FINAL SUPERVISION REPORT

For the Data Acquisition Operations of the

PJ3D & PJ2D MARINE SEISMIC SURVEYS

Conducted by

BENARIS PETROLEUM N.V.

In The Exploration Licence Area T/39P

BASS STRAIT, OFFSHORE TASMANIA

SURVEY START DATE 9th October 2005

SURVEY COMPLETION DATE 14th November 2005

Compiled by Drew Murray
Ray Doughty
November/December 2005

VOLUME I

SEISMIC SUPERVISION REPORT

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1 INTRODUCTION

1.1 OBJECTIVES

To carry out a High Quality 3D seismic survey of some 195.885 km² full fold over the T/39P Block. An adjunct 2D survey of some 330 kilometres was also acquired at the completion of the 3D survey. The location is in the Bass Strait North of Devonport, Tasmania. The survey was acquired on behalf of Benaris Petroleum N.V.

The seismic survey vessel was the Orient Explorer operated by Nordic Maritime LTD, Total Marine provided the marine crew. The vessel was on lease to PGS, the primary seismic contractor, who supplied the seismic personnel, data processing and logistics.

1.2 3D SURVEY PARAMETRES

The following is a summary of the survey parameters:

Survey type	3D
Client	BENARIS PETROLEUM N.V.
Survey name	Bass Strait PJ3D MSS
SP interval	37.5
Source	2500 in³. Sleeve guns
Streamer Length	4 x 4350 metres
Groups	4 x 348
Fold	58
Positioning	
Primary	Fugro Skyfix XP
Secondary	Fugro Starfix AS
Water depth	70m to 90m
Number of lines	65
Survey area	194.9km³
Full fold sail line km	978.206
Port of supply	Burnie, Tasmania
Contractor	PGS Australia Pty Ltd
Vessel	Orient Explorer
Client Representation	Enquest Pty. Ltd.

1.3 2D PARAMETRES

Survey type	2D
Client	BENARIS PETROLEUM N.V.
Survey name	Bass Strait PJ2D MSS
SP interval	25.0
Source	2500 in³. Sleeve guns
Streamer Length	4350 metres
Groups	348
Fold	87

Positioning	
Primary	Fugro Skyfix XP
Secondary	Fugro Starfix AS
Water depth	70m to 90m
Number of lines	23
Full fold sail line km	330.08
Port of supply	Burnie, Tasmania
Contractor	PGS Australia Pty Ltd
Vessel	Orient Explorer
Client Representation	Enquest Pty. Ltd

1.4 3D ACQUISITION PARAMETERS

Recording System	Syntrak 24 bit
Number of Channels	4 x 348
Record Length	5000ms
Sample Interval	2ms
Low Cut Filter	3Hz at 6 db/octave
High Cut Filter	206Hz at 276 dB/Oct
Tape Format	SEG-D 8048
Digital Filter Delay	off
Energy Source Type	Bolt 1500LL and 600B
Total Capacity	2500 cubic inches
Number of Arrays	2
Number of sub-arrays	3
Array Length	14.0m
Sub Array Separation	10.0m
Total Number of Guns	26
Capacity of each Sub-Array	960 in^3 starboard, 490 in^3 inner, 1050 in^3 port.
Typical Output	87.5 bar/metres pk-pk (at 6 metres)
Primary / bubble ratio	25.0 (full array, at 6 metres)
Pressure	1800psi +/- 10%
Depth	6.0 metres
Firing Delay from Time Zero	50ms
Shot Interval	18.75 metres
Coverage	58 Fold
Number Of Groups	4 x 348
Group Length	12.5 metres
Group Interval	12.5 metres
Group Sensitivity	17.4v/ bar
Hydrophones per Group	16 in parallel (8 per 6.25m base group)
Streamer depth	8 metres +/- 1.0m
Typical Noise	1.5 to 4.0 microbars
Offset (In-line)	94.0m
Nav Ref.-Cent. Source	166.00m
Primary Navigation	Multifix 4 Version 1.3
Secondary Navigation	Starfix Suite 6.2

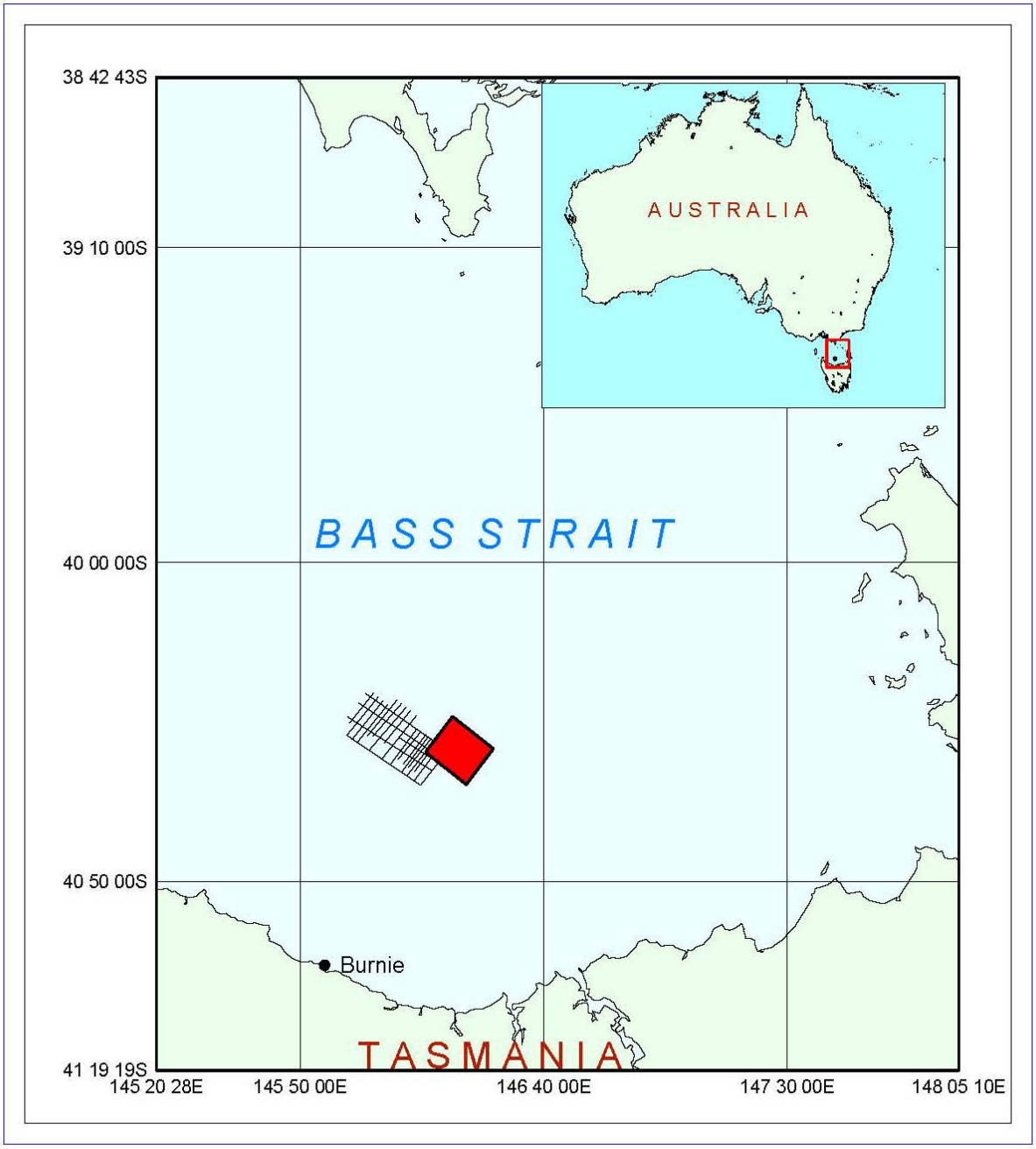
Integrated Navigation System	SPECTRA
Coverage Binning System	CENSUS
Echo Sounder	Kongsberg-Simrad EA500, 38/200 kHz

1.5 2D ACQUISITION PARAMETERS

Recording System	Syntrak 24 bit
Number of Channels	348
Record Length	5000ms
Sample Interval	2ms
Low Cut Filter	3Hz at 6 db/octave
High Cut Filter	206Hz at 276 dB/Oct
Tape Format	SEG-D 8048
Digital Filter Delay	off
Energy Source Type	Bolt 1500LL and 600B
Total Capacity	2500 cubic inches
Number of Arrays	1
Number of sub-arrays	3
Array Length	14.0m
Sub Array Separation	10.0m
Total Number of Guns	26
Capacity of each Sub-Array	960 in^3 starboard, 490 in^3 inner, 1050 in^3 port.
Typical Output	87.5 bar/metres pk-pk (at 6 metres)
Primary / bubble ratio	25.0 (full array, at 6 metres)
Pressure	1800psi +/- 10%
Depth	6.0 metres
Firing Delay from Time Zero	50ms
Shot Interval	25.0 metres
Number Of Groups	348
Group Length	12.5 metres
Group Interval	12.5 metres
Group Sensitivity	17.4v/ bar
Hydrophones per Group	16 in parallel (8 per 6.25m base group)
Streamer depth	8 metres +/- 1.0m
Typical Noise	1.5 to 4.0 microbars
Offset (In-line)	94.0m
Nav Ref.-Cent. Source	166.00m
Primary Navigation	Multifix 4 Version 1.3
Secondary Navigation	Starfix Suit 6.2
Integrated Navigation System	SPECTRA
Echo Sounder	Kongsberg-Simrad EA500, 38/200 kHz

1.6 LOCATION MAP

Survey Centre 40° 30’ 00” S 146° 22’00” E



1.7 3D SAIL LINE CO-ORDINATES

Line	Latitude	Longitude	Easting	Northing	Metres
1004	403447.27S	1462406.93E	449382.7	5507715.9	
1004	402944.21S	1461545.10E	437506.9	5516971	15056.25
1012	403442.18S	1462412.20E	449505.6	5507873.7	
1012	402938.75S	1461549.76E	437615	5517140.2	15075
1020	403437.09S	1462417.48E	449628.6	5508031.4	
1020	402933.67S	1461555.04E	437738	5517298	15075
1028	403432.00S	1462422.75E	449751.5	5508189.2	
1028	402928.58S	1461600.31E	437860.9	5517455.8	15075
1036	403426.91S	1462428.02E	449874.4	5508346.9	
1036	402923.50S	1461605.59E	437983.9	5517613.5	15075
1044	403421.45S	1462432.67E	449982.6	5508516.2	
1044	402918.42S	1461610.87E	438106.8	5517771.3	15056.25
1052	403416.36S	1462437.95E	450105.5	5508674	
1052	402912.96S	1461615.52E	438214.9	5517940.5	15075
1060	403411.27S	1462443.22E	450228.5	5508831.7	
1060	402907.87S	1461620.80E	438337.9	5518098.3	15075
1068	403406.18S	1462448.49E	450351.4	5508989.5	
1068	402902.79S	1461626.08E	438460.8	5518256	15075
1076	403400.71S	1462453.14E	450459.6	5509158.7	
1076	402857.71S	1461631.35E	438583.8	5518413.8	15056.25
1084	403355.62S	1462458.41E	450582.5	5509316.5	
1084	402852.62S	1461636.63E	438706.7	5518571.5	15056.25
1092	403350.53S	1462503.68E	450705.4	5509474.2	
1092	402847.16S	1461641.28E	438814.9	5518740.8	15075
1100	403345.44S	1462508.96E	450828.4	5509632	
1100	402842.08S	1461646.56E	438937.8	5518898.6	15075
1108	403339.98S	1462513.60E	450936.5	5509801.3	
1108	402837.00S	1461651.83E	439060.7	5519056.3	15056.25
1116	403334.89S	1462518.87E	451059.5	5509959	
1116	402831.91S	1461657.11E	439183.7	5519214.1	15056.25

Line	Latitude	Longitude	Easting	Northing	Metres
1124	403329.80S	1462524.15E	451182.4	5510116.8	
1124	402826.83S	1461702.38E	439306.6	5519371.8	15056.25
1132	403324.71S	1462529.42E	451305.4	5510274.5	
1132	402821.75S	1461707.66E	439429.5	5519529.6	15056.25
1140	403319.62S	1462534.69E	451428.3	5510432.3	
1140	402816.29S	1461712.31E	439537.7	5519698.9	15075
1148	403314.15S	1462539.33E	451536.4	5510601.6	
1148	402811.20S	1461717.58E	439660.6	5519856.6	15056.25
1156	403309.06S	1462544.60E	451659.4	5510759.3	
1156	402806.12S	1461722.86E	439783.6	5520014.4	15056.25
1164	403303.97S	1462549.87E	451782.3	5510917.1	
1164	402801.03S	1461728.13E	439906.5	5520172.1	15056.25
1172	403258.88S	1462555.14E	451905.3	5511074.8	
1172	402755.95S	1461733.41E	440029.5	5520329.9	15056.25
1180	403253.41S	1462559.79E	452013.4	5511244.1	
1180	402750.49S	1461738.06E	440137.6	5520499.1	15056.25
1188	403248.32S	1462605.06E	452136.4	5511401.9	
1188	402745.40S	1461743.33E	440260.5	5520656.9	15056.25
1196	403243.23S	1462610.33E	452259.3	5511559.6	
1196	402740.32S	1461748.60E	440383.5	5520814.7	15056.25
1204	403238.14S	1462615.60E	452382.2	5511717.4	
1204	402735.24S	1461753.88E	440506.4	5520972.4	15056.25
1212	403232.67S	1462620.24E	452490.4	5511886.6	
1212	402730.15S	1461759.15E	440629.4	5521130.2	15037.5
1220	403227.58S	1462625.51E	452613.3	5512044.4	
1220	402724.69S	1461803.80E	440737.5	5521299.4	15056.25
1228	403222.49S	1462630.78E	452736.3	5512202.1	
1228	402719.60S	1461809.07E	440860.5	5521457.2	15056.25
1236	403217.40S	1462636.05E	452859.2	5512359.9	
1236	402714.52S	1461814.34E	440983.4	5521614.9	15056.25
1244	403212.31S	1462641.31E	452982.1	5512517.6	
1244	402709.44S	1461819.61E	441106.3	5521772.7	15056.25
1252	403206.84S	1462645.96E	453090.3	5512686.9	
1252	402704.35S	1461824.89E	441229.3	5521930.4	15037.5

Line	Latitude	Longitude	Easting	Northing	Metres
1260	403201.75S	1462651.22E	453213.2	5512844.7	
1260	402658.89S	1461829.53E	441337.4	5522099.7	15056.25
1268	403156.66S	1462656.49E	453336.2	5513002.4	
1268	402653.80S	1461834.80E	441460.4	5522257.5	15056.25
1276	403151.57S	1462701.76E	453459.1	5513160.2	
1276	402648.72S	1461840.08E	441583.3	5522415.2	15056.25
1284	403146.10S	1462706.40E	453567.3	5513329.5	
1284	402643.63S	1461845.35E	441706.2	5522573	15037.5
1292	403141.01S	1462711.67E	453690.2	5513487.2	
1292	402638.55S	1461850.62E	441829.2	5522730.7	15037.5
1300	403135.92S	1462716.93E	453813.1	5513645	
1300	402633.09S	1461855.26E	441937.3	5522900	15056.25
1308	403130.83S	1462722.20E	453936.1	5513802.7	
1308	402628.00S	1461900.53E	442060.3	5523057.8	15056.25
1316	403125.36S	1462726.84E	454044.2	5513972	
1316	402622.92S	1461905.80E	442183.2	5523215.5	15037.5
1324	403120.27S	1462732.11E	454167.2	5514129.7	
1324	402617.83S	1461911.07E	442306.2	5523373.3	15037.5
1332	403115.18S	1462737.37E	454290.1	5514287.5	
1332	402612.75S	1461916.34E	442429.1	5523531	15037.5
1340	403110.08S	1462742.64E	454413	5514445.3	
1340	402607.66S	1461921.61E	442552	5523688.8	15037.5
1348	403104.99S	1462747.90E	454536	5514603	
1348	402602.20S	1461926.26E	442660.2	5523858.1	15056.25
1356	403059.52S	1462752.54E	454644.1	5514772.3	
1356	402557.11S	1461931.53E	442783.1	5524015.8	15037.5
1364	403054.43S	1462757.81E	454767.1	5514930	
1364	402552.03S	1461936.79E	442906.1	5524173.6	15037.5
1372	403049.34S	1462803.07E	454890	5515087.8	
1372	402546.94S	1461942.06E	443029	5524331.3	15037.5
1380	403044.25S	1462808.34E	455013	5515245.5	
1380	402541.86S	1461947.33E	443151.9	5524489.1	15037.5
1388	403038.78S	1462812.98E	455121.1	5515414.8	
1388	402536.39S	1461951.98E	443260.1	5524658.3	15037.5

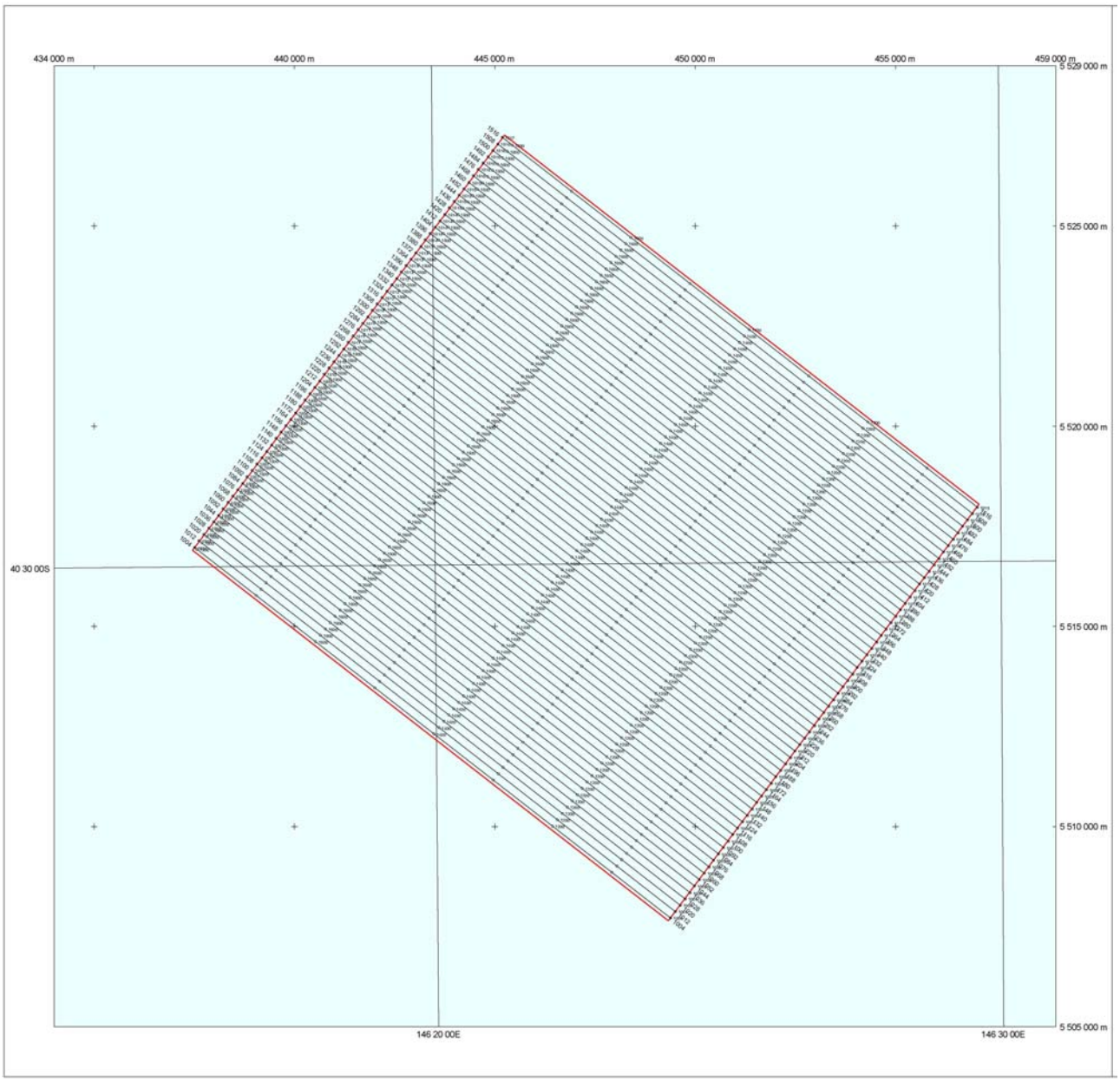
Line	Latitude	Longitude	Easting	Northing	Metres
1396	403033.69S	1462818.24E	455244	5515572.6	
1396	402531.31S	1461957.24E	443383	5524816.1	15037.5
1404	403028.59S	1462823.50E	455367	5515730.3	
1404	402526.22S	1462002.51E	443506	5524973.8	15037.5
1412	403023.50S	1462828.77E	455489.9	5515888.1	
1412	402521.13S	1462007.78E	443628.9	5525131.6	15037.5
1420	403018.03S	1462833.41E	455598.1	5516057.4	
1420	402516.05S	1462013.04E	443751.9	5525289.4	15018.75
1428	403012.94S	1462838.67E	455721	5516215.1	
1428	402510.58S	1462017.69E	443860	5525458.6	15037.5
1436	403007.85S	1462843.93E	455844	5516372.9	
1436	402505.50S	1462022.95E	443982.9	5525616.4	15037.5
1444	403002.76S	1462849.19E	455966.9	5516530.6	
1444	402500.41S	1462028.22E	444105.9	5525774.1	15037.5
1452	402957.66S	1462854.46E	456089.8	5516688.4	
1452	402455.33S	1462033.49E	444228.8	5525931.9	15037.5
1460	402952.19S	1462859.09E	456198	5516857.6	
1460	402450.24S	1462038.75E	444351.8	5526089.6	15018.75
1468	402947.10S	1462904.35E	456320.9	5517015.4	
1468	402444.78S	1462043.40E	444459.9	5526258.9	15037.5
1476	402942.01S	1462909.62E	456443.9	5517173.1	
1476	402439.69S	1462048.66E	444582.9	5526416.7	15037.5
1484	402936.92S	1462914.88E	456566.8	5517330.9	
1484	402434.60S	1462053.93E	444705.8	5526574.4	15037.5
1492	402931.45S	1462919.51E	456675	5517500.2	
1492	402429.52S	1462059.19E	444828.7	5526732.2	15018.75
1500	402926.35S	1462924.78E	456797.9	5517657.9	
1500	402424.43S	1462104.46E	444951.7	5526889.9	15018.75
1508	402921.26S	1462930.04E	456920.8	5517815.7	
1508	402419.34S	1462109.72E	445074.6	5527047.7	15018.75
1516	402916.17S	1462935.30E	457043.8	5517973.4	
1516	402413.88S	1462114.36E	445182.8	5527217	15037.5

1.8 2D LINE CORDINATES

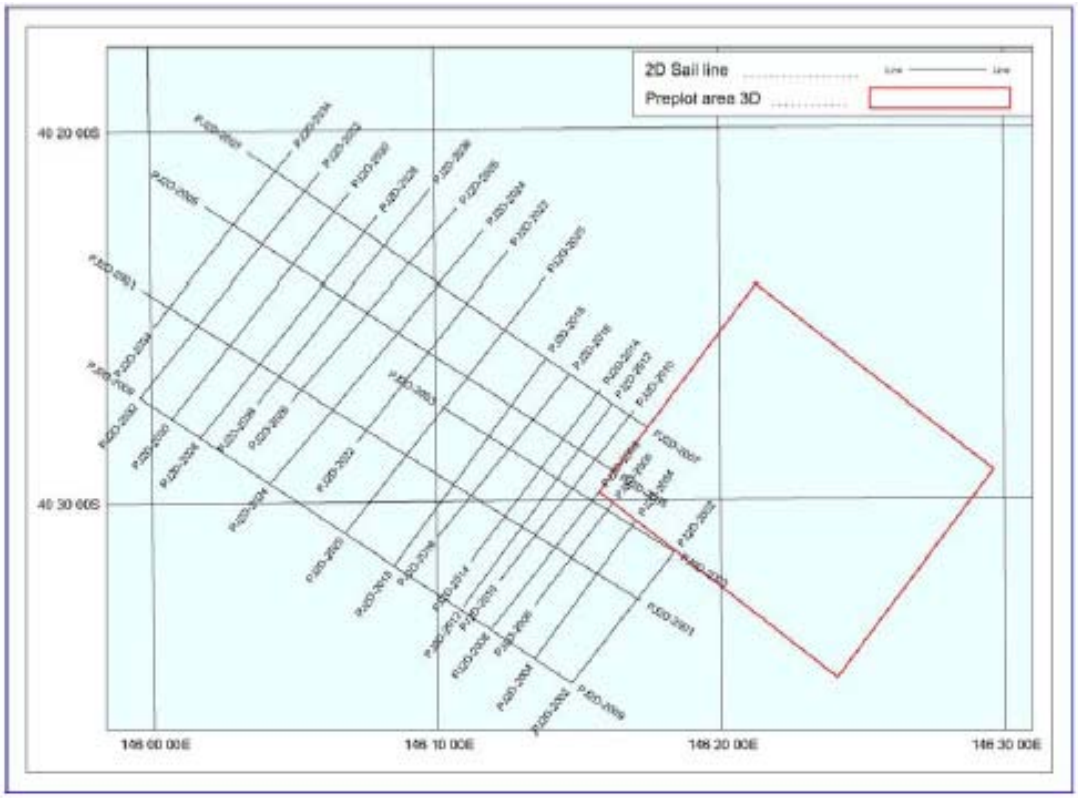
Line	Latitude	Longitude	Easting	Northing	Meters
PJ2D-2001	402414.99S	1455942.78E	414739.2	5526898.5	
PJ2D-2001	403243.11S	1461708.77E	439520.9	5511470.9	29191.5
PJ2D-2003	402726.34S	1461013.09E	429651.7	5521152.5	
PJ2D-2003	403124.91S	1461821.40E	441210.3	5513895.9	13647.69
PJ2D-2005	402202.57S	1460155.91E	417832.5	5531016.4	
PJ2D-2005	402914.48S	1461615.38E	438212	5517893.6	24239.06
PJ2D-2007	402034.54S	1460327.42E	419961.7	5533753.9	
PJ2D-2007	402803.05S	1461726.27E	439863.2	5520109.7	24129.52
PJ2D-2009	402708.42S	1455935.88E	414637.5	5521549.1	
PJ2D-2009	403456.15S	1461441.98E	436103.3	5507340	25742.55
PJ2D-2002	403456.15S	1461441.98E	436103.3	5507340	
PJ2D-2002	403124.91S	1461821.40E	441210.3	5513895.9	8310.31
PJ2D-2004	403416.18S	1461324.81E	434278.3	5508556.7	
PJ2D-2004	403035.08S	1461658.82E	439254.9	5515416.7	8475.03
PJ2D-2006	403250.40S	1461324.93E	434257.8	5511201.8	
PJ2D-2006	403006.60S	1461611.12E	438125.1	5516285.8	6387.73
PJ2D-2008	403326.24S	1461154.85E	432149.1	5510077.5	
PJ2D-2008	402946.51S	1461542.98E	437457.4	5516899.7	8644.1
PJ2D-2010	403209.03S	1461211.52E	432519.6	5512461.9	
PJ2D-2010	402736.09S	1461657.04E	439168	5520935.3	10770.32
PJ2D-2012	403250.59S	1461054.31E	430715.1	5511163.9	
PJ2D-2012	402724.54S	1461612.88E	438125.1	5521282.9	12542.02
PJ2D-2014	403136.21S	1461112.81E	431129.1	5513461.3	
PJ2D-2014	402701.83S	1461547.30E	437516.7	5521978.1	10646
PJ2D-2016	403056.25S	1461003.12E	429477.9	5514678	
PJ2D-2016	402636.05S	1461443.02E	435995.9	5522760.3	10383.06
PJ2D-2018	403143.30S	1460829.22E	427282.4	5513206.1	
PJ2D-2018	402608.95S	1461353.53E	434822.7	5523585.9	12829.51
PJ2D-2020	403048.98S	1460648.36E	424892.4	5514857.4	
PJ2D-2020	402402.09S	1461351.28E	434735.7	5527496.7	16020.06

Line	Latitude	Longitude	Easting	Northing	Meters
PJ2D-2022	402822.79S	1460713.40E	425436.8	5519371	
PJ2D-2022	402317.89S	1461234.38E	432910.7	5528843.7	12066.12
PJ2D-2024	402927.42S	1460410.69E	421155.5	5517334.2	
PJ2D-2024	402245.12S	1461143.16E	431694	5529843.1	16356.42
PJ2D-2026	402715.49S	1460455.91E	422177.8	5521413.3	
PJ2D-2026	402209.49S	1461046.47E	430347	5530929.5	12541.69
PJ2D-2028	402812.93S	1460144.09E	417679.2	5519593.7	
PJ2D-2028	402220.95S	1460758.65E	426392.8	5530538.4	13989.76
PJ2D-2030	402742.82S	1460043.64E	416245.3	5520506.3	
PJ2D-2030	402142.46S	1460700.19E	425002.3	5531711.6	14221.24
PJ2D-2032	402708.42S	1455935.88E	414637.5	5521549.1	
PJ2D-2032	402108.17S	1460559.84E	423568.3	5532754.5	14329
PJ2D-2034	402513.31S	1460008.08E	415355.7	5525106.8	
PJ2D-2034	402033.87S	1460459.52E	422134.4	5533797.4	11021.67
PJ2D-2036	402717.74S	1460345.78E	420526.6	5521326.4	
PJ2D-2036	402136.68S	1460951.59E	429043.4	5531928.9	13599.59

1.9 PROGRAM MAP 3D



1.10 PROGRAM MAP 2D



2 SYNOPSIS

2.1 OVERVIEW

The survey consisted of 65 pre-plotted lines with a total of 196 km² full fold kilometres over Permit Area T/36P located in Bass Strait. A final total of 1120.78 kilometres of surface coverage equivalent to 195.88² full fold kilometres were recorded over the 3D area. The 2D survey consisted of 23 pre-plotted lines with a total of 330.08 full fold kilometres. A total of 380.75 sail kilometres were acquired, which translates to 330.725 full fold kilometres recorded over the 2D area.

October 9th The Orient Explorer departed Portland, Victoria shortly after 17:00hrs October 8th. Due to problems acquiring fuel at Portland in the short term, the vessel made for Burnie in Tasmania were fuel would be available in the early morning of October 10th. The Explorer made the crossing in around 25hrs experiencing rough to very rough seas during the transit.

October 10th The Orient explorer remained alongside waiting for fuel. Bunkers couldn't commence at the planned 0500hrs due to the lack of power for the shore side fuel pump. Refuelling started at 07:25 and was completed at 12:52 and the vessel departed Burnie for the prospect area at 13:55. Once the Pilot had departed an emergency towing exercise was carried out involving the Chase boat Pacific Conquest and the Orient Explorer. A tag line as dropped off the stern of the Pacific Conquest and floated back to the Explorer to be grappled. Once the Captain was happy with the exercise the Explorer headed for the prospect area in company with the chase boat. Streamer deployment commenced at 15:15. At midnight work was still being carried out on ballasting and repairing the first streamer.

October 11th The first streamer (#4) was deployed at 09:40hrs. Deployment of the second streamer (#1) started by 10:00hrs and was approximately 3/4 deployed at midnight. A considerable amount of time was spent making repairs and ballasting both streamers.

October 12th Streamer deployment and ballasting of streamer #4 continued through the morning along with fault finding on streamer #1 for a power error. The Work Boat was launched at 10:03 to assist in streamer ballasting on streamer #4 and also replace a faulty section. The workboat made a number of trips through out the day in good weather conditions finally being recalled at 17:13hrs due to failing light. The tailbuoy for streamer #2 was launched at 12:33. Work on deploying streamer #2 continued through the afternoon with ballasting and some repair work being required. At 23:15hrs the engineer informed the Party Chief and Captain that the main engine had developed a water leak in the charged air cooling system and the engine needed to be shut down for approximately 6 hrs. After discussions with the Captain the decision was made to recover the deployed streamers and the partly deployed streamer #2 and head for sheltered waters so the engine could be shut down and repaired.

October 13th All streamers were recovered by 07:30 and the vessel made way to Bell Bay on the Tamar River. Dropping anchor at 10:59. An attempt at repairing the leaking cooling system while still in place failed. The damaged parts were then removed and sent ashore for repair.

October 14th Orient Explorer remained at anchor in Bell Bay. Forced air cooler has been removed and shipped to Devonport for repair.

October 15th Orient Explorer remained at anchor in Bell Bay. Forced air cooler has been removed and shipped to Devonport for repair. Latest estimate is for the repaired cooler to be back onboard mid afternoon October 16th.

October 16th The forced air cooler pipe nest was returned at 16:40hrs local. Getting it back in to the engine room and fitting it back on to the engine continued through the night.

October 17th The Orient Explorer picked her anchor up at 09:15hrs local time an proceeded to the dock to take on fresh water before heading down the Tamar River, at 11:25hrs for the prospect area. The first tailbuoy for streamer #1 was deployed at 12:48 followed by streamer #4's tailbuoy at 14:19hrs. At 16:49hrs, Streamer #4 was at the original position prior to streamer recovery. At midnight fault finding was still being carried out on streamers #1 and #4.

October 18th Streamer work continues. Parity errors showing on streamer #4 are proving difficult to trace. Third streamer, streamer #2, deployment commenced at 12:55 and was at bird #14 at 17:05. This was the position prior to streamer retrieval for the vessel engine problems. Streamer #3 deployment commenced at 21:47 and continued through midnight.

October 19th All 4 streamers were deployed by 18:50hrs. Parity error problems continued to plague streamers #1 & #4 and fault finding continues on these streamers. Helicopter crew change took place for the seismic and marine crew. Two helicopters, one at 11:17 and the next at 15:27, took off 13 marine/seismic personnel and delivered a total of 14 marine and seismic personnel. Work continues on the streamers.

October 20th The vessel is on the survey area and work continues through the day trouble shooting streamers #1 and #4. A TS dip was taken at 11:40. Towards the end of the day the parity error problem looked to be solved and Streamers #1 & #4 are being put out wide. Bad weather stopped crew change completion with the Helos unable to leave Melbourne. An available weather window is possible in around 24 hours.

October 21st Source array deployment commenced in the early hours of the morning followed by a test line at 06:00hrs local. The first acquisition line got underway at 09:27hrs. local. Streamers were set at 8.0 metres; weather conditions were favourable with a 1.5 metre swell from the North East. Feather angles have been low between 0 and 3 degrees. Streamer #2 started to have extraction errors during line 1460, seq 003, but a re-adjustment of the lead-in to remove a kink looks to have fixed the problem. At midnight line 1228, seq 004 was still in production.

October 22nd Streamer #2 failed during acquisition of sequence #4. A considerable amount of time was lost during the morning fault finding on streamer #2. Acquisition getting underway at 11:16hrs local with line 1452. Feather angles have remained low through out the day, <4.0 degrees, and weather conditions remain favourable. Visibility is poor with, <5 miles, due to foggy conditions. The workboat went out at 13:44 local to inspect the towing harnesses and ballasting at the front of the streamers. Recovery was at 16:02. At the end of the day the Explorer was running in to line PJ051220P1008.

October 23rd The run in to sequence 011 was terminated late on the run in. More than 5 hours were lost when streamers #4 and #1 malfunctioned causing parity errors and spiking data. The workboat was launched at 13:31hrs and recovered at 15:12hrs. A streamer section was changed on streamer #4 which appears to have fixed the parity error fault. Work was carried out on streamer #1's deck cable, remedying the spiking data fault. At 12:29 a Helicopter crew change took 8 marine crew off and 8 new marine crew on. At the end of the day the vessel was on a line change to line PJ051196P1013.

October 24th Weather condition deteriorated through the day causing noisy data from the compasses and acoustic net. Line 1468 sequence 016 was recorded with the streamer set at 9 metres to reduce the weather effect on the streamer. Streamer #4 started to have an increasing parity count starting with sequence 016 there were a large number of data spikes logged during seq 016, the line was provisionally accepted pending brute stack QCing. The stacks showed little in the way of spiking and the line was accepted. The term data spike is questionable, they were not spikes but low-level parity errors. Weather condition started to improve during seq. 016 and line 1180 seq. 017 was recorded with the streamer back at 8 metres. Compass data was moderately noisy. During the turn to sequence 018 a module failed in streamer #3. The run in was halted and preparations were made to retrieve the front portion of streamer #3 to replace the faulty module and also work on streamer #4. At the end of the day the Arrays were being retrieved prior to working on the streamers.

October 25th Work continued through the morning on repairs to streamers #3 and 4. Streamer lead-ins and stretch sections were checked on streamer #4 to eliminate them from the parity error problem. Fault finding pointed to the towing arrangement. The towing arrangement had been upgraded prior to commencing the survey this has been altered on streamer 4 back to the old set up and all parity errors have been eliminated. The front portion of streamer #3 was recovered to replace the faulty electronic module. The workboat was launched at 12:52 to carry out ballasting of the streamers and recovered at 15:37. The workboat was launched once more at 17:13 to check on the front end towing. Recovered at 15:37. At 17:13 the workboat was launched to check on tailbuoy separations, at 17:23 the workboat reported engine failure. The engine was restarted at 17:28 but failed at 17:32. A tow was organised with the chaseboat and the Explorer slowed to ~4.0 knots. The workboat was recovered at 18:33hrs, under her own power after being towed to the Explorer. A full Report was available with in 24hrs. 1 prime line and 1 infill line were recorded in slight seas. Infill line 1172 was still in production at midnight. The two infill lines were to pick up infill over lines 1172 and 1420. Both lines had previously been acquired at an average of 200 metres of line for coverage.

October 26th The day started with the wind from the North at 15knots on a 0.5m swell as the day progressed the wind started to swing to the North East and gain in intensity. On the line change to sequence 022 a Humpback whale, possibly 2, was sighted flipper slapping. It was determined the whale was outside the 3 kilometre range and the vessel proceeded to the line. A report was filled out and forwarded to Benaris. Towards the completion of sequence 023 the wind had strengthened to 25knots out of the NE. An attempt was made to acquire line 1156. The wind strength had increased to 35knots steady gusting to 40knots with a growing swell and confused seas. Final assessment of line 1156 after brute stacks and navigation processing had been done determined it was of poor quality and discarded. The streamers were set down to 15 metres to reduce strain and the vessel headed slightly off the prospect area to the southwest for shelter. Weather conditions were considered too severe to recover the source arrays. At midnight the Orient Explorer was down for weather.

27th October. Weather conditions started to moderate slightly as the day progressed. Line PJ051004P1025 was acquired with the streamer set at 10 metres to improve control of the streamers in the weather conditions. Strong random swell noise was evident on the streamers but filtered out in processing. Navigation data was noisy but acceptable. When the explorer tried to turn on to a line running east to west it became apparent the swell was too big (>3.0 metres), reducing vessel speed and effecting the steering. The Explorer made a turn to put the weather off the port bow and headed to the west end of the prospect. At the end of the day the Orient explorer was on weather downtime.

28th October. Weather conditions started to moderate in the early hours of the day and preparations were made to deploy the source arrays that had been retrieved during the weather down time as a safety precaution. At around 03:00hrs streamer #2 started having leakage problems. The run onto line was halted and streamer #2 retrieved to the boot section, were the streamer and lead-in are connected, a new boot section was added, streamer and arrays were deployed. The workboat was launched at 07:45hrs to change the battery pack in tailbuoy #1 and check on a bird. The WB was recovered at 09:07. The WB was launched at 13:04 to change bird #10 on streamer #2. This was the bird that failed during sequence #26. The WB was back onboard and secured at 14:53. Weather conditions since commencing acquisition on this day have been perfect. At the end of the day Line PJ051388P1029 was still in production.

29th October. The first full production day. Weather conditions started to go off around 03:00hrs with the wind rising to 20 knots from the east swell rising to 1.5 metres. The poor weather was short lived and dropped off moderate to light conditions later in the day. Conditions were never severe enough to halt production, streamer noise levels and compass data remained good through out the production day. Chase Boat Pacific Conquest departed for Burnie at 11:15hrs local and was back on station at 20:30hrs. At the end of the day the Explorer was on a line change to PJ051364P1035.

30th October. A good day's production in moderate to light conditions. As the new moon period approaches, Wed November 2nd, feather miss matches grew. Data quality is high with very low noise levels. An infill line was recorded to reduce the gap. Line changes would need to be extended by 1 to

2 hours to reduce the feather miss match. MOB drill: WB launched at 13:02 recovered 13:09. A section was changed in streamer #4. The WB launched at 15:04 streamer section changed, WB recovered at 16:01. Personnel transfer to the Pacific Conquest, one of the marine crew had to return home for personal reasons. 19:55hrs and the Conquest made for Burnie. At the end of the day the vessel was on a line change to PJ051340P1041.

31st October. Feather angles are proving difficult to predict. Wind generated currents are having more of an effect than the tidal stream and no real pattern emerged for feather angle trends. This resulted in the recording of 2 infill lines to fill in gaps in the data over lines 1108 and 1340. The Pacific conquest was back on station at 05:00hrs after yesterdays transfer to Burnie. Two field service engineers the second officer and medic departed the Explorer via the workboat to the Pacific Conquest which took them to Burnie. WB launched for transfer at 18:43 and recovered at 19:05 after making two trips to the Pacific Conquest. At days end line 1100 was still in production.

1st November. A good days recording in fair to moderate seas. Data quality was good and feather matching better than over the past couple of days. Longer line changes were necessary on to sequences 049 and 050 to improve feather matching. After taking on the Explorer's off going crew members The Pacific Conquest stayed on station and departed for Burnie at around midnight. At the end of the day the Explorer was on a line change to sequence 052.

2nd November. A good days production, good quality data with low streamer noise. The chase boat Pacific Conquest departed around midnight and was back on station at 19:15hrs local time. She came alongside the following day with new food supplies, a medic and a replacement second officer.

3rd November. Data acquisition continued through the morning. At 06:11 the workboat was launched to pick up the second officer and new medic from the chase boat, Pacific Conquest. The chase boat came alongside at 07:10 to discharge fresh food and supplies. Stores were started at 07:30 and completed at 10:38. No time was lost during this operation, the Explorer continued acquisition with the Conquest along side. Weather predictions for the afternoon indicated a rapid deterioration in conditions and the source arrays were recovered at the completion of sequence 060. The vessel was secured for severe weather and at midnight was riding out force 6 – 7 conditions and rising seas.

4th November. The Orient Explorer remained on weather down time through the day. The vessel moved closer to the coast to pick up shelter. Very the survey area wind and sea conditions were 40 to 50 knots with a swell of 4 to 5 metres. The Explorer moved back on to the survey area when conditions began to improve late in the day, and started to deploy the source arrays. At midnight all trailing equipment had been deployed and tested and the vessel was on the run in to line 1044.

5th November. Acquisition commenced at 01:03hrs in favourable seas and continued through the day. The workboat was launched twice. The first time at 10:30 to carry out a TS Dip in the water column, the WB recovered at 10:50. The second time to replace a failed compass module. The WB launched at 16:05 and recovered at 17:33. At the end of the day line PJ051508P1066 was in production.

6th November. Streamer #1 failed some 28 minutes into sequence 067. The line was terminated and preparations were started to repair the fault. This meant retrieving all source arrays and retrieving streamer #1 up to the first module which had also failed. With 4 streamers in the water this takes time. The problem was eventually traced to the lead in, which had been in place for a considerable amount of time. The failure in the lead in led to the failure of the first module. These were replaced, the streamer re-deployed and Array deployment commenced. Sequence 068 got underway at 23:10hrs and was still in production at midnight.

7th November. A good recording day in deteriorating weather. More than 4 hours were lost when an array element on string #1 failed causing an air leak. The vessel was 30 minutes into the line. Data quality continued to be good with reasonable if slightly noisy acoustic network due to the weather conditions. At midnight the vessel was on a line change to PJ051060J1074.

8th November. A good day of continuous recording in moderate to improving weather. All prime lines had been completed and at midnight infill over line 1268 was still in production. A further infill line down the centre between the two swaths still needed to be acquired to complete the survey.

9th November. 3D survey completed with the final acquisition of infill over line PJ051260J1080.
At the completion of the 3D survey the Port source array was retrieved. The 2D survey was acquired using the starboard source array and #3 streamer. All 4 streamers were being recorded. Three good quality lines were recorded and at midnight the vessel was on a line change to line 2009. The workboat was launched at 11:14 to medivac the Bosun to the chase boat for transfer to Burnie to receive attention to a torn muscle. This is a recurring injury and was not sustained through poor work practice.

10th November. Acquisition continued through the day with a break off at 06:25 for the workboat to pick up a replacement crewman from the chase boat. Down time of 31 minutes. Weather conditions started to deteriorate from around 09:30 with the wind picking up to 30 knots plus from the north west. By 18:00hrs the swell had developed short and steep 2 - 3 metres and the Explorer went on weather standby at 18:45hrs. As a safety precaution the source arrays were recovered and the vessel came to fair seas close to the prospect area.

11th November. The Orient Explore stood by the prospect area running fair seas in force 7 to 8 gale force conditions for most of the day. Weather conditions started to moderate around 22:00hrs with the wind dropping to 25knots. A run on line heading was made to confirm conditions were improving and at midnight preparations were underway to redeploy the source arrays.

12th November. Recording re-commenced in the early hours of the morning after the bad weather period. As is normal in this area the seas dropped dramatically and acquisition continued through the day in good conditions. During the line change from sequence 90 to 91 there was a change out of Navigation QC personnel via Helicopter with one QC departing a new QC plus an MMO arriving. Transfer was carried out quickly without any mishap. At the end of the day the Explorer was recording line PJ2D2020P1094.

13th November. A good days recording in perfect weather conditions. At 15:18 the workboat was launched to carry out a TSDip. The workboat being retrieved at 15:55. At midnight the Explorer was on a line change to PJ2D2026P1101.

14th November. Benaris 2D survey was completed at 09:35. The Chase boat Pacific Conquest departed for Burnie at 10:30hrs to pick up the MMO for the following survey and the Orient Explorer departed the area and headed to the north west to start the next survey. There were 2 workboat movements: At 06:05 the workboat was deployed to replace compasses on streamers 2 and 3. Recovery was at 07:38 and launched at 09:18 to replace a streamer section in streamer 4, recovery at 10:23.

2.2 3D SURVEY PRODUCTION BY LINE

Seq	Line	Dir	FCSP	LCSP	KM	KMFF	CMP	SQKMFF
001	PJ051516P	308	1001	1919	17.23125	15.05625	137.85000	3.011250
002	PJ051236P1	128	1810	891	17.25000	15.07500	138.00000	3.015000
003	PJ051460P1	308	1014	1931	17.21250	15.03750	137.70000	3.007500
005	PJ051452P1	308	1013	1931	17.23125	15.05625	137.85000	3.011250
006	PJ051228P2	128	1810	891	17.25000	15.07500	138.00000	3.015000
007	PJ051444P1	308	1014	1931	17.21250	15.03750	137.70000	3.007500
008	PJ051220P1	128	1810	1803	0.15000	0.15000	1.20000	0.030000
008	PJ051220P1	128	1802	891	17.10000	14.92500	136.80000	2.985000
009	PJ051436P1	308	1013	1931	17.23125	15.05625	137.85000	3.011250
010	PJ051212P1	128	1809	891	17.23125	15.05625	137.85000	3.011250
011	PJ051204P1	128	1809	890	17.25000	15.07500	138.00000	3.015000
012	PJ051428P1	308	1013	1931	17.23125	15.05625	137.85000	3.011250
013	PJ051196P1	128	1809	890	17.25000	15.07500	138.00000	3.015000
014	PJ051420P1	308	1013	1930	17.21250	15.03750	137.70000	3.007500
015	PJ051188P1	128	1809	890	17.25000	15.07500	138.00000	3.015000
016	PJ051468P1	308	1014	1932	17.23125	15.05625	137.85000	3.011250
017	PJ051180P1	128	1809	890	17.25000	15.07500	138.00000	3.015000
018	PJ051172P1	128	1808	889	17.25000	15.07500	138.00000	3.015000
021	PJ051412P1	308	1012	1930	17.23125	15.05625	137.85000	3.011250
022	PJ051164P1	128	1808	889	17.25000	15.07500	138.00000	3.015000
023	PJ051404P1	308	1012	1930	17.23125	15.05625	137.85000	3.011250
025	PJ051004P1	128	1804	885	17.25000	15.07500	138.00000	3.015000
026	PJ051156P2	128	1808	889	17.25000	15.07500	138.00000	3.015000
027	PJ051396P1	308	1012	1930	17.23125	15.05625	137.85000	3.011250
028	PJ051148P1	128	1808	889	17.25000	15.07500	138.00000	3.015000
029	PJ051388P1	308	1012	1126	2.15625	2.15625	17.25000	0.431250
029	PJ051388P1	308	1127	1930	15.07500	12.90000	120.60000	2.580000
030	PJ051140P1	128	1808	888	17.26875	15.09375	138.15000	3.018750
031	PJ051380P1	308	1011	1929	17.23125	15.05625	137.85000	3.011250
032	PJ051132P1	128	1807	888	17.25000	15.07500	138.00000	3.015000
033	PJ051372P1	308	1011	1929	17.23125	15.05625	137.85000	3.011250
034	PJ051124P1	128	1807	888	17.25000	15.07500	138.00000	3.015000
035	PJ051364P1	308	1011	1929	17.23125	15.05625	137.85000	3.011250
036	PJ051116P1	128	1807	888	17.25000	15.07500	138.00000	3.015000
037	PJ051356P1	308	1011	1929	17.23125	15.05625	137.85000	3.011250
039	PJ051348P1	308	1010	1929	17.25000	15.07500	138.00000	3.015000
040	PJ051108P1	128	1807	888	17.25000	15.07500	138.00000	3.015000
041	PJ051340P1	308	1010	1928	17.23125	15.05625	137.85000	3.011250
044	PJ051012P1	128	1805	885	17.26875	15.09375	138.15000	3.018750
045	PJ051332P1	308	1010	1928	17.23125	15.05625	137.85000	3.011250
046	PJ051100P1	128	1807	1383	7.96875	7.96875	63.75000	1.593750
046	PJ051100P1	128	1382	887	9.30000	7.12500	74.40000	1.425000
047	PJ051324P1	308	1010	1928	17.23125	15.05625	137.85000	3.011250

Seq	Line	Dir	FCSP	LCSP	KM	KMFF	CMP	SQKMFF
048	PJ051092P1	128	1807	887	17.26875	15.09375	138.15000	3.018750
049	PJ051476P1	308	1014	1932	17.23125	15.05625	137.85000	3.011250
050	PJ051020P1	128	1805	885	17.26875	15.09375	138.15000	3.018750
051	PJ051484P1	308	1014	1932	17.23125	15.05625	137.85000	3.011250
052	PJ051028P1	128	1805	885	17.26875	15.09375	138.15000	3.018750
053	PJ051492P1	308	1015	1932	17.21250	15.03750	137.70000	3.007500
054	PJ051244P1	128	1810	891	17.25000	15.07500	138.00000	3.015000
055	PJ051500P1	308	1015	1932	17.21250	15.03750	137.70000	3.007500
056	PJ051084P1	128	1806	887	17.25000	15.07500	138.00000	3.015000
057	PJ051316P1	308	1010	1323	5.88750	5.88750	47.10000	1.177500
057	PJ051316P1	308	1324	1928	11.34375	9.16875	90.75000	1.833750
058	PJ051036P1	128	1805	885	17.26875	15.09375	138.15000	3.018750
059	PJ051308P1	308	1009	1928	17.25000	15.07500	138.00000	3.015000
060	PJ051252P1	128	1810	892	17.23125	15.05625	137.85000	3.011250
061	PJ051044P1	128	1805	886	17.25000	15.07500	138.00000	3.015000
062	PJ051300P1	308	1009	1928	17.25000	15.07500	138.00000	3.015000
063	PJ051076P1	128	1806	887	17.25000	15.07500	138.00000	3.015000
064	PJ051292P1	308	1009	1927	17.23125	15.05625	137.85000	3.011250
065	PJ051052P1	128	1806	886	17.26875	15.09375	138.15000	3.018750
066	PJ051508P1	308	1015	1721	13.25625	13.25625	106.05000	2.651250
066	PJ051508P1	308	1722	1932	3.95625	1.78125	31.65000	0.356250
068	PJ051068P1	128	1806	1440	6.88125	6.88125	55.05000	1.376250
068	PJ051068P1	128	1439	886	10.38750	8.21250	83.10000	1.642500
071	PJ051284P1	308	1009	1927	17.23125	15.05625	137.85000	3.011250
072	PJ051060P1	128	1806	886	17.26875	15.09375	138.15000	3.018750
075	PJ051276P1	308	1008	1927	17.25000	15.07500	138.00000	3.015000
077	PJ051268P1	308	1008	1927	17.25000	15.07500	138.00000	3.015000
078	PJ051260P1	128	1811	892	17.25000	15.07500	138.00000	3.015000

2.3 SURVEY INFILL PRODUCTION BY LINE

Seq	Line	Dir	FSP	LSP	KM	KMFF	CMP	SQKMFF
019	PJ051420J1	308	1013	1930	17.21250	15.03750	137.70000	3.007500
020	PJ051172J1	128	1808	1424	7.21875	7.21875	57.75000	1.443750
020	PJ051172J1	128	1423	889	10.03125	7.85625	80.25000	1.571250
038	PJ051116J1	128	1807	888	17.25000	15.07500	138.00000	3.015000
042	PJ051108J1	128	1807	888	17.25000	15.07500	138.00000	3.015000
043	PJ051340J1	308	1010	1928	17.23125	15.05625	137.85000	3.011250
069	PJ051292J1	308	1009	1927	17.23125	15.05625	137.85000	3.011250
073	PJ051500J1	308	1015	1932	17.21250	15.03750	137.70000	3.007500
074	PJ051060J1	128	1806	886	17.26875	15.09375	138.15000	3.018750
076	PJ051052J3	128	1806	886	17.26875	15.09375	138.15000	3.018750
079	PJ051268J1	308	1008	1241	4.38750	4.38750	35.10000	0.877500
079	PJ051268J1	308	1242	1927	12.86250	10.68750	102.90000	2.137500
080	PJ051260J1	128	1811	892	17.25000	15.07500	138.00000	3.015000

2.4 2D PRODUCTION BY LINE

Seq	Line	Dir	FSP	LSP	KM	KMFF
081	PJ2D2007P1	304	1966	914	26.32500	24.15000
082	PJ2D2001P1	122	1001	2256	31.40000	29.22500
083	PJ2D2005P1	303	1971	914	26.45000	24.27500
084	PJ2D2009P1	124	1001	2118	27.95000	25.77500
085	PJ2D2010P1	038	1001	1519	12.97500	10.80000
086	PJ2D2002P1	218	1333	914	10.50000	8.32500
087	PJ2D2012P1	036	1001	1590	14.75000	12.57500
088	PJ2D2004P1	216	1340	914	10.67500	8.50000
089	PJ2D2014P1	038	1001	1514	12.85000	10.67500
090	PJ2D2006P1	218	1257	914	8.60000	6.42500
091	PJ2D2016P1	038	1001	1503	12.57500	10.40000
092	PJ2D2008P1	218	1347	914	10.85000	8.67500
093	PJ2D2018P1	038	1001	1601	15.02500	12.85000
094	PJ2D2020P1	218	1642	1491	3.80000	3.80000
094	PJ2D2020P1	218	1490	914	14.42500	12.25000
095	PJ2D2024P1	038	1001	1742	18.55000	16.37500
096	PJ2D2028P1	218	1561	914	16.20000	14.02500
097	PJ2D2034P1	038	1001	1529	13.22500	11.05000
098	PJ2D2030P1	218	1570	914	16.42500	14.25000
099	PJ2D2036P1	038	1001	1632	15.80000	13.62500
100	PJ2D2032P1	218	1574	914	16.52500	14.35000
101	PJ2D2026P1	038	1001	1590	14.75000	12.57500
102	PJ2D2022P1	218	1484	914	14.27500	12.10000
103	PJ2D2003P1	122	1001	1634	15.85000	13.67500

Total Survey Production

KM	KMFF
380.75000	330.72500

2.5 SURVEY TOTAL 3D

Total Survey Production - Prime

KM	KMFF	CMP	SQKMFF
1120.78125	979.40625	8966.25000	195.881250

Total Survey Production - Infill

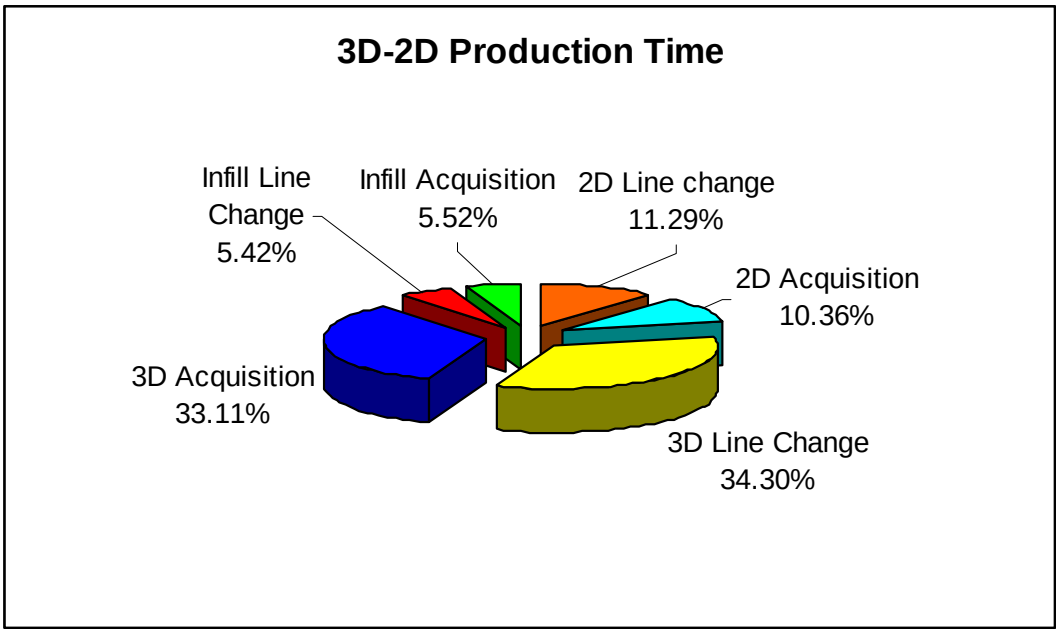
KM	KMFF	CMP	SQKMFF
189.67500	165.75000	1517.40000	33.150000

Percent Infill = 16.923% by KM

Percent Infill = 16.924% by KMFF

Percent Infill = 16.923% by CMP

Percent Infill = 16.924% by SQKMFF



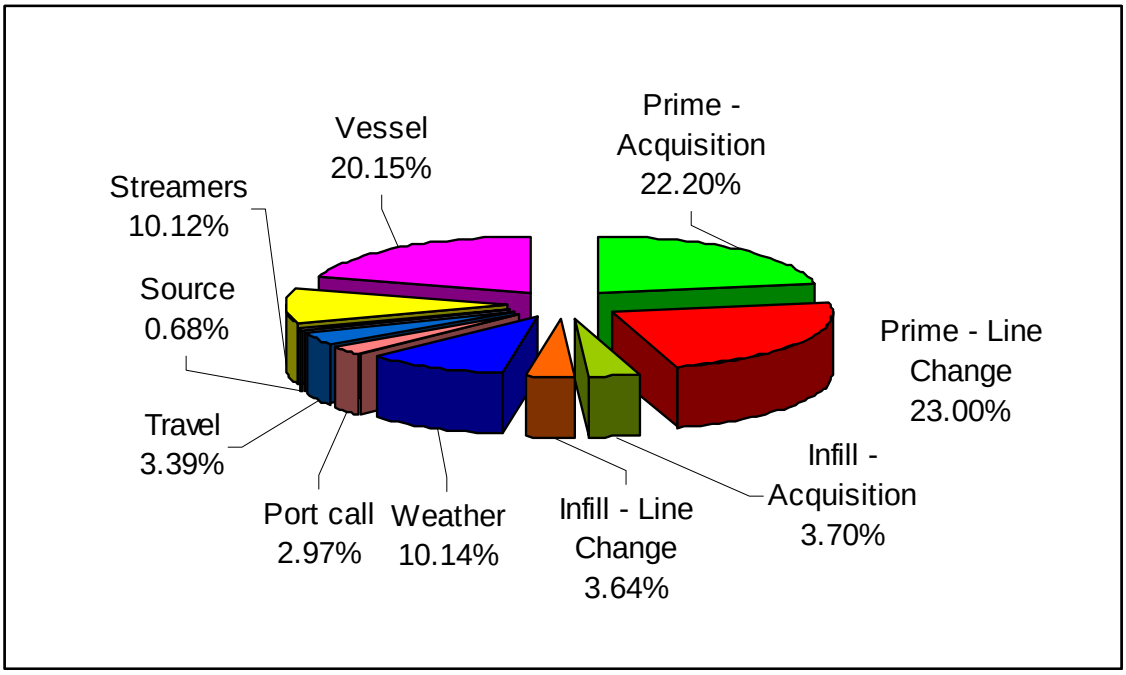
2.6 3D STATISTICAL SUMMARY

Total Survey Timing

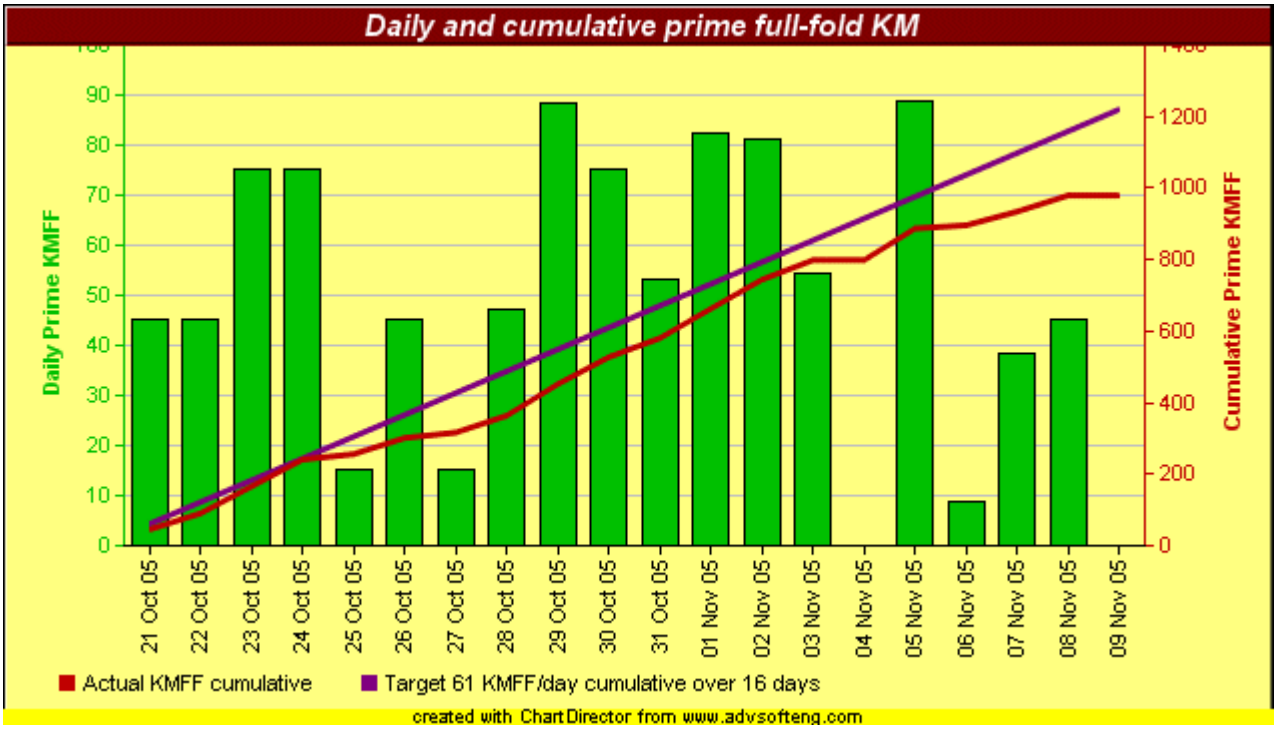
Code	Description	Duration
01	Prime - Acquisition	136.88
02	Prime - Line Change	141.80
03	Infill - Acquisition	22.82
04	Infill - Line Change	22.42
10	Weather	62.55
25	Port call	18.33
26	Travel	20.92
30	Source	4.22
32	Streamers	62.38
36	Vessel	124.25
52	Mobilisation-Deployment	133.95

Total survey time: 750.52 hours

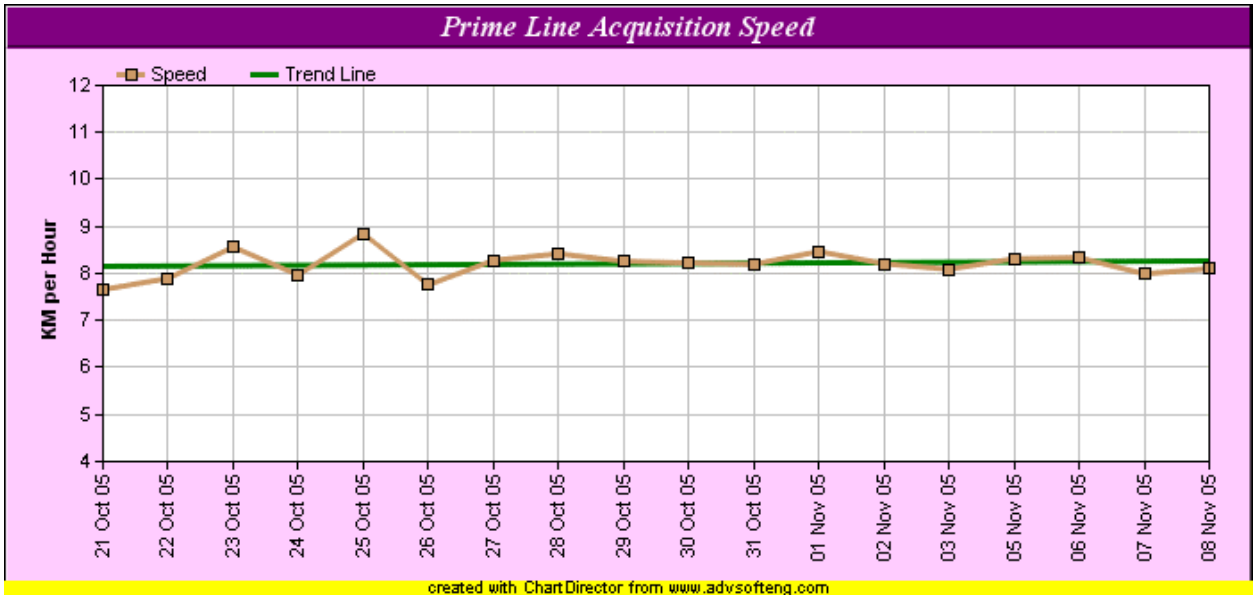
The following graph shows the survey time with the mobilisation time removed.



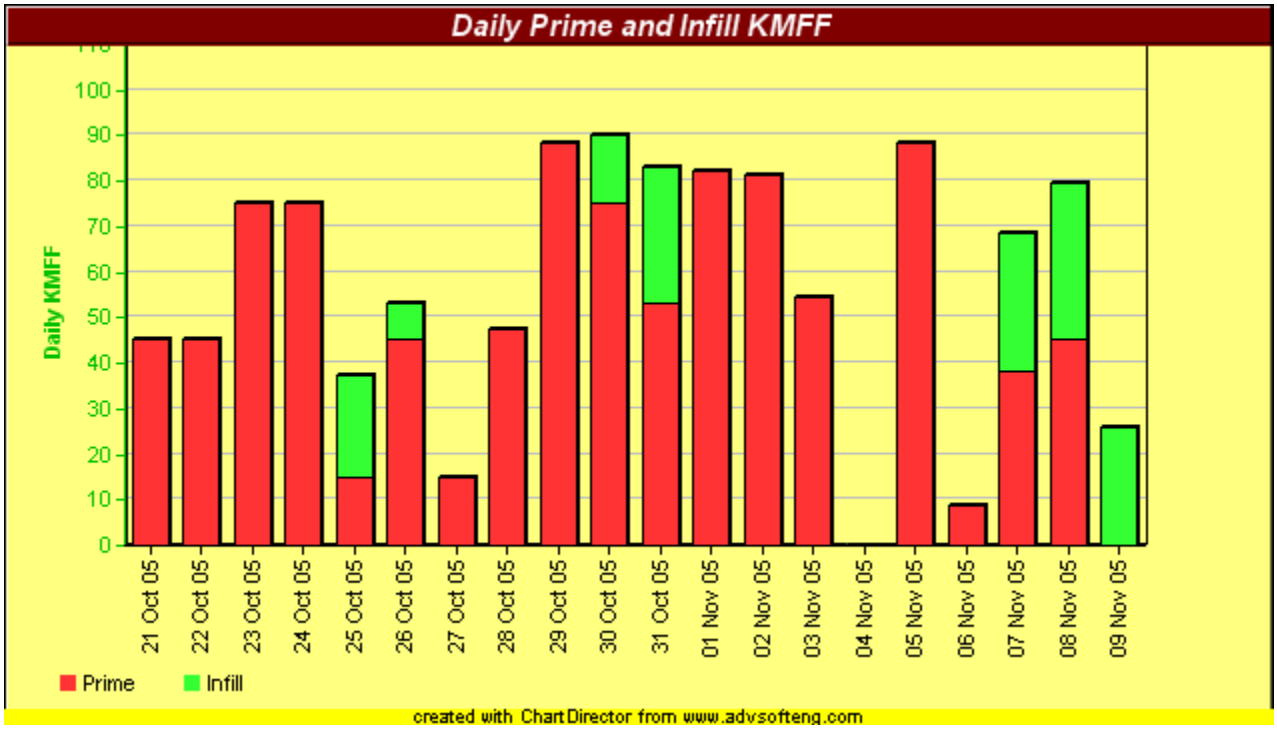
3D Daily and Cumulative Full Fold Kilometres



3D Acquisition Speed



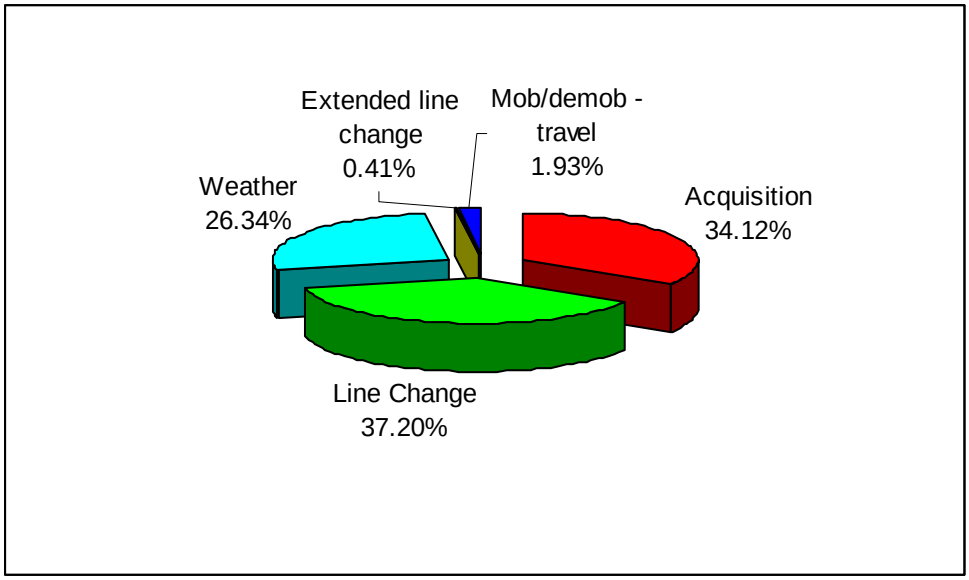
3D Daily Prime and Infill



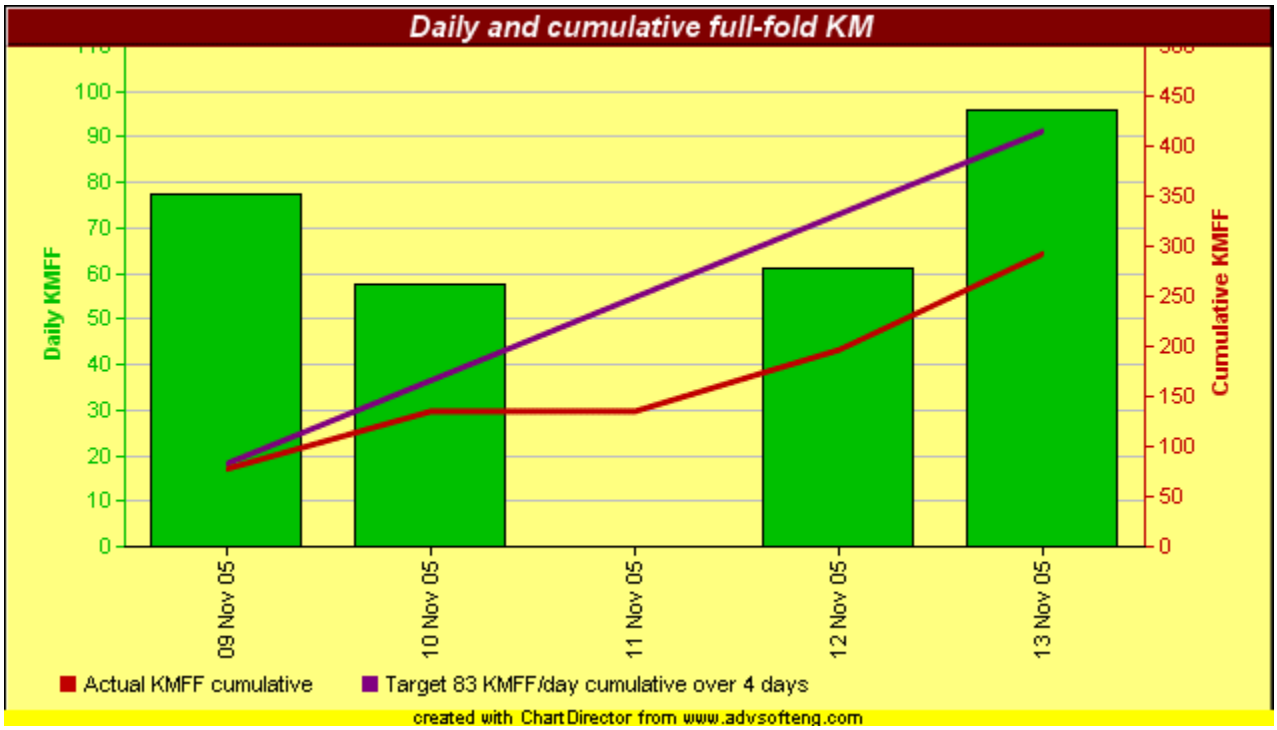
2.7 2D STATISTICAL SUMMARY

Code	Description	Duration
1	Acquisition	42.82
2	Line Change	46.68
10	Weather	33.05
20	Extended line change	0.52
51	Mob/demob - travel	2.42

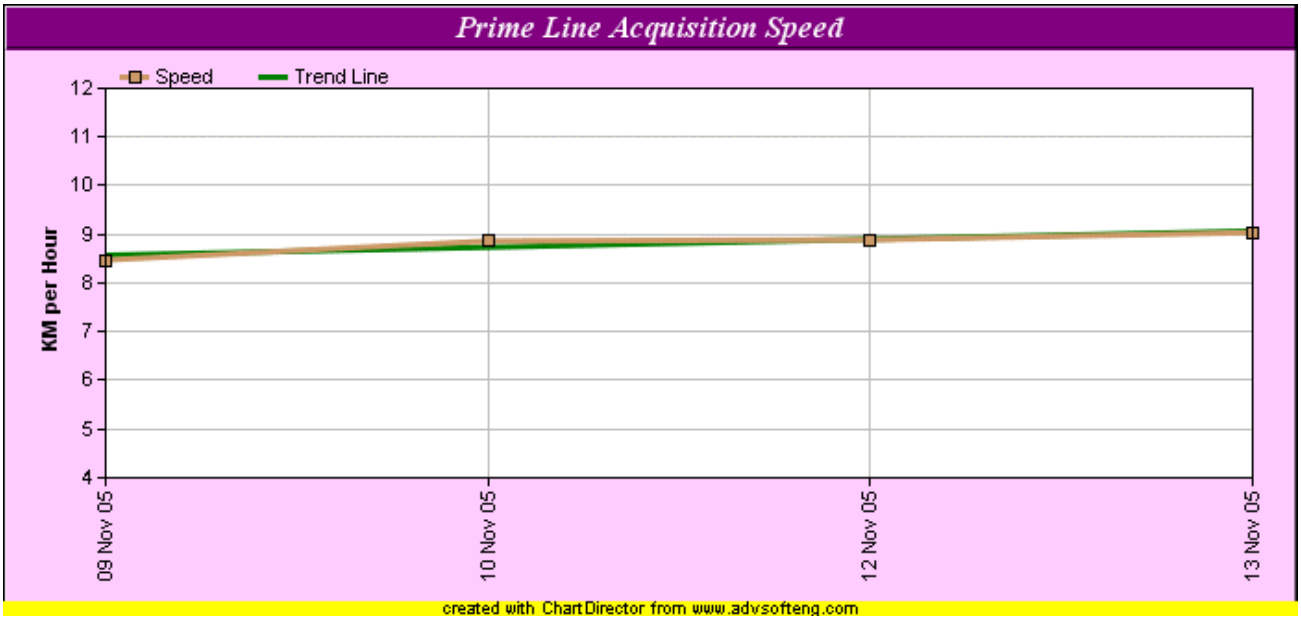
Total survey time: 125.48 hours



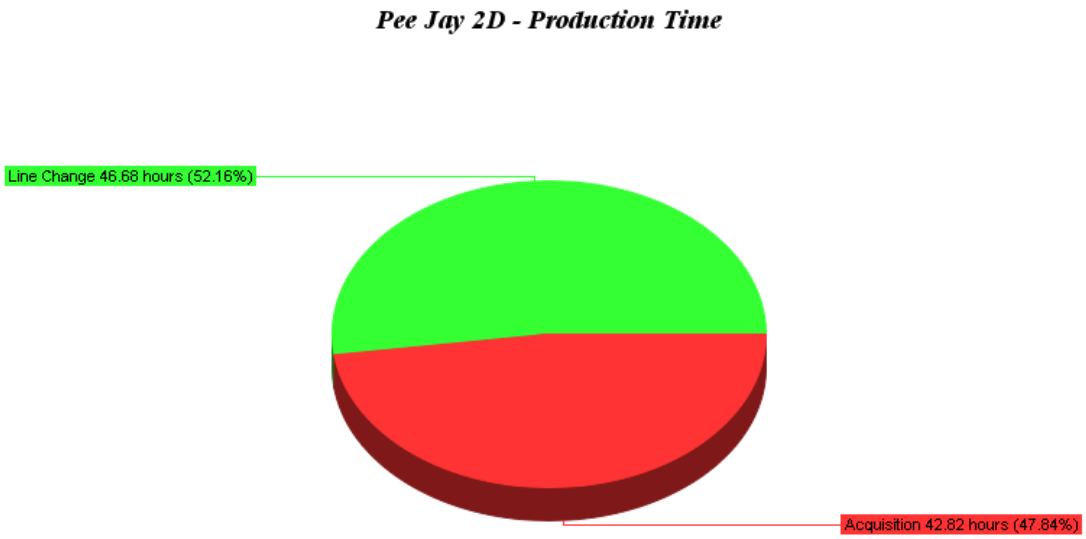
2D Daily and Cumulative Full-Fold KM



2D Acquisition Speed



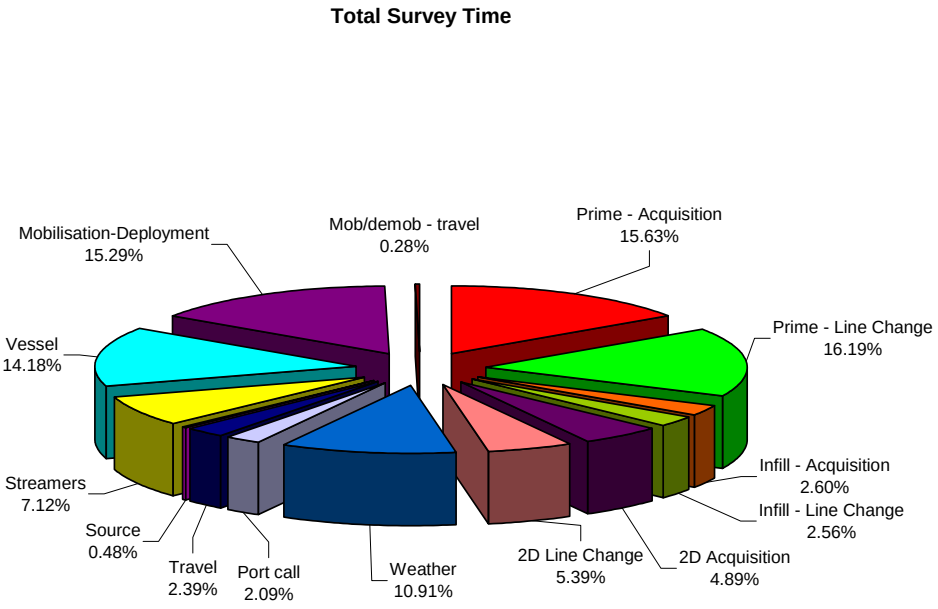
2D Production Time



2.8 SURVEY STATISTICAL SUMMARY

Discription	Duration
Prime - Acquisition	136.88
Prime - Line Change	141.8
Infill - Acquisition	22.82
Infill - Line Change	22.42
2D Acquisition	42.82
2D Line Change	47.2
Weather	95.6
Port call	18.33
Travel	20.92
Source	4.22
Streamers	62.38
Vessel	124.25
Mobilisation-Deployment	133.95
Mob/demob - travel	2.42

Total survey time: 876.00 hours



2.9 TECHNICAL SUMMARY

The following is a brief description of individual equipment performance throughout the survey:

Recording Instruments

The Orient Explorer is fitted with a Syntrak 480 multiple streamer system. Interfaced to the new PGS gAS Viper recording system The system, developed by PGS, has been in service for 2 years in the rest of the PGS fleet but is new for the Orient Explorer. The Benaris survey was the first survey acquired on the Explorer with gAS. The gAS Viper system provided a comprehensive array of real time on screen displays, showing, Real time movie image of RMS values in microbars for all streamers & all channels, together with graphical display of minimum, maximum and average values per shot, Real-time shot record displays for all shots, all streamers (cycled), with point & click ability for interactive analysis of data and header values. A shot display similar to the old oscilloscope display but greatly expanded showing all 4 streamers and all channels was also displayed. All displays could be manipulated to improve data QC,ing. A full set of daily tests was automatically carried out each day showing the recording system and streamer were within contract specification. The system operated faultlessly during the survey proving to be robust and operator friendly. . There was no time lost to systems failure at all.

Observer's reports were automatically generated using PGS's gAS Obslog package. It's possible for the observers log to be client customised to generate a number of graphs other than the standard ones. Faults from the recording system and array logging system were automatically generated at the completion of each line. The quality of the Observers logs was acceptable. There could have been more detail regarding streamer control and weather observations in regard to the streamer and data.

Streamer

The Teledyne digital streamers worked well considering there age and condition. Initial deployment of the streamers was extremely slow due to fault finding problems with parity errors on streamers #1 and #4. Taking 134 hours Deploying 4 streamers and losing a further 62 hours (8.3%) due to streamer failure is not acceptable given current streamer technology. Streamer depths varied between 8 and 9 metres depending on conditions. This was necessary to reduce swell noise also to reduce noisy compass data and maintain control of streamer depths. Noise levels on the data were monitored closely during QC processing.

Energy Source

Source control was via the industry standard Syntron GCS90 source controller, running version 4.76 software. The separate array elements were made up off Bolt 1500LL and 600B. These are an older style of gun, less reliable and require more maintenance than later versions. A rigorous maintenance schedule was maintained on the array strings and individual elements were replaced at the specified time regardless of their performance.

Two 2500 in^3 arrays, fired alternately were used. Each array was made up of 3 sub arrays equipped with 31 array elements of which 22 were active the other nine were used as spares.

The drop out spec was generated by PGS. A total of 4 hours was lost to the source arrays for both the 2D and 3D surveys. To put this in perspective the time was lost over one incident with an air leak that proved difficult to repair. The 2500 in^3 array was used through out the survey with only occasional low volume shots when single guns failed to operate and when substitutions were made.

The Explorer has five compressors. Four compressors maintained air pressure with the fifth being rotated through to allow maintenance to be carried out. Towards the end of the survey the fifth compressor failed and was taken out of service. With out the required spares this unit remained out of service.

Streamer Details

Seismic data were acquired during this survey using the Syntrak 480 Digital Streamers.

Streamer System

Manufacture and type	Teledyne, LDA
Skin material	Polyurethane
Outside diameter	72 mm
Length of each group	6.25 m, 12.5 m, 18.75 m, 25 m
Streamer set-up	Typical 4 x 4500 m
Manufacture and type of hydrophones	Teledyne T2
Type of array (e.g. linear, binomial)	Linear
Number of hydrophones per group	8 per 6.25 m /0.7 m; 16 per 12.5 /0.7m
Coupling between phones and pre-amp	Capacitive
Sensitivity of near group at 1/P to recorder	20 V/Bar
Sensitivity of far group at 1/P to recorder	20 V/Bar
Bandwidth over which above sensitivities apply	Specified at 100 Hz
Availability of shore side spares if required	Pool system
Manufacturer and type of depth controller	Input/Output (Digicourse) 5011
Manufacturer and type of compass	Input/Output (Digicourse) 5011

Recording System

Manufacturer and type	Syntrak 24 bit
Number of seismic and auxiliary channels	Typical 4 x 360 + 48
Format(s) available	SEG-D
Tape drives	IBM 3590
Sample rates	0.5ms, 1 ms, 2 ms, 4 ms
High cut filters available	824 Hz, 412 Hz, 206 Hz, 102 Hz,/276 dB
Low cut filters available	3-15 Hz
Auxiliary channels allocation	Appended to streamer 1 seismic data
Telemetry systems pre-amp gain	Standard 12 dB
Telemetry systems array forming capabilities	Optional

2.10 VESSEL

The Orient Explorer was built in 1988 at SSR #B93/8 shipyard Poland. She has since had a refit in Singapore in 1995. Prior to this survey the Orient Explorer had completed surveys for KNOC, Woodside Petroleum and a number of surveys managed by SANTOS.

The vessel is set up as a 3D vessel, but her equipment, excluding the new recording suite, is old. The streamers are old and falling behind industry standards.

There are many signs, which would suggest that the vessel has been poorly maintained over the years and it will take a concentrated effort on the part of the contractor to return the vessel to a more acceptable condition. This was clearly flagged prior to the start of this survey, when the charge air cool started to leak and was found to be in such a deplorable condition that it had to be sent ashore for repair and a new unit placed on order. A number of routine maintenance items have been ticked as completed when they obviously haven't been touched. Again the charge air cooler is perfect evidence. The sewage system is in such a poor condition that nobody is willing to wok on it, as are the two water makers. There are adequate numbers of showers and toilets available and the stewards worked hard to keep cabins and amenities clean. Dalmorneftegeofisika Trust own the vessel, Nordic Marine LTD are the Maritime operator and Total Marine in Australia supplied the marine crew. All seismic personnel were from various countries and contracted to PGS.

The instrument room is large and well laid out with plenty of working space for all personnel. The arrays and streamer deployment area's are on the same deck with the streamers stored below the deck, accessed through large hatches. The area is spacious with plenty of safe working space for both array mechanics and streamer handling.

The galley and mess areas were adequate. House keeping on the whole was good. There was an inadequate supply of bed linen and the general condition of linen and towels was extremely poor. Communications are through Norsat and Inmarsat. The client has an office close to the instrument room with network connections, phone, printer and a computer if required.

Vessel Specifications

General

Name	M/V Orient Explorer
Flag	Panama
Port of registry	Panama
Builder and date built	Szczecin, Poland 1988
Refitted	Singapore 1995
Vessel classification	DNV 1A1 + ECO + HELDK + Ice 1A (For max draught 5.3m)
Call sign	3FFX5
IMO number	8409020

Vessel Dimensions

Length	81.85 m
Breadth	14.8 m
Draft	5.99 m

Vessel Tonnage

Gross	3478 tonnes
Net	1044 tonnes

Vessel Capacities

Fuel	1061.64 cubic metres
Fresh water	217 tons
Lube oil	19 cubic metres
Cable oil	Isopar M, 35 cubic metres
Fresh water maker type and capacity	Rumia Reverse Osmosis 10t/day
Fuel consumption (shooting/cruising)	12/16 cubic metres per day
Vessel speed (shooting/cruising)	4.5/12 knots
Maximum endurance	50 days (in operational mode)
Maximum range at cruising speed	14000 nautical miles
Accommodation	60 + Hospital
Helideck	Super Puma332/Bell 212 SI
Gate valve	1 x 36 cm
Cranes and other lifting plants	1 x Abas, 3.0 T SWL
Main propulsion systems	1 x 3090 KW – 505 rpm 6 cylinders Sulzer-Zgoda 6ZL40/48, 4200 BHP
Propulsion type	Single 4 bladed CP Propeller
Bow thruster	Zamech- 220 kW

Electrical Power Supplies

Main generator	2 Sulzer 8AL with 630 kVA Dolmel
Alternators	
Other generators	1x1500 kVA Dolmel Shaft Alternator
Emergency generator	1xWola H6A with 150 kVA Elmor
Emergency Generator	
Clean Power / UPS	Chloride 80 kVA

Communications Systems

Primary transceiver	Furuno FS5000
Secondary transceiver	Furuno MF/HF DMC5
Emergency transceiver	Sat Com C
Main aviation transceiver	Jotron TR6102
Secondary aviation transceiver	Jotron FCC GW 2960 + Icom IC-A22
AUS	
VHF radio (fixed)	2 x Furuno FM 8000
VHF radio (portable)	10 Icom & Motorola units
Facsimile	Furuno, Fax-207
Telex	HP Furuno Radio Telex DP5
Marisat receiver	Inmarsat B – EB Nera
Telephone	+873 335 524 213 (bridge)
Telephone	+873 335 524 214 (PC)
Telefax	+873 335 524 215 (bridge)
Telefax	+873 335 524 211 (instr. rm)
Norsat telephone receiver	Telenor Norsat B
Telephone	+47 67 51 51 69 (Captain)
Telephone	+47 67 51 51 55 (PC)
Email address	oricapt@pgs.com (Captain), oripc@pgs.com (PC),

Navigational Aids

Auto pilot	Robertson AP9 MK II
Radar	1 x Furuno FAR-2830S APRA
	1 x Furuno FR-2110
Radio Direction Finder	RUMB (Russian)
Gyro	1 Seatex C-Plath Nav II (instrument room)
	1 x Vega (bridge)
Helicopter directional beacon	Southern Avionics Company, NDB Model SA 100TX

Vessel Fire Fighting Equipment

Fire detection system	Unitor
Pumps	1 engine room pump
	1 emergency pump
Hydrants and hoses	33 hydrants and hoses
Inert gas fixed systems	Engine room, compressor room, paint locker, cable store & other machinery spaces
Foam deluge system	Seismic reels, helideck, cable storage room, Gun Deck
Portable fire extinguishers	32 powder, 32 CO_2, 3 graphite

Vessel Safety and Survival

Fireman's outfits	7
Breathing apparatus	7
Lifeboats	1 Miriam, 65 persons
Life rafts	6 x 10 persons (Russian type),
	3 x 20 persons (Viking type)
MOB raft	2 x 6 persons
Life jackets	132
Survival suits	60
Life buoys	12
Smoke Hoods	Yes
Smoke detectors	Yes

HSE
Full compliance with SOLAS, Marpol 73/78 and other relevant maritime and industrial standards,

E&P Forum and IAGC requirements

Hospital and medical facilities	2 beds with trauma equipment and NMD/WHO medicine chest
Environmental management	Marpol 73/78
Waste segregation onboard	Biodegradable, incinerated, or stored for onshore disposal
Refueling at sea procedures	In place

2.11 SAFETY SUMMARY

The vessel fully adheres to the health and safety requirements as set out by SOLAS. All machinery and seismic equipment is maintained on a computerised planned maintenance system. Unfortunately it would appear that although the boxes have all been ticked the work has not been done and the vessel was in a poor state of repair with a lot of work needed to bring it up to a fair condition. HSE audit recommendations are implemented through FOCUS which highlights deficiencies identified during audits and sets target dates for the completion of work along with whom or which department is responsible. Regular cross audits are held to improve and bring to attention any problems in operations or work practices. All emergency exits and routes to exits are adequately marked. A fully integrated alarm system is in place and is tested on a regular basis. Flashing lights are fitted to alert personnel when equipment on the gun deck is either being pressurised or test fired. Fire fighting equipment is positioned at all necessary locations about the vessel. The streamer reel is covered by a foam deluge system. The streamer reels are fitted with a 'save-all'. Nearly all-lifting equipment on the gun deck consists of stainless steel chains and shackles. Lifting points on deck heads were not used unless they had been rated. All certification is current. More than adequate abandonment equipment is carried on board.

Emergency procedures are laid down and prominently displayed about the vessel. Vessel plans showing emergency escape routes along with the location of all emergency equipment are also prominently displayed. Emergency fire/boat and man-overboard drills are held on a weekly basis. Current policy, hazards, near misses and topics arising are dealt with during the HSE meetings held for all crew once a trip.
Procedures for handling trailing gear during deployment and recovery were clearly laid down and followed closely. Procedures are under constant review as both the equipment and therefore the handling techniques change. Procedures are also in place for two-boat operations, helicopter operations and at-sea personnel transfers. Safety 'toolbox' meetings were held with all personnel involved prior to any operation. A Permit to Work system was in place for all hot work (burning, welding, and cutting), confined space entry, work aloft, work on high-pressure systems and electrical systems.
Comprehensive first aid and medical supplies are carried onboard. A Medic was onboard and medical advice was on hand through the Alfred Hospital in Melbourne, Austin and Repatriation Hospital, Melbourne and Singapore General Hospital

All seismic personnel have completed an offshore survival course, which covers survival at sea; fire fighting, first aid and helicopter underwater escape training. The Master, Chief Officer and some senior seismic personnel have undertaken advanced first aid and HSE management courses. There was also a fully qualified para-medic onboard.

The waste management system in place onboard consisted of all food waste being separated prior to incineration. All glass and metal were separated for disposal ashore. Dirty oil, PVC and plastic refuse was also stored separately for disposal onshore in line with MARPOL regulations.

The standard of accommodation was adequate to poor. The general housekeeping was good.

HSE Details for Survey

Incidents/Accidents	Exposure Hours		
Type	**Cumulative**	**Group**	**Cumulative**
Fatality	0	Client	1788
Lost Time Incident	0	Maritime	19746
Medical Treatment Case	0	Seismic	20100
First Aid Case	1	3rd Party	828
Restricted Work Case	1		
Material Loss or Damage	1		
Environmental Damage	0		
Near Miss	0		
Hazard	2		
Unsafe Act	0		
Total Incidents	**5**	**Total Hours**	**42462**
		Total Man Days	**1769.25**

Date	Comments
09 Oct 05	13:00 to 13:15; lifeboat drill held in the mess room due to the inclement weather. Instruction was given in life raft deployment and getting into a survival suit.
10 Oct 05	An emergency towing practice was carried out between the chase boat Pacific Conquest and the Orient Explorer. A toolbox meeting was held before both vessels left Burnie. Toolbox meetings were also held prior to deploying the streamer.
12 Oct 05	The workboat was launched and spent some 6 hours working on the streamers in the water. The chase boat stayed close at hand to assist if there were any problems. Toolbox meetings were held prior to the workboats deployment and retrieval. There were no incidents to report.
13 Oct 05	There were no incidents to report.
14 Oct 05	There were no incidents to report.
15 Oct 05	There were no incidents to report.
16 Oct 05	There were no incidents to report. A Helicopter crash drill was held at 13:00hrs with relevant personnel in attendance. The use of the ships stretcher was also demonstrated.
17 Oct 05	Toolbox meetings held prior to streamer deployment. No incidents to report.
18 Oct 05	Workboat was deployed to replace GPS system on the tailbuoy. Workboat launched at 13:23 and recovered at 14:11.
19 Oct 05	Helicopters arrived at 11:17hrs and 15:27hrs, departing at 11:30hrs and 15:45hrs respectively. ESSO helicopter video was shown prior to crew departure. Toolbox meetings were held for the workboat crew (crash boat) and the fire team prior to the first helo landing.
20 Oct 05	There were no incidents to report.
21 Oct 05	There were no incidents to report.
22 Oct 05	Workboat deployed 13:44 hrs to 16:02hrs. There were no incidents to report.
23 Oct 05	Helicopter crew change took 8 marine crew off and 8 new marine crew on. Helo on Deck at 12:29, departed at 12:48. Departing crew viewed helicopter operations video before departure. The workboat was launched for streamer work at 13:31hrs and recovered at 15:12hrs. Toolbox meetings held for helo landing and workboat.

24 Oct 05	Fire drill and abandon vessel drill held at 13:00hrs local. Induction held for all new crew members who arrived on October 23.
25 Oct 05	At 17:23hrs the workboat reported engine failure. The chase boat was on standby and took the workboat in tow. The workboat managed to come alongside the Explorer under her own power. An Incident report is being developed. Procedures were in place and followed to recover the workboat.
26 Oct 05	Vessel down for weather late afternoon. Crew have secured vessel for bad weather.
27 Oct 05	Vessel secured on weather standby.
28 Oct 05	Heads of department meeting held today at 13:00hrs. Two launchings of the workboat to work on the streamer and tailbouy. Toolbox meetings held before each launch.
29 Oct 05	There were no incidents to report. A number of cross audits were carried out between the seismic departments.
30 Oct 05	MOB drill held at 13:00. Workboat launched and recovered buoy used in drill. Toolbox meetings held prior to all WB launches.
31 Oct 05	SOLAS training held. Toolbox meetings held prior to workboat launch. 2 incidents 1 involving the crane and the second involving the meat freezer. No injuries were sustained and reports are attached to this report.
01 Nov 05	There were no incidents to report.
02 Nov 05	No incidents to report.
03 Nov 05	Toolbox meeting held prior to launching the workboat. There were no incidents to report.
04 Nov 05	Vessel secured for rough weather. Toolbox meeting held prior to Array deployment.
05 Nov 05	Two launchings and recoveries of the Workboat for a TS dip and streamer work. Toolbox meetings held prior to both movements. No incidents to report.
06 Nov 05	Toolbox meetings held prior to source retrieval and deployment. Toolbox meetings held prior to streamer #1 retrieval. No incidents to report. Abandon ship drill followed by emersion suit demonstration and entering the life boat drill held 13:00 hrs.
07 Nov 05	The Bosun pulled a muscle in his shoulder. This is a recurring injury. The medic is assessing his condition and will seek advice on sending the patient ashore.
08 Nov 05	There were no incidents to report.
09 Nov 05	No incidents to report. The 3D phase of the Benaris survey concluded. Acquisition starting on the 2D survey. Toolbox meeting held prior to workboat launch.
10 Nov 05	Toolbox meeting held prior to launch of the workboat. Workboat launched at 06:46 and recovered at 06:56.
11 Nov 05	A full crew safety meeting was held at 13:00hrs. There were no incidents to report.
12 Nov 05	Benaris Navigation QC departed for Melbourne via Helicopter. Origin Nav QC and MMO arrived.
13 Nov 05	Toolbox meeting held before workboat launched to take a TS Dip. There were no incidents to report.
14 Nov 05	Survey completion. There were no incidents to report.

2.12 RECOMMENDATIONS & CONCLUSION

- The vessel works in areas of the world were the drinking water is suspect. The vessel had no water testing equipment onboard and no water treatment chemicals. A simple ecoli test kit should be a minimum requirement.
- Further to the above: sending of water samples for comprehensive testing when the vessel comes in to port should be routine
- The vessel needs three stewards, with 51 people onboard two is not adequate. This could become an OHS matter with regard to cleanliness of the vessel.
- The overall appearance of the vessel is poor, this reflects on both the contractor and the Company.
- With the over all OH&S performance expected of and delivered by both the Marine Crew and the Seismic Crew. The acceptance of a vessel in the Orient Explorers condition is lets down the hard work done by the crew in maintaining a safe and comfortable work environment.
- Constructive use of Medic (first aid course, safety instruction)
- More safety drills are required.

The over all performance of the seismic crew was excellent, the level of seismic experience was above average and work was carried out in a professional manner, any problems encountered were quickly bought to the client's attention.

Safety standards by both marine and seismic crew were high, closer cooperation during drills would be an advantage and improve teamwork.

3 NAVIGATION

3.1 NAVIGATION HARDWARE AND SOFTWARE

System	Hardware (Type and Serial No.)	Software version
Concepts Spectra	IBM X235	Spectra v 10.9.1
Sprint processing	IBM F50 Power PC	3.1.20
Binning	Unix IBM RISC 6000	CENSUS
External Header		
Compass System	Digicourse 5011	
		22944
TS-meter	VALE MIDAS SVP	
Echo Sounder	SIMRAD EA500	v 1.07
Multifix 4	Windows Workstation	

System Timing

Spectra issued closures to the source firing system and recording system 50 milliseconds before the predicted time of peak pressure. Spectra received the time break back from the GunLink source controller and all Spectra system positions are output for this time.

An additional trigger was issued from Spectra 500 milliseconds after time zero. This was sent to the recording system as a timing verification. The trigger was 5 milliseconds in duration.

3.2 SURVEY POSITIONING METHOD USED

This survey was carried out using PGS's standard mode of operation for multiple streamer, dual source surveys.

Positioning of the vessel was by Single frequency differential DGPS with delivery of differential correction data in RTCM 104 format and recorded in the P2/94 files.

The source was positioned relative to the vessel using a network consisting of rGPS units mounted on all 3 sub-arrays and acoustics on the centre sub arrays.

An acoustic network positioned the front, centre and tailbuoy end of the streamers. Also mounted were a compass heading unit and rGPS unit from the streamers head buoy, which positioned the centre near group of the streamer.

The centre last group of the streamer was also positioned using a network consisting of one rGPS system unit mounted on the tail buoy and streamer mounted compass heading units.

The streamer shape was modelled by 18 Digicourse series 5011 combined streamer depth control and magnetic compass units on each streamer.

Least squares condition equations for the streamer assuming circular arcs between compasses and relating the tracking nodes, compasses, tension corrected distances between compasses, rotation bias and scale were used to compute scale, rotation and individual compass corrections. The streamer shape was then computed by the circular arc method.

3.3 SURFACE POSITIONING

General

Datum

Survey Datum	WGS84
Ellipsoid	WGS84
Semi Major Axis	6378137 m
1/Flattening	298.257223563
Geoidal height, EGM 96 model, PJ3D and PJ2D	-1.3 m

Map Projection

Projection	Transverse Mercator
Projection System	UTM, Zone 55
Central Meridian	147º E
Scale Factor on Central Meridian	0.9996
Latitude of Origin	0º
False Northing	10000000 m
False Easting	500000 m

Surface positioning

System I

System	SkyFix.XP, Clock/Orbit corrected GPS
Global Corrections via	Optus Spot/POR Inmarsat
Subcontractor	Fugro-Survey AS

System II

System	StarFix.L1, single frequency DGPS
Differential Corrections via	Optus Spot/POR Inmarsat
Reference Stations at	Melbourne 325 km distant Bathurst 850 km distant *Cobar 1000 km distant Ceduna 1450 km distant Brisbane 1575 km distant

* Cobar on Optus only

Subcontractor	Fugro-Survey AS

By employing a correlation model for weighting the multiple range corrections in a least squares estimation process, the optimum pseudo-range corrections are obtained. W-testing and F-testing techniques detect and reject correction outliers.

Quality control is based upon UKOOA's recommended DGPS quality indicators - the precision and reliability of the fix are displayed as an Error Ellipse and Marginally Detectable Errors (MDE).

The differential corrections were transmitted to, and received on-board the vessel by two independent means and provided a high degree of redundancy to ensure continuous vessel positioning.

Float Navigation

Float (tailbuoy, headbuoy and source) surface navigation was provided by Kongsberg-Seatex Seatrack relative GPS. The in-sea units incorporated a GPS receiver and interfacing for direct data transmission of the raw satellite pseudo-range data via UHF link to the vessel.
On board the vessel, the raw pseudo-range data from the float unit was matched with simultaneously received data at the vessel's GPS receiver to compute a vector describing the location of the float unit relative to the vessel, from which the float position was derived.

Streamer Compasses
18 series 5011 Digicourse combined magnetic compass and streamer depth controllers were attached to the streamers. All compasses were used for positioning and shaping the streamers.

Compass Sampling Rate	=	2 second
Averaging constant	=	14 seconds

Compass performance was monitored on a line-to-line basis throughout the acquisition phase of the survey.

Gyro Compass's
The gyro compass's used during the survey were:

Gyro 1	(NEMA)- SEAPATH. Fixed Correction -0.2º
Gyro 2	CPLATH Navigat II DHY-04J. Fixed correction -1.48º
Gyro 3	VEGA Fixed correction 0.24º (this unit is not used)

Magnetic Declination

Model	IGRF2005	Date 2005-11-01
Position	40°30'00.000"S 146°22'00.000"E	
Magnetic	Declination 13.2ºE	

Velocity of Sound in Water

CTD/CTD Velocity Profiler Model SD204 is programmed to measure data at one-metre intervals. The probe is allowed to free-fall and is then recovered. Speed of sound and depth are computed by the program, which decodes the stored information from the probe. The raw data is entered into a spreadsheet where the Medwin formula is used to calculate velocity. TS Dip calculations are set out in the appendices.

3.4 ECHO SOUNDER

Primary Echo Sounder Simrad Model EA500 200/38KHz

The echo sounder speed of sound was set to 1500 m/s. A draught correction of zero was entered in the echo sounder. Depth data was recorded throughout the survey using a dual transducer/dual frequency (38 KHz/ 200 KHz) Simrad EA600 Echo sounder.

Echo Sounder Verification

A verification was performed, alongside in Portland, Victoria. This was done using a lead line, and also depth reading from the calibrated TS probe.

All depths recorded are based on the position of the Fathometer's transducer on the vessel's Hull. Depths are NOT draught corrected. Diagram and explanation in Appendix "A"

3.5 INTEGRATED NAVIGATION SYSTEM

The integrated navigation system used for this survey was Spectra from Concept Systems Ltd. UK. Spectra is an integrated navigation and data management system designed to handle environments of multi-vessel operations such as under shooting obstructions like rigs. Spectra delivers data management, positioning techniques and flexibility with the following key benefits:
.

- Navigation acquisition and validation with real-time source and streamer positioning for marine seismic surveys ranging from simple 2D and high resolution requirements to extensive 3D multi-streamer, multi-vessel configurations.
- Distributed data server provides simple connectivity to easily configure multi-vessel surveys.
- Real-time data acquisition units with integrated GPS receiver provide triggering to 50 micro-seconds, allowing remote synchronization of seismic and acoustic systems.
- Real-time binning, CMP and offset distribution with simultaneous bin expansion capabilities.
- Data logging to UKOOA P1/90 and P2/94 standards with full redundancy providing confidence in data integrity.
- Quality control process providing alarm and audit facilities meeting UKOOA guidelines. Extensive online graphical analysis facilities and end of line reporting facilities.
- Positioning using Kalman Filtering with advanced data snooping statistical testing techniques.
- DGPS and RGPS real-time recomputation.
- Autopilot interface controlled from instrument room leaving the navigator in charge of steering. This facility is fully integrated with a comprehensive turn planning utility providing optimum efficiency on line changes

PGS implementation of Spectra runs on work stations based on the IBM Pentium-4 PC architecture, and on the LINUX operating system.

NAVIGATION SUMMARY

The navigation system ran smoothly through out the survey. Navigation processing was efficient; files are included in the attached CD

ECHO SOUNDER

Echo Sounder data was generally good throughout the prospect. In the shallow water depths of the survey you would expect nothing less.

4 ENVIRONMENT

4.1 WEATHER

It was possible, via the 'World Wide Web', to access data about local environmental conditions from www.weatherbuoy.com Information was reported daily with a 3 day forecast. The Australian Bureau of Metrology also provided a good website with reasonably accurate forecasts for the local area. Wind direction and weather forecasts were also down loaded from the pay for service Offshore Weather Service. Tidal influence is minor with the current flowing west on the rising tide and east on the falling tide. Over the survey area it was less than 1 knot. Further information such as tidal movements were available the admiralty pilot for the area.

This is an area of intense weather conditions with a predominant southwest swell through out the year driven by strong low-pressure systems in the southern ocean. Spring is considered a period of unpredictable conditions heavy swells and wind driven seas interspersed with periods of relative calm. Swell height averaged between 0.5 and 2.0 metres with wind strength varying between 1.0 to 20 knots. There were occasions when swells exceeded 4.0 metres and wind strength was >40.0 knots. The weather in this area should be considered volatile and hard to accurately predict at any time.

4.2 TIDES, CURRENT AND FEATHER

There was very little tidal influence in the area. Streamer feather angles remained well with in contract specifications for the entire survey with. The major influence on feather angles came from wind generated currents. This made it difficult to produce a feather plot for matching. The pilot for the area indicated that tidal movement in the area is around 0.6 to 2.6 metres at Burnie

4.3 NAVIGATION HAZARDS

The survey was conducted in relatively open waters of around 60 to 70 metres depth. The main North South shipping channel crossed to the north of the survey area and didn't present any problems. Very few vessels were seen during the survey and those that were, were readily contacted and kept clear of the survey area.

4.4 ENVIRONMENTAL

In keeping with modern survey practice environmental protection played an important role in the operating practices of PGS, in line with Benaris's own environmental concerns and the contract requirements. Survey operations were carried out under procedures designed to minimise any environmental impact at all times.

There was no off shore refuelling during the survey. The other possible area for concern was the streamer fluid. Fortunately the fluid in the streamer is very light and evaporates rapidly leaving no harmful residues. There were no streamer fluid spills during the survey.

Great care was taken to follow International Maritime Regulations with regard to the disposal of garbage and waste. The Orient Explorer was equipped with an incinerator so that where possible most of the waste could be burnt. Ash from the incinerator was stored for proper disposal ashore. Putrescibles were discharged over the side in compliance with MARPOL regulations. Garbage that was unsuitable for burning was segregated and stored on board the vessel for proper disposal ashore. In addition the ship operates a garbage separation scheme to separate plastics, glass and metal waste. Hazardous wastes such as lithium batteries and chemicals were stored for proper disposal under the manufacturer's guidelines.

The overall environmental performance of the crew was up to modern industry standards with no garbage disposal to the sea, the main areas for improvement would be to replace the fluid filled streamer with a modern solid streamer, which contains no fluid, the installation of an industrial standard macerator, and a fully operational sewage system.

4.5 CETACEAN REPORTING

The survey was carried out outside of the known whale migration period. All watch keepers were instructed to keep watch for any Cetaceans and a log was kept on the Bridge. There were no sightings of any cetaceans during the survey.

On all lines, the acoustic energy source was gradually brought up to maximum capacity over a 30-minute period (soft start) to give sufficient notice to any marine life that might have been in the area. A low volume array element was run during all line changes.

4.6 FISHING

Fishing activity was low in the area. The Orient Explorer broadcast the position and intent during the day. A navigation broadcast requesting all vessels to give the Titan a 6-mile clearance was broadcast at 6 hourly intervals.

4.7 CORAL REEFS

There are no reefs shown in the survey area. The vessel operated in water depths ranging from 60 to 70 metres with the streamer towed at a depth of 8 metres and the source arrays at 6 metres. No physical damage was caused in the survey area.

4.8 CONCLUSION

The Orient Explorer and associated operations had no detrimental impact on the local environment during the seismic survey.

The only discharges into the sea were small quantities of food scraps and sewage waste, which fell within MARPOL guidelines.

5 INSTRUMENT TESTS

Before the beginning of the survey a complete set of instrument tests was performed.
These tests were as follows:

- Instrument Noise
- Instrument Distortion
- Instrument Crosstalk
- Instrument Gain/Phase
- Instrument Common Mode
- Field Hydrophone Leakage
- Field Capacitance
- Field Cut Off
- Field Noise

The start of contract tests were recorded to tape, and sent to the processing centre together with the seismic data. The result of the Start of Job Instrument tests showed all system tests well in specification and no bad seismic hydrophone groups on the streamer.

Instrument Noise Test

This test is to measure the noise of the ADC converter in the FDU. The converter's input is connected to the internal test network. A DFT is performed and the noise spectral power below 3Hz is computed. As the total energy of the output signal is known, the total noise within the bandwidth can be deduced.

Instrument Gain and Phase Test

This test is used to check for any drift of the gain and phase of the FDU's built in ADC converter within the band from DC to the filter's cut-off frequency.

The ADC supplies a pulse with known amplitude and width to the internal test network. The ADC input is connected to the internal test network. The voltage across the internal test network is measured. A DFT is computed on the DSP's output signal (for different test frequencies) and compared to a model computed with the same frequencies. The error is computed in terms of difference in amplitude and phase with respect to the model.

The test returns the maximum error computed in amplitude and phase.

Instrument Distortion Test

This test is used to check the FDU's built in ADC converter for linear response. A sine wave with known amplitude and frequency is applied to its input via the internal test network. The test returns the ratio of the spectral power of the output signal to the spectral power of all harmonics within the bandwidth determined by the selected filter.

Instrument CMRR Test

This test is used to measure the Common Mode Rejection Ratio of the FDU's built in ADC converter. A sine wave with known amplitude and frequency is applied to both of its inputs via the internal test network. The test returns the ratio of the RMS value of the output voltage, relative to the input, to the common mode voltage.

Instrument Cross Talk Test

This test is used to measure cross talk between FDU's. The test includes two sequences:

During the first sequence, the test generator applies a sine wave to the test network in each even FDU. The ADC converter in each odd FDU measures the resulting voltage across its own test network. (The test generator in odd FDU's is disabled).

Conversely, during the second test sequence, the test sine wave is fed to each odd FDU and the resulting voltage is measured across the test network in each even FDU.

The ratio of the measured voltage to the theoretical value of the test signal is computed and displayed as Instrument Cross talk for each FDU.

Sensor Capacitance Test

This test is used to measure the capacitance of the seismic sensor connected on the channel input. The DAC supplies a sine wave with known frequency and amplitude to the channel input. The DftCorr of the output from the ADC is computed at the test frequency. Knowing the current supplied to the sensor, the total impedance can be computed.

The capacitance can finally be computed by using the imaginary part of the impedance.

Sensor Cut-off Frequency Test

With hydrophones as input sensors, measuring the cut-off frequency of the seismic channel is equivalent to determining the pulse response for the channel. The DAC supplies a pulse (with known amplitude and width) to the channel input. From the resulting voltage, measured by the ADC, the cut-off frequency of the channel is computed using a least-squares method.

Sensor Leakage Test

This test is used to measure the global leakage resistance between the seismic channel and the earth ground. During this test, the test generator creates a leak current at precisely determined points in the test network, via the FDU's earth resistance. The resulting voltage at particular points in the network is measured. As the output current of the test generator is known, the measurements allow the system to determine the leakage resistance on the positive and negative input paths of the channel. Finally the total resistance to ground can then be calculated.

End of Job Test

At the end of the survey a complete set of instrument tests was performed. These tests were as follows:

1. DCO/Noise/Range
2. Streamer RMS Noise
3. Channel Gain Accuracy
4. HD Harmonic Distortion
4. Common Mode Rejection
5. Impulse Response
6. Crosstalk Isolation Odd
7. Crosstalk Isolation Even
8. Hydrophone Response and Leakage

The result of the End of Job instrument tests verified the system. Comparing results from all the instrument tests showed that the system was stable and in specification throughout the survey.

6 DIARY

October 9th 2005

00:00 DT In transit to Burnie, Tasmania to take on fuel.
19:35 DT Alongside waiting on bunkers, Burnie, Tasmania.

October 10th 2005

00:00 DT Orient Explorer alongside waiting on Fuel.
07:25 DT Fuelling complete 248.9 cubic metres.
12:52 DT Vessel prepares for sailing, Pilot onboard.
13:55 DT Vessel heading for the prospect area.
15:15 MO Deploying the first of 4 streamers.

October 11th 2005

00:00 MO Deploying first streamer #4.
09:40 MO Deploying second streamer #1.

October 12th 2005

00:00 MO Streamer deployment continues.
10:03 MO Work continued on streamers #1 and #4.
12:33 MO Tailbuoy for streamer #2 deployed. Streamer #2 being deployed.
23:55 DT Recovering streamers to work on vessels main engine.

October 13th 2005

00:00 DT Recovering streamers and doors.
07:30 DT Vessel in transit to Bell Bay, Tamar River.
10:59 DT At anchor, Bell Bay.

October 14th 2005

00:00 DT Orient explorer at anchor in Bell Bay, Tasmania.

October 15th 2005

00:00 DT Orient Explorer at anchor in Bell Bay.

October 16th 2005

00:00 DT Explorer at anchor in Bell Bay.

October 17th 2005

00:00 DT At anchor Bell Bay, Tasmania.
09:15 DT Anchor lifted, vessel alongside jetty taking on water.
11:25 DT Depart Bell Bay for prospect area.
12:48 DT Deploying streamers #1 and #4.

October 18th 2005

00:00 MO Deploying and fault finding streamer #1 and #4.

12:55 DT Deploying streamer #2 to bird 14.
17:05 MO Deploying streamer #2.
21:47 MO Deploying streamer #3.

October 19th 2005

00:00 MO Deploying streamers. Streamer #3 deployed.
18:50 MO All streamers deployed. Fault finding continues on streamer #4.

October 20th 2005

00:00 MO Work continues on deploying the streamers.

October 21st 2005

00:00 MO Working on streamer spread.
01:10 MO Deploying source arrays.
05:55 MO Running a test line.
06:40 MO Running in to line PJ051516P1001.
09:27 SB Recording line PJ051516P1001
11:38 SB On line change to PJ051236P1002
14:09 SB Recording line PJ051236P1002.
16:34 SB Line change to PJ051460P1003.
18:48 SB Recording line PJ051460P1003.
20:57 SB Line change to PJ051228P1004.
23:08 DT Recording line PJ051228P1004.

October 22nd 2005

00:00 DT Recording line PJ051228P1004
00:55 DT Fault finding on streamer #2.
11:16 SB Recording line PJ051452P1005.
13:24 DT Line change to line PJ051228P2006.
15:34 SB Recording line PJ051228P2006.
17:51 SB Line change to PJ051444P1007.
19:54 SB Recording line PJ051444P1007
22:02 SB Line change to PJ051220P1008.
23:59 SB Recording line PJ051220P1008

October 23rd 2005

00:00 SB Recording line PJ051220P1008
01:50 SB Line change to PJ051436P1009
03:48 SB Recording line PJ051436P1009.
05:50 SB Line change to PJ051212P1010.
07:52 SB Recording line PJ051212P1010.
10:00 SB Line change to PJ051428P1. Terminated on run in due to streamer faults.
11:52 DT Streamers #4 & #1 being worked on to resolve parity errors and spiking data.
17:20 SB Recording line PJ051204P1011.
19:24 SB Line change to PJ051428P1012.
21:22 SB Recording line PJ051428P1012.
23:21 SB Line change to PJ051196P1013

October 24th 2005

00:00 SB Line change to PJ051196P1013.

01:23	SB	Recording line PJ051196P1013.
03:36	SB	Line change to PJ051420P1014.
05:43	SB	Recording line PJ051420P1014
07:43	SB	Line change to PJ051188P1015.
09:54	SB	Recording line PJ051188P1015.
12:10	SB	Line change to PJ051468P1016. Line change extended to pick up an outer line at 9.0 metre streamer depth.
14:30	SB	Recording line PJ051468P1016.
16:37	SB	Line change to PJ051180P1017.
18:48	SB	Recording line PJ051180P1017.
21:01	SB	Line change.
23:01	DT	Module in stmr #3 failed, parity error count stmr #4 rising. Stmr #3 being retrieved.

October 25th 2005

00:00	DT	Work continues on streamers #1 and #2.
15:00	SB	Recording line PJ051172P1018.
16:57	SB	Line change to PJ051420J1019
19:01	SB	Recording infill on line PJ051420J1019
20:59	SB	Line change to PJ051172J1020.
23:07	SB	Recording infill line PJ051172J1020.

October 26th 2005

00:00	SB	Recording infill line PJ051172J1020.
01:09	SB	Line change to PJ051412P1021.
03:22	SB	Recording line PJ051412P1021.
05:39	SB	Line change to PJ051164P1022.
07:48	SB	Recording line PJ051164P1022.
09:55	SB	Line change to PJ051404P1023.
12:02	SB	Recording line PJ051404P1023
14:18	SB	Line change to PJ051156P1024.
16:33	SB	Recording line PJ051156P1024.
18:35	SB	Orient Explorer down for weather.

October 27th 2005

00:00	SB	Vessel on weather standby running over survey area.
14:36	SB	Recording line PJ051004P1025.
16:41	SB	Line change.
18:41	SB	Vessel on weather standby in 3.0 metre seas wind WNW 30knts.

October 28th 2005

00:00	SB	On weather downtime heading to pick up line PJ051156P2026.
03:00	DT	Streamer #2 failed. Streamer recovered to boot section to replace boot.
11:32	SB	Recording line PJ051156P2026.
13:30	SB	Line change to PJ051396P1027.
15:31	SB	Recording line PJ051396P1027.
17:37	SB	Line change to PJ051148P1028.
19:37	SB	Recording line PJ051148P1028.
21:41	SB	Line change to PJ051388P1029.
23:44	SB	Recording line PJ051388P1029.

October 29th 2005

00:00	SB	Recording PJ051388P1029
01:48	SB	Line change to PJ051140P1030.
03:52	SB	Recording line PJ051140P1030
05:56	SB	Line change to PJ051380P1031.
08:07	SB	Recording line PJ051380P1031
10:12	SB	Line change to PJ051132P1032
12:16	SB	Recording line PJ051132P1032.
14:19	SB	Line change to PJ051372P1033.
16:24	SB	Recording line PJ051372P1033
18:33	SB	Line change to PJ051124P1034.
20:41	SB	recording line PJ051124P1034.
22:48	SB	Line change to PJ051364P1035.

October 30th 2005

00:00	SB	Line change to PJ051364P1035.
00:48	SB	Recording line PJ051364P1035.
02:50	SB	Line change to PJ051116P1036.
04:51	SB	Recording line PJ051116P1036.
06:52	SB	Line change to PJ051356P1037
09:00	SB	Recording line PJ051356P1037.
11:05	SB	Line change to PJ051116J1038.
13:08	SB	Recording infill line PJ051116J1038.
15:11	SB	Line change to PJ051348P1039.
17:16	SB	Recording line PJ051348P1039.
19:19	SB	Line change to PJ051108P1040
21:23	SB	Recording line PJ051108P1040
23:41	SB	Line change to PJ051340P1041.

October 31st 2005

00:00	SB	Line change to PJ051340P1041.
01:52	SB	Recording line PJ051340P1041.
04:01	SB	Line change to PJ051108J1042.
06:07	SB	Recording line PJ051108J1042.
08:14	SB	Line change to PJ051340J1043.
10:20	SB	Recording line PJ051340J1043.
12:20	SB	Line change to PJ051012P1044.
14:37	SB	Recording line PJ051012P1044.
16:43	SB	Line change to PJ051332P1045.
18:56	SB	Recording line PJ051332P1045.
20:58	SB	Line change to PJ051100P1046.
23:00	SB	Recording line PJ051100P1046.

November 1st 2005

00:00	SB	Recording line PJ051100P1046.
01:09	SB	Line change to PJ051324P1047.
03:09	SB	Recording line PJ051324P1047
05:12	SB	Line change PJ051092P1048.
07:16	SB	Recording line PJ051092P1048
09:27	SB	Line change to PJ051476P1049.
11:53	SB	Recording line PJ051476P1049.
13:52	SB	Line change to PJ051020P1050.

16:32 SB Recording line PJ051020P1050
18:28 SB Line change to PJ051484P1051.
21:02 SB Recording line PJ051484P1051.
23:01 SB Line change to PJ051028P1052

November 2nd 2005

00:00 SB Line change to PJ051028P1052
01:32 SB Recording line PJ051028P1052
03:44 SB Line change to PJ051492P1053
06:18 SB Recording line PJ051492P1053
08:23 SB Line change to PJ051244P1054.
10:24 SB Recording line PJ051244P1054
12:29 SB line change to PJ051500P1055.
14:33 SB Recording line PJ051500P1055.
16:35 SB Line change to PJ051084P1056.
19:03 SB Recording PJ051084P1056.
21:10 SB Line change to PJ051316P1057.
23:18 SB Recording PJ051316P1057.

November 3rd 2005

00:00 SB Recording line PJ051316P1057.
01:22 SB Line change to PJ051036P1058.
03:31 SB Recording line PJ051036P1058.
05:40 SB Line change to PJ051308P1059.
07:49 SB Recording line PJ051308P1059.
09:58 SB Line change to PJ051252P1060. Line change time extended due to a tear drop turn.
12:44 SB Recording line PJ051252P1060.
14:52 SB Line change to sequence 061.
16:52 SB Vessel on weather standby.

November 4th 2005

00:00 SB Orient Explorer down for weather.
20:35 SB Weather down time. Source arrays being deployed.
22:35 SB Deploying Source arrays.
23:00 SB All arrays deployed vessel coming up to speed and heading for line PJ051044P1061.

November 5th 2005

00:00 SB Weather down time heading onto line PJ051044P1061.
01:03 SB Recording line PJ051044P1061.
03:06 SB Line hange to PJ051300P1062.
05:20 SB Recording line PJ051300P1062.
07:35 SB Line change to PJ051076P1063.
09:43 SB Recording line PJ051076P1063.
11:44 SB Line change to PJ051292P1064.
13:46 SB Recording line PJ051292P1064.
15:46 SB Line change to PJ051052P1065.
17:50 SB Recording line PJ051052P1065.
19:53 SB Line change to PJ051508P1066.
22:24 SB Recording line PJ051508P1066.

November 6th 2005

00:00 SB Recording line PJ051508P1066.
00:28 SB Line change to PJ051052J1067.
02:54 DT Recording line PJ051052J1067.
03:19 DT Work continues on repairing streamer #1.
19:20 DT Deploying source arrays.
22:10 DT Run in to line PJ051068P1068.
23:10 SB Recording line PJ051068P1068.

November 7th 2005

00:00 SB Recording line PJ051068P1068.
01:15 SB Line change to PJ051292J1069.
03:18 SB Recording infill line PJ051292J1069.
05:19 SB Line change to PJ051052J2070.
07:30 DT Recording line PJ051052J2070.
08:00 DT Repairs being carried out on source arrays.
11:43 SB Recording line PJ051284P1071.
13:49 SB Line change to PJ051060P1072.
15:54 SB Recording line PJ051060P1072.
18:10 SB Line change to PJ051500J1073.
20:41 SB Recording line PJ051500J1073.
22:44 SB Line change to PJ051060J1074.

November 8th 2005

00:00 SB Line change to PJ051060J1074.
01:15 SB Recording line PJ051060J1074.
03:25 SB Line change to PJ051276P1075.
05:33 SB Recording line PJ051276P1075
07:36 SB Line change to PJ051052J3076.
09:39 SB Recording line PJ051052J3076
11:41 SB Line change to PJ051268P1077.
13:44 SB Recording line PJ051268P1077.
15:54 SB Line change to PJ051260P1078.
18:33 SB Recording line PJ051260P1078.
20:43 SB Line change to PJ051268J1079.
23:25 SB Recording line PJ051268J1079.

November 9th 2005

00:00 SB Recording line PJ051268J1079
01:43 SB Line change to PJ051260J1080.
04:26 SB Recording line PJ051260J1080
06:31 SB Line change from Benaris 3D to 2D.
09:26 SB Recording line PJ2D2007P1081
12:25 SB Line change to PJ2D2001P1082.
14:41 SB Recording Line PJ2D2001P1082.
18:23 SB Line change to PJ2D2005P1083.
20:07 SB Recording line PJ2D2005P1083.
23:22 SB Line change to PJ2D2009P1084

November 10th 2005

00:00 SB Line change to PJ2D2009P1084.

01:39	SB	Recording line PJ2D2009P1084
04:56	SB	Line change to PJ2D2010P1085.
06:25	DT	Vessel came off line to stbd to give a lee for the workboat to retrieve a crewman from the chase boat.
06:56	SB	Cont. line change to PJ2D2010P1085
08:44	SB	Recording line PJ2D2010P1085
10:06	SB	Line change to PJ2D2002P1086
11:48	SB	Recording line PJ2D2002P1086
13:01	SB	Line change to PJ2D2012P1087
15:06	SB	Recording line PJ2D2012P1087
16:42	SB	Line change to PJ2D2004P1088.
18:45	SB	Vessel down for weather recovering source arrays.
20:40	SB	Vessel down for weather.

November 11th 2005

00:00	SB	Orient explorer standing by for weather.

November 12th 2005

00:00	SB	Weather downtime.
03:48	SB	Recording line PJ2D2004P1088
04:59	SB	Line change to PJ2D2014P1089.
06:43	SB	Recording line PJ2D2014P1089.
08:11	SB	Line change to PJ2D2006P1090
10:07	SB	Recording line PJ2D2006P1090.
11:07	SB	Line change to PJ2D2016P1091.
13:18	SB	Recording line PJ2D2016P1091.
14:38	SB	Line change to PJ2D2008P1092
16:18	SB	Recording line PJ2D2008P1092
17:38	SB	Line change to PJ2D2018P1093
19:37	SB	Recording line PJ2D2018P1093
21:12	SB	Line change to PJ2D2020P1094.
23:32	SB	Recording line PJ2D2020P1094.

November 13th 2005

00:00	SB	Recording line PJ2D2020P1094.
01:41	SB	Line change to PJ2D2024P1095.
03:39	SB	Recording line PJ2D2024P1095.
05:45	SB	Line change to PJ2D2028P1096.
07:23	SB	Recording line PJ2D2028P1096
09:07	SB	Line change to PJ2D2034P1097.
10:41	SB	Recording line PJ2D2034P1097.
12:07	SB	Line Change to PJ2D2030P1098.
14:03	SB	Recording line PJ2D2030P1098
15:54	SB	Line change to PJ2D2036P1099
17:58	SB	Recording line PJ2D2036P1099.
19:40	SB	Line change to PJ2D2032P1100.
21:14	SB	Recording line PJ2D2032P1100.
23:02	SB	Line change to PJ2D2026P1101.

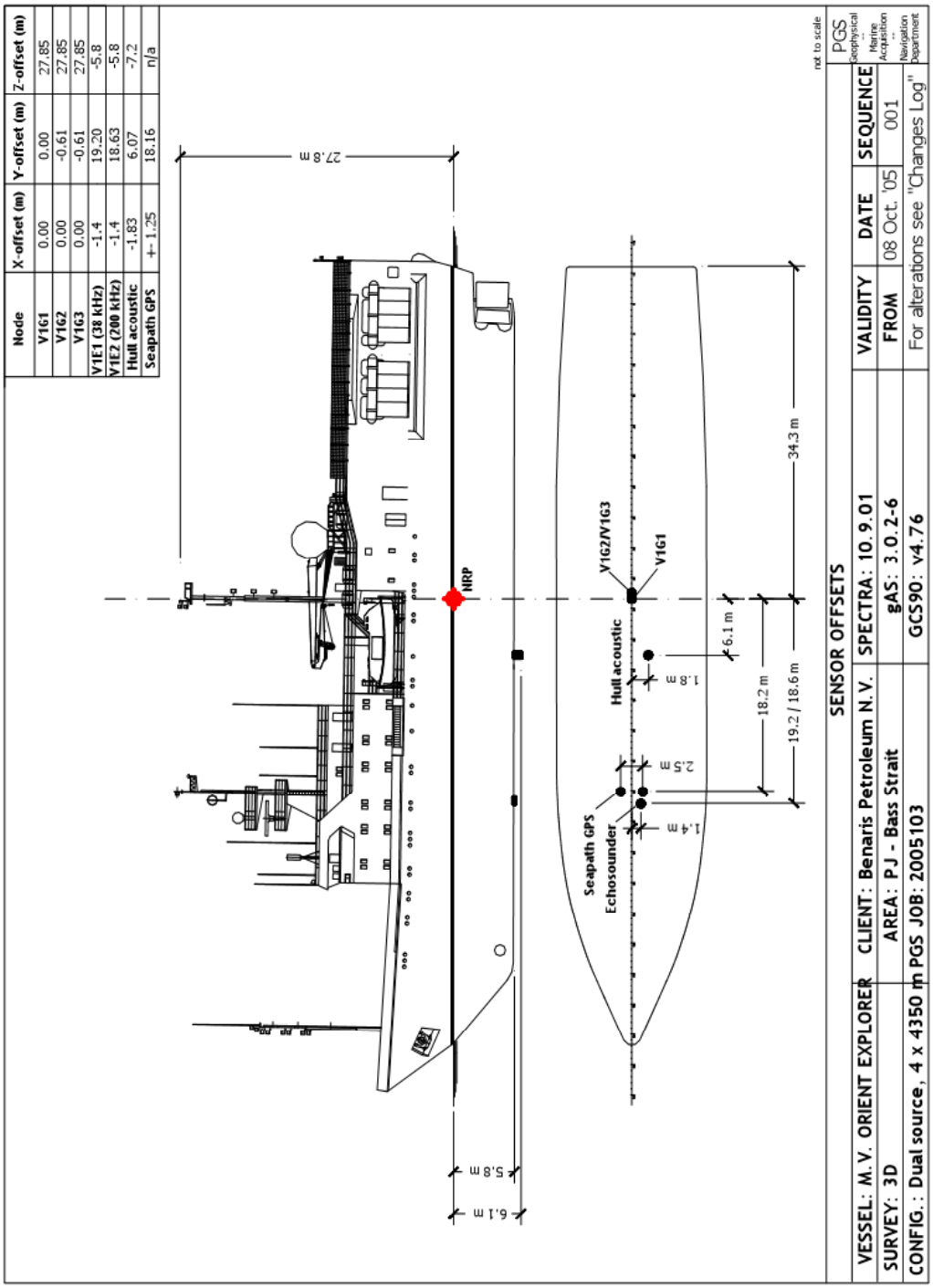
November 14th 2005

00:00	SB	Line change to PJ2D2026P1101.
00:41	SB	Recording line PJ2D2026P1101.

02:15	SB	Line change to PJ2D2022P1102
04:08	SB	Recording line PJ2D2022P1102
05:40	SB	Line change to PJ2D2003P1103.
07:56	SB	Recording line PJ2D2003P1103
09:35	MO	Departing Benaris Prospect area at the completion of the survey for new survey area.

7 MEASUREMENTS

7.1 GPS ANTENNA POSITION



7.2 OFFSET DIAGRAM & TOWING DIMENSIONS

See file “Explorer Drawings” on accompanying CD

7.3 ARRAY TOWING SYSTEM & CONFIGURATION

See file “Explorer Drawings” on accompanying CD

8 APPENDICES

8.1 PGS CONVENTIONS AND TERMINOLOGY

Glossary:

Active : 75m active streamer section (40 used in streamer)

BCU : Bird Compass Unit, Digicourse series depth / compass unit

Module : Streamer electronics module

dGPS : Differential Global Positioning System. Primary and secondary satellite navigation systems.

MOB : Man overboard boat. A fast rescue craft designed for emergencies.

SEAL 24 : Data acquisition, streamer interface and recording system

Inmarsat B : Telecom satellite communication system

DNP : Do Not Process. Data acquired but not accepted.

rGPS : Relative GPS system used for positioning source and tailbuoys

RU : Remote unit commonly known as either a bird or compass unit

SPU : Source Positioning Unit. rGPS units situated on sub-arrays

Skyfix : Fugro RTCM delivery system

Spectra : Real Time navigation system

SPECTRA : Seismic processing system

SEALINK : Digital energy source timing system

SEISPOS : Navigation QC system

8.2 LINE AND SHOT POINT NUMBER CONVENTION

Line/Job prefix: PJ05/ PJ2D.

Sail Line Format: Sail line numbers had the format: PJ05/ PJ2Dxxxxyyzzz, where:

PJ = Pee Jay survey identifier
05 = Year of acquisition
2D = 2D line identifier
xxxx = Sail line number.
yy = P1,Primary, R1, Reshoot or J1, Infill.
zzz = sequence number

Shot Point numbers : incremented to the NW Decremented to the SE. for the 3D survey
: Incrementing to the east Decrementing to the west for the 2D survey

8.3 DESCRIPTION OF LINE LOG CONTENTS

The following provides details of the data recorded for each line in the Observers Line Logs. All items appear on the individual Line Logs found on the CD accompanying this report.

Line Statistics

Seq.	: Sequence number of line (Order in which lines were shot)
Sail Line	: Client specified line number
Date	: Date on which line was started
Dir.	: Nominal line heading
Start Time	: Time of start of line, local time
End Time	: Time of end of line, local time.
SOL	: Start of line column heading
EOL	: End of line column heading
FSP	: First Shotpoint
LSP	: Last Shotpoint
KM	: Total kilometers recorded
KMFF	: Total kilometres full fold
CMP	: Na.
SQKMFF	: Square Kilometres Full Fold
Vessel Speed	: Vessels speed in knots at the start and end of the line.

Environment

Wind Speed	: Average wind speed in knots
Wind Dir.	: Average direction of wind
Water Depth	: Water depth below the transducer at the start and end of line
Swell	: Average swell height at the Start and End of line.
Sea State	: Sea conditions i.e. slight, moderate or rough at BOL/EOL

Streamers

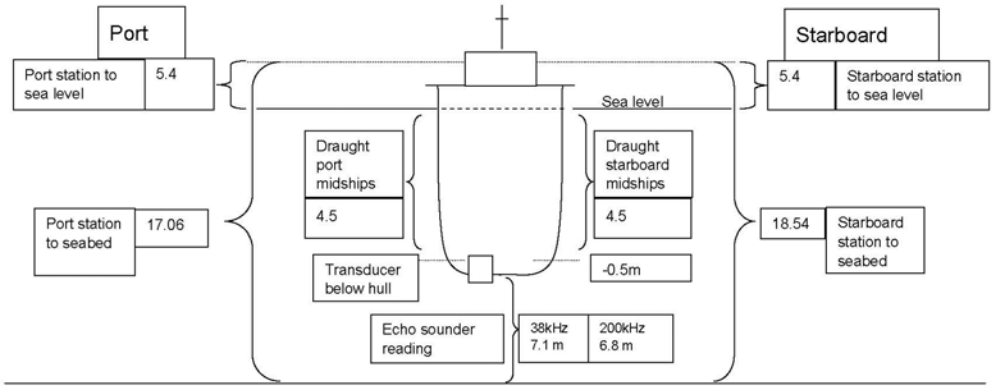
SOL noise	: Ambient RMS streamer noise calculated at start of line
EOL noise	: Ambient RMS streamer noise calculated at end of line
Bad Channels	: The number of defective channels on the streamer. These can be classed as bad for several reasons, dead, noisy, spiking, leaking etc.
Feather	: The angle the streamer deviates off the line heading, negative numbers indicate port, positive numbers indicate starboard

Summary

Status	: Whether line complete or incomplete
Comments	: General summary of line quality and any particular aspect of the line which may require special attention.
Bad Records	: The number of bad shots or records on the line.

8.4 ECHOSOUNDER CALIBRATION OCTOBER 8 2005

Portland, Victoria.



Port station to seabed	17.06
Port station to sea level	5.40
Port water depth	**11.66**
Subtract port draught *	-4.5
	7.16
Transducer offset below hull	-0.5
CALCULATED DEPTH	6.66

	38kHz	200kHz
average from port and stbd readings	7.40	
	7.40	7.40
Measured depth (echo-sounder reading)	7.1	6.8
Difference (metres)	**0.3**	**0.6**

Starboard station to seabed	18.54
Starboard station to sea level	5.40
Starboard water depth	**13.14**
Subtract starboard draught *	-4.5
	8.64
Transducer offset below hull	-0.5
CALCULATED DEPTH	8.14

	38kHz	200kHz
	7.40	7.40
MEASURED DEPTH (echo-sounder reading)	7.1	6.8
Difference (metres)	**0.3**	**0.6**

Method: The echo-sounder was tuned to the first return, without draught correction and speed of sound at 1500metres/second. Echo-sounder data was set to log to computer disc.

The mid-ship draught marks of the ship were noted along with time.

Measuring stations were established on the weather deck, at the ships bulwark, port and starboard, approximately 1.0 metre forward of the main mast (just aft of the sixth porthole counted aft from forward). A weighted steel tape measure was used to establish the distance to sea level and then to seabed level.

The mid-ship draught mark was checked again along with the time. The echo sounder reading was taken as the mean reading between the times of draught observations.

8.5 ASSOCIATED FILES ON CD ROM

The accompanying CD-rom includes this report as well as a number of supporting documents as shown on the layout diagram below. Including the logs and analyses provided by the observers, navigators, and the ProMAX QC.

CD Folders:

1. Observer Line Logs
2. Observers EOL Plots
3. Navigators Line Logs
4. Navigation EOL Plots
5. Echosounder Calibrations
6. Source Specifications
7. Binning Coverage Displays
8. Vessel drawings and diagrams
9. Final Report

VOLUME 2

3D NAVIGATION SUPERVISION REPORT

TABLE OF CONTENTS

1. INTRODUCTION

Enquest Pty Ltd. was contracted by Benaris Petroleum NV to provide quality assurance services for their Pee Jay 3D marine seismic survey in Victoria Block T39/P Bass Straits. Mr. Drew Murray, and Mr. Ray Doughty provided the onboard seismic, and positioning quality assurance respectively.

Data acquisition of the PJ 3D survey commenced at 09.27 hours on the 21st October 2005, and was completed at 06:31 hours on the 9th November 2005.

The Pee Jay 3D survey comprised of 65 sail lines, at 200-metre spacing, and a total Full Fold length of 978.20 kilometres. The full fold survey area was equal to 195.64 square kilometres. The Sail line total distance amounted to 11958.12 kilometres. Line azimuth 307.93/127.93 Grid. To maximise the efficiency of line changes, and minimize zone boundary lines the 3D prospect was divided into two swathes.

The 3D survey was acquired using 4 x 4350 metre streamers. 348 x 12.5 metre groups. The streamers were towed at 100 metre separations to provide a 25 metre CMP line separation. Dual 2550 cubic inch source arrays were fired on an alternating 18.75 metre shot interval to produce a 37.5m CMP line shot point interval.

The absolute positioning of the recording spread was provided by Differential GPS, and Relative GPS. The net consisted of rGPS units mounted on the centre string of each array, and the four tailbuoys. The Sonardyne SIPS1 provided the front, mid, and tail acoustic nets. DigiCourse 5011 streamer compass/birds were utilized on each streamer to provide a total of 72 compass azimuths

Concept System Spectra integrated navigation system, and Sprint processing system were used for online acquisition, and post-processing of the positioning data. CMP binning was performed by the Concepts Reflex binning system.

FGPS software was utilized for independent checks of the P2/94 header, and position comparison checks of the contractors final P1/90.

3D Sail lines were designed to cover the block as a function of grid co-ordinates and parallel bearings. Sail lines were prefixed PJ05. Each line was assigned a unique numerical identification suffix. Line co-ordinates for the perimeter of the full-fold area in terms of geographical co-ordinates based on the GDA94 datum, and were generated by PGS.

A total of 80 line sequences were recorded. 76 sequences were processed, and accepted by the Clients onboard representatives, of these 09 were infill sequences. The percentage of infill acquired was 13.60%.

All time references in this report were in Local time (GMT time +11 hours).

3D PRODUCTION MAP

2 CONCLUSIONS AND RECOMMENDATIONS

2.1 CONCLUSIONS

The Navigation team conducted the positioning acquisition, and processing functions of the survey in a professional, and efficient manner. Assistance, and information was provided whenever requested. Satisfactory standards with respect to utilization and maintenance of resources were reflected in the incidence of downtime attributable to navigation technical failures.

The quality control tools available to the navigators were sufficient to alert the operator to potentially damaging effects of degraded systems performance in real-time and post-processing. Positioning objectives, as detailed in the General Survey Parameters, were adhered to with minor but acceptable exception.

Good standards of acquisition were adopted on the vessel ensuring satisfactory and reliable generation of final deliverable products. All the final processed positioning data was accepted onboard the vessel.

The navigation team were actively involved in the HSE safety management system and training modules. The team carried out their duties in a safe and professional manner

The vessel absolute positioning, provided by Differential GPS, and Relative GPS observations were of a sufficiently high quality to provide a good constraint for the in-sea positioning network. The StarFix/MRdGPS was operated in the single frequency mode, something not now used in many other areas of the world. The use of duel frequency receivers would further enhance results.

The Sonardyne SIPS1 acoustic networks were configured to provide adequate redundancy in the front, mid and tail networks. Acoustic units were installed on each array centre string, and an rGPS unit on each array string. This configuration assured the source position. Turbulence caused by the wash of the vessel, and the source resulted in some data loss from the source to the steamer and inter streamer. Particularly affected were streamers two, and three. It was noticeable when the sea increased to more than a metre on the beam the quality of the acoustic data was adversely affected. The overall quality of the acoustic data was good with few problems experienced in post-processing.

The streamer compass data was of high standard, with never more than one compass disabled from a total of 74 utilized on the four streamers. The prime reason for the fine record was the prompt intervention when units became faulty. A magnetic anomaly was observed across the survey area, and is discussed later in this report.

The towing arrangements were stable except for a number of lines when it is suggested that the wash of the vessel caused the “trouser leg” affect. The affect a linear divergence from the front end to the tail end of streamer two to three, which resulted in a small loss of coverage. Local currents of any note were not observed, and the tidal regime is discussed later in this report.

The integration of Spectra Ins real-time navigation and real-time Census Binning System fulfilled positioning, navigation, steering, binning and system synchronisation requirements. No downtime was caused by the systems.

The Sprint 3D post processing system features were thorough, comprehensive, and fulfilled the off-line QC processing tasks.

The utilisation of the FGPS SeisPos, and QC Tools independent navigation processing software by the client’s navigation representative served to verify the results produced by the contractor. The results give the clients, and the contractor a high level of confidence in the final P1/90 data set.

All insea positioning equipment was maintained at a high operational level. It is something for all to consider that a more pragmatic attitude is required when viewing compass, and acoustic data acquired in the Bass Strait region. The sea state in other waters of Australia, and the tropics are more sympathetic to data acquired from in sea positioning systems. During the survey A priori acoustic SDs were slightly increased during inclement sea conditions. With this said the positioning data set as viewed onboard was still considered of a good order.

One “Stop Card” was completed by the author. The small lifeboat embarkation deck had become storage for a number of articles, including a streamer reel, which was not secured for heavy seas. The entrance/exit from the deck to the lifeboat was partially blocked by a garbage bin. This was indicative of the vessel, which appeared to lack adequate storage facilities. A further example was the helicopter reception room, which housed the primary fire station lockers and the main exit from the accommodation to the embarkation deck. Much of this area was used to store free standing bottled water, and cans/ bottles of soft drinks. The author, and on watch seaman re sited cases of drinks, which had broken loose on a particularly stormy night, after the taking of victuals at sea from the chase boat.

2.2 RECOMMENDATIONS

The following recommendations are made for the client’s consideration and possible incorporation into specifications for future projects should the MV Orient Explorer be chartered in the future for a similar survey:

1. The vessel is equipped with a pitch, heave and roll sensor. The data is logged to P2/94, and applied to the echo sounder. To eliminate the motion of the GPS antenna when surveying particularly when the sea is on the beam the data from the sensors be incorporated in the GPS processing procedures.

2. The installation of two operational velocity sensors on the streamers is now considered the norm. PGS should make every effort for a similar installation on the MV Orient Explorer. It is essential the dynamic velocity of sound is applied to the acoustic data, particularly where the velocity has a relative large change of magnitude along any given survey line.

3. Acoustic Doppler Current Profiler (VM Profiler), or Current Meter should be installed on the MV Orient Explorer. The data would assist in the survey planning and operation with the aim of reducing infill.

4. To increase the redundancy of the front net Sonardyne acoustic units should be installed on all the array strings. Further enhancement of the system would be the installation of rGPS buoys at the front end of the streamers

5. Under normal 24 hour survey operations, to ensure the data quality of the final deliverables a dedicated experienced Sprint positioning processor be employed by the contractor.

6. It is recommended that the client continue supporting the provision of the independent FGPS software. The software allows an independent, comprehensive QC audit of raw data quality and subsequent post-processed archives.

3.0 ACQUISITION

3.1 GENERAL

The prospect was surveyed in two swaths with only one boundary line as a result. This enabled optimal line changes with a turn radius on a normal line change of approximately 3.2 km. The RobTrack Automatic Steering system was in use throughout the survey data acquisition period. The run-out distance was 2175m (116 shot points), equivalent to half the active streamer length.

The average sea state during the survey period was four feet, often with a short wave period of a few seconds. The wind for the most was from the north to east quadrant.

A tidal regime was observed, but the time cycle was never fully mastered. Late in the survey period with more observed feather data available better predictions could be made. The variable weather conditions, short lines, and the stoppages for inclement weather were valid reasons for the time scale, which resulted on a small number of occasions in a feather mismatch.

Although no noticeable local currents were experienced, approximately 15% of lines were affected by the “trouser leg” effect, with mean tail end separations greater than 120 metres. A further 16% of lines were possibly affected with mean tail separations of greater than 110 metres recorded. Various explanations have been given for this event, the divergence of streamers two, and three, which is particularly noticeable at the tail end. The author considers the most likely reason for the event is when certain combinations of feather, and seas exist a small divergence at the front end started by the wash of the vessel continues with a linear increase to the tail end of the streamers. The example given is sequence 058 line 1036P1 the mean tail separation streamer two to three was recorded as 145 metres. The result of the divergence is convergence of streamers one to two, and streamer three to four, with at times a small loss of coverage.

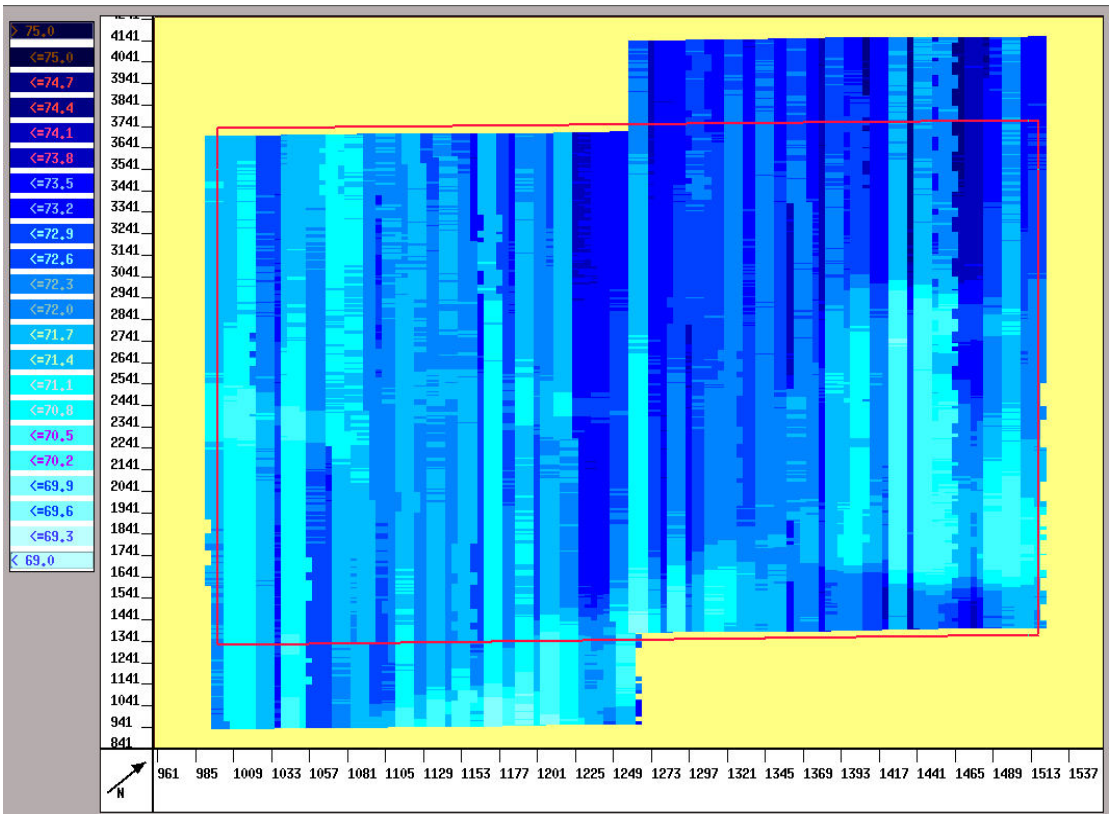
The wash of the vessel can be clearly seen in the below photograph, which was taken on one of the few days during the survey when a calm sea was experienced.

The Vessels Wash

Bathymetric data in the final P1/90 was not corrected for the draught of the echo sounder transducer head, or tides. The velocity of sound was set at 1500 metres per second. The reader should keep this in mind when viewing the *Sounding Attribute.* The velocity through the total water column was observed on three separate occasions.

Sounding records viewed on a line, by line basis indicated a relative flat sea bed with few features. The one noticeable feature of approximately two metres height appeared regularly on the records. This feature can be seen on the bathymetric attribute presented below. The feature starts on the right hand boundary (north east side of prospect), and narrows to the centre of the bottom boundary (south east). The feature was better defined on the sounding records, which can be found in Appendix L Spectra end of line graphs

The Sounding Attribute.



The velocity sensor installed on streamer one, worked intermittently therefore dynamic water velocities were not applied when processing Sonardyne acoustic net data, For the Bee Jay survey this was not a problem as the small amount of acquired data from the dynamic sensor showed the velocity along the line varied by less than 2 metres per second.
The velocity of sound to eight metres, the streamers normal working depth was observed on four separate occasions, and was applied when processing Sonardyne acoustic data.

Of the 76 accepted sequences the Sprint processed feather data showed that a maximum feather of greater than 5 degrees was experienced on 13 sequences. Only on 4 sequences was the feather greater than 6 degrees. The maximum feather recorded was minus 9.8 degrees during sequence 014. This was one of the prime reasons for the low amount of infill required.

The vessels average speed throughout the survey was a follows.

Bottom speed 4.43 knots and through the water 4.55 knots.

The data was extracted from the Spectra end of line QC statistics.

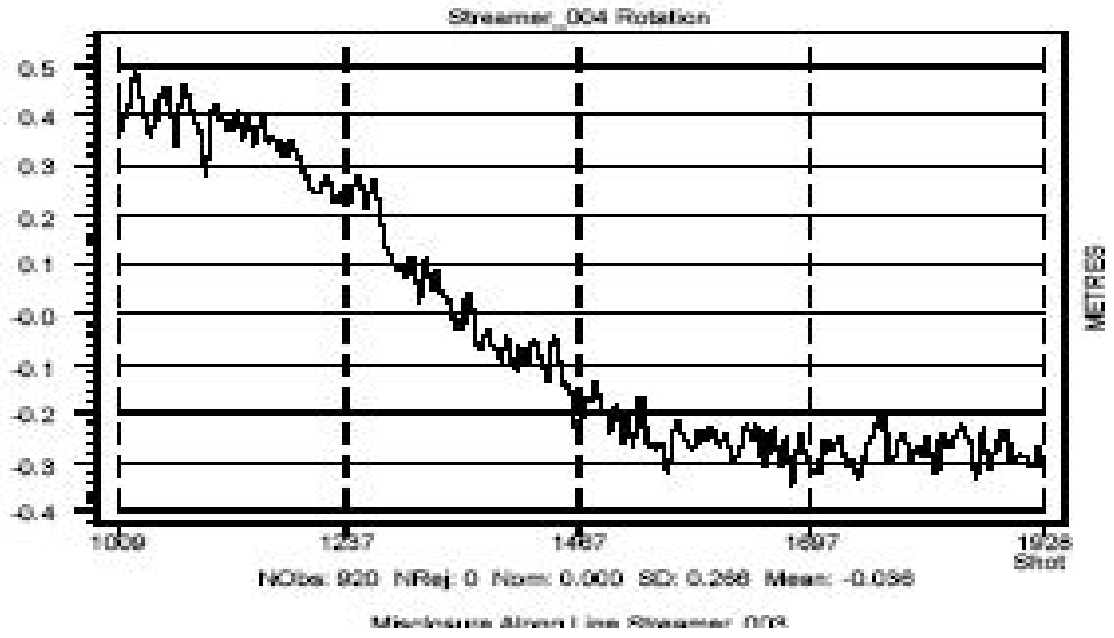
The tailbuoy rotation angle end of line statistics indicated a magnetic anomaly across the survey area. This was confirmed by review of the Admiralty chart, and the Australian Pilot. Close to the location of the survey the Admiralty chart warns of “Local Magnetic Anomaly” The Australian Pilot states, local survey results show significant anomalies between Birnie & Ullveston at position S 41.00 : E 146.15degrees this position some 24NM due south of the project. The rotation angle change along a line varied at times from minus 0.5 to plus 0.5 degrees.

The mean rotation for the all sequences follows in the table below. A misleading statistic when considering the variation along each line.

Streamer Rotation 1		Streamer Rotation 2		Streamer Rotation 3		Streamer Rotation 4		
Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	
-0.03	0.17	-0.10	0.17	-0.11	0.17	-0.11	0.17	*Mean*
0.10	0.05	0.09	0.05	0.09	0.05	0.09	0.05	**SD**
0.28	0.26	0.15	0.26	0.15	0.26	0.15	0.27	**Max**
-0.26	0.08	-0.31	0.08	-0.30	0.08	-0.28	0.09	**Min**

The example below is taken from the Sprint end of line statistics for sequence number 014.

Tailbouy Rotation Sequence 014



3.2 BINNING AND COVERAGE

The binning system employed during the survey was Energy Innovations Census system

Hardware and Software

Type	Census
Supplier	I/O
Software version	4.4.1
Machine type	IBM F50 PowerPC (AIX 4.3.2)
Tape storage	IBM Magstar 3590 model B1A (10 GB)

Binning and Coverage Specifications

Binning Parameters	Streamer Segment	Streamer Segment	Streamer Segment
	Nears (1-200)	Mids (200-2700)	Fars (2700-4350)
Nominal Fold Coverage	16 fold	20 fold	22 fold
Flex Binning Technique	Linear Taper	Linear Taper	Linear Taper
Static Bin Width	25 m	25	25
Flex start of Segment	50 %	91 %	143 %
Flex end of Segment	91 %	43 %	200 %
Near Trace Bin Width	Flexed 37.5 m	47.50	60 .25
Far Trace Bin Width	Flexed 47.5	60.25	75.00

Coverage Parameters	Coverage % with Flex Applied	Minimum Fold
Near Trace Coverage	80 %	13
Mid Trace Coverage	75 %	15
Far Trace Coverage	70 %	15

Two separate binning systems were utilized throughout the survey; the online or real-time binning system used 'real-time P1/90' data injected directly from the navigation system and the offline binning system used the final processed and approved P1/90 data.

A subsurface bin size of 25 metres cross-line and 18.75 m (online) and 6.25 m (offline) in-line was used.

The flexed (cross-line expanded) binning grid was not used during acquisition, but was sometimes used as an aid when planning feather matching. All offset groups displays were available to the navigator during the acquisition phase.

Performance

The PJ survey area was comprehensively covered to within specification with an overall infill percentage recorded as 13.6%

A short description of the binning system can be found in Appendix B, Navigation Equipment Descriptions.

3.3 SOURCE AND STREAMER GEOMETRY

Throughout the survey mean front end streamer geometry fell outside the 10% of the nominal distance of 100 metres streamer separation on two occasions, Sequence 25, and 71. The outer streamer separation fell outside of the 10% nominal 300 metres on five sequences, the worst case was sequence 25 when 284.6 metres was recorded.

Mean Streamer Front Separations taken from Spectra EOL QC statistics

FRONT	**Streamers 1- 2**	**Streamers 2- 3**	**Streamers 3- 4**
Mean	99.33	97.12	99.80
SD	0.64	3.56	0.37
Max	100.45	103.99	100.40
Min	97.4	85.12	98.56

The variation of the tail separation can be clearly seen. Much of the variation was seen when the "trouser leg" affect was observed. The affect has been discussed earlier in this report.

Mean Streamer Tail Separations taken from Spectra EOL QC statistics

TAIL	**Streamers 1- 2**	**Streamers 2- 3**	**Streamers 3- 4**
Mean	93.79	106.05	91.24
SD	13.87	18.63	13.39
Max	114.80	146.81	115.12
Min	57.12	79.47	54.48

Centre source to separation averaged 49.22 metres. The source mean separation increased between some deployment when collars were not seated correctly. Sequence 23, and 52 the mean array separation fell outside the 10% of the nominal 50 metres.

Source, and Array String mean Separations taken from Spectra EOL QC statistics

	Array Sep G1- G2	**String G1R1-G1R3**	**String G1R3-G1R5**	**String G2R1-G2R3**	**String G2R3-G2R5**
Mean	49.22	8.97	10.91	11.50	8.70
SD	2.13	0.60	0.72	0.87	0.64
Max	56.23	9.84	12.52	12.99	10.55
Min	46.15	7.36	9.40	9.49	7.57

The Mean Inline Offsets taken from Sprint QC data.

Vessel to Source 1	**Vessel to Source 2**	**Vessel to Source**	
198.31	199.51	198.91	*Mean*
0.33	0.33	0.30	**SD**
199.06	200.02	199.52	**Max**
197.57	198.05	197.92	**Min**
Source1 to CNG all Strms	**Source2 to CNG all Strms**	**Source to CNG**	
93.56	93.32	93.44	*Mean*
2.53	2.49	2.24	**SD**
98.03	96.69	96.69	**Max**
82.06	84.46	83.51	**Min**

Graphical statistics of the source and streamer geometry are presented in Appendix D Quality Control Plots.

3.5 INTEGRATED NAVIGATION SYSTEM

The SPECTRA INS (Integrated Navigation System) was produced and developed by Concept Systems Ltd. Edinburgh, UK. It is a system that is used by the majority of the contractors within the seismic industry and has been in constant development for over twelve years.

Hardware and Software

Type	Spectra
Supplier	Concept Systems Ltd.
Software version	10.9.01 (Linux RH9)
Real Time Interface	RTNU CMDS ver. 10.7.1.OS9 ver 3.03
Machine type	IBM x 235 server
Tape storage	DDS4 (20 GB)

The system was initially configured as per the contractor's work instructions. P2/94, and P1/90 checks were made and approved by the PGS Navigation department in Oslo. Subsequent changes were made whenever necessary for the following reasons:

When instrument changes were made, or offsets modified.

Performance

The overall performance of the system was satisfactory, and provided the necessary interfaces required in linking, and control of the numerous equipments typically associated with a wide tow multi-streamer 3D marine seismic exploration survey. This performance also reflected on the competence of the operators.

The Spectra Ins methodology was demonstrated to satisfy real-time acquisition, the Kalman filtering ensuring uninterrupted and stable positioning consistent with requirements to steer the common mid points for optimised coverage. Stable, and reliable "distance controlled " shot point firing was seen.
A True time GPS time receiver provided the shot point time-tag synchronisation for both seismic, and positioning data logging.

All displays, reports and statistics files were clear and informative, and allowed continual monitoring of the vessel and towed equipment, via a multitude of visual displays and quality reporting statistics.
The quality control statistics were monitored to assess the data reliability, and accuracy of the real time networks. End of line statistical analysis was available, and presented in digital format for review by the onboard client representatives.

The navigators kept a log throughout the survey highlighting the equipment, and system configuration changes made in Spectra system, which is a useful tool for reference.

A description of this system and all of its functions is provided in Appendix B Navigation Equipment Descriptions.

4.0 POST PROCESSING

4.1 SPRINT

Concept Systems' Sprint post-processing system was used for navigation data processing. As with Spectra, it is a well-established and highly regarded system within the industry.

Hardware and Software

Type	Sprint
Supplier	Concept Systems Ltd.
Software version	3.1.20
Computer	IBM RS/6000 7025-F50 Power PC
Operating System	AIX 4.3.3.0 ML 10
Printer /Plotter	HPLaser Jet 4200 / DesignJet 755CM
Tape Storage	2 x IBM Magstar 3590 B1A

The input to Sprint is the P2/94 file produced online by the Spectra system. The P2/94 data is copied across the vessel Ethernet directly from the SPECTRA SSA hard disk to both the Sprint, and to the Navigation Representative for Independent Processing. The operator has the option of selecting different solutions in processing to those used in acquisition.

Thresholds and Processing

The following table the filter, and a priori standard deviations (SD) used in the adjustment**.**
Some alterations were made when necessary to deal with variations in the

- Data Quality
- Weather
- Vessel Movement

When filtering was required, Low Pass Weiner (LPW) filters were used.

Observation	Default SD	Gate	Filter	Interp/Exrap
Front Acx	0.7	ROC(M)	LPW, 60 sec	100/20
Gun Acx	0.9	ROC (M)	LPW, 60 sec	100/20
Inline Acx	0.7	ROC (M)	LP W, 60 sec	100/20
Tail Mid Nets	0.5	ROC (M)	LPW, 60 sec	100/20
Compass	0.5	ROC (M)	LPW, 90 sec	100/20
Depthsensor	1.0	RM	LPW, 40 sec	100/20
Echosounder	1.0	ROC(M)	LPW, 20 sec	250/20
Velocimeter	1.0			
GPS E^N	1.5	ROC M	LPW, 45 sec	50/20
GYRO	0.5			
rGPS-Gun-B	00.6 deg.	ROC (M)	LPW, 60 sec	100/20
rGPS-Gun-R	2.0	ROC (M)	LPW, 40 sec	100/20
rGPS-TB-B	0.03 deg.	ROC (M)	LPW, 60 sec	100/20
rGPS-TB-R	2.0	ROC (M)	LPW, 60 sec	100/20

The streamer -shaping algorithm was an arc of curve through the pre-processed compass data, and the computation of streamer convergence limit 0.1 degree.

The receiver groups were numbered from 001 at the tail of streamer 1 (starboard) to 1392 at the head of streamer 4 (port). Streamer compasses were numbered from the tail of each streamer. (ID 01 to 18)

Tidal corrections, draught of vessel, and observed velocity of sound through the water column were not applied to the processed bathymetry data. The velocity applied was 1500 m-s, and echo sounder head draught setting at zero metres.

The following data records were written:

V: vessel	E: echo sounder	S: active source
Z: both sources	T: tailbuoys	C: near common mid points
R: receiver groups		

A processing report for each line was produced showing the various stages of processing, and results. This is defined by the processor, but would normally include:

Compass data, residuals, degrees of freedom, semi-major axis, error ellipses, streamer rotations, inline misclosures, network variance factor, raw-vs. -processed position comparisons, and various time series plots of streamer/gun separations, GPS comparisons etc.

Final coordinates were recorded to file in UKOOA P1/90 format. The coordinates are in datum GDA-94 Central meridian 147° UTM Zone 55. The data was then copied to IBM-3590 tape cartridges.

QA / QC

The initial line sequence data was dispatched to the PGS Oslo office for an independent, post processing, comparison, verification, and conformance checks of the P2/94, and P1/90 dataset. It was reported that no format errors had were found. This QC step illustrated that the onboard Spectra, and Sprint processing set up, and methods in place were satisfactory. The UKOOA recommendations for P2/94, and P1/90 format were strictly adhered to in all significant respects.

The client QC positioning representative task was to examine for accuracy, and acceptability all online, and offline post processed data for each acquired line. For the survey duration imperative data was input in to a series of spreadsheets, which were designed to highlight any errors or abnormalities. A small sample of the data was graphed, and are presented in Appendix D.

The FGPS software produced a final P1/90. The position of the GPS antenna, source, selected receiver groups were compared with the contractors final P1/90 for abnormalities. On satisfactory completion of the above checks the line from a positioning viewpoint would be accepted.

The final results were Quality Controlled by the following checks.

- Analysis of Spectra End of Line reports for each line
- The Sprint Processed reports, which included the following
- The Network adjustment report
- Processing QC reports and Processed data plots.
- dGPS difference plots.
- Source and streamer separation plots.
- Streamer rotation and stretch plots
- Compass bias estimate results
- Bird depths
- FGPS vs. Sprint P1/90 Position Comparisons.

Performance

During the period of the survey the performance of the Sprint system, and the operator, were good. The Sprint suffered no hardware failures. All accepted lines were processed to a high standard, with turn-around times being adequate for on passage of the final P1/90 for seismic navigation merging, and onboard clients representatives perusal.

One dedicated navigation processor was employed on board the vessel during the survey period. The navigation team on leave prefer a different system, which allows anyone of them an opportunity to process data. It is the view of the author that a dedicated, experienced onboard navigation processor is essential to ensure the data quality of the final deliverables, especially when confronted with a difficult positioning data set. The variables, which contrive to make a difficult data set, were not experienced on the PJ survey, and therefore resulted in a relative straight forward date set.

A few variations in the general trends were obvious on examination of the processed data. This was in general related to feather, and sea state. Normally Infill lines, when steering for coverage affect the streamer shape, and at times distorts the statistics. The length of infill lines, and the coverage required on the PJ rarely had any obvious affect on statistics, in particular feather.

Sequence 25 from a positioning viewpoint is deemed to be a marginal line for acceptance. The sea state was not conducive, even with the streamers set at 10 metres depth. The result both compass, and acoustic data quality was less good than the norm.

Although all logs were well annotated a mention of sequence one is believed to be necessary. A mistake by the navigation team resulted with the first shot (FSP) recorded as 1001. The correct FSP should have been recorded as SP1015. Although the FSP annotation was incorrect, the position on the earth's surface was the intended.

There were no unusual statistics that could not be explained, and all lines processed were accepted. A description of this system and all of its functions is provided in Appendix B Navigation Equipment Descriptions.

4.2 INDEPENDENT NAVIGATION PROCESSING FGPS

The clients' navigation representative was furnished with Fast Geophysical Positioning Solutions Limited (FGPS) Seispos software program, version 13.33. SeisPos is a Windows NT/95/98/2000 program, which processes positioning data from UKOOA P2/94 raw data format to UKOOA P1/90 final data format. The program was used on the author's laptop computer, which was connected to the local vessel network.

The network greatly eased the problems of the transfer of raw and processed data for independent processing and final comparisons. The SeisPos program is modular with each of the main processing steps functioning separately. The processing steps are similar to those used in other processing systems.

The initial step was to input the P2 raw data into a database. During this process, the format and integrity of the data was automatically checked and a report produced. Additional integrity checks could then be carried out within the database module. Nodes and observations could be viewed and edited. Observation attributes used within the precondition and network adjustment modules, such as filters, gates, C-O's, S.D.'s etc, could be edited within this module. Changes made to either the nodes or observations could then be saved and used as the default values on subsequent data.

Another utility enabled a comparison to be made between the header files of any two P2/94 data files. By running this utility, any changes made to the header between subsequent data files were reported for further investigation if necessary.

Despiking, editing, filtering and interpolation of the raw data was then carried out within the precondition module. This module can be run automatically but for this survey only the interactive mode was used which involved the processor viewing all the observations as individual time series plots and manually carrying out any additional editing of the data considered necessary. This was a time consuming operation when surveying six lines per day, with SIPS 1 acoustics, and considering other QC checks, which were required.

The network adjustment module, within the SeisPos program, is more powerful and has more QC statistics available than other similar programs. It performs a fully integrated weighted least squares adjustment and uses the Baarda method of data rejection as the default. Statistical testing and rejection/weighting (using the Delft method) is user configurable. QC statistics for individual nodes and observations can be viewed during the adjustment and a full range of statistics are available once the adjustment has been completed. The processed data was then saved in the standard UKOOA format in the output module. This module also supports P1/90 decimation.

Comparisons of the SeisPos generated P1/90 data and the contractor's P1/90 data were then made using the FGPS's P1Tools program. The summary of the comparison was produced in a comma separated value (csv) file which was copied into an excel spreadsheet to perform an ongoing analysis of trends. In addition to making comparisons, the P1Tools program facilitates the comparison of any node positions (i.e. seismic offsets, cable separations etc), analysis by shot-to-shot of any node movement and the graphical replay of the P1/90 data.

Performance

The overall performance of the SeisPos system was good and it proved to be a most valuable tool in checking both the raw and processed data produced by PGS, and therefore the system is strongly recommended for any future similar survey. Results of comparisons between the contractor's Sprint, and SeisPos generated P1/90 data using the sister programme P1Tools showed a close tie. A satisfactory result. Charts of the nodes chosen for the P1/90 comparison can be found in Appendix D of this report.

Sequence 25 was the only line when differences reached marginal acceptance levels. The nodes affected were along the streamers, this can be explained as the compass data was "very noisy" and the PGS put much work into processing of the said data. There was no change in difference comparisons of the vessel, source, and tail positions.

PGS P2/94 file did not strictly adhere to the UKOOA format. This resulted in the SeisPos program reporting 20 plus format violations, before automatically ignoring any further violations, for every line input. None of the violations were significant. Minor discrepancies in the format of event and time records caused the same format violation report to be repeated and resulted in the excessive number of reports.

The only problem encountered was whilst processing with the SeisPos software through the changeover from BST to GMT on 30th October. The software closed down, and was off air until new license codes were issued by FGPS. The P1Tools comparison program was not in use at the time, and was not affected. FGPS informed the author that the problem has been encountered in the past.

The network adjustment proved to be robust and efficient.

It is the authors opinion when positioning data quality is good, and six lines a day are surveyed comparison checks of every line is not necessary. The tool should be used for random checks, and considered difficult data sets. This would then give the client's representative more time for other types of QC checks.

5.0 EQUIPMENT PERFORMANCE

5.1 DIFFERENTIAL GPS (DGPS)

Differential Global Positioning System was employed for the vessel positioning.

For both systems height aiding was disabled, and a 10° satellite elevation mask was applied at the commencement of the survey within the Fugro software.

Primary Positioning System	Description
Type	SkyFix.XP dual-frequency WAdGPS
Fallback Solution	StarFix single frequency dGPS
Receiver	Trimble MS750 12 channel, version 1.55
Differential Corrections via	Inmarsat B (IOR), Spot (109E APSat)
Reference stations	Satellite clock/ephemeris corrections
Software	MultiFix4, version 1.07
Sub-Contractor	Fugro-Survey AS

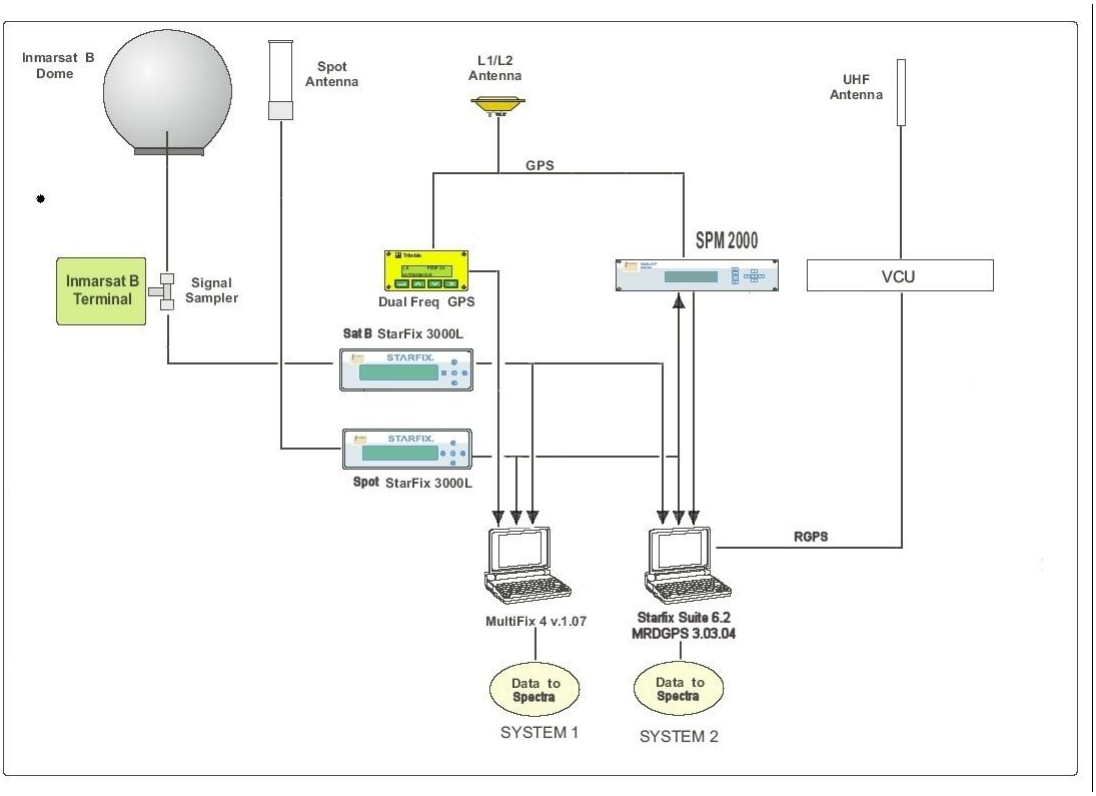
The SkyFix XP system corrections are real time for each satellite, rather than individual reference stations. The corrections computed the reference stations globally are then broadcast to the receiver onboard on the existing down links.

Secondary Positioning System	Description
Type	StarFix single-frequency dGPS
Receiver	SPM 2000 12 channel L1/L2 Ashtech receiver
Differential Corrections via	Inmarsat B (POR), Spot (109E APSat)
Software	MRdGPS, version 3.03.04
Sub-Contractor	Fugro-Survey AS

StarFix RTCM correction via Spot beam, and Inmarsat antennas

Reference Station	ID	Frequency	Range to Prospect (km)
POR – Inmarsat			
Melbourne	385	Single	325
Bathurst	336	Single	850
Ceduna	355	Single	1450
Brisbane	275	Single	1575
AP-Sat –Spot beam			
Melbourne		Single	325
Bathurst		Single	850
Cobar		Single	1000
Cedona		Single	1450

Flow Diagram ***GPS Reception Paths***



Performance

The dGPS performed satisfactorily throughout the survey with no downtime attributable to the systems.

There were an adequate number of reference stations with two sources of corrections via three delivery systems. This gave ample redundancy and meant that the loss of reference station data due to local power outages or climatic conditions did not inhibit the computation of the solution.

The one notable outage was reported by Fugro on the APSAT service for maintenance at the uplink site. The maintenance was underway during the survey of Sequence 77. Four reference stations were available during the period, but only three were seen. The SkyFix correction latency was 14.5 mean as against 12.5 the norm during the survey. Spectra INS received a position from each of the systems, the corrected solution was used in a weighted least squares solution for the position of the vessel.

Quality appraisal was maintained by way of plots and statistics produced by both systems, as well as position comparisons between the two systems. A limited selection of the statistics are presented in graphical form in Appendix D, Quality Control Plots.

The mean radial distance between the systems was normally less than 0.6 metres with maximum outliers normally no greater than 1metre. Results are presented below

	Diff. East		Diff. North	
	Mean	Sd	Mean	Sd
Mean	-0.09	0.16	-0.13	0.24
SD	0.21	0.05	0.31	0.19
Max	0.34	0.35	0.67	1.72
Min	-0.66	0.08	-0.80	0.12

The mean Horizontal Dilution of Precision (HDOP), was less than 2.5 for all lines indicating generally good constellation geometry.

The mean Semi-major Axis (SMA) at the 95% probability level was normally less than 1m for all lines. Normally there was 6 or more Satellite Vehicles in sight, with a mean PDOP less than 2.3.

The SkyFix XP calculation requires a minimum of 5 SVs. The system failed to re converge following two very short periods when only 4 SVs (Space Vehicles) were in sight. The receiver was rebooted, as it appeared one channel was blocked, and the problem was resolved.

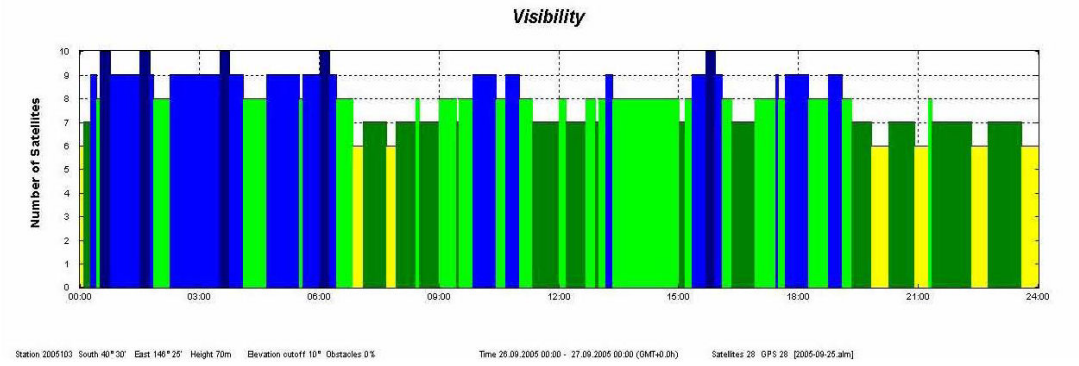
This problem/fault has been experienced by the author on two previous surveys.

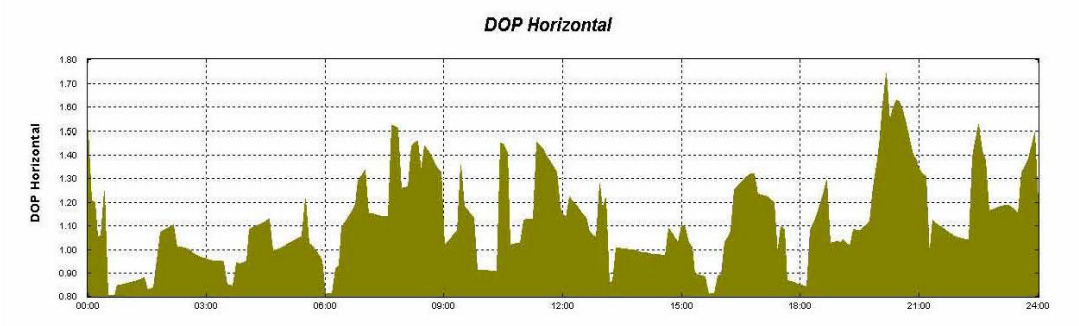
The StarFix/MRdGPS single frequency system worked surprisingly well for any future survey at these latitudes no reason could be seen why the system should not be employed. The scatter plot of system differences was more erratic than normally experienced, but the magnitude similar.

Quality figures monitored for this dGPS included PDOP, Height, Number of Satellites, Error Ellipse and residual of the position.

The value of two onboard systems dGPS cannot be over stated.

Predicted GPS Coverage. (PRN 31 UNUSFN)





A verification of the systems was completed alongside in Singapore on the 7 June 2005.
A summary of the results can be found in Appendix C.
A brief description of the various components of the SkyFix XP system be found in Appendix B, Positioning Equipment Descriptions.

5.2 STREAMER AND SOURCE POSITIONING

Streamer and source positioning was provided by a three networks (front, mid and tail) made up of Sonardyne (SIPS1) acoustics, combined with DigiCourse compass birds and the PGS rGPS system

5.2.1 Relative GPS (rGPS)

The rGPS (MRdGPS software) was used as the primary source and tailbuoy positioning system from the commencement of the survey.

Relative GPS	Seatrack 220/320.
GPS receiver	Ashtech G 12-L.
UHF communication	Wood & Douglas radio / Seatrack VCU
Software version	Fugro RGPS, version 3.02.04

rGPS Tailbuoy Units and Source Positioning Units were located on the six gun floats, and the four tailbuoys. A relative positioning Global Positioning System (GPS) not dependent on the reception of differential corrections for the computation of the tailbuoy positions. The MRdGPS would continue to compute tailbuoy positions if the RTCM link failed for the computation of the vessels position.

The raw GPS L1 carrier and phase code data was captured by each 220 beacon mounted on the tailbuoys and transmitted to the vessel via a UHF telemetry link. The MRdGPS rGPS software on the vessel then processed the data. The computed slant range, and bearing vector for each beacon was then to transferred to the Spectra INS. for a position computation

Each gun array was fitted with Seatex 320 beacons which are similar to the 220 models used on the tailbuoys, but more robust to cope with the rigours of the gun firing.

Data was transferred by a UHF telemetry link (457.6 mHz, 457.8 mHz) to the vessel.

Performance

The rGPS system was reliable and provided the necessary position accuracy to position all gun strings, and tailbuoys. Few equipment failures were reported, and the rGPS system had no attributable down time. In this respect the performance was impressive, this contributed greatly to assuring that the high standards of source, and far trace positioning attained.

Intermittent data throughout the line for approximately eight sequences from the unit fitted on the port array inner string (R2G1), was cured by heightening the antenna, unit replacement, and repairs to the power box. Only one tailbuoy battery unit (TB01) was replaced during the survey period.

The rGPS antenna on each centre gun string was offset relative to the centre of source by 0.5 metres. With the minimal antenna offsets, and good positioning data, the centre of array position was assured.

rGPS data quality statistics were monitored online, but not recorded.

During online acquisition, and offline processing, statistical test on the network-adjusted observations indicated that satisfactory performance standards were repeatedly attained, good correlation with acoustics measurements being demonstrated.

Buoys were fitted with lights. The lights flashed in sync the Morse letter “U”. “You are running into danger” Little information was available, but it is understood the units are pre programmed, and synchronised by a GPS unit.

The unit locations are shown in Appendix E, Offset Diagrams.

Pre-mobilisation verifications were performed in Singapore, and Portland, 7 June, and 8 October 2005.

A resume of results is presented in Appendix C, Calibrations.

5.2.2 Acoustics

The Seismic Integrated Positioning System (SIPS 1) was utilised on the vessel.

System name	Sonardyne SIPS1
Software version	7.00.07-T
Frequency	EHF, 55-110 kHz

Sonardyne have adopted four standard frequency bands. The extra high frequency band (EHF) and omni directional acoustic units.were used during the survey.
SIPS used the *range – range* method to position transceivers relative to the vessel, and rGPS nodes.

The system comprised of a Front, Mid, and Tail acoustic net.
Each of the networks was designed to form interlinked braced quadrilaterals, with best possible geometry, and redundancy throughout.

Physically the system consisted of two sub-systems.

- Cross Streamer Ranging System (XSRS units).
- Head and Gun Positioning System (HGPS units).
-

The XSRS were clamped to the streamers and communication was through an inductive coil link. The HGPS are less susceptible to noise as communication with the onboard processor is by hard wiring with no external coil interface.

The range data is collated by the processor, optionally displayed by the navigators and sent to the integrated navigation system.

The units are powered alkaline batteries, with a life span of 30/40 days during normal use. Sonardyne terminology is to refer to XSRS, and HGPS units as nodes. The total number of nodes deployed was 33. This comprised of 10 in the front net, 8 in the middle net, 12 in the tail net, 2 on the arrays, and 1 on the vessel.

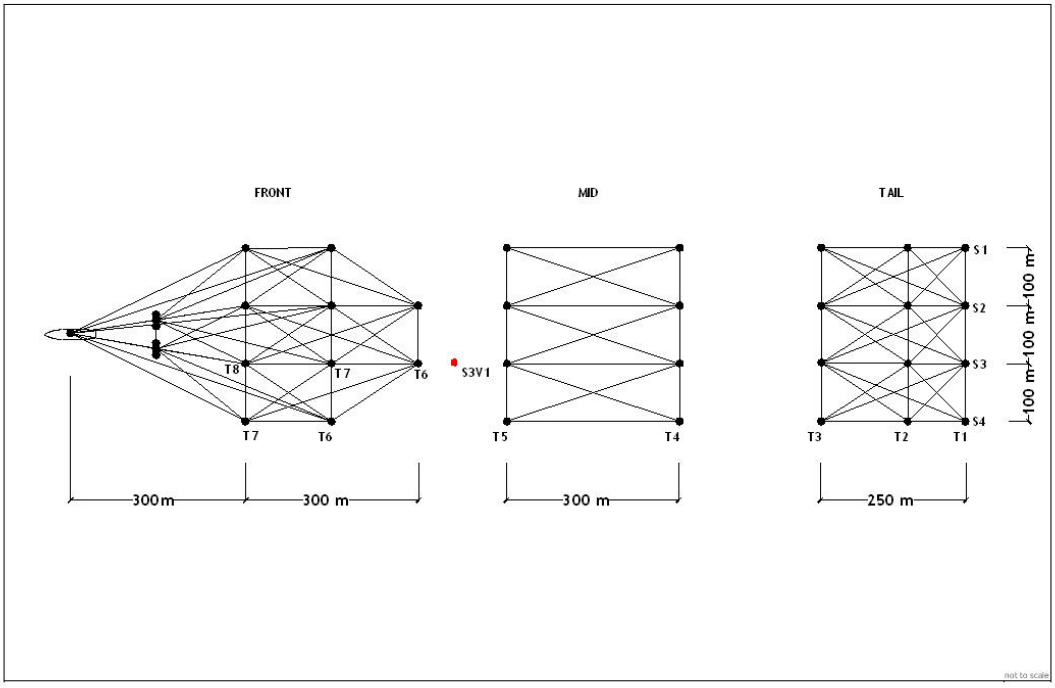
The following is a brief overview of the complex system.

The Cycle Time of approximately 9 seconds is made up of 10 Events.
Pre selected transceivers (nodes) within each net are initialised at each event.
The selected nodes transmit one of the available 16 frequency groups, each group made up of three pulses of 1.0 m-sec duration with a 5.0 m-sec wait time
Receipt of the transmissions in each event is by pre-selected nodes, which store the data.
In turn through the cycle time. The nodes are initialised until the 10 events are completed.
The data from all transceivers/nodes is then communicated to the onboard computer systems.

Different frequencies are selected each event time to ensure residue data from the previous event is not recorded. The maximum range of units can be determined by the Sonar Equation and is much greater than designed net baselines. Sonardyne state the theoretical, and practical range of units is 1200 metres. This is a serious consideration when the Events are initially set by the operator

If three valid signals are received within a pre set range window the data is considered good, and is seen on the operator's displays as a green light. When only two signals are seen an amber light appears. Initially if only one range is received it is considered good, unless outside the range window.

The SIPS 1 Acoustic Net



The Table below shows the distance s at the commencement of the survey of each transceiver relative to the centre of the near group (CNG). The source acoustics units, one installed on each array center string are not shown.

Strm. 1	metres	Srtm. 2	metres	Strm. 3	metres	Strm. 4	metres
Tr'ceiver ID	From CNG	T'ceiver ID	From CNG	T'sceiver ID	From CNG	T'sceiver ID	From CNG
ST07	7.52	ST08	7.52	ST07	7.52	ST08	7.52
ST06	-137.23	ST07	-137.23	ST06	-137.23	ST07	-137.23
		ST06	-286.76	ST06	-286.76		
ST05	-2155.17	ST05	-2155.17	ST05	-2155.17	ST05	-2155.52
ST04	-2454.05	ST04	-2454.05	ST04	-2454.05	ST04	-2454.40
ST03	-4172.29	ST03	-4172.29	ST03	-4172.29	ST03	-4172.65
ST02	-4321.65	ST02	-4321.65	ST02	-4321.65	ST02	-4322.00
ST01	-4425.16	ST01	-4425.16	ST01	-4425.16	ST01	-4425.51

The Sonardyne Event Sequence at Survey commencement.

Sonardyne Frequency Set-Up

	Event 1		Event 2		Event 3		Event 4		Event 5		Event 6		Event 7		Event 8		Event 9		Event 10	
	tx freq.	node	tx freq.	node	tx freq.	node	tx freq.	node	tx freq.	node	tx freq.	node	tx freq.	node	tx freq.	node	tx freq.	node	tx freq.	node
Front 1	0	V1T1	10	G1T1	0	G2T1	10	S3T8	0	S4T6	10	S4T7	0	S3T7	10	S2T7	0	S4T6	10	
Front 2	1		11	S3T6	1	S2T6	11	S1T6	1	S2T8	11	S1T7	1		11		1	S1T6	11	
Mid 1	0	S1T4	10	S4T5	0	S2T4	10	S3T4	0		10		0		10		0		10	
Mid 2	1	S4T4	11	S1T5	1		11		1	S3T5	11	S2T5	1		11		1		11	
Mid 3																				
Tail 1	0	S3T1	10	S4T2	0	S4T3	10	S3T3	0	S2T3	10		0		10	S4T1	0		10	
Tail 2	1	S1T3	11	S1T2	1	S2T1	11		1		11	S2T2	1	S3T2	11	S1T1	1		11	
Tail 3																				

Performance

Turbulence and gun bubble were two causes of attenuation, and loss of signal. A number of inter source ranges, and front net inter steamers two to three ranges were lost, or extremely noisy. The reason given to the author why units were not fitted on all array strings was that experienced had shown many ranges from units when fitted were lost because of turbulence. It was considered that ranges were better used in other parts of the net.

With all the above said the front net had sufficient acoustic ranges to produce an acceptable level of redundancy. No problems were caused by acoustic unit battery failure.

Factors, which ensured the good performance of the Sonardyne acoustic system.
The steamer depth at eight metres masked inclement sea conditions often experienced.
The water depth negated bottom reflections.
The normally confused sea surface negated surface reflections.
No strong local currents, or large quickly changing feather angles.
The navigation teams diligence whilst operating the system.

The velocimeter mounted on streamer one (S1V1) was of little value. Data was either non existent, or intermittent. The intermittent data showed a maximum change of 2m-s over a line length, therefore the observed velocity of propagation at eight metres was applied when processing the acoustic data. PGS should address soonest the fitting of two operational sensors on the streamers so as to provide dynamic velocities for the process of acoustic data. This is a vital tool in areas where the velocity rapidly changes over a small distance.

Something which sometimes is overlooked, but is essential for the Sonardyne system is a good line of sight for acoustic rays from the vessel to streamer front end streamer units, and the HGPS units mounted close to the source.

Quality appraisal was evaluating the raw data, and reviewing the network adjustment statistics.
The mid and tail-end networks worked well, with few problems, and considered good quality data.

A static in water verification of the units was not completed prior to the commencement of the survey.

5.2.3 Streamer Compasses

Bird Compasses	DigiCourse, 5011 Compass/Bird
Software version	System 3, Version 3.1.2
Supplier	Input/Output Systems

The DigiCourse 5011 series are made up of a heading sensor and the Remote Cable Leveller designed for streamer depth control. The compasses comprised of flux-gate sensors, which measure the horizontal components of the Earth's magnetic field, thereby providing a heading relative to Magnetic North.

The magnetic declination applied for the survey period was13.2 degrees.

Eighteen (18) active DigiCourse compass depth controllers were deployed on each of the four streamers. The units were numbered from the far end of each streamer. The compasses on each streamer were spaced at a nominal distance of no more than 300m with an extra compass unit at the head, and tail of each streamer.

The table below shows the compass locations at the commencement of the survey relative to the Centre Near Group (CNG).

Strm. 1	metres	Srtm. 2	metres	Strm. 3	metres	Strm. 4	metres
Compass ID	From CNG	Compass ID	From CNG	Compass Position	From CNG	Compass Position	From CNG
18	0.12	18	0.12	18	0.12	18	0.12
17	-74.82	17	-74.82	17	-74.82	17	-74.82
16	-224.92	16	-224.36	16	-224.36	16	-224.36
15	-448.47	15	-448.47	15	-448.47	15	-448.47
14	-747.49	14	-747.49	14	-747.49	14	-747.49
13	-1046.49	13	-1046.49	13	-1046.49	13	-1046.49
12	-1345.47	12	-1345.47	12	-1345.47	12	-1345.47
11	-1644.77	11	-1644.42	11	-1644.42	11	-1644.77
10	-1943.70	10	-1943.34	10	-1943.34	10	-1943.70
09	-2242.24	09	-2242.24	09	-2242.24	09	-2242.60
08	-2541.12	08	-2541.12	08	-2541.12	08	-2541.47
07	-2840.96	07	-2840.96	07	-2840.96	07	-2840.32
06	-3139.79	06	-3139.79	06	-3139.79	06	-3139.14
05	-3437.58	05	-3437.58	05	-3437.58	05	-3437.94
04	-3736.35	04	-3736.35	04	-3736.35	04	-3736.71
03	-4035.10	03	-4035.10	03	-4035.10	03	-4035.45
02	-4259.32	02	-4259.32	02	-4259.32	02	-4259.67
01	-4330.17	01	-4330.17	01	-4330.17	01	-4330.52

The sampling rate was set at 2 seconds with an averaging index of 2, thus the heading data was a rolling average of 7 readings over 14 seconds. The sampling, and averaging constant can be accessed from the ship borne controller by command through communications lines embedded in the streamers. The controller was the DigiCourse System 3, which provided the means for controlling the depth, and heading data.

The compass data received at every shot point was routed to the navigation system, Spectra for use in real time modelling of the streamer shape, and data recorded in UKOOA P2/94 format. P2/94 header records logged all compass serial numbers, and offsets relative to the centre of near group. The compass headings were corrected in Spectra by adding the magnetic declination, and the grid convergence at the shot point, to derive a grid bearing.

All compass biases had been measured, and corrected at the factory prior to delivery to the customer. The industry standard would normally request that all compasses have valid certificates, and may be subject to a static test should lapse time since the previous calibration exceed the manufactures recommendations. PGS policy based on the manufacturers recommendation, is no longer to dispatch the 5000 series for re calibration, or verification, as units are quality checked both in real time, and final post processing.

The factory calibration certificates issued for each unit were not seen by the author, as they are not held onboard. In the authors opinion there was no reason to call for a verification of units during, or on completion of the survey.

In post processing dynamic bias checks were achieved on the compass data for every line sequence acquired. These checks were performed during navigation reprocessing for every line where an assessment of how appropriately the compass data match with adjacent compass, and thereafter to a streamer shape model (arc). Normally any compass with a bias of 1 degree for consecutive lines would be rejected from the solution.

Performance

The performance of the DigiCourse compasses was satisfactory, and except for occasional compass depth controller replacement, mostly due to wing controller, or depth sensor fault, no profound problems were experienced. The efficient use of the work boat by the contractor ensured the high operational standard experienced.

Streamer rotations (misclosures) were monitored to ensure that the magnetic declination adopted was appropriate for the survey. Streamer rotation is the dynamic correlation of the far receiver groups position derived by a compass traverse, and a tail end network solution. The magnetic declination, and the Magnetic Anomalies" is discussed in Section 3 of this report. The Sprint processed tailbuoy rotation can be seen in graphed form in Appendix K Sprint QC Inline Offsets.

The overall streamer shape quality determines the accuracy of offset receiver group positioning, which is dependant on the compass raw data, reliability, and repeatability of bias, and consistency of streamer rotation. The most prominent consequence is normally caused by inclement sea conditions, and high dynamics inducing noisy/erratic compass observations, and not effectively filtered (real time averaging). When considering the area of operations, the Bass Straits, the final data set was of a good order. The exception is Sequence 25, which is considered to be marginal data set" caused by the rough sea conditions, which prevailed..

A brief description of these units can be Appendix B, Navigation Equipment Descriptions.

5.3 ECHO SOUNDER

Type and model	Simrad Hydrographic Echosounder EA500
Transceiver frequency	200/38 kHz (200 kHz set to Master)
Heave compensated	Yes. PRH from Seatex-MRU5

A Simrad EA500 echo sounder with the 200KHz transducer selected as the prime, data interface, and logged to P2/94 line file in Spectra. The heave compensation applied was derived from the Seatex unit. The data recorded in the final UKOOA P1/90 files was not corrected for the draught of the echo sounder transducer head. Water depths were measured from the transducer head. 1500 m-sec was set for the speed of sound.

It is a normal practise for PGS in house to apply corrections to seabed bathymetry. draught, propagation of the water velocity, and tides. It would be expected the processed data be delivered at a later stage to the Company.

A verification of the Simrad EA500 echo sounder installed on the Orient Explorer was performed at dockside, Portland Victoria Singapore on the 8th October 2005 15th June 2005. The results of the verification can be found in Appendix C .

Performance

The echo sounder performed well for the duration of the survey. The data quality was good and no loss of data was experienced. Data from both the 200, and 38kHz was presented in the Spectra QC files, and can be seen in Appendix L. A description of the instrument can be found in Appendix B, Navigation Equipment Descriptions.

5.4 GYRO COMPASS

GPS Heading / Attitude system	Seatex Seapath 200, MRU 5.2
Software version	SCC 1.02.06, MRC 2.52
Gyro compass	Litton C.Plath Navigat II
Gyro compass	Vega

The vessel was fitted with two independent direction systems for determination of the vessel's real time heading. The primary Seatex Seapath-200 GPS precision heading/attitude/positions system, and the secondary Litton C –Plath 11 gyro compass were interfaced to the Spectra.

The Seapath-200 GPS system consisted of two Trimble dome antennas (L1 single frequency) fitted on either end of a two metre (approximately) cross-yard, mounted at the vessels masthead, and an Imperial Measurement Unit. The data gathered by these sensors were then integrated with a Kalman filter in the Seapath Processing Unit (SPU).

The SPU processed heading, pitch, roll, and heave measurements were then injected into Spectra, and recorded for each P2/94 line file. This data was applied to the echo sounder (heave compensation), but was not used for compensation of any GPS antenna movement,
Seapath can also output position, but this function was not employed.

The most recent dockside alignment verification of the systems was carried out alongside the JSML yard in Singapore. Corrections computed were applied throughout the survey
The Schuler affect was not recorded, as the verification was in one direction only.
A summary of results can be found in Appendix C.

Performance

No problems were experienced with the instruments during the survey period.
Infield checks of the gyrocompasses were not taken.
Real time comparisons between the instruments for each sequence acquired revealed the misalignment as shown in the table below.

Mean	0.06 deg.	**SD**	0.07	**Max**	0.20	**Min**	-0.12

The results in graph form are presented in Appendix D, Quality QC graph plots.

5.5 SOUND VELOCITY METERS

The Valeport Limited, Midas (SVP) Sound Velocity Profiler was utilised throughout the survey.

A summary of of results of the mean velocity of sound through the water column calculated by the Chen and Millero formula follows. The formula was adopted by UNESCO during1983.

The results show little change of the velocity of sound throughout the survey, or across the survey area. This was confirmed from the small amount of intermittent data recorded by the dynamic sensor situated on the streamer.

OBS No.	**Date**	**Latitude *South***	**Longitude *East***	**Depth *metres***	**Column Velocity**	**Depth *metre***	**Velocity 8metres**
1	20-10-05	48º 28' 00"	146º25' 00"	***15.2***	***1504.402ms^{-1}***	8.0	1504.398ms^{-1}
2	22-10-05	40º 27' 24"	146º19' 00"	77.0	1503.406 ms^{-1}	8.0	1504.527ms^{-1}
3	28-10-05	40º 32' 42"	146º31' 20"	77.5	1503.847 ms^{-1}	8.0	1504.369ms^{-1}
4	05-11-05	40º31' 25"	146º 20'36"	78.3	1504.725 ms^{-1}	8.0	1504.599 ms^{-1}

The author viewed a calibration certificate number 15250 issued by Valeport on the 5 November 2004 for a Midas SVP, serial number 22249. Valeport used their standard calibration procedures, and equipment traceable to NAMAS, or National Standards for the calibration of the instrument.

The Dynamic velocity sensor/meter installed on streamer one was rarely fully operational, and therefore results were never applied in processing of the Sonardyne acoustic ranges.
The intermittent data did show that the velocity of sound over a line varied less than two metres per second.

Steerage

The industry standard systems were employed throughout the survey period

Autopilot	Robertson AP9 MKII
RobTrack	Robertson STS500
Water speed	Furuno Doppler DS-80.
Timing QC	TrueTime XL-AK

Performance.

For the first 15% of sequence 05 the track of the vessel was sinusoidal. RobTrack setting were adjusted for the prevailing sea conditions, and no further problems were experienced.

APPENDICES

APPENDIX A POSITIONING PARAMETERS

POSITIONING RARAMETERS

A.1 GEODETIC

GPS Datum:

Name	**WGS-84**
Ellipsoid	**WGS-84**
Semi-major Axis	**6 378 137.0m**
Inverse Flattening	**298.257 224**

GDA94 is a realisation of WGS84 coincident to within 1 metre.
This transformation has accuracy equal to the coincidence figure.

WGS84 to GD94 (EPSG code 1150)

Datum Shift	Not Applicable:
DX	**0**
DY	**0**
DZ	**0**
X Rotation	**0**
Y Rotation	**0**
Z Rotation	**0**
Scale Factor	**0**

Survey Datum:

Name	**GDA-94**
Ellipsoid	**GRS-1980**
Semi-major Axis	**6 378 137.0m**
Inverse Flattening	**298.2572221**

Projection:

Datum	**GDA-94**
Datum	**UTM South Zone 55**
Ellipsoid	**GRS-80**
Central Meridian	**147° 00’ 00.0000” E**
Latitude of Origin	**0° 00’ 00 N**
False Easting	**500000 m**
False Northing	**10 000 000 m**
Scale Factor at CM	**0.99960**

Magnetic Variation

The Magnetic Declination applied 013.2 deg.
Derived from the IGRF – 10 (2005) model for 1st November 2005

Geoidal Height

Minus -1.3m. Taken from the EGM 96 model for PJ3D, & PJ2D

A.2 ACQUISITION

Survey name	**Pee Jay 3D Seismic Survey**
	Line pre-fix PJ05
Line naming	**LLLLTA-SSS**
	where: LLLL = line number
	T= Type (PJR) Prime Infill Reshoot
	A= Attempt 1 to 9
	SSS = sequence number
No. of prime sail lines	**65**
Line headings	**127.93° and 307.93° Grid**
Tow configuration	**Single vessel, Dual source.**
No. of CMP lines per pass	**8**
Fold	**58**
CMP line spacing	**25.0m**
Geometry Bin size	**6.25 m Inline, 25.0m Crossline**
Reflex Bin size	**18.75 m Inline, 25.0m Crossline**
Shotpoint interval	**18.75m**
No. of streamers	**4**
No. of receiver groups	**348 per streamer, 1392 total**
Receiver group interval	**12.5m**
Streamer length	**4350m**
Nominal streamer depth	**8.0m (+/-1.0m)**
Streamer separation	**100m (+/-10m)**
No. of sources	**2. Dual source Flip-flop**
Source separation	**50.0m (+/-5.0m)**
Source depth	**5.0m (+/-1m)**
Sub-arrays	**3 per source**
Sub-array separation	**8m (+/-1m)**
Source to near group in-line	**90m nominal**
Steering point	**Centre of the Nears**
The run-out	**2175m (116 shot points),**

APPENDIX B NAVIGATION EQUIPMENT DESCRIPTION

B.1 TRIMBLE – MS 750 DUAL FREQUENCY GPS RECEIVER

The MS750 is a 12 channel L1/L2 C/A and P code and phase tracking receiver. P code tracking during anti-spoofing is supported. A single RTCM transmission may be used for differential mode. The unit can be controlled by external control and display unit (CDU). Standard NMEA GGA and raw data output at 1Hz.

Typically for seismic applications the unit is used only as a receiver to supply raw data to the navigation software. It can, however, be used as a stand alone dGPS receiver using corrections from a single reference station and computing the navigation solution in a least squares adjustment.

B.2 SkyFix XP / MultiFix 4 XP dGPS – Primary Navigation

SkyFix XP / MultiFix 4 system was considered as the Primary positioning system. SkyFix XP is a high accuracy GPS service being offered by Thales. (PGS no longer use the terminology prime, and secondary systems. The reason for this is they give equal weight to each system position in the final solution). It is based around corrections to the GPS broadcast orbits and clocks. This technique has been called Satellite Differential GPS as the differential corrections are for the GPS satellites and not the individual reference station. The satellite corrections are derived from Fugros (Formerly Thales) global network of reference stations and are transmitted to the user via the existing SkyFix Spot (high power) satellite communication infrastructure.

The orbit and clock corrections are contained in a set of proprietary RTCM messages, which can be received using the existing SkyFix decoders. Users require a dual-frequency dGPS receiver as well as the MultiFix 4 Positioning and QC software.

The high accuracy is obtained by new processing techniques within MultiFix 4 that correct, estimate and/or eliminate the common GPS error sources (orbits, clocks, troposphere, ionosphere, multipath, noise). The Tropospheric error is removed utilising a Tropospheric modelling technique as part of the position calculation. Whilst the ionospheric delay is eliminated by using a dual frequency GPS receiver at the users location. Multipath and receiver noise at the users location are limited by using the carrier phase observations.

Note
The SkyFix XP service can be used simultaneously with the SkyFix and SkyFix Premier dGPS services in the new MultiFix 4 software. The software also allows comparisons to SkyFix and SkyFix Premier position calculations and these calculations can be configured as back-up solutions to the primary SkyFix XP calculation. This latter point being important as the SkyFix XP calculation requires a minimum of 5 SVs.

B.3 DigiCourse 5011 STREAMER/LEVELLER/CONTROLLER COMPASS UNIT

The Digibird 5000 (5011) series combined leveller, depth transducer, and compass units were employed throughout the survey period. The microprocessor design incorporates a variety of functions, which include heading correction, filtering, and sampling rate.

Each compass is calibrated by the manufacturer corrected for bias, and semi circle deviation in NS, and EW directions.

The compasses comprised of flux-gate sensors, which measure the horizontal components of the Earth's magnetic field, thereby providing a heading relative to Magnetic North.

The manufacturer's specifications are:

Operating depth:	0 to 122m
Battery life:	8 weeks with lithium batteries
Compasses:	
Resolution:	0.3°
Accuracy:	±0.5°
Sampling interval:	0.5 – 25.5 sec
Averaging constant:	0 – 126 sec depending on sample interval
Depth transducers:	
Resolution:	0.3m
Sampling interval:	0.5 – 25.5 sec
Averaging constant:	0 – 126 sec depending on sample interval
Levellers:	
Fin angle:	-15° to +15°
Dead band:	0.4°
Lift:	16kg at 15° and 5 knots
Communications:	
Type:	serial FSK
Frequency:	27kHz
Data rate:	2400 bits/sec

B.4 SIMRAD EA500 ECHO SOUNDER

The Simrad EA 500 is a triple frequency instrument used for recording bathymetry data. The system is configurable with various sizes and types of transducers, single and dual beam, suitable for depths of 1m to 10000m. Data is output to both paper chart and digitally to peripheral equipment.

The bottom detection algorithm is fully implemented within the unit. Briefly, the software builds up a history of returns with an associated flag. By this means of tracking it is able to distinguish between a continuous surface and outlying returns, for example from a school of fish. If no such distinction is made the data is flagged bad rather than being output erroneously.

The technical specifications are as follows.

Frequencies:	Numerous transducers available 11.99kHz – 714.286kHz	
Pulse length:	18kHz:	0.70, 2.00 and 7.00ms
	38kHz:	0.30, 1.00 and 3.00ms
	200kHz:	0.06, 0.20 and 0.60ms
Resolution	18kHz:	0.25m
	38kHz:	0.10m
	200kHz:	0.02m
Output power	18kHz:	2, 4kW
	38kHz:	1, 2.4, 4kW
	200kHz:	0.1, 1, 1.5, 1kW
Beam width 3dB	18kHz:	11°, 14°
	38kHz:	7° – 13°
	200kHz:	3° – 30°
Range:	1-10000m transducer dependent	
Ping rate:	0.1s increment adjustable	
Output:	Serial 9600 baud	

B.5 THE VALEPORT LIMITED, MIDAS (SVP) SOUND VELOCITY PROFILER

Sensor Specifications.

Sound velocity	
Type	Valeport “time flight” sound velocity sensor
Range	1400 to 1600 m/s. Factory fit option 1600 to 1850 m/s
Accuracy	+or – 0.03 m/s
Resolution	0.001 m/s
Pressure	
Type	Strain Gauge
Range	500Bar absolute (approx 5000m water depth) standard
Accuracy	+or – 0.04% Full scale
Resolution	0.005% Full scale
Temperature	
Type	Fast response PRT
Range	-5 to +35 deg. C
Accuracy	+or – 0.01 deg. C
Resolution	0.002 deg. C

B.6 SPECTRA INTERGRATED NAVIGATION SYSTEM

The SPECTRA INS (Integrated Navigation System) was produced and developed by Concept Systems Ltd. Edinburgh, UK. It is a system that is used by most of the contractors within the seismic industry and has been in constant development for over twelve years.

Hardware and Software

Type	Spectra
Supplier	Concept Systems Ltd.
Software version	10.9.01 (Linux RH9)
Real Time Interface	RTNU CMDS ver. 10.7.1.OS9 ver 3.03
Machine type	IBM x 235 server
Tape storage	DDS4 (20 GB)

System Description

The main software runs on any UNIX computer under Redhat Linux, IBM AIX, Solaris or HP operating systems. The interface and timing distribution unit, the RTNU (Real Time Navigation Unit) is a hardware device that handles serial and network I/O and control timing and event synchronisation.

RTNU

Based on a VME chassis these units contain a processor board and hard disk, a triggers card with GPS, ethernet cards, a and up to nine, three channel serial I/O cards. A separate closure unit belongs to this sub-system and this allows for 16 output and 8 input triggers. Software is contained on the unit’s own hard disk, the operating system is OS9.

Functionality

This system is designed to perform the following functions:

- Integrate raw positioning sensor data
- Provide vessel steering inputs
- Provide real-time source and receiver co-ordinates
- Display any real-time network and sensor data
- Log raw and processed data to UKOOA standard formats

- Provide accurate event synchronisation
- Provide quality assurance statistics for network data
- Log all interface and trigger data in proprietary format for future analysis

Source-Receiver Positioning in Real-time

Real-time positions for sources and receivers are computed by a Kalman filtered algorithm. A network approach is applied to these algorithms to allow inclusion of any available positioning sensor observations in a least squares weighted solution. Positions are transformed to the desired geodetic spheroid, datum and projection in real-time. Shot positions are achieved by estimation based on a fast cycling (1Hz) Kalman filtered network calculation.

Data Logging

Raw data can be recorded in P2/91 or P2/94 format, ensuring that all raw GPS and positioning sensor data are available for reprocessing. Results of the real-time positioning algorithm are logged in UKOOA P1/90 format. All raw interface data and trigger information can be logged in a proprietary format by the QCLN (Quality Control Logging Node). These data can be analysed using the QCN (Quality Control Node).

Displays and QC

Comprehensive displays of line relative information network status and performance are available. Network compliance statistics can be viewed for any sensor data or node, e.g. C-O, residual, SD, MDE and 2dRMS error. Real-time binning displays can be configured to show any offset ranges of interest. Statistics for separations between cables, sources etc. can be displayed, as can cable shapes and acoustic and rGPS/laser ranges. The online binning option in Spectra was not used, this function being performed by Census.

Vessel Steering and Control

Spectra provides steering information to a number of common autopilots. With this facility the vessel can be very precisely positioned to obtain the best coverage possible whilst on line. Turns can also be defined and steered automatically from the Spectra system, designing the most efficient line changes can greatly improve the transit time between lines.

Timing and Synchronisation

Timing of triggers and time-stamping of raw data is achieved by use of the GPS receiver within the RTNU. Trigger times are accurate to within 50 microseconds. Time stamping of sensor data allows for correct de-skewing of observations with the network algorithm. The precise time-stamping of input/output triggers means that extensive QC information of source/recorder events can be obtained.

B.7 SPRINT 3D POST PROCESSING

Hardware and Software

Type	Sprint
Supplier	Concept Systems Ltd.
Software version	3.1.20
Computer	IBM F50 Power PC
Operating System	AIX 4.3.3
Printer /Plotter	HPLaser Jet 4200 / DesignJet 755CM
Tape Storage	IBM Magstar 3590 B1A

Features and Operation of Sprint

Sprint is complex and multi-functional software, and a full description of its capabilities and operation is beyond the scope of this report. The following brief description covers the main features of the system.

Data Import

The input to Sprint is the P2/94 file produced online by the Spectra A system. All raw data recorded during a line are written to file and are available for post-processing, allowing the operator the option of selecting different solutions in processing to those used in acquisition. The P2/94 data are copied across the vessel Ethernet directly from the Spectra SSA hard disk.

Geodetic Computations

Sprint can perform a full range of geodetic transformations, and has libraries of all commonly used Projection, Spheroid and Datum parameters. This survey was acquired on the GDA94 datum.

Pre-Processing

The pre-processing node of Sprint allows for data to be filtered and manipulated for noise and spikes before the network adjustment. A number of different filter techniques are available for use and pre-gating can be set up to automatically reject data values that are obvious gross errors or zeros before the main filtering process begins. The system features recursive, Wiener and Kalman filters. Another important feature is manual data clipping, where the mouse is used to select regions of poor data for editing. This is particularly useful in editing acoustic ranges, which are often very noisy, and where the expected value is normally clear.
Note that the Sprint database retains all raw data, allowing for editing and filtering to be revised if necessary.

Network Adjustment

Sprint performs an integrated network solution to resolve the positions of all elements simultaneously. The process uses a Least Squares technique, which produces positions for each network item as well as a raft of quality indicators for each node and for the solution as a whole. *A priori* Standard Deviations (SD) for each sensor are entered by the operator, so that the software can apply an appropriate weight to each data type. The choice of SDs is critical, as it accounts for the inherent errors and reliability for each of the individual systems involved in the adjustment. Overall network quality is shown by time series displays of unit variance and statistics for Degrees of Freedom. The final reporting from this module gives information on maximum, minimum, mean, SD and MDE (Marginal Detectable Error) for each observation: as well as 1- error ellipse semi-major axis, maximum, minimum, mean and SD, for each network node.

Data Export

Final processed data and backups of raw data were written to IBM 3590 tapes using the *Make* UKOOA Tapes option.

B.8 REFLEX BINNING SYSTEM

Type	Census
Supplier	I/O
Software version	4.4.1
Machine type	IBM F50 PowerPC (AIX 4.3.2)
Tape storage	IBM Magstar 3590 model B1A (10 GB)

REFLEX has been designed and developed by Concept Systems Limited to provide 3D binning and coverage-control combined with more general spatial analysis facilities. Intended to link closely with the Sprint Navigation Processing system such that the position of each trace will primarily be derived from post-processed data, REFLEX thus provides a much more accurate data set.

The REFLEX database can include attributes other than fold. Attributes such as source/ receiver azimuth, seismic data quality, and any other raw or computed parameters available from the Sprint database can be used.

Acceptance criteria can then be constructed as a function of several attributes, allowing infill decisions to be made precisely. Spatial analysis extends to any measured or computed positioning parameters, enabling the detection of localised positioning errors.

REFLEX is built as a number of modules that interact with the database. The database design is proprietary, with database access libraries provided to retrieve data from and write data to the database.

REFLEX provides the following facilities:

- A database capable of holding position and attribute information for all points of interest in any 3D seismic survey.
- Import and analysis of deep marine and OBC data.
- Fast access to this data, under a variety of conditions, for presentation purposes.
- Text reports on various parameters.
- Graphical time series plots of parameters by line, or line summary against line sequence (time) or line number (area).
- Binning of data using a variety of binning configurations including flexi-binning.
- Coverage analysis, including various options to display offset distribution, coverage statistics and “greater than” or “less than” thresholds.
- Spatial plots analysing attributes.
- Output of all forms of presentation as full resolution hard copy Post-Script plots.
- Batch mode import and sampling of lines.
- Edits of database parameters including shot range edits and individual trace edits.
- Comprehensive audit of all steps performed.
- Data from multiple sources.

APPENDIX C CALIBRATIONS

C1. GPS & GYROCOMPASS VERIFICATION

The Swift Survey verification report was not available onboard the vessel, only a resume of results passed by the survey contractor to the onboard navigation team. It is noted that the verification was only completed in one direction, and therefore the Gyro compass Schuler affect was not observed. The results are presented below.

Swift Survey Pte Ltd was appointed by PGS Geophysical (AP) to carry out gyro calibrations and GPS verifications on the 07 June 2005, at JSML Yard in Singapore.
The requirements follow.

- StarFfix.Plus and SkyFix.XP verification.
- Seapath, Vega, and C-Plath gyro calibrations in one direction.
- rGPS verification.

The Surveyor's calculated minus observed (c-o) mean differences are summarised below.

Sensor	East (m)	North (m)
Starfix.Plus (V1G2)	-0.58	0.18
Skyfix.XP (V1G1)	-0.40	-0.05
Starfix.Plus (V1G3 - backup)	-0.56	0.17

Sensor	Dir'n. NE (°)
Seapath 200 GPS/INS	-0.20
C-Plath gyro	-1.48
Vega gyro	n/a due to power failure.

Sensor	Bearing (°)	Dist. (m)
Seatrack 220 s.n. 900	-0.070	-0.60
Seatrack 220 s.n. 210	-0.169	-0.71
Seatrack 220 s.n. 211	-0.182	-0.28
Seatrack 220 s.n. 247	-0.129	0.08

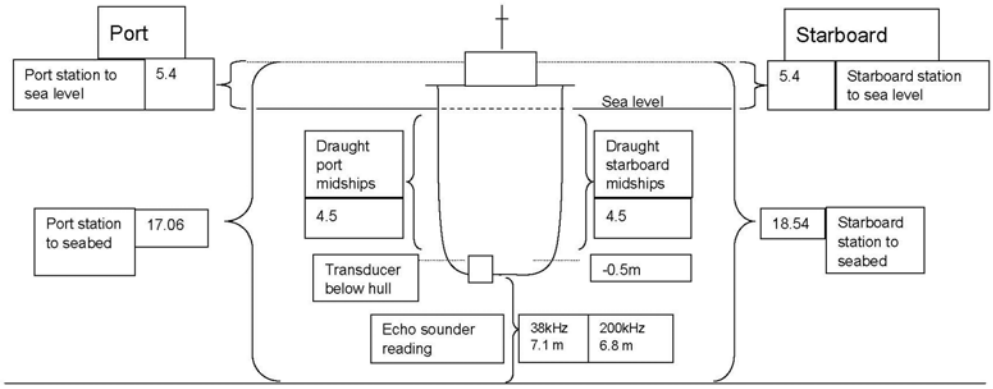
Please see Appendix I for rGPS Portland Verification Results .08.10.05

C2 STREAMER COMPASSES

The author was informed by onboard PGS personal that all compass birds had valid calibration certificates of less than 2 years. The certificates were never seen onboard, and therefore cannot be verified.

Compass biases were monitored on a line-by-line basis, but not applied. PGS adopted a flexible compass bias exception criteria excluded compasses from contributing to generation of final receiver positions normally when 1.0° bias was evident.

C3. ECHO SOUNDER



Echo Sounder Verification, 8 October 2005, Portland, Victoria.

Port station to seabed	17.06
Port station to sea level	5.40
Port water depth	**11.66**
Subtract port draught *	-4.5
	7.16
Transducer offset below hull	-0.5
CALCULATED DEPTH	6.66

	38kHz	200kHz
average from port and stbd readings	7.40	
	7.40	7.40
Measured depth (echo-sounder reading)	7.1	6.8
Difference (metres)	**0.3**	**0.6**

Starboard station to seabed	18.54
Starboard station to sea level	5.40
Starboard water depth	**13.14**
Subtract starboard draught *	-4.5
	8.64
Transducer offset below hull	-0.5
CALCULATED DEPTH	8.14

	38kHz	200kHz
	7.40	7.40
MEASURED DEPTH (echo-sounder reading)	7.1	6.8
Difference (metres)	**0.3**	**0.6**

Notes: *Only the midship draught marks are used due to the proximity of the echo-sounder
Drawing is schematic only! Measurements in metres

Method: The echo-sounder was tuned to the first return, without draught correction and speed of sound at 1500metres/second. Echo-sounder data was set to log to computer disc. The mid-ship draught marks of the ship were noted along with time.

Measuring stations were established on the weather deck, at the ships bulwark, port and starboard, approximately 1.0 metre forward of the main mast (just aft of the sixth porthole counted aft from forward). A weighted steel tape measure was used to establish the distance to sea level and then to seabed level. The mid-ship draught mark was checked again along with the time. The echo sounder reading was taken as the mean reading between the times of draught observations.

Results and Conclusion: Given the limitations of the methodology, the differences between the measured and calculated depths are acceptable

APPENDIX D QUALITY CONTROL PLOTS

Vessel & Source Position *FGPS v SPRINT Position Comparisons*
Near Receiver Groups *FGPS v SPRINT Position Comparisons*

Near Mid Receiver Groups *FGPS v SPRINT Position Comparisons*

Far Mid Receiver Groups *FGPS v SPRINT Position Comparisons*

Far Receiver Groups *FGPS v SPRINT Position Comparisons*
Network Quality

Total Streamer Separation Front End.

Streamer Front Separation

Mid Streamer Separation
Tail Streamer Separations

Source Separation
Sub Array Separation

rGPS Source Ranges
rGPS Tailbuoy Ranges

Vessel to Source (inline)
Centre Source to Centre Near Group

Centre Source 1&2 to Centre Near Group
Centre Source to Centre Near Group. *Radial*

Water Depth/Sea State
Velocity Observations

Max Min Feather
Streamer Rotation

Streamer Across Line Tailbuoy Misclosure
Streamer Along Line Tailbuoy Misclosure

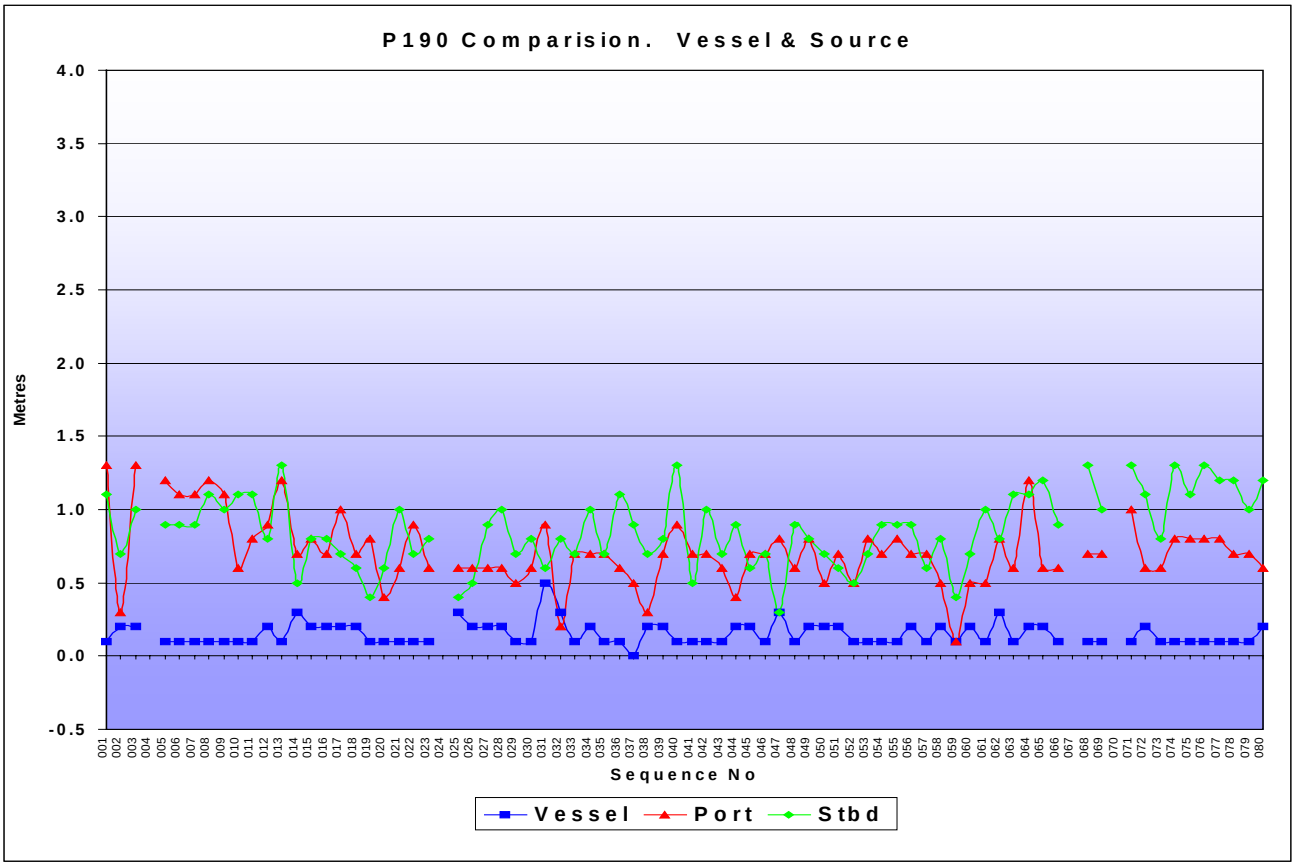
dGPS Position Comparison
Geodial Height

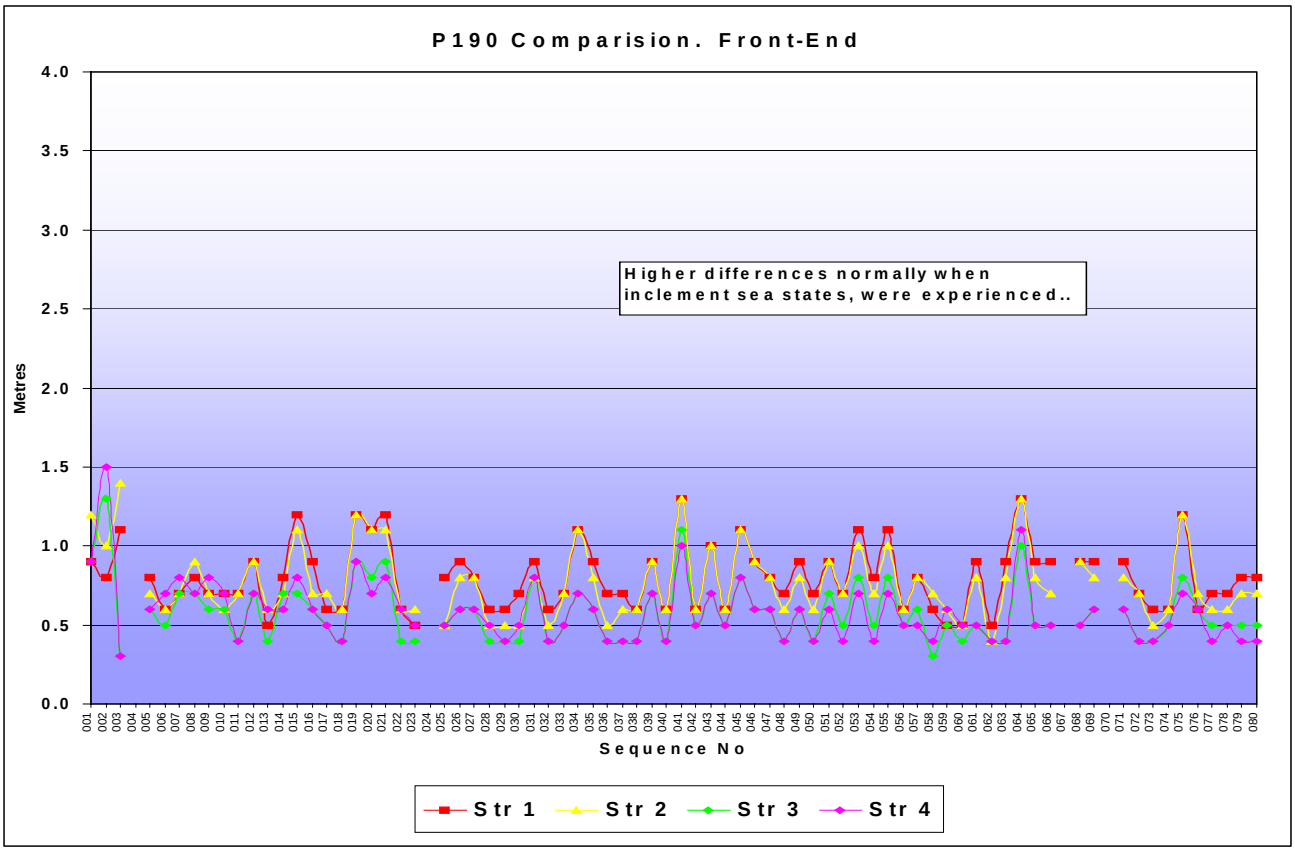
HDOP/PDOP
Number of S.Vs

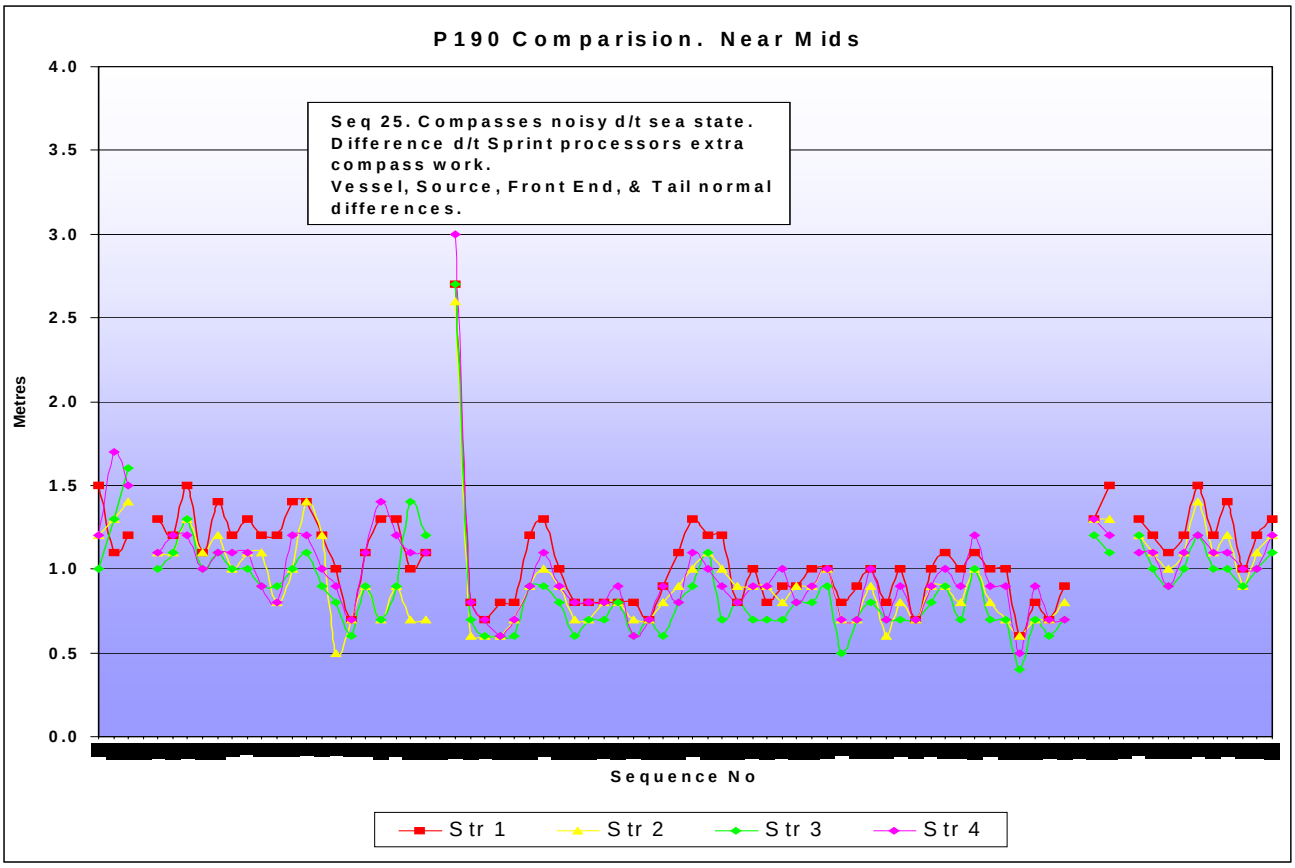
StarFix Age of Fix
Ref. Station Age of Correction

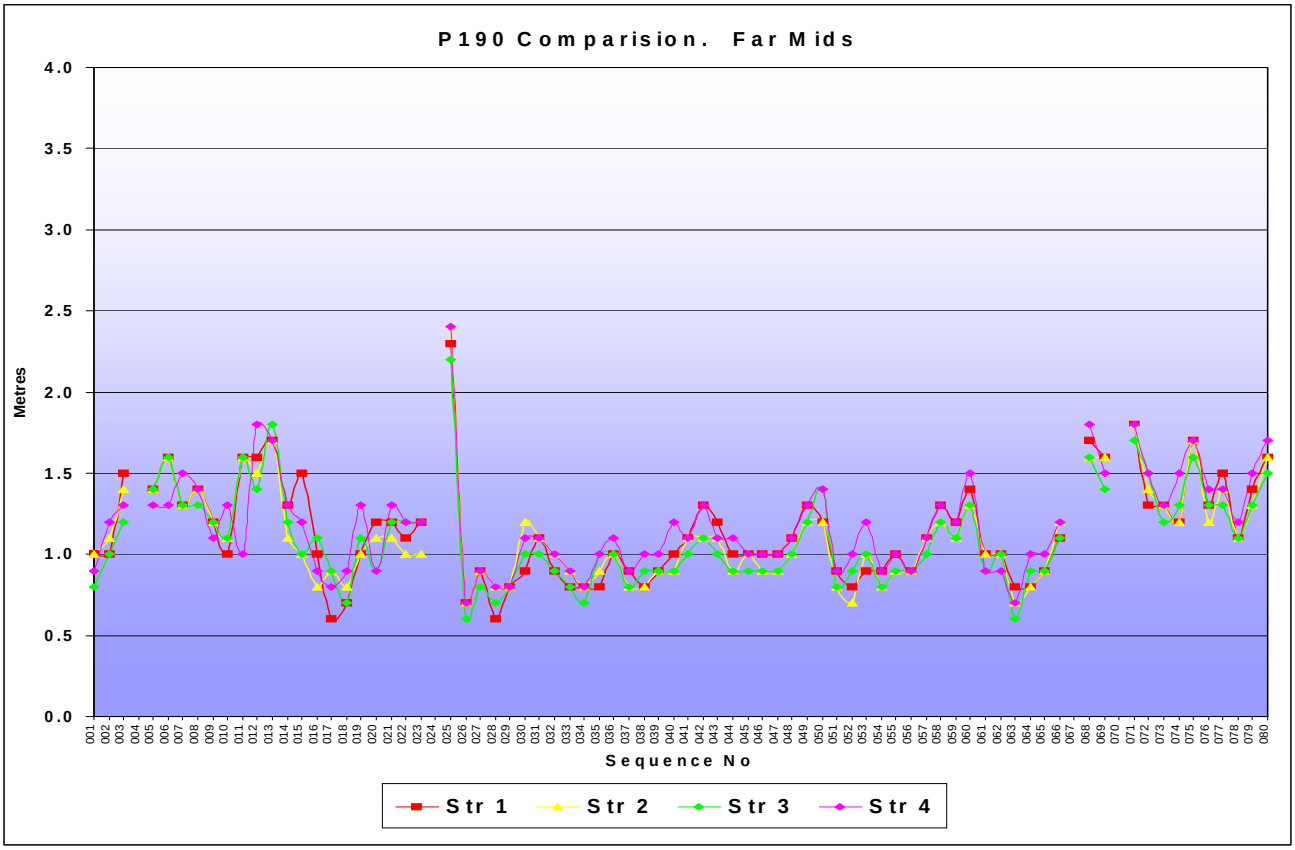
SMA GPS
Unit Variance GPS

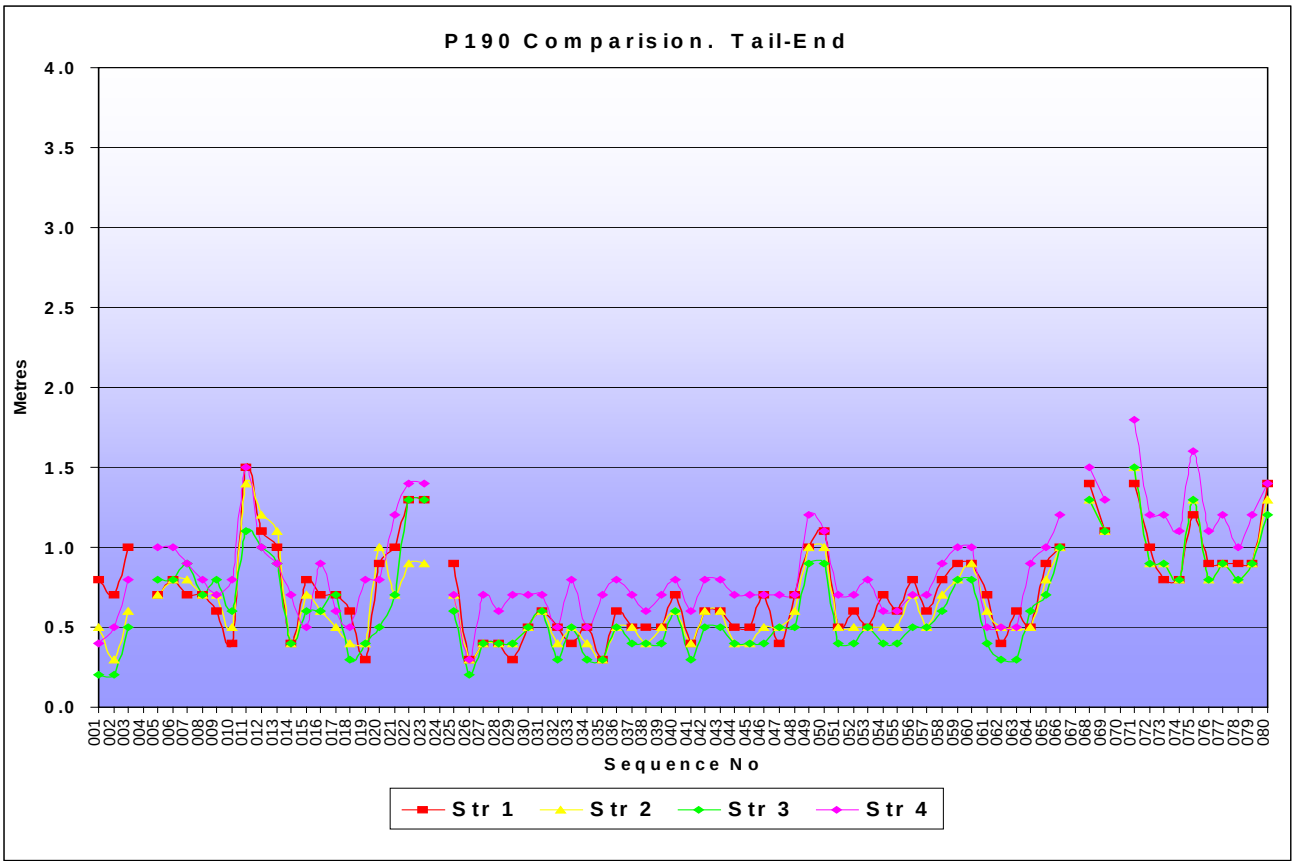
Vessel Mean Speed
Gyro compass Comparison

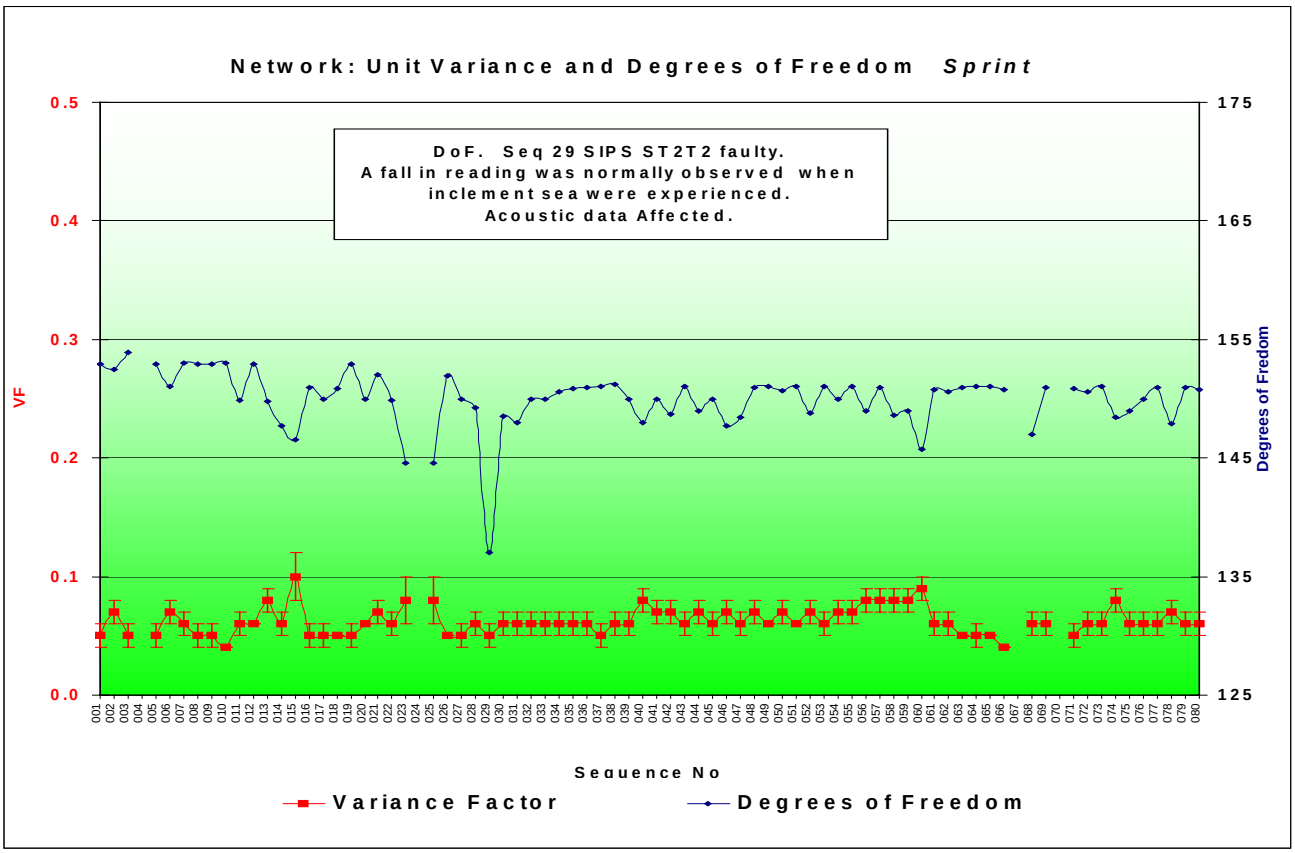


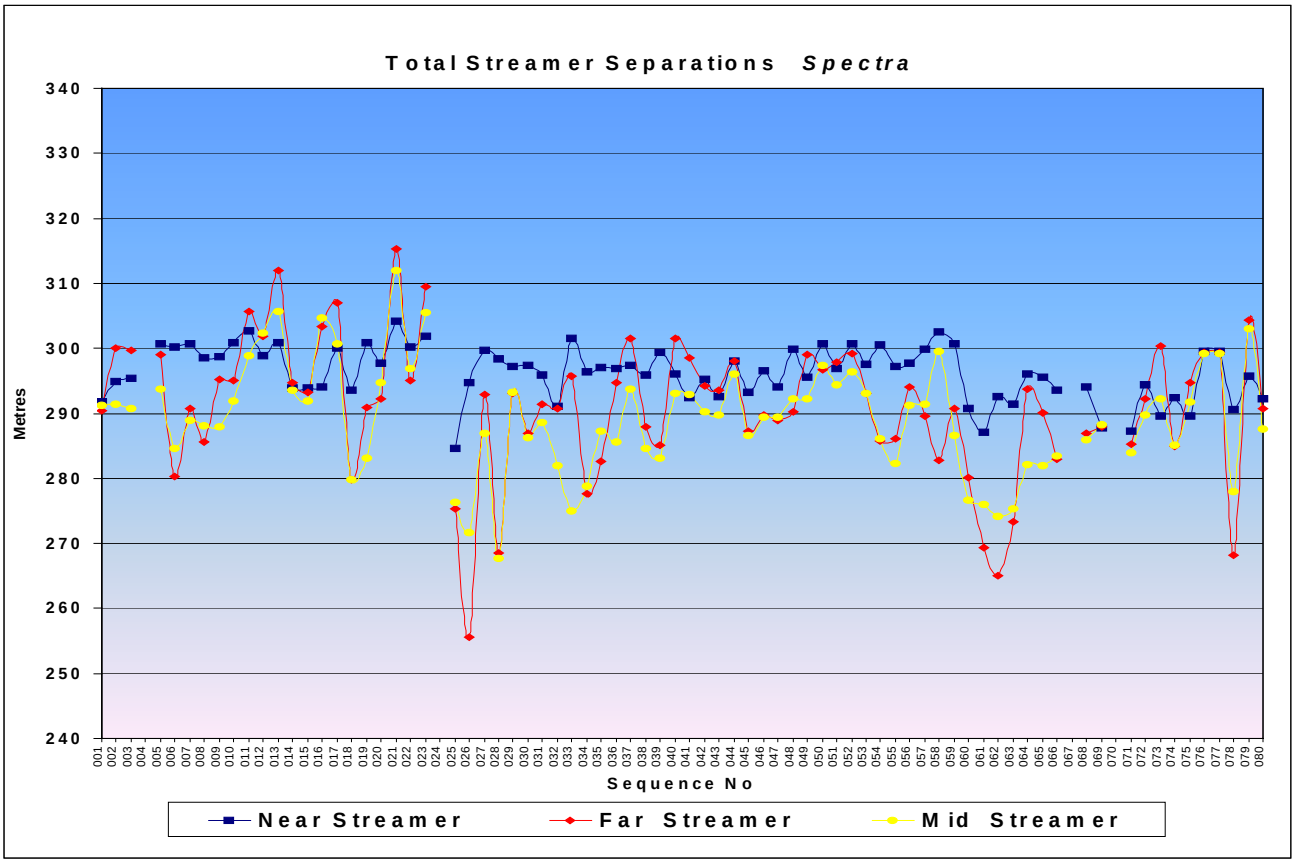


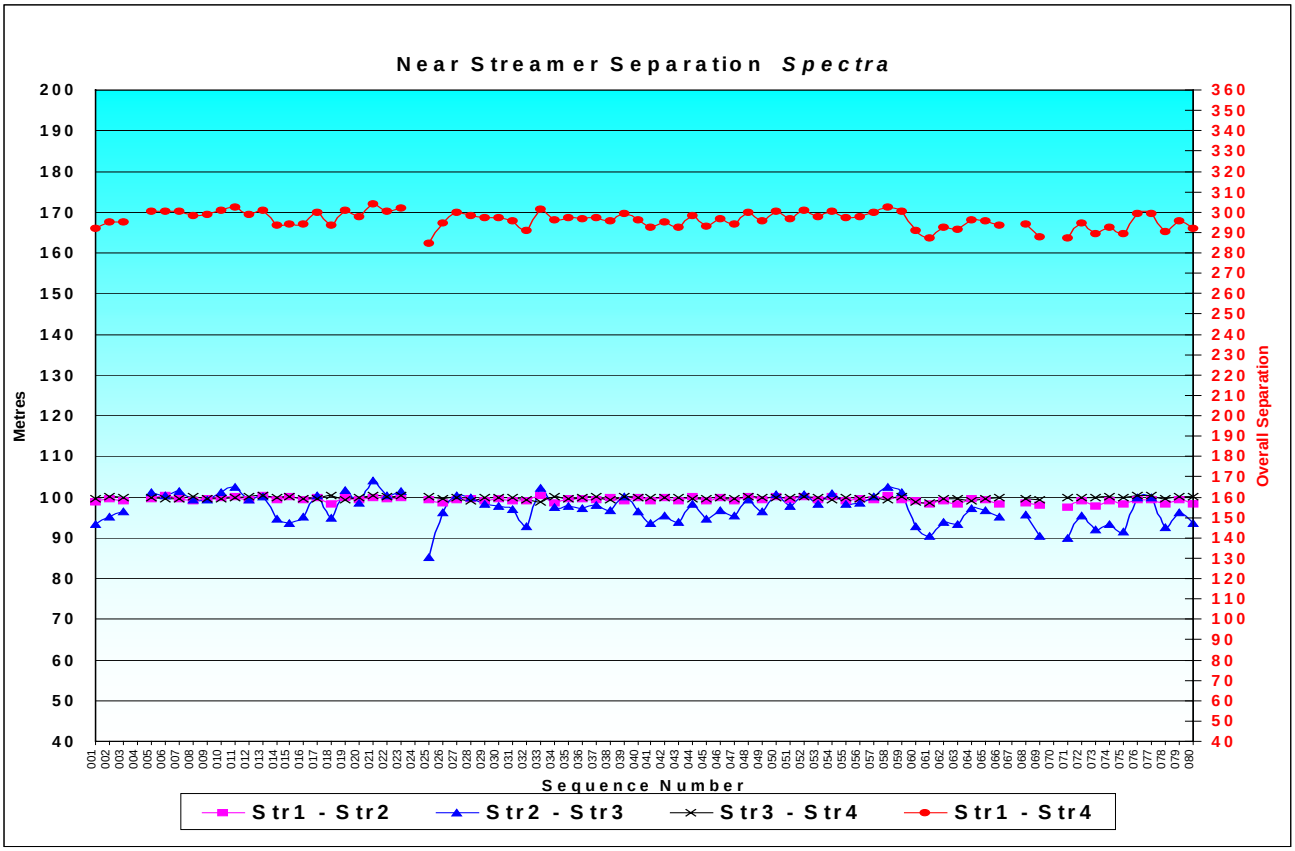


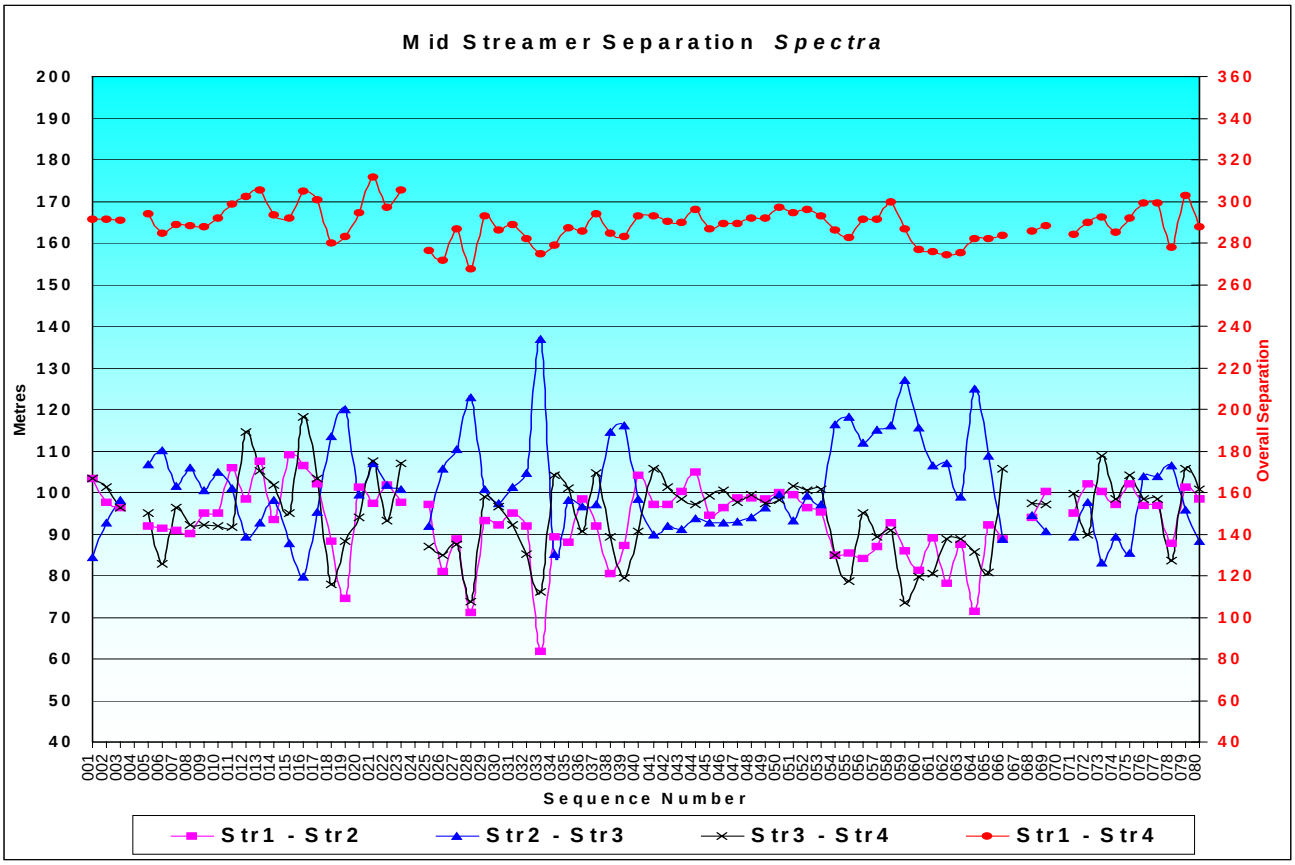


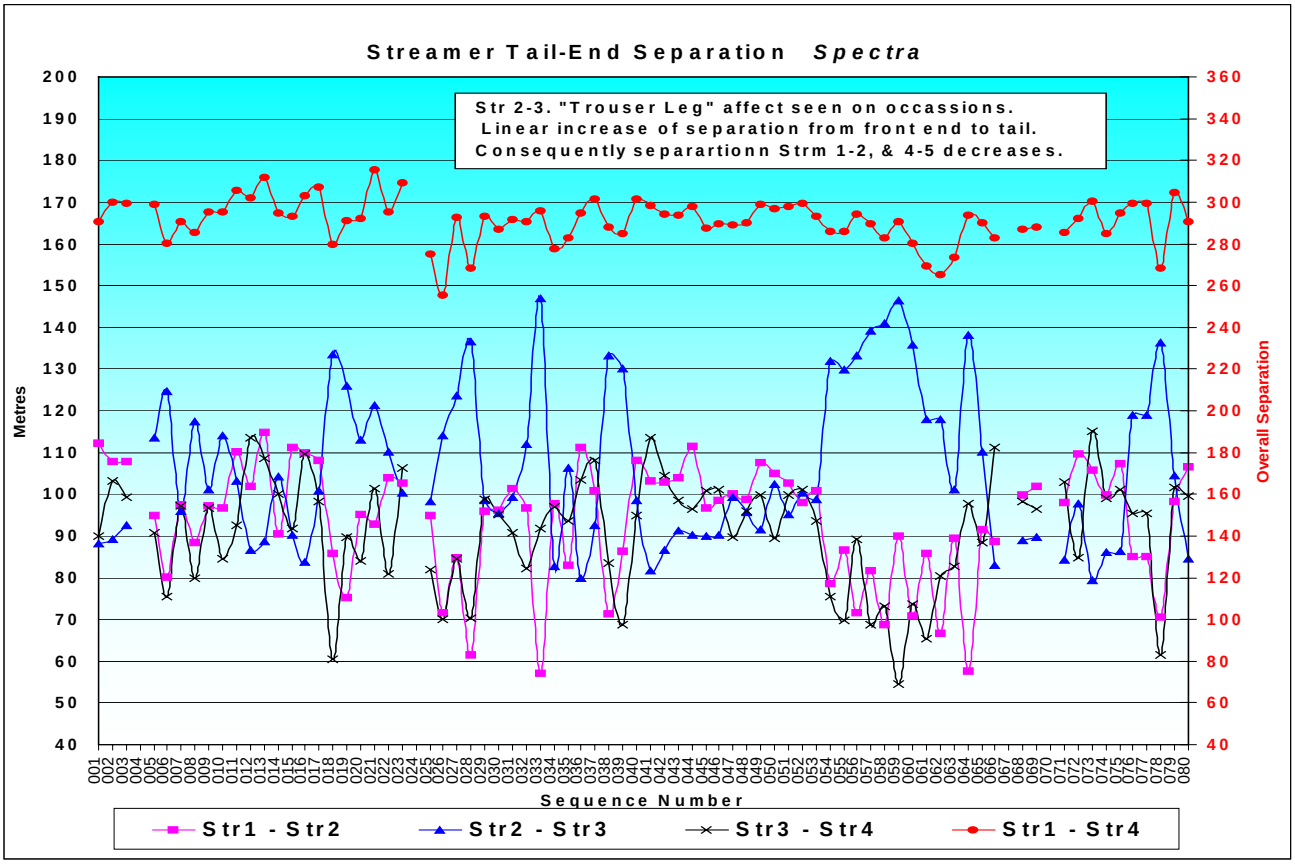


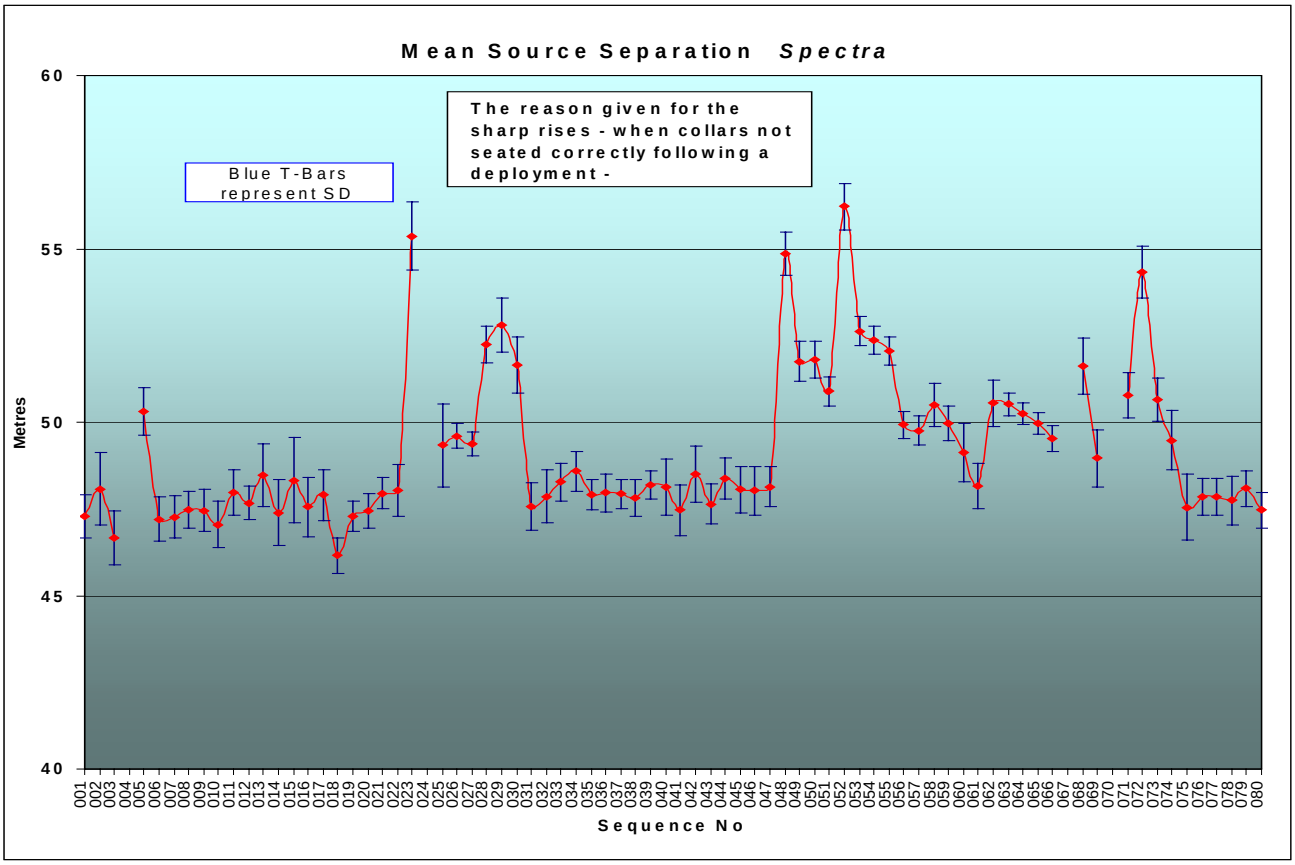


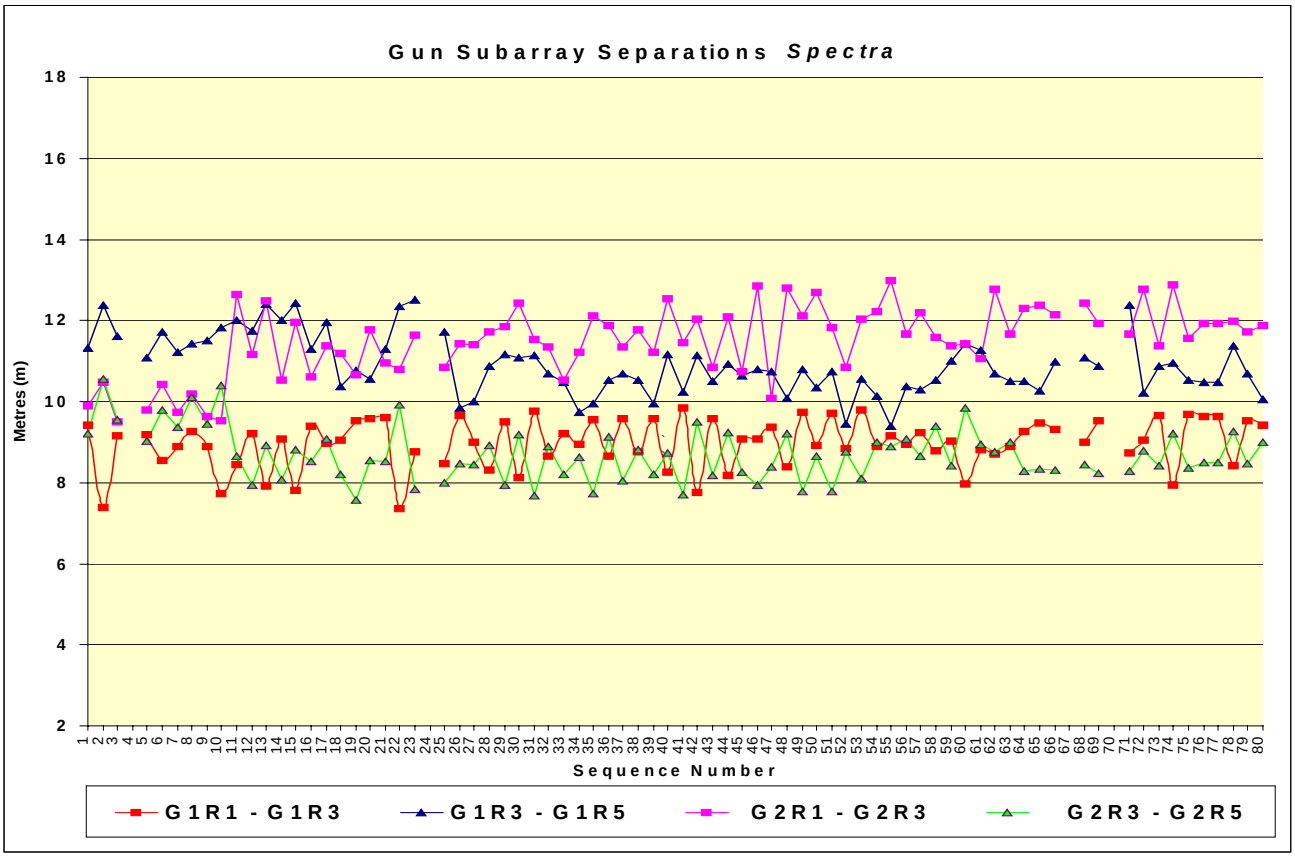


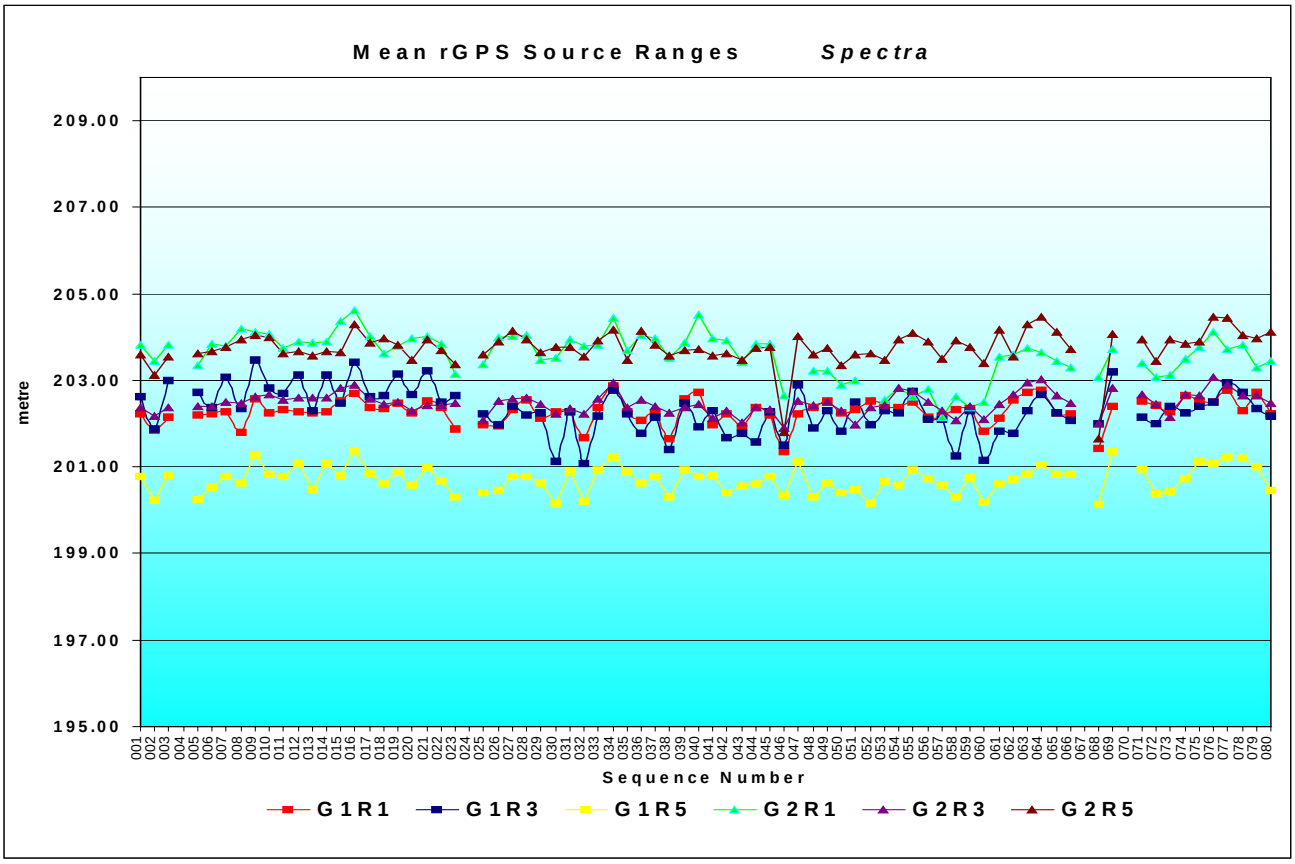


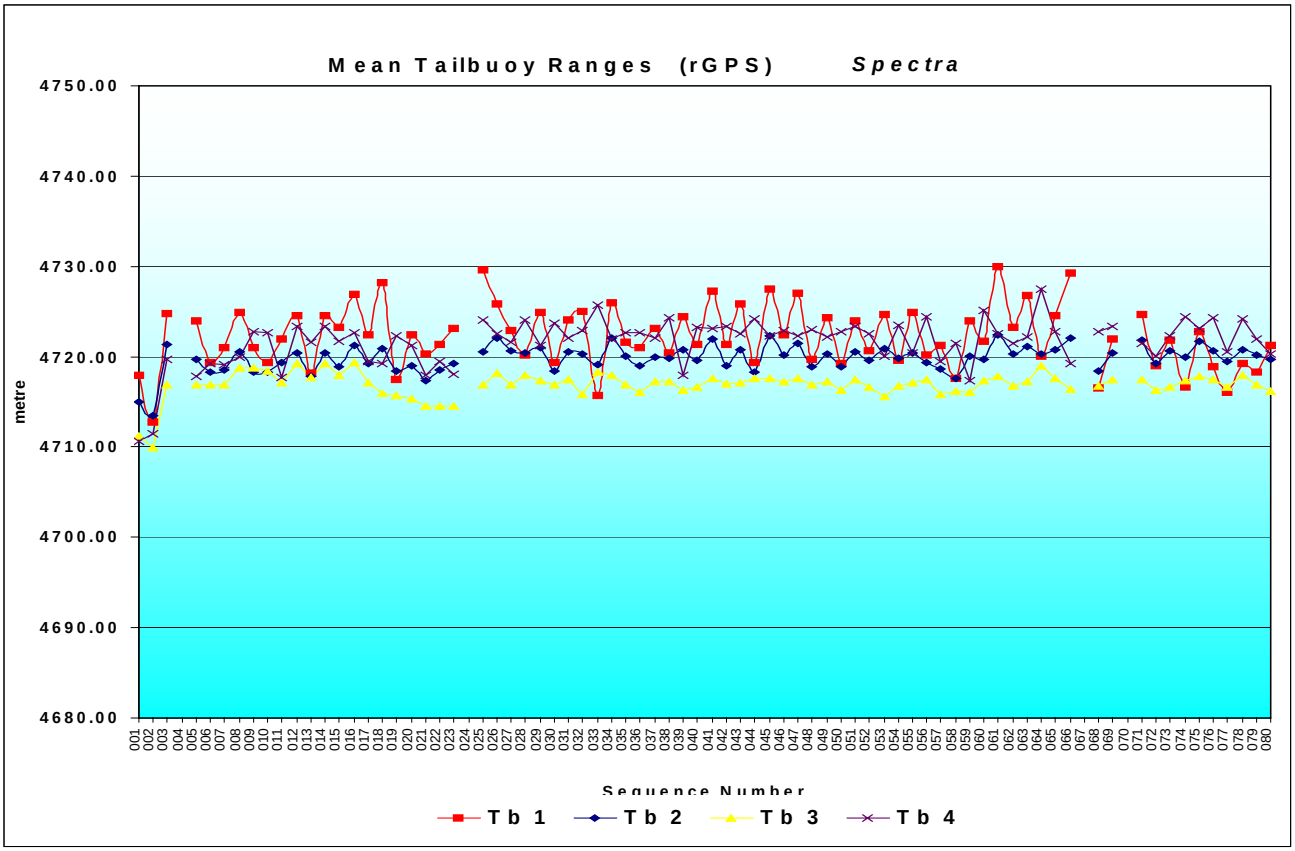


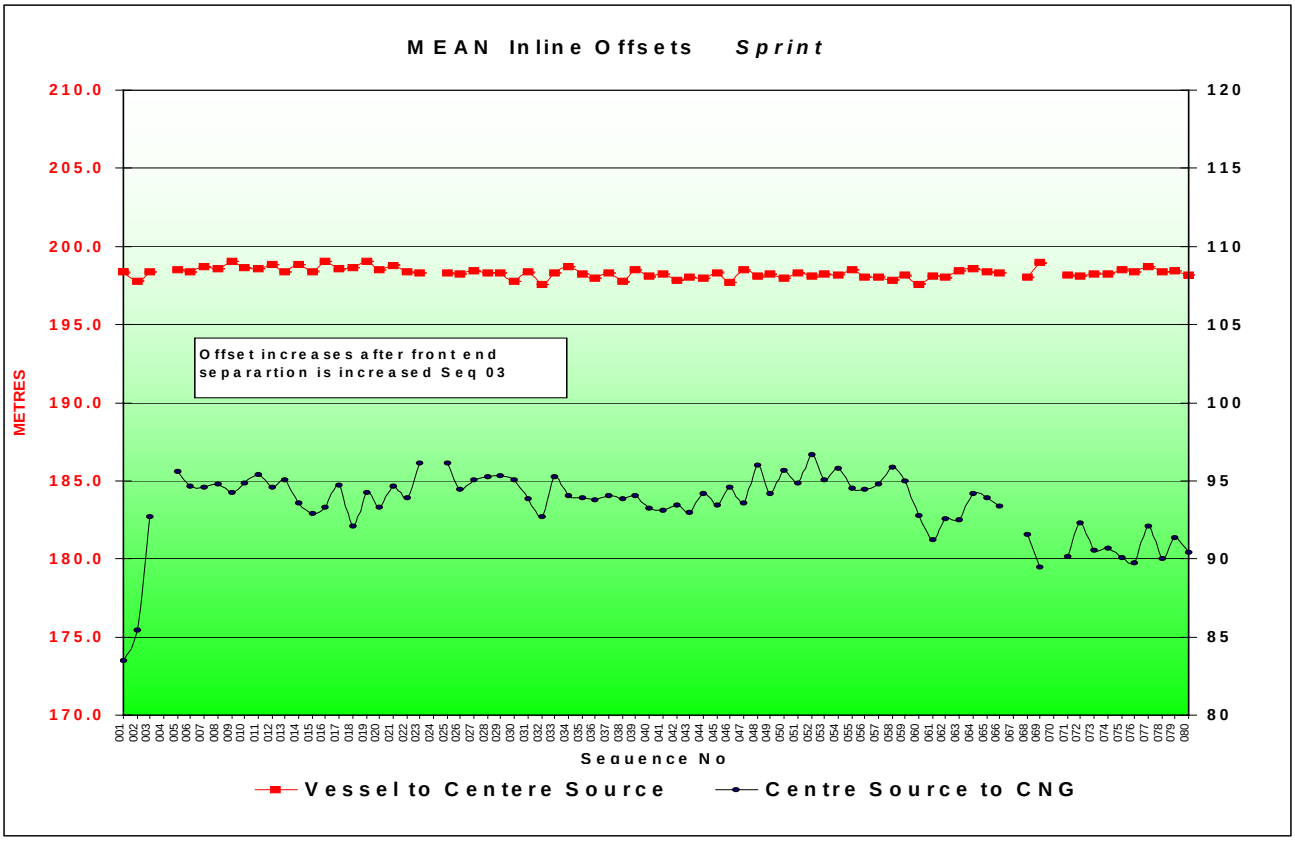


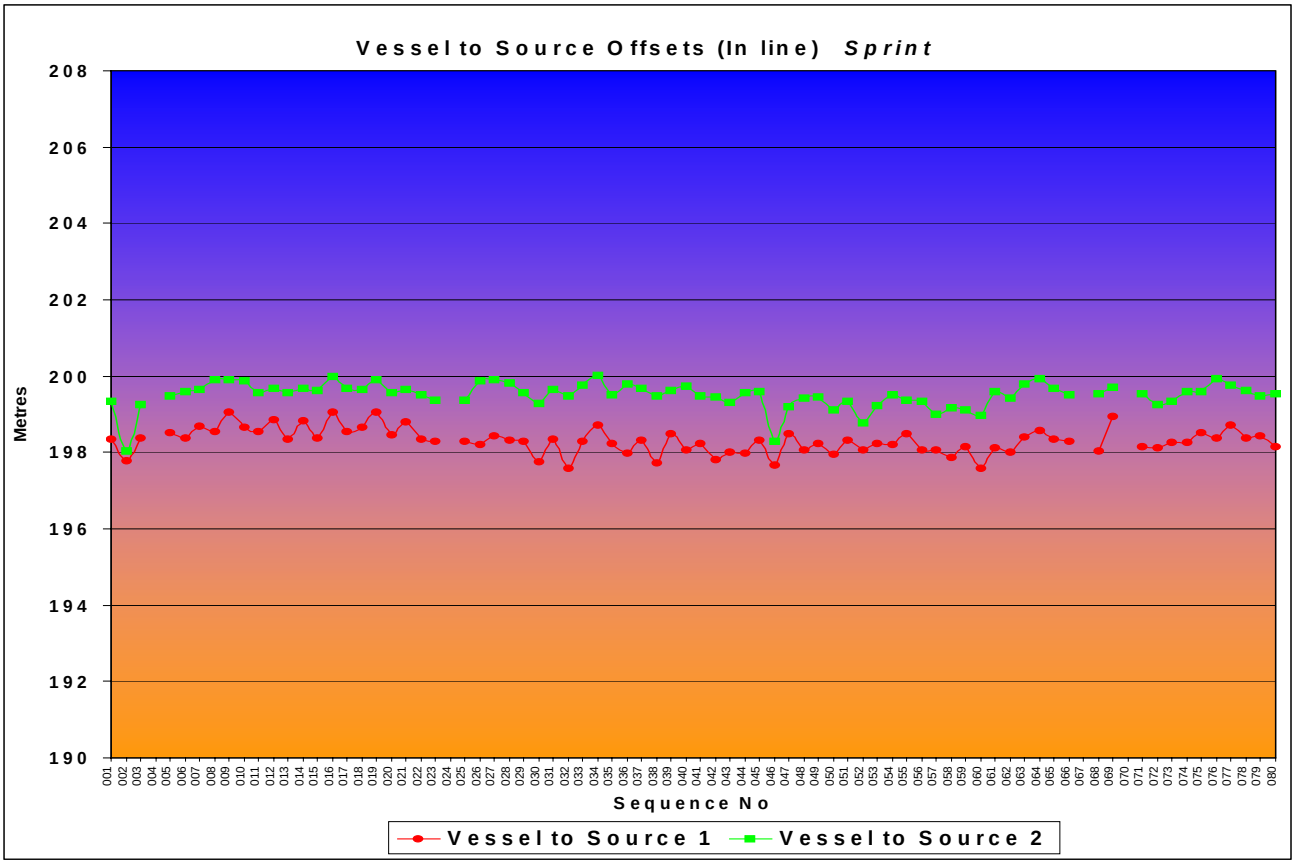


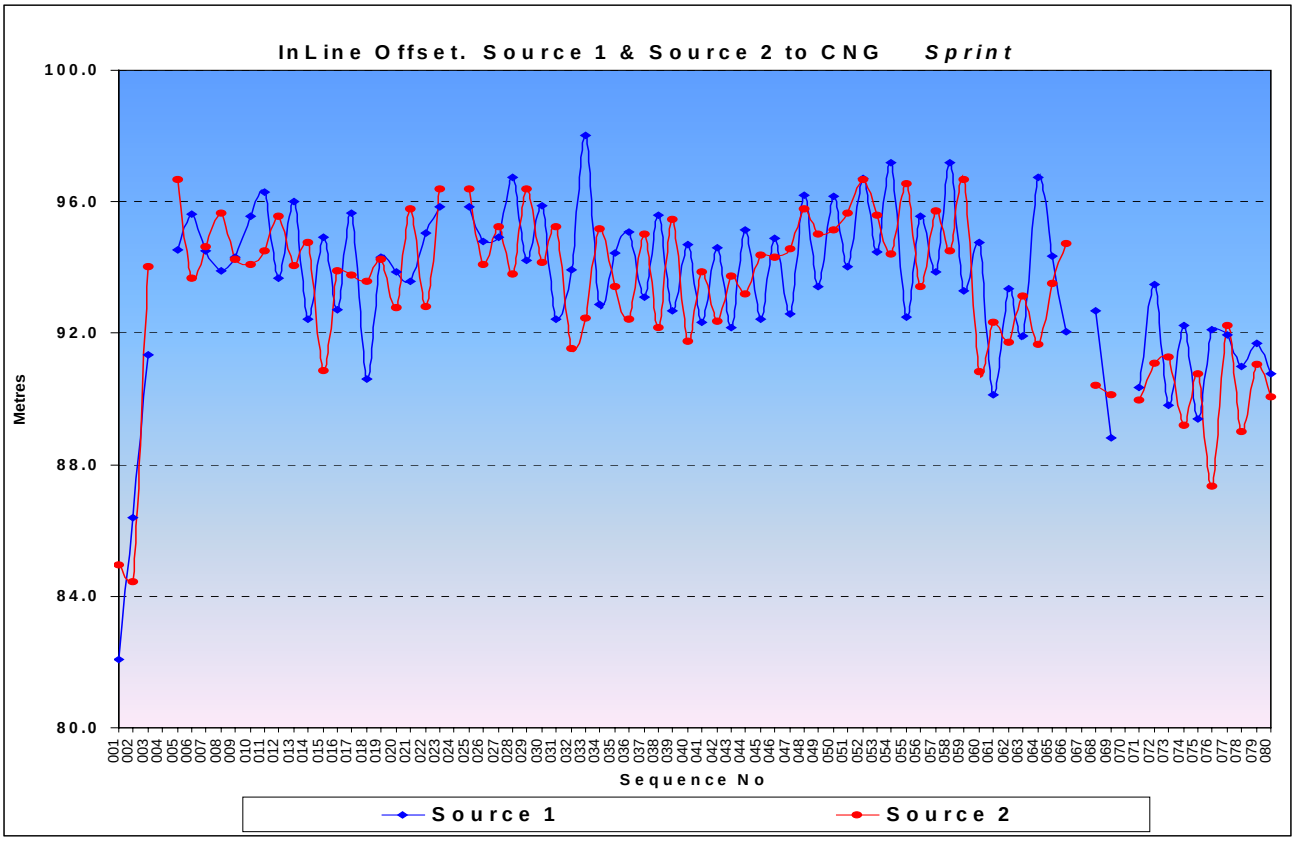


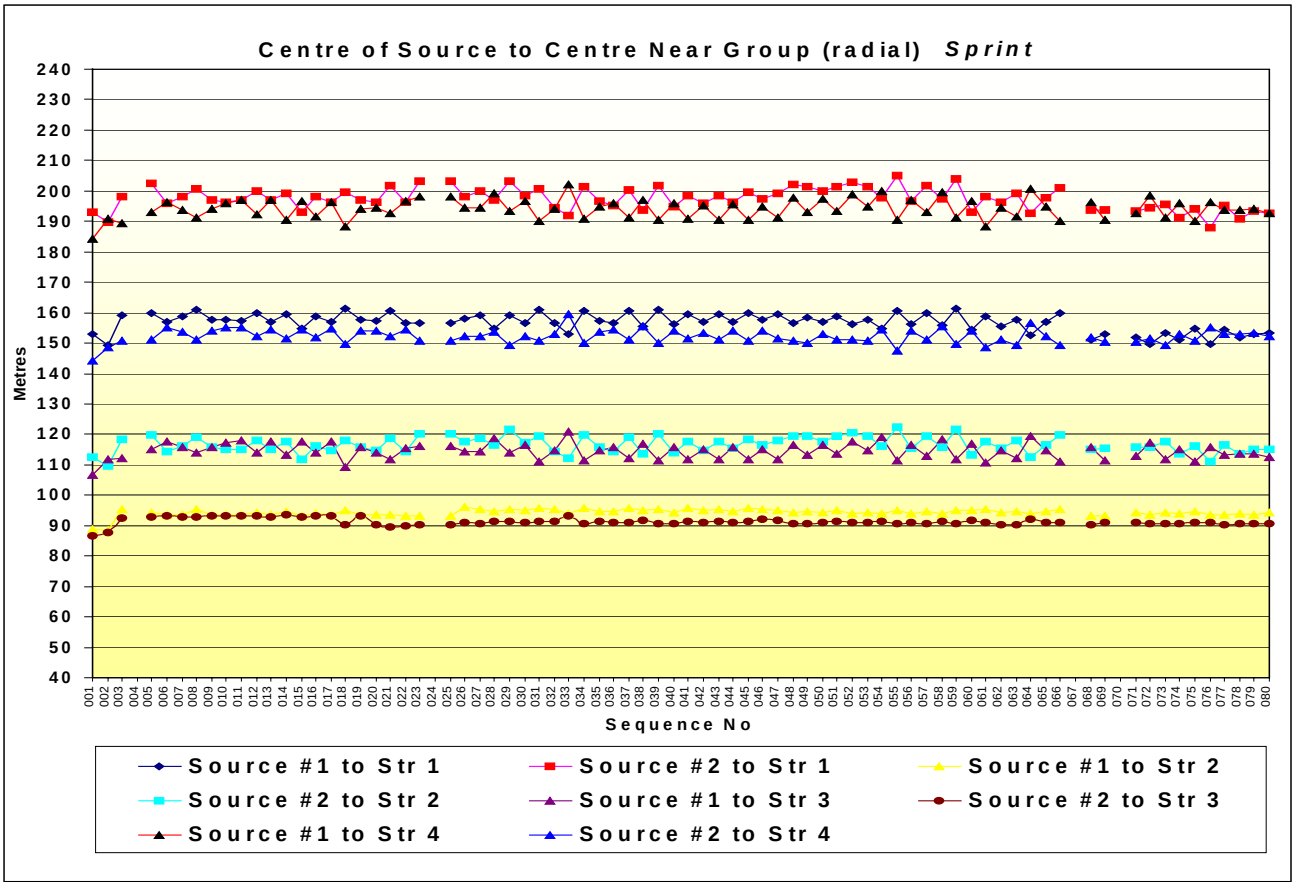


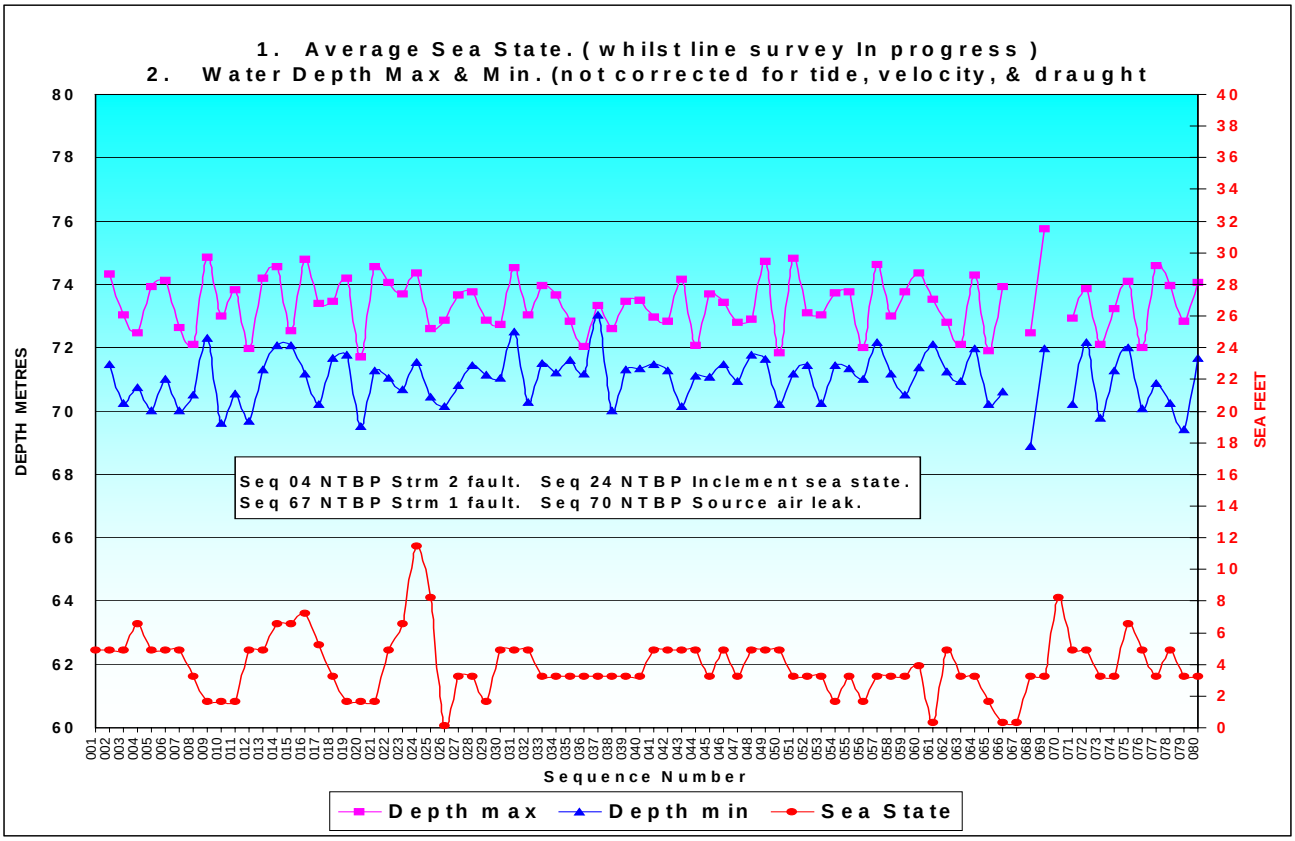


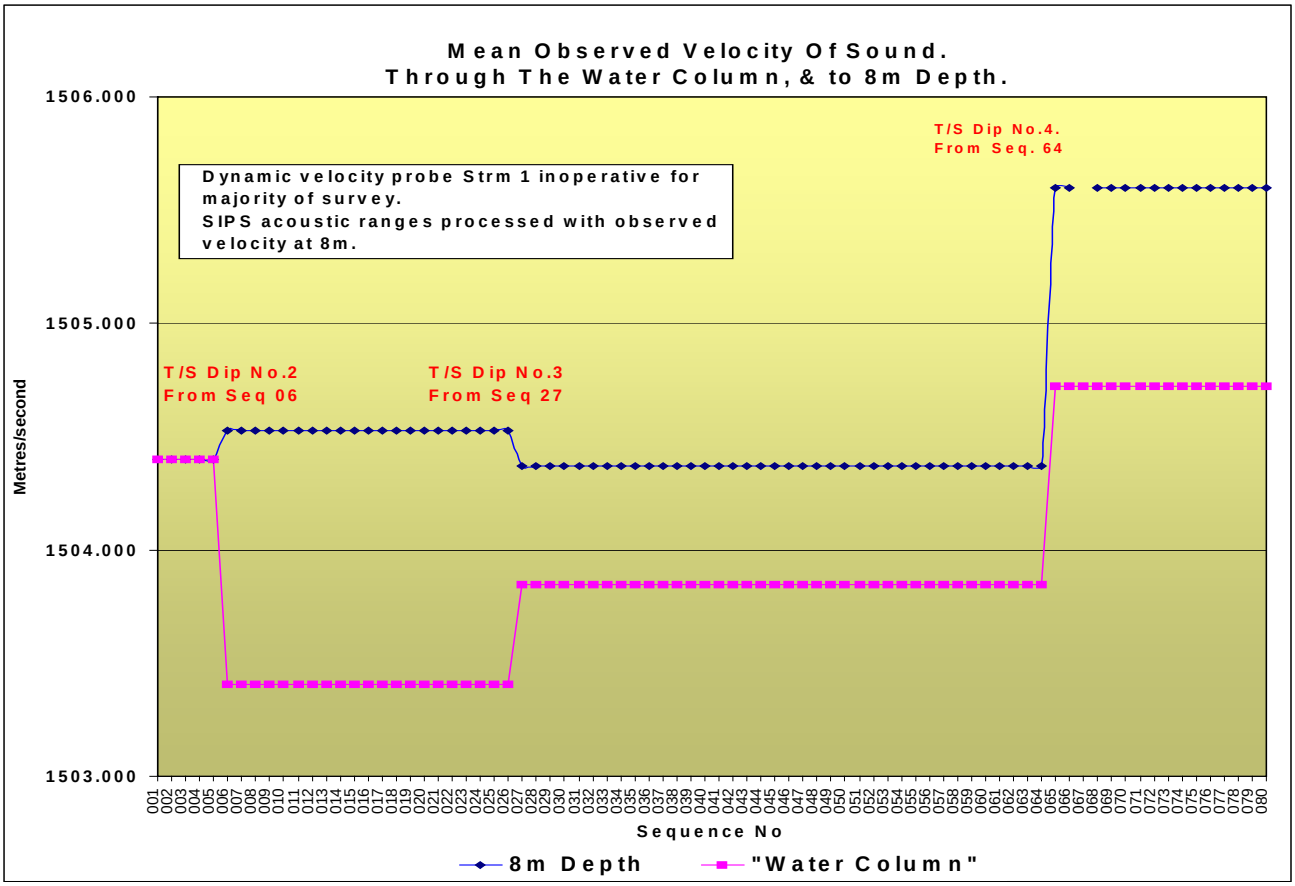


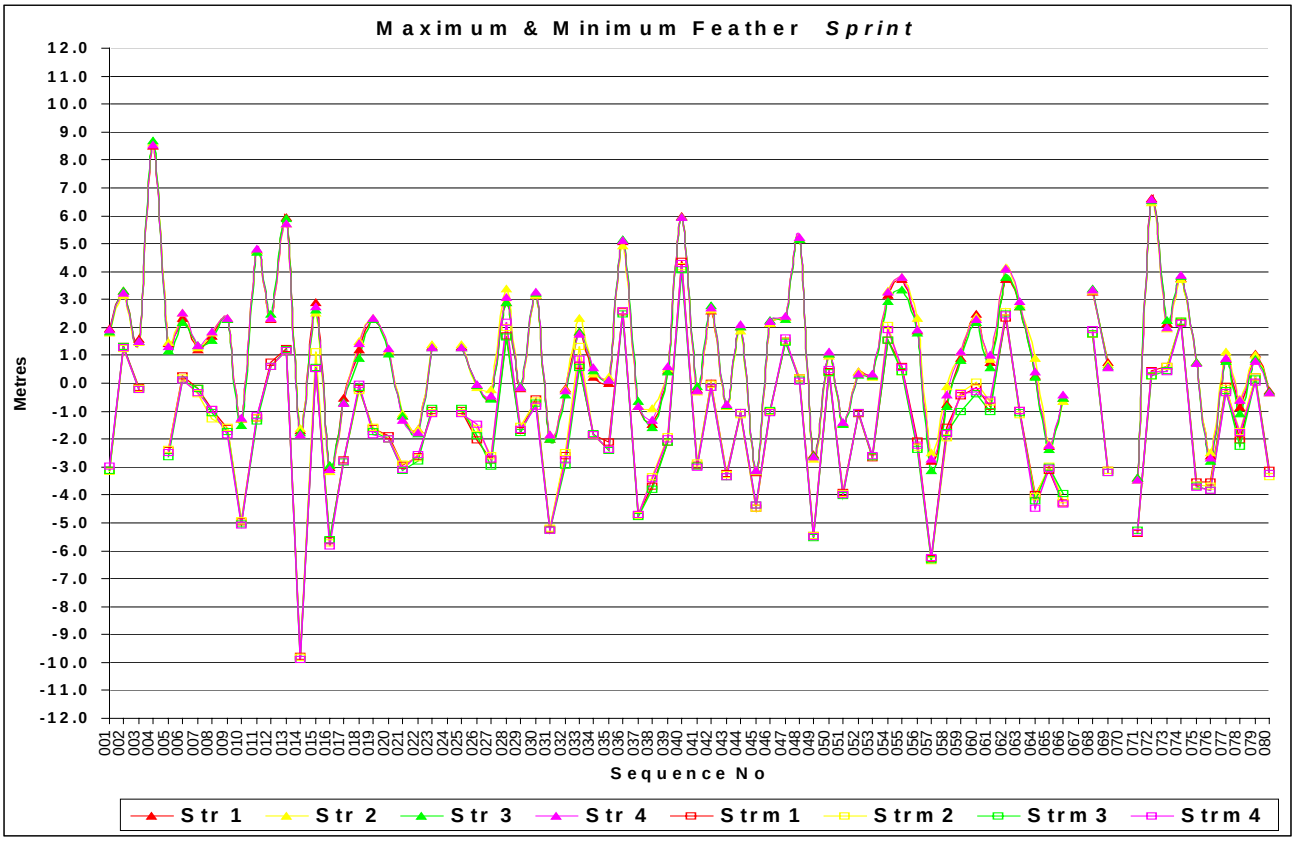


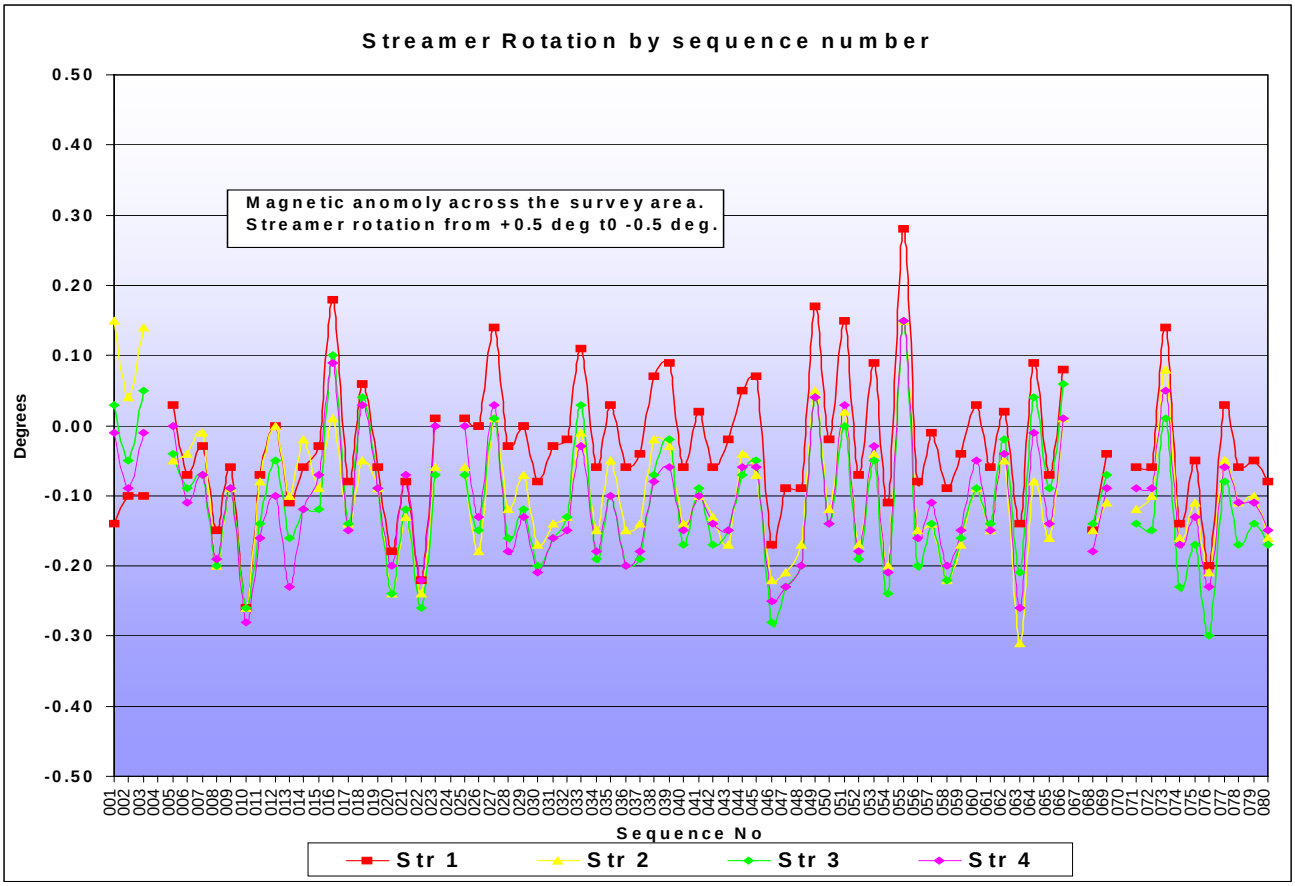


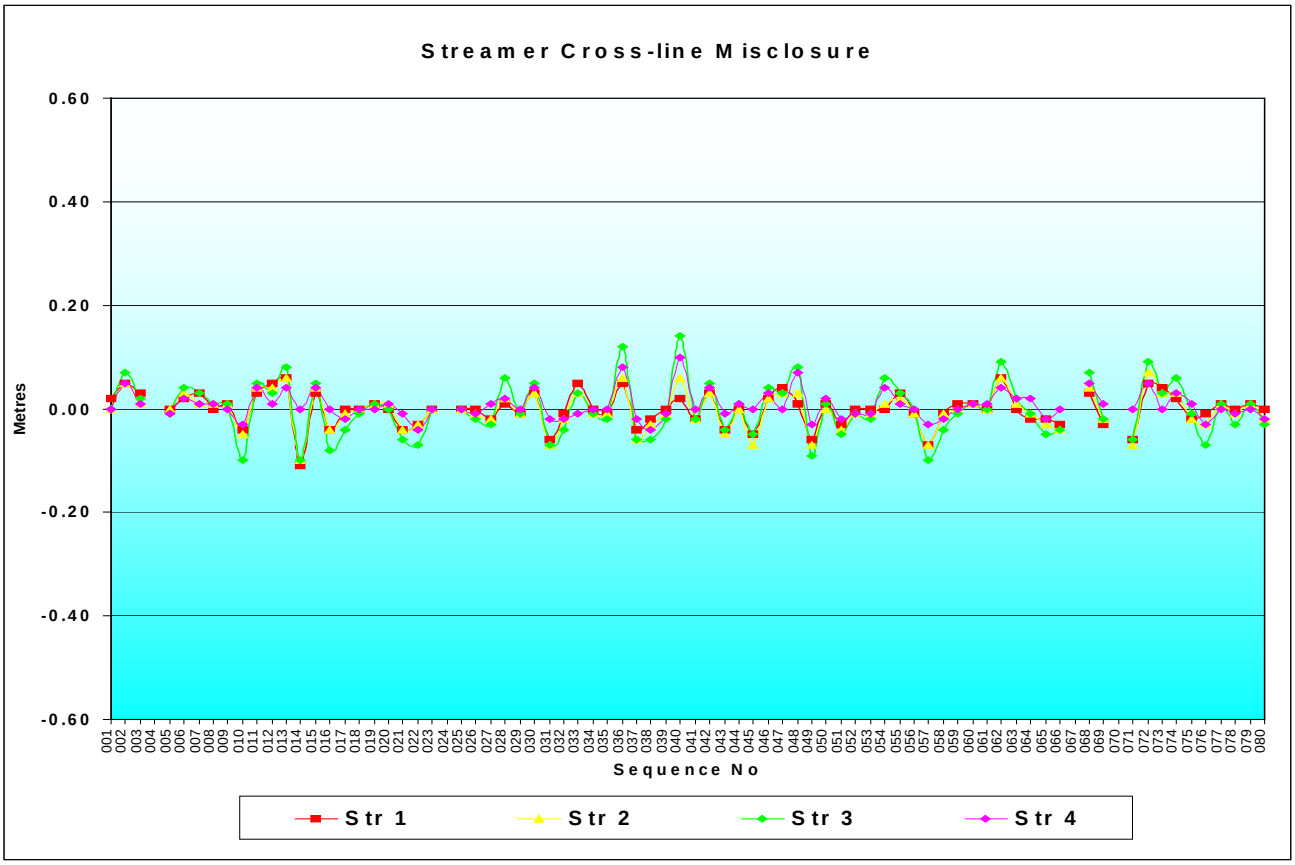


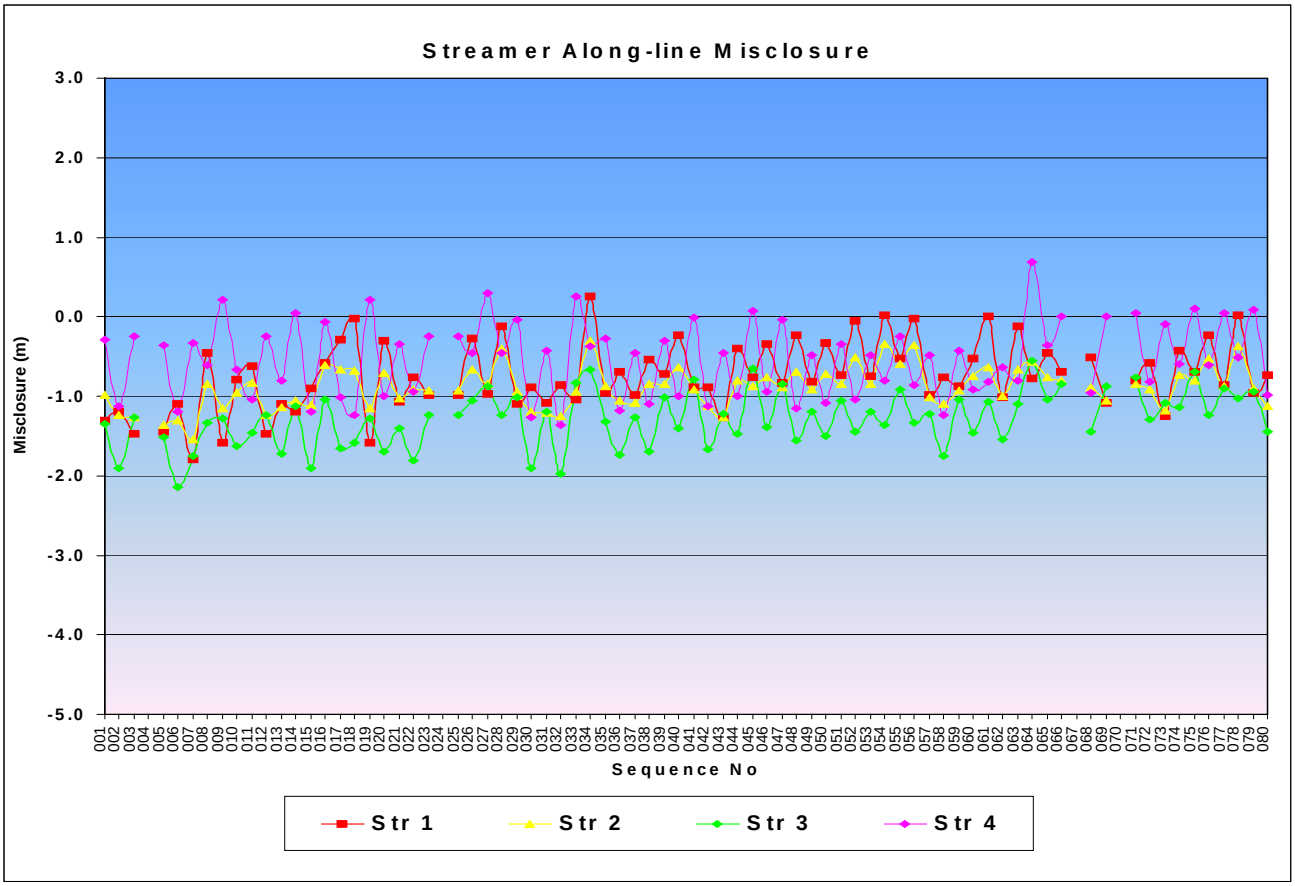


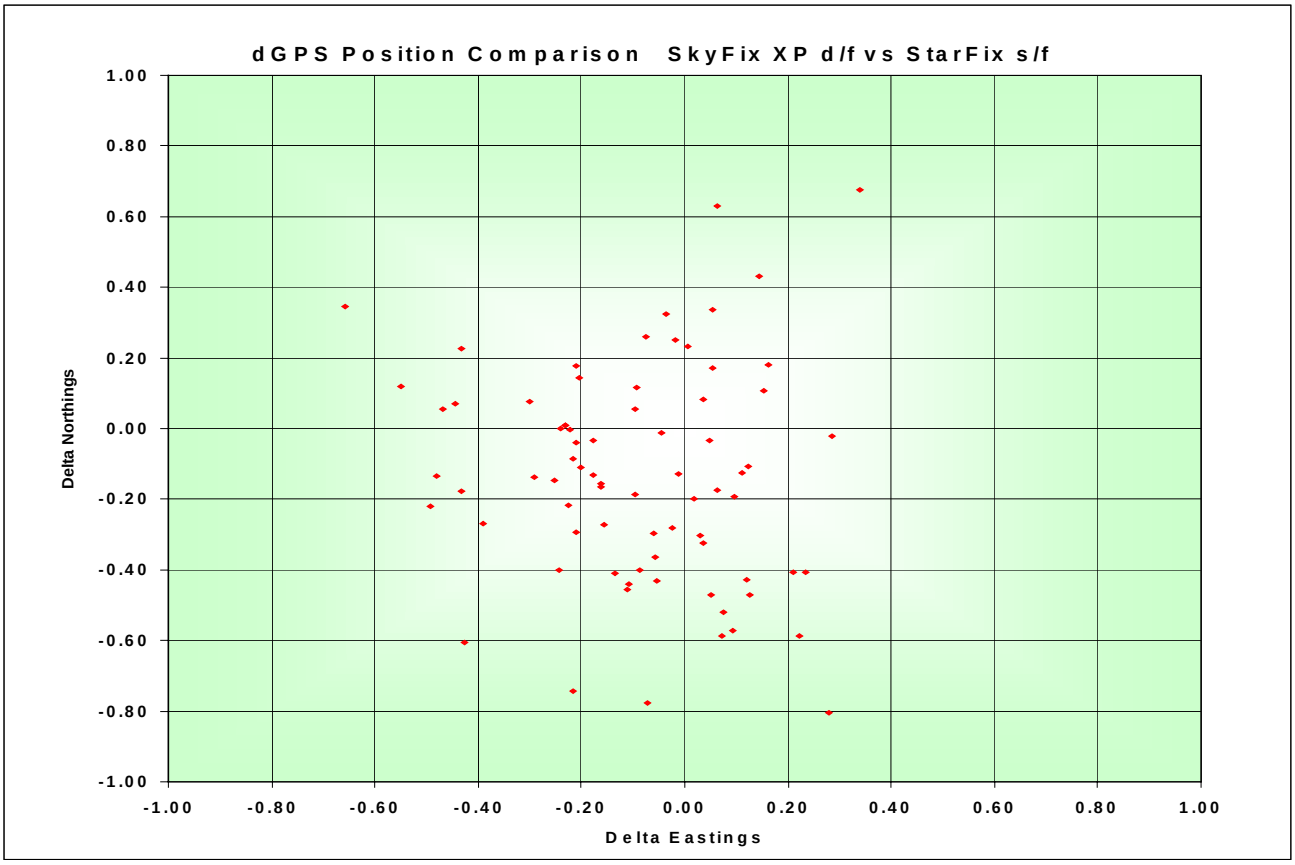


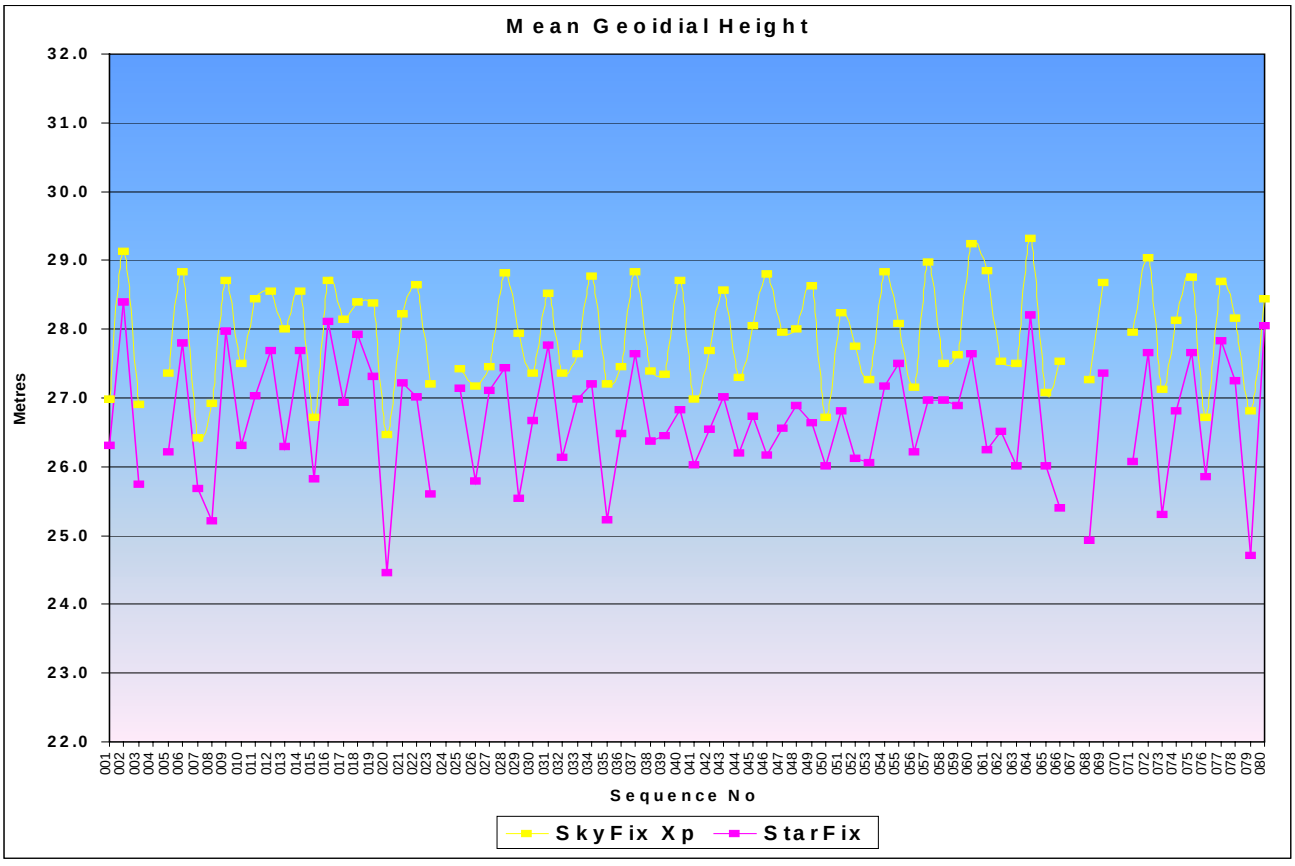


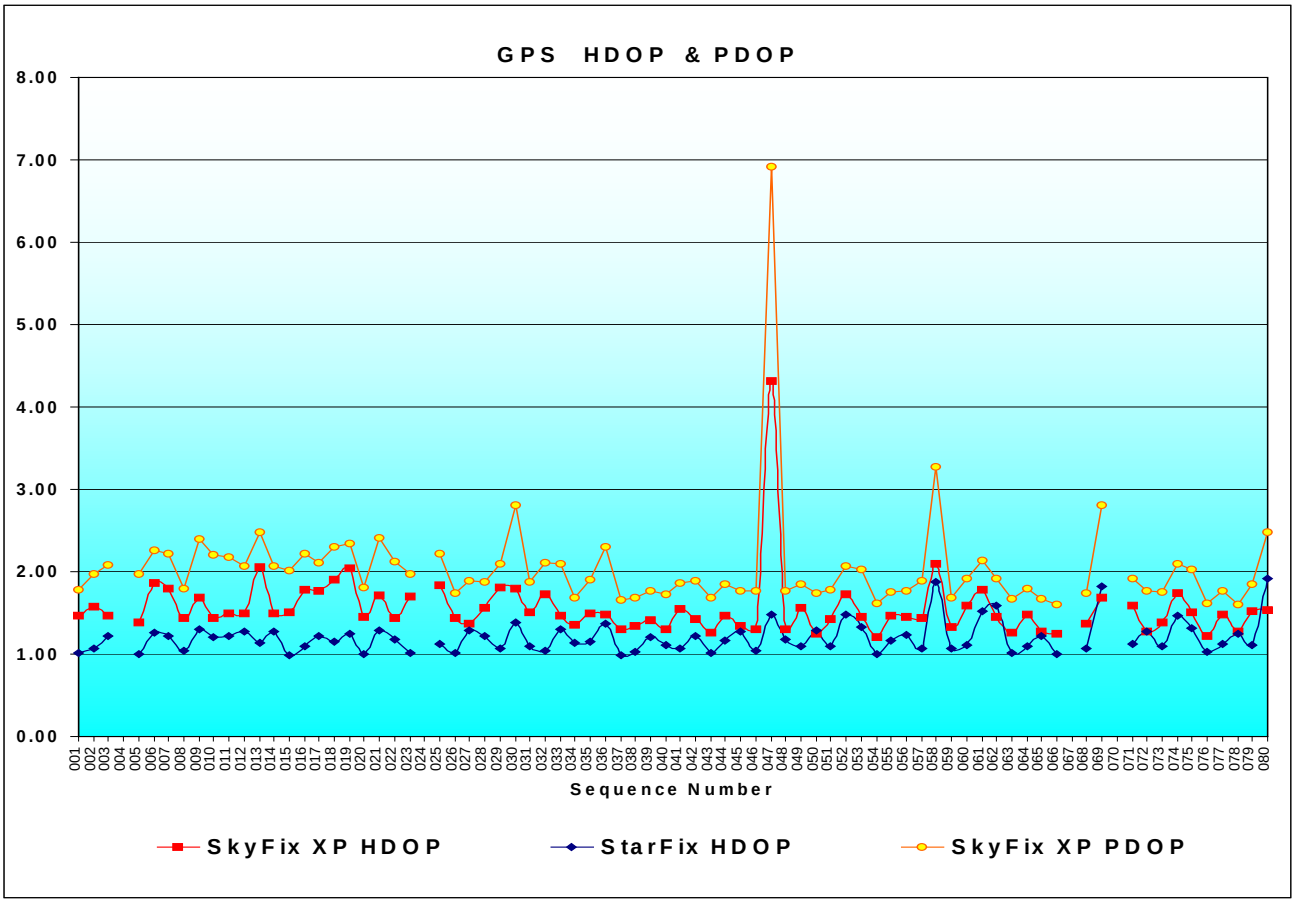


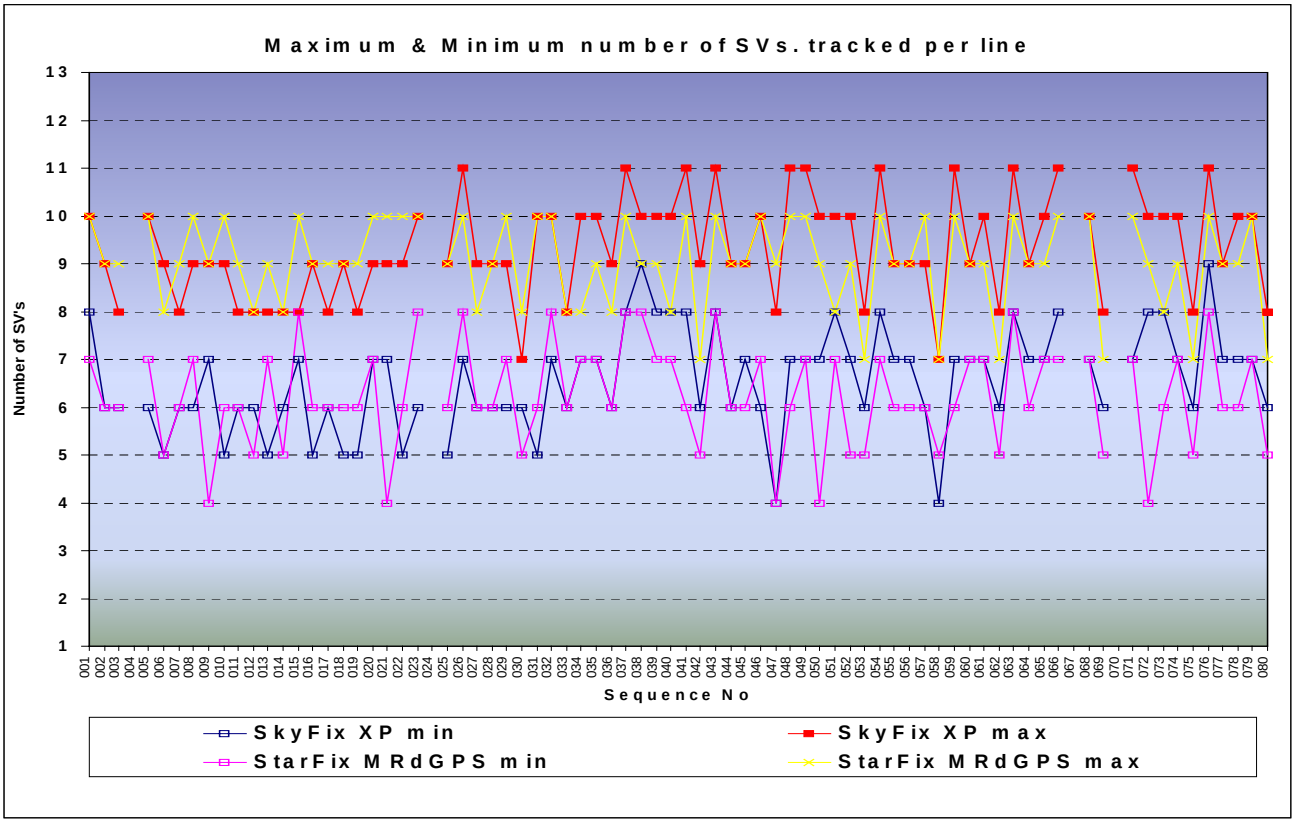


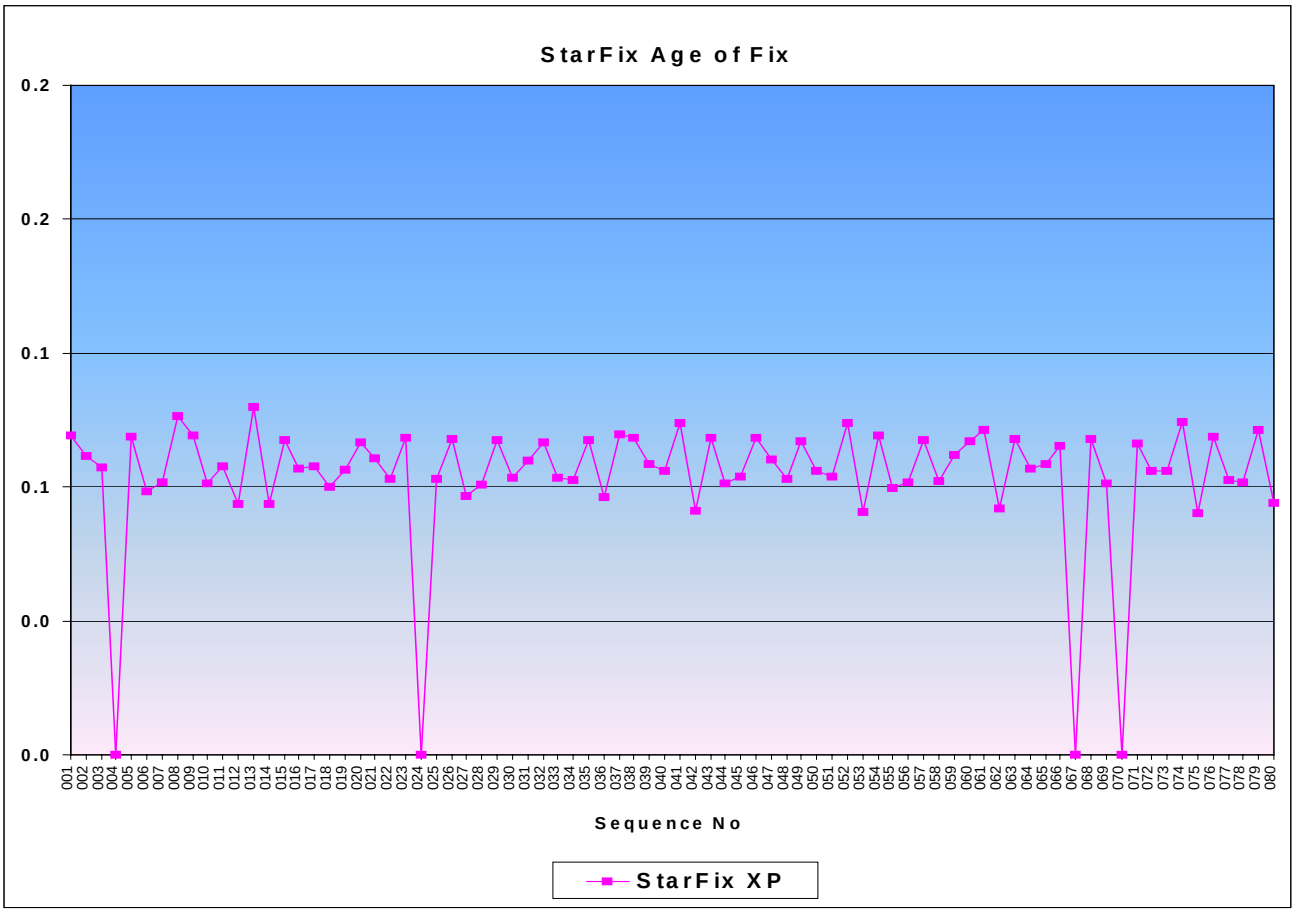


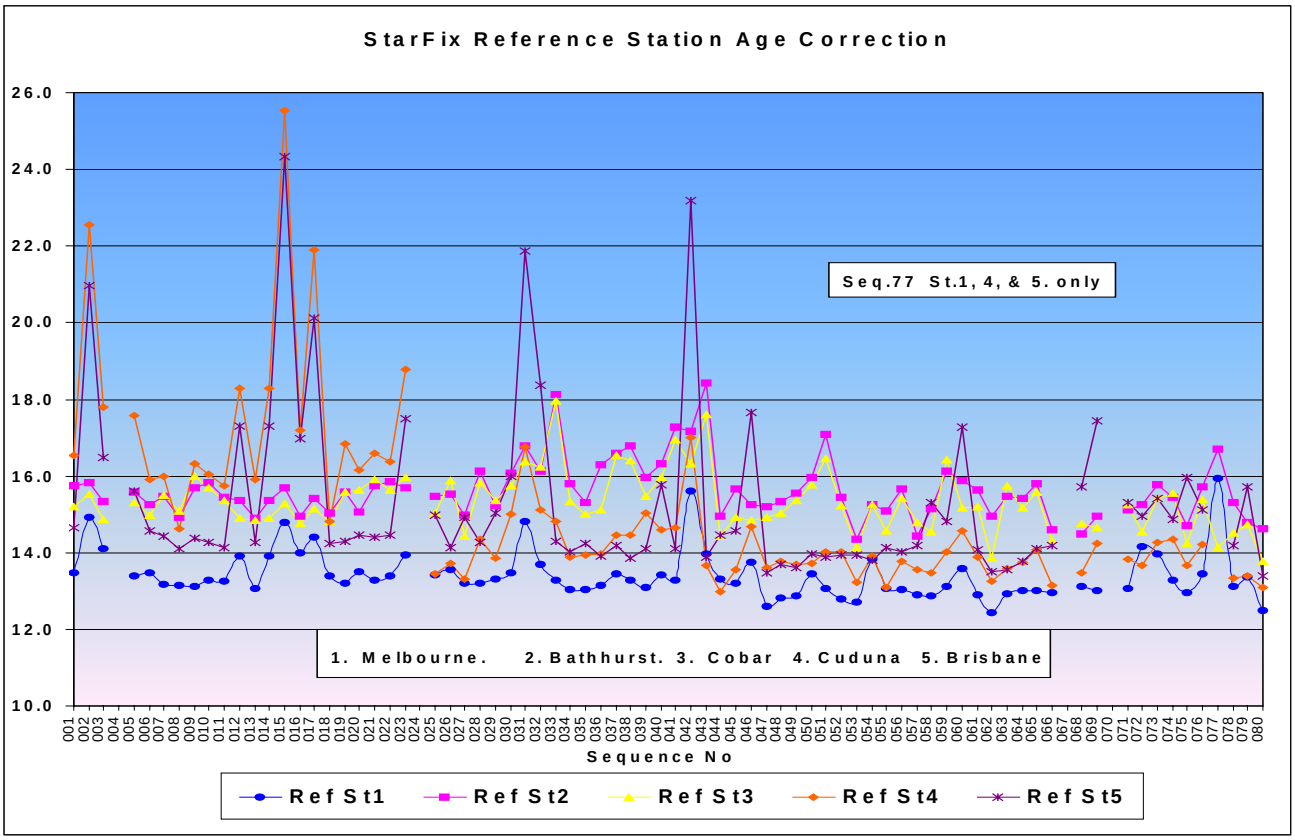


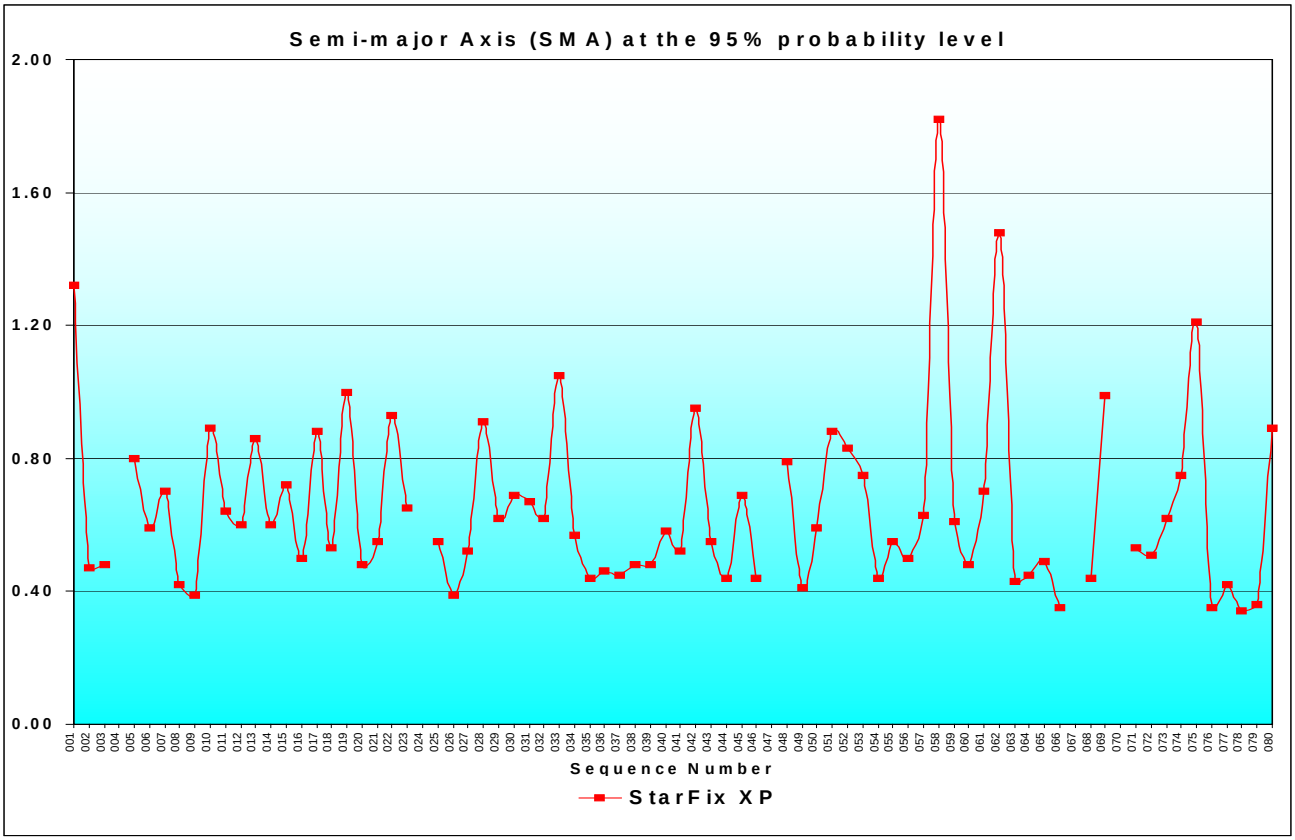


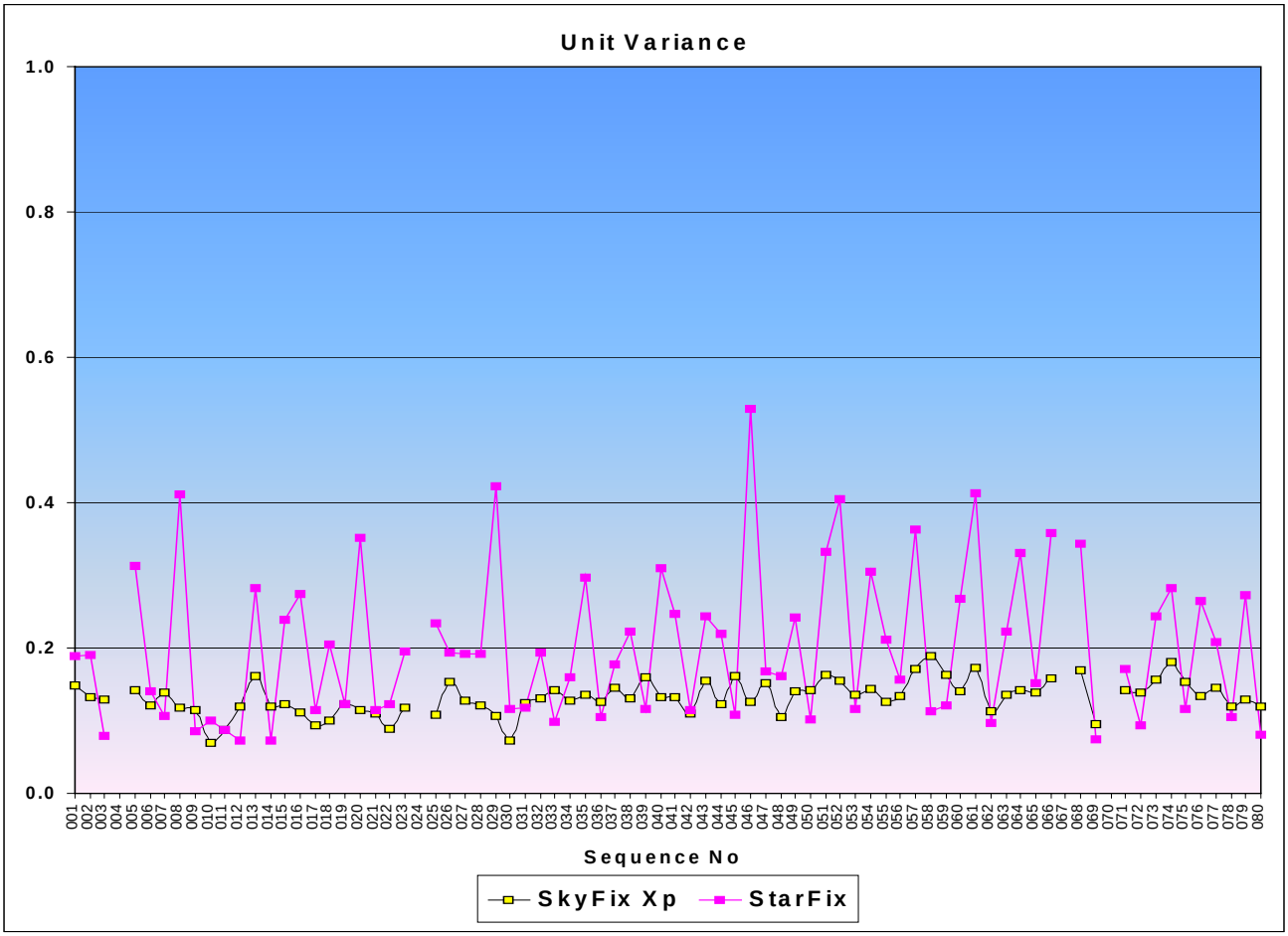


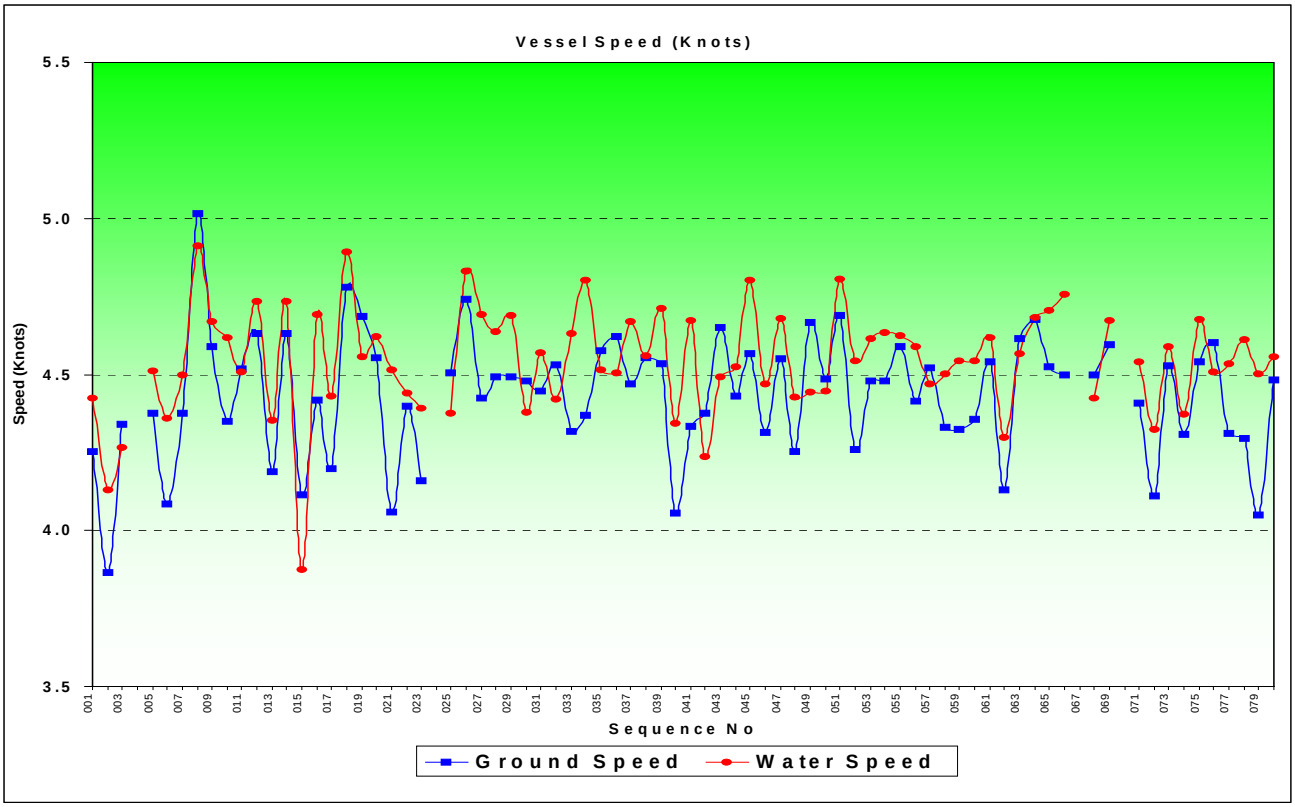


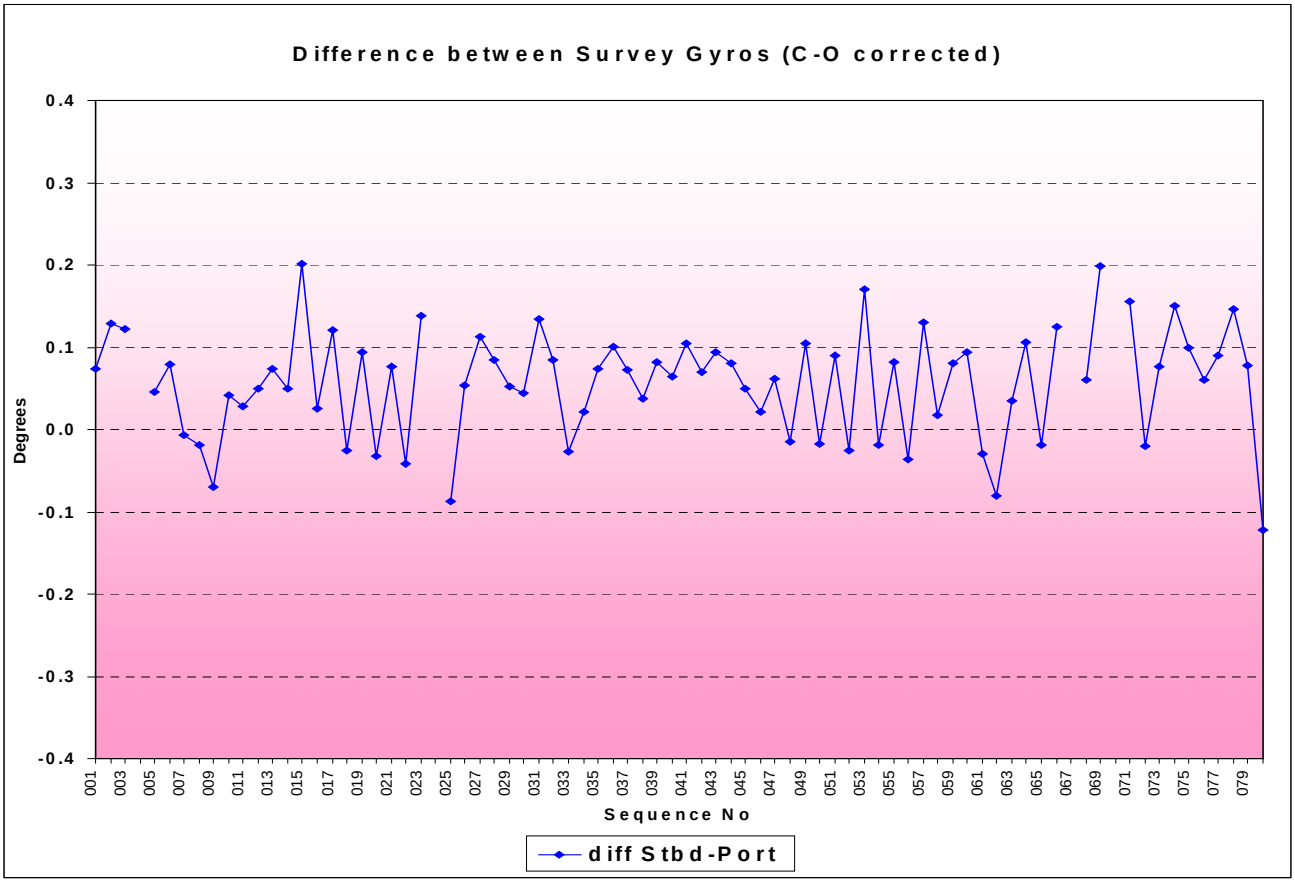












APPENDIX E SAIL LINE CO ORDINATES

SAIL LINE LISTING

CLIENT NAME: Benaris Energy N.V
SURVEY AREA: PJ3D

PGS PROJECT NUMBER: 2005103
SURVEY TYPE: 3D Seismic Survey
PRODUCTION DATE/TIME: Thursday September 08 2005, 13:16
PREPLOT VERSION: 1
VERSION COMMENT:
PRODUCED BY: PGS Marine Acquisition, Navigation Department
PROGRAM VERSION: .49 2004/08/09
SOURCE INFORMATION: Fauziah Sukander 07.09.05
****
NO ACCOUNT OF HAZARDS TO NAVIGATION HAS BEEN TAKEN
DURING THE PRODUCTION OF THIS LISTING
****
GEODETIC DATUM: WGS84
SPHEROID NAME: WGS84
SPHEROID SMA and 1/F: 6378137.000 298.2572236
PROJECTION: U.T.M. SOUTH
UTM ZONE 55
GRID ORIGIN (LAT): 0 00 00.00N
GRID ORIGIN (LON): 147 00 00.00E
FALSE EASTING: 500000.00
FALSE NORTHING: 10000000.00
GRID SCALE CONSTANT: 0.9996000000

LINE-UP POINT (LINE, SHOT): 1001 1001
LINE-UP POINT (E, N): 449328.90 5507646.90
SPACING (CMP SEP., SHOT INT. 25.000 18.750
CMP COLUMNS PER SAILINE: 8
SPREAD IS: SYMMETRICAL ABOUT SAIL-LINE
CONFIGURATION: 1 vessel, 2 source, 4 Streamers
CMP INCREMENT 1
SHOT INCREMENT: 1

COVERAGE POLYGON (GRID): 445243.70 5527269.90
437457.40 5516899.70
449328.90 5507646.90
457080.30 5518052.00

AREA SIZE OF POLYGON (GRID): 194.88 km² (scale factor not applied)

COVERAGE POLYGON (GEOGRAPHIC): 402412.18S 1462116.96E
402946.51S 1461542.98E
403449.49S 1462404.62E
402913.63S 1462936.87E

NO. OF SAIL-LINES & STATS.: 65, 52236 shots, 978206.25 m
NO. OF CMP-LINES & STATS.: 520, 7825650.00 m
FULL FOLD SAIL AREA: 195.64 km² (CMPmeters x CMPseparation)

****
SPECIAL COMMENTS
****

LINE NAMING CONVENTIONS The SAIL line number is the same as the number of the CMP line closest left of that SAIL line relative to the line azimuth.

LINE AZIMUTH (GRID BEARING) 307.930000

LINE PREFIX "

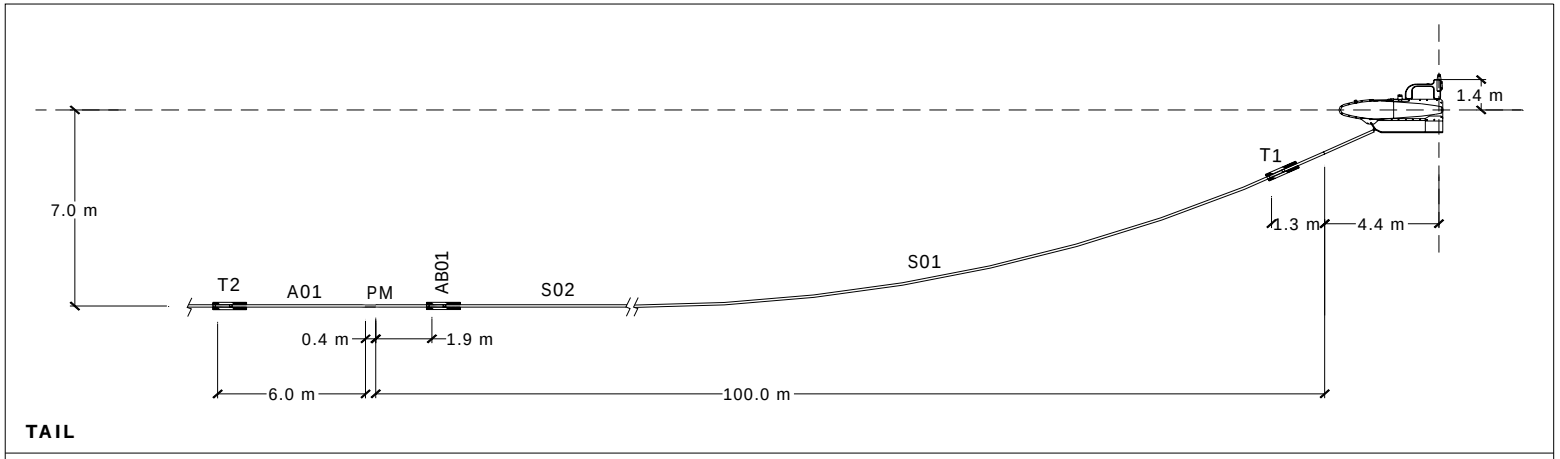
Line	Shot	Latitude	Longitude	Easting	Northing	M
1004	1001	403447.27S	1462406.93E	449382.7	5507715.9	
1004	1804	402944.21S	1461545.10E	437506.9	5516971.0	15056.25
1012	1001	403442.18S	1462412.20E	449505.6	5507873.7	
1012	1805	402938.75S	1461549.76E	437615.0	5517140.2	15075.00
1020	1001	403437.09S	1462417.48E	449628.6	5508031.4	
1020	1805	402933.67S	1461555.04E	437738.0	5517298.0	15075.00
1028	1001	403432.00S	1462422.75E	449751.5	5508189.2	
1028	1805	402928.58S	1461600.31E	437860.9	5517455.8	15075.00
1036	1001	403426.91S	1462428.02E	449874.4	5508346.9	
1036	1805	402923.50S	1461605.59E	437983.9	5517613.5	15075.00
1044	1002	403421.45S	1462432.67E	449982.6	5508516.2	
1044	1805	402918.42S	1461610.87E	438106.8	5517771.3	15056.25
1052	1002	403416.36S	1462437.95E	450105.5	5508674.0	
1052	1806	402912.96S	1461615.52E	438214.9	5517940.5	15075.00
1060	1002	403411.27S	1462443.22E	450228.5	5508831.7	
1060	1806	402907.87S	1461620.80E	438337.9	5518098.3	15075.00
1068	1002	403406.18S	1462448.49E	450351.4	5508989.5	
1068	1806	402902.79S	1461626.08E	438460.8	5518256.0	15075.00
1076	1003	403400.71S	1462453.14E	450459.6	5509158.7	
1076	1806	402857.71S	1461631.35E	438583.8	5518413.8	15056.25
1084	1003	403355.62S	1462458.41E	450582.5	5509316.5	
1084	1806	402852.62S	1461636.63E	438706.7	5518571.5	15056.25
1092	1003	403350.53S	1462503.68E	450705.4	5509474.2	
1092	1807	402847.16S	1461641.28E	438814.9	5518740.8	15075.00
1100	1003	403345.44S	1462508.96E	450828.4	5509632.0	
1100	1807	402842.08S	1461646.56E	438937.8	5518898.6	15075.00
1108	1004	403339.98S	1462513.60E	450936.5	5509801.3	
1108	1807	402837.00S	1461651.83E	439060.7	5519056.3	15056.25
1116	1004	403334.89S	1462518.87E	451059.5	5509959.0	
1116	1807	402831.91S	1461657.11E	439183.7	5519214.1	15056.25
1124	1004	403329.80S	1462524.15E	451182.4	5510116.8	
1124	1807	402826.83S	1461702.38E	439306.6	5519371.8	15056.25
1132	1004	403324.71S	1462529.42E	451305.4	5510274.5	
1132	1807	402821.75S	1461707.66E	439429.5	5519529.6	15056.25
1140	1004	403319.62S	1462534.69E	451428.3	5510432.3	
1140	1808	402816.29S	1461712.31E	439537.7	5519698.9	15075.00
1148	1005	403314.15S	1462539.33E	451536.4	5510601.6	
1148	1808	402811.20S	1461717.58E	439660.6	5519856.6	15056.25
1156	1005	403309.06S	1462544.60E	451659.4	5510759.3	
1156	1808	402806.12S	1461722.86E	439783.6	5520014.4	15056.25
1164	1005	403303.97S	1462549.87E	451782.3	5510917.1	
1164	1808	402801.03S	1461728.13E	439906.5	5520172.1	15056.25
1172	1005	403258.88S	1462555.14E	451905.3	5511074.8	
1172	1808	402755.95S	1461733.41E	440029.5	5520329.9	15056.25
1180	1006	403253.41S	1462559.79E	452013.4	5511244.1	

1180	1809	402750.49S	1461738.06E	440137.6	5520499.1	15056.25
1188	1006	403248.32S	1462605.06E	452136.4	5511401.9	
1188	1809	402745.40S	1461743.33E	440260.5	5520656.9	15056.25
1196	1006	403243.23S	1462610.33E	452259.3	5511559.6	
1196	1809	402740.32S	1461748.60E	440383.5	5520814.7	15056.25
1204	1006	403238.14S	1462615.60E	452382.2	5511717.4	
1204	1809	402735.24S	1461753.88E	440506.4	5520972.4	15056.25
1212	1007	403232.67S	1462620.24E	452490.4	5511886.6	
1212	1809	402730.15S	1461759.15E	440629.4	5521130.2	15037.50
1220	1007	403227.58S	1462625.51E	452613.3	5512044.4	
1220	1810	402724.69S	1461803.80E	440737.5	5521299.4	15056.25
1228	1007	403222.49S	1462630.78E	452736.3	5512202.1	
1228	1810	402719.60S	1461809.07E	440860.5	5521457.2	15056.25
1236	1007	403217.40S	1462636.05E	452859.2	5512359.9	
1236	1810	402714.52S	1461814.34E	440983.4	5521614.9	15056.25
1244	1007	403212.31S	1462641.31E	452982.1	5512517.6	
1244	1810	402709.44S	1461819.61E	441106.3	5521772.7	15056.25
1252	1008	403206.84S	1462645.96E	453090.3	5512686.9	
1252	1810	402704.35S	1461824.89E	441229.3	5521930.4	15037.50
1260	1008	403201.75S	1462651.22E	453213.2	5512844.7	
1260	1811	402658.89S	1461829.53E	441337.4	5522099.7	15056.25
1268	1008	403156.66S	1462656.49E	453336.2	5513002.4	
1268	1811	402653.80S	1461834.80E	441460.4	5522257.5	15056.25
1276	1008	403151.57S	1462701.76E	453459.1	5513160.2	
1276	1811	402648.72S	1461840.08E	441583.3	5522415.2	15056.25
1284	1009	403146.10S	1462706.40E	453567.3	5513329.5	
1284	1811	402643.63S	1461845.35E	441706.2	5522573.0	15037.50
1292	1009	403141.01S	1462711.67E	453690.2	5513487.2	
1292	1811	402638.55S	1461850.62E	441829.2	5522730.7	15037.50
1300	1009	403135.92S	1462716.93E	453813.1	5513645.0	
1300	1812	402633.09S	1461855.26E	441937.3	5522900.0	15056.25
1308	1009	403130.83S	1462722.20E	453936.1	5513802.7	
1308	1812	402628.00S	1461900.53E	442060.3	5523057.8	15056.25
1316	1010	403125.36S	1462726.84E	454044.2	5513972.0	
1316	1812	402622.92S	1461905.80E	442183.2	5523215.5	15037.50
1324	1010	403120.27S	1462732.11E	454167.2	5514129.7	
1324	1812	402617.83S	1461911.07E	442306.2	5523373.3	15037.50
1332	1010	403115.18S	1462737.37E	454290.1	5514287.5	
1332	1812	402612.75S	1461916.34E	442429.1	5523531.0	15037.50
1340	1010	403110.08S	1462742.64E	454413.0	5514445.3	
1340	1812	402607.66S	1461921.61E	442552.0	5523688.8	15037.50
1348	1010	403104.99S	1462747.90E	454536.0	5514603.0	
1348	1813	402602.20S	1461926.26E	442660.2	5523858.1	15056.25
1356	1011	403059.52S	1462752.54E	454644.1	5514772.3	
1356	1813	402557.11S	1461931.53E	442783.1	5524015.8	15037.50
1364	1011	403054.43S	1462757.81E	454767.1	5514930.0	
1364	1813	402552.03S	1461936.79E	442906.1	5524173.6	15037.50
1372	1011	403049.34S	1462803.07E	454890.0	5515087.8	
1372	1813	402546.94S	1461942.06E	443029.0	5524331.3	15037.50
1380	1011	403044.25S	1462808.34E	455013.0	5515245.5	
1380	1813	402541.86S	1461947.33E	443151.9	5524489.1	15037.50
1388	1012	403038.78S	1462812.98E	455121.1	5515414.8	
1388	1814	402536.39S	1461951.98E	443260.1	5524658.3	15037.50
1396	1012	403033.69S	1462818.24E	455244.0	5515572.6	
1396	1814	402531.31S	1461957.24E	443383.0	5524816.1	15037.50
1404	1012	403028.59S	1462823.50E	455367.0	5515730.3	

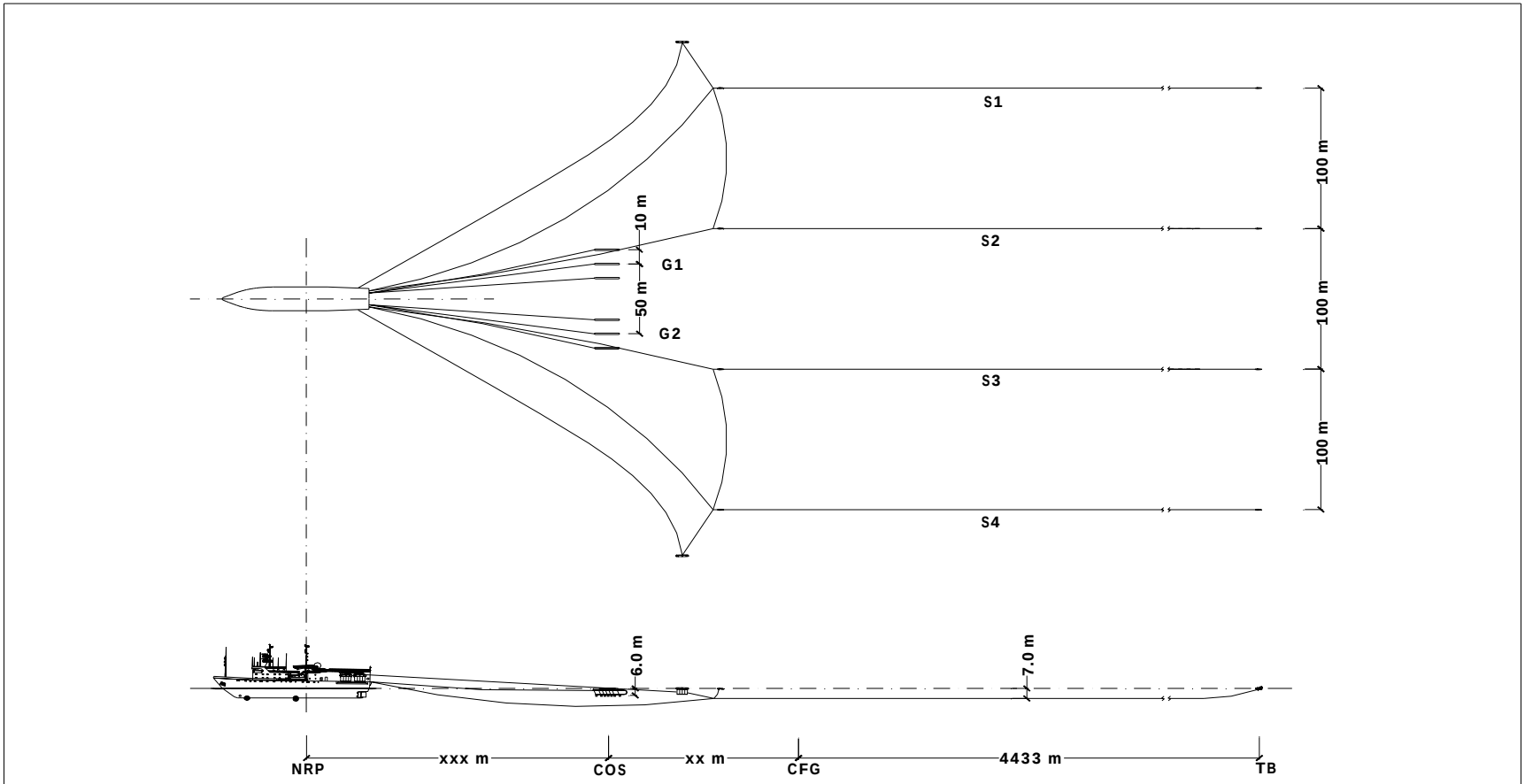
1404	1814	402526.22S	1462002.51E	443506.0	5524973.8	15037.50
1412	1012	403023.50S	1462828.77E	455489.9	5515888.1	
1412	1814	402521.13S	1462007.78E	443628.9	5525131.6	15037.50
1420	1013	403018.03S	1462833.41E	455598.1	5516057.4	
1420	1814	402516.05S	1462013.04E	443751.9	5525289.4	15018.75
1428	1013	403012.94S	1462838.67E	455721.0	5516215.1	
1428	1815	402510.58S	1462017.69E	443860.0	5525458.6	15037.50
1436	1013	403007.85S	1462843.93E	455844.0	5516372.9	
1436	1815	402505.50S	1462022.95E	443982.9	5525616.4	15037.50
1444	1013	403002.76S	1462849.19E	455966.9	5516530.6	
1444	1815	402500.41S	1462028.22E	444105.9	5525774.1	15037.50
1452	1013	402957.66S	1462854.46E	456089.8	5516688.4	
1452	1815	402455.33S	1462033.49E	444228.8	5525931.9	15037.50
1460	1014	402952.19S	1462859.09E	456198.0	5516857.6	
1460	1815	402450.24S	1462038.75E	444351.8	5526089.6	15018.75
1468	1014	402947.10S	1462904.35E	456320.9	5517015.4	
1468	1816	402444.78S	1462043.40E	444459.9	5526258.9	15037.50
1476	1014	402942.01S	1462909.62E	456443.9	5517173.1	
1476	1816	402439.69S	1462048.66E	444582.9	5526416.7	15037.50
1484	1014	402936.92S	1462914.88E	456566.8	5517330.9	
1484	1816	402434.60S	1462053.93E	444705.8	5526574.4	15037.50
1492	1015	402931.45S	1462919.51E	456675.0	5517500.2	
1492	1816	402429.52S	1462059.19E	444828.7	5526732.2	15018.75
1500	1015	402926.35S	1462924.78E	456797.9	5517657.9	
1500	1816	402424.43S	1462104.46E	444951.7	5526889.9	15018.75
1508	1015	402921.26S	1462930.04E	456920.8	5517815.7	
1508	1816	402419.34S	1462109.72E	445074.6	5527047.7	15018.75
1516	1015	402916.17S	1462935.30E	457043.8	5517973.4	
1516	1817	402413.88S	1462114.36E	445182.8	5527217.0	15037.50

APPENDIX F OFFSET DIAGRAMS

ASAT THE COMMENCEMENT OF THE BEE JAY 3D SURVEY



STREAMER CONFIGURATION						PGS Geophysical – Marine Acquisition – Navigation Department
VESSEL: M.V. ORIENT EXPLORER	**CLIENT:** Benaris Petroleum N.V.	**SPECTRA:** 10.9.01	**VALIDITY**	**DATE**	**SEQUENCE**	
SURVEY: 3D	**AREA:** PJ - Bass Strait	**gAS:** 3.0.2-6	**FROM**	08 Oct. '05	001	
CONFIG.: Dual source, 4x 4350 m	**PGS JOB:** 2005103	**GCS90:** v4.76	For alterations see "Changes Log"			



not to scale

TOWING CONFIGURATION

VESSEL: M.V. ORIENT EXPLORER	**CLIENT:** Benaris Petroleum N.V.	**SPECTRA:** 10.9.01	**VALIDITY**	**DATE**	**SEQUENCE**
SURVEY: 3D	**AREA:** PJ - Bass Strait	**gAS:** 3.0.2-6	**FROM**	08 Oct. '05	001
CONFIG.: Dual source, 4 x 4350 m	**PGS JOB:** 2005103	**GCS90:** v4.76	For alterations see "Changes Log"		

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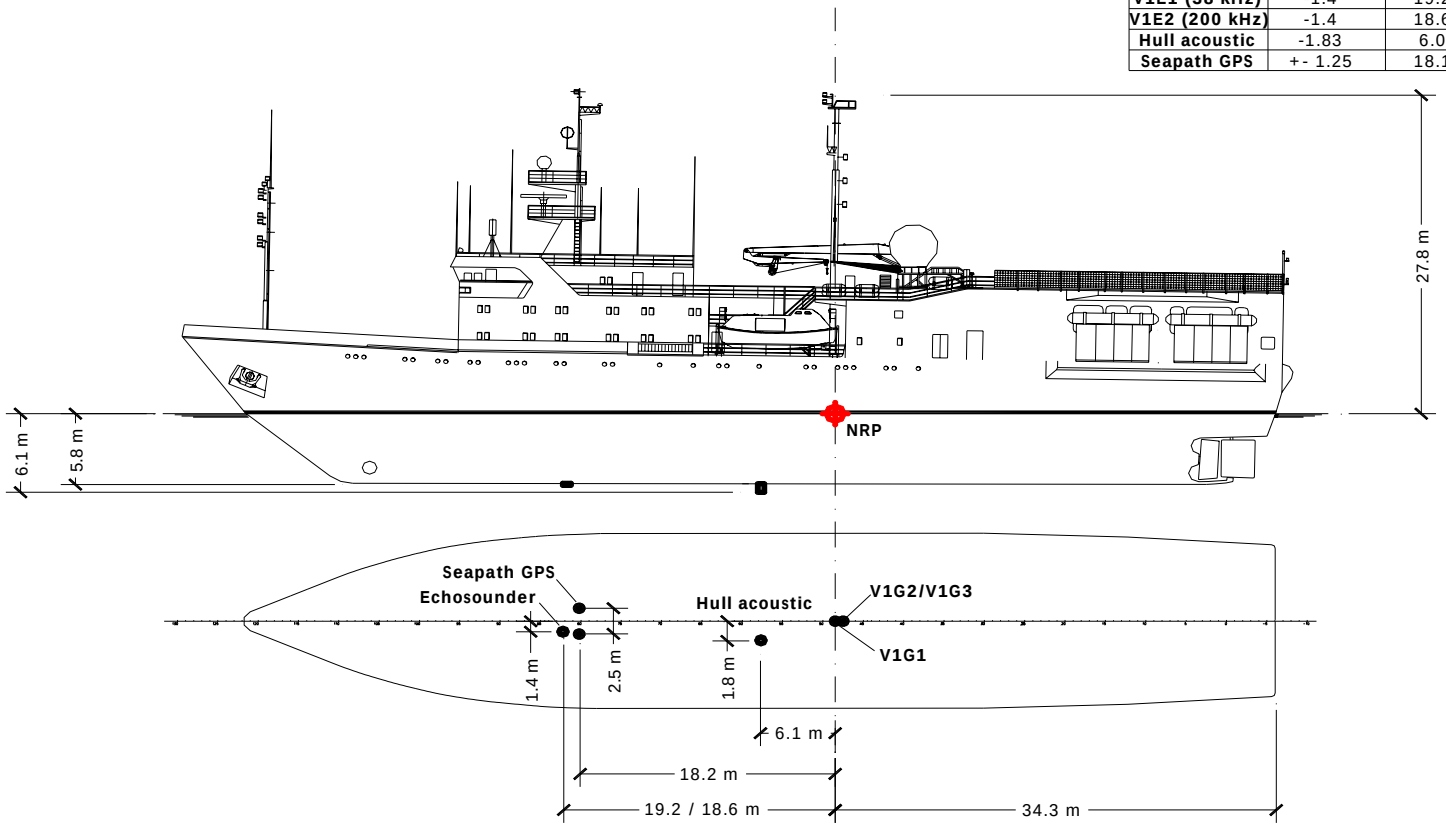
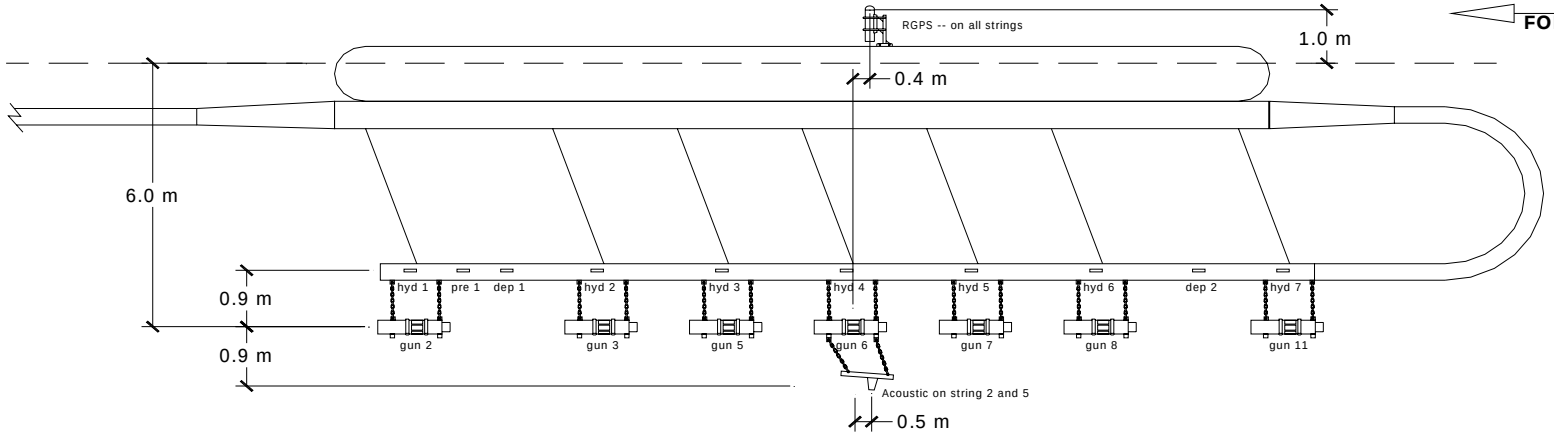
Node	X-offset (m)	Y-offset (m)	Z-offset (m)
V1G1	0.00	0.00	27.85
V1G2	0.00	-0.61	27.85
V1G3	0.00	-0.61	27.85
V1E1 (38 kHz)	-1.4	19.20	-5.8
V1E2 (200 kHz)	-1.4	18.63	-5.8
Hull acoustic	-1.83	6.07	-7.2
Seapath GPS	+- 1.25	18.16	n/a



not to scale

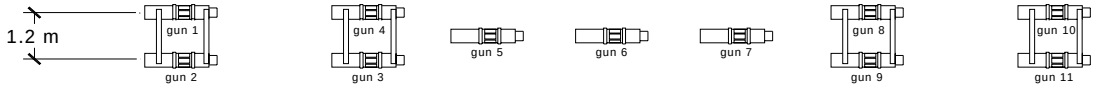
SENSOR OFFSETS						PGS Geophysical -- Marine Acquisition -- Navigation Department
VESSEL: M.V. ORIENT EXPLORER	CLIENT: Benaris Petroleum N.V.	SPECTRA: 10.9.01	VALIDITY	DATE	SEQUENCE	
SURVEY: 3D	AREA: PJ - Bass Strait	gAS: 3.0.2-6	FROM	08 Oct. '05	001	
CONFIG.: Dual source, 4 x 4350 m	PGS JOB: 2005103	GCS90: v4.76	For alterations see "Changes Log"			

PROFILE



PLAN -- 2 / 5

PLAN -- 1 / 3 / 4 / 6



Active Gun
Spare Gun
No Gun

	STRING 1			STRING 2			STRING 3			STRING 4			STRING 5			STRING 6		
	type	vol.	id	type	vol.	id	type	vol.	id	type	vol.	id	type	vol.	id	type	vol.	id
gun 1	Bolt 1500II	250 ci	1	Bolt 1500II	150 ci	17	Bolt 1500II	250 ci	33	Bolt 1500II	250 ci	49	Bolt 1500II	150 ci	65	Bolt 1500II	250 ci	81
gun 2	Bolt 1500II	250 ci	2	Bolt 1500II	150 ci	18	Bolt 1500II	250 ci	34	Bolt 1500II	250 ci	50	Bolt 1500II	150 ci	66	Bolt 1500II	250 ci	82
gun 3	Bolt 1500II	150 ci	3			19	Bolt 1500II	150 ci	35	Bolt 1500II	150 ci	51			67	Bolt 1500II	150 ci	83
gun 4	Bolt 1500II	150 ci	4			20	Bolt 1500II	150 ci	36	Bolt 1500II	150 ci	52			68	Bolt 1500II	150 ci	84
gun 5	Bolt 1500II	70 ci	5	Bolt 1500II	60 ci	21	Bolt 1500II	70 ci	37	Bolt 1500II	70 ci	53	Bolt 1500II	60 ci	69	Bolt 1500II	70 ci	85
gun 6	Bolt 600b	40 ci	6	Bolt 600b	20 ci	22	Bolt 600b	40 ci	38	Bolt 600b	40 ci	54	Bolt 600b	20 ci	70	Bolt 600b	40 ci	86
gun 7	Bolt 1500II	60 ci	7	Bolt 600b	40 ci	23	Bolt 1500II	60 ci	39	Bolt 1500II	60 ci	55	Bolt 600b	40 ci	71	Bolt 1500II	60 ci	87
gun 8	Bolt 1500II	100 ci	8	Bolt 1500II	70 ci	24	Bolt 1500II	100 ci	40	Bolt 1500II	100 ci	56	Bolt 1500II	70 ci	72	Bolt 1500II	100 ci	88
gun 9	Bolt 1500II	100 ci	9			25	Bolt 1500II	100 ci	41	Bolt 1500II	100 ci	57			73	Bolt 1500II	100 ci	89
gun 10	Bolt 1500II	100 ci	10			26	Bolt 1500II	100 ci	42	Bolt 1500II	100 ci	58			74	Bolt 1500II	100 ci	90
gun 11	Bolt 1500II	100 ci	11			27	Bolt 1500II	100 ci	43	Bolt 1500II	100 ci	59			75	Bolt 1500II	100 ci	91
dep 1			1			17			33			49			65			81
dep 2			11			27			43			59			75			91
pre 1			6			5			4			3			2			1

not to scale

GUN STRING CONFIGURATION -- 2500 ci

VESSEL: M.V. ORIENT EXPLORER	**CLIENT:** Benaris Petroleum N.V.	**SPECTRA:** 10.9.01	**VALIDITY**	**DATE**	**SEQUENCE**
SURVEY: 3D	**AREA:** PJ - Bass Strait	**gAS:** 3.0.2-6	**FROM**	08 Oct. '05	001
CONFIG.: Dual source, 4 x 4350 m	**PGS JOB:** 2005103	**GCS90:** v4.76	For alterations see "Changes Log"		

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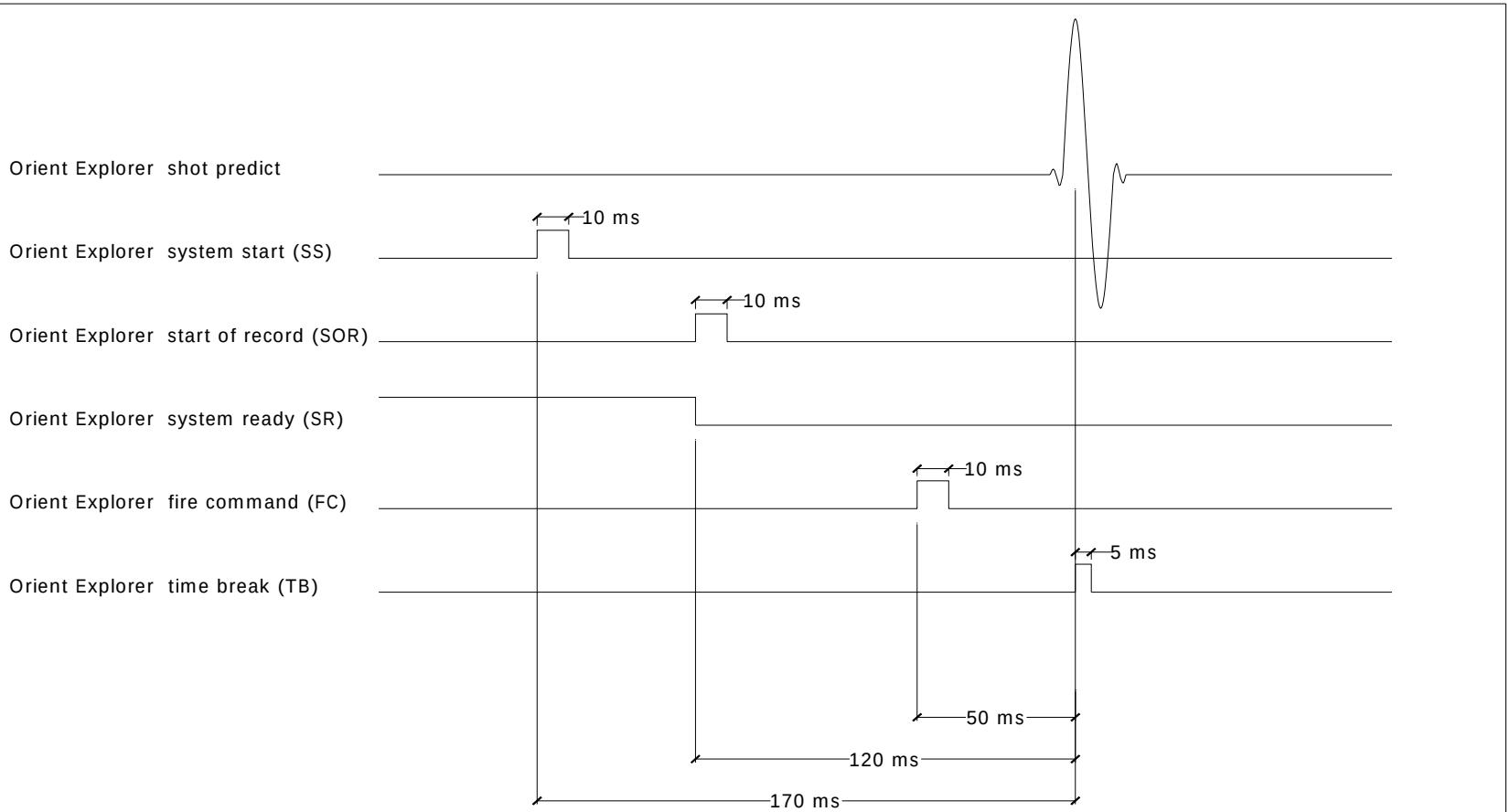

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TIMING 24bit					
VESSEL: M.V. ORIENT EXPLORER	**CLIENT:** Benaris Petroleum N.V.	**SPECTRA:** 10.9.01	**VALIDITY**	**DATE**	**SEQUENCE**
SURVEY: 3D	**AREA:** PJ - Bass Strait	**gAS:** 3.0.2-6	**FROM**	08 Oct. '05	001
CONFIG.: Dual source, 4 x 4350 m	**PGS JOB:** 2005103	**GCS90:** v4.76	For alterations see "Changes Log"		

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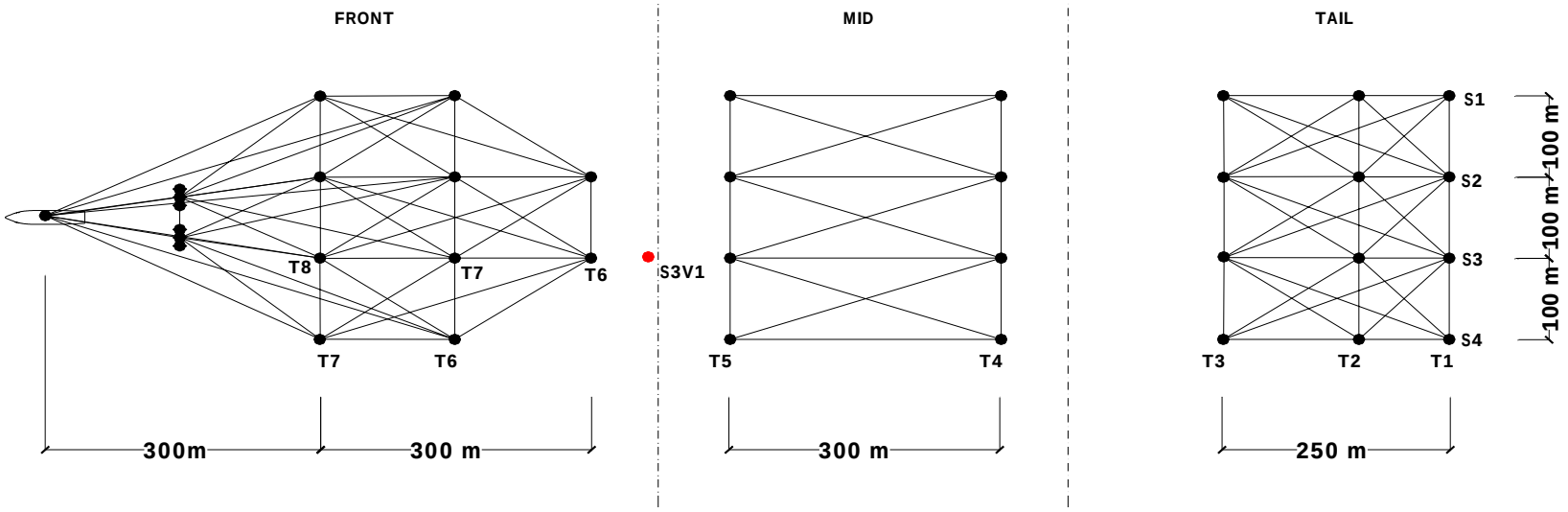

not to scale

ACOUSTIC NETWORK					
VESSEL: M.V. ORIENT EXPLORER	**CLIENT:** Benaris Petroleum N.V.	**SPECTRA:** 10.9.01	**VALIDITY**	**DATE**	**SEQUENCE**
SURVEY: 3D	**AREA:** PJ - Bass Strait	**gAS:** 3.0.2-6	**FROM**	08 Oct. '05	001
CONFIG.: Dual source, 4 x 4350 m	**PGS JOB:** 2005103	**GCS90:** v4.76	**For alterations see "Changes Log"**		

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ADDITIONAL APPENDICESON ACCOMPANYING CD

APPENDIX G	POSITIONING EQUIPMENT DAILY STATUS RESUME
APPENDIX H	VELOCITY OF SOUND COMPUTATIONS
APPENDIX I	PORTLAND VERIFICATION RESULTS
APPENDIX J	PGS CHANGES LOG
APPENDIX K	PGS NAVIGATION LINE LOGS
APPENDIX L	SPRINT QC FILES
APPENDIX M	SPECTRA END OF LINE GRAPHS