

HERCULES

MANUAL ULTRASONIC INSPECTION SYSTEM OF SPOT WELDS



HERCULES is an outstanding manual ultrasonic evaluation system for spot welds, portable, fit to purpose, and combining the power of a high performance ultrasonic electronics with the most advanced and accurate signal selection and evaluation algorithms. As a unique additional feature, **HERCULES** operates with durable, easily interchangeable **dry coupling ultrasonic probes**.

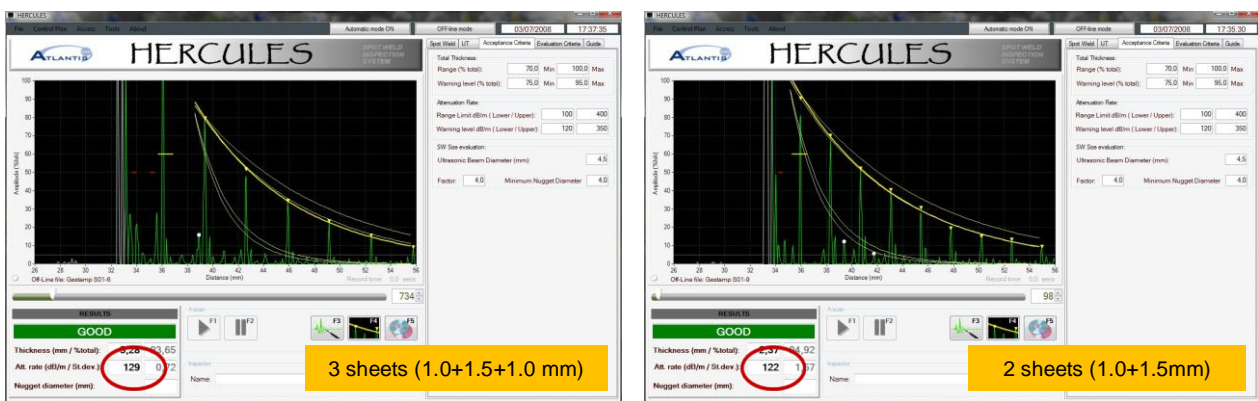
Reliability and Efficiency

Reliability in manual spot weld inspection is affected by the correct positioning of the probe onto the centre of the spot weld, its relative orientation to the surface of the spot weld, the quality of the coupling, which is related to the pressure on the probe and the particular surface condition, the selection of the right signal to evaluate among the number of those obtained during the test and, the consistency of the signal evaluation performed.

The negative impact of these factors, in the practice of the manual spot weld inspection, is minimized by **HERCULES** by the **larger number of captures**, the **signal recording** feature with continuous evaluation and a more clever and complete **automatic signal selection and evaluation** capability: independent of the quality of coupling and operator's skill.

Up to 100 A-scans are captured and evaluated per second and 6000 A-scans can be recorded per spot weld to play back for re-evaluation when required: even when the optimal probe coupling / orientation condition is matched for a fraction of a second, the system can automatically select the suitable A-scan for evaluation, performing well over the capability of even the most skilled operator... **HERCULES** is capable of getting the signals an operator and even other slower systems can miss, and consistently selects the one matching better a series of conditions, rather than stopping the acquisition forced by a simple criteria related with the fact a first BWEs reach a certain height.

Evaluation of the complete sequence of BWEs beyond the near field by calculating the actual attenuation rates instead of just counting the number of echoes avoids mistaking stick, good and burnt spot welds, especially when the defined thresholds are tight. HERCULES thus performs a quantitative evaluation which is, additionally, **independent of the gain and actual coupling conditions**.



Evaluation and Acceptance Criteria

A complete set of evaluation parameters are available for adjustment (access permitted user) in order to set up ultrasonic parameters and optimise echo detection for the different combinations of sheet number and thickness.

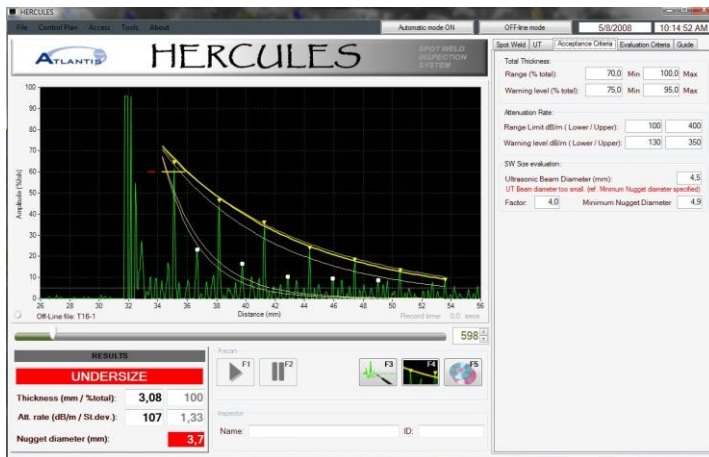
Total thickness, attenuation rate of BWEs and calculated nugget diameter are checked against suitable thresholds or range limits for rejection or warning. Those shall be set up after a **proper calibration** (acoustic velocity), using the required **reference samples** and attending to the **applicable engineering specifications** for acceptance or rejection of spot welds. All parameters can be modified for adjustment on the recorded A-scan series allowing live re-evaluation of acquired results.

Spot Weld Classification

HERCULES signal selection and evaluation algorithms are optimised for the most reliable performance in testing spot welds of different materials, including Zn coated steels, UHSS, Aluminium,... and configurations with two and three sheets. Acquired signals are evaluated and then **spot welds are consistently classified in different groups according to user defined acceptance thresholds** and with the limitations intrinsically imposed by the ultrasonic method.



This automatic evaluation is performed attending to accurate thickness measurement, back wall echoes attenuation rate calculation and, the relative amplitudes of the series of relevant intermediate echoes. After each test, values of back wall echo attenuation rate, thickness and nugget diameter are available for re-evaluation (automatic recording together with the spot weld ID data, setup parameters, acceptance criteria and complete A-scan sequence).



Spot Weld Classification
Good
Stick
Burnt
Loose
Thickness Out Of Range
Undersize
Stick and Undersize
Zn bonding
Porosity

Hardware

HERCULES uses a high performance ultrasonic data acquisition board with a **high voltage square wave pulser** (adjustable pulse width) at up to **2 KHz pulse repetition frequency**, with a **low noise**, high time of flight measurement accuracy receiver. The suitable tuning of the pulser and receiver allows the best signal to noise ratio and resolution when driving a given frequency probe for the specific purpose of the spot weld inspection.

HERCULES is a portable, light weight (4,9 Kg) and rugged system suitable to operate in industrial environments, and including all the required connectivity: wireless networking for remote control, data sharing and, software update, advise and troubleshooting from the OEM. Typical product presentation includes an industrial laptop (conforms to MIL-STD-810F) and an expansion box for the UT board.

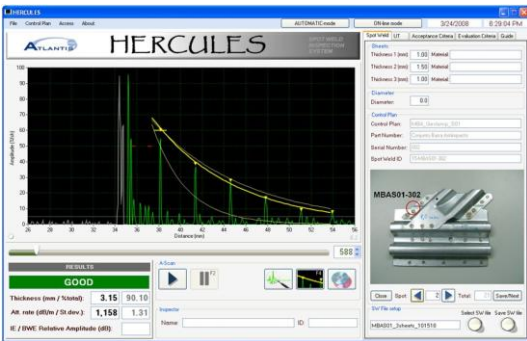
Probes and Dry Coupling Delays



A specialized series of high resolution ultrasonic probe has been developed giving the best performance for spot weld inspection and durability. Probes with frequencies **10, 15 and 20 MHz** are available as well as different probe diameters.

A unique solid interchangeable rubber delay line allows a **dry contact test** for a larger scope of sheet thicknesses and weld diameters than can be inspected using a traditional bubble probe... and with a much higher mechanical resistance avoiding frequent and time consuming delay replacements.

Control Plans and Data Recording



For a given part, having previously defined the suitable setups for the different spot welds (thicknesses, ultrasonics, acceptance criteria, etc.), a **Control Plan** can be easily build up including all relevant data parameters, and a guiding image (standard bmp, jpeg, tiff...format) for each position.

When loaded to run it, the part serial number is required and the operator is guided along the sequence of spot welds. While testing a given spot weld, the best matching is found well automatically according to a defined threshold or, well, among a series of signals until the operator stops or a given timeout is reached... input data, date and time, Operator's ID, all results and, optionally, suitable A-scan series, are automatically recorded in an **MS Excel file** for post processing, re-evaluation, statistics, etc.

Date	Knot (Control)	Thickness 1	Thickness 2	Thickness 3	Thickness 4	Thickness 5	Alt rate	Slew	Relative Alt	Spot Weld ID	Part Number	SN	Inspector ID	Inspector Name	Date	Time	Spot ID
25/03/2008	6000	2,50	1,50	0,00	4,07	100,00	1,701	1,01	GF-01	Sample	February 1				25/03/2008	8:30:24 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	4,07	100,00	1,461	1,00	GF-02	Sample	February 1				25/03/2008	8:30:43 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	4,30	100,00	1,186	0,78	GF-03	Sample	February 1				25/03/2008	8:31:04 AM	Gedra
25/03/2008	LOOK1	2,50	1,50	0,00	2,59	84,67	818	1,13	GF-04	Sample	February 1				25/03/2008	8:31:18 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	4,26	100,00	1,158	1,18	GF-05	Sample	February 1				25/03/2008	8:31:34 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	3,45	86,20	2,013	1,03	GF-07	Sample	February 1				25/03/2008	8:32:21 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	4,22	100,00	1,211	1,20	GF-09	Sample	February 1				25/03/2008	8:32:48 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	4,30	100,00	1,160	0,18	GF-10	Sample	February 1				25/03/2008	8:33:17 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	3,91	97,73	1,378	1,28	GF-11	Sample	February 1				25/03/2008	8:33:36 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	4,21	100,00	1,177	1,20	GF-12	Sample	February 1				25/03/2008	8:33:44 AM	Gedra
25/03/2008	6000	2,50	1,50	0,00	3,59	89,14	1,054	0,11	GF-13	Sample	February 1				25/03/2008	8:33:51 AM	Gedra
25/03/2008	BURN1	1,50	1,50	0,00	2,59	86,41	3,772	0,61	GLA-A	Sample	February 1				25/03/2008	8:34:13 AM	Gedra
25/03/2008	6000	1,50	1,50	0,00	3,01	100,00	1,197	1,11	GLS-B	Sample	February 1				25/03/2008	8:35:02 AM	Gedra
25/03/2008	6000	1,50	1,50	0,00	3,11	100,00	1,288	1,33	GLS-C	Sample	February 1				25/03/2008	8:37:35 AM	Gedra
25/03/2008	6000	1,50	1,50	0,00	3,00	100,00	1,180	0,08	GLS-D	Sample	February 1				25/03/2008	8:37:51 AM	Gedra
25/03/2008	LOOK1	1,50	1,50	0,00	1,52	50,83	814	1,00	GPS-1	Sample	February 1				25/03/2008	8:39:54 AM	Gedra
25/03/2008	6000	1,50	1,50	0,00	1,52	50,85	2,013	0,87	GPS-2	Sample	February 1				25/03/2008	8:40:47 AM	Gedra
25/03/2008	6000	1,50	1,50	0,00	2,89	99,11	1,198	1,04	GPS-3	Sample	February 1				25/03/2008	8:40:58 AM	Gedra
25/03/2008	BURN1	1,50	1,50	0,00	2,86	98,55	1,820	0,28	GPS-4	Sample	February 1				25/03/2008	8:42:07 AM	Gedra