Schlumberger

Cement Bond Logging Tools

APPLICATIONS

- Evaluation of cement quality
- Determination of zone isolation
- Location of cement top

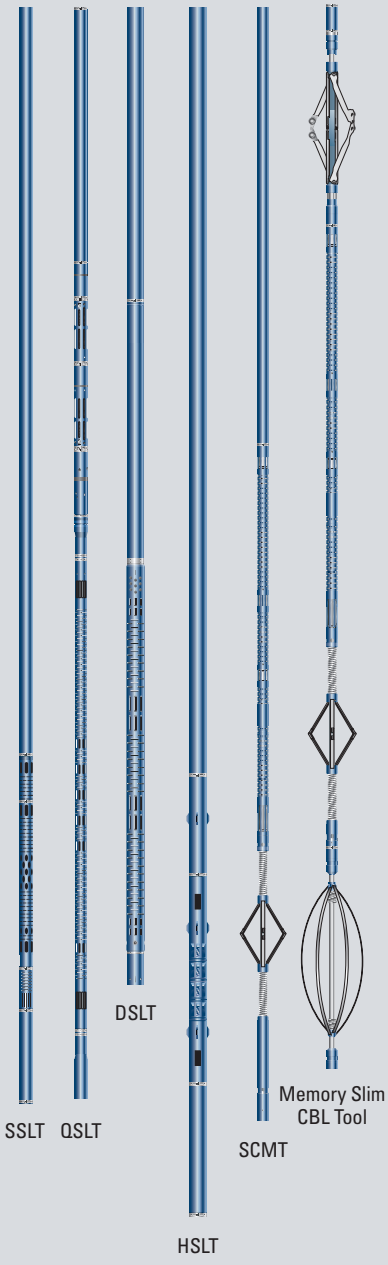
Cement bond tools measure the bond between the casing and the cement placed in the annulus between the casing and the wellbore. The measurement is made by using acoustic sonic and ultrasonic tools. In the case of sonic tools, the measurement is usually displayed on a cement bond log (CBL) in millivolt units, decibel attenuation, or both. Reduction of the reading in millivolts or increase of the decibel attenuation is an indication of better-quality bonding of the cement behind the casing to the casing wall. Factors that affect the quality of the cement bonding are

- cement job design and execution as well as effective mud removal
- compressive strength of the cement in place
- temperature and pressure changes applied to the casing after cementing
- epoxy resin applied to the outer wall of the casing.

SLIM ARRAY SONIC TOOL

The Slim Array Sonic Tool (SSLT) is a digital sonic tool that provides conventional openhole sonic measurements, standard CBL amplitude and Variable Density* log (VDL), and attenuation measurements, which are less affected by borehole environmental conditions. The SSLT can also make a short-spacing (1-ft [0.30-m]) CBL measurements for cement evaluation in fast formations. The two transmitters and six receivers of the SSLT sonde have transmitter–receiver spacings of 1, 3, 3.5, 4, 4.5, and 5 ft [0.30, 0.91, 1.07, 1.22, 1.37, and 1.52 m] to compute the following:

- standard 3-ft CBL and 5-ft VDL measurements
- borehole-compensated (BHC) attenuation from the 3.5- and 4.5-ft spacing receivers
- near-pseudoattenuation from the 3-ft spacing receivers
- short-spacing attenuation from the 1-ft spacing receiver for cement bond measurement in fast formations that may affect the standard 3-ft spacing.



Cement Bond Logging Tools

SLIMXTREME SONIC LOGGING TOOL

The SlimXtreme* Sonic Logging Tool (QSLT) provides the same measurements as the SSLT of the cement bond amplitude, attenuation, and Variable Density display for evaluation of the cement bond quality of a cemented casing in high-pressure and high-temperature environments.

CEMENT BOND LOG FROM DIGITAL SONIC LOGGING TOOL

The Digital Sonic Logging Tool (DSLT) uses the Sonic Logging Sonde (SLS) to measure the cement bond amplitude and provide a Variable Density display for evaluation of the cement bond quality of a cemented casing string. Variable Density or x-y waveform display of the sonic signal is presented in conjunction with the bond index and amplitude signal. The DSLT is also used in the open borehole environment for conventional sonic measurements of BHC (3- to 5-ft) transit time and long-spacing depth-derived BHC (DDBHC) (9- to 11-ft [2.74 to 3.35-m]) transit time.

CEMENT BOND LOG FROM HOSTILE ENVIRONMENT SONIC LOGGING TOOL

The Hostile Environment Sonic Logging Tool (HSLT) provides the same measurements of the cement bond amplitude and Variable Density display for evaluation of the cement bond quality of a cemented casing string as the SSLT in high-pressure and high-temperature environments.

SLIM CEMENT MAPPING TOOL

The Slim Cement Mapping Tool (SCMT) is a through-tubing cement evaluation tool combinable with the PS Platform* production logging service for a variety of well diagnostics. The two sizes are 1 11/16 in [4.29 cm] for the standard (302 degF [150 degC]) temperature rating and 2 1/16 in [5.24 cm] with a 392 degF [200 degC] temperature rating. The SCMT is suitable for running workover operations and in new wells. SCMT operations provide a clear advantage in workover wells because there is no need to pull tubing above the zone of interest for cement evaluation. The SCMT is capable of running through most tubings to evaluate the casing below. In new wells the SCMT is an excellent tool for evaluating casing that is 7⅝ in [19.36 cm] or less.

The SCMT features a single transmitter, two receivers spaced at 3 and 5 ft from the transmitter, and eight segmented receivers 2 ft [0.61 m] from the transmitter. The output of the near (3-ft) receiver is used for CBL and transit-time measurement. The output of the far (5-ft) receiver is used for the VDL measurement. The eight segmented receivers generate a radial image of the cement bond variation.

MEMORY SLIM CEMENT BOND LOGGING TOOL

The Memory Slim Cement Bond Logging Tool provides through-tubing 3-ft CBL and 5-ft VDL measurements with the same accuracy and quality as surface-readout logs. Because of its slim size, the 1 11/16-in tool can be run into the zone of interest without having to remove the tubing from the well. The tool simultaneously records gamma ray, casing collar location, pressure, temperature, and waveforms in a single pass, with the waveforms fully digitized downhole. More than 40 h of combined tool running time is possible, including 16 h of continuous waveform recording time. Depth-recording systems are available for both hazardous and nonhazardous environments.

The Memory Slim CBL Tool can be run with other Memory PS Platform* production logging tools for complete well and reservoir evaluation in one descent. The tools and sensors can be conveyed in the borehole by drillpipe, coiled tubing, slickline, or unintelligent tractor. PS Platform software is used to perform onsite data processing or any necessary postprocessing and prepare the log presentation.

Measurement Specifications

	SSLT	QSLT	DSLT	HSLT	SCMT-C and SCMT-H	Memory Slim CBL Tool
Output	3-ft [0.91-m] CBL and attenuation, 1-ft [0.30-m] attenuation, 5-ft [1.52-m] Variable Density log	3-ft [0.91-m] CBL and attenuation, 1-ft [0.30-m] attenuation, 5-ft [1.52-m] Variable Density log	3-ft [0.91-m] amplitude CBL With SLS-C and SLS-D: 5-ft [1.52-m] Variable Density log	3-ft [0.91-m] amplitude CBL, 5-ft [1.52-m] Variable Density log	3-ft [0.91-m] amplitude CBL, 5-ft [1.52-m] Variable Density log, cement bond variation map	3-ft [0.91-m] CBL, 5-ft [1.52-m] Variable Density log, gamma ray, CCL, traveltime, cement compressive strength
Logging speed	3,600 ft/h [1,097 m/h]	3,600 ft/h [1,097 m/h]	3,600 ft/h [1,097 m/h]	3,600 ft/h [1,097 m/h]	1,800 ft/h [549 m/h]	1,800 ft/h [549 m/h]
Vertical resolution	Near attenuation: 1 ft [0.30 m] CBL: 3 ft [0.91 m] VDL: 5 ft [1.52 m]	Near attenuation: 1 ft [0.30 m] CBL: 3 ft [0.91 m] VDL: 5 ft [1.52 m]	CBL: 3 ft [0.91 m] VDL: 5 ft [1.52 m]	CBL: 3 ft [0.91 m] VDL: 5 ft [1.52 m]	CBL: 3 ft [0.91 m] VDL: 5 ft [1.52 m] Cement bond variation map: 2 ft [0.61 m]	CBL: 3 ft [0.91 m] VDL: 5 ft [1.52 m]
Depth of investigation	CBL: Casing and cement interface VDL: Depends on bonding and formation	CBL: Casing and cement interface VDL: Depends on bonding and formation	CBL: Casing and cement interface VDL: Depends on bonding and formation	CBL: Casing and cement interface VDL: Depends on bonding and formation	CBL: Casing and cement interface VDL: Depends on bonding and formation	CBL: Casing and cement interface VDL: Depends on bonding and formation
Mud type or weight limitations	None	None	None	None	None	None
Combinability	Part of SlimAccess* system	Part of SlimXtreme system	Combinable with most tools	Part of Xtreme* system, combinable with most tools	Combinable with PS Platform system	Combinable with Memory PS Platform system
Special applications	Logging through drillpipe, tubing, and in small casing Fast formations	Logging through drillpipe, tubing, and in small casing Fast formations			Logging through drillpipe, tubing, and in small casing Fast formations	Logging through drillpipe, tubing, and in small casing

Mechanical Specifications

	SSLT	QSLT	DSLT	HSLT	SCMT-C and SCMT-H	Memory Slim CBL Tool
Temperature rating	302 degF [150 degC]	500 degF [260 degC]	302 degF [150 degC]	500 degF [260 degC]	SCMT-C: 302 degF [150 degC] SCMT-H: 392 degF [200 degC]	302 degF [150 degC]
Pressure rating	14,000 psi [97 MPa]	30,000 psi [207 MPa]	20,000 psi [138 MPa]	25,000 psi [172 MPa]	15,000 psi [103 MPa]	15,000 psi [103 MPa]
Casing size—min.	3 ½ in [8.89 cm]	4½ in [11.43 cm]	5½ in [13.97 cm]	5½ in [13.97 cm]	SCMT-C: 2¼ in [6.03 cm] SCMT-H: 2¼ in [7.30 cm]	2¼ in [7.30 cm]
Casing size—max.	8 ⅝ in [21.91 cm]	8⅝ in [21.91 cm]	13⅜ in [33.97 cm]	13⅜ in [33.97 cm]	7⅝ in [19.37 cm]	7⅝ in [19.37 cm]
Outside diameter	2.5 in [6.35 cm]	3 in [7.62 cm]	3.625 in [9.21 cm]	3.875 in [9.84 cm]	SCMT-C: 1.6875 in [4.29 cm] SCMT-H: 2.06 in [5.23 cm]	1.6875 in [4.29 cm]
Length	23.1 ft [7.04 m]	Without inline centralizer: 23 ft [7 m] With inline centralizer: 29.9 ft [9.11 m]	With SLS-E: 20.63 ft [6.29 m] With SLS-F: 23.81 ft [7.26 m]	25.5 ft [7.77 m]	SCMT-C: 23.45 ft [7.14 m] SCMT-H: 28.85 ft [8.79 m]	23.45 ft [7.15 m]
Weight [1]	232 lbm [105 kg]	270 lbm [122 kg]	With SLS-E: 313 lbm [142 kg] With SLS-F: 353 lbm [160 kg]	440 lbm [199 kg]	SCMT-C: 100 lbm [45 kg] SCMT-H: 162 lbm [73 kg]	100.2 lbm [45.4 kg]
Tension	13,000 lbf [57,830 N]	13,000 lbf [57,830 N]	29,700 lbf [132,110 N]	20,000 lbf [88,960 N]	5,900 lbf [26,240 N]	5,900 lbf [26,240 N]
Compression	4,400 lbf [19,570 N]	4,400 lbf [19,570 N]	2,870 lbf [12,270 N]	6,000 lbf [26,690 N]	150 lbf [670 N]	150 lbf [670 N]

[1] In air

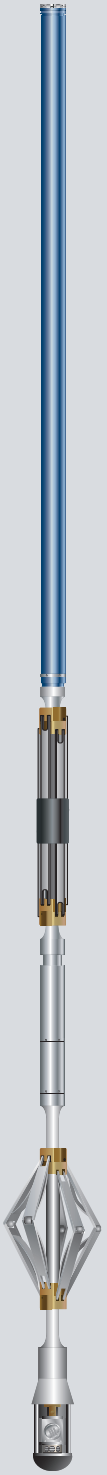
Cement Bond Logging Tools

APPLICATIONS

- Cement evaluation
- Casing inspection
  - Corrosion detection and monitoring
  - Detection of internal and external damage or deformation
  - Casing thickness analysis for collapse and burst pressure calculations

USI ULTRASONIC IMAGER TOOL

The USI* UltraSonic Imager tool (USIT) uses a single transducer mounted on an Ultrasonic Rotating Sub (USRS) on the bottom of the tool. The transmitter emits ultrasonic pulses between 200 and 700 kHz and measures the received ultrasonic waveforms reflected from the internal and external casing interfaces. The rate of decay of the waveforms received indicates the quality of the cement bond at the cement/casing interface, and the resonant frequency of the casing provides the casing wall thickness required for pipe inspection. Because the transducer is mounted on the rotating sub, the entire circumference of the casing is scanned. This 360° data coverage enables the evaluation of the quality of the cement bond as well as the determination of the internal and external casing condition. The very high angular and vertical resolutions can detect channels as narrow as 1.2 in [3.05 cm]. Cement bond, thickness, internal and external radii, and self-explanatory maps are generated in real time at the wellsite.



Cement Bond Logging Tools

Measurement Specifications

	USIT
Output	Acoustic impedance, cement bonding to casing, internal radius, casing thickness
Logging speed	1,800 ft/h [549 m/h]
Range of measurement	Acoustic impedance: 0 to 10 MRayl [0 to 10 MPa.s/m]
Vertical resolution	Standard: 6 in [15.24 cm]
Accuracy	Less than 3.3 MRayl: ±0.5 MRayl
Depth of investigation	Casing-to-cement interface
Mud type or weight limitations†	Water-base mud: Up to 15.9 lbm/gal Oil-base mud: Up to 11.2 lbm/gal
Combinability	Bottom only tool, combinable with most tools
Special applications	Identification and orientation of narrow channels

† Exact value depends on the type of mud system and casing size.

Mechanical Specifications

	USIT
Temperature rating	350 degF [177 degC]
Pressure rating	20,000 psi [138 MPa]
Casing size—min.	4½ in [11.43 cm]
Casing size—max.	13⅜ in [33.97 cm]
Outside diameter†	3⅜ in [8.57 cm]
Length†	19.75 ft [6.02 m]
Weight†	333 lbm [151 kg]
Tension	40,000 lbf [177,930 N]
Compression	4,000 lbf [17,790 N]

† Excluding the rotating sub

USIT Rotating Sub Mechanical Specifications

	USRS-AB	USRS-A	USRS-B	USRS-C	USRS-D
Outside diameter	3.41 in [8.66 cm]	3.58 in [9.09 cm]	4.625 in [11.75 cm]	6.625 in [16.83 cm]	8.625 in [21.91 cm]
Length	9.8 in [24.89 cm]	9.92 in [25.20 cm]	9.8 in [24.89 cm]	8.3 in [21.08 cm]	8.3 in [21.08 cm]
Weight	7.7 lbm [3.5 kg]	7.7 lbm [3.5 kg]	10.6 lbm [4.8 Kg]	15.0 lbm [6.8 kg]	18.3 lbm [8.3 kg]

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07-CE-005 March 2007

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