipulated so the ultrasonic energy passes through the required volume of weld and adjacent base material.

13.11.1.2 Scanning shall be at a gain setting at least two (2) times the primary reference level (+6 dB), and evaluation shall be at the primary reference level.

13.11.2 Reflectors oriented transverse to the weld seam:

13.11.2.1 Scanning with Weld Reinforcement: If the weld cap is not machined or ground flat, the examination shall be performed from the base material on both sides of the weld cap. While scanning parallel to the weld axis, the angle beam shall be directed from 0° to 60° with respect to the weld axis in both axial directions, with the angle beam passing through the required examination volume.

13.11.2.2 Scanning without Weld Reinforcement: If the weld cap is machined or ground flat, the examination shall be performed on the weld. While scanning, the angle beam shall be directed essentially parallel to the weld axis in both axial directions. The search unit shall be manipulated so that the angle beam passes through the required examination volume.

13.11.2.3 Scanning shall be at a gain setting at least two (2) times the primary reference level (+6 dB), and evaluation shall be at the primary reference level.

13.12 Single-Sided Access Welds

13.12.1 Welds that cannot be fully examined in two directions per paragraphs 13.11.1 and 13.11.2 using the angle beam technique shall also be examined to the maximum extent possible with a straight beam technique applied from an adjacent base metal surface. This may be applicable to vessel corner and tee joints, nozzle and manway neck to shell or head joints, and pipe to fittings or branch connections. The area(s) of single-sided access and, if applicable, the extent of limited coverage shall be noted in the examination report.

14.0 EVALUATION

14.1 General

14.1.1 All indications in excess of 20% of reference level (or longer than 40% of rejectable flaw size for Non-Distance Amplitude Techniques) shall be investigated to the extent that the operator can determine the discontinuity type (noise, part geometry, flaw).

14.1.2 It is recognized that not all ultrasonic reflections indicate flaws, since certain metallurgical conditions may produce indications that are not relevant. Included in this category are plate segregates in the heat-affected zone that become reflective after fabrication. Under straight beam examination, these may appear as spot or line indications. Under angle beam examination, indications that are determined to originate from surface conditions (such as weld root geometry) or variations in metallurgical structure in austenitic materials (such as automatic-to-manual weld clad interface) may be classified as geometric indications. The identity, maximum amplitude, location, and extent of geometric reflectors causing an indication exceeding 50% of reference level shall be recorded [For example: internal attachment, 200% DAC, 1 inch above centerline, on the inside surface, from 90° to 95°]. The following steps shall be taken to classify the indication as geometric:

14.1.2.1 Plot and verify the reflector coordinates. Prepare a cross-sectional sketch showing the reflector position and surface discontinuities such as root and counterbore.

14.1.2.2 Review fabrication or weld preparation drawings. Other ultrasonic techniques or nondestructive examination methods may be helpful in determining a reflector's true position, size, and orientation.

14.2 Indication Discrimination

14.2.1 The following indication characteristics are listed for additional guidance. These characteristics should not be considered as mandatory criteria for classifying indications, but are listed as significant points of interest for the examiner to consider during evaluation of suspect areas.

14.2.2 Geometric and Metallurgical Indications

14.2.2.1 The indication appears at or near the centerline of the weld or other documented geometrical condition (i.e., counterbore) and can be seen continuously or intermittently along the length of the weld at consistent amplitude and sweep positions. This characteristic can be supported by obtaining localized thickness and surface contour recordings at the location of the indication(s).

14.2.2.2 The indication provides additional responses, which occur from the same scan position, but at different sweep positions (multiples) along the length of the weld. This may be a sign of mode-converted shear-wave signals from counterbore or similar geometric reflectors. This characteristic may require an increase in time base size in order to observe these responses.

14.2.2.3 The indication can be seen across the entire length of the scan, either continuously or intermittently, at consistent amplitude and sweep positions. This characteristic can be supported by scanning along the indicated length laterally.

14.2.2.4 When examining with a higher angle search unit, the amplitude response is lower or not detected. This characteristic should consider localized thickness and contour information to ensure that the search unit angles provide comparable examination volume coverage and sound penetration. This characteristic can additionally be supported with an adequate reference reflector (inside surface notch or equivalent).

14.2.2.5 The indication provides minimal echo-dynamic travel (walk). This characteristic can be supported by observing other areas along the length of sample and with an adequate reference reflector (inside surface notch or equivalent).

14.2.2.6 The indication provides a rapid and consistent drop in signal amplitude when the beam is skewed away from normal in either direction.

14.2.2.7 The indication provides a clean, single signal response with minimal to no signal faceting. No discernible tip signals are observable. This characteristic can be supported by optimizing the signal presentation on an adequate reference reflector (inside surface notch or equivalent).

14.2.2.8 The signal responses are consistent from each side of the weld for axial scans, or from each direction, clockwise (CW) or counter-clockwise (CCW) for circumferential scans.

14.2.3 Flaw Indications

14.2.3.1 The indication has a good signal-to-noise ratio (e.g., minimum SN 2:1) with defined start and end points. This characteristic can be supported by observing signal-to-noise ratio variation along the component's length.

14.2.3.2 The indication plots to a location susceptible to cracking. This characteristic can be supported by obtaining localized thickness and surface contour recordings at the location of the indication(s).

14.2.3.3 The indication can be detected with multiple search unit angles, and a higher angle provides comparable or greater signal response. This characteristic can be supported with an adequate reference reflector (inside surface notch or equivalent).

14.2.3.4 The indication provides substantial and unique echo-dynamic travel (walk). This characteristic can be supported by observing other areas along the length of sample and with an adequate reference reflector (inside surface notch or equivalent).

14.2.3.5 Several areas of unique or multiple amplitude peaks are observed throughout the indication length. This characteristic can be supported by observing other areas along the length of sample and by scanning along the indication length laterally.

14.2.3.6 The indication maintains or provides an increase in signal amplitude when the beam is skewed away from normal. This characteristic can be supported by observing other areas along the length of sample.

14.2.3.7 Inconsistent time base positions are observed throughout the indication length as the search unit is moved parallel along the length of the reflector. This characteristic can be supported by scanning along the indicated length laterally.

14.2.3.8 The indication shows evidence of flaw tip signals.

14.2.3.9 Circumferential indications provide axial components while performing tangential scans.

14.2.3.10 For circumferential flaws, the indication(s) can be confirmed from the opposite side of the weld. This characteristic may require a reduced search unit frequency.

14.2.3.11 For axial flaws, the indication(s) can be confirmed from the opposite direction. This characteristic is dependent upon flaw orientation and may not always be available.

14.2.3.12 The indication is in close proximity to, or initiates from, a geometrical reflector and distinct signal separation and amplitude fluctuation can be observed. This characteristic may require an increase in signal resolution capability in order to make this evaluation. Examples include reducing screen size and slower scan speeds.

14.2.3.13 For components where access is limited to a single side of the component, the following additional information shall be considered: Because of the uncertainties associated with the flaw orientation and the actual thickness of the component on the inaccessible side of the weld, an accurate inside surface connection on the far side of the weld may not be obtainable. For suspect far side flaw indications, several search unit angles should be evaluated to optimize the response.

14.3 Length Sizing

14.3.1 Length sizing shall be performed utilizing information obtained on the same side of the weld as the indications. If component geometry provides limitations (e.g., longitudinal weld obstructions, welded attachments, etc.) or the flaw orientation provides improved and satisfactory UT responses, then length-sizing data from opposite side examinations may be used to provide additional information to the same-side data.

14.3.2 If the indication is detectable with multiple search unit angles, the primary search unit should generally be utilized for final length determination. If geometric conditions or examination limitations prohibit

adequate length sizing data with the primary search unit, additional angles shall be utilized.

14.3.2.1 If multiple angles are evaluated, the angle that provides the most conservative dimension (greatest length) should be utilized.

14.3.3 If an extreme length discrepancy exists between search unit angles, the examiner shall attempt to identify the cause of discrepancy (e.g., scan limitation, surface condition, beam spread, geometrical effects, etc.) and may utilize the length sizing measurement of a less conservative search unit.

14.3.4 Length sizing shall be performed in accordance with the technique below. Multiple search unit angles should be evaluated in order to properly discriminate flaw responses from surrounding metallurgical and geometrical conditions.

14.3.5 Optimize the signal response from the flaw indication.

14.3.6 Scan the indication area with specific focus on the flaw signal responses (e.g., signal shape, walk, orientation, effect of skew, etc.). Adjust the system gain as needed to optimize flaw responses.

14.3.7 Scan an adjacent unflawed area in close proximity to the flaw area with specific focus on the surrounding geometrical responses (weld material noise, root, counterbore, etc.).

14.3.8 Maximize the signal response from the flaw indication. Adjust the system gain until this response is 80% FSH.

14.3.9 Scan along the length of the flaw in each direction until the signal response has been reduced to 20% FSH (12 dB drop).

14.3.9.1 Axial Flaws – The length sizing techniques identified above provide an acceptable level of accuracy for dimensioning axial flaws detected with the circumferential scan.

14.3.9.2 Circumferential Flaws – The length sizing techniques identified above provide an outside diameter length dimension which is longer than the actual inside diameter length dimension due to curvature of the piping material. To calculate the actual flaw length at the inside surface, the following formula shall be used:

$$\text{ID Flaw Length} = \text{OD Flaw Length} \times (\text{ID} / \text{OD})$$

14.3.9.3 Flaws detected at locations other than the OD or ID shall be calculated based on their actual cross-sectional location in the examination volume.

15.0 ACCEPTANCE STANDARDS

15.1 General

15.1.1 Acceptance/rejection criteria shall be based on the referencing Code Section or customer requirements and shall be documented on the examination report.

15.2 API 1104 21st Edition Section 12 Acceptance Criteria

15.2.1 Acceptance criteria for ultrasonic testing of welds shall be in accordance with API 1104 21st Edition Section 12. When the referencing code, contract, or customer specification requires compliance with API 1104, the acceptance criteria of API 1104 Section 12 shall apply to pipeline girth welds and related facilities welds. See Appendix III for detailed acceptance criteria tables.

15.3 ASME Section I and Section VIII Divisions 1 and 2 Acceptance Criteria

15.3.1 For Division 1 and 2: Indications characterized as cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length.

15.3.2 For Division 1: Other imperfections shall be unacceptable if the indications exceed the reference level amplitude and have lengths which exceed:

15.3.2.1 $\frac{1}{4}$ in. (6 mm) for t up to $\frac{3}{4}$ in. (19 mm)

15.3.2.2 $\frac{1}{3} t$ for t from $\frac{3}{4}$ in. (19 mm) to $2\frac{1}{4}$ in. (57 mm)

15.3.2.3 $\frac{3}{4}$ in. (19 mm) for t over $2\frac{1}{4}$ in. (57 mm), where t is the thickness of the weld excluding any allowable reinforcement.

15.3.3 For Division 2: All other linear type imperfections shall be unacceptable if the indications exceed the reference level amplitude and have lengths which exceed:

15.3.3.1 $\frac{1}{4}$ in. (6 mm) for t less than $\frac{3}{4}$ in. (19 mm)

15.3.3.2 $\frac{1}{3} t$ for t greater than or equal to $\frac{3}{4}$ in. (19 mm) and less than or equal to $2\frac{1}{4}$ in. (57 mm)

15.3.3.3 $\frac{3}{4}$ in. (19 mm) for t greater than $2\frac{1}{4}$ in. (57 mm), where t is the thickness of the weld excluding any allowable reinforcement.

15.3.4 For Divisions 1 and 2: Unrepaired areas having responses that exceed 50% of the reference level shall be noted and include the location of each area, the response level, the dimensions, the depth below the surface, and the classification.

15.3.5 For Divisions 1 and 2: For a butt weld joining two members having a different thickness at the weld, t is the thinner of the two thicknesses joined. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet shall be included.

ASME Section I and VIII Acceptance Criteria Summary:

Wall Thickness (t)	Maximum Acceptable Indication Length
$t \leq \frac{3}{4}$ in. (19 mm)	$\frac{1}{4}$ in. (6 mm)
$\frac{3}{4}$ in. (19 mm) < $t \leq 2\frac{1}{4}$ in. (57 mm)	$\frac{1}{3} t$
$t > 2\frac{1}{4}$ in. (57 mm)	$\frac{3}{4}$ in. (19 mm)

15.4 ASME B31.3 Acceptance Criteria

15.4.1 When the calibration block has not received the same heat treatment as the material being tested, the transfer correction described in paragraph 15.4.2 shall be done:

15.4.1.1 For sizes $\leq$ NPS 2 in. (50 mm), once for each 10 welded joints examined.

15.4.1.2 For sizes $>$ NPS 2 in. (50 mm) and $\leq$ NPS 18 in. (450 mm), once in each 5 ft (1.5 m) of welding examined.

15.4.1.3 For sizes $>$ NPS 18 in. (450 mm), once for each weld joint examined.

15.4.2 Each type of material and each size and wall thickness shall be considered separately in applying the transfer method. In addition, it shall be used at least twice for each type of weld joint. Transfer is accomplished by noting the difference between responses received from the same reference reflector (an angle beam wedge) in the block and in the component and correcting the reference gain level for the difference.

15.4.3 A linear type discontinuity is unacceptable if the amplitude of the indication exceeds the reference level, and its length exceeds:

15.4.3.1 $\frac{1}{4}$ in. (6 mm) for $t \leq \frac{3}{4}$ in. (19 mm)

15.4.3.2 $\frac{1}{3} t$ for $t > \frac{3}{4}$ in. (19 mm) to $2 \frac{1}{4}$ in. (57 mm)

15.4.3.3 $\frac{3}{4}$ in. (19 mm) for t over $2 \frac{1}{4}$ in. (57 mm)

15.5 ASME B31.1 Acceptance Criteria

15.5.1 Welds that are shown by UT to have discontinuities that produce an indication greater than 20% of the reference level shall be investigated to the extent that UT personnel can determine their shape, identity, and location so that they may evaluate each discontinuity for acceptance in accordance with paragraphs 15.5.2 and 15.5.3 below.

15.5.2 Discontinuities evaluated as being cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length.

15.5.3 Other discontinuities are unacceptable if the indication exceeds the reference level and their length exceeds the following:

15.5.3.1 $\frac{1}{4}$ in. (6 mm) for t up to $\frac{3}{4}$ in. (19 mm)

15.5.3.2 $\frac{1}{3} t$ for t from $\frac{3}{4}$ in. (19 mm) to $2 \frac{1}{4}$ in. (57 mm)

15.5.3.3 $\frac{3}{4}$ in. (19 mm) for t over $2 \frac{1}{4}$ in. (57 mm)

Note: If the weld joins two members having different thicknesses at the weld, t is the thinner of these two thicknesses.

15.5.4 When fracture mechanics acceptance criteria for ASME B31.1 is specifically requested by the customer in work order or contract, refer to Prime Inspections Inc. procedure PAUT-ASME-Piping, latest revision. Manual UT is not allowed for alternative acceptance criteria like fracture mechanics.

15.6 ASME Section IX Acceptance Criteria

15.6.1 All indications characterized as cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length.

15.6.2 Indications exceeding $\frac{1}{8}$ in. (3 mm) in length are considered relevant and are unacceptable when their lengths exceed:

15.6.2.1 $\frac{1}{8}$ in. (3 mm) for t up to $\frac{3}{8}$ in. (10 mm)

15.6.2.2 $\frac{1}{3} t$ for t from $\frac{3}{8}$ in. (10 mm) to $2 \frac{1}{4}$ in. (57 mm)

15.6.2.3 $\frac{3}{4}$ in. (19 mm) for t over $2\frac{1}{4}$ in. (57 mm), where t is the thickness of the weld excluding any allowable reinforcement.

15.6.3 For a butt weld joining two members having different thicknesses at the weld, t is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thickness of the throat of the fillet shall be included in t.

16.0 POST-EXAMINATION CLEANING

16.1 When post-examination cleaning is required by the work procedure, it is to be conducted as soon as practical after evaluation and documentation. Manual removal of couplant materials using standard cleaning liquids that will not adversely affect the part are to be used. Arrangements shall be made with the customer when other cleaning techniques are specified.

16.2 All couplant residue shall be removed from the component surfaces. Solvents or cleaning agents used shall be compatible with the component material and shall not leave residues that could cause corrosion or contamination.

16.3 If the component was marked with layout reference points, the markings shall be left in place unless otherwise directed by the customer or referencing Code Section. Layout markings shall not interfere with subsequent fabrication or coating operations.

16.4 All cleaning materials and solvents shall be handled and disposed of in accordance with the Material Safety Data Sheet (SDS) and applicable environmental regulations.

17.0 PROCEDURE QUALIFICATION

17.1 When required by the referencing Code Section, this procedure shall be qualified in accordance with reference 2.1 (ASME Section V Article 4). Documentation of this qualification shall remain on file and be available upon request.

17.2 When procedure qualification is required, any change to a requirement identified as an essential variable (see Table T-421) shall require requalification of this procedure by demonstration. Where a range is specified for an essential variable, the bounding values of the range shall be qualified by demonstration. A change of a requirement identified as a nonessential variable does not require requalification of the written procedure.

17.3 All changes of essential or nonessential variables from those in this procedure shall require a revision of, or an addendum to, the procedure.

17.4 When ASME B31.1 is the applicable code, personnel, procedures, and equipment used to collect and analyze UT data shall demonstrate their ability to perform an acceptable examination as specified by the customer's requirements.

17.5 For austenitic and high nickel alloy weld examinations, the technique qualification per paragraph 13.5.3 shall be documented and maintained on file by the Level III. The qualification shall include the weld mockup configuration, reference reflectors, search units and angles used, and the examination technique description.

17.6 Procedure qualification records shall be maintained in accordance with PII-WP-1 and the Prime Inspections Inc. record retention policy.

18.0 RECORDS

18.1 Examination Reports

18.1.1 The record of the ultrasonic examination shall be documented on an Ultrasonic Examination Report and on an Ultrasonic Calibration Record. Standard Ultrasonic Examination Reports and Ultrasonic Calibration Records are in editable PDF format (see Appendices IV and V).

18.2 Ultrasonic Examination Report Content

18.2.1 The information required on the Ultrasonic Examination Report shall include, but not be limited to:

18.2.1.1 Procedure and revision number.

18.2.1.2 Identification and location of weld or volume scanned.

18.2.1.3 Surface(s) from which examination was conducted, including surface condition.

18.2.1.4 Map or record of rejectable indications detected or areas cleared.

18.2.1.5 Areas of restricted access or inaccessible welds.

18.2.1.6 Examiner's name, signature, and certification level.

18.2.1.7 Date and time examinations were performed.

18.2.1.8 Rejectable indications including the type of indication (i.e., crack, non-fusion, lag, etc.), location, and extent (i.e., length).

18.2.1.9 Non-rejectable indications from uncorrected areas having responses that exceed 50% of the reference level. This record shall locate each area, the response level, the dimensions, the depth below the surface, and the classification (i.e., slag, geometry, etc.).

18.2.1.10 Repaired areas shall be noted as well as the results of the reexamination of the repaired areas.

18.2.1.11 For austenitic and high nickel alloy welds only, a reference to the technique qualification(s) shall be included on the report.

18.3 Ultrasonic Calibration Record Content

18.3.1 The Ultrasonic Calibration Record shall include as a minimum:

18.3.1.1 Instrument identification, including manufacturer's serial number.

18.3.1.2 Search unit(s) identification (including manufacturer's serial number, frequency, and size).

18.3.1.3 Beam angle(s) used.

18.3.1.4 Couplant used, brand name or type.

18.3.1.5 Search unit cable(s) used, type and length.

18.3.1.6 Calibration block identification.

18.3.1.7 Instrument reference level gain and, if used, damping and reject setting(s).

18.3.1.8 Calibration data (including reference reflector(s), indication amplitude(s), and distance reading(s)).

18.3.1.9 Calibration block and component temperature at time of calibration and examination.

18.3.1.10 Verification times and results.

18.4 Record Retention

18.4.1 A copy of the ultrasonic examination report and calibration record shall be retained as specified by the referencing Code Section.

18.4.2 Unless otherwise specified, all UT records and reports shall be maintained in accordance with the Prime Inspections Inc. record retention policy.

18.5 Personnel and Procedure Demonstration Documentation

18.5.1 Personnel or procedure demonstrations performed in compliance with the requirements of reference 2.1 Article 1 shall be documented as specified by the referencing Code Section.

18.5.2 When documentation requirements for personnel or procedure demonstrations performed in accordance with reference 2.1 Article 1 are not specified by the referencing Code Section, the following information shall be recorded as a minimum:

18.5.2.1 Name of the organization responsible for preparation and approval of the examination procedure.

18.5.2.2 Examination method applied.

18.5.2.3 Procedure number and designation.

18.5.2.4 Number and date of most recent revision.

18.5.2.5 Date of the demonstration.

18.5.2.6 Name and certification level (if applicable) of personnel performing the demonstration.

18.5.3 Personnel or procedure demonstrations performed in compliance with customers' requests shall be documented as specified by the customer in the PO, Contract, or customer's specification.

19.0 SAFETY

19.1 General Safety Requirements

19.1.1 Prior to beginning work, all personnel shall read, understand, and follow the requirements of the applicable Job Hazard Analysis (JHA). In addition, personnel shall observe and follow all site-specific safety requirements.

19.1.2 Personnel shall be aware of and follow all applicable federal, state, and local safety regulations, including OSHA requirements as applicable.

19.1.3 Personal Protective Equipment (PPE) shall be worn as required by the JHA, site requirements, and Prime Inspections Inc. safety policies. Minimum PPE shall include safety glasses, hard hat, safety shoes, and gloves as applicable.

19.2 Couplant Handling

19.2.1 Couplant materials shall be handled in accordance with the manufacturer's Safety Data Sheet (SDS). SDS sheets shall be maintained on file and available to personnel.

19.2.2 Skin contact with couplant materials shall be minimized. If skin contact occurs, wash the affected area with soap and water.

19.2.3 Couplant materials shall be disposed of in accordance with applicable environmental regulations and the manufacturer's SDS recommendations.

19.3 Electrical Safety

19.3.1 UT instruments shall be inspected for damage to power cords, cables, and connectors prior to use. Damaged equipment shall be removed from service immediately.

19.3.2 When using AC-powered instruments in wet or damp environments, Ground Fault Circuit Interrupter (GFCI) protection shall be used.

19.3.3 Instrument power sources shall be verified as appropriate for the work environment. Battery-powered instruments shall be used in areas where AC power is not available or safe to use.

19.4 Working at Heights and Confined Spaces

19.4.1 When examinations are performed at elevated locations, fall protection shall be used in accordance with site requirements and OSHA regulations.

19.4.2 When examinations are performed in confined spaces, confined space entry permits shall be obtained and all confined space safety requirements shall be followed, including atmospheric testing and ventilation as required.

19.5 High Temperature Surfaces

19.5.1 When examinations are performed on components at elevated temperatures, appropriate heat-resistant gloves and PPE shall be worn. Contact with hot surfaces shall be minimized.

19.5.2 High-temperature couplant and wedges shall be used in accordance with the manufacturer's temperature ratings.

TABLE T-421 – Requirements of an Ultrasonic Examination Procedure

Requirement	Essential Variable	Nonessential Variable	Reference
Method (UT)	X		Section 1.0
Material/Product Form	X		Section 1.0
Thickness Range	X		Section 1.0, 10.0
Type of Weld/Joint	X		Section 1.0, 13.0
Search Unit Type	X		Section 8.0
Search Unit Frequency	X		Section 8.0
Search Unit Size	X		Section 8.0
Beam Angle(s)	X		Section 13.7
Calibration Block Type	X		Section 10.0
Couplant Type	X		Section 9.0
Scanning Technique	X		Section 13.2
Scanning Speed		X	Section 13.2
DAC Curve	X		Section 12.0, 13.0
Acceptance Criteria	X		Section 15.0
Instrument Type	X		Section 6.0, 7.0
Surface Preparation		X	Section 11.5
Recording Method		X	Section 18.0
Personnel Qualification	X		Section 5.0
Post-Exam Cleaning		X	Section 16.0
Examination from ID/OD Surface	X		Section 13.0
Curvature Range	X		Section 11.0
Temperature Range	X		Section 10.7

APPENDIX I – STRAIGHT BEAM INSPECTION OF NOZZLE WELD FUSION ZONES AND/OR ADJACENT NOZZLE PARENT METAL

I-1.0 When the referencing Code Section specifies that an ultrasonic examination be performed to examine either the nozzle side weld fusion zone and/or adjacent nozzle parent metal, a straight beam examination shall be conducted from the inside nozzle surface.

I-2.0 Unless otherwise specified, the requirements in the main body of this procedure apply.

I-3.0 The full circumference of the nozzle shall be scanned to cover the entire nozzle side fusion zone of the weld plus 1 in. (25 mm) beyond the weld toes. The search unit may be moved either circumferentially around or axially across the examination zone.

I-4.0 The screen range shall cover as a minimum, 1.1 times the full thickness of the nozzle wall.

I-5.0 Nozzles that cannot be fully examined (e.g., restricted access that prevents hand placement of the search unit) shall be noted in the examination report.

I-6.0 Calibration Block

I-6.1 Configuration: The calibration block configuration shall be as shown in Figure T-434.5.1. The block size and reflector locations shall be adequate to perform calibrations to cover the nozzle side weld fusion zone and/or adjacent nozzle parent metal. If the internal surface of the nozzle is clad before the examination, the ID surface of the calibration block shall be clad.

I-6.2 Block Thickness: The calibration block thickness shall be the maximum thickness of the nozzle wall adjacent to the nozzle weld plus $\frac{3}{4}$ in. (19 mm).

I-6.3 Curvature: For examinations with an inside diameter (ID) equal to or less than 20 in. (500 mm), the contact surface of the calibration block shall have the same curvature or be within the range of 0.9 to 1.5 times the diameter as detailed in Figure T-434.1.7.2.

I-6.4 Calibration Reflectors: The calibration reflectors shall be side-drilled hole(s) that are in accordance with the requirements of Figure T-434.2.1 for the nozzle wall thickness.

I-6.5 Alternative Blocks

I-6.5.1 Alternative Calibration Blocks: Existing calibration blocks may be used for similar types of examinations provided the sound path distance(s) to the block's reflector(s) is/are within $\frac{1}{4}$ in. (6 mm) of what is required, and the side-drilled hole(s) is/are the same or a smaller diameter than what is required.

I-7.0 Calibration for Nozzle Side Weld Fusion Zone and/or Adjacent Nozzle Parent Metal

I-7.0.1 The number of calibration holes used depends upon the requirements for the examination. If only the nozzle side fusion zone is to be examined, then only a single side-drilled hole at the nozzle wall thickness needs to be used.

I-7.1 Single Hole

I-7.1.1 The response from the single side-drilled hole shall be set at $80\% \pm 5\%$ of FSH. This is the primary reference level.

I-7.2 Multiple Holes

I-7.2.1 The straight beam shall be directed toward the calibration reflector that yields the maximum response. The gain control shall be set so that this response is at $80\% \pm 5\%$ of FSH. This shall be the primary reference level. The search unit shall then be manipulated, without changing instrument settings, to obtain the maximum responses from the other hole position(s) to generate a DAC curve.

APPENDIX II – LAYOUT OF VESSEL REFERENCE POINTS

II-1.0 Markers used for vessel layout shall be permanent paint or felt tip markers. Low stress stamps or vibratooling may be used if specified and supplied by the Manufacturer or Owner. Markings applied after final stress relief shall not be any deeper than 3/64 in. (1.2 mm).

II-2.0 The layout of the vessel shall consist of placing reference points on the centerline of the weld. The spacing of the reference points shall be in equal increments (e.g., 12 in. (300 mm), 3 ft (900 mm), 1 m, etc.) and identified with numbers (e.g., 0, 1, 2, 3, 4, etc.). The increment spacing, number of points, and the starting point shall be recorded on the reporting form. The weld centerline shall be the divider for the two examination surfaces.

II-2.1 Circumferential (Girth) Welds: The standard starting point shall be the 0° axis of the vessel. The reference points shall be numbered in a clockwise direction, as viewed from the top of the vessel, or for horizontal vessels, from the inlet end of the vessel. The examination surfaces shall be identified (e.g., for vertical vessels, as being either above or below the weld).

II-2.2 Longitudinal Welds: Longitudinal welds shall be laid out from the centerline of circumferential welds at the top end of the weld or, for horizontal vessels, the end of the weld closest to the inlet end of the vessel. The examination surface shall be identified as clockwise or counterclockwise as viewed from the top of the vessel or, for horizontal vessels, from the inlet end.

II-2.3 Nozzle-to-Vessel Welds: The external reference circle shall have a sufficient radius so that the circle falls on the vessel's external surface beyond the weld's fillet. The internal reference circle shall have sufficient radius so that the circle falls within ½ in. (12 mm) of the weld's centerline. The 0° point on the weld shall be the top of the nozzle. The 0° point for welds of vertically oriented nozzles shall be located at the 0° axis of the vessel, or for horizontal vessels, the point closest to the inlet end of the vessel. Angular layout of the weld shall be made clockwise on the external surface and counterclockwise on the internal surface. The 0°, 90°, 180°, and 270° lines will be marked on all nozzle welds examined; 30° increment lines shall be marked on nozzle welds greater than nominal 8 in. (200 mm) diameter; 15° increment lines shall be marked on nozzle welds greater than nominal 24 in. (600 mm) diameter; and 5° increment lines shall be marked on nozzle welds greater than nominal 48 in. (120 cm) diameter.

II-2.4 A dimensioned weld map may be produced on the examination report, construction drawings, or sketch paper showing the volume scanned and recordable/rejectable indications or areas cleared. Attach a copy to the Ultrasonic Examination Report.

APPENDIX III – API 1104 21st EDITION SECTION 12 ACCEPTANCE CRITERIA FOR UT OF WELDS

III-1.0 Scope and Application

III-1.1 This appendix provides the acceptance criteria for ultrasonic testing of welds in accordance with API 1104 21st Edition Section 12. These criteria apply to pipeline girth welds and related facilities welds when specified by the referencing code, contract, or customer specification.

III-2.0 Acceptance Criteria for Length and Amplitude

III-2.1 For welds examined in accordance with API 1104 21st Edition Section 12, the following acceptance criteria shall apply. Indications shall be evaluated against the reference level established during calibration.

API 1104 Section 12	Acceptance Criteria
Crack indications	Unacceptable regardless of length
Lack of fusion	Unacceptable regardless of length
Incomplete penetration	Unacceptable regardless of length
Linear indications exceeding reference level	Unacceptable if length exceeds criteria below
Rounded indications	Evaluate per API 1104 Section 12
Amplitude-based acceptance	Indications exceeding reference level amplitude are evaluated for length

III-2.2 Maximum Acceptable Length by Wall Thickness

III-2.2.1 For indications other than cracks, lack of fusion, or incomplete penetration, the maximum acceptable length by wall thickness is:

Wall Thickness (t)	Maximum Acceptable Indication Length
$t \leq \frac{1}{2}$ in. (12.5 mm)	$\frac{1}{2}$ in. (12.5 mm) or $2t$, whichever is less
$\frac{1}{2}$ in. (12.5 mm) $< t \leq 1$ in. (25 mm)	$\frac{1}{2}$ in. (12.5 mm)
$t > 1$ in. (25 mm)	$\frac{3}{4}$ in. (19 mm) or $1.5t$, whichever is greater

III-3.0 Evaluation and Disposition

III-3.1 All indications exceeding 20% of the reference level shall be investigated and characterized. The type, location, length, and amplitude of each indication shall be recorded on the Ultrasonic Examination Report.

III-3.2 Indications determined to be geometric (root geometry, counterbore, internal attachments) shall be classified as geometric and documented as such. Geometric indications exceeding 50% of the reference level shall be recorded with their location, amplitude, and extent.

III-3.3 Repair areas shall be re-examined after repair. The results of the re-examination shall be documented on the Ultrasonic Examination Report.

III-3.4 When the acceptance criteria of API 1104 Section 12 conflict with other code or customer requirements, the most stringent criteria shall apply unless otherwise specified by the customer in the contract or purchase order.

APPENDIX IV – ULTRASONIC EXAMINATION REPORT FORM TEMPLATE

IV-1.0 The following form template shall be used for documenting ultrasonic examination results. All fields shall be completed for each examination.

FIELD	ENTRY
Prime Inspections Inc. – Ultrasonic Examination Report	
Procedure Number / Revision	PII-MUT Rev 04
Customer / Project	
Component / Weld ID	
Material / P-Number	
Wall Thickness (in./mm)	
Weld Length Examined (in./mm)	
Examination Surface(s)	
Surface Condition	
Acceptance Criteria (Code)	
Search Unit – Type / Freq / Size	
Search Unit – Angle(s)	
Calibration Block ID	
Couplant Type	
Instrument Make / Model / S/N	
Primary Reference Level (dB)	
Calibration Block Temp (°F/°C)	
Component Temp (°F/°C)	
Calibration Date / Time	
Verification Times	
Indication #	
Indication Type (crack/lack of fusion/etc.)	
Location (from reference point)	
Distance from Surface (in./mm)	
Amplitude (% Reference)	
Length (in./mm)	
Classification (Accept/Reject)	
Geometric Indications (>50% ref.)	

Repaired Areas / Re-exam Results	
Inaccessible / Restricted Areas	
Examiner Name / Cert. Level / Signature	
Date of Examination	
Reviewed By (Level III)	
Review Date	

APPENDIX V – ULTRASONIC CALIBRATION RECORD FORM TEMPLATE

V-1.0 The following form template shall be used for documenting ultrasonic calibration data. All fields shall be completed for each calibration.

FIELD	ENTRY
Prime Inspections Inc. – Ultrasonic Calibration Record	
Instrument Manufacturer	
Instrument Model	
Instrument Serial Number	
Instrument Type (Analog/Digital)	
Search Unit 1 – Type	
Search Unit 1 – Frequency (MHz)	
Search Unit 1 – Size (in./mm)	
Search Unit 1 – Serial Number	
Search Unit 1 – Beam Angle	
Search Unit 2 – Type	
Search Unit 2 – Frequency (MHz)	
Search Unit 2 – Size (in./mm)	
Search Unit 2 – Serial Number	
Search Unit 2 – Beam Angle	
Search Unit Cable Type	
Search Unit Cable Length	
Couplant Type / Brand	
Calibration Block ID / Serial No.	
Calibration Block Material / P-No.	
Calibration Block Thickness (T)	
Damping Setting	
Reject Setting	
Primary Reference Level Gain (dB)	
DAC Curve – Point 1 (Distance / Amplitude)	
DAC Curve – Point 2 (Distance / Amplitude)	
DAC Curve – Point 3 (Distance / Amplitude)	
Split DAC Used? (Y/N)	

Sweep Range Setting	
Calibration Block Temperature	
Component Temperature	
Verification – Start of Exam (Time / Result)	
Verification – 4-Hour Check (Time / Result)	
Verification – End of Exam (Time / Result)	
Calibration Performed By (Name/Cert.)	
Date / Time of Calibration	
Reviewed By (Level III)	
Review Date	

END OF DOCUMENT