**Record 19-2943**

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| **ASME Section V:**  **Back wall vs back-wall vs back wall**   |  |  | | --- | --- | | **CURRENT (2019 Edition)** | **PROPOSED** | | **Delete the wording in blue**  **TABLE OF CONTENTS**  Page xxi  N-482(a) Schematic of Flaw Locations and TOFD Image  Showing the Lateral Wave, **~~Backwall,~~** and Three of the Four Flaws . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 182  N-482(b) Schematic of Flaw Locations and TOFD Display Showing the  Lateral Wave, **~~Backwall~~**, and Four Flaws . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 183  N-483(a) Acceptable Noise Levels, Flaws, Lateral Wave, and Longitudinal  Wave **~~Backwall~~** . . . . . . . . 184  Page 9  I-121.2 UT — Ultrasonics.  back-wall echo: a specular reflection from the **~~back-wall~~** of the component being examined. | **Insert the wording in red**    Back wall  Back wall  back wall  Back wall |  |  |  | | --- | --- | | **MANDATORY APPENDIX III**  **TIME OF FLIGHT DIFFRACTION (TOFD) TECHNIQUE**  ASME BPVC.V-2019 Article 4  **Page 108**  **III-486 FLAW SIZING AND INTERPRETATION**  When height of flaw sizing is required, after the system is calibrated per III-463, a free run on the calibration block shall be performed and the depth of the **back-wall** reflection calculated by the system shall be within 0.04 in. (1 mm) of the actual thickness. For multiple zone examinations where the back wall is not displayed or barely discernible, a side-drilled hole or other known depth reference reflector in the calibration block may be used. See Nonmandatory Appendices L and N of this Article for additional information on flaw sizing and interpretation. Final interpretation shall only be made after all display parameter adjustments (i.e., contrast, brightness, lateral  and **~~backwall~~** removal and SAFT processing, etc.) have been completed.  **Page 107**  **III-471.6 RecordingData(Gated Region).** The unrectified (RF waveform) A-scan signal shall be recorded. The A-scan gated region shall be set to start just prior to the lateral wave and, as a minimum, not end until all of the first back-wall signal with allowance for thickness and mismatch variations, is recorded. Useful data can be obtained from  mode-converted signals; therefore, the interval from the first **~~back-wall~~** to the mode-converted back-wall signal shall also be included in the data collected when required by the referencing Code.  **MANDATORY APPENDIX VII**  **ULTRASONIC EXAMINATION REQUIREMENTS FOR**  **WORKMANSHIP-BASED ACCEPTANCE CRITERIA**  **Page 115**  **VII-485 EVALUATION**  Final flaw evaluation shall only be made after all display parameter adjustments (e.g., contrast, brightness, and, if applicable, lateral and  **~~backwall~~** removal and SAFT processing, etc.) have been completed.  **Page 117**  **VIII-485 EVALUATION SETTINGS**  Final flaw evaluation shall only be made after all display parameter adjustments (e.g., contrast, brightness, and, if applicable, lateral and  **~~backwall~~** removal and SAFT processing, etc.) have been completed.  **MANDATORY APPENDIX XI**  **FULL MATRIX CAPTURE**  **Page 127**  **XI-464**  **XI-464.2 Sensitivity.** Calibration sensitivity shall be established by recording the imaged intensity of an SDH described in XI-462.8.1 to a level greater than or equal to 50% full screen height (FSH), and shall not  exhibit saturation. Other reflectors (i.e., entry surface, **~~backwall~~**)  **Page 128**  **XI-474**  **XI-474.1 Examination Sensitivity.** Examination sensitivity shall not be less than that established during calibration. However, sensitivity may be adjusted on the actual component, provided that the methodology and  component reflector used are identified (e.g., **~~backwall~~**), and the upper and lower limits of the sensitivity range are qualified. The process for this qualification shall be included in the procedure.  **NONMANDATORY APPENDIX F**  **EXAMINATION OF WELDS USING FULL MATRIX CAPTURE**  Pg154  **F-471 EXAMINATION**  **Figure F-471-1**  **Examples of Ultrasonic Imaging Modes L-462 SYSTEM CHECKS**    **~~Backwall~~**  GENERAL NOTES:  (a) This Figure shows some of the different modes that are available. L indicates longitudinal wave and T indicates transverse (shear wave). Illustrated are some examples of different modes with pulse echo FMC, and pitch-catch, including transmit receive longitudinal (TRL), using separate probes for pulsing and receiving.  (b) Two capital letters placed together (e.g., L–L) represent a path/mode that reflects from a datum. A dash incorporated into this nomenclature (e.g., LL–L) indicates the returning sound to the search unit.  (c) Other means of identifying the path/modes occur in industry. For example, letters may denote a change in sound direction. In this case, LL–L” would be “LrbLdL,”where rb” indicates “rebound”  (from back wall, etc.), and “d” indicates a datum.  NOTES:  (1) L = longitudinal wave cross talk; no interaction with the datum (image point).  (2) L–L = direct: longitudinal wave directly to the datum and longitudinal wave directly from the datum.  (3) L–T = direct: longitudinal wave directly to the datum and transverse wave directly from the datum.  (4) LL–L = half-skip: longitudinal wave reflecting from back wall without mode conversion on its way to the datum and longitudinal wave directly from the datum.  (5) LT–T = half-skip: longitudinal wave reflecting from back wall with mode conversion on its way to the datum and transverse wave directly from the datum.  (6) LT–TL = full-skip: longitudinal wave reflecting from back wall with mode conversion on its way to the datum and transverse wave reflecting from back wall with mode conversion on its way from the datum.  **NONMANDATORY APPENDIX K**  **RECORDING STRAIGHT BEAM EXAMINATION DATA FOR PLANAR REFLECTORS**  **Page 163**  **K-490 RECORDS/DOCUMENTATION**  Record all reflectors that produce a response equal to or greater than 50% of the distance–amplitude correction (DAC). However, clad interface  and **~~back wall~~** reflections need not be recorded. Record all search unit position and location dimensions to the nearest tenth of an inch.  **NONMANDATORY APPENDIX L**  **TOFD SIZING DEMONSTRATION/DUAL PROBE — COMPUTER IMAGING TECHNIQUE**  **Page 165**  **L-483 CLASSIFICATION/SIZING SYSTEM**  **L-483.1 Sizing.**  *(c) Bottom-Surface Connected Flaws*. Flaw indications consisting solely of an upper-tip diffracted signal and with an associated shift of the  **~~backwall~~** or interruption of the back-wall signal, shall be considered as extending to the bottom surface unless further evaluated by other NDE methods.  **NONMANDATORY APPENDIX M**  **GENERAL TECHNIQUES FOR ANGLE BEAM LONGITUDINAL WAVE CALIBRATIONS**  **Page 168**  **M-461.3.4 Repeat Adjustments**    ~~1st~~  **~~backwall~~**  ~~1 in. (25 mm)~~  **NONMANDATORY APPENDIX N**  **TIME OF FLIGHT DIFFRACTION (TOFD) INTERPRETATION**  **N-421 TOFD IMAGES — DATA VISUALIZATION**  **Page 170**  *(b)* TOFD images are generated by the stacking of these grayscale transformed A-scans as shown in Figure N-421(b). The lateral wave and  **~~backwall~~** signals are visible as continuous multicycle lines. The midwall flaw shown consists of a visible upper and lower tip signal. These show as intermediate multicycle signals between the lateral wave and the  **~~backwall~~**.  *(c)* TOFD grayscale images display phase changes,  some signals are white-black-white; others are blackwhite-black. This permits identification of the wave source (flaw top or bottom, etc.), as well as being used for flaw sizing. Depending on the phase of the incident pulse (usually a negative voltage), the lateral wave would be positive, then the first diffracted (upper tip) signal negative, the second diffracted  back-wall  (lower tip) signal positive, and the **~~backwall~~** signal negative. This is shown schematically in Figure N-421(c). This phase information is very useful for signal interpretation; consequently, RF signals and unrectified signals are used for TOFD. The phase information is used for correctly identifying signals (usually the top and bottom of flaws, if they can be differentiated), and for determining the correct location for depth measurements.  **Page 172**  *(d)* An actual TOFD image is shown in Figure N-421(d), with flaws. The time-base is horizontal and the axis of motion is vertical [the same as the schematic in Figure N-421(c)]. The lateral wave is the fairly strong  multicycle pulse at left, and the **~~backwall~~** the strong multicycle pulse at right. The flaws show as multicycle gray and white reflections between  the lateral and **~~backwall~~** signals. The scan shows several separate flaws (incomplete fusion, porosity, and slag). The ultrasonic noise usually comes from grain reflections, which limits the practical frequency that can be used. TOFD scans may only show the lateral wave (O.D.) and  **~~backwall~~** (I.D.), with “noise. “There is also ultrasonic information  available past the **~~backwall~~** (typically shear wave diffractions), but this is generally not used.  **Page 172**  **N-451 MEASUREMENT TOOLS**  TOFD variables are probe spacing, material thickness, sound velocity,  transducer delay, and lateral wave transit and **~~backwall~~** reflection arrival time. Not all the variables need to be known for flaw sizing. For example, calibration using just the lateral wave (front wall or  O.D.) and **~~backwall~~** (I.D.) signals can be performed without knowing the transducers delay, separation, or velocity. The arrival time, Figure N-451,  of the lateral wave (*t*1) and the **~~backwall~~** signal (*t*2) are entered into the computer software and cursors are then displayed for automated sizing.  **N-452 FLAW POSITION ERRORS**  There will be positional and sizing errors associated with a noncentered flaw, as shown in Figure N-452(b). However, these errors will be small, and generally are tolerable since the maximum error due to off-axis position is less than 10% and the error is actually smaller yet since both the top and bottom of the flaw are offset by similar amounts. The biggest  sizing problems occur with small flaws near the **~~backwall~~**. Exact error values will depend on the inspection parameters.  **Page 173**  **N-481 SINGLE FLAW IMAGES**  *(a)* Point flaws [Figure N-481(a)], like porosity, show up as single  multicycle points between the lateral and **~~backwall~~** signals. Point flaws typically display a single TOFD signal since flaw heights are smaller than the ringdown of the pulse (usually a few millimeters, depending on the transducer frequency and damping). Point flaws usually show parabolic  “tails” where the signal drops off towards the **~~backwall~~**.  *(b)* Inside (I.D.) far-surface-breaking flaws [Figure N-481(b)] shows no  interruption of the lateral wave, a signal near the **~~backwall~~**, and a related  interruption or break of the **~~backwall~~** (depending on flaw size).  *(d)* Midwall flaws [Figure N-481(d)] show complete lateral and  **~~backwall~~** signals, plus diffraction signals from the top and bottom of the flaw. The flaw tip echoes provide a very good profile of the actual flaw. Flaw sizes can be readily black-white, while the lower echo is black-whiteblack. Also note the hyperbolic curve that is easily visible at the left end of the top echo; this is similar to the effect from a point flaw [see N-481(a)] and permits accurate length measurement of flaws [see N-50(a)].  **Page 176**  *(e)* Lack of root penetration [see Figure N-481(e)] is similar to an inside (I.D.) far-surface-breaking flaw [see N-481(b)]. This flaw gives a strong diffracted signal (or more correctly, a reflected signal) with a phase  inversion from the **~~backwall~~** signal. Note that whether signals are  diffracted or reflected is not important for TOFD characterization; the analysis and sizing is the same. Also note even though there is a  perturbation of the **~~backwall~~** signal, the **~~backwall~~** is still visible across the whole flaw. This material also shows small point flaws and some grain noise, which is quite common. TOFD typically overemphasizes small point flaws, which are normally undetected by conventional shear wave pulse-echo techniques.  *(f)* Concave root flaws [see Figure N-481(f)] are similar to lack of root penetration. The top of the flaw is visible in the TOFD image, as well as  the general shape. The **~~backwall~~** signal shows some perturbation as expected.  **Figure N-452(b)**  **Measurement Errors From Flaw Position Uncertainty**    GENERAL NOTE: In practice, the maximum error on absolute depth position lies below 10%. The error on height estimation of internal (small) flaws is  negligible. Be careful of small flaws situated at the **~~backwall~~**.  **Page 175**  **Figure N-454(a)**  **TOFD Image Showing Top and Bottom Diffracted Signals From Midwall Flaw and A-Scan Interpretation**    **~~Backwall~~**  **~~echo~~**  **Figure N-454(b)**  **TOFD Image Showing Top and Bottom Diffracted Signals From Centerline Crack and A-Scan Interpretation**    **~~Backwall~~**  **Page 176**  **Figure N-481(a)**  **Schematics of Image Generation, Scan Pattern, Waveform, and TOFD Display Showing the Image of the Point Flaw**    **~~Backwall~~**  **Page 177**  **Figure N-481(b)**  **Schematics of Image Generation, Flaw Location, and TOFD Display Showing the Image of the Inside (ID)**  **Surface-Breaking Flaw**    **~~No back wall~~** ~~echo~~  **N-482 MULTIPLE FLAW IMAGES**  **N-482.1 Plate 1 [Figure N-482(a)**]. Figure N-482(a) clearly illustrates the significant advantages of TOFD (midwall flaw detection, flaw sizing), the limitations due to dead zones, and that *(b)* the incomplete fusion at the  root was not easily detected, though it did disturb the **~~backwall~~**. This is  not surprising in the **~~backwall~~** dead zone due to a shear-shear diffracted wave. This example illustrates the potential value of using information later in the time base, but this is outside the scope of this interpretation manual.  **N-482.2 Plate 2 [Figure N-482(b)**]. Figure N-482(b)  shows that:  *(a)* all four flaws are detectable  *(b)* the incomplete fusion at the root shows up clearly in this scan because  it is deeper. Both the **~~backwall~~** perturbation and the flaw tip signals are clear.  *(c)* the crown toe crack is clearly visible, both by complete disruption of the lateral wave and by the bottom tip signal. Both the incomplete fusion at the root and crown toe crack are identifiable as surface-breaking by the  disruption of the lateral wave and **~~backwall~~** signal, respectively.  **Page 182**  **Figure N-482(a)**  **Schematic of Flaw Locations and TOFD Image Showing the**  **Lateral Wave, ~~Backwall~~, and Three of the Four Flaws**  **Page 183-184**  **Figure N-482(b)**  **Schematic of Flaw Locations and TOFD Display Showing the**  **Lateral Wave, ~~Backwall~~, and Four Flaws**  **N-483 TYPICAL PROBLEMS WITH TOFD INTERPRETATION**  *(d)* Correct gate settings are critical, because TOFD  A-scans are not that easy to interpret since there are multiple visible signals. As a minimum, the gates should encompass the lateral wave and longitudinal wave back-wall signal; the gate can extend to the shear wave  **~~back-wall~~**, if required. Typically, the best signal to use as a guide is the  first (longitudinal wave) **~~backwall~~**, since it is strong and always present (assuming the transducer separation is reasonably correct). The following figures show examples of incorrect gate positioning, which will inherently lead to poor flaw detection.  The first example, Figure N-483(d)(1), shows the gate set too early, the  lateral wave is visible, and the **~~backwall~~** is not. Any inside (I.D.)  near **~~backwall~~** flaws will be missed.  The second example, Figure N-483(d)(2), shows the gate set too late. The  lateral wave is not visible. The first signal is the **~~backwall~~**, and the second  signal is the shear wave **~~backwall~~**. With this setup, all the outside (O.D.) near-surface flaws will be missed.  The third example, Figure N-483(d)(3), is with the gate set too long. Though this is not technically incorrect, the image will show the diffracted  **~~backwall~~** shear-shear wave signal. These S-S waves may show additional and confirmatory information. The diffracted shear waves show the porosity more clearly than the diffracted longitudinal waves and there is a strong mode-converted signal that occurs just before the shear wave gate, which could cause interpretation problems. Normally, the gate is set fairly  short to enclose only the lateral wave and the longitudinal wave **~~backwall~~** to clarify interpretation.  *(e)* Incorrect (too far apart) transducer separation [Figure N-483(e)]  results in the **~~backwall~~** signal becoming distorted, the lateral wave becomes weaker, and some of the diffracted signal amplitudes drop.  *(f)* Incorrect (too close together) transducer separation [Figure N-483(f)]  results in the lateral waves becoming stronger, and the **~~backwall~~** weaker. Again, the TOFD image of the flaws is poor.  **Page 184**  **Figure N-483(a)**  **Acceptable Noise Levels, Flaws, Lateral Wave, and Longitudinal**  **Wave ~~Backwall~~**    **~~Backwal~~l**  Back-wall  **Page 187**  **Figure N-483(d)(2)**  **TOFD Image With the Gate Set Too Late**    **~~backwall~~**  **~~signal~~**  **~~backwall~~**  **Figure N-483(d)(3)**  **TOFD Image With the Gate Set Too Long**    **~~backwall~~**  **~~signal~~**  **~~backwall~~**  **~~signal~~**  **Page 188**  **Figure N-483(e)**  **TOFD Image With Transducers Set Too Far Apart**    **~~Distorted~~**  **~~L-wave~~**  **~~backwall~~**  **Figure N-483(f)**  **TOFD Image With Transducers Set Too Close Together**    **~~backwall~~**  **~~signal~~**  **Page 648**  **A7.5 Time-Base Linearity (Horizontal Linearity)**  A7.5.4 With the probe coupled to the block and the A-scan displaying 10 clearly defined multiples as illustrated in Fig. A7.4, the display software is used  back-wall  to assess the interval between adjacent **~~backwall~~** signals. | back wall  back-wall signal  back wall  back wall  back wall  back wall  Back wall    back-wall  back wall  1st  back wall  1 in. (25 mm)  back-wall  back-wall signal  back-wall signal is  back-wall  back-wall signals  **back-wall**  back wall  back-wall  back-wall  back-wall  back wall  Back-wall  back-wall  back wall  back wall  back wall  back-wall  back-wall  back-wall  back wall  back-wall  back wall    Back-wall  echo    Back wall  Back wall  **Back-wall**  No back-wall echo  back wall  back-wall  back-wall  back-wall  Back wall  Back wall  back wall  back wall  back wall  back wall  back wall  back wall  back-wall  back wall  back-wall  back wall  Back wall  Back wall  back wall  back-wall signal  back-wall signal  back-wall signal  DistortedL-wave back wall  back-wall  signal | |