



Application Note Title: Using the vEO for Weld Inspection Based on ASTM-E2700-09

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Introduction

This document is a guide for Sonatest customers and distributors. It contains our interpretation of the compliance of our instruments and transducers to specific codes. It shall NOT be considered as an official decision. It demands a careful judgement. We include here clarifications on the paragraphs of the codes that are imposing a constraint on the instrument capabilities. This is followed by a section of advices on how the Sonatest vEO 16:64 can be used for welds inspections based on ASTM-E2700-09.

Scope of ASTM E2700-09 Standard Practice for Contact Ultrasonic Testing of Welds Using Phased Arrays

The ASTM E2700-09 describes ultrasonic techniques for inspecting welds using phased array ultrasonic methods. It covers angle beam inspection of ferrous and aluminum alloy with thickness ranging from 9 to 200mm (0.375 to 8 in.)

Compliance of Sonatest vEO 16:64 unit and DAAH probes

Paragraph	Title	Explanation
5.5	Significance and Use	Inspector qualification can be selected from the Inspection menu and will be included in the examination report.
7.1.x	Equipment	Requirements related to equipment.
7.1.1	Phased Array Instrument	The vEO is design to work in pulse-echo or pitch and catch mode and has a gain control precision of 0.1 dB. The vEO is capable of displaying a variety of views including S-scan and B-scan ¹ .
7.1.2	Focal Law Calculator	The vEO has an embedded focal law calculator permitting instantaneous calculation of delays when parameters are modified.
7.1.3	Data Storage	The vEO provides permanent data storage on an external USB device and also offer an internal USB device storage.
7.1.4	Amplitude and Height Linearity	The vEO amplitude and height linearity is confirmed at manufacturing time and has to be standardized annually.

¹ When ASTM E2700 refers to B-scan, this is equivalent to an L-scan on the vEO.

7.1.5	Frequencies	The veo is capable of pulsing and receiving at nominal frequencies from 0.5MHz to 20MHz
7.1.6	Digitization	The veo offers an acquisition frequency (digitization) of 50MHz or 100MHz, which is sufficient for probe frequency of up to 20MHz. This is combined with digitizer of 12bits (that is 4096 levels).
7.1.7	Angle Corrected Gain (ACG)	The veo is equipped with a wizard guiding the user through the steps required for equalization of the amplitude response of target at a fixed sound path at all angles.
7.1.8	Time Corrected Gain (TCG)	The veo is equipped with a wizard guiding the user through the steps required for equalization of the amplitude response across the time-base.
7.2.x	Phased Array Probes	Requirements related to phased array probes.
7.2.2	Array Types	The veo supports 1D arrays type.
8.x.x	Standardization	
8.1	Range and Wedge Delay	The veo is equipped with a wizard guiding the user through the steps required for correction of wedge travel time to ensure correct depth measurements.
8.1.2	Time Base Linearity	The veo time base linearity is confirmed at manufacturing time and has to be verified annually.
8.1.3	True Depth	Both the B-scan (L-scan on veo) and the S-scan offer true depth measures.
8.2.1	Reference Block	The veo can be calibrated using side-drilled holes (SDH), flat-bottomed holes (FBH), radius or notches.
8.2.2	Standardization	Once the unit calibration (velocity, wedge delay, ACG, TCG) have been completed, green indicators are displayed. These indicators confirmed that standardization has been completed and that the inspector can start the examination.
8.2.7	Controls Affecting Amplitude	Any control which affects instrument amplitude response will break invalidate the veo standardization. When a change is made, a warning message is informing the user.
8.2.8	Controls Affecting Linearity	Any control which affects instrument linearity shall not be used.
8.2.9	Element Activity	The veo is equipped with an Element Activation wizard for assessment of element activity.
10.4.1	Time-Corrected Gain	The veo offers a wide choice of color palette to suit customer needs. Color palette are based on signal amplitude and can be customised if required.
10.4.2	Reference Target	The reference level and reference gain can be adjusted on the veo.
10.4.3	Reference Reflectors at Other Distances	TCG calibration can be performed manually combined with interpolation or using an automated process to apply the correction to all beams.

11	Examination Procedures	It is important to remember that phased array examination procedures are nominally identical to conventional ultrasonic procedures.
11.2	Scanning Procedure	Scanning procedures have to be established using scan plans. The veo offers complete scan plan capabilities showing probe stand-off distance, volume coverage, beam angles, etc.
11.3	Cross-Cracking	When cross-cracking is suspected, ultrasonic beams need to be directed parallel or essentially parallel to the weld centerline. On the veo, probe can be rotated to accomplish this.
11.4	Scan Configurations	The veo offers a multi group capability allowing simultaneous scan combining S-scan and L-scan on one or multiple probes.
11.5	Scanning	The veo can be used for manual or semi-automated inspection.
11.6	Manual Scanning	The scanning speed in manual mode will be limited by the PRF and the Max Frame Rate.
11.7	Semi-Automated Scanning	The veo has a 2 axis encoding capability. Axes can be calibrated using the Encoder Wizard.
11.8	Multiple Probes	The veo offers multi-group capability. Up to 4 phased array scans can be fired simultaneously with 1 and up to 4 phased array probes.
12	Indication Level	
12.2	Manual Scanning	
12.2.1	Real-Time S-scan or B-scan	The veo can display real-time S-scan or B-scan and gates can be used for evaluation threshold.
12.3	Encoded Scanning	
12.3.2	Real-Time Views	The veo can display S-scan, B-scan, Top and End views in real-time while encoding.
12.3.3	Evaluation of Indications	Full waveform signal is recorded when scanning with the veo. All A-scan waveforms are available for analysis using the extractor.
12.3.4	Encoded Data	On the veo, encoded data can be reviewed using projections such as Top and End views.
12.3.5	Encoded Section	Welds scanned using multiple section can be identified using theScan Start Position on the veo. The various data files can also be identified based on the start position. (ex: Weld01_SideA_0to1000mm.utdata and the second section Weld01_SideA_950to2000mm.utdata)
12.3.6	Evaluation Threshold	Evaluation can be color based on the veo by selecting the appropriate color palette or building a custom palette.
12.3.7	Volume Corrected Views	Top and End views can be used for amplitude or depth measurements.
12.3.8	Coordinate System	The veo offers a comprehensive coordinate system to build scan plan, including datum and group reference points. All indications can be located based on this

coordinate system.

13 Reporting

13.1 Items to be Reported

Items to be reported can be selected from the vEO report options.

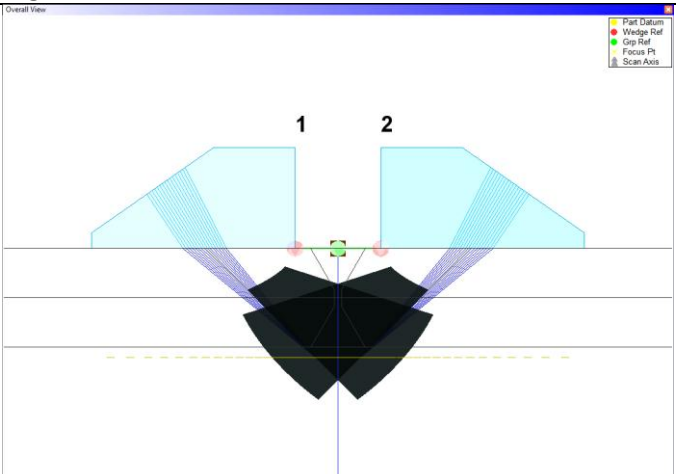
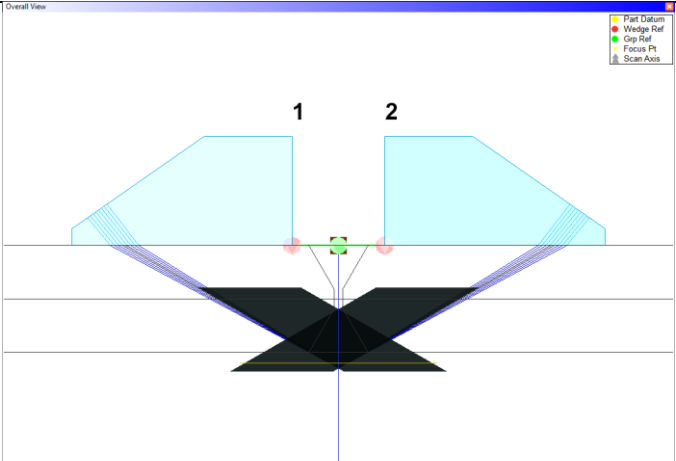
13.2.x Report Details

The vEO offers a complete set of identifiers and scan plan details that can be automatically included in the examination report.

General guidelines for ASTM E2700 inspection using the Sonatest vEO

The ASTM E2700 is a standard practice that can be used as a generic procedure for phased array inspection of welds. The Sonatest vEO being a universal phased array flaw detector meets and exceeds the requirements established by ASTM E2700.

Specific instructions on how to prepare a phased array setup and calibration can be found in the vEO User guide. Below is a list of examples based on ASTM E2700 showing various scanning techniques commonly used for weld inspections. Please contact Sonatest or visit our website to access the example files.

<p>Example_2xSectorial_2xSides_12.7mm_SingleV_ButtWeld.utcfg</p> <p>Single V Butt welds inspection from both sides using Sectorial scans.</p>	
<p>Example_2xSectorial_2xSides_12.7mm_SingleV_ButtWeld.utcfg</p> <p>Single V Butt welds inspection from both sides using Linear scans.</p>	

Example_2xLinear_2xSides_12.7mm_SingleV_ButtWeld.utcfg

Single V Butt welds inspection from both sides using
Section scan and Linear scans

