Scope

This procedure is intended to be used by EWI personnel for field ultrasonic (UT) linear phased-array (LPA) inspection of pipeline girth weld joints in 30-in. (762-mm)-diameter carbon steel pipe with a 0.39-in. (9.8-mm) wall thickness. This procedure is applicable for the detection and sizing of flaws in the weld and heat-affected zone (HAZ). The procedure described herein may be applicable to other pipe sizes; however, verification of the procedure is required. The inspection data gathered will be used for improving automated ultrasonic testing (AUT) inspection of girth welds and will not be used final disposition of the welds.

References

The following reference forms a part of this procedure as specified herein.

- SNT-TC-1A (ASNT Recommended Practice) – "Personnel Qualification and Certification in Nondestructive Testing"

Personnel

Personnel performing to this procedure shall as a minimum be qualified to the Level II guidelines of SNT-TC-1A and have a minimum of 20 hours PA UT training and 6 months of PA UT experience.

Equipment

The following equipment, or equivalent, is needed to perform this procedure:

- PA probes: Two 7.5-MHz, 60-element LPA probes having element dimensions of 0.035 × 0.39 in. (0.9 × 10 mm) and a pitch of 0.039 in. (1.0 mm).
- Time-of-flight diffraction (TOFD) probes: A pair of dedicated TOFD probes may be used for additional collection of TOFD data. The probes should have a frequency of 5 to 10 MHz with an element size of 0.13 to 0.25 in. (3 to 6 mm).
- PA wedges: Shear wave wedges shall be used to achieve the beam angles needed. The wedge shall be made from Rexolite and have a wedge angle of 33.7 degrees. The wedges shall have irrigation ports to allow and adequate water supply between the wedge and pipe.
- TOFD wedges: TOFD probes shall be mounted on Rexolite wedges that will produce a refracted longitudinal beam angle of 60 to 70 degrees.
- Instrumentation: PA instrumentation capable of driving 128 element linear PA probes. The PA instrumentation shall have electronic focusing, steering, and scanning capabilities, as well as, advanced imaging with the ability to display A-, B-, C-, D-, and S-scans. The PA instrumentation shall also be capable of driving probes in the frequency range of 1 to 15 MHz.
- Scanner: Fully automated or semi-automated single axis encoded general purpose pipe scanner.
- Calibration sample: 30-in. (762-mm)-diameter un-welded reference sample containing at least two notches and one flat bottom holes (FBH). The calibration sample shall be fabricated from the same material to be tested. The notches shall be 0.02 to 0.20 in. (0.5 to 5 mm) in depth and 0.20 to 0.59 in. (5 to 15 mm) in

length with one notch on the outside diameter (OD) surface and one notch on the inside diameter (ID) surface. The FBH(s) shall be 0.08-in. (2.0-mm) diameter and drilled so that the flat bottom portion of the hole is parallel to the weld bevel at the specified depth. The notches shall be located at a point along the length of the pipe representing weld centerline while the FBH(s) are located on the weld bevel. A light scribe line should be made around the pipe circumference to designate the weld center. Additional notches and FBHs can be used if desired.

- Couplant: Water

Calibration

1. Establish three upstream (US) and three downstream (DS) sector scan channels. Each sector scan shall sweep the beam from 50 to 70 degrees in 1-degree increments. The beam starting point for the sector scans shall be selected to provide full through wall coverage of the weld.
2. Locate the band at 9.06 in. (230 mm) from the weld centerline and parallel to the weld and attach the band scanner.
3. With the scanner mounted on the band, adjust the PA probes so that the front face of the wedges are 0.39 in. (10 mm) from the weld center reference line with one probe on the US and one probe on the DS side of the weld centerline. Then manually move the scanner around the pipe circumference and align the ultrasonic beams with a FBH on the second leg.
4. Maximize the reflected signal on the hole and adjust the gain for each PA channel so that the selected hole is at a minimum amplitude of 50% of full screen height (FSH).
5. Verify that the OD and ID notches are detected at the correct depths and that the signal amplitudes are at a minimum of 50% FSH.
6. Once the starting elements have been determined, use the delay adjustments of the instrument to position the FBH signals at the correct metal depths. A probe aperture selection of approximately 0.34 to 0.71 in. (9 to 18 mm) should be used.
7. Adjust the TOFD probe spacing so that the beams cross at a metal depth of approximately 2/3 of the thickness.
8. Adjust the instrument to so that the TOFD lateral wave signal amplitude is approximately 30 to 60% and the TOFD backwall signal is at the correct depth.
9. Set the scanner resolution, speed, and direction. The scanner shall be set to collect data every 0.04 in. (1 mm) around the pipe circumference. The travel speed of the scanner shall be set so that there is no data loss due to travel speed, but shall not exceed 4 in. (100 mm) per second. The scan direction shall be the same direction that the production welds are to be scanned.
10. With the scanner set to these parameters, scan the section of the calibration sample containing the reference reflectors. Make adjustments as needed so that the dynamic scans are consistent and repeatable, and all calibration reflectors are detected in their correct positions. After a successful calibration setup has been obtained, save the file as the primary inspection setup file.
11. Save the calibration scan using, as a minimum, the date and “in” or “out” in the filename depending on whether the calibration is at the beginning or end of the shift. Example filename: ***“12-1-08 CAL-in”***. For additional calibration scans throughout the day, add sequential numbers to the end of the filename. Example: ***“12-1-08 CAL-in2”***.

Note: At a minimum, a calibration check shall be performed at the beginning and end of each shift and after every 10 welds. During the calibration check, a scan shall be performed of the calibration sample using the same parameters used for scanning the production welds. The FBH for each channel shall be detected at a minimum amplitude of 50% FSH.

Inspection

- The scanning surfaces shall be uniform and free of paint, burrs, gouges, dirt, or other foreign material that may affect test results.
- Each joint shall be inspected from both the US and DS sides of the weld unless otherwise specified.
- Using the previously loaded and verified scan setup file, scan the production welds using the following steps:

    1. Locate the band at 9.06 in. (230 mm) from the weld centerline and parallel to the weld. The band shall be accurately located to within ±0.08 in. (2 mm).
    2. Load the setup file, established during calibration, into the PA software.
    3. Mount the scanner with probes attached onto the pipe. Place the scanner on the production pipe so that probe is in alignment with the longitudinal axis of the pipe and the PA wedge faces are located 0.39 in. (10 mm) from weld centerline. Verify that the scanner tracks parallel to the weld centerline.
    4. Manually rotate the scanner to position the center of the probe at the circumferential zero scan start position on top of the weld.
    5. The scan direction shall be clockwise (CW) when viewed from the US side of the weld.
    6. Turn on the water flow and allow air to purge from the lines.
    7. Start data acquisition.
    8. During the scan, monitor the screen displays to assure that good probe to part coupling is maintained.
    9. At the end of the scan, save the scan file and evaluate the weld for flaw indications.

Evaluation

Scans shall be reviewed and evaluated for the following:

- Verify that probe coupling was maintained throughout the scan. Scans showing inadequate coupling over a scan length of more than 0.39 in. (10 mm) shall be re-scanned. Surface irregularities that prevent adequate data acquisition shall be corrected prior to re-scanning.
- Evaluate indications that appear to be 0.20 in. (5 mm) or longer in length. The through wall height of flaws should be performed using the S-Scan channel display.
- Weld indications will be evaluated for project information purposes only and not for final acceptance.

Records

The following items shall be included in the records for each weld joint tested:

- Instrument description (make, model, and serial number).
- Scanner description (make, model, and serial number).
- Ultrasonic software version number.
- Setup file name, revision number, and revision date.
- Applicable instrument settings necessary to duplicate test.
- Probe description (frequency, part number, and probe serial number).
- Name of operator.
- Line description, weld number (sample number), etc. to uniquely identify each weld.
- Electronic data files.
- Summary of reportable flaws including the circumferential position, US/DS positioning, flaw length, depth to the bottom of the flaw, and flaw height.
- Information on whether the welds were accepted or rejected by the UT contractor.