

Platform

## Pulse1

## Tube integrity diagnostics delivering true wall thickness

Pulse1 is the newest addition to our Pulse electromagnetic platform; one of five proprietary platforms that provide powerful through-barrier diagnostics to the oilfield.

Pulse1 is the industry's first slimhole tube integrity technology capable of delivering 'true wall thickness' measurements of production tubing in eight sectors, with complete 'all-around' sensing of tube wall condition.

Pulse1 has been designed to meet the growing industry need for 'no compromise' integrity management, and overcome the drawbacks of current technologies, especially multifinger calipers and conventional electromagnetics.

Calipers measure internal diameter and estimate wall thickness by assuming a 'nominal' outside diameter (OD).

Variations in the actual OD and external corrosion, both invisible to calipers, can invalidate the thickness value. Similarly, scale or wax deposits on the inner surface can mask internal defects and lead to further false readings. Pulse1's ability to measure actual wall thickness in multiple sectors eliminates these issues, delivering greater accuracy in a wider range of scenarios.

Another consideration with calipers is coverage. Caliper fingers touch 10-30% of the inner wall surface, so localised metal loss can be missed. And in corrosion resistant tubulars, the millimeter-thin fingertips could scratch protective coatings, exposing the alloy beneath.

Pulse1 overcomes these challenges and many more, making it the ideal choice for routine or targeted tube integrity surveillance.



Pulse1 combines pioneering electromagnetics with proprietary sensor technology and advanced 3D modeling code to deliver exceptional measurement performance in primary tubulars. Every aspect of Pulse technology is designed, developed and manufactured in-house at our technology centre to ensure reliable accuracy in a wide range of operating scenarios.





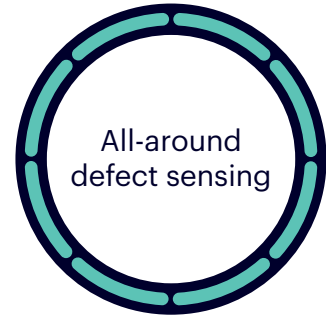
### Eight reasons to select Pulse1

Delivering true wall thickness isn't the only reason why Pulse1 can help you deliver 'no compromise' integrity management.



True wall thickness in eight sectors

**Tube integrity depends on wall thickness and regular inspection is important to maintain a secure well.** Unlike multifinger calipers that estimate thickness by measuring internal diameter and assuming a nominal outside diameter, Pulse1 uses electromagnetic energy to measure actual wall thickness directly. This can translate into greater accuracy, especially if the tube wall is coated with scale or has external corrosion. Pulse1 delivers actual wall thickness to an accuracy of up to 2% in production tubing, providing reliable assessment irrespective of scale or external corrosion.



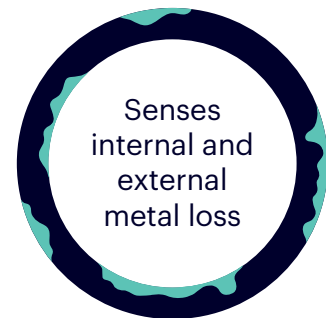
All-around defect sensing

**Holes and defects in the tube wall undermine mechanical strength and sealing performance.** The millimetre-thin tips of caliper fingers can detect small holes but only touch 10-30% of the inside wall surface; some defects may pass undetected. Pulse1 delivers all-around sensing and can detect holes equivalent to 7-10mm diameter in the most common production tubing sizes. Calipers offer greater resolution, and Pulse1 provides greater coverage; combining both delivers comprehensive assessment.



Insensitive to surface deposits

**Scale and wax deposits disrupt caliper and ultrasonic inspection techniques.** Caliper logs measure internal diameter and assume a nominal outside diameter to estimate wall thickness; scale coatings will invalidate the metal thickness calculation and mask defects underneath. Additionally, the uneven surface of scale can interfere with ultrasonic waves, leading to measurement errors. Pulse1 is not sensitive to non-metallic surface deposits and will deliver actual wall thickness, revealing metal loss on the inside and the outside.



Senses internal and external metal loss

**Caliper-based inspection techniques can only reveal internal metal loss; external corrosion and defects are invisible.** Pulse1 measures the actual metal thickness of the tube wall and will account for both internal and external metal loss. For the most comprehensive evaluation, combining Pulse1 with a caliper can help distinguish between internal and external losses.



Non-scratch  
contact



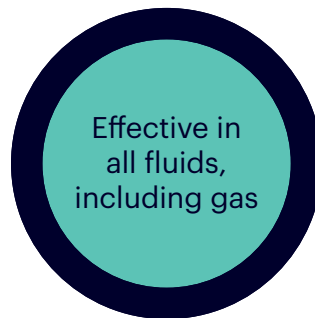
Effective in  
chrome  
completions

**The inner wall surface of corrosion-resistant tubulars are often coated with a thin protective layer.** Many operators prefer not to use calipers to inspect such completions because the millimetre-thin tips of caliper fingers might scratch the inner surface, exposing the alloy and leaving it vulnerable to attack. Pulse1 is deployed with soft-touch roller centralisers with less point-pressure on the tube wall, minimising the risk of scoring. This makes it a safer alternative for inspecting chrome completions.

**Corrosion-resistant completions provide protection from corrosive and toxic fluids, but regular inspection is still essential.** Operators prefer to use soft-contact electromagnetic techniques to avoid calipers scratching the tube wall, but ordinary electromagnetic techniques are not always reliable in high-chrome alloys. Pulse1 harnesses the same ultra-fast sensor technology and powerful 'time-domain' techniques used throughout the Pulse family, and is equally effective in chrome completions.



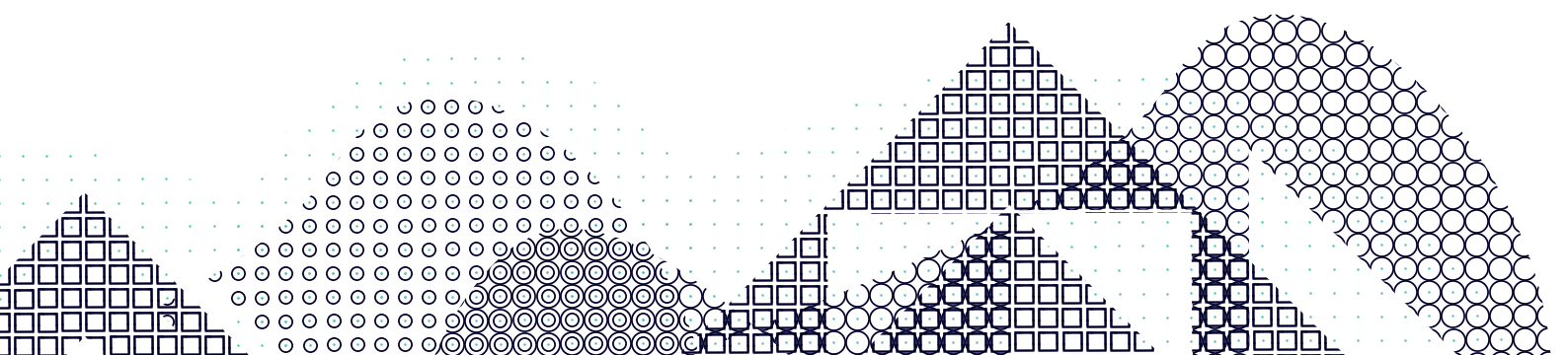
One slim  
tool, many  
tube sizes



Effective in  
all fluids,  
including gas

**Pulse1 is slim and can survey a wide range of tube sizes in one deployment, saving time and intervention costs.** Wall thickness measurements are delivered up to an accuracy of 2% in production tubing and 3.5% in production casing. Combining Pulse1 with Pulse4 enables multi-barrier surveys to improve efficiency even further.

**Pulse1 harnesses electromagnetic techniques and is effective in all typical well fluids, including those containing gas.** On the other hand, ultrasonic inspection techniques can be compromised in heavier and gaseous fluids.



### Measurement specifications

Measurement principle	Electromagnetics
Measurement type	Actual wall thickness in eight sectors
No. of sensors	8
Circumferential sensing, %	100
Operates in chrome alloys	Yes
Survey mode	Real time or Memory
Survey speed, ft/min [m/min]	6.6 to 20 [2 to 6]
Combinable	Yes, Pulse2, Pulse3, Pulse4 and Caliper
Tube wall thickness	
Range, in [mm]	0.2 to 0.5 [6 to 12]
Accuracy, %	±2 to ±3.5
Tube size, in [mm]	2-7/8 to 9-5/8 [73 to 245]
Tube wall defects	
Hole size in 2-7/8" tube, in [mm]	>0.3 [>7]
Hole size in 3-1/2" tube, in [mm]	>0.3 [>7]
Hole size in 4-1/2" tube, in [mm]	>0.4 [10]
Hole size in 5-3/4" tube, in [mm]	>0.6 [>15]
Hole size in 7" tube, in [mm]	>1.0 (>25)
Inclination	
Accuracy @ <85 deg deviation, deg	±2
Accuracy @ 85 to 95 deg deviation, deg	±1.3
Relative bearing	
Accuracy @ >10 deg deviation, deg	±5

### Mechanical specifications

Temperature range, degF [degC]	-4 to 302 [-20 to 150]
Maximum pressure, psi [MPa]	14,500 [100]
Housing material	Titanium
Maximum H <sub>2</sub> S content, %	≤30 with TFE/P black duro o-rings
Operating time one battery, hrs <sup>†</sup>	48
Maximum compression, kgf [lb]	5,300 [11,800]
Maximum tension, kgf [lb]	9,000 [20,000]
Outside diameter, in [mm]	1.89 [48]
Tool length	
Without battery or centralisers, ft [m]	3.3 [0.998]
With battery pack and centralisers, ft [m]	10.0 [3.051]
Tool weight	
Without battery or centralisers, kg [lb]	12kg [26.5]
With battery pack and centralisers, kg [lb]	25.8 [56.9]

<sup>†</sup> Operating time can be extended up to 60 hrs with proper batter storage and operating temperature <100°C  
All external materials meet NACE TM 0177-2005 and NACE TM 0284-2011.

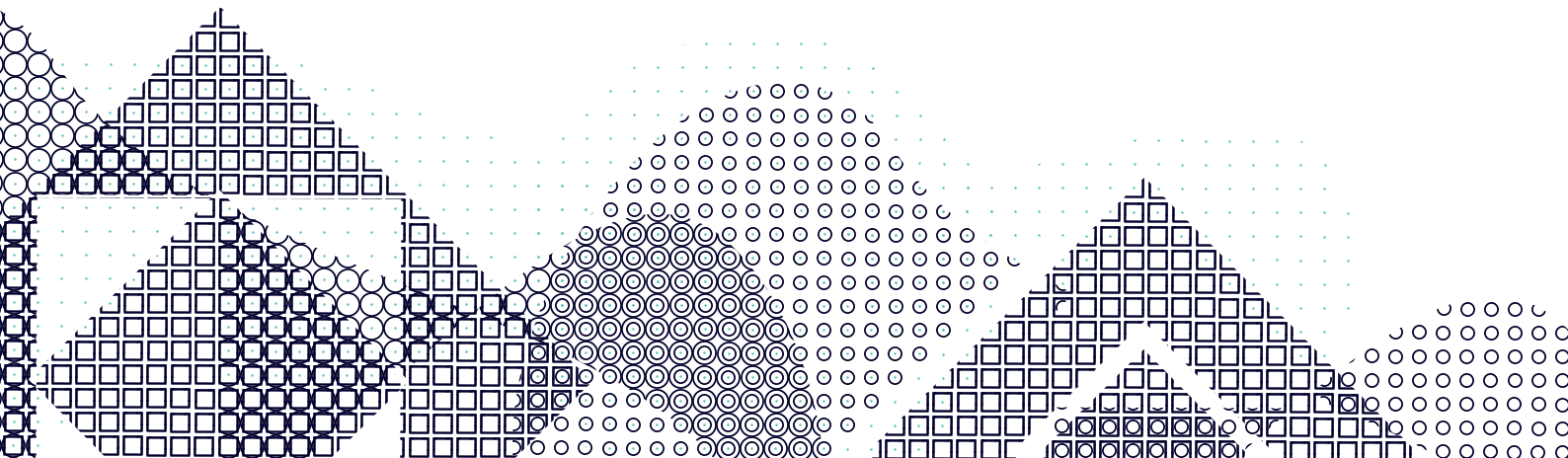
### Pulse1 applications

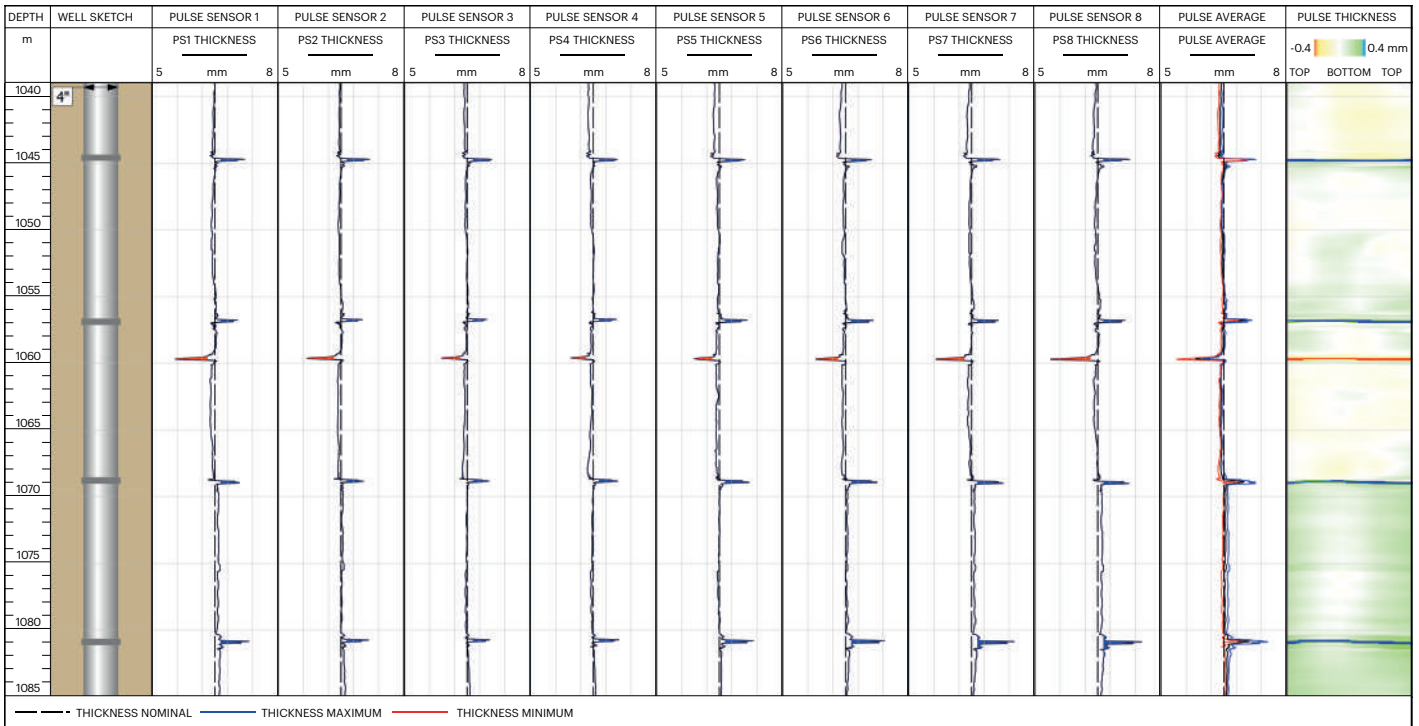
### Pulse1 benefits

Routine or targeted surveillance of primary tube integrity	Enables 'no compromise' integrity management  Delivers actual wall thickness for accurate compliance assessment  Better remediation decisions, precisely targeted
Time-lapse tube condition monitoring	Spot tube weakness before it fails
Assess both production tubing and casing in a single deployment	Improved efficiency and reduced intervention costs
Assess tube condition in presence of scale, wax or gas	Accurate tube assessment in wide range of scenarios
Evaluate integrity of high-chrome completions	Avoid caliper scratching and monitor high-stakes completions
Check status and orientation of perforations	Maintain productivity

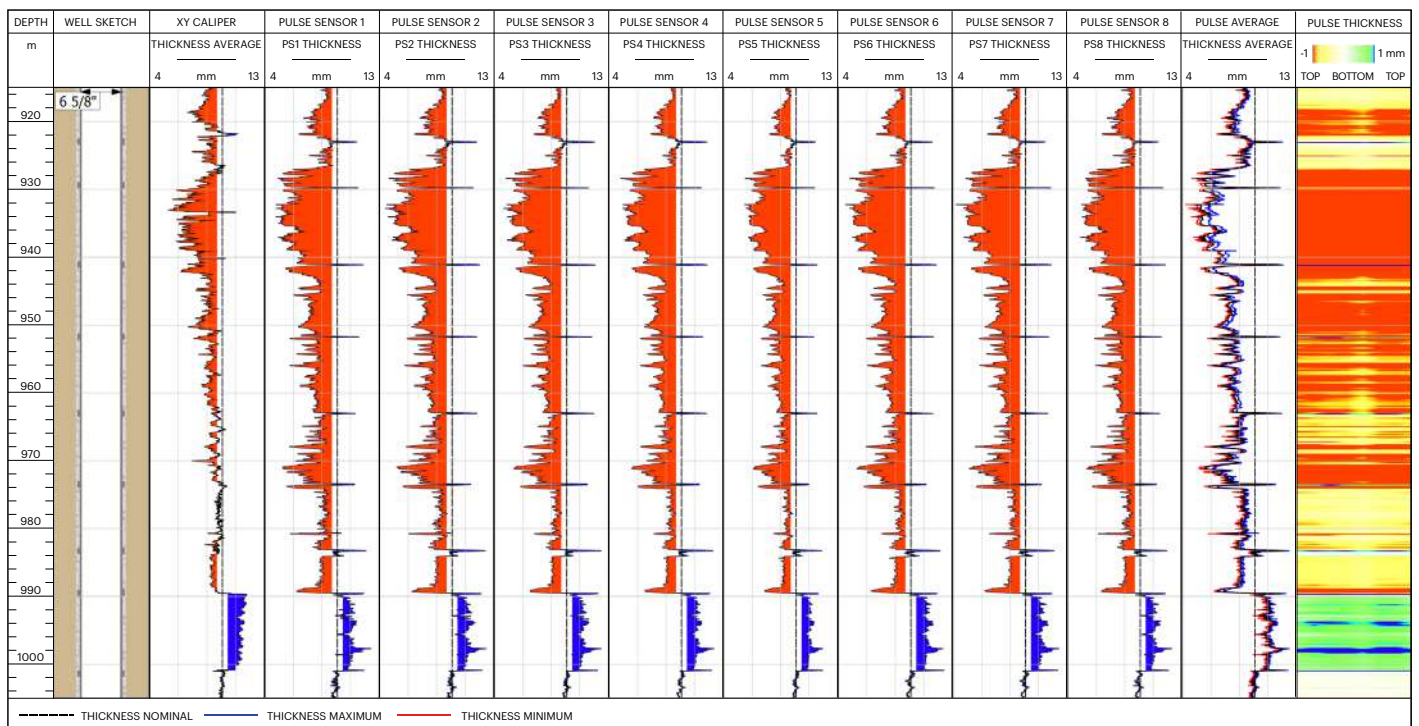
### Comparing diagnostic options for primary tubulars

	Pulse1	Multifinger caliper	Ordinary slim electromagnetic
Measures actual wall thickness in 8-sectors	Yes	No, measures ID, estimates thickness	No, measures average thickness
All-around defect sensing	Yes 100% sensing	Yes 10-30% sensing	Yes low resolution
Senses internal & external metal loss	Yes	No, internal only	Yes
Insensitive to scale or wax deposits	Yes for non-Fe scale	No	Yes for non-Fe scale
One slim tool, many tube sizes	Yes	No, tool size varies to suit tube size	Yes
Effective in chrome completions	Yes	Yes, but potential to scratch coating	Unknown
Non-scratch contact	Yes	No, may scratch	Yes
Effective in all fluids, including gas	Yes	Yes	Yes





**Example 1.** 'Primary Tube Integrity' answer product using Pulse1 to evaluate 4" production tubing. Distinct metal loss signature is visible at 1,060m, possibly a hole in the tubing.



**Example 2.** 'Primary Tube Integrity' answer product using Pulse1 to evaluate 6-5/8" casing, and comparison with XY caliper. Overall metal loss measured from Pulse1 is greater than that estimated by XY caliper. The caliper will only detect internal loss whereas Pulse1 will measure actual metal thickness and assess both internal and external loss.