HALLIBURTON

Sperry Drilling Services

LWD End of Well Report

for

Anzon Australia Ltd

Basker -2

Rig: Ocean Patriot

Field: Basker

Country: Australia

Job No: AU-FE-0003704943

Date: 15th August 2005

HALLIBURTON

Table of Contents

General Information

Company:	Anzon Australia Ltd	
Rig:	Ocean Patriot	
Well:	Basker-2	
Field:	Basker	
Country:	Australia	
API Number:		
Sperry-Sun Job Number:	AU-FE-0003704943	
Job start date:	15-Aug-05	
Job end date:	11-Sep-05	
North reference:	Grid	
Declination:	13.380 deg	
Dip angle:	-68.731 deg	
Total magnetic field:	59926 nT	
Date of magnetic data:	12-Aug-05	
Wellhead coordinates N:	38 deg. 17 min 58.510 sec South	
Wellhead coordinates E:	148 deg. 42 min 24.720 sec East	
Vertical section direction:	189.88 deg	
MWD Engineers:	A. Oraekwuotu	J. Nicolson
	A. Rule	
Company Representatives:	W. Westman	R. King
Company Geologist:	M. Woodmansee	R. Blackmore
Lease Name:	VIC/RL6	
Unit Number:	SDL-197	
State:	Victoria	
County:		

Operational Overview

Sperry Drilling Services, a division of Halliburton, were contracted by Anzon Australia Ltd to provide Logging While Drilling (LWD) services on the appraisal well Basker-2, located in the Bass Strait, offshore Victoria.

36" Hole Section
Sperry tools were not run in the 36" hole section.

17½" Hole Section
This hole section was drilled with a rotary assembly and Directional Gamma while Drilling (DGWD) tools to provide realtime directional survey as well as realtime and recorded gamma data. The tools used incorporated a positive pulser, Directional Module (DM), Gamma Module (GM) and a Battery Module (BM) to enable pumps down surveys. It was drilled in one bit run from 208.0 to 1006.0 mMDRT.

12¼" Hole section
This hole section was drilled with a steerable assembly and logging while drilling (LWD) tools to provide realtime and recorded directional survey, drilling and formation evaluation data. The tools incorporated a positive pulser, Directional Module (DM), Dual Gamma Ray (DGR), Electromagnetic Wave Resistivity (EWR) and Drillstring Dynamics Senor (DDS) to monitor downhole string vibration. It was drilled in three bit runs from 1006.0m to 2956.0 mMDRT.

8½" Hole section
This hole section was drilled with a steerable assembly and logging while drilling (LWD) tools to provide realtime and recorded directional survey and formation evaluation data. The tools incorporated a positive pulser, Position Monitor (PM), Dual Gamma Ray (DGR) and Electromagnetic Wave Resistivity (EWR). It was drilled in two bit runs from 2956.0m to Basker-2 TD at 3414.0 mMDRT.

Summary of MWD runs

Run No.	Bit No.	Hole Size (mm)	MWD Service	Start Depth (m)	End Depth (m)	Drill/Wipe Distance (m)	Run Start Date Time	Run End Date Time	BRT Hrs.	Oper. Hrs.	Circ. Hrs.	Max. Temp. (degC)	Serv. Int.	Trip for MWD	Failure Type
0100	2	445.00	DIR-GR	208.00	1006.00	798.00	15-Aug-05 13:00	17-Aug-05 02:37	37.62	37.62	26.25	24.00	No	No	
0200	3	311.00	DIR-FE	1006.00	2497.00	1491.00	19-Aug-05 15:49	25-Aug-05 14:38	142.81	142.81	57.99	63.00	No	No	
0300	4	311.00	DIR-FE	2497.00	2741.00	244.00	31-Aug-05 02:48	03-Sep-05 03:46	72.98	72.98	56.46	80.00	No	No	
0400	5	311.00	DIR-FE	2741.00	2956.00	215.00	03-Sep-05 19:32	06-Sep-05 07:40	60.14	60.14	36.57	85.00	No	No	
0500	6	216.00	DIR-FE	2956.00	3310.00	354.00	08-Sep-05 02:45	10-Sep-05 05:12	50.45	50.45	28.07	96.00	No	No	
0600	7	216.00	DIR-FE	3310.00	3414.00	104.00	10-Sep-05 05:57	11-Sep-05 22:58	41.02	41.02	22.92	108.00	No	No	
				TOTALS ⟹		3206.00			405.01	405.02	228.26		0	0	

Bitrun Summary

Run Time Data

MWD Run :	0100	
Rig Bit No:	2	
Hole Size :	445	mm
Run Start :	15-Aug-05 13:00	
Run End :	17-Aug-05 02:37	
BRT Hrs :	37.62	
Circ. Hrs :	26.25	
Oper. Hrs :	37.62	

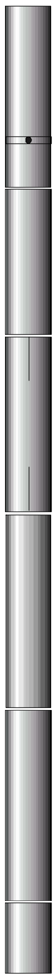
Drilling Data

Start Depth :	208.0	m
End Depth :	1006.0	m
Footage :	798.0	m
Avg. Flow Rate :	1000	gpm
Avg. RPM :	140	rpm
Avg. WOB :	14	klb
Avg. ROP :	38.19	m/hr
Avg. SPP :	2145	psig

Mud Data

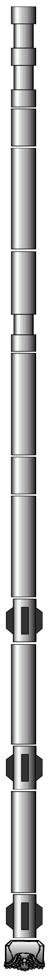
Mud Type :	Seawater / Hi-Vis			
Weight / Visc :	1.05	sg /	N/A	spqt
Chlorides :	N/A	ppm		
PV / YP :	1.00	cp /	1.00	lhf2
Solids/Sand :	N/A	% /	N/A	%
%Oil / O:W :	N/A	% /	N/A	
pH/Fluid Loss:	7.00	pH /	N/A	mptm
Max. Temp. :	24.00	degC		

MWD Schematics



6. Positive Pulser
   SN : 8298
5. TM
   SN : 10505184
4. DM
   SN : 149865
   13.88 m From Bit
3. GM
   SN : 83563
   12.00 m From Bit
2. Battery Module
   SN : 25635
1. Hang-off Collar
   SN : 209351

BHA Schematics



	Component	Length (m)	O.D. (mm)	I.D. (mm)
13.	HWDP	138.43	127	76
12.	Cross Over Sub	1.17	203	76
11.	Drill Collar	18.56	203	76
10.	Drilling Jars	10.11	203	76
09.	Drill Collar	26.68	203	76
08.	Cross Over Sub	1.17	241	75
07.	Drill Collar	27.33	241	73
06.	Integral Blade Stabilizer	1.99	241	76
05.	MWD	9.88	241	76
04.	Integral Blade Stabilizer	2.44	241	76
03.	Pony collar	3.00	241	76
02.	Integral Blade Stabilizer	1.57	241	76
01.	Tricone Hughes MX-1	0.41	445	76

Comments

Drilled 17½" hole from 208.0 m to 1005.0 mMDRT. POOH to run casing.

MWD Performance

Tool OD / Type :	241	mm / D/GWD		
MWD Real-time%:	100.0	%		
MWD Recorded%:	95.0	%		
Min. Inc. :	0.00	deg /	885.23	m
Max. Inc. :	0.19	deg /	224.64	m
Final Az. :	275.80	deg		
Max Op. Press. :	1500	psig		

HALLIBURTON

Sperry Drilling Services

Bitrun Summary

Run Time Data			Drilling Data			Mud Data				
MWD Run :	0200		Start Depth :	1006.0	m	Mud Type :	KCl/PHPA/Glycol			
Rig Bit No:	3		End Depth :	2497.0	m	Weight / Visc :	1.21	sg /	55	spqt
Hole Size :	311	mm	Footage :	1491.0	m	Chlorides :	41000	ppm		
Run Start :	19-Aug-05 15:49		Avg. Flow Rate :	920	gpm	PV / YP :	15	cp /	31	lhf2
Run End :	25-Aug-05 14:38		Avg. RPM :	100	rpm	Solids/Sand :	10	% /	0.5	%
BRT Hrs :	142.81		Avg. WOB :	10	klb	%Oil / O:W :	0	% /	N/A	
Circ. Hrs :	57.99		Avg. ROP :	34.5	m/hr	pH/Fluid Loss:	8.4	pH /	4.4	mptm
Oper. Hrs :	142.81		Avg. SPP :	3500	psig	Max. Temp. :	63	degC		

MWD Schematics

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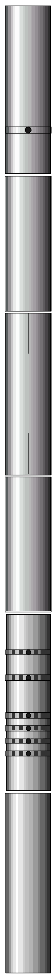

6. Positive Pulser
   SN : 8513
5. TM
   SN : 147461
4. DM
   SN : 149865
   20.89 m From Bit
3. HCIM
   SN : 160772
2. EWR-P4
   SN : 151534
   15.79 m From Bit
1. DGR
   SN : 172496
   13.42 m From Bit

BHA Schematics

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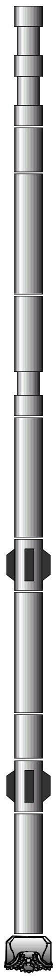


	Component	Length (m)	O.D. (mm)	I.D. (mm)
11.	HWDP	138.43	162	78
10.	Cross Over Sub	1.17	203	70
09.	Pony collar	5.02	203	71
08.	Drilling Jars	10.11	203	70
07.	Drill Collar	17.64	203	76
06.	Integral Blade Stabilizer	2.47	203	74
05.	MWD	13.10	203	74
04.	Cross Over Sub	1.03	244	75
03.	Integral Blade Stabilizer	2.35	167	75
02.	9-5/8" SperryDrill Lobe 6/7 - 5 stg	8.50	245	75
01.	PDC Security DBS FM3653Z3	0.34	311	51

Comments

Drilled 12¼" hole to 2497.0 mMDRT. POOH to change the bit.

MWD Performance

Tool OD / Type :	203	mm /	P4M	
MWD Real-time%:	77.0	%		
MWD Recorded%:	100.0	%		
Min. Inc. :	0.12	deg /	1007.58	m
Max. Inc. :	2.13	deg /	2413.64	m
Final Az. :	337.28	deg		
Max Op. Press. :	4294	psig		

HALLIBURTON Sperry Drilling Services

Bitrun Summary

Run Time Data

MWD Run :	0300	
Rig Bit No:	4	
Hole Size :	311	mm
Run Start :	31-Aug-05 02:48	
Run End :	03-Sep-05 03:46	
BRT Hrs :	72.98	
Circ. Hrs :	56.46	
Oper. Hrs :	72.98	

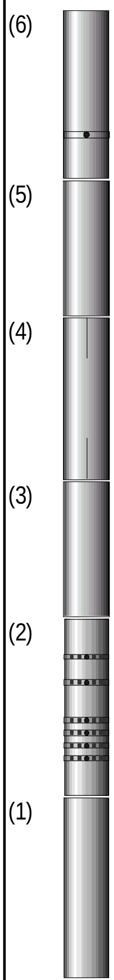
Drilling Data

Start Depth :	2497.0	m
End Depth :	2741.0	m
Footage :	244.0	m
Avg. Flow Rate :	890	gpm
Avg. RPM :	132	rpm
Avg. WOB :	28.4	klb
Avg. ROP :	7.26	m/hr
Avg. SPP :	3414	psig

Mud Data

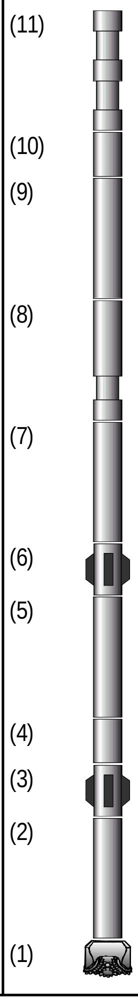
Mud Type :	KCl/PHPA/Glycol				
Weight / Visc :	1.2	sg	/	62	spqt
Chlorides :	30000	ppm			
PV / YP :	19	cp	/	37	lhf2
Solids/Sand :	10	%	/	0.5	%
%Oil / O:W :	0	%	/	N/A	
pH/Fluid Loss:	9.3	pH	/	4.4	mptm
Max. Temp. :	80	degC			

MWD Schematics



6. Positive Pulser
   SN : 8484
5. TM
   SN : 177893
4. DM
   SN : 185534
   24.18 m From Bit
3. HCIM
   SN : 93281
2. EWR-P4
   SN : 62355
   19.20 m From Bit
1. DGR
   SN : 172498
   16.84 m From Bit

BHA Schematics



	Component	Length (m)	O.D. (mm)	I.D. (mm)
11.	HWDP	138.43	162	78
10.	Cross Over Sub	1.17	203	71
09.	Pony collar	5.02	203	71
08.	Drilling Jars	10.11	203	70
07.	Drill Collar	17.64	203	76
06.	Integral Blade Stabilizer	2.47	203	74
05.	MWD	13.10	203	74
04.	Cross Over Sub	1.03	244	75
03.	Integral Blade Stabilizer	2.35	16	75
02.	9-5/8" SperryDrill Lobe 6/7 - 5 stg	8.50	245	75
01.	Tricone Smith GFS10BVOPS	0.35	311	73

Comments

Drilled 12¼" hole to 2741.0 mMDRT. Begin directional drilling at 2575.0 mMDRT. POOH to change bit.

MWD Performance

Tool OD / Type :	203	mm /	P4M	
MWD Real-time%:	96.25	%		
MWD Recorded%:	100.0	%		
Min. Inc. :	0.87	deg /	2557.34	m
Max. Inc. :	9.30	deg /	2700.45	m
Final Az. :	184.65	deg		
Max Op. Press. :	4670	psig		

Bitrun Summary

Run Time Data			Drilling Data			Mud Data					
MWD Run :	0400		Start Depth :	2741.0	m	Mud Type :	KCl/PHPA/Glycol				
Rig Bit No:	5		End Depth :	2956.0	m	Weight / Visc :	1.20	sg	/	65	spqt
Hole Size :	311	mm	Footage :	215.0	m	Chlorides :	38000	ppm			
Run Start :	03-Sep-05 19:32		Avg. Flow Rate :	889	gpm	PV / YP :	19	cp	/	45	lhf2
Run End :	06-Sep-05 07:40		Avg. RPM :	155	rpm	Solids/Sand :	10	%	/	0.5	%
BRT Hrs :	60.14		Avg. WOB :	33	klb	%Oil / O:W :	0	%	/	N/A	
Circ. Hrs :	36.57		Avg. ROP :	9.2	m/hr	pH/Fluid Loss:	8.8	pH	/	4.2	mptm
Oper. Hrs :	60.14		Avg. SPP :	3602	psig	Max. Temp. :	85	degC			

MWD Schematics

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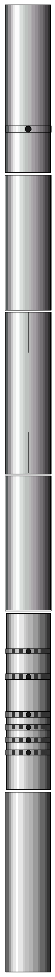

6. Positive Pulser
   SN : 8484
5. TM
   SN : 177893
4. DM
   SN : 185534
   18.39 m From Bit
3. HCIM
   SN : 93281
2. EWR-P4
   SN : 62355
   13.41 m From Bit
1. DGR
   SN : 172498
   11.05 m From Bit

BHA Schematics

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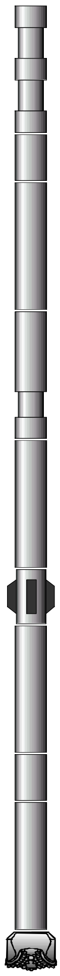

	Component	Length (m)	O.D. (mm)	I.D. (mm)
10.	HWDP	138.16	162	78
09.	Cross Over Sub	1.17	203	71
08.	Pony collar	5.02	203	71
07.	Drilling Jars	9.68	203	70
06.	Drill Collar	17.64	203	76
05.	Integral Blade Stabilizer	2.22	203	74
04.	MWD	12.97	203	74
03.	Cross Over Sub	1.03	244	75
02.	9-5/8" SperryDrill Lobe 6/7 - 5 stg	8.50	245	75
01.	Tricone Hughes MXCOPH	0.33	311	73

Comments

Drilled 12¼" hole to 2956.0 mMDRT. POOH to run casing.

MWD Performance

Tool OD / Type :	203	mm /	P4M	
MWD Real-time%:	98.5	%		
MWD Recorded%:	100.0	%		
Min. Inc. :	10.88	deg /	2728.71	m
Max. Inc. :	28.88	deg /	2930.70	m
Final Az. :	180.28	deg		
Max Op. Press. :	5010	psig		

HALLIBURTON Sperry Drilling Services

Bitrun Summary

Run Time Data

MWD Run :	0500	
Rig Bit No:	6	
Hole Size :	216	mm
Run Start :	08-Sep-05 02:45	
Run End :	10-Sep-05 05:12	
BRT Hrs :	50.45	
Circ. Hrs :	28.07	
Oper. Hrs :	50.45	

Drilling Data

Start Depth :	2956.0	m
End Depth :	3310.0	m
Footage :	354.0	m
Avg. Flow Rate :	674	gpm
Avg. RPM :	116	rpm
Avg. WOB :	12.7	klb
Avg. ROP :	22.3	m/hr
Avg. SPP :	3372	psig

Mud Data

Mud Type :	KCl/Polymer				
Weight / Visc :	1.13	sg	/	58	spqt
Chlorides :	39000	ppm			
PV / YP :	16	cp	/	36	lhf2
Solids/Sand :	7	%	/	0.5	%
%Oil / O:W :	0	%	/	N/A	
pH/Fluid Loss:	8.2	pH	/	5	mptm
Max. Temp. :	96	degC			

MWD Schematics

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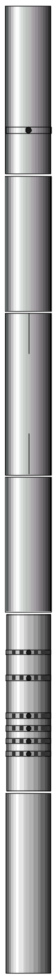

6. Positive Pulser
   SN : 8351
5. TM
   SN : 147461
4. PM
   SN : 143272
   20.44 m From Bit
3. HCIM
   SN : 161821
2. EWR-P4
   SN : 77531
   15.42 m From Bit
1. DGR
   SN : 87301
   13.06 m From Bit

BHA Schematics

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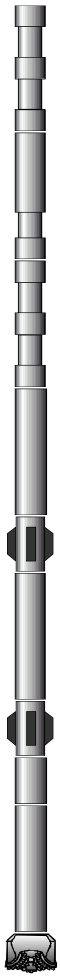

	Component	Length (m)	O.D. (mm)	I.D. (mm)
10.	HWDP	55.30	162	76
09.	Drilling Jars	9.86	165	69
08.	HWDP	109.89	162	76
07.	Drill Collar	18.67	165	73
06.	Integral Blade Stabilizer	1.91	165	74
05.	MWD	12.96	171	73
04.	Adjustable Gauge Stabilizer	3.24	200	76
03.	Float Sub	0.84	165	71
02.	7" SperryDrill Lobe 7/8 - 6 stg	7.69	178	121
01.	PDC DBS FM3743	0.25	311	73

Comments

Drilled 8½" hole. Poor detection until new mud completely sheared through the circulation system. POOH because of a pipe washout.

MWD Performance

Tool OD / Type :	171	mm /	P4M	
MWD Real-time%:	90.0	%		
MWD Recorded%:	100.0	%		
Min. Inc. :	25.94	deg /	3267.81	m
Max. Inc. :	30.08	deg /	2981.05	m
Final Az. :	171.77	deg		
Max Op. Press. :	5222	psig		

HALLIBURTON Sperry Drilling Services

Bitrun Summary

Run Time Data			Drilling Data			Mud Data					
MWD Run :	0600		Start Depth :	3310.0	m	Mud Type :	KCl/Polymer				
Rig Bit No:	7		End Depth :	3414.0	m	Weight / Visc :	1.12	sg	/	54	spqt
Hole Size :	216	mm	Footage :	104.0	m	Chlorides :	34000	ppm			
Run Start :	10-Sep-05 05:57		Avg. Flow Rate :	664	gpm	PV / YP :	17	cp	/	34	lhf2
Run End :	11-Sep-05 22:58		Avg. RPM :	106	rpm	Solids/Sand :	7	%	/	0.5	%
BRT Hrs :	41.02		Avg. WOB :	24	klb	%Oil / O:W :	0	%	/	N/A	
Circ. Hrs :	22.92		Avg. ROP :	5.4	m/hr	pH/Fluid Loss:	8.4	pH	/	4.6	mptm
Oper. Hrs :	41.02		Avg. SPP :	4013	psig	Max. Temp. :	108	degC			

MWD Schematics

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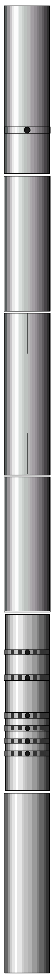

6. Positive Pulser
   SN : 8351

5. TM
   SN : 147461

4. PM
   SN : 143272
   11.62 m From Bit

3. HCIM
   SN : 161821

2. EWR-P4
   SN : 77531
   6.60 m From Bit

1. DGR
   SN : 87301
   4.24 m From Bit

BHA Schematics

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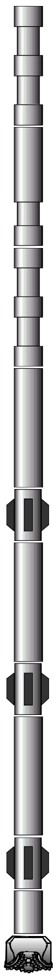


	Component	Length (m)	O.D. (mm)	I.D. (mm)
11.	HWDP	55.30	162	76
10.	Drilling Jars	9.86	165	70
09.	HWDP	109.89	162	76
08.	Drill Collar	18.66	165	73
07.	Integral Blade Stabilizer	1.97	171	73
06.	Drill Collar	9.38	165	73
05.	Integral Blade Stabilizer	1.34	171	73
04.	MWD	12.96	171	73
03.	Integral Blade Stabilizer	1.91	170	70
02.	Float Sub	0.95	165	71
01.	Ticone Hughes MX20D	0.34	311	73

Comments

Drilled to well TD at 3414.0 mMDRT.

MWD Performance

Tool OD / Type :	171	mm /	P4M	
MWD Real-time%:	98.0	%		
MWD Recorded%:	100.0	%		
Min. Inc. :	25.94	deg /	3364.81	m
Max. Inc. :	26.06	deg /	3307.72	m
Final Az. :	170.31	deg		
Max Op. Press. :	5322	psig		

Directional Survey Data

Measured Depth (metres)	Inclination (degrees)	Direction (degrees)	Vertical Depth (metres)	Latitude (metres)	Departure (metres)	Vertical Section (metres)	Dogleg (deg/30m)
176.00	0.00	0.00	176.00	0.00 N	0.00 E	0.00	TIE-IN
224.64	0.19	161.03	224.64	0.08 S	0.03 E	0.07	0.12
282.39	0.07	139.65	282.39	0.19 S	0.08 E	0.17	0.07
311.29	0.09	116.77	311.29	0.22 S	0.11 E	0.19	0.04
340.13	0.10	73.76	340.13	0.22 S	0.16 E	0.19	0.07
368.98	0.06	116.98	368.98	0.22 S	0.19 E	0.18	0.07
397.82	0.09	163.12	397.82	0.25 S	0.21 E	0.21	0.07
426.64	0.04	150.94	426.64	0.28 S	0.23 E	0.23	0.05
455.27	0.09	138.56	455.27	0.30 S	0.24 E	0.26	0.05
512.45	0.09	115.62	512.45	0.36 S	0.32 E	0.30	0.02
541.04	0.09	127.28	541.04	0.38 S	0.35 E	0.31	0.02
569.57	0.09	149.55	569.57	0.41 S	0.38 E	0.34	0.04
598.15	0.10	130.15	598.15	0.45 S	0.41 E	0.37	0.03
626.68	0.07	122.82	626.68	0.47 S	0.45 E	0.39	0.03
655.39	0.07	93.47	655.39	0.48 S	0.48 E	0.40	0.04
684.11	0.09	75.67	684.11	0.48 S	0.52 E	0.38	0.04
713.01	0.07	46.86	713.01	0.46 S	0.55 E	0.36	0.05
741.78	0.09	14.62	741.78	0.43 S	0.57 E	0.32	0.05
770.73	0.11	35.10	770.73	0.39 S	0.59 E	0.28	0.04
799.47	0.10	46.21	799.47	0.35 S	0.63 E	0.23	0.03
828.16	0.07	89.32	828.16	0.33 S	0.66 E	0.21	0.07
856.72	0.07	42.39	856.72	0.32 S	0.69 E	0.19	0.06
885.23	0.00	253.43	885.23	0.30 S	0.70 E	0.18	0.07
913.66	0.06	324.63	913.66	0.29 S	0.69 E	0.17	0.07
970.77	0.04	321.60	970.77	0.25 S	0.66 E	0.13	0.01
990.30	0.10	275.80	990.30	0.24 S	0.64 E	0.13	0.11
1007.58	0.12	323.98	1007.58	0.22 S	0.62 E	0.12	0.16
1036.29	0.17	300.46	1036.29	0.18 S	0.56 E	0.08	0.08
1065.04	0.17	5.05	1065.04	0.11 S	0.53 E	0.02	0.19
1093.90	0.22	331.06	1093.90	0.02 S	0.50 E	-0.07	0.13
1122.82	0.14	342.26	1122.82	0.06 N	0.47 E	-0.14	0.09
1151.70	0.31	334.26	1151.70	0.17 N	0.42 E	-0.24	0.18
1180.48	0.25	318.65	1180.48	0.28 N	0.35 E	-0.34	0.10
1209.26	0.31	340.89	1209.26	0.40 N	0.28 E	-0.45	0.13
1237.94	0.31	337.82	1237.94	0.55 N	0.23 E	-0.58	0.02
1294.96	0.41	316.37	1294.96	0.84 N	0.03 E	-0.83	0.09
1323.33	0.41	317.99	1323.33	0.99 N	0.11 W	-0.95	0.01
1351.78	0.50	308.15	1351.77	1.14 N	0.28 W	-1.08	0.12
1380.29	0.45	323.73	1380.28	1.31 N	0.44 W	-1.21	0.15
1408.92	0.56	313.66	1408.91	1.49 N	0.61 W	-1.37	0.15

Directional Survey Data

Measured Depth (metres)	Inclination (degrees)	Direction (degrees)	Vertical Depth (metres)	Latitude (metres)	Departure (metres)	Vertical Section (metres)	Dogleg (deg/30m)
1466.44	0.57	319.35	1466.43	1.90 N	1.00 W	-1.70	0.03
1495.45	0.53	333.19	1495.44	2.13 N	1.15 W	-1.90	0.14
1524.52	0.62	322.85	1524.51	2.38 N	1.31 W	-2.12	0.14
1553.75	0.62	337.42	1553.74	2.65 N	1.46 W	-2.36	0.16
1582.70	0.61	335.79	1582.68	2.93 N	1.58 W	-2.62	0.02
1611.64	0.79	336.96	1611.62	3.26 N	1.73 W	-2.91	0.18
1640.30	0.88	343.27	1640.28	3.65 N	1.87 W	-3.27	0.14
1727.42	1.05	341.55	1727.39	5.05 N	2.31 W	-4.58	0.06
1753.75	1.25	345.40	1753.71	5.55 N	2.46 W	-5.05	0.24
1782.06	1.31	348.87	1782.01	6.17 N	2.60 W	-5.63	0.10
1810.73	1.32	342.05	1810.68	6.81 N	2.77 W	-6.23	0.16
1839.51	1.16	347.31	1839.45	7.41 N	2.93 W	-6.80	0.20
1868.40	1.33	345.60	1868.33	8.02 N	3.08 W	-7.37	0.18
1897.60	1.53	346.99	1897.52	8.73 N	3.25 W	-8.04	0.21
1926.73	1.66	346.26	1926.64	9.52 N	3.44 W	-8.78	0.14
1955.70	1.49	331.53	1955.60	10.25 N	3.72 W	-9.46	0.45
1984.13	1.39	329.83	1984.02	10.87 N	4.07 W	-10.02	0.11
2012.56	1.45	328.82	2012.44	11.48 N	4.43 W	-10.55	0.07
2040.96	1.49	334.37	2040.83	12.12 N	4.77 W	-11.12	0.16
2069.47	1.39	333.91	2069.34	12.76 N	5.08 W	-11.70	0.10
2184.59	1.56	330.85	2184.42	15.38 N	6.46 W	-14.05	0.05
2213.55	1.69	337.47	2213.37	16.12 N	6.82 W	-14.72	0.24
2242.35	1.79	336.87	2242.15	16.93 N	7.16 W	-15.45	0.10
2271.08	1.80	337.68	2270.87	17.76 N	7.50 W	-16.21	0.03
2299.80	1.92	339.68	2299.57	18.63 N	7.84 W	-17.01	0.14
2328.31	1.98	339.76	2328.07	19.54 N	8.18 W	-17.84	0.07
2356.39	1.99	341.40	2356.13	20.46 N	8.50 W	-18.69	0.06
2384.84	2.01	340.79	2384.56	21.39 N	8.82 W	-19.56	0.03
2413.64	2.13	341.03	2413.34	22.38 N	9.16 W	-20.47	0.12
2442.71	2.02	337.08	2442.39	23.36 N	9.54 W	-21.38	0.19
2472.22	2.07	337.28	2471.89	24.33 N	9.95 W	-22.26	0.05
2499.05	2.11	341.02	2498.70	25.25 N	10.30 W	-23.10	0.16
2527.69	1.24	320.72	2527.33	25.98 N	10.66 W	-23.77	1.09
2557.34	0.87	264.89	2556.97	26.21 N	11.09 W	-23.92	1.05
2585.21	1.48	194.31	2584.84	25.84 N	11.39 W	-23.51	1.56
2612.45	3.62	191.42	2612.05	24.66 N	11.65 W	-22.29	2.36
2643.41	6.45	190.09	2642.89	21.99 N	12.15 W	-19.58	2.74
2671.36	7.27	185.29	2670.64	18.68 N	12.58 W	-16.25	1.07
2700.45	9.30	184.65	2699.42	14.51 N	12.94 W	-12.07	2.09
2728.71	10.88	181.90	2727.24	9.57 N	13.22 W	-7.16	1.76

Directional Survey Data

Measured Depth (metres)	Inclination (degrees)	Direction (degrees)	Vertical Depth (metres)	Latitude (metres)	Departure (metres)	Vertical Section (metres)	Dogleg (deg/30m)
2757.90	13.90	178.27	2755.75	3.31 N	13.20 W	-0.99	3.20
2786.38	15.37	180.97	2783.30	3.89 S	13.16 W	6.09	1.70
2814.75	16.98	182.03	2810.55	11.79 S	13.37 W	13.91	1.73
2844.32	19.56	181.05	2838.63	21.05 S	13.62 W	23.08	2.63
2872.38	24.39	182.40	2864.64	31.54 S	13.95 W	33.47	5.19
2901.45	28.38	180.27	2890.68	44.46 S	14.23 W	46.24	4.23
2930.71	28.88	180.28	2916.36	58.48 S	14.30 W	60.06	0.51
2981.05	30.08	180.84	2960.18	83.25 S	14.54 W	84.51	0.73
3009.87	29.88	179.84	2985.15	97.65 S	14.63 W	98.71	0.56
3038.46	29.08	178.87	3010.04	111.72 S	14.47 W	112.54	0.98
3066.64	28.66	178.39	3034.71	125.32 S	14.15 W	125.88	0.51
3095.28	28.69	178.54	3059.84	139.05 S	13.78 W	139.35	0.08
3123.98	28.01	177.16	3085.10	152.67 S	13.27 W	152.68	0.98
3153.21	27.87	176.17	3110.92	166.34 S	12.47 W	166.02	0.50
3181.82	27.45	174.86	3136.26	179.58 S	11.43 W	178.88	0.77
3210.14	26.65	173.92	3161.48	192.40 S	10.17 W	191.29	0.96
3238.54	26.31	172.34	3186.90	204.97 S	8.66 W	203.42	0.82
3267.81	25.94	171.77	3213.18	217.74 S	6.88 W	215.69	0.46
3307.72	26.06	170.42	3249.05	235.03 S	4.17 W	232.26	0.45
3364.81	25.94	170.20	3300.37	259.70 S	0.04 E	255.84	0.08
3401.22	25.96	170.31	3333.10	275.40 S	2.74 E	270.84	0.04
3414.00	25.96	170.31	3344.59	280.91 S	3.68 E	276.12	0.00

Directional Survey Data

CALCULATION BASED ON Minimum Curvature METHOD

SURVEY COORDINATES RELATIVE TO WELL SYSTEM REFERENCE POINT
TVD VALUES GIVEN RELATIVE TO DRILLING MEASUREMENT POINT

VERTICAL SECTION RELATIVE TO WELL HEAD
VERTICAL SECTION IS COMPUTED ALONG A DIRECTION OF 189.88 DEGREES (GRID)
A TOTAL CORRECTION OF 14.44 DEG FROM MAGNETIC NORTH TO GRID NORTH HAS BEEN APPLIED

HORIZONTAL DISPLACEMENT IS RELATIVE TO THE WELL HEAD.
HORIZONTAL DISPLACEMENT(CLOSURE) AT 3414.00 METRES
IS 279.57 METRES ALONG 178.86 DEGREES (GRID)

RT to MSL = 21.5m
Final survey projected to TD

Appendices

1. **Data Transmission**
2. **Post-Run Order on LWD Sheets**
3. **Sales Sheets for LWD Tools**

HALLIBURTON

Appendix 1.0 : Data Transmission

Discussion on factors affecting real time and recorded data transmission rates.

HALLIBURTON

Sperry Drilling Services

MUD PULSE TELEMETRY (MPT)

Sources of Noise and Pulse Attenuation

1.0 Background

This report is intended to give a broad background into factors that influence mud pulse detection.

1.1 Pulser Waves

Acoustic Velocity in a fluid (a_0):

The speed of sound in the fluid itself is defined as a_0. (This ignores the effect of pipe.)

Equation 1: $$a_0 = \sqrt{\frac{K}{\rho}}$$

Where: K = Bulk modulus of the fluid.
ρ = Density of the fluid.

Example: Assume a drilling condition (fluid, pressure, temperature, drill pipe) produces an acoustic velocity of 4,650 ft/s (a) in the pipe. If a pulse were produced at the end of an 11,000 ft drill string, it would take 2.37 seconds to reach the surface.

$$t = 11{,}000 \text{ ft} \div 4{,}650 \text{ ft/s} = 2.365\text{s}$$

The length of the wave (λ) created by the pulser can be calculated by multiplying the cycle time of the valve times the acoustic velocity of the fluid.

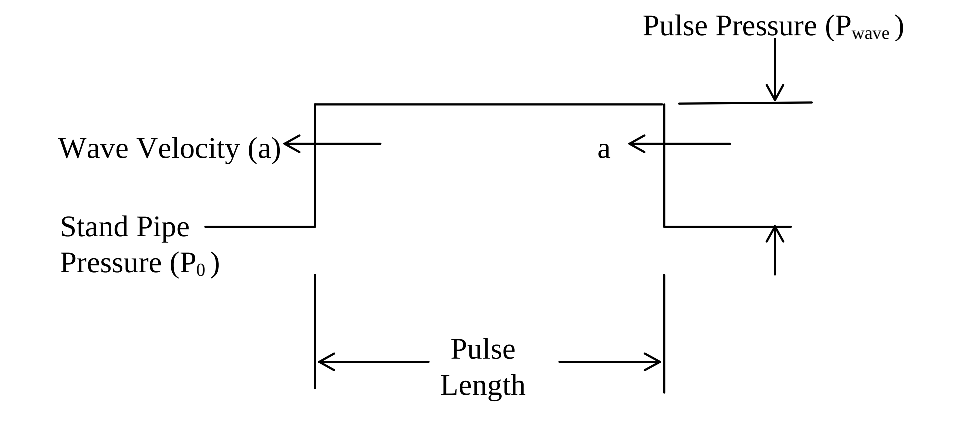


Figure 1: A pulse of length λ , amplitude (P_{wave}), and traveling in the pipe at the velocity a.

Example: 1 second DWD pulse

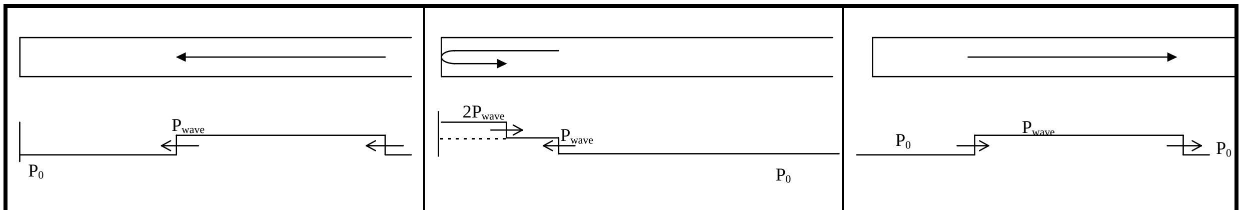
a = 4,650 ft/s

Length (λ) = 1 S X 4,650 ft/S = 4,650 ft

Note: The leading and trailing edge of the pulse are both traveling at the acoustic velocity (a).

1.2 Acoustic Reflectors & Reflections

When a MWD pressure wave travels through the piping system, it can come in contact with many different types of reflectors, which will cause the wave to reflect in different ways. When a wave reflects, the leading edge of the wave passes back over the trailing edge of the wave. Where the wave passes over itself, the pressure change at that point is the sum of the pressure waves.



A positive pressure wave approaching a “same sign” reflector.	As the wave reflects, it overlaps itself and the pressure is the sum of the waves over that section.	After the leading edge of the has passed the trailing edge of the wave the entire wave is traveling in the opposite direction.

Figure 2: The path of a wave while striking a “same sign” reflector.

Devices:

Solid end: A solid end produces a same sign reflection.[i] Meaning: if a positive wave (pressure rise) reflects from “solid end” you get the same pressure wave in magnitude and amplitude travelling in the opposite direction. Examples of this are lines with a valve <u>completely</u> closed or a positive displacement pump with <u>no</u> dampener.

Partial opening: A partially opened gate valve, an in-line orifice plate, or an orifice plate at the end of a pipe (drill bit) plate will produce a percentage of a same sign reflection.

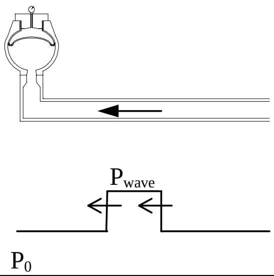
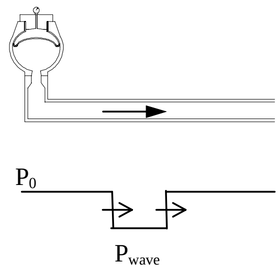
Constant pressure: A constant pressure device will produce a reverse sign reflection.

Pipe Changes:

Changes in pipe diameter, pipe material, or the junction of pipes will cause a reflection of the incident (original or initial) wave as it passes through the transition.

Hydro-pneumatic Dampeners:

The hydro-pneumatic dampeners use the gas charge in the bladder to act as a spring to absorb and expel fluid fluctuations while pumping. We consider a gas bag dampener to be a “constant pressure device” since it attempts to maintain a constant fluid pressure. Therefore in theory, it will produce a reverse sign reflection from a MWD pulse.

	
A positive pressure wave approaching a reverse sign reflector.	The pressure spike is inverted and becomes a pressure drop.
Figure 3: A wave reflecting off of a “reverse sign” reflector.	

The disadvantages are:

- Distorts MWD pulses: The gas bag dampeners produce a distorted reflection which can make detection very difficult.
- Pre-charge pressure: The bladders are limited by the amount of pressure they can handle during pre -charging. Hydril recommends 25% - 75% of stand pipe pressure, to a maximum of 2,000 psi..
- Changes during pumping: As the standpipe pressure changes operation, the efficiency of the dampener
  changes due to the change in the pre-charge to stand pipe ratio. This of course can be minimised by adjusting the dampeners between bit runs. However, it is not common for the rig operator to adjust the dampeners.
- No dampening until the stand pipe pressure exceeds the precharge pressure.

Recommendations for the field:

- DWD system: 30 - 40% of stand pipe pressure
- F.E. system: 30 - 50% of stand pipe pressure

1.3 Positive Displacement Pumps

Drilling operations use positive displacement reciprocating pumps to circulate fluid while drilling. The most prevalent type of pump in the oil industry is the Triplex - Single Acting (TSA) pump. However, In some locations you may encounter a Duplex - Double Acting pump or a pump synchroniser. The cycling pistons of a positive displacement pump produce two types of pressure fluctuations in the fluid. The first types are flow pulses, which always occur. The second type is called acceleration pulses. These Pulses are pressure shocks which are created by the instantaneous acceleration of the fluid into the manifold, and can occur under certain operating conditions.
The fundamental frequency that pumps produce varies linearly with the pump speed and are equal to twice the stroke rate for duplex pumps and thrice the stroke rate for triplex pumps. For example a triplex pump operating at 60 strokes per minute or one stroke per second, will have fundamental frequency of 3 Hz. That pump will also generate harmonics at regular increments of the fundamental frequency.

Both of these pressure fluctuations are considered noise to the MWD detection effort. They must be removed by either mechanical or mathematical means, to detect the pressure pulses generated downhole by the MWD pulser. A known problem situation for positive pulse tools is were both a Triplex and Duplex are online both at the same time.

Calculating Pump Frequency:

The “fundamental frequency” in signal analysis is the simplest or lowest repeating signal. The advanced equipment used for pulse detection is able to see the repeating cycles of the pumps. The size of this signal will grow or shrink based on how uniform the pump is operating at the time. Therefore, the “fundamental frequency” is defined as follows.

Fundamental Frequency (f_1): The fundamental frequency of the pump is simply the pump speed in strokes per second.

Equation 2:
$$f_1 = \frac{strokes}{\min} \times \frac{1\min}{60\sec}$$

It is important to note that the pump speeds are often stated as “strokes per minute (SPM)” and not “revolutions per minute (RPM).” Normally they mean the exact same. When the driller states that pumps are “operating at X SPM,” they mean the pumps are rotating at X RPM, NOT the number of piston strokes the pump is performing. I believe that this expression comes from the fact that whisker switches are often used to monitor pump speed. Since there is only one switch on the pump counting a single cylinder, you are effectively counting once per revolution.

Dominant Frequency (f_d): The dominant frequency of the pump can be calculated by knowing the pump speed and type.

Equation 3:
$$f_d = \frac{strokes}{\min} \times \frac{1\min}{60\sec} \times \frac{\#\,piston\_pulses}{stroke}$$

Pump type	# piston strokes per crank revolution
Duplex - Single Acting (DSA)	2
Duplex - Double Acting (DDA)	4
Triplex - Single Acting (TSA)	3
Triplex - Double Acting (TDA)	6
etc. :	

Flow Pulses:

The piston is continually accelerating or decelerating. Each piston creates a flow pulse every time it discharges fluid into the manifold. As fluid is being injected into the discharge manifold, its velocity is constantly changing due to the rotating crank. This change in fluid velocity causes a pressure change. The magnitude of the pressure rise depends on the change in velocity and the flow conditions.

Acceleration pulses:

Under certain operating conditions, the discharge stroke can be delayed. The result, is a situation where the fluid is subjected to an instantaneous change in velocity (acceleration) in the manifold. This acceleration causes a pressure pulse. Generally acceleration pulses, and the resonating pulses caused by them, should not cause a problem for detection. They are very high in frequency (~50 Hz or greater) relative to the transmission frequency, which we are trying to detect, so we are able to remove them by using software and hardware filters. However, there is the danger that these pulses can excite other components in the systems and create a problem for detection; or that the software filters are not set correctly.

The real problem with acceleration pressure spikes is that they:

- Cause damage and premature failure of the rig equipment.
- Can trip emergency relief valves.
- Damage seals in the system.

2.0 Common Mud Pulse Noise Sources

2.1 Bit Noise

This noise is speculated to be caused by many natural sources which include rubbing at the bottom, pressure variations caused by the bit, and surge and swab from the motion of the bit. This is normally characterised as random noise in the 0 – 50 Hz range with pressure fluctuations of less than 3 psi. This noise generally decreases as the well gets deeper and when the bit is off bottom. The noise will also vary based on the formation being drilled.

2.2 Drillstring Vibration

This is characterised by large sinusoidal variations, usually in the 1 to 3 Hz range. The frequency is related directly to RPM and weight-on-bit (WOB) but the torque and reactive torque can broaden the frequency range. This noise is in the 10 – 40 psi range and can occur at any depth in the well. The noise associated with WOB and the related mechanics of the BHA can increase and decrease with changes in WOB. The noise can come and go at random and may increase or decrease as hole angle changes.

2.3 Drillstring Resonance

This noise is associated with drillstring resonance frequency. Actual frequencies are a function of the drillstring interaction with the formation and the drilling fluid and are below the free drillstring resonance frequencies. Noise from this source can be in excess of 500 psi and is usually accompanied by substantial Kelly/Top drive movement. A 10-20 percent change in RPM will usually remove this source of noise.

2.4 Rapid Pipe Movement

This noise is substantially caused by surge and swab pressures caused by the movement of the drillstring. The magnitude of the noise is related to the rate of change in the pipe movement (ROP) and is typically less than 50 psi. The noise is substantially a positive or negative pressure pulse of varying duration, Drilling breaks, jerky pipe movement while wiping or moving to tag bottom, and driving the bit into the formation while jetting are the most common sources of the problem.

2.5 Pump Noise

Pump noise is usually a very large repetitive signal. The signal is related to the pump speed, pulsation dampener operation, super charging pump operation, and the condition of the pump valves, liners and swabs. The output from the mud pump pistons is repetitive and contains several harmonics of the principal rotational frequency (see section 3.0 Positive Displacement Pumps). The second, third, and fifth harmonics are the most common. The noise is generally around 100 psi but can approach 250 psi with some pumps. Very often the fundamental frequency is suppressed relative to the first several harmonics.

Although pump noise is generated at the pump, this noise is often seen travelling back up hole after reflecting off the bit. The reflected wave can in turn reflect back off the pumps starting the process again. This phenomena is most frequent in shallow holes when the fluid viscosity is very low.

A bad piston, liner or valve will modulate the signal with a low frequency interplay or beat when two pumps are used. This frequency is usually in the 0.25 Hz range and may also be related to the different frequencies of the pumps. This problem is typically the greatest when the speeds of the pumps are very close.

Bad pistons, liners and valves can also cause high frequency modulation. This noise effect can extend from below the fundamental pump frequencies to beyond 10 Hz.

Mud pump suction problems typically caused by gas cut mud, insufficient charging pump operation, or "choked" flow lines can cause noise problems from the fundamental pump frequencies to beyond 10 Hz. Although the noise developed is similar to piston, valve, and liner problems, this type of problem is usually accompanied by substantial pump knocking.

Leaking and/or undercharged pulsation dampeners can cause significant noise in the range of 1 to 12 times the fundamental pump frequency. The noise is effectively random and can be in excess of 100 psi. Defective or undercharged pulsation dampeners can be identified by regularly checking the pulsation dampener precharge.

2.6 Mud Motors

High torque, low speed positive displacement motors cause noise problems similar to bit noise. The problem is most frequent when PDC bits are used. It is believed that the noise is generated when the bit torque is inconsistent. The change in bit torque is translated into pressure surges by the positive displacement motor.

2.7 Standing Waves

Standing pressure waves are set up in the drillpipe and provide noise in the 0.5 – 0.25 Hz range. This noise is a function of depth and the speed of sound in the mud. At more shallow depths the noise can be in excess of 100 psi but drops to 5 – 10 psi at 2,500 meters.

2.8 Ringing

Ringing is dependent on the surface piping configuration and the effective operation of the pulsation dampener. Ringing is caused by multiple reflections induced by short sections of pipe typically not in the main flow path. The pulsation dampener will usually eliminate the phenomena. The ringing becomes a problem when the frequency approaches the signal frequency.

2.9 Reflections

All pressure waves are reflected from every discontinuity in the flow line. The most significant discontinuities are the bit and the mud pump. These reflections can be used to increase or to decrease the effective noise.

Other discontinuities typically create noise problems. The most common problems are tapered drill pipe, dead ends in the surface piping system, dual flow paths, and faulty surface piping valves. Each of these problems should be avoided/corrected whenever possible.

2.10 Surface Noise

Surface noise is interference to pressure signals due to surface sensors and computers. Common causes for this are heavy power lines running close to cables to the surface transducers, faulty transducers, power problems to the MWD computers and floating ground connections. These can effect the 4-40mA signal that is being sent from the transducers by erratically spiking the signal, making it difficult for the computer filters to decode the pressure pulses.

3.0 MWD Signal Attenuation

The MPT (Mud Pulse Telemetry) signal is attenuated by many factors ranging from microscopic pits in the drill pipe, blockages in the flow lines, to the most common form of attenuation, **viscosity.** The following have the greatest effect on signal attenuation.

3.1 Reflections (Depth)

Technically, each and every discontinuity in the transmission line (drill string) reflects a portion of the signal. Since the generated pulse begins with a finite energy level, each reflection decreases the signal level. The most significant reflective losses are caused by multiple sized and tapered drill pipe and by the commulative effects of lots of pipe with lots of connections.

The reflected losses in long lengths of pipe generate a near infinite set of reflected pressure waves. However, the amplitude of the reflections are small and spread over a long period. These reflections are not detectable at the surface. The reflections from tapered and multi-sized drillpipe can be numerous and relatively large in amplitude. These reflections have the same basic profile as the signal and cause an increase in the noise level propagated from downhole.

3.2 Mud Viscosity

The effect of viscosity is the dominating factor in the attenuation of the signal. Typically, no single change in the mud property will have a greater impact on signal attenuation. Signal attenuation increases as viscosity increases.

Viscosity effects can be looked at as the bond strength between the mud components. As the viscosity increases the mud components are held tighter together causing an increase in the energy needed to move the pulse through the mud column.

3.3 Pipe Diameter

The effect of pipe diameter is a viscosity related effect. The signal must break the bonds formed between the pipe wall and the fluid column to move to the surface. The force required to move the pulse is related to the pipe wall contact area which is a function of the length of the pulse and the pipe diameter. The pulse energy is related to the length of the pulse and the pipe area. Because the pipe area varies with the square of the pipe diameter, the greater the pipe diameter the lower the signal attenuation.

3.4 Mud Weight

The effect of mud weight is essentially a momentum effect. By increasing the mud weight (particle mass) the signal has more energy given a constant velocity. The greater the energy, the farther the signal will travel. The best demonstration of this concept is the attenuation of a audible noise in a vacuum. Sound does not travel in a vacuum because there is no mass to carry the signal.

3.5 Signal Frequency (Pulse Width)

The effects of signal attenuation in a given fluid increase as the frequency increases. This can most easily be seen at the extremes in the mud system. The mud pumps coming on and off generate a very low frequency signal. When pumping continuously for 30 minutes the pumps on/off frequency is about 1/3600 Hz. There is no attenuation of this signal, the level remains substantially constant for the entire pumps on period. A very short signal, say on the order of 0.000001 seconds or 1 MHz, would be totally attenuated after a very short period.

3.6 Speed of Sound in Mud

The effect of the speed of sound in the mud (signal propagation velocity) can be thought of as similar to the effect of velocity on a projectile. The faster the projectile moves the more energy is available to push aside the media and impact the target.

3.8 Gas Cut Mud

In addition to the suction problems mentioned in basic pump noise, gas cut mud can substantially attenuate the pulse transmission from downhole. The trapped gas acts similar to a high viscosity fluid and attenuates all of the pressure fluctuations. Gas cut mud decreases both the signal and the noise from downhole but has little effect on surface generated noise.

Conclusion

When bad detection is encountered there are many reasons that may be causing the interruption. The troubleshooting process to determine the problem can be quite complex and may require input from many sources on the rig.

Regards

Sperry Drilling Services

Appendix 2.0 : Post-Run Order on LWD Sheets

Summary of LWD tool specifications for each run with Real-time and Recorded sampling rates, battery life and memory fill information.

sperry-sun DRILLING SERVICES

Post 100 LWD Logging Data Sheet

Customer:	Anzon Australia Ltd	Latitude:	38 ° 17 58.51" S	RT-MSL:	21.5m	Depth In (m):	208.0	Geologists:	M Woodmansee / R Blackmore
Well:	Basker-2	Longitude:	148 ° 42 24.72" E	Water Depth:	152.5mss	Depth Out (m):	1006.0	Engineers:	A Oraekwuotu / J. Nicolson
Hole Size/Run #:	17.5	UTM co-ords:	649251.90 mE	CSG MWD:	208	CSG Tally (m):	208.0		
Date/time in hole:	15-08-05 13:00 hrs		5759566.40 mN	Pip Tag MWD:		Pip Tag Tally:			
Date/time out hole:	17-Aug-2005 02:37	GDA94; MGA Zone 55	^{0}E					Company Rep.	W Westman / S. Rodda

CIM Battery:	n/a			Max expected ROP:	60 m/hr	Mud Type:	Seawater	Rmf:	
CIM Battery Life:	n/a	HCIM T-Delay:	n/a	Controlled drilling from/to:	n/a	Mud Weight:		Rm:	
BAT Battery:	n/a	SLD T-Delay:	n/a	Drill rate controlled at:	n/a	Mud Chlorides:		Rmc:	
BAT Battery Life:	n/a	BAT T-Delay:	n/a	Expected flowrate:	1000	KCl:		Max Rec BHT:	
			n/a	Min flowrate for Detection:	900	CWS		Rmf at max BHT:	
		DDS T-Delay:	n/a			Form W Salinity:			

Tool SN	Tool Description	Distance to Bit (m)	Data Rate (sec) Real Time	Data Rate (sec) Recorded	Data Density per meter at Max ROP Real Time	Data Density per meter at Max ROP Recorded	Log Scales	Memory Fill Time	Date & time of failure	Remarks
8298	Mk 8 Pulser (PUL)									
10505184	Telemetry Mod (TM)									
149865	Dir. Mod (DM)	13.88	NA		NA					Data rate is for toolfaces. Surveys taken over conxn, pumps off surveys
n/a	Sonic (BAT	NA								
83563	Gamma (GM)	12.00	19	10	3.16	6.00	0-150 api			
25635	Battery Mod BM	NA								Allows pumps down surveys

LWD Engineer:

Well Site Geologist:

If tool fails, include in remarks section depth of failure and possible reasons of failure.

sperry-sun DRILLING SERVICES

Post 200 LWD Logging Data Sheet

Customer:	Anzon Australia Ltd	Latitude:	38 ° 17 58.51" S	RT-MSL:	21.5m	Depth In (m):	1006.0	Geologists:	M Woodmansee / R Blackmore
Well:	Basker-2	Longitude:	148 ° 42 24.72" E	Water Depth:	152.5mss	Depth Out (m):	2497.0	Engineers:	A Oraekwuotu / J. Nicolson
Hole Size/Run #:	12.25	UTM co-ords:	649251.90 mE	CSG MWD:	998	CSG Tally (m):	1000.1		
Date/time in hole:	19-08-05, 15:49 hrs		5759566.40 mN	Pip Tag MWD:	998	Pip Tag Tally:			
Date/time out hole:	20-Aug-2005 14:38	GDA94; MGA Zone 55	⁰E					Company Rep.	W Westman / S. Rodda

CIM Battery:	17.69 Amp-hrs			Max expected ROP:	60 m/hr	Mud Type:	KCL/PHPA	Rmf:	0.6 @ 23.3° C
CIM Battery Life:	10 days	HCIM T-Delay:	3 hrs	Controlled drilling from/to:	n/a	Mud Weight:	1.20 sg	Rm:	0.8 @ 23.3° C
BAT Battery:	n/a	SLD T-Delay:		Drill rate controlled at:	n/a	Mud Chlorides:	43000 mg/l	Rmc:	1.0 @ 23.3° C
BAT Battery Life:	n/a	BAT T-Delay:	n/a	Expected flowrate:	900 - 950 gpm	KCl:	7.00%	Max Rec BHT:	58 °C
				Min flowrate for Detection:	800 gpm	OWS	0 / 90 / 10	Rmat max BHT:	0.45 @ 58° C
		DDS T-Delay:	3 mins			Form W Salinity:			

Tool SN	Tool Description	Distance to Bit (m)	Data Rate (sec) Real Time	Data Rate (sec) Recorded	Data Density per meter at Max ROP Real Time	Data Density per meter at Max ROP Recorded	Log Scales	Memory Fill Time	Date & time of failure	Remarks
8513	Mk 8 Pulser (PUL)									
147461	Telemetry Mod (TM)									
DM90081131K8 14985	Dir. Mod (DM)	20.89	15		4.00					Data rate is for toolfaces. Surveys taken over conxn, pumps off surveys
n/a	Sonic (BAT									
DM90081129H1RGV8	Processor (HCIM)									
DM90081129H1RGV8	Gamma (DGR)	13.42	32	12	1.88	5.00	0-150 api			
DM90081129H1RGV8	Resistiviy (EWR-P4)	15.79	32	14	1.88	4.29	0.2 - 2000 ohm/m	135 hrs		can reduce sampling rate to increse memory fill time

LWD Engineer:

Well Site Geologist:

If tool fails, include in remarks section depth of failure and possible reasons of failure.

sperry-sun
DRILLING SERVICES

Post 300 LWD Logging Data Sheet

Customer:	Anzon Australia Ltd	Latitude:	38 ° 17 58.51" S	RT-MSL:	21.5m	Depth In (m):	2497.0	Geologists:	M Woodmansee / R Blackmore
Well:	Basker-2	Longitude:	148 ° 42 24.72" E	Water Depth:	152.5mss	Depth Out (m):	2741.0	Engineers:	A Oraekwuotu / J. Nicolson
Hole Size/Run #:	12.25	UTM co-ords:	649251.90 mE	CSG MWD:	998	CSG Tally (m):	1000.1		
Date/time in hole:	13-Aug-2005 02:48		5759566.40 mN	Pip Tag MWD:	998	Pip Tag Tally:			
Date/time out hole:	03-Sep-2005 03:46	GDA94; MGA Zone 55	^{0}E					Company Rep.	W Westman / S. Rodda

CIM Battery:	14.47 Amp-hrs			Max expected ROP:	20 m/hr	Mud Type:	KCL/PHPA	Rmf:	0.11 @ 22.0° C
CIM Battery Life:	>10 days	HCIM T-Delay:	3 hrs	Controlled drilling from/to:		Mud Weight:	1.20 sg	Rm:	0.12 @ 21.7° C
BAT Battery:	n/a	SLD T-Delay:		Drill rate controlled at:		Mud Chlorides:	43000 mg/l	Rmc:	0.22 @ 20.0° C
BAT Battery Life:	n/a	BAT T-Delay:	n/a	Expected flowrate:	900 - 950 gpm	KCl:	7.00%	Max Rec BHT:	80 °C
				Min flowrate for Detection:	800 gpm	O/W/S	0 / 90 / 10	Rm at max BHT:	0.05 @ ° C
		DDS T-Delay:	3 mins			Form W Salinity:			

Tool SN	Tool Description	Distance to Bit (m)	Data Rate (sec) Real Time	Data Rate (sec) Recorded	Data Density per meter at Max ROP Real Time	Data Density per meter at Max ROP Recorded	Log Scales	Memory Fill Time	Date & time of failure	Remarks
8484	Mk 8 Pulser (PUL)									
177893	Telemetry Mod (TM)									
185534	Dir. Mod (DM)	24.18	15		12.00					Data rate is for toolfaces. Surveys taken over conxn, pumps off surveys
n/a	Sonic (BAT									
DM80081130HIRGV8	Processor (HCIM)									
DM80081130HIRGV8	Gamma (DGR)	16.84	60	12	3.00	15.00	0-150 api			
DM80081130HIRGV8	Resistiviy (EWR-P4)	19.20	60	14	3.00	12.86	0.2 - 2000 ohm/m	135 hrs		can reduce sampling rate to increse memory fill time

LWD Engineer:

Well Site Geologist:

If tool fails, include in remarks section depth of failure and possible reasons of failure.

sperry-sun DRILLING SERVICES

Post 400 LWD Logging Data Sheet

Customer:	Anzon Australia Ltd	Latitude:	38 ° 17 58.51" S	RT-MSL:	21.5m	Depth In (m):	2741.0	Geologists:	M Woodmansee / R Blackmore
Well:	Basker-2	Longitude:	148 ° 42 24.72" E	Water Depth:	152.5mss	Depth Out (m):	2956.0	Engineers:	A Oraekwuotu / A Rule
Hole Size/Run #:	12.25	UTM co-ords:	649251.90 mE	CSG MWD:	1000.1	CSG Tally (m):	1000.1		
Date/time in hole:	03-Sep-2005 19:32		5759566.40 mN	Pip Tag MWD:	1000.1	Pip Tag Tally:			
Date/time out hole:	06-Sep-2005 07:40	GDA94; MGA Zone 55	^{0}E					Company Rep.	R King / S Rodda

CIM Battery:	13.75 Amp-hrs			Max expected ROP:	20 m/hr	Mud Type:	KCL/PHPA	Rmf:	0.11 @ 21.0° C
CIM Battery Life:	>10 days	HCIM T-Delay:	200 mins	Controlled drilling from/to:		Mud Weight:	1.20 sg	Rm:	21.0 @ 21.0° C
BAT Battery:	n/a	SLD T-Delay:		Drill rate controlled at:		Mud Chlorides:	38000 mg/l	Rmc:	0.24 @ 20.0° C
BAT Battery Life:	n/a	BAT T-Delay:	n/a	Expected flowrate:	900 - 950 gpm	KCl:	6.20%	Max Rec BHT:	85°C
				Min flowrate for Detection:	800 gpm	OWS	0 / 90 / 10	Rmf at max BHT:	0.05 @ ° C
		DDS T-Delay:	90 mins			Form W Salinity:			

Tool SN	Tool Description	Distance to Bit (m)	Data Rate (sec) Real Time	Data Rate (sec) Recorded	Data Density per meter at Max ROP Real Time	Data Density per meter at Max ROP Recorded	Log Scales	Memory Fill Time	Date & time of failure	Remarks
8484	Mk 8 Pulser (PUL)									
177893	Telemetry Mod (TM)									
185534	Dir. Mod (DM)	18.39	15		12.00					Data rate is for toolfaces. Surveys taken over conxn, pumps off surveys
n/a	Sonic (BAT									
DM8081130HIRGV8	Processor (HCIM)									
DM8081130HIRGV8	Gamma (DGR)	11.05	27	12	6.67	15.00	0-150 api			
DM8081130HIRGV8	Resistiviy (EWR-P4)	13.41	27	14	6.67	12.86	0.2 - 2000 ohm/m	7.2 days		can reduce sampling rate to increse memory fill time

LWD Engineer:

Well Site Geologist:

If tool fails, include in remarks section depth of failure and possible reasons of failure.

sperry-sun
DRILLING SERVICES

Post 500 LWD Logging Data Sheet

Customer:	Anzon Australia Ltd	Latitude:	38 ° 17 58.51" S	RT-MSL:	21.5m	Depth In (m):	2956.0	Geologists:	M Woodmansee / R Blackmore
Well:	Basker-2	Longitude:	148 ° 42 24.72" E	Water Depth:	152.5mss	Depth Out (m):	3310.0	Engineers:	A Rule / J. Nicolson
Hole Size/Run #:	8.5" (216mm)	UTM co-ords:	649251.90 mE	CSG MWD:	2949	CSG Tally (m):	2944.9		
Date/time in hole:	08-Sep-2005 02:45		5759566.40 mN	Pip Tag MWD:		Pip Tag Tally:			
Date/time out hole:	10-Sep-2005 05:12	GDA94; MGA Zone 55	^{0}E					Company Rep.	R King / S. Rodda

CIM Battery:	19.9 Amp-hrs			Max expected ROP:	20 m/hr	Mud Type:	KCL/PHPA	Rmf:	0.09 @ 21.0° C
CIM Battery Life:	>10 days	HCIMT-Delay:	120 mins	Controlled drilling from/to:		Mud Weight:	1.13 sg	Rm:	0.12 @ 22.0° C
BAT Battery:	n/a	SLDT-Delay:		Drill rate controlled at:		Mud Chlorides:	39000 mg/l	Rmc:	0.13 @ 22.0° C
BAT Battery Life:	n/a	BATT-Delay:	n/a	Expected flowrate:	700-720 gpm	KCl:	5.20%	Max Rec BHT:	96°C
				Min flowrate for Detection:	600 gpm	OWS	0 / 93 / 7	Rmat max BHT:	0.04 @ ° C
		DDST-Delay:	3 mins			Form W Salinity:			

Tool SN	Tool Description	Distance to Bit (m)	Data Rate (sec)		Data Density per meter at Max ROP		Log Scales	Memory Fill Time	Date & time of failure	Remarks
			Real Time	Recorded	Real Time	Recorded				
8351	Mk 8 Pulser (PUL)									
147461	Telemetry Mod (TM)									
90082560M6 143272	Position Monitor (PM)	20.44	15		12.00					Data rate is for toolfaces. Surveys taken over conxn, pumps off surveys
n/a	Sonic (BAT									
NZ200H1RGV6	Processor (HCIM)									
NZ200H1RGV6	Gamma (DGR)	13.06	31	12	5.81	15.00	0-150 api			
NZ200H1RGV6	Resistiviy (EWR-P4)	15.42	31	14	5.81	12.86	0.2 - 2000 ohm/m	7.2 days		can reduce sampling rate to increse memory fill time

LWD Engineer:

Well Site Geologist:

If tool fails, include in remarks section depth of failure and possible reasons of failure.

Post 600 LWD Logging Data Sheet

Customer:	Anzon Australia Ltd	Lattitude:	38 ° 17 58.51" S	RT-MSL:	21.5m	Depth In (m):	3310.0	Geologists:	M Woodmansee / R Blackmore
Well:	Basker-2	Longitude:	148 ° 42 24.72" E	Water Depth:	152.5mss	Depth Out (m):	3414.0	Engineers:	A Rule / J. Nicolson
Hole Size/Run #:	8.5" (216mm)	UTM co-ords:	649251.90 mE	CSG MWD:	2949	CSG Tally (m):	2944.9		
Date/time in hole:	10-Sep-2005 05:57		5759566.40 mN	Pip Tag MWD:		Pip Tag Tally:			
Date/time out hole:	11-Sep-2005 22:58	GDA94; MGA Zone 55	^{0}E					Company Rep.	R King / S. Rodda

CIM Battery:	18.89 Amp-hrs			Max expected ROP:	20 m/hr	Mud Type:	KCL/PHPA	Rmf:	0.09 @ 21.0° C
CIM Battery Life:	>10 days	HCIMT-Delay:	240 mins	Controlled drilling from/to:		Mud Weight:	1.13 sg	Rm:	0.11 @ 21.0° C
BAT Battery:	n/a	SLD T-Delay:		Drill rate controlled at:		Mud Chlorides:	39000 mg/l	Rmc:	0.13 @ 22.0° C
BAT Battery Life:	n/a	BAT T-Delay:	n/a	Expected flowrate:	675 gpm	KCl:	5.20%	Max Rec BHT:	108°C
				Min flowrate for Detection:	600 gpm	O:W:S	0 / 93 / 7	Rm at max BHT:	0.04 @ ° C
		DDS T-Delay:	30 mins			Form W. Salinity:			

Tool SN	Tool Description	Distance to Bit (m)	Data Rate (sec) Real Time	Data Rate (sec) Recorded	Data Density per meter at Max ROP Real Time	Data Density per meter at Max ROP Recorded	Log Scales	Memory Fill Time	Date & time of failure	Remarks
8513	Mk 8 Pulser (PUL)									
147461	Telemetry Mod (TM)									
90082560M6 143272	Position Monitor (PM)	11.62	N/A		N/A					Data rate is for toolfaces. Surveys taken over conxn, pumps off surveys
n/a	Sonic (BAT									
NZ200H1RGV6	Processor (HCIM)									
NZ200H1RGV6	Gamma (DGR)	4.20	18	12	10.00	15.00	0-200 api			
NZ200H1RGV6	Resistiviy (EWR-P4)	6.60	18	14	10.00	12.86	0.2 - 2000 ohm/m	7.1 days		can reduce sampling rate to increse memory fill time

LWD Engineer:

Well Site Geologist:

If tool fails, include in remarks section depth of failure and possible reasons of failure.

Appendix 3.0 : Sales Data Sheets

Information sheets on each LWD tool used for the Basker-2 well.

3.1 DGR – Dual Gamma Ray

3.2 EWR – Electromagnetic Wave Resistivity

3.3 DDS – Drillstring Dynamics Sensor

Sperry-Sun

DGR™ (Dual Gamma Ray) Tool

Providing Accurate and Reliable LWD Natural Gamma Ray Logs

Sperry-Sun's DGR™ tool provides accurate LWD natural gamma ray logs with Sperry-Sun's proven reliability. It is available in 4-3/4-, 6-3/4-, 8-, and 9-1/2-inch tool sizes and can log boreholes ranging from 5-7/8 to 30 inches in diameter. The DGR™ sensor is an integral part of Sperry-Sun's Stellar™ LWD services, which include gamma ray, resistivity, neutron porosity, spectral density, dipole sonic, formation tester, and caliper measurements. It can also be combined with directional surveying and drilling efficiency tools, such as the PWD (pressure-while-drilling) and DDS™ drillstring dynamics sensors.

Accuracy

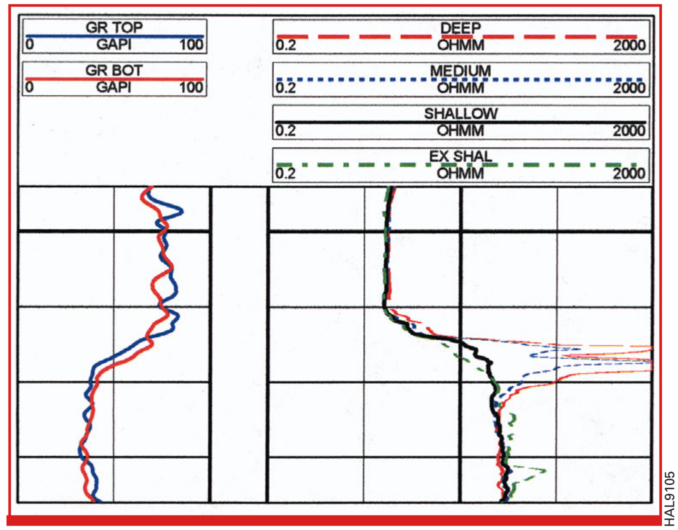
API calibration and environmental corrections for hole size, mud weight, and mud potassium content result in accurate gamma ray logs for correlation, shale volume calculations, casing and coring point selection, and a variety of other applications. Because drilling speed is typically slower than wireline logging speeds, DGR™ logs generally have better vertical resolution than wireline gamma ray logs.

Reliability

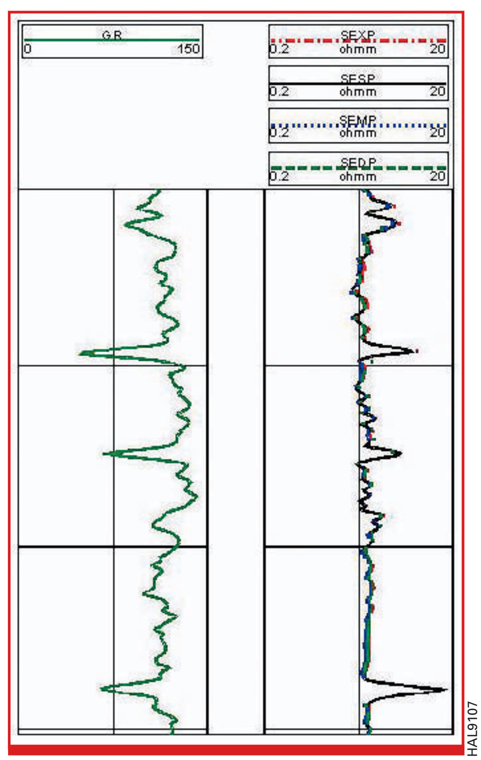
The DGR™ sensor consists of two opposing banks of rugged Geiger-Müller detectors with two independent counting circuits. This redundant configuration provides two independent natural gamma ray logs. The count rates from the two detector banks are typically combined in order to improve statistical precision. However, in the unusual event of a failure of one bank, an accurate, complete gamma ray log can be produced from the other detector bank.

Azimuthal Capability

For geosteering in horizontal wells, the DGR™ sensor can be configured to provide azimuthal gamma ray measurements. In this application, the two opposed detector banks can provide independent oriented gamma ray logs from the high side and low side of the borehole in a sliding mode. This can, for example, provide real-time data to determine if the bit has exited the top or the bottom of a target reservoir formation.



This log example shows the azimuthal gamma ray capability of the DGR™ sensor. The two opposed banks are oriented to the high side and low side of the borehole, and the bed boundary is logged in a sliding mode while transmitting both gamma ray curves in real time. The depth shift of the bed boundary between the high-side and low-side gamma ray curves indicates that the bit drilled stratigraphically up, out the top of the shale, and into the bottom of the sand. Note that polarization horns on the medium and deep resistivity curves confirm the high relative dip angle at the bed boundary.



The DGR™ service provides accurate, high-resolution gamma ray logs.

HALLIBURTON

DGR™ Tool Specifications				
Nominal tool OD	4-3/4 in 121 mm	6-3/4 in [3] 171 mm	8 in [2,3] 203 mm	9-1/2 in [3] 221 mm
Length	Integral part of the EWR-PHASE 4™ tool	4.5 ft/1.37 m	4.5 ft/1.37 m	5.07 ft/1.55 m
Connections	3.5 in IF box x box	4.5 in IF box x pin	6 5/8 in REG box x pin	7 5/8 in REG box x pin
Make-up torque range (ft-lb)	9,900-10,900	30,000-33,000	53,000-58,000	87,000-91,000
Max dogleg severity Sliding Rotating	 30°/100 ft 14°/100 ft	 21°/100 ft 10°/100 ft	 14°/100 ft 8°/100 ft	 14°/100 ft 8°/100 ft
Max operating temp	284°F/140°C			
Max survival temp	284°F/140°C			
Max working pressure (psi)	18,000			13,500
Max mass flow rate (lb mass/min)	3,750	10,000	10,000	20,000
Max sand content	2%	1%	1%	5%
Measure point from bottom of DGR™ sub	14.85 ft/4.5 m from bottom	1.74 ft/0.53 m from bottom	1.78 ft/0.54 m from bottom	1.9 ft/0.58 m from bottom
Max LCM	No restrictions			
Max RPM	250	180	180	180
Max WOB (lb)	25,000	45,000	45,000	45,000
Detector type	Dual Geiger-Müller detector banks			
System accuracy	5%			

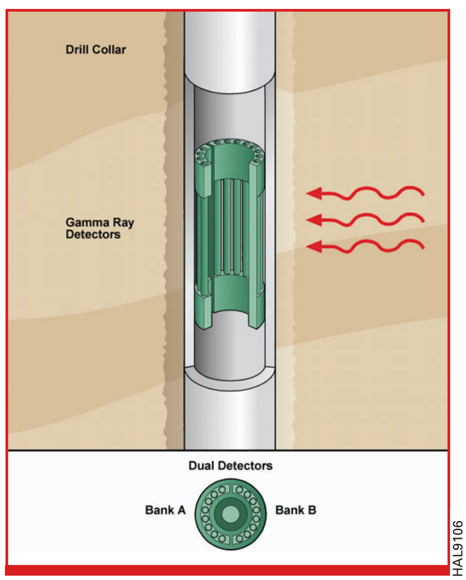
[1]High-temperature (347°F/175°C) and high-pressure (25,000 psi) tools are available upon special request.
[2]High-flow (20,000 lb mass/min) and high-pressure (25,000 psi) tools are available upon special request.
[3]For high-temperature (347°F/175°C) service in these tool sizes, the gamma module is used.

Features

- Dual detectors for redundancy and reliability
- API calibration and complete environmental corrections
- Azimuthal capability for geosteering applications
- Excellent vertical resolution due to slower drilling speeds
- Combinable with directional, resistivity, caliper, neutron, density, sonic, and formation tester sensors

Applications

- Correlation
- Shale volume calculation
- Casing/coring point selection
- Geosteering



The two opposed detector banks of the DGR™ sensor provide measurement redundancy for superior reliability as well as azimuthal sensitivity for geosteering applications.

Produced by Halliburton Communications

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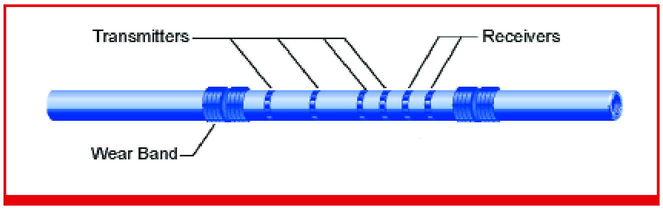
H02936R 09/03

HALLIBURTON

EWR-PHASE 4™ Sensors

Complete Formation Resistivity Evaluation in Boreholes from 3-3/4 to 36 Inches

The EWR-PHASE 4™ sensor is a high-frequency LWD induction resistivity sensor. This tool comprises four radio-frequency transmitters and a pair of receivers. By measuring both the phase shift and the attenuation for each of the four transmitter-receiver spacings, eight different resistivity curves with differing depths of investigation can be provided. EWR-PHASE 4™ tools are available in 3-1/8, 4-3/4, 6-3/4, 8, and 9-1/2 in. tool sizes and can log boreholes ranging in diameter from 3-3/4 in. to 30 in. The EWR-PHASE 4™ sensors operate in all mud types, including fresh- and salt-water muds, oil-based muds and aerated muds, foam used in underbalanced drilling, as well as in air-filled boreholes. The EWR family of tools has been in commercial service since 1983 and has established a track record of high reliability under a wide variety of formation and borehole conditions.



The EWR-PHASE 4™ sensor has four transmitter-receiver spacings.

Interpretation Modeling

The multiple resistivity measurements of the EWR-PHASE 4™ sensor facilitate various interpretation models for evaluating invaded and anisotropic formations. The INVAMOD™ program computes R_t, R_{xo}, and D_i in invaded formations; this can be particularly applicable when logging significantly after drilling when formations may be deeply invaded, e.g., logging a cored interval on a subsequent bit run. The ANIMOD program computes the vertical and horizontal formation resistivity values (R_v and R_h) and relative dip angle when logging anisotropic formations at high relative dip angles. For geosteering applications, the forward modeling capability of the StrataSteer™ software provides a synthetic log along the proposed well path to use as a correlation “road map” when geosteering horizontal wells. VRI (vertical resistivity inversion) processing corrects for shoulder bed and dipping bed effects, providing resolution-matched curves with enhanced vertical resolution.

Large or Small—There Is an EWR-PHASE 4™ Sensor for Any Size Job

In addition to the standard tool sizes of 4-3/4, 6-3/4, and 8 in., there are also special large and superslim tool designs.

The 9-1/2 in. EWR-PHASE 4D sensor is designed for logging larger holes that are in diameters up to 30 in.

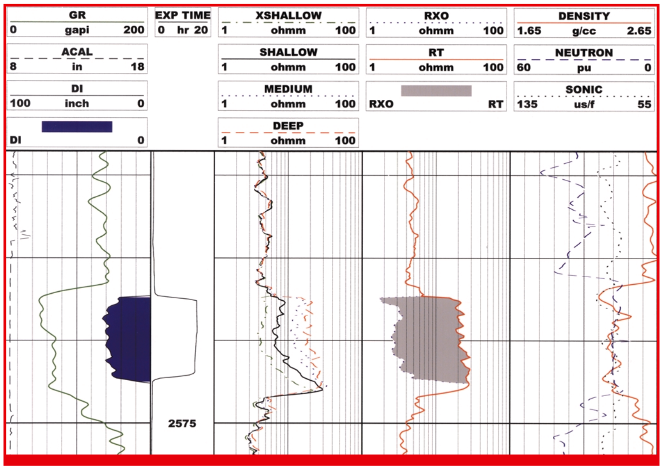
This tool has extended transmitter-receiver spacings to increase the depth of investigation, minimizing borehole effects in large boreholes. For logging very small boreholes, the 3-1/8 in. EWR-PHASE 4™ superslim sensor is suitable for coiled tubing drilling, through-tubing rotary drilling, and conventional rotary drilling applications in borehole diameters as small as 3-3/4 in.

Features

- Operates in all mud types
- Proven design provides superior reliability
- Four phase-shift resistivity curves
- Four attenuation resistivity curves
- Excellent vertical resolution in low-resistivity, thinly bedded formations

Applications

- R_t, R_{xo}, and D_i in invaded formations
- R_v and R_h in anisotropic formations
- High-resolution R_t in deviated wells and/or dipping beds
- Pre-invasion R_t measurement in deeply invading formations
- Pre-washout R_t measurement in unconsolidated formations
- LWD replacement for wireline array resistivity tools



This LWD quad-combo log shows deep, water-based filtrate invasion in a pay sand. A bit trip in the middle of the sand resulted in a long formation exposure time and, thus, deep invasion. However, the INVAMOD™ program provided R_t, R_{xo}, and D_i to facilitate accurate calculation of S_w and movable oil.

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EWR-PHASE 4™, EWR-PHASE 4D, and EWR-PHASE 4 Superslim Sensor Specifications

Nominal tool OD	3-1/8 in. 79 mm	4-3/4 in. 121 mm	6-3/4 in. 171 mm[1]	8 in. 203 mm[2,3]	9-1/2 in. 221 mm
Length	11.3 ft/3.44 m	9 ft/2.74 m	12 ft/3.69 m	12.2 ft/3.72 m	12 ft/3.69 m
Connections	2.75 in.-8 stub acme box x box	3.5 in. IF box x box	4.5 in. IF box x box	6-5/8 in. REG box x box	7-5/8 in. REG box x box
Make-up torque range (ft/lb)	1,950-2,150	9,900-10,900	30,000-33,000	53,000-58,000	89,000-91,000
Max dogleg severity					
Sliding	60°/100 ft	30°/100 ft	21°/100 ft	14°/100 ft	14°/100 ft
Rotating	30°/100 ft	14°/100 ft	10°/100 ft	8°/100 ft	8°/100 ft
Max operating temp	302°F/150°C	284°F/140°C	284°F/140°C	284°F/140°C	284°F/140°C
Max survival temp	302°F/150°C	302°F/150°C	302°F/150°C	302°F/150°C	302°F/150°C
Max working pressure (psi)	16,000	18,000	18,000	18,000	13,500
Max mass flow rate (lb mass/min)	1,800	3,750	10,000	10,000	20,000
Max sand content	1%	2%	1%	1%	5%
Measure point from bottom of EWR tool	4 ft/1.22 m	7.5 ft/2.29 m	4.5 ft/1.37 m	4.5 ft/1.37 m	4.5 ft/1.37 m
Max LCM	No restrictions				
Max RPM	60[4]	250	180	180	180
Max WOB (lb)	15,000	25,000	45,000	45,000	45,000

[1] High-temperature (347°F/175°C) and high-pressure (25,000 psi) tools are available upon special request.
[2] High-flow (20,000 lb mass/min) and high-pressure (25,000 psi) tools are available upon special request. Their make-up torque range is 43,000-48,000 ft-lb.
[3] High-temperature (347°F/175°C) tools are available upon special request.
[4] Empirical drilling data have shown that vibration increases significantly when the rotational speed exceeds 60 RPM.

4-3/4 in., 6-3/4 in., and 8 in. EWR-PHASE 4™ Sensors

Transmitter Spacing (Inches)*	Frequency	Depth of Investigation† @ 1 Ω•m (Inches)		Depth of Investigation† @ 20 Ω•m (Inches)	
		Phase Shift	Attenuation	Phase Shift	Attenuation
9	2 MHz	19	31	29	74
15	2 MHz	23	37	39	84
27	2 MHz	31	47	54	100
39	1 MHz	42	66	75	141

*Transmitter spacing is the axial distance between the transmitter and the mid point (measure point) between the two receivers.
† Depth of investigation is defined as the diameter corresponding to the 50% value of the integrated radial pseudo-geometric factor.

9-1/2 in. EWR-PHASE 4D Sensor

Transmitter Spacing (Inches)*	Frequency	Depth of Investigation† @ 1 Ω•m (Inches)		Depth of Investigation† @ 20 Ω•m (Inches)	
		Phase Shift	Attenuation	Phase Shift	Attenuation
18	2 MHz	24	36	40	86
24	2 MHz	27	43	48	93
30	2 MHz	30	47	55	102
42	1 MHz	42	66	76	142

3-1/8 in. EWR-PHASE 4 Superslim Sensor

Transmitter Spacing (Inches)*	Frequency	Depth of Investigation† @ 1 Ω•m (Inches)		Depth of Investigation† @ 20 Ω•m (Inches)	
		Phase Shift	Attenuation	Phase Shift	Attenuation
12	2 MHz	19	31	32	76
20	2 MHz	24	39	42	88
28	2 MHz	29	46	52	100
44	500 kHz	36	58	68	120

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DDS™ Drillstring Dynamics Sensor

Detect and Avoid Destructive Downhole Vibrations

Sperry-Sun's DDS™ sensor measures downhole vibration in real time, making it possible to avoid or eliminate damaging stress to MWD tools, motors, bits, and other drillstring components. By monitoring in real time, drilling parameters such as weight-on-bit and rotary speed can be adjusted the instant high vibration levels are detected, thus avoiding extended periods of exposure to damaging levels of vibration. By reducing the number of MWD failures and drillstring twistoffs and the amount of bit damage, the DDS™ sensor can improve drilling efficiency plus reduce the amount of rig time for tripping and fishing. This will result in lower total drilling costs.

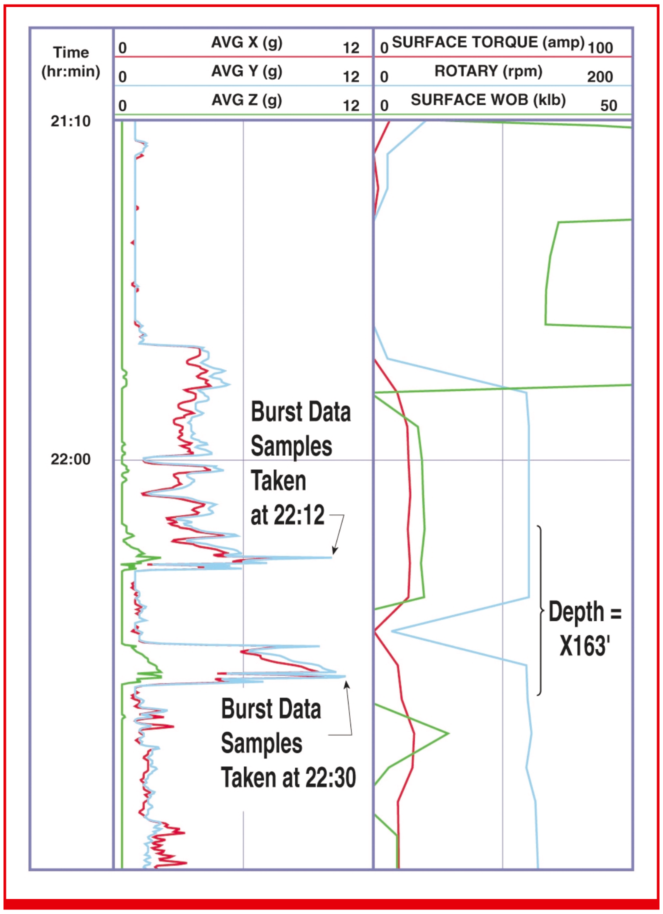
The DDS™ sensor consists of triaxial accelerometers mounted on the insert of the DGR™ (dual gamma ray) sensor. It measures lateral, torsional, and longitudinal accelerations. Average, peak and instantaneous (burst) accelerations are measured for each of the three axes. This detects both vibration severity and mode (e.g., bit bounce, lateral shock, stick-slip, bit whirl).

Applications

- Vertical or near-vertical wells
- High-cost drilling environments, in which tripping costs are prohibitive
- Harsh drilling environments
- Intermediate hole sections with large diameters
- Areas known for large formation washouts
- Areas of unexplained low ROP
- Areas of unexplained drillstring damage or MWD failures

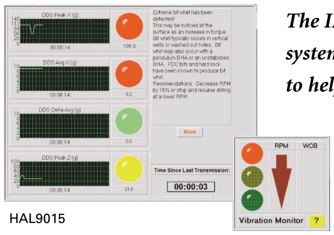
Benefits

- Improved drilling practices
- Faster ROP
- Superior hole quality
- Increased tool reliability and bit life
- Improved planning and design



HAL9014

Plot of DDS™ sensor downhole average and peak vibration data and surface parameters versus time, indicating that bit whirl occurred while drilling the top of this limestone formation.



HAL9015

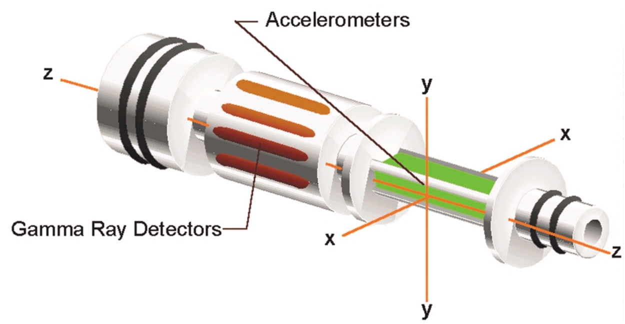
The INSITE™ information management system makes real-time recommendations to help alleviate downhole vibrations.

Sperry-Sun

The orthogonal accelerometers of the DDS™ sensor monitor three axes (X, Y, and Z), are rated from ±200g, and have a frequency response of 5,000 Hz with a resolution of 0.2g. The X axis measures lateral and radial acceleration, the Y axis measures lateral and tangential acceleration, and the Z axis measures axial acceleration.

Rotational acceleration (stick-slip) creates fluctuations in downhole rpm, and these changes are measured by the X and Y accelerometers. Due to the long period of stick-slip motion (usually several seconds), the tangential component should be smaller than the radial component. Bit whirl, expecially backward whirl, has been shown to be a major contributor to premature PDC bit failure. Maximum whirling frequency can be calculated from spectral analysis of the X and Y accelerometer data.

DDS™ sensor-equipped DGR™ sensor subs are available in 4-3/4 in., 6-3/4 in., 8 in., and 9-1/2 in. sizes.



The DDS™ sensor is incorporated into the DGR™ sensor

HAL9013

Operating Applications DDS™ Sensor Response Summary		
Harmful Downhole Conditions	Primary Indication	Secondary Indication
Whirl	High average X and Y accelerations	Analysis of recorded spectral data
Rotational acceleration (stick-slip)	Average X higher than average Y accelerations	Peak X higher than peak Y accelerations
Axial vibrations (bit bounce)	High peak Z acceleration	High average Z acceleration
Lateral shocks	High peak X and Y acceleration	High average X and Y acceleration

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