

# 2010 MWD/LWD Services Directory

Service line (s)	Tool OD, in.	Length, ft	Max. DLS - 100 ft (collars, excluding)	Equipment bearing stiffness	Max. op. temperature (°C)	Max. op. press, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gal/min
<b>Directional</b>											
<b>APS Technology (Rental Division) Brian A. Stroehlein 7 Laser Lane Wallingford, CT 06492 (860) 613-4450 bstroehlein@aps-tech.com</b>											
APS SureShot	3 1/8, 3 1/2, 4 3/4, 6 1/4, 6 3/4, 8, 9 1/2+	25	Collar-limited	Collar-defined	150 and 175	20	(3 1/2) 27, (4 3/4 - 6 3/4) 6, (8) 3, (9 1/2) 2	(3 1/2) 150, (4 3/4 - 6 3/4) 35, (8) 20, (9 1/2) 10	(6 1/2 - 6 3/4) 114, (8) 61, (9 1/2) 32	(9 1/2) 220	(3 1/8, 3 1/2) 70 - 250 (4 3/4) 150 - 350 (6 1/4, 6 3/4) 150-750 (8) 300 - 1,100 (9 1/2+) 650 - 1,200
APS SureShot with Gamma	3 1/8, 3 1/2, 4 3/4, 6 1/4, 6 3/4, 8, 9 1/2+	29	Collar-limited	Collar-defined	150 and 175	20	(3 1/2) 29, (4 3/4 - 6 3/4) 6, (8) 3, (9 1/2) 2	(3 1/2) 165, (4 3/4 - 6 3/4) 40, (8) 20, (9 1/2) 10	(6 1/2 - 6 3/4) 114, (8) 61, (9 1/2) 32	(9 1/2) 225	(3 1/8, 3 1/2) 70 - 250 (4 3/4) 150 - 350 (6 1/4, 6 3/4) 150-750 (8) 300 - 1,100 (9 1/2+) 650 - 1,200
<b>Baker Hughes Charles Van Lammeren - 2001 Rankin Rd, Houston, TX 77073, (713) 625-5526, charles.vanlammeren@bakerhughes.com</b>											
AutoTrak G3 (Rotary Steerable System, including OnTrak or AziTrak Integrated MWD/LWD)	4 3/4 6 3/4 8 1/4 9 1/2	(4 3/4) 50.8 (6 3/4) 49.9 (8 1/4) 56.9 (9 1/2) 58.1 (zzz)	(4 3/4) 30/10, (6 3/4) 20/13, (8 1/4) 9/6.5, (9 1/2) 13/6.5 (z)	BHA-dependent	(All Sizes) 150 (6.3/4", 8.1/4", 9.1/2") opt. 175	std. 20 (4 3/4, 6 3/4, 8.1/4) opt. 30 (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1290, (9 1/2) 300-1,600
AutoTrak X-treme (Rotary Steerable System, including OnTrak or AziTrak Integrated MWD/LWD and hard-wired, precontoured modular X-treme mud motor)	4 3/4 6 3/4 9 1/2	(4 3/4) 68 (6 3/4) 70 (9 1/2) 82 (zzz)	(4 3/4) 30/10, (6 3/4) 20/13, (8 1/4) 9/6.5, (9 1/2) 13/6.5 (z)	BHA-dependent	(All sizes) 150 (6.3/4", 8.1/4", 9.1/2") opt. 175	std. 20 (4 3/4, 6 3/4, 8.1/4) opt. 30 (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1290, (9 1/2) 300-1,600
AutoTrak eXpress (Rotary Steerable System including MWD, can be run with hard-wired modular X-treme motor)	4 3/4 6 3/4 9 1/2	(4 3/4) 56.9 (6 3/4) 58.2 (zzz) (9 1/2) 64.6 (zzz)	(4 3/4) 30/10 (6 3/4) 23/8 (9 1/2) 13/6.5 (z)	BHA-dependent	150	20	(i)	(i)	(i)	(i)	(4 3/4) 125-350 (6 3/4) 200-900 (9 1/2) 300-1,600
AutoTrak V	4 3/4 6 3/4 9 1/2	(4 3/4) 23.1, (6 3/4) 19.7, (9 1/2) 22.3	(4 3/4) 30/10, (6 3/4) 23/8, (9 1/2) 13/6.5 (z)	BHA-dependent	std. 150 (6.3/4" & 8.1/4") opt. 30 opt. 175	std. 20 (4 3/4, 6 3/4, 8.1/4) opt. 30 (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350 (6 3/4) 200-900 (9 1/2) 300-1,600
CoilTrak	2 3/8 and 3" Coil	(2 3/8) 49.5, (3) 37.6 typical BHA including motor	(2 3/8) 50, (3) 45 - sliding only	As applicable to standard Coil	150	14.5	(i)	(i)	(i)	(i)	(2 3/8) max 80, (3) max 211
GyroTrak (Gyro MWD) w/ OnTrak	9.5	16 feet (4.88m)	Probe limits: (1 3/4) 115/51	N/A	115	20	(i)	(i)	(i)	(i)	300 - 1600
GyroTrak (Gyro MWD) w/ NaviTrak	3 1/8 and larger collars	Standard NMDC, 29 feet (8.84 m)	Probe limits: (1 3/4) 115/51	N/A	115	20	(i)	(i)	(i)	(i)	75 - 1600
Multiple Propagation Resistivity	3 1/8, 4 3/4, 6 3/4, 8 1/4	(3 1/8) 17 (4 3/4 - 8 1/4) 12	(z)	(3 1/8) To be determined, (4 3/4) 4.6x2.25, (6 3/4) 6.62x2.81, (8 1/4) 8.23x4	150	20	(i)	(i)	(i)	(i)	(3 1/8) 80-160, (4 3/4) 100-350, (6 3/4) 200-800, (8 1/4) 300-1,600
NaviTrak	1 3/4 or 2 OD probe; (2) 3 3/4 and larger collars, (1 3/4) 3 1/8 and larger collars	(1 3/4) 22, (2) 24	Probe limits: (1 3/4) 115/51, (2) 49.5/43	As applicable to standard NMDC	150	20	(i)	(i)	(i)	(i)	75-1600
OnTrak MWD	4 3/4, 6 3/4, 8 1/4, 9 1/2	(4 3/4) 20.2, (6 3/4) 17.0, (8 1/4) 19.0, (9 1/2) 18.1	(4 3/4) 33/12, (6 3/4) 25/15, (8 1/4) TBD, (9 1/2) 10/7	NA	std. 150, opt. 175	std. 20 (4-3/4, 6-3/4 & 8-1/4, 9-1/2) opt. 25, (4-3/4, 6-3/4 & 8-1/4) opt. 30	(i)	(i)	(i)	(i)	4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1295, (9 1/2) 300-1,600
AziTrak MWD	4 3/4, 6 3/4	(4 3/4) 40.4, (6 3/4) 35.3	(z)	TBD	150	std. 20 (4 3/4) opt. 25, (6 3/4) opt. 30	(i)	(i)	(i)	(i)	4 3/4) 125-350, (6 3/4) 265-900
EMTrak	4 3/4, 6 1/2	(4 3/4, 6 1/2) 39.6	Slick collar: (4 3/4) 21/7, (6 1/2) 12.5/6.5 Flexible collar: (4 3/4) 58/32, (6 1/2) 48/25	As applicable to standard NMDC	150	20	(i)	(i)	(i)	(i)	(4 3/4) max 350, (6 1/2) max 660
TruTrak	4 3/4 6 3/4 8 9 1/2	(4 3/4) 30.4 (6 3/4) 31.0 (8) 36.1 (9 1/2) 36.1 + add. MWD	BUR (4 3/4) 5, (6 3/4) 3, (8 & 9 1/2) 2 (non-rotational system)	N/A	150	20	(i)	(i)	(i)	(i)	(4 3/4) 125-317, (6 3/4) 264-660, (8) 395-900, (9 1/2) 528-1162
VertiTrak	4 3/4 6 3/4 8 9 1/2	(4 3/4) 30.4 (6 3/4) 31.0 (8) 36.1 (9 1/2) 36.1	Drop rate (4 3/4) 5, (6 3/4) 3, (8 & 9 1/2) 2 (non-rotational system)	N/A	150	20	(i)	(i)	(i)	(i)	(4 3/4) 125-317, (6 3/4) 264-660, (8) 395-900, (9 1/2) 528-1162
TeleTrak	6 1/2, 6 3/4	(6 1/2, 6 3/4) 39.83	Probe limits: (1 3/4) 115/51	As applicable to standard NMDC	150	std. 20, opt. 25	(i)	(i)	(i)	(i)	(6 1/2, 6 3/4) 240-700
3 1/8" Advanced SLIM MWD System	3 1/8"	26.4	50, 12	N/A	150	20	(i)	(i)	(i)	(i)	79 - 180
<b>DrillTech LLC Brad Vincent - 248 Rousseau Road, Youngsville, LA 70592, (337) 837-1219, brad.vincent@drilltech.net</b>											
Positive Pulse MWD Probe Based	1 7/8 tool OD, 4 3/4 - 8 collars	18-25	60/30	As applicable to standard NMDC	150 - 175	20 (137 mpa)	50 (NMDC dependent)	100 (NMDC dependent)	150 (NMDC dependent)	N/A	(3 1/4) 50-130, (4 3/4) 130-275, (6 3/4) 235-600, (8) 400-800
<b>GE Energy Oilfield Technology Jim Coghill - 25 Walton Rd, Aberdeen, UK, +44 4227 772 222, James.Coghill@ge.com</b>											
Geolink	4 3/4, 6 3/4, 8, 9 1/2	Shortest probe length 15	(4 3/4) 30/15 (6 3/4) 21/10 (8) 14/8 (9 1/2) 7/4	(4 3/4) 4.75x2.81, (6 3/4) 6.71x2.81, (8) 7.93x2.81, (9 1/2) 9.46x2.81	150	20 (opt. 23K)	(3 1/8, 3 1/2) 14, (2 7/8) 7	(4 3/4) 16, (6 3/4) 6, (8) 3, (9 1/2) 1	(9 1/2) 5, (8) 9, (6 3/4) 20, (4 3/4) 51	(9 1/2) 32, (8) 62	(4 3/4) 480, (6 3/4) 800, (8, 9 1/2) 1,100

Transmission trigger	Telemetry type	Wireline retrievable	Downlink kind	Downlink scheme	MTF/GTF switch	Resolution update period, sec	Survey time period, sec	Survey / Logging (max/min)	Measurements from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/type, hr	Resolution	Repeatability		
Flow-on and timer	MPT positive pulse or EM	Y (4 3/4+)	Y	N	N	Programmable threshold	Config. dependent	Config. dependent	Y/Y	Dir: 6.4	Incl: +/-0.1° Azi: +/-1.0° (Incl. >10°; Dip <70°) GTF: +/-1.0° (Incl. >10°) MTF: +/-2.25° (Dip <70°)	Tri-axial fluxgate magnetometer with USGS-NIST-traceable calibration; tri-axial quartz accelerometer	Azi, Incl., MTF, GTF, temp. (Optional Lateral & Axial Vib.)	Lithium battery	Optional turbine-alternator	Y	Y
Flow-on and timer	MPT positive pulse or EM	Y (4 3/4+)	Y	N	N	Programmable threshold	Config. dependent	Config. dependent	Y/Y	Dir: 6.4 Gamma: 2.1	Incl: +/-0.1° Azi: +/-1.0° (Incl. >10°; Dip <70°) GTF: +/-1.0° (Incl. >10°) MTF: +/-2.25° (Dip <70°) Gamma: 0 - 800 API +/-5%	Tri-axial fluxgate magnetometer with USGS-NIST-traceable calibration; tri-axial quartz accelerometer Gamma: NaI scintillation with PMT	Azi, Incl., MTF, GTF, temp. (Optional Lateral & Axial Vib.), Gamma	Lithium battery	Optional turbine-alternator	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	Y (zz)	N	Op. Sel.	Op. Sel.	55	Y/Y	(4 3/4) 28.8, NBI 3.8 (6 3/4) 27.5, NBI 3.1 (8 1/4) 32.4, NBI 3.1 (9 1/2) 33.1, NBI 3.9	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.1(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	Y (zz)	N	Op. Sel.	Op. Sel.	55	Y/Y	(4 3/4) NBI 3.8 (6 3/4) NBI 3.1 (8 1/4) NBI 3.1 (9 1/2) NBI 3.9 (zz)	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.1(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop and start pumps, or stop rotary	Positive mud-pulse	N	Y	N	N	N/A	Op. Sel.	62	Y/Y	(4 3/4) 32.8, NBI 3.8 (6 3/4) 34.7, NBI 3.1 (9 1/2) 40.8, NBI 3.9	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.1(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse	N	Y	N	N	N/A	Op. Sel.	N/A	N/N	(4 3/4) NBI 3.8 (6 3/4) NBI 3.1 (9 1/2) NBI 3.9	Incl: +/- 0.1(k)	Tri-axial accelerometer	Near bit incl., Temp.	Turbine generator, no limit	Y	N	
Power On	Wire / positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	56	Y/Y	(2 3/8) 5.2, (3) 5.4	TF: +/- 1.4, Azi: +/- 1, Incl.: +/- 0.1(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
pumps off survey	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	90	Y/Y	1.63	TF: +/- 2.0, Azi: +/- 2.0, Incl.: +/- 0.05(k)	Tri-axial accelerometer/ two axis rate gyro	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
pumps off survey	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	90	Y/Y	1.63	TF: +/- 2.0, Azi: +/- 2.0, Incl.: +/- 0.05(k)	Tri-axial accelerometer/ two axis rate gyro	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, or stop rotary	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	60	Y/Y	(3 1/8) 1.7, (4 3/4) 3.6, (6 3/4) 8 1/4) 2.5	TF: +/- 1.4, Azi: +/- 1, Incl.: +/- 0.1(k)	Single axis accelerometer	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, or stop rotary	Positive mud-pulse, wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	62	Y/Y	(1 3/4 probe) 16, (2 probe) 12	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.2(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	63	Y/Y	(4 3/4) 15.7, (6 3/4) 11.0, (8 1/4) 13.5, (9 1/2) 13.0	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.1(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	64	Y/Y	(4 3/4) 17.7, (6 3/4) 17.6	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.1(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps	Electromagnetic	N	Y	N	N	Op. Sel.	Op. Sel.	120 sec. from pumps off	Y/N	(4 3/4) 6 3/4) 10.5	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.2(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference, Temp.	Lithium battery, 150+ hours depending on transmission rate	Y	Y	
Stop pumps, start pumps	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	55	Y/N	(4 3/4) 36.6 NBI 19.1, (6 3/4) 52.5 NBI 22.9, (8, 9 1/2) 57.7 NBI 27.9	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.2(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference, Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	N/A	N/N	(4 3/4) NBI 19.1, (6 3/4) NBI 22.9, (8, 9 1/2) NBI 27.9	Incl: +/- 0.2(k)	Dual-axis accelerometer	Incl., Temp.	Turbine generator, no limit	Y	N	
Stop pumps, start pumps, stop rotary	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	62	Y/Y	(1 3/4 probe) 16	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.2(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	62	Y/Y	5.4	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.2(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps	Positive pulse	Y	Y	N	N	Op. Sel. 2 Deg. Min.	12 (6 bit res.)	60-250	Y/N	11, 17, 25	Azm: +/- 5 Inc: +/- 2	Tri-axial accelerometer, Tri-axial magnetometer	Incl., Azi., TF, battery voltage, tool temp, gravity, magnetic field strength, Dip angle	Lithium battery, 400-800 Hours	Y	Y	
Flow	Negative mud pulse	N	Y	N	N	3*auto.	Op. Sel.	60	Y	2	TF: 0.5, Azi: 0.5, Incl.: 0.05	Flux gate magnetometer, Oz hinge accelerometer	Azi, Incl., TF, Temp, Local field	Battery, 240-500 depending on operations	Y	Y	

# 2010 MWD/LWD Services Directory

Service line (s)	Tool OD, in.	Length, ft	Max. D.P.S. - 100 ft (collars, rotation)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. pressure, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 500 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gpm/min
E-Link	4 3/4, 6 1/2	Shortest probe length 24	(4 3/4) 30/15 (6 1/2) 21/10	(4 3/4) 4.75x2.81, (6 1/2) 6.71x2.81	150	20	(4 3/4) 3, (6 1/2) 1	(4 3/4) 16, (6 1/2) 9	(4 3/4) 52, (6 1/2) 15	N/A	(4 3/4) 480, (6 3/4) 920
Geolink UltraSlim	3.5	Shortest probe length 15	100 / 50	(3 1/2) 3.46x2.5	150	20	14	N/A	N/A	N/A	(3 1/2) 150
WellTracer	3 1/2, 4 3/4, 6 1/2, 8, 9 1/2	Shortest probe length 16.6	(4 3/4) 30/15 (6 3/4) 21/10 (8) 14/8 (9 1/2) 7/4	(4 3/4) 4.75x2.81, (6 3/4) 6.71x2.81, (8) 7.93x2.81, (9 1/2) 9.46x2.81	150	20	(4 3/4 - 6 3/4) 8	(4 3/4 - 6 3/4) 47	(4 3/4 - 6 3/4) 153	(9 1/2) 450	100-800
Pilot	3 1/2, 4 3/4, 6 1/2, 8, 9 1/2	Shortest probe length 17.8	(4 3/4) 30/15 (6 3/4) 21/10 (8) 14/8 (9 1/2) 7/4	(4 3/4) 4.75x2.81, (6 3/4) 6.71x2.81, (8) 7.93x2.81, (9 1/2) 9.46x2.81	150	20	(4 3/4 - 6 3/4) 8	(4 3/4 - 6 3/4) 47	(4 3/4 - 6 3/4) 153	(9 1/2) 450	100-1200
Tensor	3 1/2, 4 3/4, 6 1/2, 8, 9 1/2	Shortest probe length 25	(3 1/2) 100/50 (4 3/4) 30/15 (6 3/4) 21/10 (8) 14/8 (9 1/2) 7/4	As applicable to standard NMDC	175	20	(4 3/4 - 6 3/4) 6	(4 3/4 - 6 3/4) 39	(4 3/4 - 6 3/4) 127	(9 1/2) 373	75-1200
<b>Halliburton/Sperry Drilling Billy Hendricks - P.O. Box 60070, Houston, Texas 77205, (281) 871-5396, billy.hendricks@halliburton.com</b>											
Electromagnetic Telemetry System	3 1/2, 4 3/4, 6 1/2	(3 1/2) 33.9, (4 3/4) 33.5, (6 1/2) 35.6 (t)	35/14	(3 1/2 flex) 2.9x1.5, (4 3/4 flex) 4.06x2.25, (6 1/2 flex) 4.63x2.81	125	15		(3 1/2) 171, (4 3/4) 139, (6 1/2) 40	(4 3/4) 400, (6 1/2) 150	N/A	N/A
Negative Pulse Telemetry System	6 3/4, 8, 9 1/2	9.2	(6 3/4) 21/10, (8, 9 1/2) 14/8	(6 3/4) 6.54x2.81, (8) 7.76x2.81, (9 1/2) 9.35x3	150	18 std., 25 opt.		(6 3/4, 8) 17, (9 1/2) 4	(6 3/4, 8) 31, (9 1/2) 7	(6 3/4, 8) 182, (9 1/2) 36	(x)
Positive Pulse Telemetry System	3 3/8, 3 1/2, 4 3/4, 6 1/2, 6 3/4, 7 1/4, 8, 9 1/2	(3 3/8, 3 1/2) 21, (4 3/4 - 9 1/2) 26	(3 3/8 - 4 3/4) 30/14, (6 1/2 - 7 1/4) 21/10, (7 3/4 - 9 1/2) 14/8	(3 3/8) 3.21x1.5, (3 1/2) 3.35x1.5, (4 3/4) 4.66x2.25, (6 1/2 - 9 1/2) Equivalent to a standard NMDC	150 std. 175 opt.	20, 22.5, 25, 30	(3 3/8, 3 1/2) 120 at 150 gal/min	(4 3/4) 140	170	380	(3 3/8, 3 1/2) 90-200, (4 3/4) 150-350, (6 1/2 - 9 1/2) 225-650, (7 1/4 - 9 1/2) 400-1500
MWD Gyro	6 3/4, 8, 9 1/2	25.8	(6 3/4) 21/10, (8) 14/8, (9 1/2) 14/8	Equivalent to standard NMDC	150	20		(6 3/4, 8) 17, (9 1/2) 4	(6 3/4, 8) 31, (9 1/2) 7	(6 3/4, 8) 182, (9 1/2) 36	225-1500
<b>MWD Services LLC. Clyde Cormier - P O Box 750, or 219 Griffin Rd, Youngsville, LA 70592, (337) 856-5965, ccormier@mwdsci.com</b>											
MWD Shuttle	1 7/8 tool OD, 3 1/8 - 9 1/2	22.7 w/single battery, 29.1 w/dual battery	60/30	As applicable to standard NMDC	150	20	40	80	150		75-1,000
<b>Navigate Energy Services Steve Krase - 15700 International Plaza Drive, Suite 150, Houston, TX 77032, 832-300-0030, stevekrase@navigateenergy.com</b>											
Drift	6 1/2, 8, 9 1/2	8 ft	API conn limited	TBD	150	20	N/A	60	125	N/A	250-1300
Directional	4 3/4, 6 1/2, 8 available Q4 '09	(4 3/4) 10, (6 1/2 & 8) 10	(4 3/4) 32/16, (6 3/4) TBD, (8) TBD	As applicable to standard NMDC	150	20	N/A	60	125	N/A	225-1000
<b>PathFinder Allan Rennie - 23500 Colonial Pkwy, Katy, TX 77493, (281) 769-4501, allan.rennie@pathfinderw.com</b>											
HDS-1L Directional Survey	4 3/4, 6 3/8, 6 3/4, 8 LF, 8 HF, 9 1/2	30	(4 3/4) 31/17, (6 3/8) 24/11.5, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/8) 6.47x2.81, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.98x2.81, (9 1/2) 9.5x3	150	20	(4 3/4) 40, (6 3/8) 40, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/8) 50, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4, 6 3/8) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45, (9 1/2) 45	(4 3/4, 6 3/8, 6 3/4, 8 LF) N/A, (8 HF) 200,	(4 3/4, 6 3/8) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500
HDS-1M Directional	6 3/4, 8 LF, 8 HF, 9 1/2	26.6	(6 3/4) 17/9, (8 LF) 18/10, (8 HF) 18/10, (9 1/2) 12/6	(6 3/4) 6.43x2.81, (8 LF) 7.85x2.81, (8 HF) 7.60x2.81, (9 1/2) 9.36x3.00	150	20	(6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(6 3/4) 50, (8 LF, 8 HF, 9 1/2) N/A	(6 3/4) 90, (8 LF) 90, (8 HF, 9 1/2) 40	(6 3/4, 8 LF, 8 HF) N/A, (9 1/2) 200	(6 3/4) 315-750, (8 LF) 315-950, (8 HF) 375-1,125, (9 1/2) 500-1500
HDS-1R Directional	3 1/8 - 9 1/2	30	60/30 Dependent on drill collar	As applicable to standard NMDC	150	20	250	250	250	250	(2 1/4) 60-180, (2 1/2) 140-280, (2 11/16) 180-350, (2 13/16) 250-550, (3 1/4) 300-1,000 (3 1/2) 600-1,500
HDS-1S Directional	4 3/4, 6 3/4, 8 LF, 8 HF	16	(4 3/4) 31/17, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9	(4 3/4) 4.69x2.25, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.98x2.81	150	20	(4 3/4) 40, (6 3/4, 8 LF, 8 HF) N/A	(4 3/4) 50, (6 3/4, 8 LF) 45, (8 HF) N/A	(4 3/4) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45	(4 3/4, 6 3/4, 8 LF) N/A, (8 HF) 200	(4 3/4) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125
Survivor HDS-1 Directional	4 3/4, 6 3/8, 6 3/4, 8 LF, 8 HF, 9 1/2	30	(4 3/4) 31/17, (6 3/8) 24/11.5, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/8) 6.47x2.81, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.98x2.81, (9 1/2) 9.5x3.0	175	25	(4 3/4) 40, (6 3/8) 40, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/8) 50, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4, 6 3/8) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45, (9 1/2) 45	(4 3/4, 6 3/8, 6 3/4, 8 LF) N/A, (8 HF) 200,	(4 3/4, 6 3/8) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500
Survivor HDS-1R Directional	3 1/8 - 9 1/2	30	60/30 Dependent on drill collar	As applicable to standard NMDC	175	25	250	250	250	250	(2 1/4) 60-180, (2 1/2) 80-280, (2 11/16) 100-350, (2 13/16) 150-550, (3 1/4) 300-1,000 (3 1/2) 600-1,500
Survivor HDS-1S Directional	4 3/4, 6 3/4, 8 LF, 8 HF	16	(4 3/4) 31/17, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9	(4 3/4) 4.69x2.25, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.98x2.81	175	25	(4 3/4) 40, (6 3/4, 8 LF, 8 HF) N/A	(4 3/4) 50, (6 3/4, 8 LF) 45, (8 HF) N/A	(4 3/4) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45	(4 3/4, 6 3/4, 8 LF) N/A, (8 HF) 200	(4 3/4) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125
Payzone Inclination Gamma	4 3/4, 6 3/4	7.13 upper, 2.7 lower	(4 3/4) 31/17, (6 3/4) 17/9	(4 3/4) 4.66x2.25, (6 3/4) 6.57x2.81	150	20	N/A	(4 3/4) 70, (6 3/4) 20	(4 3/4) N/A, (6 3/4) 35	N/A	(4 3/4) 125-375, (6 3/4) 250-750
Gyro HDS1	4 3/4, 6 3/4, 8 LF, 8 HF, 9 1/2	30	(4 3/4) 31/17, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.98x2.81, (9 1/2) 9.39x3	150	20	(4 3/4) 40, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/4, 8 LF) 45, (8 HF, 9 1/2) N/A	(4 3/4) N/A, (6 3/4, 8 LF) 50, (8 HF, 9 1/2) 50	(4 3/4, 6 3/4, 8 LF) N/A, (8 HF, 9 1/2) 200	(4 3/4) 125-375, (6 3/4) 250-600, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500
Gravity HDS1	4 3/4, 6 3/8, 6 3/4, 8 LF, 8 HF, 9 1/2	46	(4 3/4) 31/17, (6 3/8) 24/11.5, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/8) 6.47x2.81, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.98x2.81, (9 1/2) 9.5x3	150	20	(4 3/4) 40, (6 3/8) 40, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/8) 50, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4, 6 3/8) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45, (9 1/2) 45	(4 3/4, 6 3/8, 6 3/4, 8 LF) N/A, (8 HF) 200, (9 1/2) 200	(4 3/4, 6 3/8) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500
Survivor Gravity HDS1	4 3/4, 6 3/8, 6 3/4, 8 LF, 8 HF, 9 1/2	46	(4 3/4) 31/17, (6 3/8) 24/11.5, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/8) 6.47x2.81, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.98x2.81, (9 1/2) 9.5x3	175	25	(4 3/4) 40, (6 3/8) 40, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/8) 50, (6 3/4, 8 LF, 8 HF, 9 1/2) N/A	(4 3/4, 6 3/8) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45, (9 1/2) 45	(4 3/4, 6 3/8, 6 3/4, 8 LF) N/A, (8 HF) 200, (9 1/2) 200	(4 3/4, 6 3/8) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500
APS SureShot	3 1/8, 3 1/2, 4 3/4, 6 1/4, 6 3/4, 8, 9 1/2+	25	Collar-limited	Collar-defined	175	20	(3 1/2) 27, (4 3/4 - 6 3/4) 6, (8) 20, (9 1/2) 2	(3 1/2) 150, (4 3/4 - 6 3/4) 35, (8) 20, (9 1/2) 10	(6 1/2 - 6 3/4) 114, (8) 61, (9 1/2) 32	(9 1/2) 220	(3 1/8, 3 1/2) 70 - 250 (4 3/4) 150 - 350 (6 1/4, 6 3/4) 150 - 750 (8) 600 - 1,100 (9 1/2+) 650 - 1,200

Transmission trigger	Telemetry type	Wireline retrievable				MTF/GTF switch	Realtine update period, sec	Survey time period, sec	Survey / Logging (min/line)	Measure points / from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recover
		Wireline retrievable	Downlink kind	Downlink scheme	Downlink scheme											
Flow	Electromagnetic	Y	Y	N	N	3*auto.	Op. Sel.	Transmission Frequency dependent 30-180s	Y/N	2	TF: 0.5, Azi.: 0.5, Incl.: 0.05	Flux gate magnetometer. Qz hinge accelerometer	Azi., Incl., TF, Temp, Local field	Battery, 240-500 depending on operations	Y	Y
Flow	Negative mud pulse	N	Y	N	N	3*auto.	Op. Sel.	60	Y	2	TF: 0.5, Azi.: 0.5, Incl.: 0.05	Flux gate magnetometer. Qz hinge accelerometer	Azi., Incl., TF, Temp, Local field	Battery, 240-500 depending on operations	Y	Y
Flow	Positive mud pulse	Y	Y	N	N	Op. Sel 3 - 10 deg	Op. Sel.	60	Y	Variable	TF: 0.5 (up to 10 deg only), Azi.: 1.0, Incl.: 0.2	Fluxgate Mags, Q flex accelerometers	Azi., Incl., TF, Temp, Local field	Battery, 500-1000 depending on operations	Y	Y
Flow	Positive mud pulse	Y	Y	N	N	Op. Sel 3 - 10 deg	Op. Sel.	60	Y	Variable	TF: 0.5, Azi.: 0.5, Incl.: 0.1	Fluxgate Mags, Q flex accelerometers	Azi., Incl., TF, Temp, Local field	Battery, up to 400 hrs depending on operations	Y	Y
Flow	Positive mud pulse	Y	Y	N	N	Op. Sel.	Op. Sel.	105-208 data dependent	Y	Variable	TF: 0.5, Azi.: 0.25, Incl.: 0.1	Flux gate magnetometer. Qz hinge accelerometer	Azi., Incl., TF, Temp, Local field	Battery, 350-400 depending on operations	Y	Y
Op. Sel., from surface or continuous	Electromagnetic	N	N	N	Y	Op. Sel.	Variable	60	Y/N	12	TF: 2.8, Azi.: 1.5, Incl.: 0.2	Tri-axial magnetometers and accelerometers	Magnetic field strength and acceleration vectors	Battery, 200	Y	Y
Stop pumps, start pumps, selectable press.	Negative pulse	N	Y	N	N	0-16	Variable	90-190	N/N	4	TF: 1.5, Azi.: 0.5, Incl.: 0.1	Tri-axial magnetometers and accelerometers	Magnetic field strength and acceleration vectors	Battery, 250	Y	Y
Stop pumps, start pumps	Positive pulse	N	Y	N	N	0-8	Variable	81-332	Y/N	4.2	TF: 2.8, Azi.: 0.5 or 1.5, Incl.: 0.1 or 0.2	Tri-axial magnetometers and accelerometers	Magnetic field strength and acceleration vectors	Generator, battery	Y	Y
Stop pumps, start pumps	Positive or negative pulse	N	Y	N	N	0-16	Variable	150-270	Y/N	3 ft	TF +/- 1° Inc +/- 0.1° Azi +/- 1°	Two dual axis dry-tuned rate gyroscopes, three single axis accelerometers	True North Reference Azimuth, acceleration	Battery	Y	Y
Stop pumps, stop rotary, start pumps	Positive pulse	Y	Y	N	N	Y	14-26, resolution dependant	97-261, data dependant	Y/Y	15.3, 21.7 opt.	Azi.: +/- 0.25, Incl.: +/- 0.1	Tri-axial accelerometer and tri-axial magnetometer	Incl., Azi., mTFA, gTFA, temp, battery voltage, Dip/A, Grav, MagF	Lithium battery, 150 single, 300 dual battery	N	N
Stop pumps, start pumps	Positive	N	N	N	N	N	On demand	150	Y	3	Inc +/- 1 Mem +/- 125 RT	Proprietary	Inc.	Lithium battery, 1000 hours	Y	Y
Stop pumps, start pumps	Positive	N	N	N	N	Yes	Variable	50	Y/N	10	Azi +/- .3, Inc +/- .1, TF +/- .1	Tri-axial accelerometer, Tri-axial magnetometer	GX, GY, GZ, HX, HY, HZ, Azi., Inc., TF reference, Temp.	Lithium battery, 500 hours	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	12.65	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 630 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	15.1	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 342 hr	Y(a)	Y
Stop pumps, start pumps	Positive	Y	Y	N	N	Op. Sel.	8	46	Y/N	14.6	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 548 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	9	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 315 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	13.14	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery up to 630 hr	Y	Y
Stop pumps, start pumps	Positive	Y	Y	N	N	Op. Sel.	8	46	Y/N	14.6	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 548 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	9	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 315 hr	Y	Y
Stop pumps, start pumps	Positive pulse (EM sub to sub)	N	Y	N	N	N/A	8	N/A	Y	(4 3/4) Gamma 0.9, Incl. 1.8, (6 3/4) Gamma 1.6, Incl. 2.6	Incl. +/- 0.25	Tri-axial accelerometer and scintillator	AAPL GR, Incl., RPM,	Lithium battery (4 3/4) 200, (6 3/4) 400	Y	N
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	N	9	GYRO (Incl. +/- 0.1, Azi.: +/- 1, TF: +/- 1, at Incl. 0-20, HD51 (TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15)	Rate-gyro, Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 630 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	13.14	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 630 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	13.14	TF: +/- 1.5 at Incl. > 6, +/- 3.0 at 3 Incl., Azi.: +/- 1 at Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.15	Tri-axial accelerometer and magnetometer	Azi., Incl., MTF, GTF, temp, Lateral Vib., Bat Voltage, TGF, TMF	Lithium battery, up to 630 hr	Y	Y
Flow-on and timer	Positive	Y (4 3/4+)	Y	N	N	Programmable threshold	Config. dependant	Config. dependant	Y/Y	Dir: 6.4	Incl: +/- 0.1 Azi: +/- 1.0 (Incl. > 10; Dip < 70) GTF: +/- 1.0 MTF: +/- 2.25 (Incl. > 10; Dip < 70)	Tri-axial fluxgate magnetometer with USGS-NIST-traceable calibration; tri-axial quartz accelerometer	Azi., Incl., MTF, GTF, temp, (Optional Lateral & Axial Vib.)	Lithium battery Optional turbine-alternator	Y	Y

# 2010 MWD/LWD Services Directory

Service line (s)	Tool OD, in.	Length, ft	Max. DLS - 100 ft (collars, rotating)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. press, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gal/min
Slim Array Wave Resistivity	4.75	20	30/15	4.72x2.25	150	25	6	29	N/A	N/A	120-375
Survivor Slim Array Wave Resistivity	4.75	20	30/15	4.72x2.25	175	25	6	29	N/A	N/A	120-375
Array Wave Resistivity	6 3/4, 8, 9 1/2	20	(6 3/4) 16/10, (8, 9 1/2) 16/10	(6 3/4) 6.4x2.81, (8) 8.9x3, (9 1/2) 8.9x3	150	(6 3/4, 8, 9 1/2) 25	N/A	(6 3/4) 30, (8) 30, (9 1/2) 30	(6 3/4) 75, (8) 75, (9 1/2) 75	(6 3/4) N/A, (8) N/A, (9 1/2) 300	(6 3/4) 250-750, (8) 250-1,125, (9 1/2) 250-1,500
Survivor Array Wave Resistivity	6 3/4, 8, 9 1/2	20	(6 3/4) 16/10, (8, 9 1/2) 16/10	(6 3/4) 6.4x2.81, (8) 8.9x3, (9 1/2) 8.9x3	175	(6 3/4, 8, 9 1/2) 25	N/A	(6 3/4) 30, (8) 30, (9 1/2) 30	(6 3/4) 75, (8) 75, (9 1/2) 75	(6 3/4) N/A, (8) N/A, (9 1/2) 300	(6 3/4) 250-750, (8) 250-1,125, (9 1/2) 250-1,500
2D Rotary Steering Tool	8 1/2, 12 1/4	18.5, 21.5	(8 1/2) 20/7, (12 1/4) 13/4	(8 1/2) 6.75x5, (12 1/4) 8.75x6	150	20	50	75	100	150	(8 1/2) 650, (12 1/4) 1,300
PathMaker Rotary Steerable	4 3/4, 6 3/4, 8, 9 1/2	21, 20, 20, 20	Capability (*100 ft) : (4 3/4) 10+, (6 3/4) 8, (8) 6, (9 1/2) 6 Pass Through (*100 ft) : (4 3/4) 15/10, (6 3/4) 15/10, (8) 12/8, (9 1/2) 10/6	N/A	(4 3/4) 175, (6 3/4) 8, (8) 18, (9 1/2) 150	(4 3/4) 25, (6 3/4) 22, (8) 18, (9 1/2) 15	N/A	N/A	N/A	N/A	(4 3/4) 150-350, (6 3/4) 250-750, (8) 250-1250, (9 1/2) 250-1250
<b>Ryan Energy Technologies</b> Butch Belcher - 19510 Oil Center Blvd., Houston, TX 77073, (281) 443-1414, butch.belcher@ryanenergy.com											
Ryan EM	1 7/8 tool OD, 3 1/8 - 6 3/4 collars	34			150	20 (137 mpa)					
Ryan Mud Pulse	1 7/8 tool OD, 3 1/8 - 9 1/2 collars	30		As applicable to standard NMDC	150	20 (137 mpa)					(3 1/8) 50-130, (4 3/4) 130-265, (6 3/4) 235-530, (8) 400-925, (9 1/2) 500-925
<b>Schlumberger</b>											
PowerDrive Xtra Rotary Steerable Tool	4 3/4, 6 3/4, 8 1/4, 9, 11	(4 3/4) 14.95, (6 3/4) 13.6, (8 1/4, 9) 14.6, (11) 15.1	Capability (*100 ft) : (4 3/4, 6 3/4, 8 1/4) 8, (9) 5, (11) 4 Pass Through (*100 ft) : (4 3/4) 30/15, (6 3/4, 8.25, 9) 20/10, (11) 15/8	N/A	125	20	N/A	36 (600 - 800 psi required across bit)	30 (600 - 800 psi required across bit)	46 (600 - 800 psi required across bit)	130-1,000
PowerDrive X5 Rotary Steerable Tool	4 3/4, 6 3/4, 8 1/4, 9, 11	(4 3/4) 14.95, (6 3/4) 13.48, (8 1/4, 9) 14.6, (11) 15.1	Capability (*100 ft) : (4 3/4, 6 3/4, 8 1/4) 8, (9) 5, (11) 4 Pass Through (*100 ft) : (4 3/4) 30/15, (6 3/4, 8.25, 9) 20/10, (11) 15/8	N/A	150	20	N/A	36 (600 - 800 psi required across bit)	30 (600 - 800 psi required across bit)	46 (600 - 800 psi required across bit)	130-1,900
Power Drive Xceed Rotary Steerable Tool	6.75	25	8° DLS capability 15/8 pass through	6.75x2.81x31	150	20	N/A	N/A	60	N/A	290-800
PowerV Vertical drilling Rotary Steerable Tool	4 3/4, 6 3/4, 8 1/4, 9, 11	(4 3/4) 14.95, (6 3/4) 13.48, (8 1/4, 9) 14.6, (11) 15.1	Capability (*100 ft) : (4 3/4, 6 3/4, 8 1/4) 8, (9) 5, (11) 4 Pass Through (*100 ft) : (4 3/4) 30/15, (6 3/4, 8.25, 9) 20/10, (11) 15/8	N/A	150	20	N/A	36 (600 - 800 psi required across bit)	30 (600 - 800 psi required across bit)	46 (600 - 800 psi required across bit)	130-1,900
PowerDrive vorteX475	4.75	30	8° DLS capability 30/15 pass through	N/A	150	20	N/A	235	N/A	N/A	220-400
PowerDrive vorteX675	6.75	43	8° DLS capability 20/10 pass through	N/A	150	18	N/A	N/A	250	N/A	320-650
PowerDrive vorteX825	8	49.6	6° DLS capability 20/10 pass through	N/A	150	18	N/A	N/A	200	350	480-1,500
PowerDrive vorteX900	9	50.6	6° DLS capability 20/10 pass through	N/A	150	18	N/A	N/A	200	350	480-1,500
PowerDrive vorteX1100	11	50.6	4° DLS capability 15/8 pass through	N/A	150	20	N/A	N/A	N/A	350	2,000 max
PowerPak ERT high performance positive displacement motors	4 3/4, 6 3/4, 8, 9 5/8	17.3 (4 3/4), 16.3 (6 3/4), 30.2 (8), 30 (9 5/8)	As per motor specification for bend setting	N/A	175	30	Dependent on specific model	Dependent on specific model	Dependent on specific model	Dependent on specific model	125-325 (4 3/4), 300-650 (6 3/4), 300-900 (8), 600-1200 (9 5/8)
Impulse	4.75	32	30/15	4.75x2.25x38.5	150 std., 175 opt.	20 std., 25 opt.	N/A	125 (varies with Modulator gap)	N/A	N/A	130-400
ShortPulse	4.75	27.3	30/15	4.75x2.25x34.8 -OR- 4.59x2.25x30.3	150 std., 175 opt.	20	N/A	125 (varies with Modulator gap)	N/A	N/A	130-400
PowerPulse	6 3/4, 8 1/4, 9, 9 1/2	24.7	(6 3/4) 16/8 (8 1/4) 12/7 (9, 9 1/2) 10/6	(6 3/4) 6.75x2.81x31.5 (8 1/4) 8x2.81x26.2 (9 1/4) 9.25x3x28 (9 1/2) 9.5x3.5x26.2	150 std., 175 opt.	25	N/A	(6 3/4) 56 (8 1/4) 32 (varies with modulator gap)	(6 3/4) 151 (8 1/4, 9 1/2) 84 (varies with modulator gap)	(8 1/4, 9 1/2) 595 (varies with modulator gap)	(6 3/4) 250-800 (8 1/4) 300-1,200 (8 1/4) opt. 800-1,400 (9 1/2) 400-1,200 (9 1/2) opt. 400-1,600
TeleScope	6 3/4, 8 1/4, 9, 9 1/2	24.7	(6 3/4) 16/8 (8 1/4) 12/7 (9, 9 1/2) 10/6	(6 3/4) 6.75x2.81x31.5 (8 1/4) 8x2.81x26.2 (9 1/4) 9.25x3x28 (9 1/2) 9.5x3.5x26.2	150 std., 175 opt.	20 std., 30 opt.	N/A	(6 3/4) 56 (8 1/4) 32 (varies with modulator gap)	(6 3/4) 151 (8 1/4, 9 1/2) 84 (varies with modulator gap)	(8 1/4, 9 1/2) 595 (varies with modulator gap)	(6 3/4) 250-800 (8 1/4) 300-1,200 (8 1/4) opt. 800-1,400 (9 1/2) 400-1,200 (9 1/2) opt. 400-1,600
SlimPulse	1 3/4 tool OD 3 1/8 to 9 1/2 collars	Collar based probe normally 30	(4 3/4 and smaller) 145/40 (6 3/4) 28/10 (8 1/4) 20/8 (9 1/2) 19/7	(4 3/4) 4.75x2.81x33 (6 3/4) 6.75x2.81x32	150 std., 175 opt.	20 std., 22 opt.	(4 3/4) 68 (6 3/4) 16	(6 3/4) 100 (8 1/4) 18	(6 3/4) 324 (8 1/4, 9 1/2) 58	(8 1/4, 9 1/2) 411	Multiple configurations: 35-1,200
E-Pulse	4 3/4, 6 1/2	(4 3/4) 58.6 (6 1/2) 60.8	(4 3/4) 30/15 (6 1/2) 15/8	(4 3/4) 4.75x2.25x75.5, (6 1/2) 6.5x2.813x76.9	125	12	(4 3/4) 15, (6 3/4) 5	(4 3/4) 91, (6 3/4) 31	(6 3/4) 98	N/A	(4 3/4) 0-400 (6 3/4) 0-600
E-Pulse XR	4 3/4, 6 1/2	45	(4 3/4) 30/15 (6 1/2) 15/8	(4 3/4) 4.75x2.25x75.5, (6 1/2) 6.5x2.813x76.9	125	12	(4 3/4) 5, (6 3/4) 2	(4 3/4) 25, (6 3/4) 10	(6 3/4) 34	N/A	(4 3/4) 0-400 (6 3/4) 0-600

Transmission trigger	Telemetry type	Wireline retrievable					MTR/RTT switch	Rebalance update period, sec	Survey time period, sec	Survey / Logging (min/line)	Measurements from tool body, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery
		Wireline retrievable	Downlink kind	Downlink scheme	Downlink e-mag	Downlink e-mag											
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	Op. Sel.	5	Y/Y	Res -10.4 Gr -3.7 Inc -3.3	Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.14	Tri-axial accelerometer	Incl.	Lithium battery	Y	Y	
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	Op. Sel.	5	Y/Y	Res -10.4 Gr -3.7 Inc -3.3	Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.14	Tri-axial accelerometer	Incl.	Lithium battery	Y	Y	
Real-time, pumps on downhole recording	Positive	N	N	N	N	GTF	Op. Sel.	8	Y/Y	Res -10 Gr -3.2 Inc -2.8	Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.14	Tri-axial accelerometer	Incl.	Lithium battery	Y	Y	
Real-time, pumps on downhole recording	Positive	N	N	N	N	GTF	Op. Sel.	8	Y/Y	Res -10 Gr -3.2 Inc -2.8	Incl. > 6, +/- 2 at 3 Incl., Incl. +/- 0.14	Tri-axial accelerometer	Incl.	Lithium battery	Y	Y	
Stop pumps, start pumps	Positive pulse	N	Y	N	N	N/A	Every flow cycle	180	Y	(8 1/2) 3.12, (12 1/4) 4.25	Dia. = +/- 1/16-in.	Linear potentiometer	Stabilizer gauge diameter	Lithium battery, 400 hr	Y	Y	
Stop pumps, start pumps	Positive Uplink Rotary Downlink	N	N	N	N	GTF	Op. Sel.	Op. Sel.	Y	(9 1/2) Caliper: 4.0, Inc: 6.0, Gamma:15.4 (8) Caliper: 4.0, Inc:6.0 Gamma: 15.4 (6 3/4) Caliper: 3.3, Inc: 6.5, Gamma: 13.8 (4 3/4) Caliper: 2.3, Inc: 7.9, Gamma: 12.2	+/- 0.01", +/-0.1	Linear potentiometer, Tri-axial accelerometers	Caliper, RPM, Stick-slip, Inc, Lateral, Axial and Torsional Vibration	Lithium battery, 200-350 hr	Y	Y	
Stop pumps, start pumps	Electromagnetic	Y	N	N	N	Op. Sel.	5	25	Y/N	23	TF: +/-1, Azi: +/-1, (>5.0 INC) Incl.: +/-0.2	Tri-axial accelerometer, Tri-axial magnetometer	Incl., Azi., TF, battery voltage, tool temp, local gravity and magnetic field strength	Lithium battery, 50-120 hr	Y	N	
Stop pumps, start pumps	Positive pulse	Y	Y	N	N	Op. Sel.	10	55	Y/N	18	TF: +/-1, Azi: +/-1, (>5.0 INC) Incl.: +/-0.2	Tri-axial accelerometer, Tri-axial magnetometer	Incl., Azi., TF, battery voltage, tool temp, local gravity and magnetic field strength	Lithium battery, 200-400 hr	Y	N	
Continuous link to MWD	E-mag to MWD with RT Link	N	Y	N	N	5°	Variable	Continuous	N/A	(4 3/4) 6.73, (6 3/4) 7.27, (8 1/4, 9) 8.43, (11) 8.83	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Near bit inclination azimuth RT-status	Turbine	Y	N	
Continuous link to MWD	E-mag to MWD with RT Link	N	Y	N	N	5°	Variable	Continuous	N/A	(4 3/4) 6.73, (6 3/4) 7.27, (8 1/4, 9) 8.43, (11) 8.83	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Near bit inclination azimuth RT-status Gamma Ray image	Turbine	Y	Y	
Continuous link to MWD	Hard wire to MWD Wired drill pipe opt.	N	Y	Y	N	5°	Variable	Continuous	N/A	12.8	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Near bit inclination azimuth RT-status	Turbine	Y	Y	
N/A	N/A	N	N	N	N	5°	Variable	Continuous	N/A	(4 3/4) 6.73, (6 3/4) 7.27, (8 1/4, 9) 8.43, (11) 8.83	Incl.: 0.1 at 1 sigma	3 axis accelerometer	N/A	Turbine	Y	N	
Continuous link to MWD	E-mag to MWD with Xtra RT Link	N	Y	N	N	5°	Variable	Continuous	N/A	10.3	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Near bit inclination azimuth RT-status	Turbine	Y	N	
Continuous link to MWD	E-mag to MWD with Xtra RT Link	N	Y	N	N	5°	Variable	Continuous	N/A	10.3	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Near bit inclination azimuth RT-status	Turbine	Y	N	
Continuous link to MWD	E-mag to MWD with Xtra RT Link	N	Y	N	N	5°	Variable	Continuous	N/A	10.3	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Near bit inclination azimuth RT-status	Turbine	Y	N	
Continuous link to MWD	E-mag to MWD with Xtra RT Link	N	Y	N	N	5°	Variable	Continuous	N/A	10.3	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Near bit inclination azimuth RT-status	Turbine	Y	N	
Continuous link to MWD	E-mag to MWD with Xtra RT Link	N	Y	N	N	5°	Variable	Continuous	N/A	10.3	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Near bit inclination azimuth RT-status	Turbine	Y	N	
N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Stop pumps, stop rotary, start pumps	Positive Continuous wave and downhole recording	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 70bps effective)	30-108	Y/Y	15	TF: 3, Azi: 1 at 1 sigma, Incl.: 0.1 at 1 sigma	Accelerometer magnetometer	Local gravity and magnetic field	Turbine	Y	Y	
Stop pumps, stop rotary, start pumps	Positive Continuous wave and downhole recording	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 70bps effective)	30-108	Y/Y	6.8	TF: 3, Azi: 1 at 1 sigma, Incl.: 0.1 at 1 sigma	Accelerometer magnetometer	Local gravity and magnetic field	Turbine	Y	Y	
Stop pumps, stop rotary, start pumps	Positive Continuous wave	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 120bps effective)	30-88	Y/Y	11	TF: 3, Azi: 1 at 1 sigma, Incl.: 0.1 at 1 sigma	Accelerometer magnetometer	Local gravity and magnetic field	Turbine	Y	N	
Stop pumps, stop rotary, start pumps	Positive Continuous wave / Wired drill pipe opt.	N	Y	Y	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 120bps effective)	27-80	Y/Y	11	TF: 3, Azi: 1 at 1 sigma, Incl.: 0.1 at 1 sigma	Accelerometer magnetometer	Local gravity and magnetic field	Turbine	Y	Y	
Stop pumps, stop rotary, start pumps	Positive Continuous wave and downhole recording	Y	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (0.5bps physical to 3bps effective)	104sec to 150sec at 1bps	Y/Y	15 (variable)	TF: 3, Azi: 1 at 1 sigma, Incl.: 0.1 at 1 sigma	Accelerometer magnetometer	Local gravity and magnetic field	Lithium battery	Y	Y	
Continuous	E-mag and downhole recording	N	N	N	Y	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (up to 12bps)	44 sec	Y/Y	15	TF: 3, Azi: 1 at 1 sigma, Incl.: 0.1 at 1 sigma	Accelerometer magnetometer	Local gravity and magnetic field	Lithium battery	Y	Y	
Continuous (sleep mode optional)	E-mag and downhole recording	Y	N	N	Y	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (up to 12bps)	44 sec	Y/Y	24.9	TF: 3, Azi: 1 at 1 sigma, Incl.: 0.1 at 1 sigma	Accelerometer magnetometer	Local gravity and magnetic field	Lithium battery	Y	Y	

# 2010 MWD/LWD Services Directory

Service line (s)	Tool OD, in.	Length, ft.	Max. D.P.S. - 100 ft (rolling, rotating)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. pressure, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 500 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gpm/min
GyroPulse	8 1/4, 9, 9 1/2	(8 1/4) 24.6, (9) 24.7, (9 1/2) 24.9	(8 1/4) 12/12 (9) 10/10, (9 1/2) 10/10	(8 1/4) 8.25x3.5x26.2 (9) 9x3.5x28 (9 1/2) 9.5x3.5x26.2	150	25	N/A	N/A	4	26	400-1200
<b>Sondex Drilling (Rentals Division) Allan Clark - Howe Moss Drive, Dyce, Aberdeen AB21 0GL, UK, +44 (0)1224 778850, aclark@sondex.com</b>											
Orienteer Retrievable	4 3/4, 6 3/4, 8, 9 1/2	Shortest probe length 12 ft	As applicable to standard NMDC	(4 3/4) 4.75x2.81, (6 3/4) 6.71x2.81, (8) 7.93x2.81, (9 1/2) 9.46x2.81	150 (i)	20	(3 1/8, 3 1/2) 14, (2 7/8) 7	(4 3/4) 16, (6 3/4) 6, (8) 3, (9 1/2) 1	(9 1/2) 5, (8) 9, (6 3/4) 2b, (4 3/4) 51	(9 1/2) 32, (8) 62	(3 3/4) 480, (6 3/4) 800, (8, 3 1/2) 1,100
Orienteer Standard	4 3/4, 6 3/4, 8, 9 1/2	Shortest probe length 15	As applicable to standard NMDC	(4 3/4) 4.75x2.81, (6 3/4) 6.71x2.81, (8) 7.93x2.81, (9 1/2) 9.46x2.81	150 (i)	20	(3 1/8, 3 1/2) 14, (2 7/8) 7	(4 3/4) 16, (6 3/4) 6, (8) 3, (9 1/2) 1	(9 1/2) 5, (8) 9, (6 3/4) 2b, (4 3/4) 51	(9 1/2) 32, (8) 62	(4 3/4) 480, (6 3/4) 800, (8, 9 1/2) 1,100
Orienteer E-Link	4 3/4, 6 3/4, 8, 9 1/2	Shortest probe length 15	As applicable to standard NMDC	(4 3/4) 4.75x2.81, (6 3/4) 6.71x2.81, (8) 7.93x2.81, (9 1/2) 9.46x2.81	150 (i)	20	(3 1/8, 3 1/2) 14, (2 7/8) 7	(4 3/4) 16, (6 3/4) 6, (8) 3, (9 1/2) 1	(9 1/2) 5, (8) 9, (6 3/4) 2b, (4 3/4) 51	(9 1/2) 32, (8) 62	(4 3/4) 480, (6 3/4) 800, (8, 9 1/2) 1,100
Orienteer Microlite	2.875	Shortest probe length 15	1/0.5	2.5x1.5	150 (i)	20	30	N/A	N/A	N/A	80
Orienteer Ultralite	3.125	Shortest probe length 15	1/0.5	(2 7/8) 2.66x1.5, (3 1/8) 2.96x2.12	150 (i)	20	30	N/A	N/A	N/A	(2 7/8), 80, (3 1/8) 160
Orienteer UltraSlim	3.5	Shortest probe length 15	1/0.5	(3 1/2) 3.46x2.5	150 (i)	20	14	N/A	N/A	N/A	(3 1/2) 150
WellTracer	3 1/2, 4 3/4, 6 1/2, 8, 9 1/2	Shortest probe length 10.5	As applicable to standard NMDC	As applicable to standard NMDC	150 (i)	20	(4 3/4 - 6 3/4) 8	(4 3/4 - 6 3/4) 47	(4 3/4 - 6 3/4) 153	(9 1/2) 450	100-800
Pilot MWD	4 1/2, 4 3/4, 6 1/2, 8, 9 1/2	Shortest probe length 24	As applicable to standard NMDC	As applicable to standard NMDC	150 (i)	20	(4 3/4 - 6 3/4) 8	(4 3/4 - 6 3/4) 47	(4 3/4 - 6 3/4) 153	(9 1/2) 450	100-1200
<b>Target MWD Inc. Craig Constant - 1125 Regional Park Drive, Houston TX 77060, (281) 951-2100, craig.constant@targetmwd.com</b>											
Target Retrievable System	1 7/8 tool OD, 3 1/8 - 9 1/2	25 w/single battery, 32 w/dual battery	(3 1/8) 100/20, (4 3/4) 70/20, (6 3/4) 40/14, (8 1/4) 20/10	As applicable to standard NMDC	150	20	40	80	150		75-1000
<b>Weatherford Doug McGregor - 16210 West Hardy Rd., Houston, TX 77060, Douglas.McGregor@weatherford.com</b>											
Revolution Rotary Steerable	4 3/4, 6 3/4, 8 1/4	(4-3/4") 12", (6-3/4") 14", (8 1/4") 17"	(4 3/4) 10, (6 3/4), 10, (8 1/4) 7.5		150	20 std. 25 opt.	20	35	55	N/A	(4 3/4) 350; (6 3/4) 750; (8 1/4) 1,500
High Temperature Rotary Steerable (Revolution HT)	4 3/4, 6 3/4, 8 1/4	(4-3/4") 12", (6-3/4") 14", (8 1/4") 17"	(4 3/4) 10, (6 3/4), 10, (8 1/4) 7.5		165 std. 180 opt.	25	20	35	55	N/A	(4 3/4) 350; (6 3/4) 750; (8 1/4) 1,500
EMpulse (Electromagnetic)	All sizes	(3 1/16) 28.4, (4 3/4) 33.1, (6 3/4) 34.8, (8) 35.4, (9 1/2) 36.4	(3 1/16) 116/38, (4 3/4) 25/16, (6 1/4) 20/14, (6 3/4) 18/13, (8) 15/10, (9 1/2) 14/7.5	(3 1/16) 3.06x2.16, (3 3/8) 3.38x2.16, (4 3/4) 4.53x2.25, (6 3/4) 6.59x2.81, (8) 7.78x2.81, (9 1/2) 9.69x3	150	15	(3 1/16, 3 3/8, 3 1/2) 100; (4 3/4) 8; (6 1/4) 9	(4 3/4) 20; (6 1/4) 25, (6 3/4, 8) 7; (9.5) 4	(6 3/4, 8) 20; (9.5) 13	(3 1/16, 3 3/8, 3 1/2) 160; (4 3/4, 6 1/4) 350; (6 3/4) 800	
Hostile Environment Logging	4 3/4, 6 3/4, 8, 8 1/4, 9 1/2	(All sizes) 22	(4 3/4) 30/15, (6 3/4), 19/10, (8, 8 1/4) 14/8, (9 1/2) 14/8	(4 3/4) 4.75x3.22, (6 3/4) 6.75x4.24, (8, 8 1/4) 8x4.28	150 std. 180 opt.	(4.75, 6.75, 8) 20 std., 30 opt., (8.25, 9.5) 20 std., 25 opt.	(4 3/4) 12, (6 3/4) 2, (8, 8 1/4) 2	(4 3/4) 64, (6 3/4) 9, (8, 8 1/4) 9	(4 3/4) 193, (6 3/4) 26, (8, 8 1/4) 26	(6 3/4, 8, 8 1/4) 170	(4 3/4) 80-350; (6 3/4, 8) 80-800; (8 1/4, 9 1/2) 80-1,800
HyperPulse	All sizes	31	(3 1/16) 116/38, (4 3/4) 37/25, (6 1/4, 6 3/4) 27/15	(4 3/4) 4.75x2.69, (6 1/4) 6.25x3.25, (6 3/4) 6.75x3.25	150	15	100	116	200		70-1,000
<b>Drilling Mechanics</b>											
<b>APS Technology (Rental Division)</b>											
APS Push-the-Bit Rotary Steerable Motor (RSM)	6 3/4 (bitbars and stabilizers for 8 1/2 and 8 3/4 holes)	17	Programmable build rates of 0.5 to 5.2. Also, vertical mode.		150	20	250 psi @ 600 gal/min				300 - 600 gal/min
<b>Baker Hughes</b>											
Acoustic Caliper	4 3/4, 6 3/4, 8 1/4	Part of LithoTrak service			150	std 20 (4 3/4) opt 25 (6 3/4 & 8 1/4) opt. 30					
AutoTrak G3 (Rotary Steerable System, including OnTrak or AziTrak Integrated MWD/LWD)	4 3/4, 6 3/4, 8 1/4, 9 1/2	(4 3/4) 50.8, (6 3/4) 49.9, (8 1/4) 56.9, (9 1/2) 58.1 (zzz)	(4 3/4) 30/10, (6 3/4) 20/13, (8 1/4) 9/6.5, (9 1/2) 13/6.5 (z)	BHA-dependent	(All Sizes) 150 (6 3/4", 8 1/4", 9 1/2") opt. 175	std. 20 (4 3/4, 6 3/4, 8 1/4) opt. 30 (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1250, (9 1/2) 300-1,600
AutoTrak Generation 3.0 (includes OnTrak or AziTrak MWD), can also be run in combination with Modular X-treme motor.	4 3/4, 6 3/4, 8 1/4, 9 1/2	(4 3/4) 50.8, (6 3/4) 49.9, (8 1/4) 56.9, (9 1/2) 58.1	(4 3/4) 30/10, (6 3/4) 20/13, (8 1/4) 9/6.5, (9 1/2) 13/6.5	N/A	std. 150 (6 3/4", 8 1/4" & 9 1/2") opt. 175	std 20 (4 3/4) opt. 25, (6 3/4 & 8 1/4) opt. 30, (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1250, (9 1/2) 300-1,600
AutoTrak eXpress	4 3/4, 6 3/4, 9 1/2	(4 3/4) 56.9, (6 3/4) 57.4, (9 1/2) 64.6	(4 3/4) 30/10, (6 3/4) 23/8, (9 1/2) 13/6.5	As applicable to standard NMDC	150	20	(i)	(i)	(i)	(i)	4 3/4) 125-350, (6 3/4) 200-900, (9 1/2) 300-1,600
AutoTrak V	4 3/4, 6 3/4, 9 1/2	(4 3/4) 23.1, (6 3/4) 19.7, (9 1/2) 22.3	(4 3/4) 30/10, (6 3/4) 23/8, (9 1/2) 13/6.5	N/A	std. 150 (6 3/4" & 9 1/2") opt. 175	std 20 (4 3/4) opt. 25, (6 3/4) opt. 30, (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (9 1/2) 300-1,600
CoilTrak	2 3/8 and 3" Coil	(2 3/8) 49.5, (3) 37.6 typical BHA including motor	(2 3/8) 50, (3) 45 - sliding only	As applicable to standard Coil	150	14.5	(i)	(i)	(i)	(i)	(2 3/8) max 80, (3) max 211
CoPilot	4 3/4, 6 3/4, 8 1/4, 9 1/2	(4 3/4) 8.9, (6 3/4) 7, (8 1/4) 8.1, (9 1/2) 7.5	(z)	N/A	150	std 20, opt 25	(i)	(i)	(i)	(i)	(4 3/4) 100-350, (6 3/4) 200-800, (8 1/4) 300-1,600

Transmission rigging	Telemetry type	Wireline retrievable	Downlink kind	Downlink cable	Downlink & mag	MTF/GTF switch	Realtime update period, sec	Survey time period, sec	Survey / Logging (pushing)	Measure points from tool bottom ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery
Stop pumps, stop rotary, start pumps	Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	30-98	Y/Y	3.4	TF: 3, Azi: 1 at 1 sigma, Incl.: 0.1 at 1 sigma	North referencing rate gyro	Azimuth, inclination, tool face	Lithium battery and Turbine	Y	Y
Flow	Positive mud pulse	Y	Y	N	N	3*auto.	Op. Sel.	60	Y	2	TF: 1, Azi: 0.5, Incl.: 0.05	Flux gate magnetometer. Qz hinge accelerometer	Azi, Incl., TF, Temp, Local field	Battery, 240-1,500 depending on operations	Y	Y
Flow	Negative mud pulse	N	Y	N	N	3*auto.	Op. Sel.	60	Y	2	TF: 1, Azi: 0.5, Incl.: 0.05	Flux gate magnetometer. Qz hinge accelerometer	Azi, Incl., TF, Temp, Local field	Battery, 240-1,500 depending on operations	Y	Y
Flow	Electromagnetic	N	Y	N	N	3*auto.	Op. Sel.	60	Y	2	TF: 1, Azi: 0.5, Incl.: 0.05	Flux gate magnetometer. Qz hinge accelerometer	Azi, Incl., TF, Temp, Local field	Battery, 240-1,500 depending on operations	Y	Y
Flow	Positive mud pulse	N	Y	N	N	3*auto.	Op. Sel.	60	Y	2	TF: 1, Azi: 0.5, Incl.: 0.05	Flux gate magnetometer. Qz hinge accelerometer	Azi, Incl., TF, Temp, Local field	Battery, 240-1,500 depending on operations	Y	Y
Flow	Positive mud pulse	N	Y	N	N	3*auto.	Op. Sel.	60	Y	2	TF: 1, Azi: 0.5, Incl.: 0.05	Flux gate magnetometer. Qz hinge accelerometer	Azi, Incl., TF, Temp, Local field	Battery, 240-1,500 depending on operations	Y	Y
Flow	Positive and negative mud pulse	N	Y	N	N	3*auto.	Op. Sel.	60	Y	2	TF: 1, Azi: 0.5, Incl.: 0.05	Flux gate magnetometer. Qz hinge accelerometer	Azi, Incl., TF, Temp, Local field	Battery, 240-1,500 depending on operations	Y	Y
Flow	Positive mud pulse	Y	Y	N	N	Op. Sel 3 - 10 deg	Op. Sel.	60	Y	Op. Sel. 16 or 21	TF: 1, Azi: 1.0, Incl.: 0.2	MEMS/MRS	Azi, Incl., TF, Temp, Local field	Battery, 500-1000 depending on operations	Y	Y
Flow	Positive mud pulse	Y	Y	N	N	Op. Sel 3 - 10 deg	Op. Sel.	60	Y	Op. Sel. 10 - 25	TF: 1, Azi: 1.0, Incl.: 0.1	Flux gate magnetometer. Qz hinge accelerometer	Azi, Incl., TF, Temp, Local field	Battery, 500-1000 depending on operations	Y	Y
Stop pumps, stop rotary, start pumps	Positive pulse	Y	Y	N	N	Y	14-26, resolution dependant	97-261, data dependant	Y/Y	15.3, 21.7 opt.	Azi: +/- 0.25, Incl.: +/- 0.1	Tri-axial accelerometer and tri-axial magnetometer	Incl., Azi., mTFA, gTFA, temp, battery voltage, DipA, Grav, MagF	Lithium battery, 150 single, 300 dual battery	N	N
Stop and start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	Op. Sel.	Y	45	N/Y	(4 3/4) 11 (6 3/4) 14 (8 1/4) 16	TF: +/- 1.5, Azi: +/- 0.5, Incl.: +/- 0.1	Tri-axial Accelerometer and Magnetometer	RPM, TF, Deflection, Stick-Slip	Lithium battery, up to 1400 hrs.	Y	Y
Stop and start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	Op. Sel.	Y	45	N/Y	(4 3/4) 11 (6 3/4) 14 (8 1/4) 16	TF: +/- 1.5, Azi: +/- 0.5, Incl.: +/- 0.1	Tri-axial Accelerometer and Magnetometer	RPM, TF, Deflection, Stick-Slip	Lithium battery, up to 1400 hrs.	Y	Y
Two Way EM Comm.	Electromagnetic	Y	N	N/A	Y	Op. Sel.	96	45	Y/N	18	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.1	Tri-axial Accelerometer and Magnetometer	Azi, Incl., TF, GR	Lithium battery	Y	Y
Stop and start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	N	Op. Sel.	TF - 3	30	Y/Y	(4 3/4, 6 3/4, 8) 5.7	TF: +/- 1.5, Azi: +/- 0.5, Incl.: +/- 0.1	Tri-axial Accelerometer and Magnetometer	Azi, Incl., TF, GR	Lithium battery, up to 1400 hrs.	Y	Y
Stop pumps, stop rotary, start pumps	Positive Pulse, downhole recording	Y	N	N/A	N	Op. Sel.	12	180	Y/N	27	TF: +/- 2, Azi: +/- 1, Incl.: +/- 0.2	Tri-axial Accelerometer and Magnetometer	Azi, Incl., TF, GR	Lithium battery	Y	Y
Flow-on + rotation	EM short-hop to MWD	N	Y	N	N	Y	Config. dependant	Config dependant	Y/Y	Dir: 3.5	Incl: +/-0.1° Azi: +/-1.0° (Incl. >10°; Dip <70°) GTF: +/-1.0° (Incl. >10°) MTF: +/-2.25° (Dip <70°)	Tri-axial fluxgate magnetometer with USGS-NIST-traceable calibration; tri-axial quartz accelerometer	Azi, Incl., MTF, GTF; temp, lime, steering mode, blade activity; Integrated memory.	Mud-motor driving alternator + hydraulic pump	Y	Y
	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)						Op. Sel.	Continuous		Referenced to density measurement	Range 0 - 2, 10%	Acoustic transducer	Hole diameter	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	Y (zz)	N	Op. Sel.	Op. Sel.	55	Y/Y	Pressure: (4 3/4) 18.4, (6 3/4) 16.7, (8 1/4) 21, (9 1/2) 23.6, others referenced to bit depth	1%, 0-82 Hz - vibration, 0 - +/- 1,000 rpm - stick-slip, 0.25% full-scale (0-25k) - pressure	Tri-axial accelerometer (vibration) and two-axis magnetometer (stick-slip), strain gauge (pressure)	Lateral and axial vibration (grms) stick-slip severity level, flow-on and flow-off annular and bore pressure.	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	Pressure: (4 3/4) 18.4, (6 3/4) 16.7, (8 1/4) 21, (9 1/2) 23.6, others referenced to bit depth	1%, 0-82 Hz - vibration, 0 - +/- 1,000 rpm - stick-slip, 0.25% full-scale (0-25k) - pressure	Tri-axial accelerometer (vibration) and two-axis magnetometer (stick-slip), strain gauge (pressure)	Lateral and axial vibration (grms) stick-slip severity level, flow-on and flow-off annular and bore pressure.	Turbine generator, no limit	Y	Y
Stop and start pumps, or stop rotary	Positive mud pulse	N	Y	N	N	N/A	Op. Sel.	Continuous	N/A	referenced to bit depth	1%, 1-100 Hz 1%	Tri-axial accelerometer and magnetometer	Lateral and axial vibration (grms) stick-slip severity level	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	N/N	referenced to bit depth	1%, 0-82 Hz - vibration, 0 - +/- 1,000 rpm - stick-slip	4 3/4 Tri-axial accelerometer and magnetometer	4 3/4 Lateral and axial vibration (grms) stick-slip severity level	Turbine generator, no limit	Y (4 3/4), N (6 3/4 & 9 1/2)	Y (4 3/4), N (6 3/4 & 9 1/2)
Power On	Wire / positive mud pulse	N	N	Y	N	Op. Sel.	Op. Sel.	Continuous	N/A	(2 3/8 and 3) Pressure - 1.2, others referenced to bit depth	WOB: 2%, +/- 11 kib Pressure: 0.25% 0-14.5 kpsi Vibration: 1%, +/- 15g Stick-Slip: 0.1%, -200-1,000 rpm	Tri-axial accelerometer (vibration) and two-axis magnetometer (stick-slip), strain gauges (pressure and weight)	Weight on bit, Lateral and axial vibration (grms) stick-slip severity level, annular and bore pressure	Surface Power	Y	N
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave, Wired Pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	Pressure: (4 3/4) 3.1, (6 3/4) 1.9, (8 1/4) 2.2, (9 1/2) 1.9; others referenced to bit depth	WOB: 1%, +/- 85 kib Torque: 1% +/- 28 kib Bending: 0.4% +/- 85 kib Pressure: 0.25% 0-25 kpsi Vibration: 1%, +/- 50g Stick-Slip: 0.1%, -500-1,000 rpm	Tri-axial accelerometer and flux gate magnetometer, strain gauges	see footnote (p), 14 channels sampled at either 40, 100, 200, or 1,000 Hz.	Turbine generator, no limit	Y	Y

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Service line (s)	Tool OD, in.	Length, ft	Max. D.J.S. - 100 ft (collaring, rebar)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. press, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gpm/min
Drill Collar Pressure	6 3/4, 8 1/4, 9 1/2	(6 3/4, 8 1/4) 5.6, (9 1/2) 8.8	(z)	(6 3/4) 6.5x2.81, (8 1/4) 8x2.81	150	20	(j)				(6 3/4) 200-800, (8 1/4, 9 1/2) 300-1,600
EMTrak	4 3/4, 6 1/2	(4 3/4, 6 1/2) 39.6	Slick collar: (4 3/4) 21/7, (6 1/2) 12.5/6.5 Flexible collar 4 3/4) 58.0/32, (6 1/2) 48/25	As applicable to standard NMDC	150	20	(j)				(4 3/4) max 350, (6 1/2) max 600
NaviTrak II Advanced Pressure	3 1/8, 4 3/4	3.7	(z)	(3 1/8) TBD, (4 3/4) 4.587x2.25	150	20	(j)				(3 1/8) TBD, (4 3/4) 160-320
TeleTrak	6 1/2, 6 3/4	(6 1/2, 6 3/4) 39.83	Probe limits: (1 3/4) 115/51	As applicable to standard NMDC	150	std 20, opt 25	(j)				(6 1/2, 6 3/4) 240-700
OnTrak MWD	4 3/4, 6 3/4, 8 1/4, 9 1/2	(4 3/4) 20.2, (6 3/4) 17.0, (8 1/4) 19.0, (9 1/2) 18.1	(4 3/4) 33/12, (6 3/4) 25/15, (8 1/4) TBD, (9 1/2) 10/7	NA	std. 150, opt. 175	std 20 (4-3/4, 6-3/4 & 8-1/4, 9-1/2) opt. 25, (4-3/4, 6-3/4 & 8-1/4) opt. 30	(j)				4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1295, (9 1/2) 300-1,600
AziTrak MWD	4 3/4, 6 3/4	(4 3/4) 40.4, (6 3/4) 35.3	(z)	TBD	150	std 20 (4 3/4) opt. 25, (6 3/4) opt. 30	(j)				4 3/4) 125-350, (6 3/4) 265-900
Vibration Stick-Slip	3 1/8 - 9 1/2	In basic directional OnTrak & NaviTrak tools	N/A	N/A	N/A	N/A	N/A				N/A
3 1/8" Advanced Slim MWD System + Drilling Performance Sub	3 1/8"	7.7	50, 12	N/A	150	20	(j)				79 - 180
<b>GE Energy Oilfield Technology</b>											
Sentinel, Shock and Vibration	3-1/2 - 9 1/2	Part of E-Link & Geolink MWD	As per Geolink MWD	As per Geolink MWD	150	20	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD
Guardian, Pressure During Drilling	4 3/4 - 9 1/2	Additional 4 ft sub to Geolink or E-Link MWD	As per Geolink MWD	As per Geolink MWD	150	20	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD
<b>Halliburton/Sperry Drilling</b>											
AcoustiCaliper	6 3/4, 8	(6 3/4) 6, (8) 7.7	(6 3/4) 21/10, (8) 14/8	(6 3/4) 6.45x2.81, (8) 7.81x2.81	150	18		(6 3/4) 3, (8) 4	(6 3/4) 10, (8) 12	(6 3/4) 57, (8) 73	
Drillstring Dynamics	4 3/4, 6 3/4, 8, 9 1/2	Part of some dual gamma ray tools, see below			150						
Pressure While Drilling	4 3/4, 6 3/4, 8, 9 1/2	(4 3/4) 10.8, (6 3/4, 8) 4.51, (9 1/2) 4.45	(4 3/4) 30/14, (6 3/4) 21/10, (8, 9 1/2) 14/8	(4 3/4) 4.66x2.25, (6 3/4) 6.54x2.81, (8) 7.76x2.81, (9 1/2) 9.35x3	175	18 - 25		(4 3/4) 70, (6 3/4, 8) 2, (9 1/2) 1	(4 3/4) 190, (6 3/4, 8) 7, (9 1/2) 2	(6 3/4, 8) 42, (9 1/2) 14	
Vibration Severity	4 3/4, 6 3/4, 8, 9 1/2	Part of pressure-while-drilling tool (see above) as well as some other tools			175						
Annular Mud Temperature	8	25.3 (part of EWR-M5 tool)	14/8	7.65 x 2.81	150	25	N/A	5	13	75	
<b>PathFinder</b>											
Drilling Formation Tester	6.75	37	16/7	6.37x2.81	150	20	N/A	N/A	70	N/A	275-750
Dynamic Pressure Module	4 3/4, 6 3/4, 8, 9 1/2	4.7	(4 3/4) 30/16.6, (6 3/4) 17.5/9, (8) 19/11, (9 1/2) 13/7	(4 3/4) 4.5x2.25, (6 3/4) 6.44x2.81, (8) 7.18x2.81, (9 1/2) 8.82x2.81	150	20	(4 3/4) 22 at 150 gal/min	(4 3/4) 58, (6 3/4) 26, (8, 9 1/2) N/A at 400	(4 3/4) N/A (6 3/4) 49, (8) 39, (9 1/2) 39 at 750	(4 3/4) N/A (6 3/4) 65, (8) 52, (9 1/2) 52 at 1000	(4 3/4) 125-375, (6 3/4) 250-750, (8) 400-1,500, (9 1/2) 500-1,500
Survivor Dynamic Pressure Module	4 3/4, 6 3/4	8.5	(4 3/4) 30/17, (6 3/4) 18/9	(4 3/4) 4.5x2.25, (6 3/4) 6.44x2.81	175	25	(4 3/4) 22 at 150 gal/min	(4 3/4) 58, (6 3/4) 26	(4 3/4) N/A (6 3/4) 49,	N/A	(4 3/4) 125-375, (6 3/4) 250-750
Payzone Inclination Gamma	4 3/4, 6 3/4	7.13 upper, 2.7 lower	(4 3/4) 31/17, (6 3/4) 17/9	(4 3/4) 4.66x2.25, (6 3/4) 6.57x2.81	150	20	N/A	(4 3/4) 70, (6 3/4) 20	(4 3/4) N/A, (6 3/4) 35	N/A	(4 3/4) 125-375, (6 3/4) 250-750
2D Rotary Steering Tool	8 1/2, 12 1/4	18.5, 21.5	(8 1/2) 20/7, (12 1/4) 13/4	(8 1/2) 6.75x5, (12 1/4) 8.75x6	150	20		50	75	100	150
PathMaker Rotary Steerable	4 3/4, 6 3/4, 8, 9 1/2	21, 20, 20, 20	Capability (*100 ft) : (4 3/4) 10+, (6 3/4) 8, (8) 6, (9 1/2) 6 Pass Through (*100 ft) : (4 3/4) 15/10, (6 3/4) 15/10, (8) 12/8, (9 1/2) 10/6	N/A	(4 3/4) 175, (6 3/4) 175, (8) 18, (9 1/2) 150	(4 3/4) 25, (6 3/4) 22, (8) 18, (9 1/2) 15	N/A	N/A	N/A	N/A	(4 3/4) 150-350, (6 3/4) 250-750, (8) 250-1250, (9 1/2) 250-1250
<b>Schlumberger</b>											
ImPulse *Downhole shocks *Downhole flow/washout *APWD (with VisionPWD sub)	4.75	32	30/15	4.75x2.25x38.5	150 std., 175 opt.	20 std., 25 opt.	20	125 (varies with Modulator gap)	N/A	N/A	130-400
ShortPulse *Downhole shocks *Downhole flow/washout *APWD (with VisionPWD sub)	4.75	27.3	30/15	4.75x2.25x34.8 -OR- 4.59x2.25x30.3	150 std., 175 opt.	20	20	125 (varies with Modulator gap)	N/A	N/A	130-400

Transmission trigger	Telemetry type	Wireline retrievable	Downlink kind	Downlink scheme	Downlink e-mag	MTR/OTF switch	Regulation update period, sec	Survey time period, sec	Survey / Logging mode(s)	Measure points / from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recover
Stop pumps, start pumps, or stop rotary	Positive mud pulse	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/N	(6 3/4, 8 1/4) 3.7, (9 1/2) 11	(6 3/4) 0.25% full-scale (0-20k) with 25k psi option	Strain gauge	Flow-on and flow-off annular and bore pressure	Turbine generator, no limit, lithium battery (flow-off), 172 hr	Y	Y
Stop pumps	Electromagnetic	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/N	(4 3/4, 6 3/4) Pressure - 0.6, others referenced to bit depth	1%, 0-120 Hz for vibration, -200 - 1,000 rpm for stick-slip, 0.25% full-scale (0-20k) for pressure	Tri-axial accelerometer (vibration) and two-axis magnetometer (stick-slip), strain gauge (pressure)	Lateral and axial vibration (grms) stick-slip severity level, flow-on and flow-off annular and bore pressure.	Lithium Battery, 150+ hours depending on transmission rate	Y	Y
Stop pumps, start pumps	Positive mud pulse, Wired Pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/N	(4 3/4) 2.3	0.25% full-scale (0-20k) with 25k psi option	Strain gauge	Flow-on and flow-off annular and bore	Turbine generator, no limit, lithium battery	Y	Y
Stop pumps, start pumps, or stop rotary	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	62	YY	(1 3/4 probe) 16	TF: +/- 1.5, Azi: +/- 1, Incl: +/- 0.2(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl, TF reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous		Pressure: (4 3/4) 5.1, (6 3/4) 1.3, (8 1/4) 2.1, (9 1/2) 3.6 Vibration: (4 3/4) 15.7, (6 3/4) 11.0, (8 1/4) 13.5, (9 1/2) 13.0	1%, 0-82 Hz - vibration, 0 - +/- 1,000 rpm - stick-slip, 0.25% full-scale (0-25k) - pressure	Tri-axial accelerometer (vibration) and two-axis magnetometer (stick-slip), strain gauge (pressure)	Lateral and axial vibration (grms) stick-slip severity level, flow-on and flow-off annular and bore pressure.	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	64	YY	Pressure: (4 3/4) 8.7, (6 3/4) 9.7, others referenced to bit depth	1%, 0-82 Hz - vibration, 0 - +/- 1,000 rpm - stick-slip, 0.25% full-scale (0-25k) - pressure	Tri-axial accelerometer (vibration) and two-axis magnetometer (stick-slip), strain gauge (pressure)	Lateral and axial vibration (grms) stick-slip severity level, flow-on and flow-off annular pressure.	Turbine generator, no limit	Y	Y
N/A	See OnTrak or Navitrac Telemetry	N/A	N/A	N/A	N/A	N/A	Op. Sel.	Continuous	N/A	referenced to bit depth	1%, 1 - 100 Hz 1%	Tri-axial accelerometer and magnetometer	Lateral and axial vibration (grms) stick-slip severity level	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.		YY		WOB & Torque: +/- 2%, Pressure: +/- 0.25% 0-20 kpsi, Vibration: +/- 1%, Stick-Slip: 1%, -500-1,000 rpm	Tri-axial accelerometer and magnetometer (stick-slip), strain gauge (pressure, WOB, Torque)	Lateral and axial vibration (grms) stick-slip severity level; Flow-on & flow-off pressure bore and annular, WOB, Torque	Turbine generator, no limit	Y	Y
Flow	Negative mud pulse and E-mag	Y	Y	N	N	N/A	Op. Sel.	N/A	N/A	2	+/- 5%	X-Z Solid State Accelerometers	Axial and Lateral drill string shock	Battery - Up to 1,200 hrs	Y	Y
Flow	Negative mud pulse and E-mag	N	Y	N	N	N/A	Op. Sel.	N/A	N/A	2	+/- 0.25% Range	Piezo-resistive pressure sensor	Drill pipe and annulus pressure	Battery - Up to 1,200 hrs	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			(6 3/4) 1.2, (8) 2.5	0.1 in.	Piezoelectric	Hole diameter and ellipticity	Battery/500 hr	Y	Y
Continuous or above a programmable threshold	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			(4 3/4) 17.8, (6 3/4) 1.8 or 2.7, (8) 2.8 or 1.8, (9 1/2) 3.2 or 1.9	Average: 0.2 g, peak: 1 g	Tri-axial accelerometers	Three axes of acceleration	Negative pulse: battery, positive pulse: generator and/or battery	Y	Y
Continuous or above a programmable threshold	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			(4 3/4) 5.5 or 5.2, (6 3/4, 8) 1.1 or 3.4	12 psi	Quartz gauges	Annular and internal pressures	Negative pulse: battery, Positive pulse: generator	Y	Y
Continuous or above a programmable threshold	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			(4 3/4) 5.5 or 5.2, (6 3/4, 8) 1.1 or 3.4, (9 1/2) 1 or 3 1/2	0.2 g	Single-axis accelerometer	Lateral acceleration	Negative pulse: battery, positive pulse: generator and/or battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			15	+/- 1.5 C	Two terminal IC transducer	Annular Mud Temperature	Negative pulse: battery, positive pulse: generator and/or battery	Y	Y
Stop pumps, start pumps	Positive pulse	N	Y	N	N	N/A	8	N/A	N/A	11.3	+/-0.02% of full scale and 0.01% of reading	Quartz gauge	Formation pressure, annular pressure	Lithium battery 400 hr	Y	Y
Stop pumps, start pumps	Positive pulse	N	Y	N	N	N/A	5	N/A	N/A	3.5	+/-0.15% of full scale	Piezoelectric	Annular and drillpipe pressures, Delta P, temperature	Lithium battery 1600 hr	Y	Y
Stop pumps, start pumps	Positive pulse	N	Y	N	N	N/A	2	N/A	N/A	3.3	+/-0.02% of full scale and 0.01% of reading	Quartz gauge	Annular and drillpipe pressures, Delta P, annular and drillpipe temperatures	Lithium battery 800 hr	Y	Y
Stop pumps, start pumps	Positive pulse (EM sub to sub)	N	Y	N	N	N/A	8	N/A	Y	(4 3/4) Gamma 0.9, Incl. 1.8, (6 3/4) Gamma 1.6, Incl. 2.6	Incl. +/- 0.25	Tri-axial accelerometer and scintillator	AAP GR, Incl., RPM,	Lithium battery (4 3/4) 200, (6 3/4) 400	Y	N
Stop pumps, start pumps	Positive pulse	N	Y	N	N	N/A	Every flow cycle	180	Y	(8 1/2) 3.12, (12 1/4) 4.25	Dia. = +/- 1/16-in.	Linear potentiometer	Stabilizer gauge diameter	Lithium battery, 400 hr	Y	Y
Stop pumps, start pumps	Positive Uplink Rotary Downlink	N	N	N	N	GTF	Op. Sel.	Op. Sel.	Y	(9 1/2) Caliper: 4.0, Inc: 6.0, Gamma:15.4 (8) Caliper: 4.0, Inc:5.0 Gamma: 15.4 (6 3/4) Caliper: 3.3, Inc: 6.5, Gamma: 13.8 (4 3/4) Caliper: 2.3, Inc: 7.9, Gamma: 12.2	+/- 0.01", +/-0.1	Linear potentiometer, Tri-axial accelerometers	Caliper, RPM, Stick-slip, Inc, Lateral, Axial and Torsional Vibration	Lithium battery, 200-350 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive Continuous wave and downhole recording	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 70bps effective)	30-108	YY	Various	Various	Various	*Shocks *Downhole flow/washout *Stick Slip *Collar RPM *Tool temperature *Continuous D&I *APWD	Turbine	Y	Y
Stop pumps, stop rotary, start pumps	Positive Continuous wave and downhole recording	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 70bps effective)	30-108	YY	Various	Various	Various	*Shocks *Downhole flow/washout *Stick Slip *Collar RPM *Tool temperature *Continuous D&I *APWD	Turbine	Y	Y

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Service Line (s)	Tool OD, in.	Length, ft	Max. DLS, * 100 ft (collars, rotation)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. pressure, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gal/min
PowerPulse *APWD *3 axis Vibrations (MVC) *Downhole WOB *Downhole TORQ *Downhole flow/washout	6 3/4, 8 1/4, 9, 9 1/2	24.7	(6 3/4) 16/8 (8 1/4) 12/7 (9, 9 1/2) 10/6	(6 3/4) 6.75x2.81x31.5 (8 1/4) 8x2.81x26.2 (9 1/4) 9.25x3x28 (9 1/2) 9.5x3.5x26.2	150 std., 175 opt.	25	N/A	(6 3/4) 56 (8 1/4) 32 (varies with modulator gap)	(6 3/4) 151 (8 1/4, 9 1/2) 84 (varies with modulator gap)	(8 1/4, 9 1/2) 595 (varies with modulator gap)	(6 3/4) 250-800 (8 1/4) 300-1,200 (8 1/4) opt. 800-1,400 (9 1/2) 400-1,200 (9 1/2) opt. 400-1,600
TeleScope *APWD *3 axis vibrations (MVC) *Downhole WOB *Downhole TORQ *Downhole flow/washout	6 3/4, 8 1/4, 9, 9 1/2	24.7	(6 3/4) 16/8 (8 1/4) 12/7 (9, 9 1/2) 10/6	(6 3/4) 6.75x2.81x31.5 (8 1/4) 8x2.81x26.2 (9 1/4) 9.25x3x28 (9 1/2) 9.5x3.5x26.2	150 std., 175 opt.	20 std., 30 opt.	N/A	(6 3/4) 56 (8 1/4) 32 (varies with modulator gap)	(6 3/4) 151 (8 1/4, 9 1/2) 84 (varies with modulator gap)	(8 1/4, 9 1/2) 595 (varies with modulator gap)	(6 3/4) 250-800 (8 1/4) 300-1,200 (8 1/4) opt. 800-1,400 (9 1/2) 400-1,200 (9 1/2) opt. 400-1,600
SlimPulse *Shocks *Stick Slip	1 3/4 tool OD 3 1/8 to 9 1/2 collars	Collar based probe normally 30	(4 3/4 and smaller) 145/40 (6 3/4) 28/10 (8 1/4) 20/8 (9 1/2) 19/7	(4 3/4) 4.75x2.81x33 (6 3/4) 6.75x2.81x32	150 std., 175 opt.	20 std., 22 opt.	(4 3/4) 68, (6 3/4) 16	(6 3/4) 100, (8 3/4) 18	(6 3/4) 324, (8 3/4, 9 3/4) 58	(8 3/4, 9 3/4) 411	Multiple configurations: 35-1200
E-Pulse *Shocks *Stick Slip *APWD	4 3/4, 6 1/2	(4 3/4) 58.6, (6 1/2) 60.8	(4 3/4) 30/15, (6 1/2) 15/8	(4 3/4) 4.75x2.25x75.5, (6 1/2) 6.5x2.81x76.9	125	12	(4 3/4) 15, (6 3/4) 5	(4 3/4) 91, (6 3/4) 31	(6 3/4) 98	N/A	(4 3/4) 0-400 (6 3/4) 0-600
E-Pulse XR *Shocks *Stick Slip	4 3/4, 6 1/2	45	(4 3/4) 30/15, (6 1/2) 15/8	(4 3/4) 4.75x2.25x75.5, (6 1/2) 6.5x2.81x76.9	125	12	(4 3/4) 5, (6 3/4) 2	(4 3/4) 25, (6 3/4) 10	(6 3/4) 34	N/A	(4 3/4) 0-400 (6 3/4) 0-600
EcoScope *APWD *Multi-axis shock & vibration *Ultrasonic caliper	6 3/4 with 7 7/8, 8 3/8, or 9 3/8 Stabilizer Options	25.2	16", 8"	6.5x2.81x24.5	150 std., 175 opt.	20	2	10	32	N/A	250-800
proVISION (Magnetic Resonance while Drilling) *3 axis motion detection *Shocks *Stick Slip *Downhole flow/washout	6 3/4 with Slick, 8 1/4, or 9 3/8 Stabilizer Options	37.3	16", 8"	6.5x2.81x36.5	150	18	4	25	81	N/A	300-800
<b>Sondex Drilling (Rentals Division)</b>											
Sentinel, Shock and Vibration	2 7/8 - 9 1/2	As directional	As applicable to standard NMDC	As Directional Tool	150	20	As Directional Tool				(4 3/4) 480, (6 3/4) 800, (8, 9 1/2) 1,100
Guardian, Pressure During Drilling	4-3/4 - 9 1/2	Additional 4 ft sub	As applicable to standard NMDC	As Directional Tool	150	20	As Directional Tool				(4 3/4) 480, (6 3/4) 800, (8, 9 1/2) 1,100
<b>Weatherford</b>											
BAP (Borehole/Annular Pressure)	4 3/4, 6 3/4, 8, 8 1/4, 9 1/2	10.8	(4 3/4) 30/15, (6 3/4), 19/10, (8, 8 1/4) 14/8, (9 1/2) 14/8	(4 3/4) 4.75x3.22, (6 3/4) 6.75x4.24, (8, 8 1/4) 8x4.28	150 std., 180 opt.	(4.75, 6.75, 8") 20 std., 30 opt. (8.25, 9.5) 20 std., 25 opt.	(4 3/4) 12, (6 3/4) 2, (8, 8 1/4) 2	(4 3/4) 64, (6 3/4) 9, (8, 8 1/4) 9	(4 3/4) 193, (6 3/4) 26, (8, 8 1/4) 26	(6 3/4, 8, 8 1/4) 170	(4 3/4) 80-350; (6 3/4, 8) 80-800; (8 1/4, 9 1/2) 80-1,800
TVM (True Vibration Monitor)	4 3/4, 6 3/4, 8, 8 1/4, 9 1/2	No additional Length	(4 3/4) 30/15, (6 3/4), 19/10, (8, 8 1/4) 14/8, (9 1/2) 14/8	(4 3/4) 4.75x3.22, (6 3/4) 6.75x4.24, (8, 8 1/4) 8x4.28	150 std., 180 opt.	(4.75, 6.75, 8") 20 std., 30 opt. (8.25, 9.5) 20 std., 25 opt.	(4 3/4) 12, (6 3/4) 2, (8, 8 1/4) 2	(4 3/4) 64, (6 3/4) 9, (8, 8 1/4) 9	(4 3/4) 193, (6 3/4) 26, (8, 8 1/4) 26	(6 3/4, 8, 8 1/4) 170	(4 3/4) 80-350; (6 3/4, 8) 80-800; (8 1/4, 9 1/2) 80-1,800
ESM (Environmental Severity Measurement)	4 3/4, 6 3/4, 8, 8 1/4, 9 1/2	No additional Length	(4 3/4) 30/15, (6 3/4), 19/10, (8, 8 1/4) 14/8, (9 1/2) 14/8	(4 3/4) 4.75x3.22, (6 3/4) 6.75x4.24, (8, 8 1/4) 8x4.28	150 std., 180 opt.	(4.75, 6.75, 8") 20 std., 30 opt. (8.25, 9.5) 20 std., 25 opt.	(4 3/4) 12, (6 3/4) 2, (8, 8 1/4) 2	(4 3/4) 64, (6 3/4) 9, (8, 8 1/4) 9	(4 3/4) 193, (6 3/4) 26, (8, 8 1/4) 26	(6 3/4, 8, 8 1/4) 170	(4 3/4) 80-350; (6 3/4, 8) 80-800; (8 1/4, 9 1/2) 80-1,800
RAT (Rapid Annular Temperature)	4 3/4, 6 3/4, 8, 8 1/4, 9 1/2	No additional length	(4 3/4) 30/15, (6 3/4), 19/10, (8, 8 1/4) 14/8, (9 1/2) 14/8	(4 3/4) 4.75x3.22, (6 3/4) 6.75x4.24, (8, 8 1/4) 8x4.28	150 std., 180 opt.	(4.75, 6.75, 8") 20 std., 30 opt. (8.25, 9.5) 20 std., 25 opt.	(4 3/4) 12, (6 3/4) 2, (8, 8 1/4) 2	(4 3/4) 64, (6 3/4) 9, (8, 8 1/4) 9	(4 3/4) 193, (6 3/4) 26, (8, 8 1/4) 26	(6 3/4, 8, 8 1/4) 170	(4 3/4) 80-350; (6 3/4, 8) 80-800; (8 1/4, 9 1/2) 80-1,800
<b>Gamma Ray</b>											
<b>APS Technology (Rental Division)</b>											
APS SureShot	3 1/8, 3 1/2, 4 3/4, 6 1/4, 6 3/4, 8, 9 1/2+	25	Collar-limited	Collar-defined	150 and 175	20	(3 1/2) 27, (4 3/4 - 6 3/4) 6, (8) 3, (9 1/2) 2	(3 1/2) 150, (4 3/4 - 6 3/4) 35, (8) 20, (9 1/2) 10	(6 1/2 - 6 3/4) 114, (8) 61, (9 1/2) 32	(9 1/2) 220	(3 1/8, 3 1/2) 70 - 250 (4 3/4) 150 - 350 (6 1/4, 6 3/4) 150 - 750 (8, 300 - 1,100 (9 1/2+) 650 - 1,200

Transmission trigger	Telemetry type	Wireline retrievable	Downlink kind	Downlink scheme	MTF/GTF switch	Realtime update period, sec	Survey time period, sec	Survey / Logging mode(s)	Measure point(s) from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery	
Stop pumps, stop rotary, start pumps	Positive Continuous wave	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 120bps effective)	30-88	Y/Y	Various	Various	*3D vibrations /shocks (MVC) *Downhole WOB *Downhole TORQ *Downhole flow/washout *Annular Pressure *Stick Slip *Collar RPM *Tool Temperature *Annular Temperature *Continuous D&I *Gamma Ray *Torsional Vibration	Turbine	Y	N	
Stop pumps, stop rotary, start pumps	Positive Continuous wave / Wired drill pipe opt.	N	Y	Y	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 120bps effective)	27-80	Y/Y	Various	Various	*3 axis vibrations/shocks *Downhole WOB *Downhole TORQ *Downhole flow/washout *Annular Pressure *Stick slip *Collar RPM *Tool Temperature *Annular temperature *Continuous D&I *Gamma Ray *Torsional vibration	Turbine	Y	Y	
Stop pumps, stop rotary, hold static, start pumps	Positive Continuous wave and downhole recording	Y	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (0.5bps physical to 3bps effective)	0.5 bps 296 sec or 208 sec	Y/Y	Various	Various	*Shocks *Tool temperature *Continuous D&I *Gamma Ray	Lithium battery	Y	Y	
Continuous	E-mag and downhole recording	N	N	N	Y	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (up to 12bps)	44 sec	Y/Y	Various	Various	*Shocks *APWD *Tool temperature *Continuous D&I *Gamma Ray *StickSlip *Collar RPM	Lithium battery	Y	Y	
Continuous (sleep mode optional)	E-mag and downhole recording	Y	N	N	Y	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (up to 12bps)	44 sec	Y/Y	Various	Various	*Shocks *Tool temperature *Continuous D&I *Gamma Ray *StickSlip *Collar RPM	Lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous Wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	9	Inclination (Incl.: 0.1 at 1 sigma), GR (+/- 3%), Density (+/- 0.015 g/cc from 1.7 - 3.05 g/cc)	Accelerometer / Scintillation	Accelerometer 4 and 16 sector azimuthal density image derived density Real time and recorded images 16 sector GR image	TeleScope turbine	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	7.8	Incl.: 0.1 at 1 sigma	3 axis accelerometer	Total porosity, BVF, FFV, T1 and/or T2 modes	Turbine	Y	Y
Flow	Positive and negative mud pulse and E-mag	Y	Y	N	N	Op. Sel.	N/A	N/A	2	40 milli-g	Accelerometer	Axial and Lateral drill string shock	Battery - Up to 1,200 hrs	Y	N	
Flow	Positive and negative mud pulse and E-mag	Y	Y	N	N	Op. Sel.	N/A	N/A	2	+/- 0.25% Range	Piezo-resistive pressure sensor	Drill pipe and annulus pressure	Battery - Up to 1,200 hrs	Y	Y	
N/A	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	Op. Sel.	Variable	N/A	N/A	(4 3/4, 6 3/4, 8) 10.6	+/- 7.5 psi	Quartz gauges	Annular and drillpipe pressure, temperature	Lithium batteries, up to 1400 hrs	Y	Y
N/A	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	Op. Sel.	Variable Trigger	N/A	N/A	(4 3/4, 6 3/4, 8) 17.3	0 - 200 g's	Accelerometer.	Three axis acceleration, shock and RPM	Lithium batteries, up to 1400 hrs.	Y	Y
N/A	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	Op. Sel.	Variable	N/A	N/A	(4 3/4, 6 3/4, 8) 17.3		Accelerometer.	Lateral acceleration and shock	Lithium batteries, up to 1400 hrs.	Y	Y
N/A	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	Op. Sel.	Variable	N/A	N/A	(4 3/4, 6 3/4, 8) 10.6	+/- .5 deg C @ 20 C +/- 2 deg C @ 200 C	IC Semiconductor	Annular fluid temperature	Lithium batteries, up to 1400 hrs	Y	Y
Flow-on and timer	MPT positive pulse or EM	Y (4 3/4)	Y	N	N	Program-mable threshold	Config. dependent	Config. dependent	Y/Y	Dir: 6.4	Incl: +/-0.1° Azi: +/-1.0° (Incl. >10°; Dip <70°) GTF: +/-1.0° (Incl. >10°) MTF: +/-2.25° (Dip <70°)	Tri-axial fluxgate magnetometer with USGS-NIST-traceable calibration; tri-axial quartz accelerometer	Azi, Incl., MTF, GTF, temp. (Optional Lateral & Axial Vib.)	Lithium battery Optional turbine-alternator	Y	Y

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Service line (s)	Tool OD, in.	Length, ft	Max. D.S. - 100 ft (collaring, rotation)	Equipment bending stiffness	Max. op. temperature (°C)	Max. op. pressure, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gal/min
APS SureShot with Gamma	3 1/8, 3 1/2, 4 3/4, 6 1/4, 6 3/4, 8, 9 1/2+	29	Collar-limited	Collar-defined	150 and 175	20	(3 1/2) 29, (4 3/4 - 6 3/4) 6, (8) 3, (9 1/2) 2	(3 1/2) 165, (4 3/4 - 6 3/4) 40, (8) 20, (9 1/2) 10	(6 1/2 - 6 3/4) 114, (8) 61, (9 1/2) 32	(9 1/2) 225	(3 1/8, 3 1/2) 70 - 250 (4 3/4) 150 - 350 (6 1/4, 6 3/4) 150- 750 (8) 300 - 1,100 (9 1/2+) 650 - 1,200
<b>Baker Hughes</b>											
AutoTrak G3 (Rotary Steerable System, including OnTrak or AziTrak Integrated MWD/LWD)	4 3/4 6 3/4 8 1/4 9 1/2	(4 3/4) 50.8 (6 3/4) 49.9 (8 1/4) 58.9 (9 1/2) 58.1 (zzz)	(4 3/4) 30/10, (6 3/4) 20/13, (8 1/4) 9/6.5, (9 1/2) 13/6.5 (z)	BHA-dependent	(All sizes) 150 150 (6.3/4", 8.1/4", 9.1/2") opt. 175	std. 20 (4 3/4, 6 3/4, 8.1/4) opt. 30 (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1290, (9 1/2) 300-1,600
AutoTrak X-treme (Rotary Steerable System, including OnTrak or AziTrak Integrated MWD/LWD and hard-wired, precontoured modular X-treme mud motor)	4 3/4 6 3/4 9 1/2	(4 3/4) 68 (6 3/4) 70 (9 1/2) 82 (zzz)	(4 3/4) 30/10, (6 3/4) 20/13, (8 1/4) 9/6.5, (9 1/2) 13/6.5 (z)	BHA-dependent	(All sizes) 150 150 (6.3/4", 8.1/4", 9.1/2") opt. 175	std. 20 (4 3/4, 6 3/4, 8.1/4) opt. 30 (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1290, (9 1/2) 300-1,600
AutoTrak xPress (Rotary Steerable System including MWD, can be run with hard-wired modular X-treme motor)	4 3/4 6 3/4 9 1/2	(4 3/4) 56.9 (6 3/4) 58.2 (9 1/2) 64.6 (zzz)	(4 3/4) 30/10 (6 3/4) 23/8 (9 1/2) 13/6.5 (z)	BHA-dependent	150	20	(i)	(i)	(i)	(i)	(4 3/4) 125-350 (6 3/4) 200-900 (9 1/2) 300-1,600
CoilTrak	2 3/8 and 3" Coil	(2 3/8) 49.5, (3) 37.6 typical BHA including motor	(2 3/8) 50, (3) 45 - sliding only	As applicable to standard Coil	150	14.5	(i)				(2 3/8) max 80, (3) max 211
EMTrak	4 3/4, 6 1/2	(4 3/4, 6 1/2) 39.6	Slick collar: (4 3/4) 21/7, (6 1/2) 12.5/6.5 Flexible collar: (4 3/4) 8/32, (6 1/2) 48/25	As applicable to standard NMDC	150	20	(i)				(4 3/4) max 350, (6 1/2) max 660
Multiple Propagation Resistivity	2 3/8, 3 1/8, 4 3/4, 6 3/4, 8 1/4	(3 1/8) 17, (4 3/4 - 8 1/4) 12	(z)	(3 1/8) TBD, (4 3/4) 4.6x2.25, (6 3/4) 6.62x2.81, (8 1/4) 8.23x4	150	20	(i)				(3 1/8) 80-160, (4 3/4) 100-350, (6 3/4) 200-800, (8 1/4) 300-1,600
NavGamma	1 3/4 or 2.0D probe; (2) 3 3/4 and larger collars; (1 3/4) 3 1/8 and larger collars	(1 3/4) 4, (2) 5	Probe limits: (1 3/4) 115/51, (2) 49.5/43	NA	150	20	(i)				(1 3/4) 75-1600
TeleTrak	6 1/2, 6 3/4	(6 1/2, 6 3/4) 39.83	Probe limits: (1 3/4) 115/51	As applicable to standard NMDC	150	std. 20, opt. 25	(i)				(6 1/2, 6 3/4) 240-700
OnTrak MWD	4 3/4, 6 3/4, 8 1/4, 9 1/2	(4 3/4) 20.2, (6 3/4) 17.0, (8 1/4) 19.0, (9 1/2) 18.1	(4 3/4) 33/12, (6 3/4) 25/15, (8 1/4) TBD, (9 1/2) 10/7	NA	std. 150, opt. 175	std. 20 (4-3/4, 6-3/4 & 8-1/4, 9-1/2) opt. 25, (4-3/4, 6-3/4 & 8-1/4) opt. 30	(i)				4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1295, (9 1/2) 300-1,600
AziTrak MWD	4 3/4, 6 3/4	(4 3/4) 40.4, (6 3/4) 35.3	(z)	TBD	150	std. 20 (4 3/4) opt. 25, (6 3/4) opt. 30	(i)				4 3/4) 125-350, (6 3/4) 265-900
Near Bit Gamma	9.5	4.77	(z)	TBD	150	std. 20, opt. 25	(i)				300-1,600, function of MWD platform
TruTrak	4 3/4", 6 3/4, 8, 9 1/2	(4 3/4) 30.4, (6 3/4) 31.0, (8) 36.1, (9 1/2) 36.1 +add. MWD	(4 3/4) 5, (6 3/4) 3, (8 & 9 1/2) 2 (non-rotational system)	N/A	150	20	(i)				(4 3/4) 125-317, (6 3/4) 264-650, (8) 395-900, (9 1/2) 528-1162
3 1/8" Advanced SLIM MWD System	3 1/8"	26.4	50, 12	N/A	150	20	(i)				79 - 180
<b>DrilTech LLC</b>											
Positive Pulse MWD and API Gamma Ray Probe Based	1 7/8 tool OD, 4 3/4 - 8 collars	23-28	60/30	As applicable to standard NMDC	150 - 175	20 (137 mpa)	50 (NMDC dependent)	100 (NMDC dependent)	150 (NMDC dependent)	N/A	(3 1/4) 50-130, (4 3/4) 130-275, (6 3/4) 235-600, (8) 400-800
<b>GE Energy Oilfield Technology</b>											
Geolink Modular Gamma	3 1/2, 4 3/4, 6 3/4, 8, 9 1/2	Shortest probe length with MWD 21.26	As per Geolink MWD	As per Geolink MWD	150	20	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD
Pilot Gamma	3 1/2, 4 3/4, 6 1/2, 8, 9 1/2	Shortest probe length with MWD 26.21	As Per Pilot MWD	As Per Pilot MWD	150 (i)	20	As Per Pilot MWD	As Per Pilot MWD	As Per Pilot MWD	As Per Pilot MWD	As Per Pilot MWD
Scinturion Gamma	3 1/2, 4 3/4, 6 1/2, 8, 9 1/2	Shortest probe length with MWD 31	As per Tensor MWD	As per Tensor MWD	175	20	As per Tensor MWD	As per Tensor MWD	As per Tensor MWD	As per Tensor MWD	As per Tensor MWD
<b>Halliburton/Sperry Drilling</b>											
Dual Gamma Ray (DGR)	4 3/4, 6 3/4, 8, 9 1/2	(4 3/4) 7.5, (6 3/4, 8) 4.5, (9 1/2) 4.4	(4 3/4) 30/14, (6 3/4) 21/10, (8, 9 1/2) 14/8	(4 3/4) 4.66x2.25, (6 3/4) 6.54x2.81, (8) 7.76x2.81, (9 1/2) 9.35x2.81	150	18 std. 25 opt.		(4 3/4) 68, (6 3/4, 8) 2, (9 1/2) 1	(4 3/4) 184, (6 3/4, 8) 7, (9 1/2) 3	(6 3/4, 8) 43, (9 1/2) 16	
Gamma Ray Probe	Depends on hang-off collar OD	Depends on hang-off collar	Depends on hang-off collar	Depends on hang-off collar	150 std. 175 opt.	20 std. 30 opt.	Depends on hang-off collar ID	Depends on hang-off collar ID	Depends on hang-off collar ID	(3 3/8, 3 1/2) 90-200, (4 3/4) 150-350, (6 1/2 - 9 1/2) 225-650, (7 1/4 - 9 1/2) 400-1,500	
Azimuthal Gamma Ray (AGR)	6 3/4, 8, 9 1/2	(6 3/4) 23.6, (8) 25.3, (9 1/2) 25.4 (part of EWR-MS tool)	(6 3/4) 21/10, (8, 9 1/2) 14/8	(6 3/4) 6.60 x 2.81, (8) 7.65 x 2.81, (9 1/2) 9.23 x 3.00	150	25	N/A	(6 3/4) 12, (8, 9 1/2) 5	(6 3/4) 35, (8, 9 1/2) 13	(6 3/4) 200, (8, 9 1/2) 75	
Geo-Pilot Gamma Ray (ABG)	6 3/4, 9 5/8	(6 3/4) 20, (9 5/8) 22 (part of GeoPilot RST)	(6 3/4) 21/10, (9 5/8) 14/8	Depends on rotary steerable tool mode	150 std., 175 opt.	20 std. 30 opt.		(6 3/4) 38, (9 5/8) 6	(6 3/4) 105 (9 5/8) 17	(9 5/8) 96	
Gamma Ray/AT-Bit Inclination (GABI)	4.75	Part of Mud Motor	30/14	Depends on mud motor	150	20	Depends on mud motor	Depends on mud motor			100-265

Transmission trigger	Telemetry type	Wireline retrievable	Downlink mud	Downlink E-mag	MTF/GTF switch	Resolution update period, sec	Survey time period, sec	Survey / Logging mode(s)	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery		
Flow-on and timer	MPT positive pulse or EM	Y (4 3/4+)	Y	N	N	Program-mable threshold	Config. dependent	Config. dependent	Y/Y	Dir: 6.4 Gamma: 2.1	Incl: +/-0.1° Azi: +/-1.0° (Incl. >10°; Dip <70°) GTF: +/-1.0° (Incl. >10°) MTF: +/-2.25° (Dip <70°) Gamma: 0 - 800 API +/-5%	Tri-axial fluxgate magnetometer with USGS-/NIST-traceable calibration; tri-axial quartz accelerometer Gamma: NaI scintillation with PMT	Azi, Incl., MTF, GTF, temp, (Optional Lateral & Axial Vib.), Gamma	Lithium battery Optional turbine-alternator	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	Y (zz)	N	Op. Sel.	Op. Sel.	65	Y/Y	(4 3/4) 15.4 (6 3/4) 17.7 (8 1/4) 20.3 (9 1/2) 24.3 (zz)	+/- 2.5 cps at 100 API	2 scintillation (Azi.)	API GR, 4 and 8 sector Azimuthal Gamma Ray	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	Y (zz)	N	Op. Sel.	Op. Sel.	55	Y/Y	(4 3/4) 33.4 (6 3/4) 37.8 (9 1/2) 38.4 (zz)	+/- 2.5 cps at 100 API	2 scintillation (Azi.)	API GR, 4 and 8 sector Azimuthal Gamma Ray	Turbine generator, no limit	Y	Y
Stop and start pumps, or stop rotary	Positive mud-pulse	N	Y	N	N	N/A	Op. Sel.	62	Y/Y	(4 3/4) 29.5, (6 3/4) 31.3, (9 1/2) 37.5 (zz)	+/- 3 cps at 100 API	Scintillation	API GR	Turbine generator, no limit	Y	Y
Power On	Wire / positive mud pulse	N	N	Y	N	Op. Sel.	Op. Sel.	Continuous	N/A	(2 3/8 and 3) 2.1	+/- 3 cps at 100 API	Scintillation	API GR	Surface Power	Y	N
Stop pumps	Electromagnetic	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	(4 3/4, 6 3/4) 7.0	+/- 3 cps at 100 API	Scintillation	API GR	Lithium battery, 150+ hours depending on transmission rate	Y	Y
Stop pumps, start pumps, or stop rotary	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/N	(3 1/8) 1.7, (4 3/4) 3.6, (6 3/4, 8 1/4) 2.5	+/- 3 cps at 100 API	Scintillation	API GR	(3 1/8) lithium battery, 140 hr, (4 3/4 - 8 1/4) turbine generator, no limit, or lithium batteries, 140 hr	Y	Y
Stop pumps, start pumps, or stop rotary	Positive mud-pulse, wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/N	(1 3/4) 1.07, (2) 2.3	+/- 3 cps at 100 API	Scintillation	API GR	Turbine generator, no limit, lithium batteries >200 hr	Y	Y
Stop pumps, start pumps, or stop rotary	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	62	Y/Y	(1 3/4 probe) 16	TF: +/- 1.5, Azi: +/- 1, Incl.: +/- 0.2(k)	Tri-axial accelerometer/tri-axial flux gate	GX, GY, GZ, HX, HY, HZ, Azi, Incl., Tf reference Near bit incl. Temp.	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	(4 3/4) 2.5, (6 3/4) 2.2, (8 1/4) 1.3, (9 1/2) 4.2	+/- 2.5 cps at 100 API	2 scintillation (Azi.)	API GR, 4 and 8 sector Azimuthal Gamma Ray	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	(4 3/4) 13.1, (6 3/4) 12.8	+/- 2.5 cps at 100 API	2 scintillation (Azi.)	API GR, 4 and 8 sector Azimuthal Gamma Ray	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Wired Pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	2.1	+/- 5 API @ 100 API	2 Scintillation	API GR	Turbine generator, no limit	Y	Y
Stop pumps, start pumps	Positive mud pulse	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/N	(4 3/4) 33.6, (6 3/4) 35.6, (8, 9 1/2) 42.2	+/- 3 cps at 100 API	Scintillation	API GR	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	2.1	+/- 3 cps at 100 API	Scintillation	API GR	Turbine generator, no limit	Y	Y
Stop pumps, start pumps	Positive pulse	Y	Y	N	N	Op. Sel. 2 Deg. Min.	12 (6 bit res.)	60-250	Y/N	11, 17, 25	Azm: +/- .5 Inc: +/- 2	Tri-axial accelerometer, Tri-axial magnetometer	MWD Plus..... 0 - 800 API Gamma	Lithium battery, 400-800 Hours	Y	Y
Flow	Negative mud pulse and E-mag	Y	Y	N	N	N/A	30-60	N/A	Y/Y	1.7	+/- 1.5% range	Scintillation	AAPI units	Battery, Minimum 250 hrs	Y	Y
Flow	Positive mud pulse	Y	Y	N	N	N/A	24-50	N/A	Y/Y	8.2	+/- 1.5% range	Scintillation	AAPI units	400-800	Y	Y
Flow	Positive mud pulse	Y	Y	N	N	Op. Sel.	18-36	20	Y/Y	10.6	+/- 1.5% range	Scintillation	AAPI units	Lithium battery, 140-280 hr	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	Variable				(4 3/4) 15, (6 3/4) 2.8 or 1.8, (8) 2.8 or 1.8, (9 1/2) 2.2 or 1.9	+/- 5% API	Geiger-Mueller	API GR	Negative pulse: battery, positive pulse: generator and/or battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N or Y	Variable				0.5, 0.6, or 1.9	+/- 5% API	Scintillation or Geiger-Mueller	API GR	Generator, battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	Op. Sel.	Variable			(6 3/4) 1.82, (8) 1.85, (9 1/2) 1.89	+/- 2.5% API	2 azimuthally binned scintillation detectors	Total and azimuthal (8 sector) API GR, borehole image	Negative pulse: battery, positive pulse: generator and/or battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	Variable				3.1	+/- 3% API	3 azimuthally focused scintillation detectors	Total and 3 azimuthal API GR	Battery, 200 hr.	Y	Y
	E-M short-hop through mud motor and then Positive or Electromagnetic	N	Y	N	N	Variable				10, but depends on mud motor	+/- 3% API	4 azimuthally focused scintillation detectors	Total and 4 azimuthal (16 sector) API GR; inclination	Battery, 300 hr.	Y	Y

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Service line (s)	Tool OD, in.	Length, ft.	Max. D.P.S. - 100 ft (collars - rotation)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. press, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gal/min	
<b>MWD Services Inc.</b>												
MWD Shuttle	Sub dia: 3 1/8 - 9 1/2, tool dia: 1 7/8	29.1 w/single battery, 35.5 w/dual battery	60/30	As applicable to standard NMDC	150	20	40	80	150		75-1,000	
<b>Navigate Energy Services</b>												
Directional Gamma	4 3/4, 6 1/2 & 8 available QI *10	(4 3/4) 10, (6 1/2 & 8) 10	(5 3/4) 32/16, (6 3/4) TBD, (8) TBD	As applicable to standard NMDC	150	20	N/A	60	125	N/A	225-1000	
<b>PathFinder</b>												
HDS-1L Directional Gamma	4 3/4, 6 3/8, 6 3/4, 8 LF, 8 HF, 9 1/2	30	(4 3/4) 31/17, (6 3/8) 24/11.5, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/8) 6.47x2.81, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.95x2.81, (9 1/2) 9.5x3	150	20	(4 3/4) 40, (6 3/8) 40, (6 3/4) 40, (8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/8) 50, (6 3/4) 8 LF 45, (8 HF, 9 1/2) N/A	(4 3/4, 6 3/8) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45, (9 1/2) 45	(4 3/4, 6 3/8, 6 3/4, 8 LF) N/A, (8 HF) 200, (9 1/2) 200	(4 3/4, 6 3/8) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500	
HDS-1S Directional Gamma	4 3/4, 6 3/4, 8 LF, 8 HF, 9 1/2	16	(4 3/4) 31/17, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.95x2.81, (9 1/2) 9.5x3	150	20	(4 3/4) 40, (6 3/4) 40, (8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/4) 8 LF 45, (8 HF, 9 1/2) N/A	(4 3/4) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45, (9 1/2) 45	(4 3/4, 6 3/4, 8 LF) N/A, (8 HF) 200, (9 1/2) 200	(4 3/4) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500	
HDS-1R Directional Gamma	3 1/8 - 9 1/2	30	60/30 Dependent on drill collar	As applicable to standard NMDC	150	20	250	250	250	250	(2 1/4) 60-180, (2 1/2) 80-280, (2 11/16) 100-350, (2 13/16) 150-550, (3 1/4) 300-1,000	
Survivor HDS-1L Directional Gamma	4 3/4, 6 3/8, 6 3/4, 8 LF, 8 HF, 9 1/2	30	(4 3/4) 31/17, (6 3/8) 24/11.5, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/8) 6.47x2.81, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.95x2.81, (9 1/2) 9.5x3	175	25	(4 3/4) 40, (6 3/8) 40, (6 3/4) 40, (8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/8) 50, (6 3/4) 8 LF 45, (8 HF, 9 1/2) N/A	(4 3/4, 6 3/8) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45, (9 1/2) 45	(4 3/4, 6 3/8, 6 3/4, 8 LF) N/A, (8 HF) 200, (9 1/2) 200	(4 3/4, 6 3/8) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500	
Survivor HDS-1S Directional Gamma	4 3/4, 6 3/4, 8 LF, 8 HF, 9 1/2	16	(4 3/4) 31/17, (6 3/4) 17/9, (8 LF) 18/9, (8 HF) 18/9, (9 1/2) 15/8	(4 3/4) 4.69x2.25, (6 3/4) 6.74x2.81, (8 LF) 7.98x2.81, (8 HF) 7.95x2.81, (9 1/2) 9.5x3	175	25	(4 3/4) 40, (6 3/4) 40, (8 LF, 8 HF, 9 1/2) N/A	(4 3/4) 50, (6 3/4) 8 LF 45, (8 HF, 9 1/2) N/A	(4 3/4) N/A, (6 3/4) 50, (8 LF) 50, (8 HF) 45, (9 1/2) 45	(4 3/4, 6 3/4, 8 LF) N/A, (8 HF) 200, (9 1/2) 200	(4 3/4) 125-375, (6 3/4) 250-750, (8 LF) 250-950, (8 HF) 375-1,125 (9 1/2) 500-1,500	
Survivor HDS-1R Directional Gamma	3 1/8 - 9 1/2	30	60/30 Dependent on drill collar	As applicable to standard NMDC	175	25	250	250	250	250	(2 1/4) 60-180, (2 1/2) 80-280, (2 11/16) 100-350, (2 13/16) 150-550, (3 1/4) 300-1,000	
Payzone Inclination Gamma	4 3/4, 6 3/4	7.13 upper, 2.7 lower	(4 3/4) 31/17, (6 3/4) 17/9	(4 3/4) 4.66x2.25, (6 3/4) 6.57x2.81	150	20	N/A	(4 3/4) 70, (6 3/4) 20	(4 3/4) N/A, (6 3/4) 35	N/A	(4 3/4) 125-375, (6 3/4) 250-750	
APS SureShot with Gamma	3 1/8, 3 1/2, 4 3/4, 6 1/4, 6 3/4, 8, 9 1/2+	29	Collar-limited	Collar-defined	175	20	(3 1/2) 29, (4 3/4 - 6 3/4) 6, (8) 3, (9 1/2) 2	(3 1/2) 165, (4 3/4 - 6 3/4) 40, (8) 20, (9 1/2) 10	(6 1/2 - 6 3/4) 114, (8) 61, (9 1/2) 32	(9 1/2) 225	(3 1/8, 3 1/2) 70 - 250 (4 3/4) 150 - 350 (6 1/4, 6 3/4) 150 - 750 (8) 300 - 1,100 (9 1/2+) 650 - 1,200	
Compensated Wave Resistivity	6 3/4, 8, 9 1/2	25	(6 3/4) 14/5, (8) 12/4, (9 1/2) 8/2	(6 3/4) 5.94 x2.81, (8) 6.9x2.81, (9 1/2) 8.49x3	150	20	N/A	(6 3/4) 30, (8) 30, (9 1/2) 30	(6 3/4) 80, (8) 80, (9 1/2) 80	(6 3/4) n/a, (8) n/a, (9 1/2) 300	(6 3/4) 250-750, (8) 250-1,125, (9 1/2) 250-1,250	
Slim Array Wave Resistivity	4.75	20	30/15	4.72x2.25	150	25	6	29	N/A	N/A	120-375	
Survivor Slim Array Wave Resistivity	4.75	20	30/15	4.72x2.25	175	25	6	29	N/A	N/A	120-375	
Array Wave Resistivity	6 3/4, 8, 9 1/2	20	(6 3/4) 16/10, (8, 9 1/2) 16/10	(6 3/4) 6.4x2.81, (8) 8.9x3, (9 1/2) 8.9x3	150	6 3/4, 8, 9 1/2	25	N/A	(6 3/4) 30, (8) 30, (9 1/2) 30	(6 3/4) 75, (8) 75, (9 1/2) 75	(6 3/4) N/A, (8) N/A, (9 1/2) 300	(6 3/4) 250-750, (8) 250-1,125, (9 1/2) 250-1,500
Survivor Array Wave Resistivity	6 3/4, 8, 9 1/2	20	(6 3/4) 16/10, (8, 9 1/2) 16/10	(6 3/4) 6.4x2.81, (8) 8.9x3, (9 1/2) 8.9x3	175	6 3/4, 8, 9 1/2	25	N/A	(6 3/4) 30, (8) 30, (9 1/2) 30	(6 3/4) 75, (8) 75, (9 1/2) 75	(6 3/4) N/A, (8) N/A, (9 1/2) 300	(6 3/4) 250-750, (8) 250-1,125, (9 1/2) 250-1,500
PathMaker Rotary Steerable	4 3/4, 6 3/4, 8, 9 1/2	21, 20, 20, 20	Capability (*100 ft) : (4 3/4) 10+, (6 3/4) 8, (8) 6, (9 1/2) 6 Pass Through (*100 ft) : (4 3/4) 15/10, (6 3/4) 15/10, (8) 12/8, (9 1/2) 10/6	N/A	(4 3/4) 175, (6 3/4) 175, (8) 18, (9 1/2) 150	(4 3/4) 25, (6 3/4) 22, (8) 18, (9 1/2) 15	N/A	N/A	N/A	N/A	(4 3/4) 150-350, (6 3/4) 250-750, (8) 250-1,250, (9 1/2) 250-1,250	
<b>Schlumberger</b>												
PowerDrive X5	4 3/4, 6 3/4, 8 1/4, 9, 11	(4 3/4) 14.95, (6 3/4) 13.48, (8 1/4, 9) 14.6, (11) 15.1	Capability (*100 ft) : (4 3/4, 6 3/4, 8 1/4, 9) 5, (11) 4 Pass Through (*100 ft) : (4 3/4) 30/15, (6 3/4, 8 25, 9) 20/10, (11) 15/8		150	20	N/A	36 (600 - 800 psi required across bit)	30 (600 - 800 psi required across bit)	46 (600 - 800 psi required across bit)	130-1,900	
ShortPulse	4.75	27.3	30/15	4.75x2.25x34.8 -OR- 4.59x2.25x30.3	150 std., 175 opt.	20	20	125 (varies with Modulator gap)	N/A	N/A	130-400	
ImpPulse	4.75	32	30/15	4.75x2.25x38.5	150 std., 175 opt.	20 std., 25 opt.	20	125 (varies with Modulator gap)	N/A	N/A	130-400	
PowerPulse	6 3/4, 8 1/4, 9, 9 1/2	24.7	(6 3/4) 16/8 (8 1/4) 12/7 (9, 9 1/2) 10/6	(6 3/4) 6.75x2.81x31.5 (8 1/4) 8x2.81x26.2 (9 1/4) 9.25x3x28 (9 1/2) 9.5x3.5x26.2	150 std., 175 opt.	25	N/A	(6 3/4) 56 (8 1/4) 32 (varies with modulator gap)	(6 3/4) 151 (8 1/4, 9 1/2) 84 (varies with modulator gap)	(8 1/4, 9 1/2) 595 (varies with modulator gap)	(6 3/4) 250-800 (8 1/4) 300-1,200 (8 1/4) opt. 800-1,400 (9 1/2) opt. 400-1,600	
TeleScope	6 3/4, 8 1/4, 9, 9 1/2	24.7	(6 3/4) 16/8 (8 1/4) 12/7 (9, 9 1/2) 10/6	(6 3/4) 6.75x2.81x31.5 (8 1/4) 8x2.81x26.2 (9 1/4) 9.25x3x28 (9 1/2) 9.5x3.5x26.2	150 std., 175 opt.	20 std., 30 opt.	N/A	(6 3/4) 56 (8 1/4) 32 (varies with modulator gap)	(6 3/4) 151 (8 1/4, 9 1/2) 84 (varies with modulator gap)	(8 1/4, 9 1/2) 595 (varies with modulator gap)	(6 3/4) 250-800 (8 1/4) 300-1,200 (8 1/4) opt. 800-1,400 (9 1/2) opt. 400-1,600	
SlimPulse	1 3/4 tool OD 3 1/8 to 9 1/2 collars	Collar based probe normally 30	(4 3/4 and smaller) 145/40 (6 3/4) 28/10 (8 1/4) 20/8 (9 1/2) 19/7	(4 3/4) 4.75x2.81x33 (6 3/4) 6.75x2.81x32	150 std., 175 opt.	20 std., 22 opt.	(4 3/4) 68, (6 3/4) 16	(6 3/4) 100, (8 3/4) 18	(6 3/4) 324, (8 3/4, 9 3/4) 58	(8 3/4, 9 3/4) 411	Multiple configurations: 35-1200	
E-Pulse	4 3/4, 6 1/2	(4 3/4) 58.6, (6 1/2) 60.8	(4 3/4) 30/15, (6 1/2) 15/8	(4 3/4) 4.75x2.25x75.5, (6 1/2) 6.5x2.81x76.9	125	12	(4 3/4) 15, (6 3/4) 5	(4 3/4) 91, (6 3/4) 31	(6 3/4) 98	N/A	(4 3/4) 0-400 (6 3/4) 0-600	

Transmission trigger	Telemetry type	Wireline retrievable	Downlink kind	Downlink scheme	Downlink scheme	MTR/GTF switch	Resolution (update period, sec)	Survey time period, sec	Survey time period, sec	Survey / Logging (max/min)	Measurements from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery
Stop pumps, stop rotary, start pumps	Positive pulse	Y	Y	N	N	Y	14 - 26, resolution dependant		Y/Y	8.7		Gamma +/- 5%	Scintillation	Gama, 0-255 cps, AAPI	Lithium battery, 120 single, 240 dual battery	N	N
Stop pumps, start pumps	Positive	N	N	N	N	Yes	Variable	50	Y/N	10		Gamma +/- 5%	Scintillation	Formation Gamma	Lithium battery, 500 hours	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	4.58		Gamma +/- 5%	Scintillation	0-508 AAPI	Lithium battery, up to 550 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	5.24		Gamma +/- 5%	Scintillation	0-508 AAPI	Lithium battery, up to 315 hr	Y	Y
Stop pumps, start pumps	Positive	Y	Y	N	N	Op. Sel.	8	46	Y/N	11.81		Gamma +/- 5%	Scintillation	0-508 AAPI	Lithium battery, up to 423 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	5.24		Gamma +/- 5%	Scintillation	0-508 AAPI	Lithium battery, up to 550 hr	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	Op. Sel.	5	37	Y/N	5.24		Gamma +/- 5%	Scintillation	0-508 AAPI	Lithium battery, up to 315 hr	Y	Y
Stop pumps, start pumps	Positive	Y	Y	N	N	Op. Sel.	8	46	Y/N	11.81		Gamma +/- 5%	Scintillation	0-508 AAPI	Lithium battery, up to 423 hr	Y	Y
Stop pumps, start pumps	Positive pulse (EM sub to sub)	N	Y	N	N	N/A	8	N/A	Y	(4 3/4) Gamma 0.9, Incl. 1.8, (6 3/4) Gamma 1.6, Incl. 2.6		Incl. +/- 0.25	Tri-axial accelerometer and scintillator	AAPI GR, Incl., RPM	Lithium battery (4 3/4) 200, (6 3/4) 400	Y	N
Flow-on and timer	Positive	Y (4 3/4+)	Y	N	N	Programmable threshold	Config. dependant	Config. dependant	Y/Y	Dir: 6.4 Gamma: 2.1		Gamma +/- 5%	Scintillation	0-800 API	Lithium battery Optional turbine-alternator	Y	Y
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	6	N/A	N/A	Resistivity 10, GR 4.7		Gamma +/- 5%	Scintillation	0-500 API	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	Op. Sel.	5	Y/Y	Res - 10.4 Gr - 3.7 Inc - 3.3		Gamma +/- 5%	Scintillation	0-600 API	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	Op. Sel.	5	Y/Y	Res - 10.4 Gr - 3.7 Inc - 3.3		Gamma +/- 5%	Scintillation	0-600 API	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	N	N	N	GTF	Op. Sel.	5	Y/Y	Res - 10 Gr - 3.2 Inc - 2.8		Gamma +/- 5%	Scintillation	0-600 API	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	N	N	N	GTF	Op. Sel.	5	Y/Y	Res - 10 Gr - 3.2 Inc - 2.8		Gamma +/- 5%	Scintillation	0-600 API	Lithium battery	Y	Y
Stop pumps, start pumps	Positive Uplink Rotary Downlink	N	N	N	N	GTF	Op. Sel.	Op. Sel.	Y	(9 1/2) Caliper: 4.0, Inc: 6.0, Gamma:15.4 (8) Caliper: 4.0, Inc:6.0 Gamma: 15.4 (6 3/4) Caliper: 3.3, Inc: 6.5, Gamma: 13.8 (4 3/4) Caliper: 2.3, Inc: 7.9, Gamma: 12.2		+/- 0.01", +/-0.1	Linear potentiometer, Tri-axial accelerometers	Caliper, RPM, Stick-slip, Inc. Lateral, Axial and Torsional Vibration	Lithium battery, 200-350 hr	Y	Y
Continuous link to MWD	E-mag to MWD with RT Link	N	Y	N	N	5°	Variable	Continuous	N/A	(4 3/4) 6.73, (6 3/4) 7.27, (8 1/4, 9) 8.43, (11) 8.83		+/- 5%	Scintillation	Near bit inclination azimuth RT-status gamma ray image	Turbine	Y	Y
Stop pumps, stop rotary, start pumps	Positive Continuous wave and downhole recording	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 70bps effective)	30-108	Y/Y	8.8		+/-3%	Scintillation	API Average GR	Turbine	Y	Y
Stop pumps, stop rotary, start pumps	Positive Continuous wave and downhole recording	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 70bps effective)	30-108	Y/Y	13.5		+/-3%	Scintillation	Azimuthal GR	Turbine	Y	Y
Stop pumps, stop rotary, start pumps	Positive Continuous wave	N	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 120bps effective)	30-88	Y/Y	9.9		2.5 cps	Scintillation	API Average GR	Turbine	Y	N
Stop pumps, stop rotary, start pumps	Positive Continuous wave / Wired drill pipe opt.	N	Y	Y	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (1bps physical to 120bps effective)	27-80	Y/Y	9.9		2.5 cps	Scintillation	API Average GR	Turbine	Y	Y
Stop pumps, stop rotary, hold static 45 seconds, start pumps	Positive Continuous wave and downhole recording	Y	Y	N	N	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (0.5bps physical to 30bps effective)	0.5 bps 296 sec or 208 sec	Y/Y	Variable		+/-6%	Scintillation	API Average GR	Lithium battery	Y	Y
Continuous	E-mag	N	N	N	Y	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (up to 120bps)	44 sec	Y/Y	12		+/-6%	Scintillation	API Average GR	Lithium battery	Y	Y

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Service line (s)	Tool OD, in.	Length, ft	Max. D.P.S. - 100 ft (collaring, rotating)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. pressure, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gal/min
E-Pulse XR	4 3/4, 6 1/2	45	(4 3/4) 30/15, (6 1/2) 15/8	(4 3/4) 4.75x2.25x75.5, (6 1/2) 6.5x2.81x76.9	125	12	(4 3/4) 5, (6 3/4) 2	(4 3/4) 25, (6 3/4) 10	(6 3/4) 34	N/A	(4 3/4) 0-400 (6 3/4) 0-600
geoVISION675	6.75	10.12	16/8	6.5x2.81x10	150	18	0.9	5.5	18	N/A	0-800
geoVISION825	8.25	12.72	13/7	8x2.81x13.5	150	15	0.15	0.95	3	21.8	0-1,200
arcVISION312	3.125	23.5	100/30	3x1.75x33	150	20	112	N/A	N/A	N/A	0-160
arcVISION475	4.75	21	30/15	4.75x2.81x22	150	25	3	30	N/A	N/A	0-400
arcVISION675	6.75	18	16/8	6.5x2.81x19	150 std. 165 opt.	20 std., 25 and 30 opt.	1	9	20	N/A	0-800
arcVISION825	8.25	18	14/7	8.25x2.81x19.8	150	25 std., 30 opt.	0.12	1.5	2.5	17.8	0-1,950
arcVISION900	9	18	12/6	9x3x20.7	150	25	0.12	1.5	2.5	17.8	0-1,950
EcoScope	6 3/4 with 7 7/8, 8 3/8, or 9 3/8 Stabilizer Options	25.2	16", 8"	6.5x2.81x24.5	150 std. 175 opt.	20	2	10	32	N/A	250-800
PeriScope	4 3/4, 6 3/4	18.3 (6 3/4), 23.5 (4 3/4)	(4 3/4) 30/15, (6 1/2) 16/8	4.75x2.25x27 (4 3/4), 6.5x2.81x19.3 (6 3/4)	150	25	(4 3/4) 10, (6 3/4) 0.7	(4 3/4) 65, (6 3/4) 4	(6 3/4) 14	N/A	0-400 (4 3/4), 0-800 (6 3/4)
<b>Sondex Drilling (Rentals Division)</b>											
Orienteer Modular Gamma	2 7/8, 3 1/8, 3 1/2, 4 3/4, 6 3/4, 8, 9 1/2	56, 73	As applicable to standard NMDC	As Directional Tool	150	20	As Directional tool				(4 3/4) 480, (6 3/4) 800, (8 1/2) 1,100
Pilot MWD	4 1/2, 4 3/4, 6 1/2, 8, 9 1/2	Shortest probe length 31	As applicable to standard NMDC	As applicable to standard NMDC	150 (i)	20	As Directional tool				100-1200
<b>Target MWD Inc.</b>											
Target Retrievable Gamma System	1 7/8 tool OD, 3 1/8 - 9 1/2 collars	32 ft w/single battery/ 39 ft w/dual battery	per Target Retrievable System	per Target Retrievable System	150	20 (137 mpa)					per target retrievable system
<b>Weatherford</b>											
EMpulse (Electromagnetic)	All Sizes	31	(3 1/16, 3 1/2 Flex) 116/38, (3 3/8) 66/27	(4 3/4) 4.53 x 2.25, (6 1/4) 6.09 x 2.25, (6 3/4) 6.59 x 2.81, (8) 7.78 x 2.81	150	15		(4 3/4) 50			(4 3/4) 80-350; (6 3/4) 80-800; (8 1/4, 9 1/2) 80-1,800
HyperPulse	All sizes	31	(3 1/16) 116/38, (4 3/4) 37/25, (6 1/4, 6 3/4) 27/15	(4 3/4) 4.75x2.69, (6 1/4) 6.25x3.25, (6 3/4) 6.75x3.25	150	15					
HAGR (High-temperature Azimuthal GR)	4 3/4, 6 3/4, 8, 8 1/4, 9 1/2	(4 3/4) 12.5 (6 3/4, 8, 8 1/4, 9 1/2) 12.3	(4 3/4) 30/15, (6 3/4) 19/10, (8, 8 1/4) 14/8, (9 1/2) 14/8	(4 3/4) 4.75x3.22 (6 3/4) 6.75x4.24 (8, 8 1/4) 8x4.28 (9 1/2) 9.5x5.16	150 std. 180 opt.	(4.75, 6.75, 8, 8.25, 9.5) 20 std. 30 opt.	(4 3/4) 12, (6 3/4) 2, (8, 8 1/4) 2	(4 3/4) 64, (6 3/4) 9, (8, 8 1/4) 9	(4 3/4) 193, (6 3/4) 26, (8, 8 1/4) 26	(6 3/4, 8, 8 1/4) 170	(4 3/4) 80-350; (6 3/4) 80-800; (8 1/4, 9 1/2) 80-1,800
SAGR (Spectral Azimuthal GR)	6.75	(6 3/4) 12.3	(6 3/4) 19/10	(6 3/4) 6.75x4.24	150	20 std. 30 opt.	2	9	26	170	(6 3/4) 80-800
At-Bit Measurement System	4 3/4, 6 3/4 NOM TOOL SIZE (5.60" and 7.325" max)	(4 3/4) 2.83 ft., (6 3/4) 3.01 ft.	(4 3/4) 36/20 (6 3/4) 19/11		(4 3/4, 6 3/4) 150	(4 3/4) 10 (6 3/4) 10	estimates (4 3/4) 12, (6 3/4) 2	estimates (4 3/4) 64, (6 3/4) 9	estimates (4 3/4) exceeds flow rate, (6 3/4) 26	estimates (6 3/4) 170	(4 3/4) 80-350; (6 3/4) 80-800; (8 1/4, 9 1/2) 80-1,800
<b>Resistivity</b>											
<b>APS Technology (Rental Division)</b>											
APS SureShot Gamma + Propagation Resistivity	3 1/2, 4 3/4, 6 3/4, 8	59 (2 pcs.)	Collar-limited	Collar-defined	150 and 175	20	Configuration-dependent	Configuration-dependent	Configuration-dependent	Configuration-dependent	(3 1/2) 190 max. (4 3/4) 350 max. (6 3/4) 700 max. (8) 1,200 max.
<b>Baker Hughes</b>											
AutoTrak G3 (Rotary Steerable System, including OnTrak or AziTrak Integrated MWD/LWD)	4 3/4, 6 3/4, 8 1/4, 9 1/2	(4 3/4) 50.8 (6 3/4) 49.9 (8 1/4) 56.9 (9 1/2) 58.1 (zzz)	(4 3/4) 30/10, (6 3/4) 20/13, (8 1/4) 9/6.5, (9 1/2) 13/6.5 (z)	BHA-dependent	(All Sizes) 150 (6 3/4), 8 1/4", 9 1/2") opt. 175	std. 20 (4 3/4, 6 3/4, 8 1/4) opt. 30 (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1,290, (9 1/2) 300-1,600
AutoTrak X-treme (Rotary Steerable System, including OnTrak or AziTrak Integrated MWD/LWD and hard-wired, precontoured modular X-treme mud motor)	4 3/4, 6 3/4, 9 1/2	(4 3/4) 68 (6 3/4) 70 (9 1/2) 82 (zzz)	(4 3/4) 30/10, (6 3/4) 20/13, (8 1/4) 9/6.5, (9 1/2) 13/6.5 (z)	BHA-dependent	(All Sizes) 150 (6 3/4), 8 1/4", 9 1/2") opt. 175	std. 20 (4 3/4, 6 3/4, 8 1/4) opt. 30 (9 1/2) opt. 25	(i)	(i)	(i)	(i)	(4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1,290, (9 1/2) 300-1,600
Multiple Propagation Resistivity	2 3/8, 3 1/8, 4 3/4, 6 3/4, 8 1/4	(2 3/8) 9.6, (3 1/8) 17, (4 3/4 - 8 1/4) 12	(z)	(2 3/8 - 3 1/8) TBD, (4 3/4) 4.597x2.25, (6 3/4) 6.625x2.61, (8 1/4) 8.23x4.005	150	20	(i)				(3 1/8) 80-160, (4 3/4) 100-350, (6 3/4) 200-900, (8 1/4) 300-1,600
OnTrak MWD	4 3/4, 6 3/4, 8 1/4, 9 1/2	(4 3/4) 20.2, (6 3/4) 17.0, (8 1/4) 19.0, (9 1/2) 18.1	(4 3/4) 33/12, (6 3/4) 25/15, (8 1/4) TBD, (9 1/2) 10/7	NA	std. 150, opt. 175	std. 20 (4-3/4, 6-3/4 & 8-1/4, 9-1/2) opt. 25, (4-3/4, 6-3/4 & 8-1/4) opt. 30	(i)				4 3/4) 125-350, (6 3/4) 200-900, (8 1/4) 300-1,295, (9 1/2) 300-1,600

Transmission trigger	Telemetry type	Wireline retrievable				Downlink e-mag	MTF/GTF switch	Realtime update period, sec	Survey time period, sec	Survey / Logging (min/line)	Measure points / foot bottom ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery
		Wireline retrievable	Downlink kind	Downlink e-line	Downlink e-mag												
Continuous (sleep mode optional)	E-mag	Y	N	N	Y	Reg 5 dwn - 8 up Low 2.5 dwn - 3.5 up	Variable (up to 12bps)	44 sec	Y/Y	28.1	+/- 6%	Scintillation	API Average GR	Lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	2.5	+/- 7%	Scintillation	API Azimuthal GR images	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	2.7	+/- 7%	Scintillation	API Azimuthal GR images	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	16	+/- 3%	Scintillation	API Average GR	Lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	10.1	+/- 3%	Scintillation	API Average GR	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	7.2	+/- 3%	Scintillation	API Average GR	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	7.2	+/- 3%	Scintillation	API Average GR	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	7.2	+/- 3%	Scintillation	API Average GR	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous Wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	5	+/- 2%	Scintillation	API Average GR 4 and 16 sector GR images (RT and RM)	TeleScope turbine	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	17.4 (4 3/4) 3.5 (6 3/4)	+/- 3%	Scintillation	API Azimuthal GR image	MWD turbine	Y	Y	
Flow	Positive and negative mud pulse and E-Link	Y	Y	N	N	N/A	30-60	N/A	N/A	1.7	+/- 1.5% range	Scintillation	AAPI units	Battery, Minimum 250 hrs (500 hr option)	Y	Y	
Flow	Positive mud pulse	Y	Y	N	N	N/A	24-50	N/A	N/A	9	+/- 1.5% range	Scintillation	AAPI units	400-800	Y	Y	
Stop pumps, start pumps	Positive pulse	Y	Y	N	N	Op. Sel.	45	55	Y/N	9	+/- 1.5% range	Scintillation	0-255 counts	Lithium battery, 140-280 hr	Y	N	
Two way EM Communication	Electromagnetic	Y	N	N	Y	Op. Sel.	Variable					Scintillation	Total AAPI	Lithium battery	Y	Y	
Stop pumps, Start pumps	Positive Pulse, downhole recording	Y	N	N	N	Op. Sel.	Variable					Scintillation	Total AAPI	Lithium battery	Y	Y	
Stop pumps, Start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	Op. Sel.	Variable			(4 3/4) 12.5, (6 3/4) 12.3 (8) 12.4	Gamma +/- 5 API	Geiger Mueller	API GR: Total, up/down, quadrant, and 8-bin azimuthal image	Lithium battery, up to 1400 hrs.	Y	Y	
Stop pumps, Start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	Op. Sel.	Variable			(6 3/4) 3.4	Gamma +/- 5 API	3 x Scintillation	API GR: Total, up/down, quadrant, and 16-bin image; K,U,Th.	Lithium battery, up to 1400 hrs.	Y	Y	
N/A	Positive mud pulse, Electromagnetic, Wired Pipe	N	N	N	N	N/A	Variable	inc 16	sliding/rotating - inc only	Inc .7 Gamma 1.5 *GR avail on 4 3/4" only	Inc >20°, +/- 25° Gamma 5% @ 100 API	Accelerometer Scintillation	1-axis inc API GR: Total, up/down *GR avail on 4 3/4" only	Lithium battery - 240 std 800 opt	Y	Y	
Flow-on and timer	MPT positive pulse or EM (Sondes; 4 3/4")	Y	Y	N	N	Program-mable threshold	Config. dependent	Config. dependent	Y/Y	Dir: 16.0 Gamma: 11.6 Prop. Resistivity: 5.3	Incl: +/- 0.1° Azi: +/- 1.0° (Incl. >10°; Dip <70°) GTF: +/- 1.0° (Incl. >10°) MTF: +/- 2.25° (Dip <70°) Gamma: 0 - 800 API +/- 5% Propagation Resistivity: ± 1% [0.1 - 50 ohm-m @ 2 MHz]; ± 1% [0.1 - 25 ohm-m] @ 400 kHz	Tri-axial fluxgate magnetometer with USGS-NIST-traceable calibration; tri-axial quartz accelerometer Gamma; NaI scintillation with PMT	Azi, Incl., MTF, GTF, temp, (Optional Lateral & Axial Vib.), Gamma, Propagation Resistivity	Lithium battery	Optional turbine-alternator	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	Y (zz)	N	Op. Sel.	Op. Sel.	55	Y/Y	(4 3/4) 22.6, (6 3/4) 21.6, (8 1/4) 25.6, (9 1/2) 25.6 (zzz)	2 MHz phase diff. +/- 0.4 mmho/m 400 kHz phase diff. +/- 0.8 mmho/m 2 MHz Atten. +/- 0.85 mmho/m 400kHz Atten. +/- 4 mmho/m	Transmitter/receiver antenna configuration	2 MHz and 400 kHz resistivity	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	Y (zz)	N	Op. Sel.	Op. Sel.	55	Y/Y	(4 3/4) 39.8, (6 3/4) 41.7, (9 1/2) 49.5 (zzz)	2 MHz phase diff. +/- 0.4 mmho/m 400 kHz phase diff. +/- 0.8 mmho/m 2 MHz Atten. +/- 0.85 mmho/m 400kHz Atten. +/- 4 mmho/m	Transmitter/receiver antenna configuration	2 MHz and 400 kHz resistivity	Turbine generator, no limit	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	(2 3/8) 3.9, (3 1/8) 9.3, (4 3/4) 10.5, (6 3/4, 8 1/4) 9.3	2 MHz phase diff. +/- 0.5 mmho/m 400 kHz phase diff. +/- 1 mmho/m 2 MHz Atten. +/- 1 mmho/m 400 kHz Atten. +/- 5 mmho/m	Transmitter/receiver antenna configuration	2 MHz and 400 kHz resistivity	(2 3/8) CT e-line no limit, (3 1/8) CT e-line no limit or Lithium battery, 140 hr, (4 3/4, 8 1/4) turbine generator, no limit, or lithium batteries, 140 hr	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	(4 3/4) 9.7, (6 3/4) 6.2, (8 1/4) 6.7, (9 1/2) 5.5	2 MHz phase diff. +/- 0.4 mmho/m 400 kHz phase diff. +/- 0.8 mmho/m 2 MHz Atten. +/- 0.85 mmho/m 400kHz Atten. +/- 4 mmho/m	Transmitter/receiver antenna configuration	2 MHz and 400 kHz resistivity	Turbine generator, no limit	Y	Y	

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Service line (s)	Tool OD, in.	Length, ft.	Max. DLS - 100 ft (collator - collator)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. press, kpsi	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gpm/in
AziTrak MWD	4 3/4, 6 3/4	(4 3/4) 40.4, (6 3/4) 35.3	(z)	TBD	150	std 20 (4 3/4) opt. 25, (6 3/4) opt. 30	(i)				4 3/4) 125-350, (6 3/4) 200-900
StarTrak	4 3/4, 6 3/4	(4 3/4) 9.8, (6 3/4) 8.3	(z)	(4 3/4) 5.25 x 3.13, (6 3/4) 7.25 x 4.6	150	std 20, opt 25	(j)				(4 3/4) 125-350, (6 3/4) 265-900, function of MWD platform
ZoneTrak (Bit Resistivity)	6 3/4, 9 1/2	(6 3/4) 6.3, (9 1/2) 5.7	(z)	(6 3/4) 7.25 x 3.64, (9 1/2) 9.63 x 3.7	150	std 20, opt 25	(j)				(6 3/4) 200-900 (9 1/2) 300-1,600 function of MWD platform
<b>GE Energy Oilfield Technology</b>											
TRIM Induction Resistivity Tool	4 3/4, 6 3/4, 8, 9 1/2	15.75	(4 3/4) 30/15 (6 3/4) 21/10 (8) 14/8 (9 1/2) 7/4	(4 3/4) 4.75x2.81, (6 3/4) 6.71x2.81, (8) 7.93x2.81, (9 1/2) 9.42x2.81	150	15	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	(4 3/4) 414, (6 3/4) 700, (8, 9 1/2) 1100
Centerfire Propagation Resistivity Tool	4 3/4, 6 3/4, 8 1/4	(4 3/4, 6 3/4) 14.5 (8 1/4) 15.16	(4 3/4) 25/12.2 (6 3/4) 17/8 (8 1/4) 14/7	(4 3/4) 5.0x2.81, (6 3/4) 6.58x2.81, (8 1/4) 8.25x2.81	175	20	As per Tensor MWD	As per Tensor MWD	As per Tensor MWD	As per Tensor MWD	(4 3/4) 100-350 (6 3/4) 300-750 (8 1/4) 450-1200
Compact Propagation Resistivity (CPR) Tool	4 3/4, 6 3/4	(4 3/4) 19.9 (6 3/4) 20.2	Dependent on BHA configuration	(4 3/4) 5.19x2.81 (6 3/4) 7.03x2.81	150	20	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	As per Geolink MWD	(4 3/4) 315, (6 3/4) 660, (8) 1,100
<b>Halliburton/Sperry Drilling</b>											
EWR-PHASE 4	4 3/4, 6 3/4, 8, 9 1/2	(4 3/4) 12.5, (6 3/4) 12.1, (8, 9 1/2) 12.2	(4 3/4) 30/14, (6 3/4) 21/10, (8, 9 1/2) 14/8	(4 3/4) 4.66x2.25, (6 3/4) 6.54x2.81, (8) 7.76x2.81, (9 1/2) 9.35x3	150 std. 175 opt.	18 or 25		(4 3/4) 90, (6 3/4, 8) 7, (9 1/2) 2	(4 3/4) 250, (6 3/4, 8) 19, (9 1/2) 7	(6 3/4) 114, (8) 115, (9 1/2) 40	
EWR-PHASE 4D	9.5	12.2	14/8	9.35x3	150	18	2	7	40		
SuperSlim EWR-PHASE 4	3.125	11.3	30/14	2.63x1.25	150	16	213 at 150 gal/min				
SuperSlim EWR-PHASE 4	3.625	12.9	30/14	TBD	150	20	TBD				
EWR-M5	6 3/4, 8, 9 1/2	(6 3/4) 23.6, (8) 25.3, (9 1/2) 25.4	(6 3/4) 21/10, (8, 9 1/2) 14/8	(6.75) 6.60 x 2.81, (8) 7.65 x 2.81, (9 1/2) 9.23 x 3.00	150	25	N/A	(6 3/4) 12, (8, 9 1/2) 5	(6 3/4) 35, (8, 9 1/2) 13	(6 3/4) 200, (8, 9 1/2) 75	
Azimuthal Focused Resistivity (AFR)	4 3/4, 6 3/4, 8	(4 3/4) 10.0, (6 3/4) 10.8, (8) 8.5	(4 3/4) 30/14, (6 3/4) 21/10, (8) 14/8	(4 3/4) 4.74x2.25, (6 3/4) 6.56x2.81, (8) TBD	150	(4 3/4) 24.5, (6 3/4) 22, (8) 24.5		(4 3/4) 78, (6 3/4) 6, (8) 2	(4 3/4) 214, (6 3/4) 17, (8) 5	(6 3/4) 101, (8) 25	
Azimuthal Deep Resistivity (ADR)	4 3/4, 6 3/4	(4 3/4) 25.5, (6 3/4) 24.3	(4 3/4) 30/14, (6 3/4) 21/10	(4 3/4) 4.76x2.25, (6 3/4) 6.71x2.81	150	25		(4 3/4) 152, (6 3/4) 14	(4 3/4) 419, (6 3/4) 38	(6 3/4) 229	
<b>PathFinder</b>											
Compensated Wave Resistivity	6 3/4, 8, 9 1/2	25	(6 3/4) 14/5, (8) 12/4, (9 1/2) 8/2	(6 3/4) 5.94 x 2.81, (8) 6.9x2.81, (9 1/2) 8.49x3	150	20	N/A	(6 3/4) 30, (8) 30, (9 1/2) 30	(6 3/4) 80, (8) 80, (9 1/2) 80	(6 3/4) n/a, (8) n/a, (9 1/2) 300	(6 3/4) 250-750, (8) 250-1,125, (9 1/2) 250-1,250
Slim Compensated Wave Resistivity	4.75	29.8	34/17	4.36 x 2.25	150	20	8	40	N/A	N/A	120-275
Slim Array Wave Resistivity	4.75	20	30/15	4.72x2.25	150	25	6	29	N/A	N/A	120-375
Survivor Slim Array Wave Resistivity	4.75	20	30/15	4.72x2.25	175	25	6	29	N/A	N/A	120-375
Array Wave Resistivity	6 3/4, 8, 9 1/2	20	(6 3/4) 16/10, (8, 9 1/2) 16/10	(6 3/4) 6.4x2.81, (8) 8.9x3, (9 1/2) 8.9x3	150	(6 3/4, 8, 9 1/2) 25	N/A	(6 3/4) 30, (8) 30, (9 1/2) 30	(6 3/4) 75, (8) 75, (9 1/2) 75	(6 3/4) N/A, (8) N/A, (9 1/2) 300	(6 3/4) 250-750, (8) 250-1,125, (9 1/2) 250-1,500
Survivor Array Wave Resistivity	6 3/4, 8, 9 1/2	20	(6 3/4) 16/10, (8, 9 1/2) 16/10	(6 3/4) 6.4x2.81, (8) 8.9x3, (9 1/2) 8.9x3	175	(6 3/4, 8, 9 1/2) 25	N/A	(6 3/4) 30, (8) 30, (9 1/2) 30	(6 3/4) 75, (8) 75, (9 1/2) 75	(6 3/4) N/A, (8) N/A, (9 1/2) 300	(6 3/4) 250-750, (8) 250-1,125, (9 1/2) 250-1,500
<b>Schlumberger</b>											
mcroVISION	4 3/4, 6 3/4, 8 1/4	19.4 (4 3/4), 22.8 (6 3/4), 21.2 (8 1/4)	(4 3/4) 30/15 (6 3/4) 15/8 (8 1/4) 14/7	22 (4 3/4), 25.8 (6 3/4), 21 (8 1/4)	150	20	(4 3/4) 12, (6 3/4) 1, (8 1/4) 1	(4 3/4) 79, (6 3/4) 8, (8 1/4) 8	(4 3/4) 250, (6 3/4) 25, (8 1/4) 25	N/A	(4 3/4) 0-400 (6 3/4) 0-800 (8 1/4) 0-800
Impulse	4.75	32	30/15	4.75x2.25x38.5	150 std., 175 opt.	20 std., 25 opt.	N/A	125	N/A	N/A	0-400
geoVISION675	6.75	10.12	16/8	6.5x2.81x10	150	18	0.9	5.5	18	N/A	0-800
geoVISION825	8.25	12.72	13/7	8x2.81x13.5	150	15	0.15	0.95	3	21.8	0-1,200

Transmission trigger	Telemetry type	Wireline retrievable	Downlink kind	Downlink e-mag	MHz/GHz switch	Realtime update period, sec	Survey time period, sec	Survey / Logging mode(s)	Measure points from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	(4 3/4) 4.6, (6 3/4) 6.2	2 MHz phase diff. +/-0.4 mmho/m 400 kHz phase diff. +/-0.8 mmho/m 2 MHz Atten. +/- 0.85 mmho/m 400kHz Atten. +/- 4 mmho/m	Transmitter/receiver antenna configuration	2 MHz and 400 kHz resistivity	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave, wired-pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	(4 3/4) 5.6, (6 3/4) 3.7		Button	High resolution azimuthal resistivity	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud-pulse, Positive Continuous Wave (yy), wired-pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	Application specific	+/- 5%	Transmitter/receiver antenna configuration	Apparent Resistivity	Turbine generator, no limit	Y	Y
Flow	Negative mud pulse and E-mag	N	Y	N	N	N/A	Op. Sel.	Op. Sel.	Y/Y	3	+/- 2.5% at 10 Ohm-m	Focused azi. induction 35.6-in. spacing	20 KHz resistivity	Battery, Minimum 250 hrs	Y	Y
Flow	Positive mud pulse	Y MWD Only	Y	N	N	N/A	Op. Sel.	Op. Sel.	Y/Y	(4 3/4, 6 3/4) 6.1 (8 1/4) 6.8	2MHz +/- 2% (0.1 to 20 ohmm) / +/- 1 mmho/m (> 20 ohmm) 400kHz +/- 2% (0.1 to 10 ohmm) / +/- 2 mmho/m (> 10 ohmm)	19, 41 in. spacing, 4 transmitters, 2 receivers	2 MHz and 400 KHz resistivity	Battery, nominal 150 hrs	Y	Y
Flow	Negative mud pulse and E-mag	N	Y	N	N	N/A	Op. Sel.	Op. Sel.	Y/Y	(4 3/4) 3.9 (6 3/4) 4.0	2MHz +/- 2% (0.2 to 25 ohmm) / +/- 0.8 mmho/m (> 25 ohmm), 400kHz +/- 2% (0.1 to 10 ohmm) / +/- 2 mmho/m (> 10 ohmm)	18, 27, 36 in. spacing	2 MHz and 400 KHz resistivity	Battery, nominal 200 hrs	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	Variable				(4 3/4) 7.9, (6 3/4, 8) 5, (9 1/2) 5.1	1% at 10 ohm-m	9, 15, 27, 39 in. spacing	1 and 2 MHz phase and atten. resistivity	Negative pulse: battery (250), positive pulse: generator and/or battery	Y	Y
	Positive, Negative, or Electromagnetic	N	Y	N	N	Variable				5.1	1% at 10 ohm-m	18, 20, 30, 42 in. spacing	1 and 2 MHz phase and atten. resistivity	Negative pulse: battery (250), positive pulse: generator and/or battery	Y	Y
	Positive or Electromagnetic	N	Y	N	N	Variable				7.1	1% at 10 ohm-m	12, 20, 28, 44 in. spacing	500 kHz and 2 MHz phase and atten.	Generator, battery	Y	Y
	Positive or Electromagnetic	N	Y	N	N	Variable				8.0	1% at 10 ohm-m	12, 20, 28, 44 in. spacing	500 kHz and 2 MHz phase and atten.	Generator, battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	Variable				(6 3/4) 9.6 and 10.3, (8, 9 1/2) 10.7 and 11.4	For 48 in. 2 MHz Phase Res: +/- 1% or +/- 0.2 mS/m for Res. < 2000 ohm-m; For 48 in. 2 MHz Attenuation Res.: +/- 0.8 mS/m or +/- 2% < 1000 ohm-m. Uncertainties for the shorter spacings and lower frequencies will be larger.	16, 24, 32, 40, and 48 in. compensated spacings	2 MHz, 500 kHz, and 250 kHz phase shift and attenuation, Rm	Negative pulse: battery (400), positive pulse: generator and/or battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	Variable				(4 3/4) 4.8, (6 3/4) 5.3, (8) 4.1	+/- 2% 0-200 ohm-m; +/- 3% @ 500 ohm-m; +/- 10% @ 1,000 ohm-m; +/- 20% @ 2,000 ohm-m	(4 3/4, 6 3/4) Electrodes at three spacings from the two transmitters and bit, (8) Electrodes at two spacings from the two transmitters and bit	Azimuthally sensitive laterolog-type resistivity and At-Bit Resistivity	Negative pulse: battery (400), positive pulse: generator and/or battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	Variable				(4 3/4) 11.4, (6 3/4) 11	For 48 in. 2 MHz Phase Res: +/- 1% or +/- 0.2 mS/m for Res. < 2000 ohm-m; For 48 in. 2 MHz Attenuation Res.: +/- 0.8 mS/m or +/- 2% < 1000 ohm-m. Uncertainties for the shorter spacings and lower frequencies will be larger.	16, 32, and 48 in. compensated resistivity spacings plus many geosteering spacings	Azimuthally sensitive 2 MHz, 500 kHz, and 125 kHz phase shift and attenuation. Geosteering signals from various spacings.	Negative pulse: battery (400), positive pulse: generator and/or battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	6	N/A	N/A	Resistivity 10, GR 4.7	Attenuation 1 mmho/m at 10 ohmm, Phase 0.5 mmho/m at 10 ohmm, Gamma +/- 5%	25-55 in. spacing	2 MHz phase/attenuation	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	6	N/A	N/A	5.6	Attenuation 1 mmho/m at 10 ohmm, Phase 0.5 mmho/m at 10 ohmm, Gamma +/- 5%	15-35 in. spacing	2 MHz phase/attenuation	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	Op. Sel.	5	Y/Y	Res - 10.4 Gr - 3.7 Inc - 3.3	2MHz Phase +/- 1% 2MHz Attenuation +/- 2% 500kHz +/- 1% 500kHz Attenuation +/- 2%	15-25-45 in. spacing	2 MHz and 500 KHz resistivity	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	Y	N	N	N/A	Op. Sel.	5	Y/Y	Res - 10.4 Gr - 3.7 Inc - 3.3	2MHz Phase +/- 1% 2MHz Attenuation +/- 2% 500kHz +/- 1% 500kHz Attenuation +/- 2%	15-25-45 in. spacing	2 MHz and 500 KHz resistivity	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	N	N	N	GTF	Op. Sel.	5	Y/Y	Res - 10 Gr - 3.2 Inc - 2.8	2MHz Phase +/- 1% 2MHz Attenuation +/- 2% 500kHz +/- 1% 500kHz Attenuation +/- 2%	15-25-45 in. spacing	2 MHz and 500 KHz resistivity	Lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive	N	N	N	N	GTF	Op. Sel.	5	Y/Y	Res - 10 Gr - 3.2 Inc - 2.8	2MHz Phase +/- 1% 2MHz Attenuation +/- 2% 500kHz +/- 1% 500kHz Attenuation +/- 2%	15-25-45 in. spacing	2 MHz and 500 KHz resistivity	Lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Y	Y	N	N	N/A	Variable	N/A	N/A	7	+/- 3% for PS res < 60 ohmm, +/- 0.5 mS/m for PS 60 < Res < 2000, +/- 5% for ATT res < 25 ohmm, +/- 2 mS/m for ATT 25 < Res < 60	33 in. spacing	2 MHz, 400 KHz phase shift, attenuation	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	6.1	+/- 2% for PS res < 60 ohm-m, +/- 3% for ATT res < 25 ohm-m	10, 16, 22, 28, 34 in. spacing	2 MHz phase shift, attenuation	Turbine	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	Ring 3.5, Button D - 4.2, Button M - 4.8, Button S - 5.2	+/- 5% 0.1<res< 250 ohm-m, +/- 10% 250<res< 500 ohm-m, +/- 20% 500<res< 5,000 ohm-m	Ring, bit, and 3 buttons	Azi. laterolog resistivity 56 sector real-time images	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	Ring 3.7, Button D - 4.2, Button M - 4.8, Button S - 5.2	+/- 5% 0.1<res< 250 ohm-m, +/- 10% 250<res< 500 ohm-m, +/- 20% 500<res< 5,000 ohm-m	Ring, bit, and 3 buttons	Azi. laterolog resistivity 56 sector real-time images	MWD turbine or lithium battery	Y	Y

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Service Line (s)	Tool OD, in.	Length, ft	Max. D.J.S. - 100 ft (Logging - only)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. pressure (kpsi)	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gal/min
arcVISION312	3.125	23.5	100/30	3x1.75x33	150	20	112	N/A	N/A	N/A	0-160
arcVISION475	4.75	21	30/15	4.75x2.81x22	150	25	3	30	N/A	N/A	0-400
arcVISION675	6.75	18	16/8	6.5x2.81x19	150 std. 165 opt.	20 std. 25 and 30 opt.	1	9	20	N/A	0-800
arcVISION825	8.25	18	14/7	8.25x2.81x19.8	150	25 std. 30 opt.	0.12	1.5	2.5	17.8	0-1,950
arcVISION900	9	18	12/6	9x3x20.7	150	25	0.12	1.5	2.5	17.8	0-1,950
PeriScope	4 3/4, 6 3/4	18.3 (6 3/4), 23.5 (4 3/4)	30/15 (4 3/4), 16/8 (6 3/4)	4.75x2.25x27 (4 3/4), 6.5x2.81x19.3 (6 3/4)	150	25	(4 3/4) 10, (6 3/4) 0.7	(4 3/4) 65, (6 3/4) 4	(6 3/4) 14	N/A	0-400 (4 3/4), 0-800 (6 3/4)
EcoScope	6 3/4 with 7 7/8, 8 3/8, or 9 3/8 Stabilizer Options	25.2	16", 8"	6.5x2.81x24.5	150 std. 175 opt.	20	2	10	32	N/A	250-800
<b>Sondex Drilling (Rentals Division)</b>											
Orienteer TRIM Resistivity	4 3/4, 6 3/4, 8	15.75	As applicable to standard NMDC	As Directional Tool	150	20	As Directional Tool				(4 3/4) 480, (6 3/4) 800, (8, 9 1/2) 1,100
Compact Propagation Resistivity (CPR) Tool	5 3/4, 6 3/4, 8, 9 1/2	17	As applicable to standard NMDC	(4 3/4) 4.84x2.81, (6 3/4) 6.52x2.81	150 (175 Opt)	20	As Directional Tool				(4 3/4) 315, (6 3/4) 660, (8) 1,100
<b>Weatherford</b>											
Multi-Frequency Resistivity (MFR)	4 3/4, 6 3/4, 8, 8 1/4, 9 1/2	(4 3/4, 6 3/4, 8, 8 1/4, 9 1/2) 29.5	(4 3/4) 30/15, (6 3/4), 19/10, (8, 8 1/4) 14/8, (9 1/2) 14/8	(4 3/4) 4.75x2.29; (6 3/4) 6.75x3.06; (8, 8 1/4) 8x4.20, (9 1/2) 9.5x5.16	150 Std. 165 opt.	(4.75, 6.75, 8") 20 std. 30 opt. (8.25, 9.5) 20 std. 25 opt.	4 3/4 - 19 6 3/4 - 2 8, 8 1/4 - 2 9 1/2 - 2	4 3/4 - 105 6 3/4 - 11 8, 8 1/4 - 11 9 1/2 - 11	4 3/4 - 320 6 3/4 - 32 8, 8 1/4 - 32 9 1/2 - 32	6 3/4 - 208 8, 8 1/4 - 208 9 1/2 - 208	(4 3/4) 80-350; (6 3/4, 8) 80-800; (8 1/4, 9 1/2) 80-1,800
Multi-Frequency Resistivity (MFR) - High Temperature	4 3/4, 6 3/4, 8, 8 1/4	(4 3/4, 6 3/4, 8, 8 1/4) 29.5	(4 3/4) 30/15, (6 3/4), 19/10, (8, 8 1/4) 14/8	(4 3/4) 4.75x2.29; (6 3/4) 6.75x3.06; (8, 8 1/4) 8x4.20	150 std. 180 opt.	(4.75, 6.75) 20 std. 30 opt. (8.25, 9.5) 20 std. 25 opt.	4 3/4 - 19 6 3/4 - 2 8, 8 1/4 - 2	4 3/4 - 105 6 3/4 - 11 8, 8 1/4 - 11	4 3/4 - 320 6 3/4 - 32 8, 8 1/4 - 32	6 3/4 - 208 8, 8 1/4 - 208	(4 3/4) 80-350; (6 3/4, 8) 80-800; (8 1/4, 9 1/2) 80-1,800
Multi-Frequency Resistivity-PLUS (MFR-PLUS)	4.75	34.7	30/15	4.75x2.29	150	20 Std., 30 opt.	19	105	320	n/a	80-350
GuideWave Azimuthal Multi-Frequency Resistivity (Az-MFR)	4.75	34.7	30/15	4.75x2.29	150	20 Std., 30 opt.	19	105	320	n/a	80-350
<b>Porosity</b>											
<b>Baker Hughes</b>											
LithoTrak	4 3/4, 6 3/4, 8 1/4	(4 3/4) 16.1, (6 3/4) 17.6, (8 1/4) 18.2	(z)	(4 3/4) 4.82x1.87, (6 3/4) 6.87x2, (8 1/4) 8.25x2.813	150	std 20 (4 3/4) opt. 25, (6 3/4 & 8 1/4) opt. 30	(j)				(4 3/4) 100-320, (6 3/4) 200-900, (8 1/4) 300-1,300 function of MWD platform
SoundTrak	6 3/4, 8 1/4, 9 1/2	(6 3/4 - 9 1/2) 32.8	(z)	n/a	150	std 20, opt 25 & 30	(j)				(6 3/4) 200-900 (8 1/4) 300-1,300 (9 1/2) 450-1,560 function of MWD platform
MagTrak (Advanced Magnetic Resonance While Drilling)	4 3/4, 6 3/4	(4 3/4) 27.7 (6 3/4) 29.9	(z)	n/a	150	std 20, opt 25	(j)	(j)	(j)	(j)	(4 3/4) 125-406 (6 3/4) 264-660
<b>Halliburton/Sperry Drilling</b>											
Bi-modal Acoustic (BAT)	4 3/4, 6 3/4, 8, 9 1/2	(4 3/4) 28, (6 3/4, 8, 9 1/2) 21	(4 3/4) 30/14, (6 3/4) 21/10, (8, 9 1/2) 14/8	(4 3/4) 4.65x2.25, (6 3/4) 6.43x2.81, (8) 7.65x2.81, (8 HP/HF) 7.53x2.81, (9 1/2) 8.96x3	150, 165	(All) 25, (6 3/4, 8, 9 1/2) 30 opt.	(4 3/4) 161, (6 3/4, 8) 11, (6 3/4 HP) 12, (8 HP/HF, 9 1/2) 4	(4 3/4) 458, (6 3/4, 8) 33, (6 3/4 HP) 35, (8 HP/HF, 9 1/2) 13	(6 3/4, 8) 198, (6 3/4 HP) 208, (8 HP/HF, 9 1/2) 76		
Compensated Neutron Porosity	6 3/4, 8	7.65	(6 3/4) 21/10, (8) 14/8	(6 3/4) 6.54x2.81, (8) 7.76x2.81	150	18	4	12	72		
Compensated Thermal Neutron (CTN)	4 3/4, 6 3/4, 8	(4 3/4) 11.1, (6 3/4) 11.8, (8) 17.5	(4 3/4) 30/14, (6 3/4) 21/10, (8) 14/8	(4 3/4) 4.72x2.25, (6 3/4) 6.62x2.81, (8) 8.04x2.81	150, 175	(4 3/4) 20, 25 (6 3/4, 8) 25, 30	(4 3/4) 72, (6 3/4) 4, (8) 3	(4 3/4) 183, (6 3/4) 12, (8) 11	(8) 63		
Magnetic Resonance Imaging Logging While Drilling (MRIL-WD)	6.75	39	21/10	6.35 x 2.81	150	20	20	58			
<b>PathFinder</b>											
Compensated Long-Spaced Sonic	4 3/4, 6 3/4, 8	(4 3/4) 31.5, (6 3/4, 8) 29	(4 3/4) 32/17.5, (6 3/4) 18/9.5, (8) 17/9	(4 3/4) 4.4x2.25, (6 3/4) 6.25x2.81, (8) 7.2x2.81	150	20	(4 3/4) 36, (6 3/4) n/a, (8) N/A	(4 3/4) 80, (6 3/4) 50, (8) 20	(4 3/4) n/a, (6 3/4) 115 (8) 35	n/a	(4 3/4) 120-300, (6 3/4) 250-750, (8) 250-1,125

Transmission trigger	Telemetry type	Wireline retrievable	Downlink kind	Downlink scheme	Downlink E-mag	MHz/RTF switch	Realtime update period, sec	Survey time period, sec	Survey / Logging (min/ing)	Measurements from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recording
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	4.4	+/- 2% for PS res<60 ohm-m, +/-0.3mS/m for PS 60 < res <3,000 ohm-m, +/- 3% for ATT res<25 ohm-m, +/-1.5mS/m for ATT 25 < res < 50 ohm-m	10, 16, 22, 28, 24 in. spacing	2 MHz, 400 KHz phase shift, attenuation	Lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	5.1	+/- 2% for PS res<60 ohm-m, +/-0.3mS/m for PS 60 < res <3,000 ohm-m, +/- 3% for ATT res<25 ohm-m, +/-1.5mS/m for ATT 25 < res < 50 ohm-m	10, 16, 22, 28, 34 in. spacing	2 MHz, 400 KHz phase shift, attenuation	Lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	6.9	+/- 2% for PS res<60 ohm-m, +/-0.3mS/m for PS 60 < res <3,000 ohm-m, +/- 3% for ATT res<25 ohm-m, +/-1.5mS/m for ATT 25 < res < 50 ohm-m	16, 22, 28, 34, 40 in. spacing	2 MHz, 400 KHz phase shift, attenuation	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	6.9	+/- 2% for PS res<60 ohm-m, +/-0.3mS/m for PS 60 < res <3,000 ohm-m, +/- 3% for ATT res<25 ohm-m, +/-1.5mS/m for ATT 25 < res < 50 ohm-m	16, 22, 28, 34, 40 in. spacing	2 MHz, 400 KHz phase shift, attenuation	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	6.9	+/- 2% for PS res<60 ohm-m, +/-0.3mS/m for PS 60 < res <3,000 ohm-m, +/- 3% for ATT res<25 ohm-m, +/-1.5mS/m for ATT 25 < res < 50 ohm-m	16, 22, 28, 34, 40 in. spacing	2 MHz, 400 KHz phase shift, attenuation	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	7.7 (4 3/4) 9.1 (6 3/4)	+/- 2% for PS res<60 ohm-m, +/-0.3mS/m for PS 60 < res <3,000 ohm-m, +/- 3% for ATT res<25 ohm-m, +/-1.5mS/m for ATT 25 < res < 50 ohm-m	16, 22, 28, 34, 40 in. spacing	2 MHz, 400 KHz phase shift, attenuation	MWD turbine	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous Wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	15	+/- 2% for PS res<60 ohm-m, +/-0.3mS/m for PS res < 3,000 ohm-m, +/- 3% for ATT res<25 ohm-m, +/-1.5mS/m for ATT res < 50 ohm-m	16, 22, 28, 34, 40 in. spacing	2 MHz, 400 KHz phase shift, attenuation	TeleScope Turbine	Y	Y
Flow	Positive and negative mud pulse and E-mag	N	Y	N	N	N/A	Op. Sel.	Op. Sel.	N/A	3	+/- 1% at 10hm	Focussed azi. induction 35.6-in. spacing	20 KHz resistivity	Battery, Minimum 250 hrs	Y	Y
Flow	Positive and negative mud pulse and E-mag	N	Y	N	N	N/A	Op. Sel.	Op. Sel.	N/A	7.2 and 8	2MHz +/- 2% (0.1 to 25 ohm) / +/- 0.8 mmho/m (> 25 ohm), 400KHz +/- 2% (0.1 to 10 ohm) / +/- 2 mmho/m (> 10 ohm)	Transmitter/receiver antenna configuration	2 MHz and 400 KHz resistivity	Battery, nominal 200 hrs	Y	Y
Stop pumps, start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	N/A	Variable	N/A	N/A	15.12 All sizes	Phase +/- .25 mmho Attenuation +/- .5 mmho	Compensated 2 MHz & 400 kHz, 20", 30", & 46" xmt. spacing	2 MHz and 400 KHz phase and atten. resistivity	Lithium battery - up to 1400 hrs.	Y	Y
Stop pumps, start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	N/A	Variable	N/A	N/A	15.12 All sizes	Phase +/- .25 mmho Attenuation +/- .5 mmho	Compensated 2 MHz & 400 kHz, 20", 30", & 46" xmt. spacing	2 MHz and 400 KHz phase and atten. resistivity	Lithium battery - up to 1400 hrs.	Y	Y
Stop pumps, start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	N/A	Variable	N/A	N/A	17.7	Phase +/- .25 mmho Attenuation +/- .5 mmho	Compensated 2 MHz, 400 & 100 kHz, 20", 30", 46" & 80" xmt. spacing	2 MHz, 400 & 100 kHz phase and atten. resistivity	Lithium battery - up to 1400 hrs.	Y	Y
Stop pumps, start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y	N/A	Variable	N/A	N/A	17.7	Phase +/- .25 mmho Attenuation +/- .5 mmho	Compensated 2 MHz, 400 & 100 kHz, 20", 30", 46" & 80" xmt. Spacing.	2 MHz, 400 & 100 kHz phase and atten. Resistivity, Up/Down, Quadrant, 8 or 16 bins	Lithium battery - up to 1400 hrs.	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	(4 3/4) 12.1, (6 3/4) 13.5, (8 1/4) 13.1, (8 1/4S) 13.4	0.5 pu below 10 pu 5% of reading for 10-50 pu	Scintillation (Li6)	Neutron porosity, 0-100 pu, near and far counts	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	(6 3/4 - 9 1/2) 9.3	+/- 2 % DeltaT compressional, +/- 5% DeltaT shear	Piezoelectric - multiple spacings	Compressional and shear acoustic slowness	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, or downlink from surface	Positive mud pulse, Positive Continuous Wave, Wired Pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	(4 3/4) 9.48 (6 3/4) 9.97	+/- 1 p.u.	Antenna	Total porosity, CBW, BW, BVI, BVM, PHE, SHC index, Permeability index, T2 distribution	Turbine generator, no limit	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			(4 3/4) 11, (6 3/4, 8, 9 1/2) 9	+/- 1 microsecond/ft	Piezoelectric, 7 T-R shear spacings, Dual receiver arrays	Compressional and shear slowness	Battery, 500	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			2.9 or 4.7	+/- 2 pu at 20 pu	Geiger-Mueller	Neutron porosity	Battery, 250	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			(4 3/4) 6, (6 3/4) 2.2, (8) 4.4	Porosity +/- 0.5 pu (0-10 pu), +/- 5% (10-50 pu), Caliper +/- 0.1 in.	Helium 3	Neutron porosity (4 3/4, 6 3/4, 8), acoustic caliper & standoff (6 3/4, 8)	Generator, battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N	N/A	Variable			6.8	+/- 1 pu (<20 pu), +/- 5% (20-50 pu)	Gradient field	Total porosity, free fluid, capillary-bound water, and clay-bound water. T1 and T2 modes	Battery, 200	Y	Y
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	6	N/A	N	(4 3/4) 9, (6 3/4, 8) 10.1	+/- 2 usec/ft, standoff 0.1 in., caliper 0.15 in.	Piezoelectric 4, 5, 6, 7 ft. spacing	Acoustic slowness rt delta T, waveforms 15 KHz	Lithium battery	Y	Y

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Service line (s)	Tool OD, in.	Length, ft.	Max. D.P.S. * 100 ft. (colling - rotation)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. pressure, MPa	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gpm/min
E Sonic	4 3/4, 6 3/4, 8	(4 3/4) 31.5, (6 3/4, 8) 29	(4 3/4) 32/17.5, (6 3/4) 18/9.5, (8) 17/9	(4 3/4) 4.4x2.25, (6 3/4) 6.25x2.81, (8) 7.2x2.81	150	20	(4 3/4) 36, (6 3/4) N/A, (8) N/A	(4 3/4) 80, (6 3/4) 25, (8) 15	(4 3/4) N/A, (6 3/4) 45, (8) 18	N/A	(4 3/4) 120-300, (6 3/4) 250-750, (8) 250-1,125
Slim Density/Neutron Stand-off Caliper	4.75	15.6	30/15	4.93x2.25	150	25	6	29	N/A	N/A	120-375
Survivor Slim Density/Neutron Stand-off Caliper	4.75	15.6	30/15	4.93x2.25	175	25	6	29	N/A	N/A	120-375
Density/Neutron Stand-off Caliper	6 3/4, 8	25	(6 3/4) 16/8, (8) 12/6	(6 3/4) 6.69x2.81, (8) 9.2x2.81	150	18	n/a	(6 3/4) 20, (8) 10	(6 3/4) 45, (8) 25	N/A	(6 3/4) 250-750, (8) 275-1,125
iFinder Density Imaging	4 3/4, 6 3/4	19.6, 19.8	(4 3/4) 30/15, (6 3/4) 16/10	(4 3/4) 4.92 x 2.25, (6 3/4) 6.68 x 2.81	175	25	6	29	65	N/A	(4 3/4) 120-375, (6 3/4) 250-750
<b>Schlumberger</b>											
SonicScope475	4.75	30	30/15	4.75x2.25x33.7	150	25 std.	11.1	69.6	N/A	N/A	0-400
sonicVISION675	6.75	23.8	16/8	6.5x2.81x35	150	25 std. 30 opt.	0.3	2.0	6.6	N/A	0-800
sonicVISION825	8.25	22.6	14/6	8.0x2.81x32	150	25 std. 30 opt.	0.1	0.7	2.3	16.0	0-1,200
sonicVISION900	9	22.6	12/4	9x2.81x27	150	25	0.1	0.7	2.3	16.0	0-1,400
advVISION475	4 3/4 with Slick, 5 7/8, or 6 1/4 Stabilizer options	23.6	30°, 15°	4.75x2.25x24.7	150 std., 175 opt.	20 std., 25 opt.	35	220	N/A	N/A	0-400
advVISION675	6 3/4 with Slick, 8 3/8, or 9 3/8 Stabilizer Options	20.5	16°, 8°	6.5x2.25x27.4	150	20 std., 25 opt.	1	4	10	N/A	0-800
advVISION825	8 1/4 with Slick or 10 3/8 Stabilizer Options	22.3	14°, 7°	8.25x2.81x26.1	150	18 std., 23 opt.	1	2	6	41	0-1,600
advVISION825s	8 1/4 with 12 stabilizer	31	12°, 4°	8.0x2.81x21.0	150	18	1	7	22	90 @ 1000	0-1,000
proVISION	6 3/4 with Slick, 8 1/4, or 9 3/8 Stabilizer Options	37.3	16°, 8°	6.5x2.81x36.5	150	18	4	25	81	N/A	300-800
EcoScope	6 3/4 with 7 7/8, 8 3/8, or 9 3/8 Stabilizer Options	25.2	16°, 8°	6.5x2.81x24.5	150 std. 175 opt.	20	2	10	32	N/A	250-800
<b>Weatherford</b>											
Thermal Neutron Porosity (TNP)	4 3/4, 6 3/4, 8 1/4	24.5 all sizes (includes AZD)	(4 3/4) 30/15, (6 3/4) 19/10, (8.25) 14/8	(4 3/4) 4.75x3.28 (6 3/4) 6.75x4.24 (8.25) 8.25x5.17	150 Std. 165 Opt.	20 std. (4.75, 6.75), 30 opt. (4.75, 6.75) 25 (8.25)	(4 3/4) 16 (6 3/4) 2 (8 1/2) 2	(4 3/4) 87 (6 3/4) 10 (8 1/2) 10	(4 3/4) 265 (6 3/4) 27 (8 1/2) 27	(6 3/4) 205 (8 1/2) 205	(4 3/4) 80-350; (6 3/4) 80-900; (8 1/4, 9 1/2) 80-1,800
Shockwave Sonic (SST)	6-3/4, 8.25	(6.75) 26, (8.25") 26.27	(6 3/4") 19/10, (8 1/4") 14/8	6.75 x 3.06, 8.25 X 4.20	150 Std. 165 Opt.	(6.75) 20 std., 30 opt. (8.25) 20 std., 25 opt.	(6 3/4) 2 (8 1/2) 2	(6.75) 9 (8.5) 10	(6.75) 25 (8.25) 27	(8.25) 205	(6.75) 0 - 750 (8.25) 1200
<b>Density</b>											
<b>Baker Hughes</b>											
LithoTrak	4 3/4, 6 3/4, 8 1/4	(4 3/4) 16.1, (6 3/4) 17.6, (8 1/4) 18.2	(2)	(4 3/4) 4.82x1.87, (6 3/4) 6.87x2, (8 1/4) 8.25x2.813	150	std 20 (4 3/4) opt. 25, (6 3/4 & 8 1/4) opt. 30	(0)				(4 3/4) 100-320, (6 3/4) 200-900, (8 1/4) 300-1,290 function of MWD platform
<b>Halliburton/Sperry Drilling</b>											
Azimuthal Lithodensity (ALD)	4 3/4, 6 3/4, 8	(4 3/4) 14.3, (6 3/4) 12.4, (8) 13.6	(4 3/4) 30/14, (6 3/4) 21/10, (8) 14/8	(4 3/4) 4.6x2.25, (6 3/4) 6.54x2.81, (8) 7.76x2.81	150, 175	(4 3/4) 20, 25, (6 3/4, 8) 18, 25	(4 3/4) 86, (6 3/4, 8) 7	(4 3/4) 237, (6 3/4) 19, (8) 21	(6 3/4) 117, (8) 128		
Stabilized Lithodensity (SLD)	4 3/4, 6 3/4, 8	(4 3/4) 14.3, (6 3/4) 12.4, (8) 13.6	(4 3/4) 30/14, (6 3/4) 21/10, (8) 14/8	(4 3/4) 4.6x2.25, (6 3/4) 6.54x2.81, (8) 7.76x2.81	140	(4 3/4) 20, (6 3/4, 8) 18	(4 3/4) 86, (6 3/4, 8) 7	(4 3/4) 237, (6 3/4) 19, (8) 21	(6 3/4) 117, (8) 128		
<b>PathFinder</b>											
Slim Density/Neutron Stand-off Caliper	4.75	15.6	30/15	4.93x2.25	150	25	6	29	N/A	N/A	120-375
Survivor Slim Density/Neutron Stand-off Caliper	4.75	15.6	30/15	4.93x2.25	175	25	6	29	N/A	N/A	120-375
Density/Neutron Stand-off Caliper	6 3/4, 8	25	(6 3/4) 16/8, (8) 12/6	(6 3/4) 6.69x2.81, (8) 9.2x2.81	150	18	N/A	(6 3/4) 20, (8) 10	(6 3/4) 45, (8) 25	N/A	(6 3/4) 250-750, (8) 275-1,125
iFinder Density Imaging	4 3/4, 6 3/4	(4 3/4) 19.6, (6 3/4) 19.8	(4 3/4) 30/15, (6 3/4) 16/10	(4 3/4) 4.92 x 2.25, (6 3/4) 6.68 x 2.81	175	25	6	29	65	N/A	(4 3/4) 120-375, (6 3/4) 250-750

Transmission trigger	Telemetry type	Wireline retrievable					MTR/OTF switch	Realtime update period, sec	Survey time period, sec	Survey / Logging (mudlogging)	Measurements from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery
		Wireline retrievable	Downlink kind	Downlink scheme	Downlink energy	MTF/OTF switch											
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	6	N/A	N	(4 3/4) 9, (6 3/4, 8) 10.1	+/- 2 usec/ft, standoff 0.1 in., caliper 0.15 in.	Piezoelectric 4, 5, 6, 7 ft. spacing	Acoustic slowness rt delta T, Dual frequency: 7 kHz and 15 kHz	Lithium battery	Y	Y	
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	4	N/A	N	10.9	+/- 1.5 pu at 30 pu	Helium 3	Neutron porosity	Lithium battery	Y	Y	
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	4	N/A	N	10.9	+/- 1.5 pu at 30 pu	Helium 3	Neutron porosity	Lithium battery	Y	Y	
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	4	N/A	N	Porosity (6 3/4) 10, (8) 11.1	+/- 1.5 pu at 30 pu	Helium 3	Neutron porosity	Lithium battery	Y	Y	
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	4	N/A	N	(4 3/4) 9.6, (6 3/4) 9.6	+/- 1.5 pu at 30 pu	Helium 3	Neutron porosity	Lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	N/A	N/A	15.76	+/- 2us/ft in range 40 to DeltaT mud for compressional. +/-1% in range from 60 to 300 us/ft. +/-2% in range from 300 to 600 us/ft	Sonic	Compressional and shear delta-T, Stoneley	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	N/A	N/A	13.9	+/- 2us/ft in range 40 to DeltaT mud	Sonic	Compressional and shear delta-T	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	N/A	N/A	14.1	+/- 2us/ft in range 40 to DeltaT mud	Sonic	Compressional and shear delta-T	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	N/A	N/A	14.02	+/- 2us/ft in range 40 to DeltaT mud	Sonic	Compressional and shear delta-T	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Source: Y	Y	N	N	N/A	Variable	N/A	N/A	8.7	+/- 0.5 pu < 10 pu +/- 5% 10-50 pu	Helium 3	Neutron porosity	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Source: Y	Y	N	N	N/A	Variable	N/A	N/A	13.7	+/- 0.5 pu < 10 pu +/- 5% 10-50 pu	Helium 3	Neutron porosity, ultrasonic caliper	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Source: Y	Y	N	N	N/A	Variable	N/A	N/A	13.7	+/- 0.5 pu < 10 pu +/- 5% 10-50 pu	Helium 3	Neutron porosity, ultrasonic caliper	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Source: Y	Y	N	N	N/A	Variable	N/A	N/A	17.7	+/- 0.5 pu < 10 pu +/- 5% 10-50 pu	Helium 3	Neutron porosity, ultrasonic caliper	MWD turbine or lithium battery	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	4.8	+/- 1 pu or +/- 5% whichever is greater	Gradient field antenna	Total porosity, BVF, FFV, T1 and/or T2 modes	Turbine	Y	Y	
Real-time, pumps on downhole recording	MWD Positive Continuous Wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	17	+/- 0.5 pu < 10 pu +/- 5% 10-50 pu	Helium 3 (Source is non-chemical)	Neutron porosity: BPHI /TNPH Ultrasonic caliper Capture Spectroscopy Sigma	TeleScope Turbine	Y	Y	
Pumps on/Pumps off	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y		Variable			14.25	Neutron 0-10 pu: +/- .5 pu; 10-40 pu: +/- 5%	He-3	Compensated neutron porosity	Lithium battery - up to 1400 hrs.	Y	Y	
Pumps-on	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y		Variable			(6.75) 14 (8.25) 14.27	+/- 1 µs/ft	piezo-electric, 6-cvtr array	Compressional and shear slowness	Lithium battery - 400+ hrs.	Y	Y	
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	(4 3/4) Density - 4.2, Acoustic standoff - 6.7; (6 3/4) Density - 4.6, acoustic standoff - 6.7; (8 1/4) Density - 5.1, acoustic standoff - 2.3; (8 1/4S) Density - 4.3, acoustic standoff - 6	Density: +/- 0.015 g/cc PEF: 0.25 B/e from 2-5 B/e acoustic standoff; +/- 0.075 up to 0.5 in., +/- 0.25 at 2 in.	Scintillation (NaI)	Bulk density (1.6 - 3.1 g/cc), 4, 8 and 16 sector Azimuthal Density, Delta Rho, Pe index, standoff and caliper	Turbine generator, no limit	Y	Y	
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N		Variable			(4 3/4) 5.3 or 9.1, (6 3/4) 4 or 8, (8) 4.3 or 8.8	+/-0.015 g/cc, 0.25 B/e	Scintillation, long and short spacing	Conventional, rapidly sampled, and azimuthal (16 sectors) density, Pe, delta rho, borehole image	Negative pulse: battery, 250, positive pulse: generator and/or battery	Y	Y	
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N		Variable			(4 3/4) 5.3 or 9.1, (6 3/4) 4 or 8, (8) 4.3 or 8.8	+/-0.025 g/cc, 0.25 B/e	Scintillation, long and short spacing	Conventional and rapidly sampled density, Pe, delta rho	Negative pulse: battery, 250, positive pulse: generator and/or battery	Y	Y	
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	4	N/A	N	5.6	+/- 0.015 g/cc	NaI Scintillation	Bulk density	Lithium battery	Y	Y	
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	4	N/A	N	5.6	+/- 0.015 g/cc	NaI Scintillation	Bulk density	Lithium battery	Y	Y	
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	4	N/A	N	Density (6 3/4) 5.1, (8) 5.0	+/- 0.015 g/cc	NaI Scintillation	Bulk density	Lithium battery	Y	Y	
Stop pumps, stop rotary, start pumps	Positive	N	Y	N	N	N/A	4	N/A	N	10.9	+/- 0.015 g/cc +/- 0.25 B/e +/- 0.1" (standoff) +/- 0.15" (caliper)	Scintillation	Azimuthal bulk density, Pe, delta rho and standoff (up to 64 sectors memory; up to 16 sectors real-time)	Lithium battery	Y	Y	

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Service Line (s)	Tool OD, in.	Length, ft.	Max. DLS - 100 ft (colling - rotation)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. press. (kpsi)	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gpm/min
<b>Schlumberger</b>											
adnVISION475	4 3/4 with Slick, 5 7/8, or 6 1/4 Stabilizer options	23.6	30°, 15°	4.75x2.25x24.7	150 std., 175 opt.	20 std., 25 opt.	35	220	N/A	N/A	0-400
adnVISION675	6 3/4 with Slick, 8 3/8, or 9 3/8 Stabilizer Options	20.5	16°, 8°	6.5x2.25x27.4	150	20 std., 25 opt.	1	4	10	N/A	0-800
adnVISION825	8 1/4 with Slick or 10 3/8 Stabilizer Options	22.3	14°, 7°	8.25x2.81x26.1	150	18 std., 23 opt.	1	2	6	41	0-1,600
adnVISION825s	8 1/4 with 12 stabilizer	31	12°, 4°	8x2.81x21	150	18	1	7	22	90 @ 1000	0-1,000
EcoScope	6 3/4 with 7 7/8, 8 3/8, or 9 3/8 Stabilizer Options	25.2	16°, 8°	6.5x2.81x24.5	150 std., 175 opt.	20	2	10	32	N/A	250-800
proVISION	6 3/4 with Slick, 8 1/4, or 9 3/8 Stabilizer Options	37.3	16°, 8°	6.5x2.81x36.5	150	18	4	25	81	N/A	300-800
StethoScope 675	6 3/4 w/ 8 1/4 stab 6 3/4 w/ 9 1/4 stab (Optional)	31	16/8		150 std.	20 std., 30 opt.	1	9	29		0-800
StethoScope 825	8 1/4 w/ 12.0 stab 8 1/4 w/ 10 3/8 stab (Optional)	31.5	13/7		150 std.	20 std., 30 opt.	1	7	21	151	0-1,600
StethoScope 475	4 3/4 w/ 5 3/4 stab 4 3/4 w/ 5 1/2 stab (Optional)	28.5	30/15		150 std.	20 std., 25 opt.	14	87			0-400
<b>Weatherford</b>											
Azimuthal Density (AZD)	4 3/4, 6 3/4, 8 1/4	24.5 all sizes (includes TNP)	(4 3/4) 30/15 (6 3/4) 19/10, (8.25) 14/8	(4 3/4) 4.75x3.28 (6 3/4) 6.75x4.24 (8.25) 8.25x5.17	150 Std. 165 Opt.	30 (4.75-6.75) 25 (8.25)	(4 3/4) 16 (6 3/4) 2 (8 1/2) 2	(4 3/4) 87 (6 3/4) 10 (8 1/2) 10	(4 3/4) 265 (6 3/4) 27 (8 1/2) 27	(6 3/4) 205 (8 1/2) 205	(4 3/4) 80-350; (6 3/4) 80-800; (8 1/4, 9 1/2) 80-1,800
<b>Formation Pressure Testing</b>											
<b>Baker Hughes</b>											
TesTrak	4 3/4, 6 3/4, 8 1/4	(4 3/4) 23.0, (6 3/4) 24.3, (8 1/4) 24.4	(z)	N/A	150	std 20 (4 3/4, 6 3/4 & 8 1/4) opt. 30	(0)				125 - 1600, function of MWD platform
<b>Halliburton/Sperry Drilling</b>											
GeoTap	4 3/4, 6 3/4, 8, 9 1/2	(4 3/4) 24, (6 3/4) 28.4, (8, 9 1/2) 26.7	(4 3/4) 30/14, (6 3/4) 21/10, (8, 9 1/2) 14/8	(4 3/4) 4.76 x 2.25, (6 3/4) 6.4x2.81, (8) 7.9 x 2.81, (9 1/2) 9.18 x 3	150	4 3/4, 25 (6 3/4, 8, 9 1/2) 25, 30	(4 3/4) 20, (6 3/4) 19, (8, 9 1/2) 15	(4 3/4) 120, (6 3/4) 39, (8, 9 1/2) 31	(6 3/4) 75, (8, 9 1/2) 60	(8, 9 1/2) 350	
<b>PathFinder</b>											
Drilling Formation Tester	6.75	37	16/7	6.37x2.81	150	20	N/A	N/A	70	N/A	275-750
<b>Schlumberger</b>											
StethoScope 675	6 3/4 w/ 8 1/4 stab 6 3/4 w/ 9 1/4 stab (Optional)	31	16/8		150 std., 165 opt.	20 std., 25 opt.	1	9	29		0-800
StethoScope 825	8 1/4 w/ 12.0 stab 8 1/4 w/ 10 3/8 stab (Optional)	31.5	13/7		150 std., 165 opt.	20 std., 25 opt.	1	7	21	151	0-1,600
StethoScope 475	4 3/4 w/ 5 3/4 stab 4 3/4 w/ 5 1/2 stab (Optional)	28.5	30/15		150 std., 175 opt.	20 std., 25 opt.	10	65			0-400
<b>Seismic</b>											
<b>Schlumberger</b>											
seismicVISION675	6.75	14	16/8	13.8	150	25	0.4	2.4	7.8	N/A	800
seismicVISION825	8.25	13.84	14/7	14.4	150	23	0.1	0.7	2.2	15.6	2,000

Transmission trigger	Telemetry type	Wireline retrievable	Downlink kind	Downlink scheme	MTF/OTF switch	Realtime update priority, sec	Survey time priority, sec	Survey / Logging (optional)	Measurements from tool bottom, ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recording	
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Source: Y	Y	N	N	N/A	Variable	N/A	N/A	5	+/- 0.015 g/cc from 1.7 - 3.05 g/cc, PEF: +/- 5% from 1-10 units	Scintillation	Average density 4 and 16 sector azimuthal density Image derived density Real time and recorded images PEF Density caliper	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Source: Y	Y	N	N	N/A	Variable	N/A	N/A	10.5	+/- 0.015 g/cc from 1.7 - 3.05 g/cc, PEF: +/- 5% from 1-10 units	Scintillation	Average density 4 and 16 sector azimuthal density Image derived density Real time and recorded images PEF Density caliper	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Source: Y	Y	N	N	N/A	Variable	N/A	N/A	10.1	+/- 0.015 g/cc from 1.7 - 3.05 g/cc, PEF: +/- 5% from 1-10 units	Scintillation	Average density 4 and 16 sector azimuthal density Image derived density Real time and recorded images PEF Density caliper	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	Source: Y	Y	N	N	N/A	Variable	N/A	N/A	10.5	+/- 0.015 g/cc from 1.7 - 3.05 g/cc, PEF: +/- 5% from 1-10 units	Scintillation	Average density 4 and 16 sector azimuthal density Image derived density Real time and recorded images PEF Density caliper	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous Wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	17	+/- 0.5 pu < 10 pu +/- 5% 10-50 pu	Helium 3 (Source is non-chemical)	Neutron porosity: BPH / TNPH Ultrasonic caliper Capture Spectroscopy Sigma	TeleScope Turbine	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	4.8	+/- 1 pu or +/- 5% whichever is greater	Gradient field antenna	Total porosity, BVF, FFV, T1 and/or T2 modes	Turbine	Y	Y
Downlink from surface	Telescope positive continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	Variable	N/A	5.28	± [2.2 + 0.01% of reading]	Advanced COG - High Precision Crystal (primary) Strain gauge (secondary)	Formation pressure, annular pressure	MWD turbine or lithium battery	Y	Y
Downlink from surface	Telescope positive continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	Variable	N/A	5.62	± [2.2 + 0.01% of reading]	Advanced COG - High Precision Crystal (primary) Strain gauge (secondary)	Formation pressure, annular pressure	MWD turbine or lithium battery	Y	Y
Downlink from surface	Telescope positive continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	Variable	N/A	5.03	± [2.2 + 0.01% of reading]	Advanced COG - High Precision Crystal (primary) Microsapphire (secondary)	Formation pressure, annular pressure	MWD turbine or lithium battery	Y	Y
Pumps on/Pumps off	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y		Variable			6.8	Density +/- .025 g/cc ; Pe +/- 5%	Gain-stabilized Scintillation	self-binned, quadrant, and 16-bin azimuthal RHOB, DRHO, Pe, and Caliper	Lithium battery - up to 1400 hrs.	Y	Y
Downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.		N/A	(4 3/4) 1.7, (6 3/4) 20.7, (8 1/4) 20.8	0.02% FS	Quartz gauge	Formation pressure, annular pressure	Turbine generator, no limit; battery opt.	Y	Y
Surface-to-downhole command sent via mud pulse telemetry	Positive or negative pulse	N	Y	N	N		Variable			(4 3/4) 7.11, (6 3/4) 7 ft, (8, 9 1/2) 7.12 ft.	+/- (1 psi + 0.012% FS)	Quartz and strain gauges	Annular and internal pressures while drilling; formation pressure while testing	Battery, 1,000+ tests	Y	Y
Stop pumps start pumps	Positive pulse	N	Y	N	N	N/A	8	N/A	N/A	11.3	+/-0.02% of full scale and 0.01% of reading	Quartz gauge	Formation pressure, annular pressure	Lithium battery 400 hr	Y	Y
Downlink from surface	Telescope positive continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	Variable	N/A	5.28	± [2.2 + 0.01% of reading]	Advanced COG - High Precision Crystal (primary) Strain gauge (secondary)	Formation pressure, annular pressure	MWD turbine or lithium battery	Y	Y
Downlink from surface	Telescope positive continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	Variable	N/A	5.62	± [2.2 + 0.01% of reading]	Advanced COG - High Precision Crystal (primary) Strain gauge (secondary)	Formation pressure, annular pressure	MWD turbine or lithium battery	Y	Y
Downlink from surface	Telescope positive continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Variable	Variable	N/A	3.25	± [2.2 + 0.01% of reading]	Advanced COG - High Precision Crystal (primary) Microsapphire (secondary)	Formation pressure, annular pressure	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Downhole logic configuration	Typical 150	N/A	36.05 hydrophone & geophones	+/- 2 ms check-shot recorded mode, 3s recording for each components	Hydrophone and 3 component geophones	RT Check shot, 4-component waveforms, RT waveforms capability	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Downhole logic configuration	Typical 150	N/A	30.41 hydrophone & geophones	+/- 2 ms check-shot recorded mode, 3s recording for each components	Hydrophone and 3 component geophones	RT Check shot, 4-component waveforms, RT waveforms capability	MWD turbine or lithium battery	Y	Y

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Service Line (s)	Tool OD, in.	Length, ft	Max. D.P.S. * 100 ft (collars, rotation)	Equivalent bending stiffness	Max. op. temperature (°C)	Max. op. pressure, kpsi	Pressure drop, psi at 100 gal/min	Pressure drop, psi at 250 gal/min	Pressure drop, psi at 450 gal/min	Pressure drop, psi at 1,200 gal/min	Flow range, gpm/min
seismicVISION900	9	13.84	12/4	14.8	150	23	0.1	0.7	2.2	15.6	2,000
<b>Well Placement Technology</b>											
<b>Baker Hughes</b>											
AziTrak MWD	4 3/4, 6 3/4	(4 3/4) 40.4, (6 3/4) 35.3	(z)	TBD	150	std 20 (4 3/4) opt. 25, (6 3/4) opt. 30	(j)				4 3/4) 125-350, (6 3/4) 265-900
ZoneTrak (Bit Resistivity)	6 3/4, 9 1/2	(6 3/4) 6.3, (9 1/2) 5.7	(z)	(6 3/4) 7.25 x 3.64, (9 1/2) 9.63 x 3.7	150	std 20, opt 25	(j)				(6 3/4) 200-900 (9 1/2) 300-1,600 function of MWD platform
DeepTrak	6.75	Transmitter Sub: 6.9 ft Receiver Sub: 22.4 ft	(z)	TBD	150	std 20, opt 25	(j)				200-900, function of MWD platform
StarTrak	4 3/4, 6 3/4	(4 3/4) 9.8, (6 3/4) 8.3	(z)	(4 3/4) 5.25 x 3.13, (6 3/4) 7.25 x 4.6	150	std 20, opt 25	(i)				(4 3/4) 125-350, (6 3/4) 265-900, function of MWD platform
<b>Halliburton/Sperry Drilling</b>											
Azimuthal Deep Resistivity (ADR)	4 3/4, 6 3/4	(4 3/4) 25.5, (6 3/4) 24.3	(4 3/4) 30/14, (6 3/4) 21/10	(4 3/4) 4.76x2.25, (6 3/4) 6.71x2.81	150	25		(4 3/4) 152, (6 3/4) 14	(4 3/4) 419, (6 3/4) 38	(6 3/4) 229	
Azimuthal Focused Resistivity (AFR)	4 3/4, 6 3/4, 8	(4 3/4) 10.0, (6 3/4) 10.8, (8) 8.5	(4 3/4) 30/14, (6 3/4) 21/10, (8) 14/8	(4 3/4) 4.74x2.25, (6 3/4) 6.56x2.81, (8) TBD	150	(4 3/4) 24.5, (6 3/4) 22, (8) 24.5		(4 3/4) 78, (6 3/4) 6, (8) 2	(4 3/4) 214, (6 3/4) 17, (8) 5	(6 3/4) 101, (8) 25	
At-Bit Inclination (ABI)	4 3/4, 6 3/4, 8, 9 5/8	Part of Mud Motor	(4 3/4) 30/14, (6 3/4) 21/10, (8, 9 5/8) 14/8	Depends on mud motor	150	18	Depends on mud motor	Depends on mud motor	Depends on mud motor	Depends on mud motor	Depends on mud motor
<b>PathFinder</b>											
Payzone Inclination Gamma	4 3/4, 6 3/4	7.13 upper, 2.7 lower	(4 3/4) 31/17, (6 3/4) 17/9	(4 3/4) 4.66x2.25, (6 3/4) 6.57x2.81	150	20	N/A	(4 3/4) 70, (6 3/4) 20	(4 3/4) N/A, (6 3/4) 35	N/A	(4 3/4) 125-375, (6 3/4) 250-750
<b>Schlumberger</b>											
PeriScope	4 3/4, 6 3/4	23.5 (4 3/4), 18.3 (6 3/4)	30/15 (4 3/4), 16/8 (6 3/4)	4.75x2.25x27 (4 3/4), 6.5x2.81x19.3 (6 3/4)	150	25	(4 3/4) 10, (6 3/4) 0.7	(4 3/4) 65, (6 3/4) 4	(6 3/4) 14	N/A	0-400 (4 3/4), 0-800 (6 3/4)
geoVISION675	6.75	10.12	16/8	6.5x2.81x10	150	18	0.9	5.5	18	N/A	0-800
geoVISION825	8.25	12.72	13/7	8x2.81x13.5	150	15	0.15	0.95	3	21.8	0-1,200
EcoScope	6 3/4 with 7 7/8, 8 3/8, or 9 3/8 Stabilizer Options	25.2	16", 8"	6.5x2.81x24.5	150 std. 175 opt.	20	2	10	32	N/A	250-800
arcVISION312	3.125	23.5	100/30	3x1.75x33	150	20	112	N/A	N/A	N/A	0-160
<b>Weatherford</b>											
Multi-Frequency Resistivity-PLUS(MFR-PLUS)	4.75	34.7	30/15	4.75x2.29	150	30	19	105	320	n/a	80-350
GuideWave Azimuthal Multi-Frequency Resistivity (Az-MFR)	4.75	34.7	30/15	4.75x2.29	150	20 Std., 30 opt.	19	105	320	n/a	80-350
At-Bit Measurement System	4 3/4, 6 3/4 NOM TOOL SIZE (5.60" and 7.325" max)	(4 3/4) 2.83 ft., (6 3/4) 3.01 ft.	(4 3/4) 30/15, (6 3/4) 19/10		(4 3/4, 6 3/4) 150	(4 3/4) 10 (6 3/4) 10	estimates (4 3/4) 12, (6 3/4) 2	estimates (4 3/4) 64, (6 3/4) 9	estimates (4 3/4) exceeds flow rate, (6 3/4) 26	estimates (6 3/4) 170	(4 3/4) 80-350; (6 3/4) 80-800; (8 1/4, 9 1/2) 80-1,800
<b>Formation Fluid Identification and Sampling</b>											
<b>Halliburton/Sperry Drilling</b>											
GeoTap IDS	6 3/4	34.7 + 11.8 per sample collar	21/10	6.89x2.81 (with one sample collar)	150	20	TBD	TBD	TBD	TBD	TBD

Transmission trigger	Telemetry type	Wireline retrievable	Downlink kind	Downlink scheme	Downlink & usage	MFT/RTF switch	Regulation update period, sec	Survey time period, sec	Survey / Logging mode(s)	Measurements from tool bottom ft	Measurement accuracy	Detector type	Measurement	Power source/life, hr	Realtime	Recovery
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording, Wired Drill Pipe option	N	Y	N	N	N/A	Downhole logic configuration	Typical 150	N/A	30.41 hydrophone & geophones	+/- 2 ms check-shot recorded mode, 3s recording for each component	Hydrophone and 3 component geophones	RT Check shot, 4-component waveforms, RT waveforms capability	MWD turbine or lithium battery	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	Op. Sel.	Op. Sel.	Continuous	Y/Y	(4 3/4) 4.6, (6 3/4) 6.2	2 MHz phase diff. +/-0.4 mmho/m 400 kHz phase diff. +/-0.8 mmho/m 2 MHz Atten. +/- 0.85 mmho/m 400kHz Atten. +/- 4 mmho/m, up to 17 ft boundary detection, +/- 2.5 cps at 100 API	Multiple spacing / frequency transmitter/receiver antenna configuration combined with orthogonal receivers for azimuthal sensitivity, 2 scintillation (Azi).	Azimuthal Gamma Ray, 360° directional deep reading propagation resistivity, boundary detection and imaging for precise reservoir navigation	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave (yy), Wired Pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	Application specific	+/- 5%	Transmitter/receiver antenna configuration	Apparent Resistivity	Turbine generator, no limit	Y	Y
Start pumps, or downlink from surface	Positive mud pulse, Positive Continuous Wave	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	10.9	± 0.01dB Att. ± 0.01° Phase Diff.	Transmitter/receiver antenna configuration	Apparent Resistivity	Turbine generator, no limit	Y	Y
Stop pumps, start pumps, stop rotary, or downlink from surface	Positive mud pulse, Positive Continuous Wave, Wired Pipe (zz)	N	Y	N	N	N/A	Op. Sel.	Continuous	Y/Y	(4 3/4) 5.6, (6 3/4) 3.7		Button	High resolution azimuthal resistivity	Turbine generator, no limit	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N		Variable			(4 3/4) 11.4, (6 3/4) 11	For 48 in. 2 MHz Phase Res: +/- 1% or +/- 0.2 mS/m for Res. < 2000 ohm-m For 48 in. 2 MHz Attenuation Res: +/- 0.8 mS/m or +/- 2% < 1000 ohm-m. Uncertainties for the shorter spacings and lower frequencies will be larger.	16, 32, and 48 in. compensated resistivity spacings plus many geosteering spacings	Azimuthally sensitive 2 MHz, 500 kHz, and 125 kHz phase shift and attenuation. Geosteering signals from various spacings.	Negative pulse: battery (400), positive pulse: generator and/or battery	Y	Y
	Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N		Variable			(4 3/4) 4.8, (6 3/4) 5.3, (8) 4.1	+/- 2% 0-200 ohm-m; +/- 3% @ 500 ohm-m; +/- 10% @ 1,000 ohm-m; +/- 20% @ 2,000 ohm-m	(4 3/4, 6 3/4) Electrodes at three spacings from the two transmitters and bit; (8) Electrodes at two spacings from the two transmitters and bit	Azimuthally sensitive laterolog-type resistivity and AT-Bit Resistivity	Negative pulse: battery (400), positive pulse: generator and/or battery	Y	Y
	Short-hop through mud motor and then Positive, Negative (6 3/4 and larger), or Electromagnetic	N	Y	N	N		Variable			(4 3/4) - 10, but depends on mud motor; (6-3/4, 8, 9-5/8) 1.3	+/- 0.5 degrees	(4 3/4, 6 3/4, 8, 9 5/8) Tri-axial accelerometers; (4 3/4) also includes 4 azimuthally focused GR scintillation detectors	Inclination	Battery	Y	Y
Stop pumps, start pumps	Positive pulse (EM sub to sub)	N	Y	N	N	N/A	8	N/A	Y	(4 3/4) Gamma 0.9, Incl. 1.8, (6 3/4) Gamma 1.6, Incl. 2.6	Incl. +/- 0.25	Tri-axial accelerometer and scintillator	AAPI GR, Incl., RPM,	Lithium battery (4 3/4) 200, (6 3/4) 400	Y	N
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	7.7 (4 3/4) 9.1 (6 3/4)	Azimuthal Resolution - 2°	22, 34, 44, 74, 84 & 96 in spacing	API Azimuthal GR, 360° directional, deep reading, bed boundary identification and mapping for optimal well placement	MWD turbine	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	Ring 3.5, Button D - 4.2, Button M - 4.8, Button S - 5.2	5% 0.1<res< 250 ohm-m, 10% 250<res< 500 ohm-m, 20% 500<res< 5,000 ohm-m	Ring, bit, and 3 buttons	Azi. laterolog resistivity 56 sector real-time images	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	Ring 3.7, Button D - 4.2, Button M - 4.8, Button S - 5.2	5% 0.1<res< 250 ohm-m, 10% 250<res< 500 ohm-m, 20% 500<res< 5,000 ohm-m	Ring, bit, and 3 buttons	Azi. laterolog resistivity 56 sector real-time images	MWD turbine or lithium battery	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous Wave and downhole recording / Wired drill pipe opt.	N	Y	N	N	N/A	Variable	N/A	N/A	9	+/- 0.015 g/cc from 1.7 - 3.05 g/cc, PEF. +/- 5% from 1-10 units	Scintillation	Average density 4 and 16 sector azimuthal density image derived density Real time and recorded images PEF PE images Density caliper	TeleScope turbine	Y	Y
Real-time, pumps on downhole recording	MWD Positive Continuous wave and downhole recording	N	Y	N	N	N/A	Variable	N/A	N/A	4.4	Inclination: 0.2° at 90° incl. ; Resistivity: +/- 2% for PS res< 60 ohm-m, +/- 0.3mS/m for PS 60 < res < 3,000 ohm-m, +/- 3% for ATT res<25 ohm-m, +/-1.5mS/m for ATT 25 < res < 50 ohm-m	Accelerometer, 10, 16, 22, 28, 24 in. spacing	Near bit Inclination, 2 MHz, 400 kHz phase shift, attenuation	Lithium battery	Y	Y
Stop pumps, start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y		Variable			15.12 All sizes	Phase +/- .25 mmho Attenuation +/- .5 mmho	Compensated 2 MHz, 400 & 100 kHz; 20°, 30°, 46° & 80° transmitter spacing	2 MHz, 400 & 100 kHz phase and attenuation resistivity	Lithium battery - up to 1400 hrs.	Y	Y
Stop pumps, start pumps	Positive mud pulse, Electromagnetic, Wired Pipe	N	Y	N	Y		Variable	N/A	N/A	17.7	Phase +/- .25 mmho Attenuation +/- .5 mmho	Compensated 2 MHz, 400 & 100 kHz; 20°, 30°, 46° & 80° xmtr. Spacing.	2 MHz, 400 & 100 kHz phase and atten. Resistivity, Up/Down, Quadrant, 8 or 16 bins	Lithium battery - up to 1400 hrs.	Y	Y
N/A	Positive mud pulse, Electromagnetic, Wired Pipe	N	N	N	N	N/A	Variable	inc 16	sliding/rotating - inc only	Inc. 7 Gamma 1.5 *GR avail on 4 3/4" only	Inc >20°, +/- .25° Gamma 5% @ 100 API	Accelerometer Scintillation	1-axis inc. API GR: Total, up/down *GR avail on 4 3/4" only	Lithium battery - 240 std 800 opt	Y	Y
Surface-to-downhole command sent via mud pulse telemetry	Positive or negative pulse	N	Y	N	N		Variable			5.4	+/- (1 psi + 0.012% FS)	Quartz and Strain gauges	Formation pressure while testing, Formation fluid ID while testing, Formation fluid sample	Mud-powered hydraulic pump	Y	Y