



Defined Procedure

For

Advanced Ultrasonic Crack Sizing

API-UT-10

This Procedure Defines the
Recommended Methods and Techniques for
Ultrasonic Crack Sizing

1.0 **PROCEDURE**

- 1.1 This procedure is applicable only to ultrasonic examinations conducted for American Petroleum Institute (API) Qualification of Ultrasonic Examiners Certification Program.
- 1.2 The following procedure addresses equipment and sizing evaluation techniques for crack height sizing examinations.
- 1.3 This procedure provides guidelines and techniques for ultrasonic sizing of planar cracks which originate at the opposite side of the scanning surface or the inside diameter (ID).
- 1.4 This procedure is applicable to carbon steel material thicknesses from 0.375 inches to 1.0 inches.
- 1.5 The Advanced Ultrasonic Crack Sizing Procedure outlines the requirements for contact methods, using refracted longitudinal wave and shear wave techniques for carbon steel materials.
- 1.6 Other methods and techniques may be used when an appropriate sizing calibration block is utilized.
- 1.7 Special longitudinal and/or shear wave search units, and special ultrasonic sizing calibration blocks are used for the sizing examinations.
- 1.8 These sizing techniques are applicable to manual examinations only.

2.0 **REFERENCES**

- 2.1 American Society for Nondestructive Testing (ASNT), SNT-TC-1A
- 2.2 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section V
- 2.3 ASTM Crack Sizing Standard ASTM E-2192

3.0 **PERSONNEL REQUIREMENTS**

3.1 Personnel performing the sizing examination should be, as a minimum, certified to UT Level II or III in accordance with their employer's written practice.

4.0 **EQUIPMENT**

4.1 Ultrasonic Instruments

4.1.1 Any ultrasonic instrument may be used provided that it satisfies the requirements of this procedure. Ultrasonic instruments should be equipped with a calibrated dB gain or attenuation control stepped in increments of 2db or less.

4.2 Search Units

4.2.1 Search units shall be in the frequency range of 1.0 to 10.0 MHz

4.2.2 Search units may be of the single or dual element type, which may produce shear and/or longitudinal waves as they apply to the appropriate crack sizing technique.

4.2.3 Search units to be used in crack sizing shall be of the type to produce the appropriate wave physics associated with the following Crack Sizing Methods described in this procedure.

4.2.3.1 ID Creeping Waves

4.2.3.2 Tip Diffraction

4.2.3.3 Bi-Modal

4.2.3.4 Focused Refracted L-Waves or focused Shear Waves

4.2.4 Other search units and techniques may be used provided that the methods and techniques are outlined in a procedure.

4.3 Cabling

4.3.1 Any convenient type and length of cable may be used.

4.4 Couplant

4.4.1 Any couplant material may be used.

4.5 Calibration and Reference Blocks

- 4.5.1 Special Crack Sizing Calibration Blocks shall be used to establish specific calibrations for the sizing methods identified in this procedure.
- 4.5.2 Sizing calibration blocks shall contain notches and/or side drilled holes (SDH) reflectors at specific known depths for calibration of the applicable sizing method.
- 4.5.3 The sizing calibration blocks shall be fabricated from the carbon steel materials.
- 4.5.4 Normally, a flat plate with notches from 20% to 80% through-wall in 20 % steps is used to calibrate the screen range in depth. Other blocks thicknesses in the range of the material being examined may be used.
- 4.5.5 Special blocks may be used for calibration of other sizing methods.
- 4.5.6 Reference blocks (i.e. IIW, DSC, Rompas, etc.) may be used for establishing linear screen ranges and determining refracted angle and exit point information. Calibration blocks should be made of carbon steel material.

5.0 **CALIBRATION**

- 5.1 The temperature of the calibration block material shall be within 25 degrees F of the component to be examined.
- 5.2 System Calibration
 - 5.2.1 System calibration shall include the complete examination system. Any changes in search unit, shoes, couplant or instrument shall be cause for recalibration.
 - 5.2.2 The crack sizing techniques utilized in accordance with this procedure are as follows:

5.2.2.1 The ID Creeping Wave (IDCR) Method, or 30-70-70 mode conversion technique is used as a precursor to determine approximate height of the crack, e.g., shallow (Inner 1/3 t), midwall (Middle 1/3 t), or deep (Outer 1/3 t). (Technique 1)

5.2.2.2 The Tip Diffraction Method is used for shallow cracks, which are shallow to midwall from 10 to 40 % in height. (Technique 2)

5.2.2.3 The Bi-Modal Method is used for cracks which are in the midwall range in the area of 30% to 70% in height. (Technique 3)

5.2.2.4 The Focused Refracted Longitudinal Wave and Focused Shear Wave Methods are used for cracks are very deep, (greater than 40 or 50 % in height), and penetrate to the outside surface. (Technique 4)

Note: The crack height ranges are presented as a guide and are indicative of the material thickness and the specific sizing method usually for a 1 inch thick component.

5.3 Calibration for screen range may be accomplished by either direct sound path or actual depth. Specific calibrations may be performed as outlined in the Appendices (Page 8) for the appropriate sizing technique.

5.4 Other sizing techniques or variations of the aforementioned techniques may be used in accordance with this procedure.

5.5 The sizing method and search unit shall be selected from the appropriate techniques, based upon the zone of investigation.

5.6 Whenever practical, the through wall crack height should be verified by more than one sizing technique.

5.7 In addition, whenever practical, sizing should be performed from both sides of the crack.

6.0 EXAMINATION

6.1 Scanning Requirements

- 6.1.1 The area designated by the API Test Administrator shall be investigated with the appropriate sizing technique. The sizing examination shall be performed along the length of the crack to determine the **maximum crack height**. The deepest crack depth or through wall height dimension shall be recorded on the API Crack Sizing Report Form.
- 6.1.2 In addition, the remaining ligament of good metal above the crack shall be recorded on the API Crack Sizing Depth Reporting Form.
- 6.1.3 Weld crown configuration may restrict search unit movement for proper crack sizing using the specific technique. Select the appropriate crack sizing technique to accommodate this limitation.

7.0 SIZING EVALUATION AND RECORDING CRITERIA

7.1 Sizing Application

- 7.1.1 The Sizing Flow Chart (Figure 1) may be used to categorize the suspected crack into the appropriate zone or material volume.

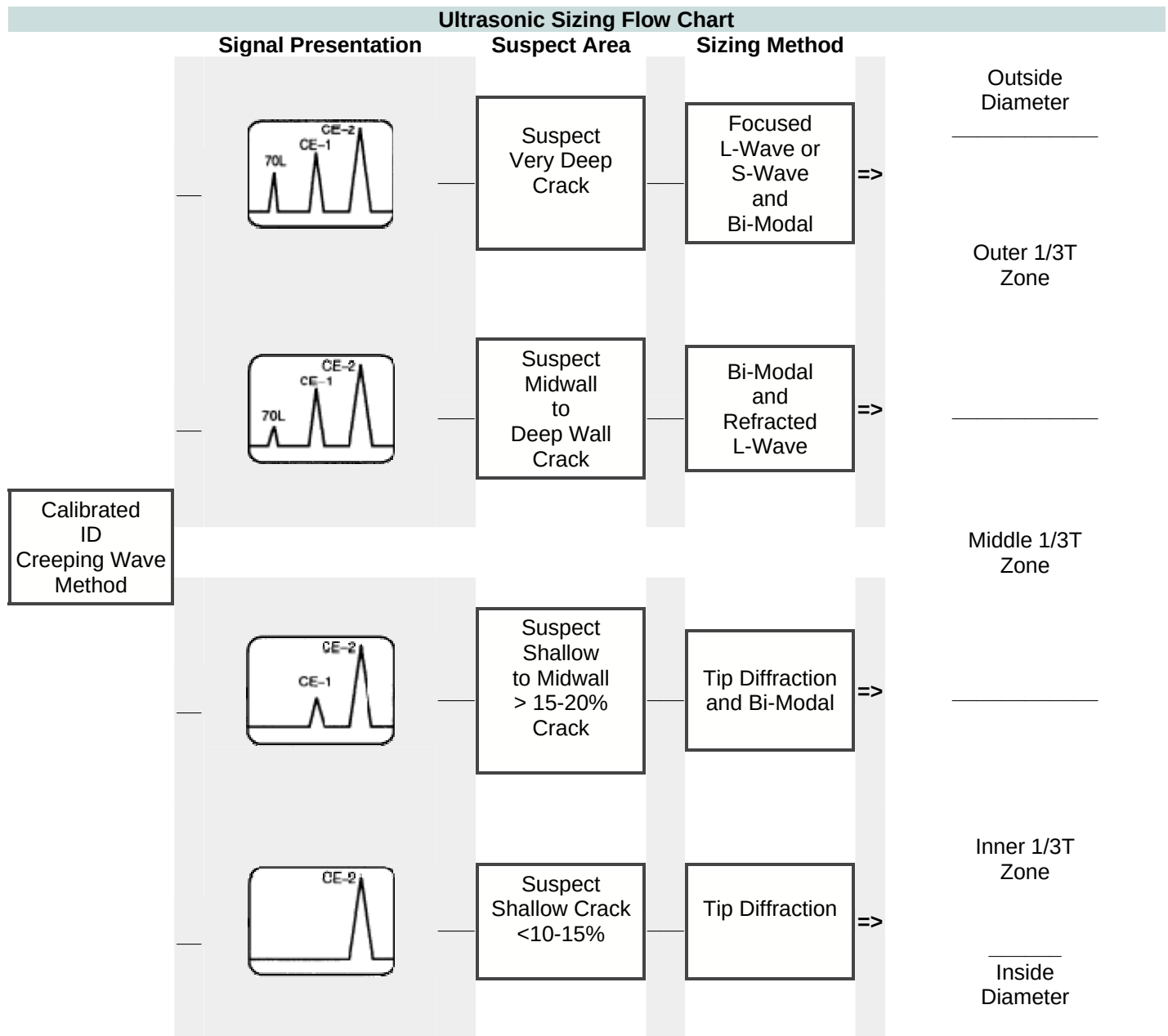


Figure 1 - ID Creeping Wave Flow Chart

- 7.1.2 Each sizing technique has certain advantages, disadvantages and limitations. **No one sizing technique is best for sizing cracks of any through-wall depths in all material types or thicknesses.**
- 7.1.3 It is important to understand the use and application of each sizing technique and the associated wave physics so that accurate crack height sizing is achieved.
- 7.2 Recording
- 7.2.1 Clearly document the height of each crack on the designated API Crack Sizing Reporting Form, Figure 1. The maximum through wall depth along the length of the crack in decimal inches from the ID shall be recorded for each of the cracks to be sized.

Appendices

The following Appendices will provide the calibration requirements for each of the Advanced Ultrasonic Crack Sizing Methods

Technique 1	ID Creeping Wave Method	Page 8
Technique 2	Tip Diffraction Method	Page 12
Technique 3	Bi Modal Method	Page 17
Technique 4	Focused Refracted L Wave (HALT) And/or Shear Wave (HAST) Methods	Page 22