



Benaris Petroleum N.V

ACQUISITION REPORT

PGS Geophysical

Benaris Petroleum N.V.

M/V Orient Explorer

Bass Strait PJ3D & PJ2D

PGS Job number 2005103

09th October to 14th November 2005



version 1

AUTHORISATION

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1 Introduction

1.1 Summary

The size of the survey, in block T/39P off the Northern coast of Tasmania, was 196 km². There was also 286 kms of 2D lines, 23 lines.

The M/V ORIENT EXPLORER arrived in Portland on the morning of 8th October during which time custom, immigration and quarantine formalities were carried out. The survey start-up meeting was held onboard that same day and later, on the same day, the vessel sailed to Burnie in Tasmania to take fuel.

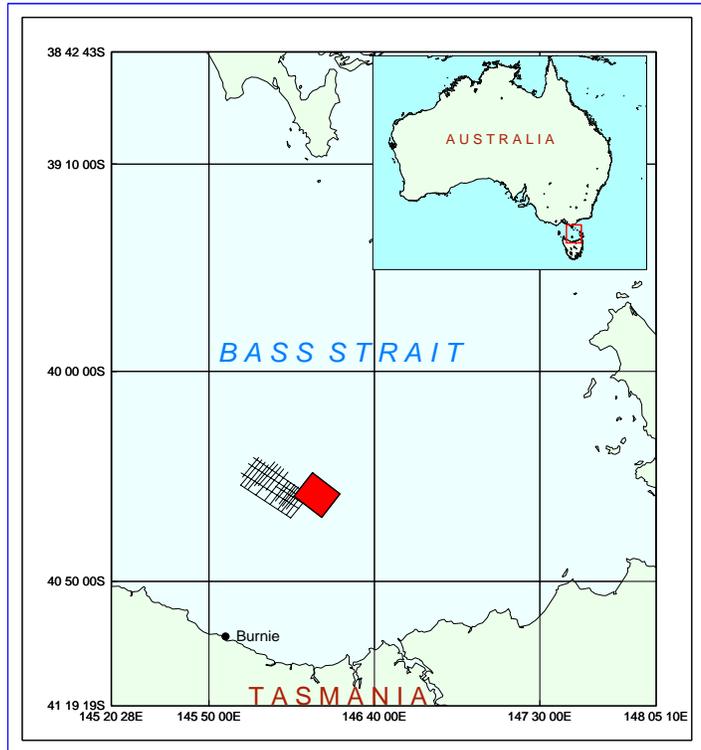
After taking fuel, the vessel was in the survey area on 10th October and streamer deployment started at 15:15 hours.

On the evening of 12th October at 23:20 the Chief Engineer notified the bridge that the seawater cooling unit water was leaking and this could have major consequences for the main engine, and that at least 6 hours was needed to carry out the repairs. It was decided at 23:55 to recover the 3 streamers that were out at this time and to go for shelter to do the repairs. On 13th October at 17:40 when the repairs were completed an attempt to start the main engine was aborted as the repair was unsuccessful. The cooler unit was dismantled and sent onshore on 14th October and returned back to the vessel late afternoon of 16th October. After re-installing the cooler, and taking on fresh water, the MV ORIENT EXPLORER set out to sea on 17th October, and immediately started deploying again.

The deployment proved a little troublesome, with a variety of streamer problems, the most prevalent of which were the parity errors, sometimes intermittent, and mostly on the outer streamers. Production eventually commenced on Friday 21st October, but for the following few days, problems persisted (parity errors, module failure), which kept interrupting production. After Sequence #25, all problematic boot sections had been removed from the streamers and production continued steadily. There was one more sizable amount of downtime on 6th November, when telemetry failure on streamer #1 resulted in a leadin, needing to be changed out. Production was only interrupted by the weather twice at the end of the 3D work, which was completed on Tuesday 9th Nov.

Provisions were made to shoot some lines with 9m and 10m streamer depth, as the weather was expected to interrupt production more than it did. However, on the 3D block there were only 2 'deep' lines, one at 9m, one at 10m, and for the 2D work the streamer depth was 8m for all lines.

The 2D job was started immediately after finishing the 3D prospect, and was completed before midday on 14th Nov. For the 2D lines, the starboard source was used, and data was recorded on all 4 streamers. Weather delayed production once, for about 32hrs.



1.2 Key parameters

Source	:	2 x 2500 in ³
Source depth	:	6 m
Streamers	:	4 x 4350 m
Streamer spacing	:	100 m
Streamer depth	:	8 m
Near trace offset	:	90 m

1.3 Systems

Source type	:	Bolt 1500LL / 600B guns
Streamer type	:	Syntron / Teledyne LDA
Recording system	:	Syntrak/gAS
Navigation	:	StarFix DGPS
	:	SkyFix XP DGPS
Float positioning	:	Seatrack 220 / 320 RGPS
Acoustic ranging	:	Sonardyne SIPS 1

1.4 Production

	Sail line km	CDP km
Prime chargeable 3D	1120.8	8966.4
Infill 3D	189.7	1517.4
Infill percentage	16.9	
2D lines	285.6	
Total	1596.1	

1.5 Survey timing

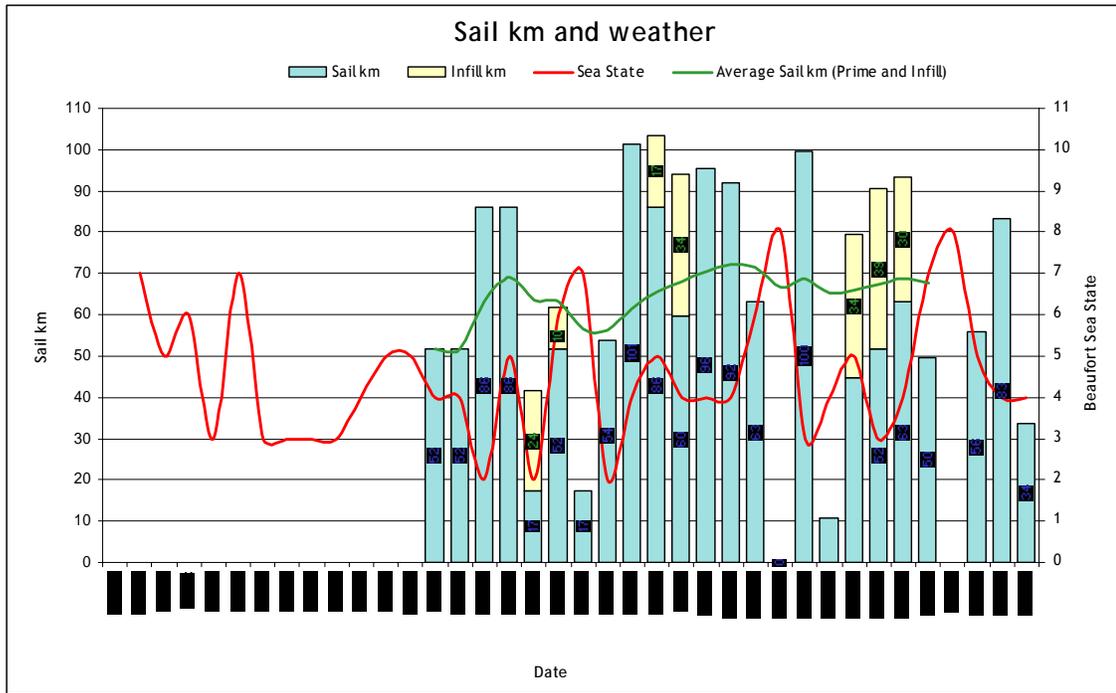
	Hours			Hours	% of total
Production	410.8	46.9%	Production prime	141.2	16.1%
			Production infill	22.8	2.6%
			Line change	160.1	18.3%
			Production 2D	42.9	4.9%
			Line change 2D	43.8	5.0%
Standby	99.1	11.3%	Crew change	0.6	0.1%
			Weather	95.6	10.9%
			Local travel 3D to 2D	2.9	0.3%
Mob / Demob	179.6	20.5%	Mob	137.9	15.7%
			Demob	2.4	0.3%
			Travel / Port call	39.3	4.5%
Downtime	186.5	21.3%	Instruments	0	0%
			Streamers	61.5	7.0%
			Navigation	0	0%
			Mechanical	4.2	0.5%
			Maritime	120.8	13.8%
Total	876	100%		876	100%

2 Sequence of events

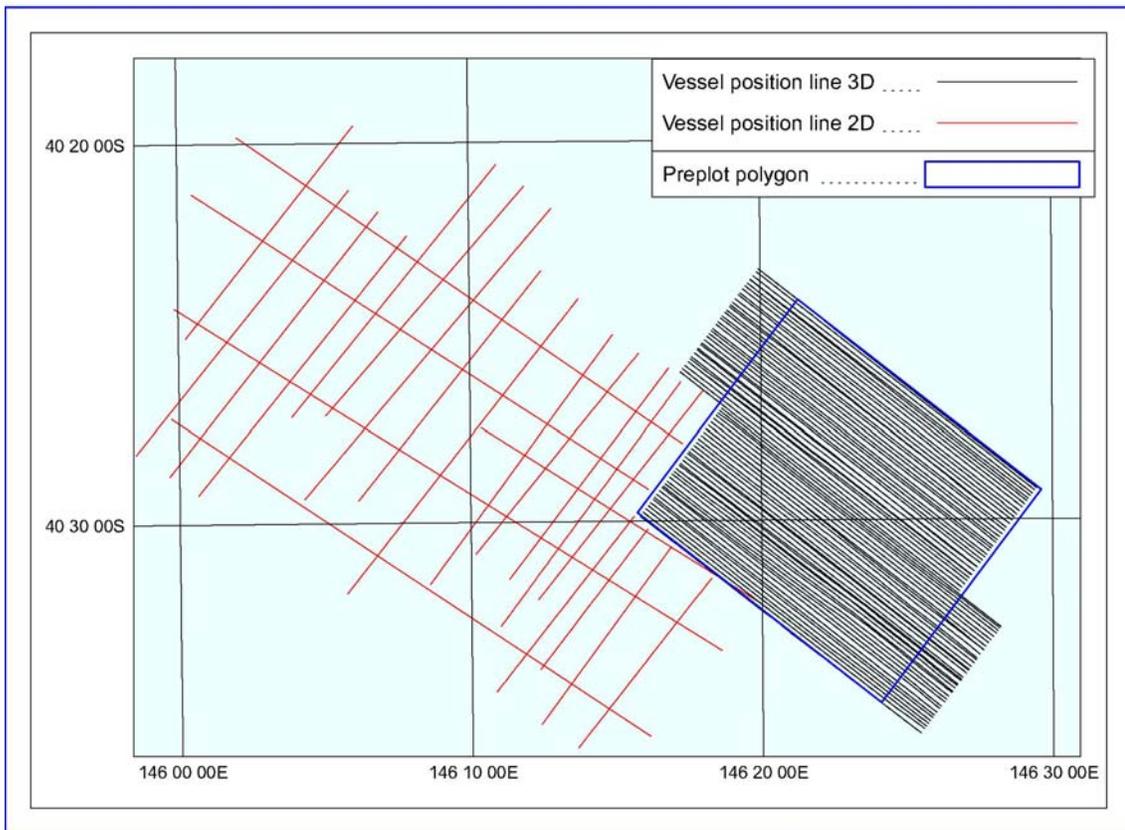
2.1 Daily log

Daily Date	Daily Total Sail km	Daily Prime Sail km	Daily Infill Sail km	Sea State Beaufort	Location	Comments
8/Oct/05					Portland	Startup meeting.
9/Oct/05				7	Transit to Burnie	Fuel order not available in Portland.
10/Oct/05				5	Burnie area	Taking bunkers. Begin deployment.
11/Oct/05				6	Prospect area	Deploying.
12/Oct/05				3	Prospect area	Deploying.
13/Oct/05				7	Prospect / shelter	Recovering for main engine cooling repairs.
14/Oct/05				3	Bell Bay	At anchor. Cooler sent ashore for repair work.
15/Oct/05				3	Bell Bay	Anchored.
16/Oct/05				3	Bell Bay	Anchored. Cooler returned.
17/Oct/05				3	Bell Bay / South Prospect	Installing cooler. Re-start deployment.
18/Oct/05				4	South of Prospect	Deploying.
19/Oct/05				5	South of Prospect	Deploying. Crew change.
20/Oct/05				5	Prospect area	Deploying.
21/Oct/05	51.694	51.694	0.000	4	Prospect	Complete deployment and start production. Seq #001 - 003.
22/Oct/05	51.863	51.863	0.000	4	Prospect	Extraction error problems on stmr #2. Seq #004 - 007.
23/Oct/05	86.044	86.044	0.000	2	Prospect	Production seq #008 - 012. Parity errors, cross-feed & power leakage cause downtime.
24/Oct/05	86.194	86.194	0.000	5	Prospect	Production seq #013 - 017. Module fails on stmr #3.
25/Oct/05	41.663	17.232	24.431	2	Prospect	Production seq #018 - 020. Fixing module on stmr #3, and also parity errors on stmr #4.
26/Oct/05	61.744	51.713	10.031	6	Prospect	Production seq #021 - 024. Weather freshening late in the day.
27/Oct/05	17.250	17.250	0.000	7	Prospect Area	Down for weather. Production seq #025.
28/Oct/05	53.888	53.888	0.000	2	Prospect	Down for weather. Parity errors on stmr #2 requiring a front end haul. Production 026 - 028.
29/Oct/05	101.306	101.306	0.000	4	Prospect	Production 029 - 034.
30/Oct/05	103.463	86.213	17.250	5	Prospect	Production 035 - 040.
31/Oct/05	94.181	59.700	34.481	4	Prospect	Production 041 - 045.
1/Nov/05	95.531	95.531	0.000	4	Prospect	Production 046 - 051.
2/Nov/05	92.081	92.081	0.000	4	Prospect	Production 052 - 056.
3/Nov/05	63.094	63.094	0.000	6	Prospect Area	Production 057 - 060. Down for weather.
4/Nov/05	0.000	0.000	0.000	8	Prospect Area	Down for weather.
5/Nov/05	99.506	99.506	0.000	3	Prospect	Production 061 - 066.
6/Nov/05	10.838	10.838	0.000	4	Prospect	Production 067. Downtime for stmr #1 telemetry problems.
7/Nov/05	79.331	44.887	34.444	5	Prospect	Production 068 - 073. Air leak.
8/Nov/05	90.675	51.750	38.925	3	Prospect	Production 074 - 078.
9/Nov/05	93.244	63.131	30.113	4	Prospect	Production 079 - 083. Complete 3D prospect & start 2D work.
10/Nov/05	49.631	49.631	0.000	7	2D Prospect	Production 084 - 087. Down for weather.
11/Nov/05	0.000	0.000	0.000	8	2D Prospect	Down for weather.
12/Nov/05	55.781	55.781	0.000	5	2D Prospect	Down for weather. Production 088 - 093.
13/Nov/05	83.363	83.363	0.000	4	2D Prospect	Production 094 - 100.
14/Nov/05	33.656	33.656	0.000	4	2D Prospect	Production 101- 103. Finish 2D & Benaris work.

2.2 Daily production and sea state



2.3 Post plotted vessel positions



3 Key personnel

	09th October to 19th October 2005	19th October to 14th November 2005
Party Chief	Esben Jettestad	Stephen Beer
Chief observer	Torkil Fenstad	Georgiy Astvatsaturov
Chief navigator	Anthony van der Wal	Jeremy Tate
Chief mechanic	Pat Stoltz	William Tivendale
Chief geophysicist	Guy Alleman	Erwan Le Duff
Client representative onboard	Drew Murray Ray Doughty	Drew Murray Ray Doughty
Client contacts onshore	Frank Renton	Frank Renton

4 HSE

4.1 Statistics

Exposure hours	Marine crew	20832
	Seismic crew	21288
	Third party crew	960
	Total	43080
Workboat operations		20
Workboat exposure hours		82.1
Safety meetings		2
Safety training meetings		5
Toolbox meetings (est.)		30
Audits		12
Drills		6
STOP cards		24

4.2 Incidents

Report no.	Date	Action by	Classification	Status	Comments
ORI0526	11.10.05	Captain	Personnel	Closed	Twisted ankle.
ORI0527	12.10.05	Ch. Eng	Equipment	Open	Engine Cooler leaking.
ORI0528	25.10.05	Ch. Eng	Equipment	Closed	Workboat breakdown.
ORI0529	30.10.05	Ch. Eng	Equipment	Open	Crane slewing.
ORI0530	07.11.05	Captain	Personnel	Closed	Torn muscle in shoulder.

5 Survey operations review

5.1 Survey area information

Oilfield installations

No oilfield installations.

Oilfield activity

No oilfield activity in this area.

Shipping Activity

There were a few cargo ships passing through the area, but none of these caused us any problems.

Sea Conditions, Tides And Currents

The job was started a few days after full moon, so the tides were weakening during the 1st week or so. Feathers were small, and there was no need to open multiple swathes for improved matching or delay any line changes. In the 2nd half of the job, as the currents grew stronger, the feather matching became a bit hit or miss. There were not enough lines left to open another swathe, so the outer lines -which were previously being kept for marginal weather days, with deeper streamers- were used as well, to improve choice of feather angles.

In Sea Dangers

There were no shallow areas on this prospect, but the Bass Strait is known for its population of sharks, of which the Great White is the most dangerous. Very occasionally a shark's fin was spotted, but identifying the type was not possible.

Time sharing

No other seismic boats in the area.

Fishing Activity

There were very few fishing boats or nets seen. Shark fishing with drift nets is fairly common place, but we didn't come across any of this type of activity. No problems or delays at all.

Weather

The weather was fairly typical for this time of year in the Bass Strait, cycling through good and bad phases. Fog caused us some problems around October's crew change, delaying the 1st helicopter for the marine crew change by 3 days. Total weather downtime for the job was 95.6hrs, during 3 separate periods, 26th-28th Oct, 3rd-5th Nov & 10th-12th Nov.

Cetaceans

A humpback whale, maybe 2, was spotted on our port beam in the morning of Wednesday, 26th October, outside the 3km 'shutdown' zone, about 3.5km. It tracked along parallel with us for about 30mins, not getting any closer, blowing and some fin slapping.

Naval Activity Including Civil Unrest

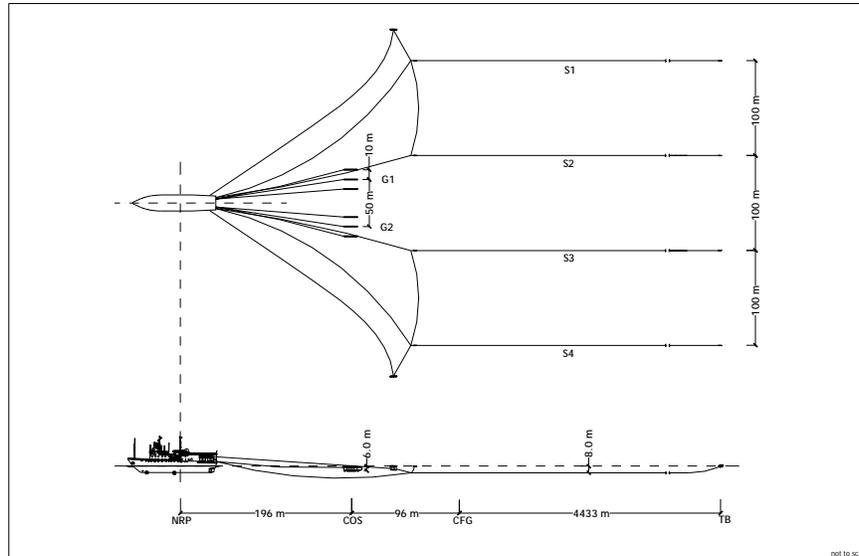
No naval activity.

6 Seismic energy source

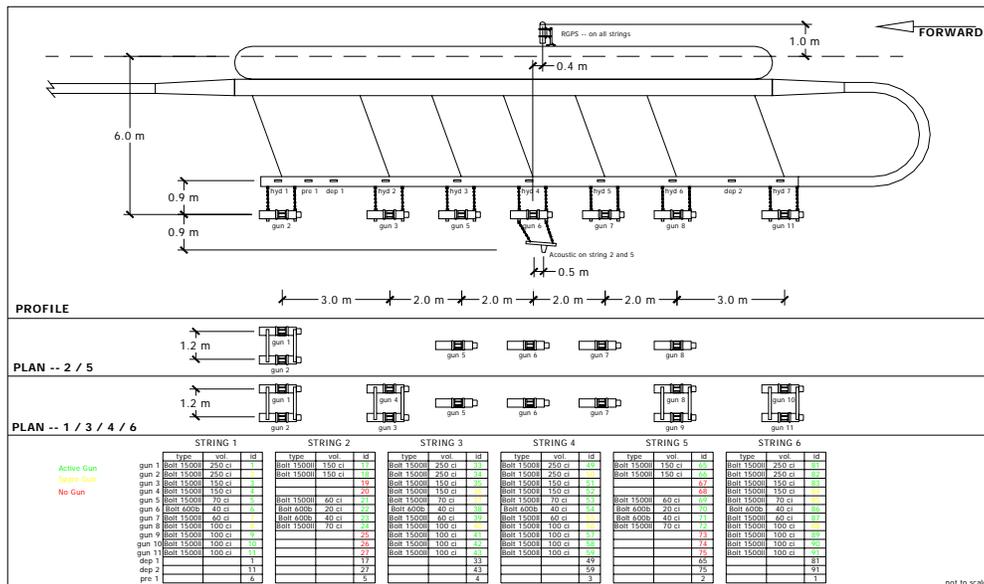
6.1 Source details

Source type	:	Bolt 1500LL / 600B air guns
Air pressure	:	1800 psi
Volume	:	2500 in ³
Number of sources	:	2
Number of sub-arrays	:	2 x 3
Source separation	:	10 m
Sub-array separation	:	50 m
Source length	:	14 m
Gun synchronisation	:	± 1.5 ms
Shot interval	:	18.75 m
Depth	:	6 m
Depth control	:	Fixed depth ropes
Depth monitoring	:	AG and Syntron depth transducers, GCS-90
Spacing control	:	Spread-ropes on sliding collars
Near field signatures	:	7 phones per subarray
Compressors	:	5 x Hamworthy 565
Source controller	:	GCS-90, version 4.76
Modelled source signature	:	See Appendix section 14.2

6.2 Offset diagram



6.3 Gun array layout

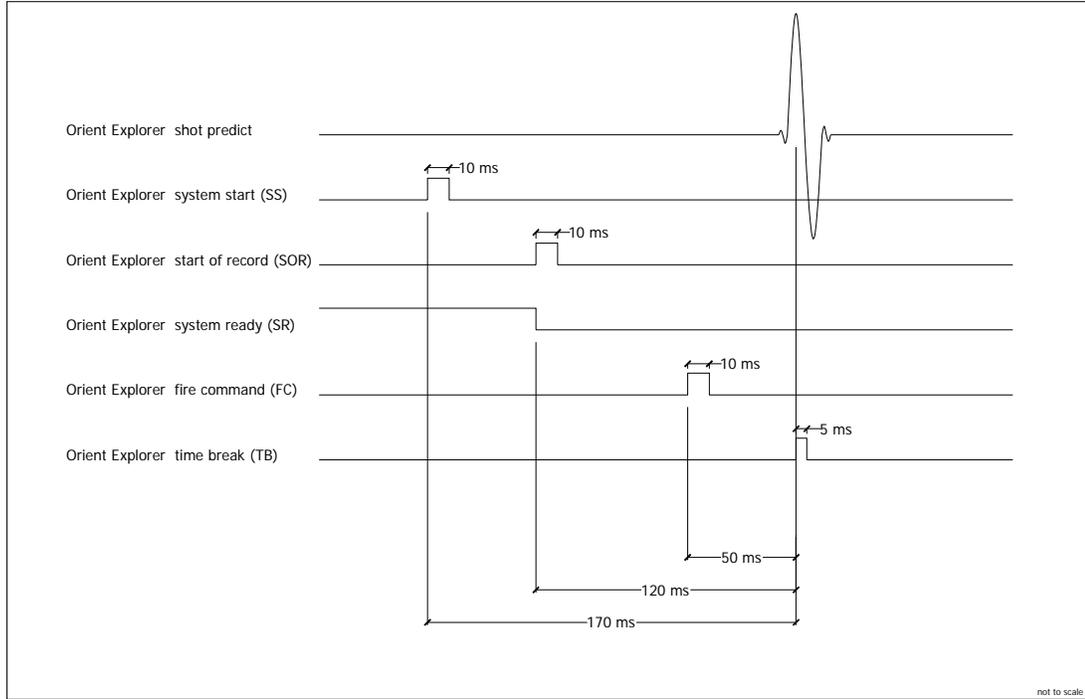


7 Seismic acquisition system

7.1 System details

Recording System	:	gAS / Syntrak 960 - 24 bit
Software Version	:	gAS 3.0.2.-6
Amplitude resolution	:	24 bit
Data Channels	:	4 x 348
Auxiliary Channels	:	48
Tape Transports	:	6 x IBM 3590 cartridge drives
Tape Format	:	SEG D 8036
Recording Media	:	Imation 3590
Record Length	:	5120 ms
Deep water delay	:	0 ms
Sample Rate	:	2 ms
High Cut Filter	:	206 Hz / 276 dB/octave
Low Cut Filter	:	3 Hz / 12 dB/octave
Gain Setting	:	12 dB
Amplifier	:	Voltage Mode Differential
Input Range	:	0-2048 mV
A/D Converter	:	Delta Sigma Architecture
Distortion	:	< 0.0005% (-106 dB)
Cross-Feed Isolation	:	> 110 dB
Power Consumption	:	7.5 W per module
Polarity Convention	:	SEG, positive pressure gives negative number
SEG-D header description	:	see Appendix section 14.3

7.2 System timing



7.3 Streamers

7.3.1 Streamer details

Type of streamer	:	Syntron / Teledyne LDA
Number of streamers	:	4
Streamer sensitivity	:	20 V/bar
Streamer length	:	4350 m
Number of groups	:	4 x 348
Group interval	:	12.5 m
Group length	:	12.5 m
Hydrophone type	:	T-2
Streamer depth control	:	Digibird 5011
Streamer depth	:	8 m
Number of compass-birds	:	18 per streamer

7.3.2 Trace Numbering

STREAMER	TRACE
Streamer 1	1 to 348
Streamer 2	349 to 696
Streamer 3	697 to 1044
Streamer 4	1045 to 1392
Auxiliaries	1 to 48

7.3.3 Component dimensions

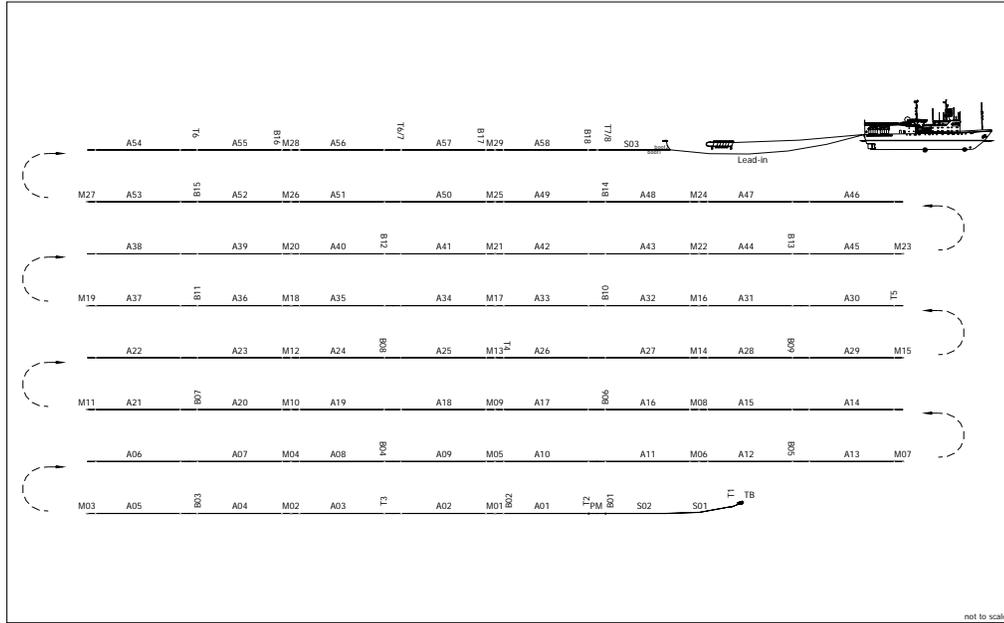
	NUMBER per STREAMER	NOMINAL LENGTH (m)
Lead-in	1	
Head AP Stretch Sections	1	3
Head Conventional Stretch Sections	1	50
Syntrak Module	29	0.358
Live Sections	58	74.54
Tail Stretch Sections	2	50
Power Adapter Section	1	3.80

7.4 Recording System

7.4.1 Recording System performance

The gAS recording system and the Syntrak MSTP system worked very well during the survey. The gAS system was installed before the start of this survey. There was no downtime associated with this system.

7.5 Streamer layout



8 Navigation and Positioning

8.1 Geodetic reference

8.1.1 Survey Datum

Survey datum	:	GDA94
Ellipsoid	:	GRS 1980
Semi Major Axis	:	6378137m
1/Flattening	:	298,2572221
<i>GPS Datum</i>	:	<i>WGS84</i>
<i>Ellipsoid</i>	:	<i>WGS84</i>
<i>Semi Major Axis</i>	:	<i>6 378 137 m</i>
<i>1/Flattening</i>	:	<i>298.257223563</i>

8.1.2 Datum shift from WGS84 to GDA94

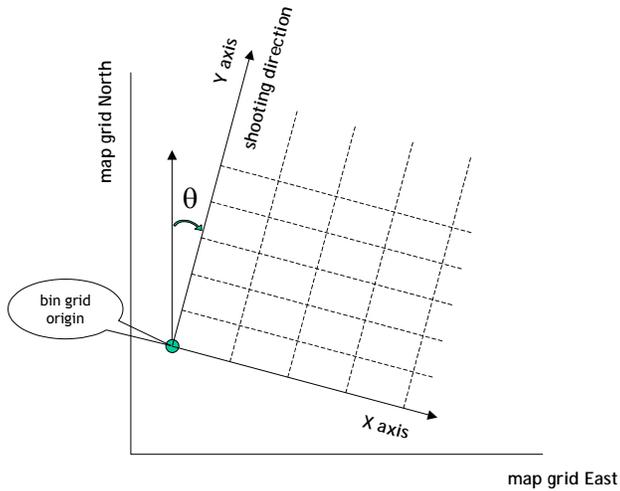
EPSG Transformation code no.	:	1150
X translation	:	0m
Y translation	:	0m
Z translation	:	0m
Geoid height	:	-1.3m

Originally the WGS84 datum was specified as the survey datum. During the project start-up meeting it was realised that the Australian authorities required GDA94 survey datum for their copy of the data. The difference between GDA94 and WGS84 is negligible for marine seismic surveys; therefore, to satisfy the authorities, GDA94 was used.

8.1.3 Map projection

Projection	:	Transverse Mercator
Projection System	:	UTM
Zone	:	55
Central Meridian	:	147° E
Scale Factor on Central Meridian	:	0.9996
Latitude of Origin	:	0°
False Northing	:	10000000m
False Easting	:	5000000m

8.1.4 Binning grid



Origin Easting (m) : 451075.27
 Origin Northing (m) : 5505002.26
 Rotation (deg) : 307.93

	X	Y
Origin bin number	961	841
Bin number increment	1	0.333
Area size (m)	15000	21300
Bin interval (m)	25	6.25
Bin size minimum (m) at 100 m offset	25	6.25
Bin size maximum (m) at 4450 m offset	75	6.25

P6/98 Full fold coverage perimeter listing : see Appendix section 12.5

8.2 Surface positioning

8.2.1 System I

Type	:	SkyFix.XP Clock/Orbit corrected GPS
Differential Corrections via	:	Inmarsat B (POR), Spot (109E APSat).
Reference stations	:	WADGPS solution
Software	:	Multifix4, version 1.07.
Sub-Contractor	:	Fugro-Survey AS.

System performance was good. The average radial difference between system I and II was 0.4 m, which is surprisingly good considering system II is a single frequency system. It was evident that the systems agreed better during the night and early morning when the Starfix.L1 position was not overly influenced by ionospheric interference.

Prior to the survey start, while the vessel was stationary alongside in Portland Victoria, a verification of the positioning systems was performed. RINEX format data was collected from our main Trimble MS750 receiver for a period of 6 hours. Twenty four hours later this data was submitted to NRCAN's free Internet-based processing service to be adjusted using enhanced orbit and clock correction data. A mean position difference between the NRCAN and system I and II solutions was determined to be better than 0.5 m in north and east directions.

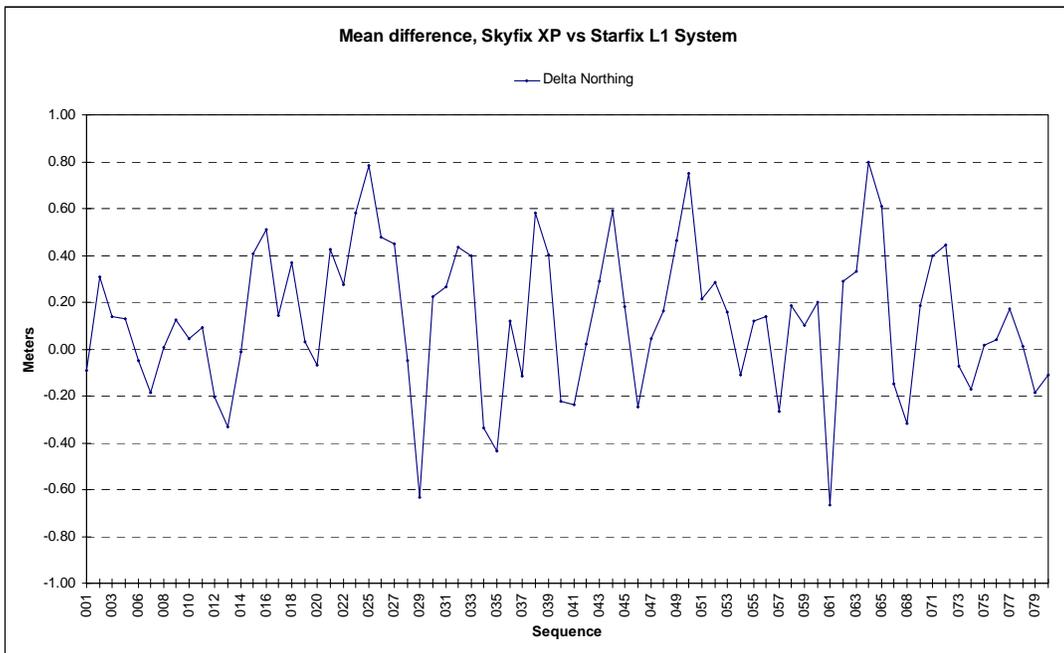
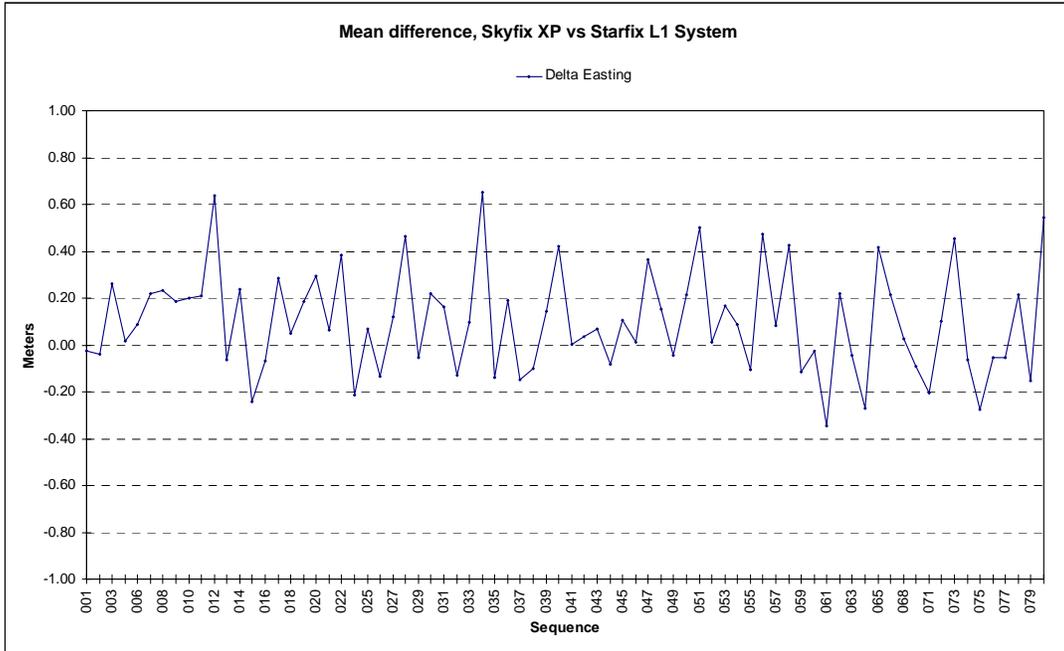
8.2.2 System II

Type	:	StarFix.L1 single-frequency, DGPS
Differential Corrections via	:	Inmarsat B (POR), Spot (109E APSat).
Reference stations	:	Melbourne 325 km distant Bathurst 850 km distant Cobar 1000 km distant Ceduna 1450 km distant Brisbane 1575 km distant
Software	:	MRDGPS, version 3.03.04., version
Sub-Contractor	:	Fugro-Survey AS.

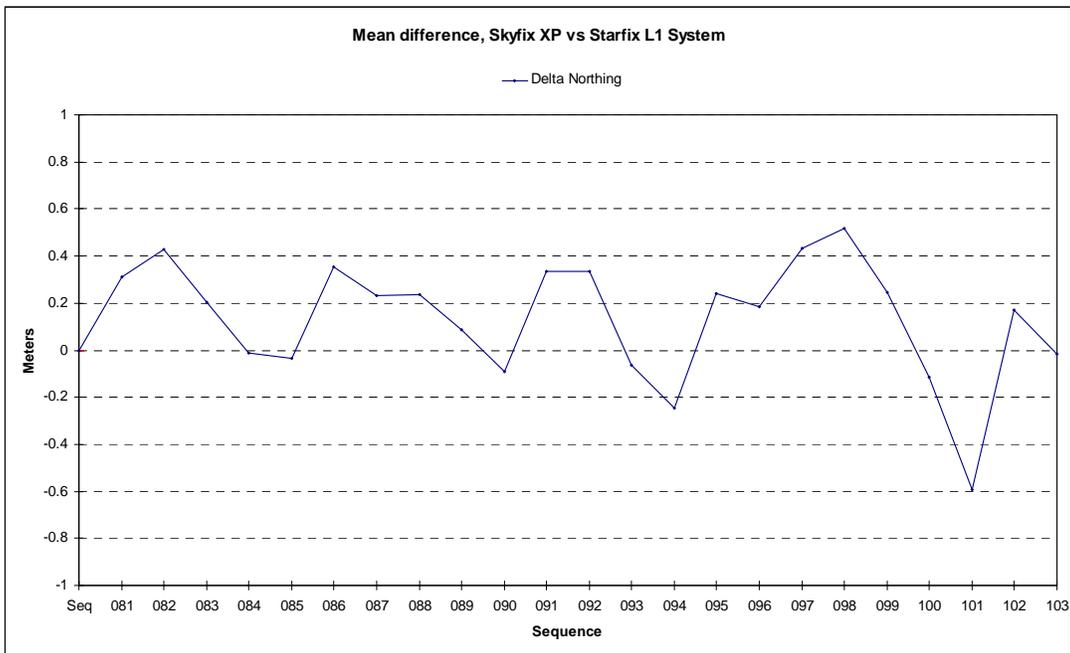
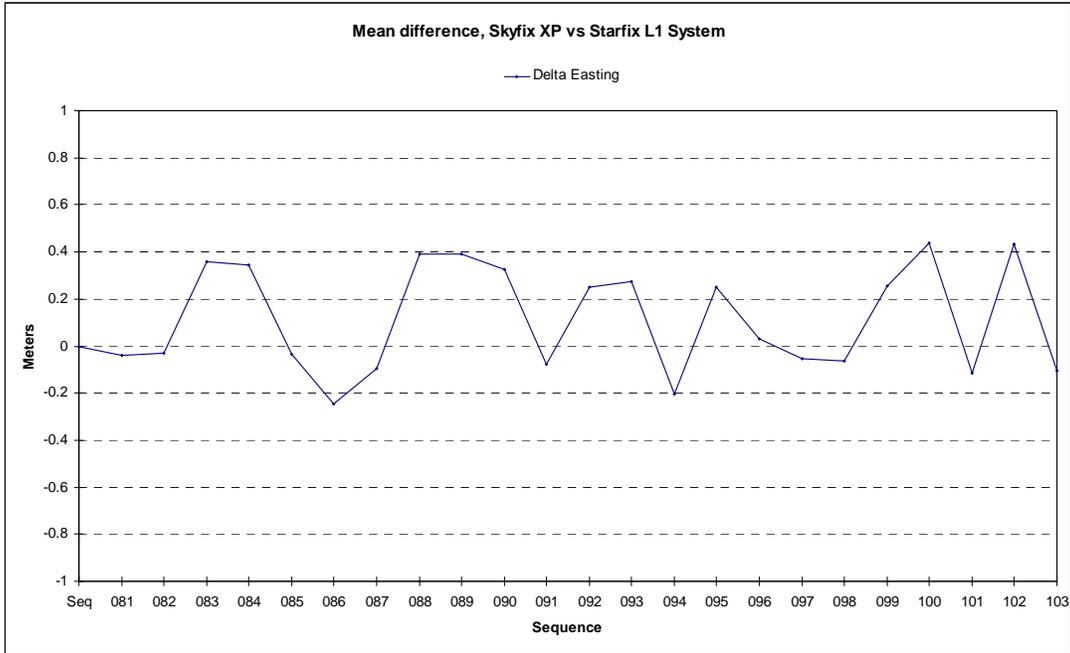
Initially the Optus Spot satellite was chosen as one of the correction sources. Unfortunately this required some older generation antenna hardware which was not available on this vessel. The solution to this problem was to use the APSat system and request Fugro to place some additional reference stations on that carrier.

From the 5 reference stations specified for this project it was possible to receive 4 of them on APSat and 3 on POR. Cobra was available only on APSat, Brisbane only on POR, and all other stations were available on both sources.

See comparison graphs between the two systems below for the 3D survey.



See comparison graphs between the two systems below for the 2D survey.



8.2.3 Float positioning

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.

Seatrack RGPS units were installed on each of the six gun strings for QC purposes only. The units on gun strings 2 and 5 were used for source positioning.

8.2.4 Heading reference

GPS Heading / Attitude system	:	Seatex Seapath 200, MRU 5.2.
Gyro	:	Litton C.Plath Navigat II.

The Seapath 200 used as the prime heading for the duration of the survey. Seapath and gyro data were de-spiked but not filtered in post processing.

8.2.5 Delivered P1/90 and P2/94

Raw navigation data were recorded in UKOOA P2/94 format during acquisition and written to 3590 tape and hard disk. At the conclusion of each sequence, the data format was checked and necessary updates made to the header to produce a final, deliverable P2/94 file. Two sets of P2/94 data on 3590 tape were delivered to the client, and one additional set on 3590 tape was archived at PGS offices in Oslo, Norway.

Processed navigation data were provided in UKOOA P1/90 format. The P1/90 data were written to 3590 tapes with individual sequence headers and included position records for vessel, sources, tailbuoys, echosounder, and all receiver groups. Two sets of P1/90 data on 3590 tape were delivered to the client, and one additional set on 3590 tape was archived at PGS offices in Oslo, Norway.

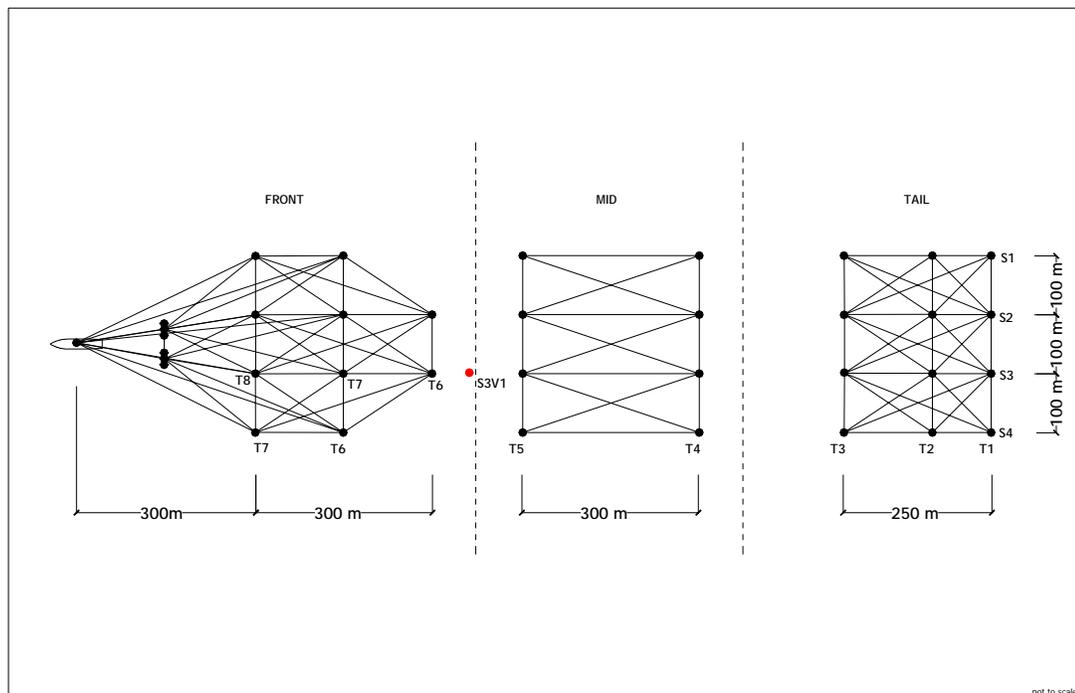
8.3 Underwater positioning

8.3.1 Acoustic ranging system

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

The acoustic ranges were good for this survey. Additional acoustics were used in the front of streamer 2 and 3 to help overcome interference from the ship's propeller wash. Reflected or unreliable ranges were removed either in pre-processing or during the netadjust process.

8.3.2 Acoustic network



8.3.3 Magnetic compasses

Bird Compasses	:	Digicourse model 5011.
Software version	:	Digicourse Sys3. version 3.1.2.
Magnetic variation	:	13.2° (IGRF 2005).

Eighteen DigiCourse compasses were deployed on each of the four streamers. The compass data was generally free of noise at the eight meter streamer depth and required only moderate gating and low-pass filtering. Compass data for all sequences were analysed for biases, stuck values and excessive noise. Unacceptable compasses were rejected from the post-processing solution and physically replaced when appropriate. The number of rejected compasses never exceeded one on any single streamer.

8.3.4 Echosounder Performance and Water Depth corrections

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

The master transducer for this survey was the 200 kHz unit. During post-processing a low-pass Wiener filter (0.05 Hz) was applied and any obvious spikes were manually removed.

The propagation velocity set in the echo sounder was 1500 meters per second. Depths were recorded at transducer level, i.e. no draught correction has been applied.

Both transducers performed well throughout the survey.

After the job was completed, one special P1/90 tape PJ05E011 containing echo sounder positions and water depths corrected for draught and sound velocity was created. A draught correction of 5.8m was applied. Full column velocity profiles were used for sound velocity corrections.

Below is shown an extraction from the header of the P1/90 tape PJ05E011. This shows what the water depth data has been corrected for.

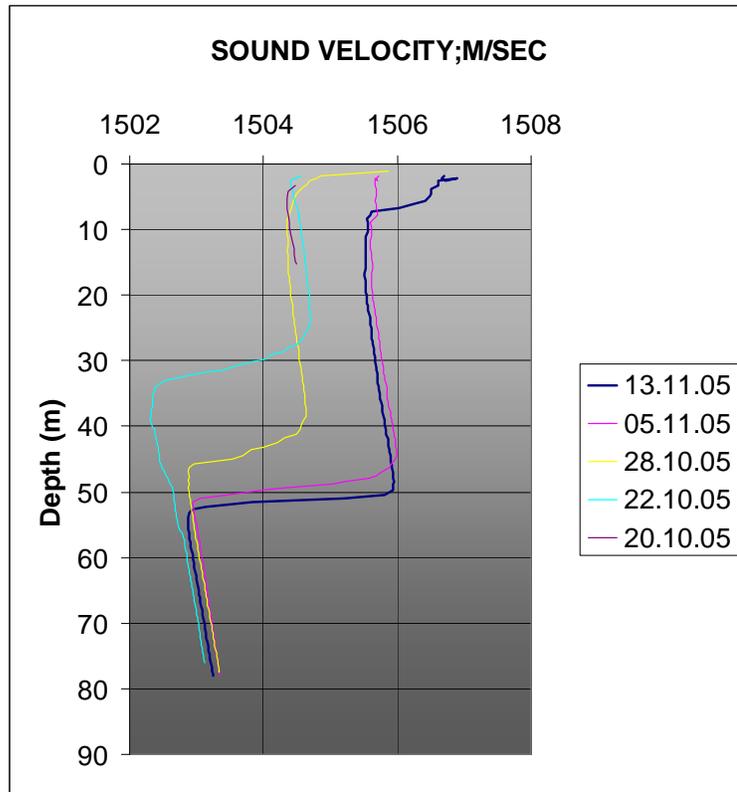
```
H2600
H2600 THIS FILE CONTAINS ECHO SOUNDER POSITIONS WITH WATER DEPTHS CORRECTED
H2600 FOR DRAFT AND SOUND VELOCITY.
H2600
H2600 SOUND VELOCITY SET IN ECHO SOUNDER: 1500M/S
H2600
H2600 DRAFT CORRECTION APPLIED: 5.8M
H2600
H2600 SOUND VELOCITY PROFILES USED:
H2600
H2600 PROFILE:          DATE:          POSITION:
H2600  2                22.10.05        40 27.4S 146 19.0E
H2600  3                28.10.05        40 32.7S 146 31.3E
H2600  4                05.11.05        40 31.4S 146 20.6E
H2600  5                13.11.05        40 27.0S 146 02.1E
```

8.3.5 Sound velocity

CDT probe : Valeport Midas SVP 5000DB s.n. 22249.
 Real time sensors : SIPS1 CT.

8.3.6 Speed of Sound Profiles

Profile no.	Date	Latitude	Longitude	SOS (m/s)	Temp. (°C)	Max. depth (m)
1	20-Oct-05	40° 28.0' S	146° 25.0' E	1504.4	14.0	15
2	22-Oct-05	40° 27.4' S	146° 19.0' E	1504.5	13.6	77
3	28-Oct-05	40° 32.7' S	146° 31.3' E	1504.4	13.7	78
4	05-Nov-05	40° 31.4' S	146° 20.6' E	1505.6	14.0	78
5	13-Nov-05	40° 27.0' S	146° 02.1' E	1505.6	14.1	78



8.4 Navigation and binning systems

8.4.1 Integrated navigation system

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).

8.4.2 Binning system

Type	:	Census.
Supplier	:	I/O
Software Version	:	4.4.1
Machine type	:	IBM F50 PowerPC (AIX4.3.2).
Tape storage	:	IBM 3950
External disks	:	54GB online, 45GB offline

9 Navigation processing

9.1 Introduction

Data were processed using SPRINT. The processing was comprised of the following steps:

- Data import
- Data pre-processing
- Network adjustments
- Data export
- Final quality control

Each of these steps is covered in more detail below.

9.2 Data import

Raw data were recorded to tape and disk in P2/94 format. After the end of the line these data were checked, and if necessary, corrections were made to the header to produce a final archived version. These data were then imported into Sprint, and a QC report generated. Included in this report were:

- P2/94 format errors or inconsistencies
- differences in configuration between successive files
- changes in gun sequence
- time between shots not within specified limit
- jump in shot numbers
- number of headers

9.3 Pre-processing

All data were pre-processed to ensure consistent results in the adjustment phase.

During pre-processing, observations were grouped by sensor type. Predefined spike rejection gates and noise suppression filters were applied to the raw data. Configuration files were used to save all gating and filter values. After analysis, the final values were applied in a batch mode.

Where circumstances dictated, the values were changed interactively before the data were batched.

After pre-processing of all the observations, a quality report was generated containing the following information:

Nobs	:	Number of raw observations.
Nrej	:	Number of data observations missing after processing.
Bad block	:	Maximum block of missing raw data (in seconds).
Nominal	:	Nominal values computed from the logged offsets, or user assigned.
Mean	:	Mean value of the observation.
Max. Delta	:	The maximum shot to shot increment.
Units	:	In which unit data is recorded.

9.4 Network adjustments

The network adjustment stage consisted of a least squares adjustment of the processed observations for each shot point. The software allows the observations to be treated as either a complete net, or a series of sub nets (e.g.: vessel antenna, front net, tail net, etc.). Sub nets were used for analysis of problem lines. A complete net was used for final adjustment after the individual sub nets were solved.

The streamer-shaping algorithm in use was an arc of curve fit through the pre-processed compasses. The streamer shape is adjusted through network computed node positions.

At the end of the net adjustment, a quality report was generated. Items included were:

- Network configuration
- Statistics on node covariances
- All observations scale/correction/SD in use
- Statistics on node shot point intervals
- Statistics on observation residuals
- Statistics on network variance factor and degrees of freedom
- The error ellipse (semi-major axis/skew) of all defined nodes
- Streamer rotation

9.5 Data analysis

Data analyses were performed for all lines and allowed all data from the Postgres database to be displayed. There were two main uses for this facility. The first was to produce a standard set of QC plots for each line, and the second was to act as an investigation tool for problems seen at any stage of processing.

Configuration files were defined to create a standard set of QC plots for every line. The following plots were included:

- Inline streamer misclosures
- Streamer rotations
- Streamer feather angles
- Streamer separations
- Source and source sub-array separations
- Offsets for vessel to sources and sources to near hydrophone groups
- Shot point intervals (distance and time) of vessel position
- Gyro and course-made-good of vessel
- Vessel position comparison (Field position vs. Post-processed position)
- Network variance factor and degrees of freedom
- Speed of sound in water
- Water depth

9.6 Data export, P1/90 output

During the export process the receiver positions were computed and a P1/90-file was generated. The in-line misclosure error was accounted for by applying a linear distribution of the error to computed receiver positions. A header was added to the data during export.

The data were written to 3590 tape cartridges.

9.7 Data quality control procedures

The first line was sent to the office for QC. Both the P1 and P2 headers were checked. The line was processed and the solution was compared with the P190 file from the vessel. This procedure was repeated after crew change to make sure there were no errors introduced. In addition, lines were sent to the office when the QC parameters exceeded the thresholds given in the PGS standard procedures, or the Client's specifications.

The final P2/94 tapes were checked using PGS internal software p2list. This program checked and returned the following information:

- Which files were on a tape and if each file had a complete header.
- Number of end-of-file markers and if the last record had an EOF mark.
- The filename, the sequence, the media label identifier (H0003), the number of shots, the number of shot inconsistencies (missing or double shots) and the number of records.
- A checksum, which were used to verify that data on tape were identical to data on disk.
- For every file the first and last E1000 record was printed.
- If there were shot inconsistencies, the E1000 records surrounding the inconsistency were printed.

Final quality control performed on the data included a number of streamer comparisons, both inline and streamer-to-streamer.

- Vessel, source and receiver positions were checked for internal consistency.
- The applied streamer rotations and the inline misclosures were checked.
- Latitude/longitude and grid coordinates were checked against the datum/projection defined in the header.
- PGS internal software was used to plot the rotated and unrotated streamer shapes. The unrotated plots provided a plan view of the post-processing results. The rotated plots displayed the streamer shapes for every shot at a 90 degree rotation; this allowed the shot to shot consistency to be checked.

The final P1/90 files were also checked using a Sprint QC tool, which checked:

- Contents of the first and last vessel record.
- Source id of the first and last source record.
- Number of even and odd shot points with different source id.
- Number of header records found.
- Number of vessel, source, tail buoy and receiver records expected and how many were found.
- Number of new line characters found.

The final P1/90 files were checked using a PGS internal software p1plot. This program checked and returned the following information:

- Tape name and date of issue.
- Datum/projection information from the header.
- For every line in the file: start/end shot and start/end co-ordinates.
- Standard comment record (H2600) concerning lines and shots in the file.
- Linefeeds in the file.
- All records 80 bytes long.
- Number of end-of-file markers and if the last record had an EOF mark.
- Grid co-ordinates correspond to the latitude and longitude with the given datum and projection.
- A checksum, which were used to verify that data on tape were identical to data on disk.

The final P1/90 tapes were checked using PGS internal software p1list. This program checked and returned the following information:

- Which files were on a tape and if each file had a complete header.
- Number of end-of-file markers and if the last record had an EOF mark.
- The filename, the tape version identifier (H0202) and the number of records.
- A checksum, which were used to verify that data on tape were identical to data on disk.
- For every line in the file the line name, FSP, LSP and the position of SOL and EOL was given.

Results of the P2list, P1list and p1plot were saved and copies are archived in the Oslo office.

All tape labels were created using PGS internal software mklab. All information on the labels was extracted from the files on the tapes.

9.8 Computer systems

Computer	:	BM RS/6000 7025-F50
Operating System	:	AIX 4.3.3.0 ML 10
Tape storage	:	2x IBM Magstar 3590 B1A
External disks	:	RAID5 SSA (Serial Storage Architecture) 64GB
Type	:	SPRINT
Software version	:	3.1.20
Supplier	:	Concept Systems Ltd.
Printer / Plotter	:	HP LaserJet 4200 / DesignJet 755CM

10 Seismic data quality

10.1 Seismic interference

The area was free from any seismic/industrial noise.

10.2 Swell noise

In order to minimize swell effect on the data, agreement was reached to shoot lines at 9 or 10 meters in borderline conditions.

Weather conditions varied a lot during the survey. Most lines were shot in calm weather but the following sequences were affected by minimal swell noise:

2,13,14,16(shot at 9m),17,40,41,42,43,46,61,87. Far traces were more affected by this light swell noise.

A few sequences were more seriously impacted by swell:

Sequence 15 (5% of traces affected, 5-6 μ B background noise, SN stacking below 3sec). This line show good data and was accepted.

Sequence 24 was started in marginal conditions (8 μ B background noise). Situation rapidly worsened (finishing 15-20 μ B background noise with 30%+ of traces affected, SN bursts contaminating target zone at 1 sec) and the line was Not To Be Processed (NTBP).

Sequence 25 was shot at 10m depth in moderate swell noise:

7-8 μ B background noise, 10-15% of traces affected, a few Swell noise bursts appeared at the bottom of the target zone (1,5sec). For this sequence SINK (PGS SI and swell noise attenuation process) was successfully applied, showing good swell attenuation and good reflectors integrity. Line was accepted.

10.3 Ship noise

No significant ship noise observed in this area situated away from shipping lines.

10.4 Bad channels

The RMS level of spiky/noisy channels has been checked against specification and observer logs updated accordingly. The number of bad channels remained within contract specifications with an average of less than 1% of traces being bad.

For 2D lines, all 4 streamers were recorded with one source firing. We thus run normal QC procedure on all 4 streamers for any streamer to be used for 2D processing.

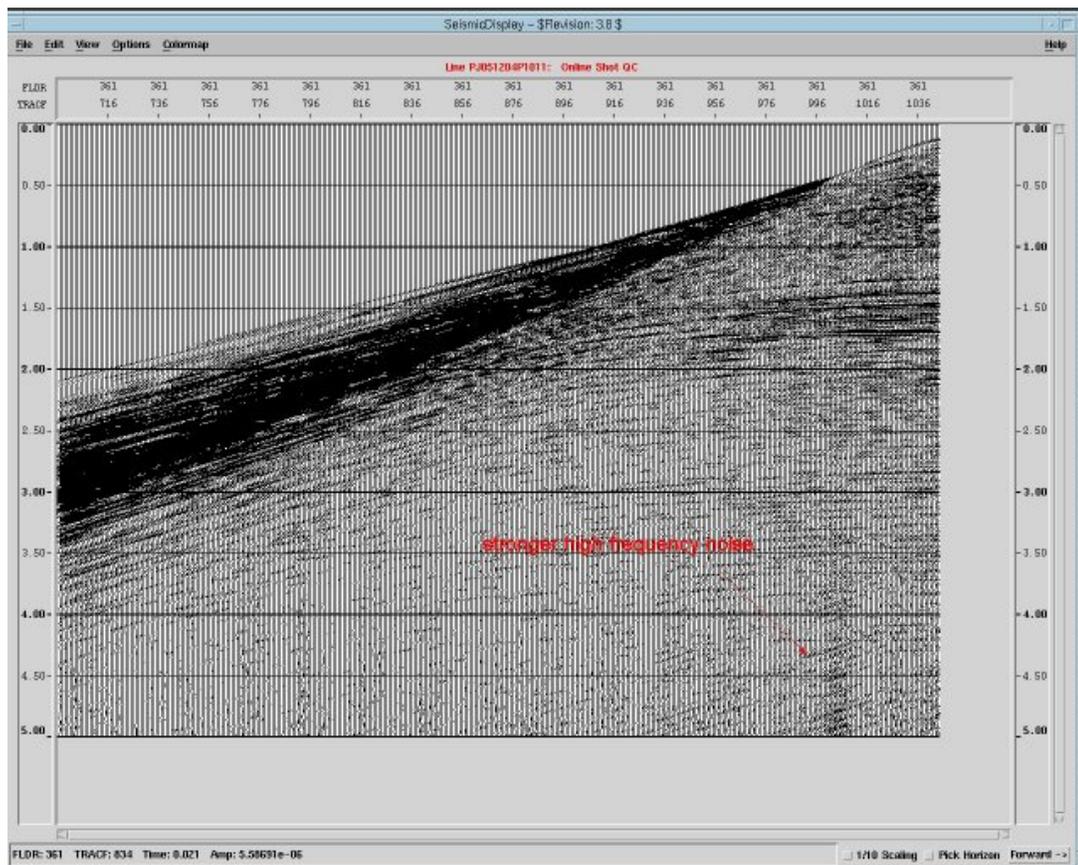
10.5 RMS and noise analysis

Cross-feed spikes:

We experienced cross-feed spikes at the beginning of the survey. On sequence 09, streamer 4 was affected. A few channels only (16) were affected for random Shot Points (13). SP/trace combinations were included in edit list in the observer log.

On sequence 10, streamer 1 was affected by moderate amplitude cross-feed spike. Most channels were affected and the all streamer was edited for the shot Point range affected (166 shots removed from coverage).

Reflection from Ship's screw noise:



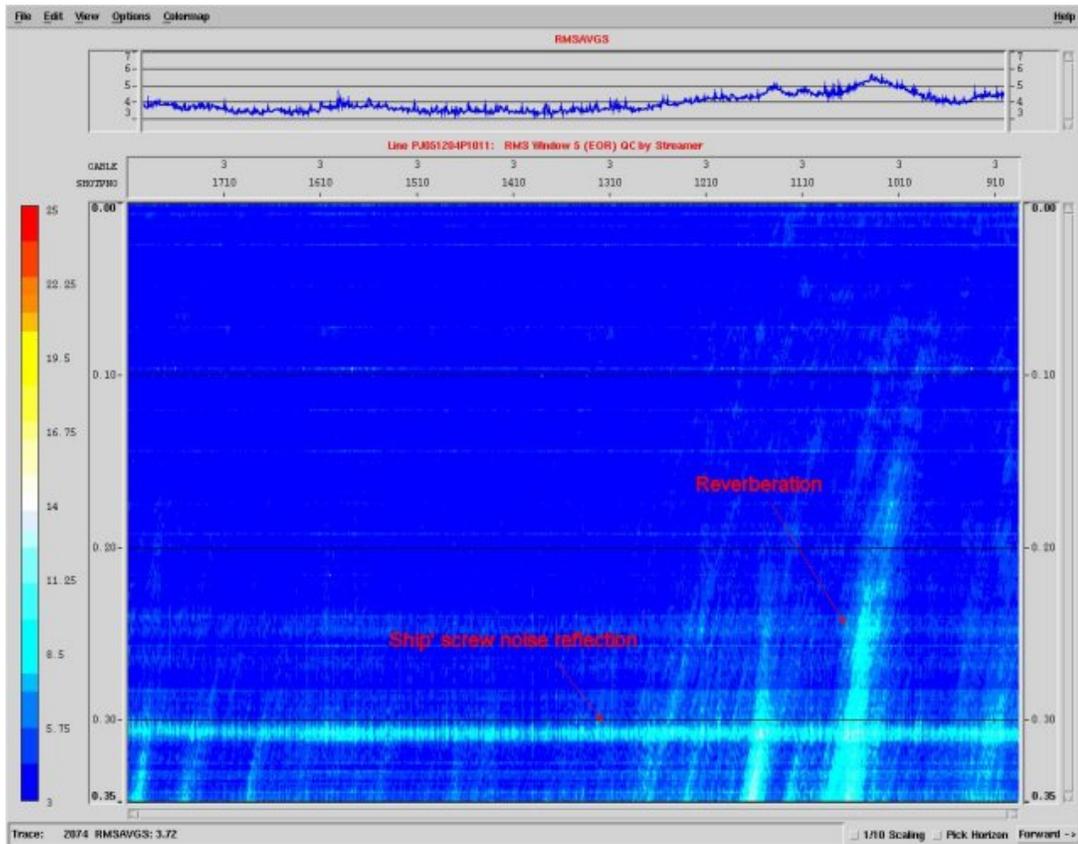
Example of ship' screw noise reflection on sequence 11, streamer 3.

During the all survey, near traces situated in a limited range, typically 300-320, show stronger screw noise.

The noise is broad/high frequency ranging 40Hz-Nyquist with roughly water velocity.

The reason for this offset range to be more affected is related to the critical angle of the reflection. For shorter offset (< critical angle) the energy is mostly absorbed in lower layers and at critical angle there's a maximum of the amplitude being reflected to the surface, fading out on longer offset.

This noise is low amplitude, typically 5 μ B above ambient noise with constant move out and should not alter data quality.



Ship' screw noise reflection as seen on End Of Record RMS window. Sequence 11, streamer 3

Note: Vertical axis is channels and horizontal axis is shots. Every channel amplitude ranges from blue (less than 3 μ bar) to red (more than 25 μ bar).

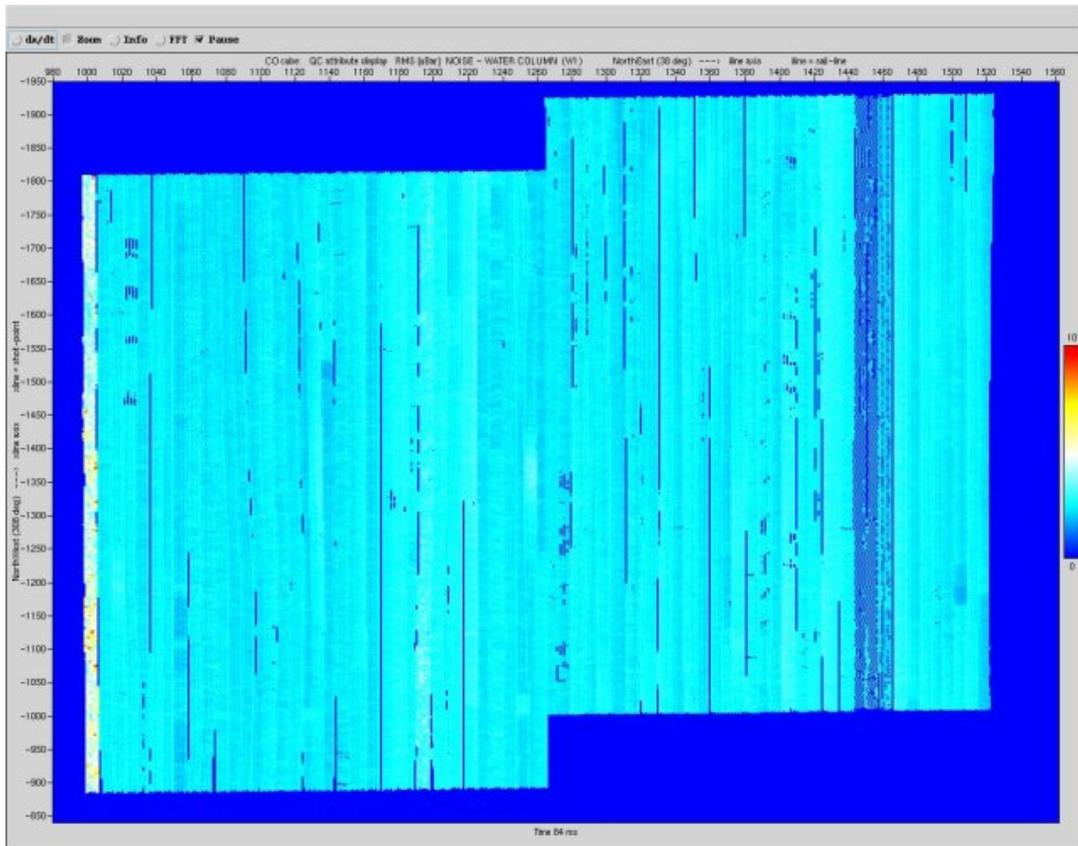
Front end noise:

During this survey, front end noise was remarkably low. The above display is typical of the absence of significant tug or strum noise. Minimal tug noise on streamer 1 only could be monitored for time to time.

RMS area display:

In addition to a line-by-line analysis, some maps of different RMS windows were generated, in order to compare the amplitudes over the whole survey. This shows the good quality of the data. Note the most westerly line (sequence 25) is showing stronger background noise since affected by swell noise.

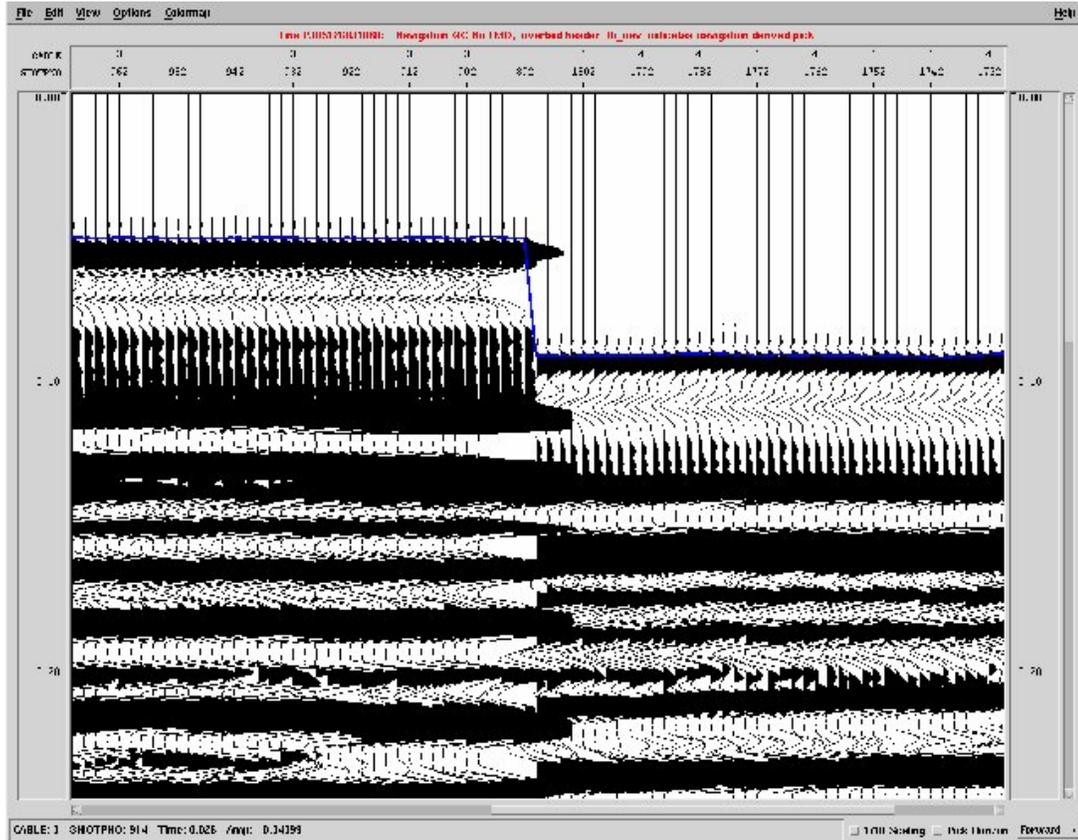
Missing pixels are due to artefact when merging RMS file with navigation.



Ambient RMS (shallow window) PJ3D project.

10.6 First break / P1 offset check

This display would show any mismatch between the direct arrival time and the navigation derived pick. Any trouble was investigated further by the Navigation processor. The quality of navigation data on this prospect was very good, with differences typically much less than 4ms.

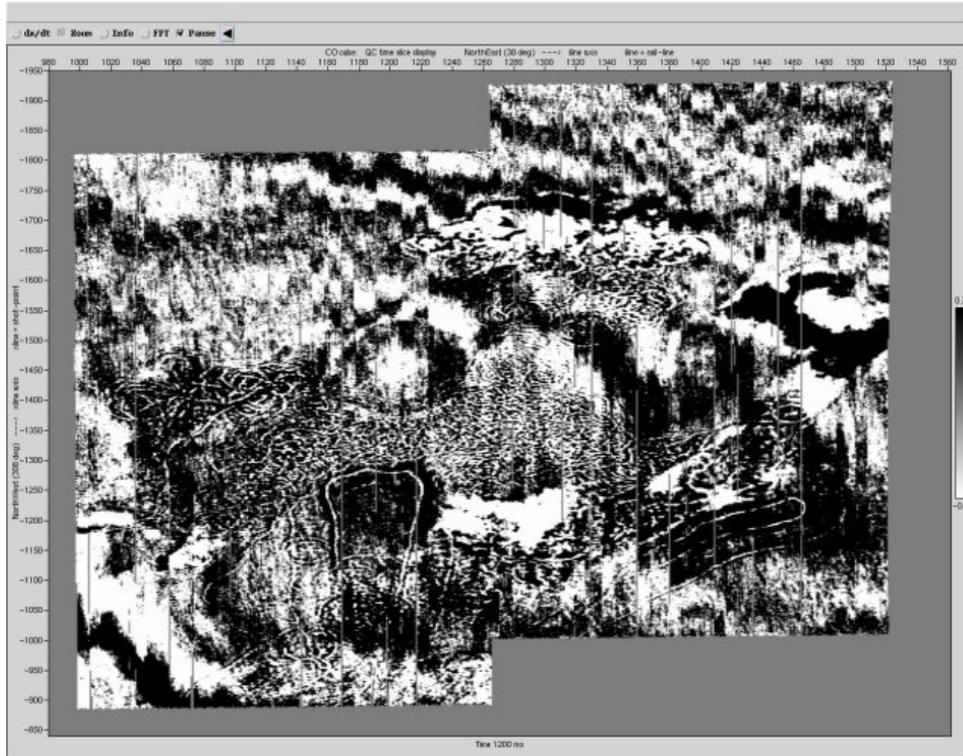


Overlay of navigation derived pick versus direct arrival, seq. 80

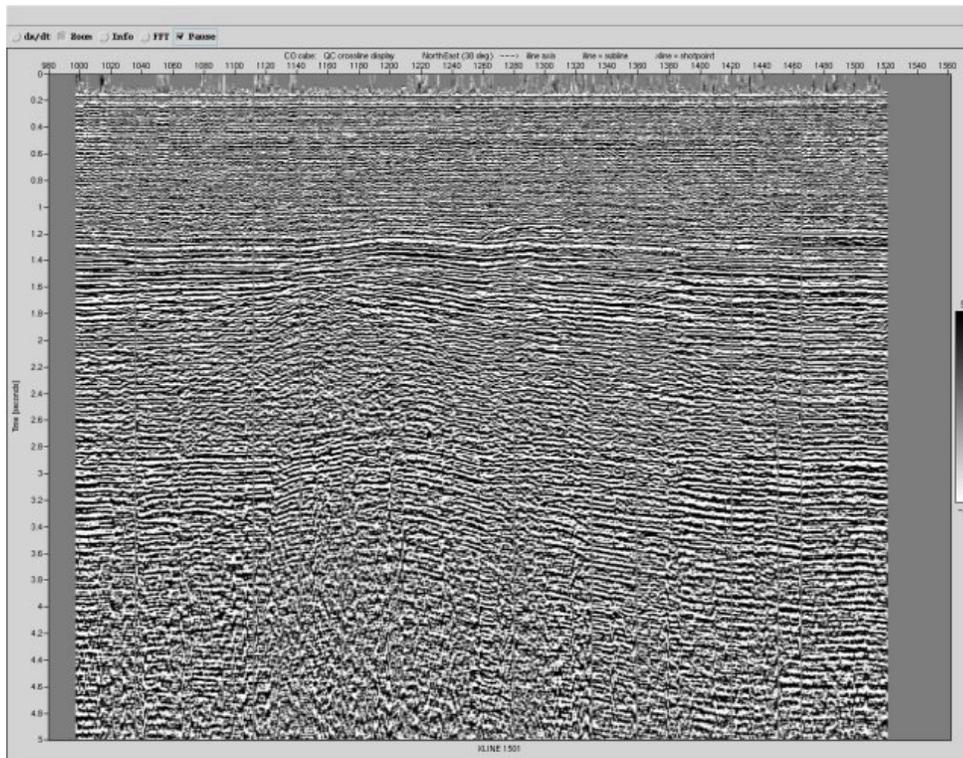
10.7 Common offset cube

For PJ3D only:

Inline, cross-line and time-slice displays were produced and analyzed at regular intervals in order to detect any miss-ties between the seismic and navigation data. The tie between adjacent sail lines and swathes was good; there were no visible data shifts visible on the time-slice displays.



PJ3D, CO trace cube, Time Slice at 1200msec



PJ3D, CO trace cube, Cross Line at SP 1501

10.8 Brute stack QC

Brute stacks were generated after completion of each line. Any visible problem on the brute stacks was investigated. Brute stack had basic processing involved (deconvolution for multiple attenuation) and was tuned for noise detection and in no case for signal to noise enhancement.

These stacks were used to analyze the potential effects of more generalised noise on the data quality of the final stack, such as swell noise.

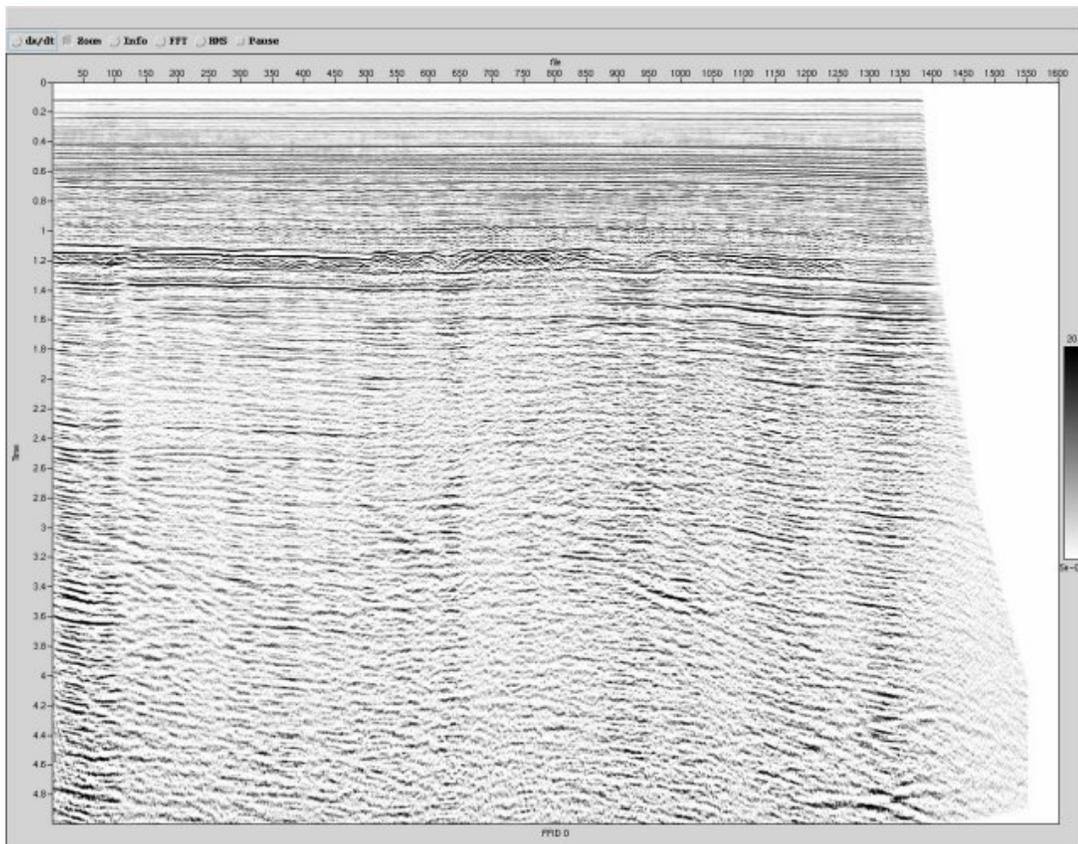
The stacking process usually proved to be effective for adequately attenuating low amplitude swell noise.

For 2 lines (24, 25) shot in bad weather, the stack quality (signal to noise ratio) appeared to be questionable. SINK tests (PGS proprietary SI/swell noise attenuation process) were run on these 2 lines.

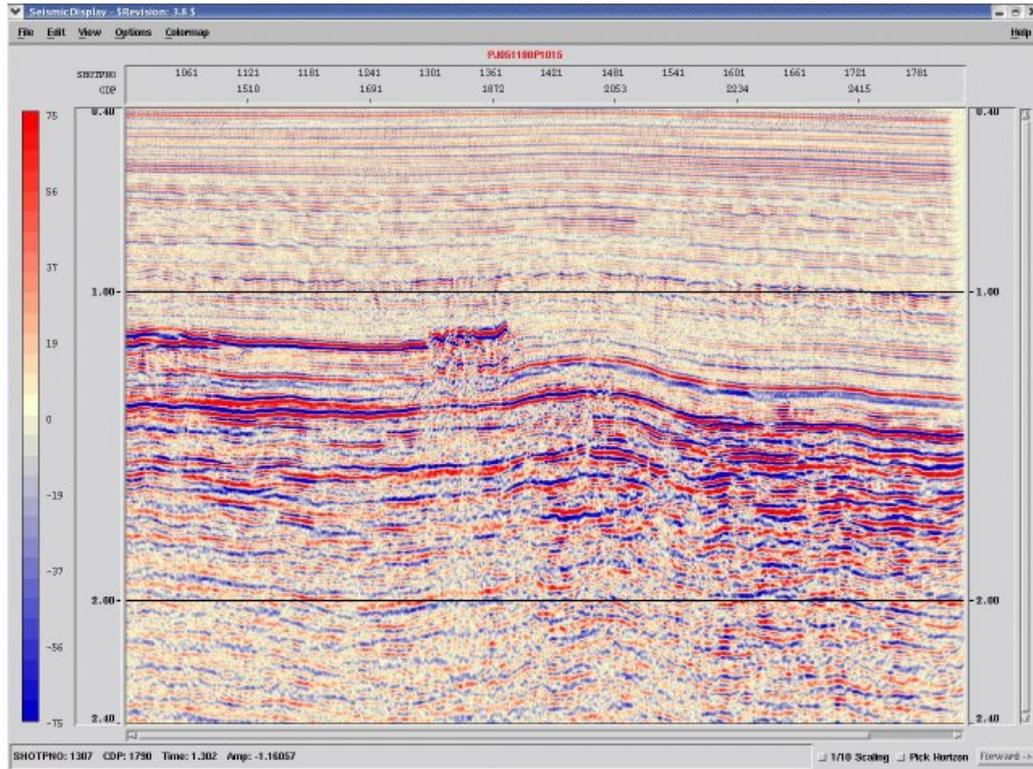
SINK indicates how successful subsequent data processing swell noise removal efforts would be and help us to assess rejection/acceptance of line.

Sequence 24 only was Not to Be Processed due to strong swell noise.

Data quality is very satisfying with clear reflectors in the target zone (1 to 1.5 sec) associated with complex structures: faults, amplitude anomalies. Some deeper structures were also visible.



Brute stack from sequence 80



Target zone, zoom of migrated brute stack on geological structure. Line 1188P1015

11 QC Processing

11.1 Online QC

All recorded seismic data and RMS values were captured to the Viper QC disk in real time using Bit3 card. Auxiliary channels and RMS value files were also written to the gAS system disk in SEG Y format for subsequent retrieval for QC analysis.

In the event of a failure of gAS or data capture, seismic data (streamer traces and auxiliary traces) were read in from field tapes via Viper. RMS files were regenerated offline in the gAS system.

Online displays:

RMS values for each window/shot/streamer were recorded during line acquisition and the 2 ambient windows (water column, End Of Record) were displayed for QC proposes via the gAS recording system. Shot to shot (port vs. starboard) RMS levels were displayed for the direct arrival and the two signal windows to assist in identification of source output differences caused by air-leaks and air pressure drops.

All 4 streamers were also displayed each shot for noise detection (spike, external noise, bad traces).

gAS instrument QC displays were run to detect spikes, misfires, auto-fires, extraction count errors and parity errors and to monitor streamer depths.

gAS displays were also used to QC the auxiliary traces: stack of auxiliaries display and individual auxiliaries display for each shot to highlight bad shots. Also, gun QC hydrophone trace segments (approx 130ms) were spliced together to form single traces representing each source and displayed.

11.2 Offline QA/QC sequence

Raw shots:

One shot was plotted for all streamers to assess trace polarity and search for bad channels.

Every 41st shot (rotating streamer) was also displayed on screen for this purpose. Any dubious shot from any streamer could also be displayed for further analyze.

Gun QC:

Auxiliary Near field channels were time limited and spliced together to form a single trace per sub-array and displayed for air leak QC. Each single trace (time limited to explosion peak and first bubble pulses) was also displayed full screen (no splice) every 10 shots.

Auxiliary channels were also stacked by common sub-array for each shot and displayed by gun_mask as a full time record to identify auto-fires.

Auxiliary time-break channel was also displayed for all shots for Time QC.

RMS QC:

RMS values for water column, End Of Record and the 2 signal windows were reviewed for each streamer. RMS amplitude for each shot/streamer are converted to trace samples and displayed. Noisy, spiking and weak channels were determined this way. External noises like swell noise, ship noise, SI were also identified.

11.2.1 2D QC stack

Brute stack was generated after completion of each line. The stack was done for a combination of one source and one streamer on rotation basis.

The processing flow used for these stacks was as follows:

- Instrument static of -120ms.
- 2D geometry. SP annotated at midpoint of source and near group.
- Combined initial low cut and anti alias filter: 3-6-90-120Hz/zero phase/Ormsby bandpass (trapezoidal)
- Resample from 2ms to 4ms.
- Edit bad channels.
- True amplitude recovery: T^2 from 0 to 5000ms; Gain = 2db/sec to 5000ms.
- 2:1 trace decimation using differential NMO.
- Predictive deconvolution: gap length 24ms, operator length 240ms.
- Normal move-out function using automatic semblance picked velocities output on a 2km grid.
- Pre-Stack (post NMO) mute.
- 2D CDP stack, normalisation (mean of stacked amplitudes).
- Gun and cable depth static correction: -9.0ms
- Dataset archive in gAS and SEG Y format.
- CGM Plot with appropriate plot gain.

11.2.2 Navigation / seismic merge QC

In order to check the near offsets, the P1/90 navigation files were merged with the seismic data. For each streamer, the direct arrival for nearest traces was displayed with a superposed navigation-derived offset predictive arrival. This arrival time was calculated using navigation source-receiver offset from final processed P190 navigation file and water velocity from TS dip at shooting depth. Apparent miss-closures were discussed and resolved with Navigation Processing personnel.

11.2.3 Common offset cube

As a further means of testing the accuracy of the tie between seismic and navigation data, a common offset cube was built.

A common offset trace (250m offset) was selected for each streamer and merged with the final processed p190 navigation data and loaded into a cube volume in VIPER system. This product had minimal processing (resample at 4msec with appropriate anti alias filter), the aim was to look for time shifts indicating recording errors and potential miss-ties at swath or sail line boundaries.

Inline, cross-line and time-slice displays were produced and analysed at regular intervals in order to detect any miss-ties between the seismic and navigation data.

11.2.4 Attribute cube

The gAS/Syntrak RMS data were used to compute mean RMS value for every shot point on each of the streamers. The value was calculated using a fixed selection of channels on every streamer for the water column window (1) and first signal window (3). These attributes were assigned to trace sample locations defined by the Common offset data cube grid and merged with the P190 navigation file.

Window 1 - Averaged over channels: 13 - 313 (far 12 and near 36 excluded from calculation)

Window 3 - Averaged over channels: 13 - 313 (far 12 and near 36 excluded from calculation)

The channel ranges were limited in this way to better define the energy types found in each window. Window 1 was limited to channels not affected by the direct arrival and tail noise. Window 3 was also limited to avoid front-end and tail noise.

Several other QC attributes were also loaded into the Viper attribute cube in this manner, including the signal to noise ratio calculated using Signal window 3 and Noise window 1. Aerial attribute cube images of these attributes were analyzed on a regular basis to identify noisy lines or line segments related to geology, weather, or external noise sources.

11.3 RMS and noise analysis

The following windows were computed online by gAS system:

RMS	Window 1	Ambient Noise	120-300ms	Water Column
RMS	Window 2	Direct Arrival	-250-500ms	Water bottom time relative
RMS	Window 3	Signal 1	500-1000ms	Water bottom time relative
RMS	Window 4	Signal 2	1004-4000ms	Water bottom time relative
RMS	Window 5	Ambient Noise - Deep	4500-5000ms	End of Record

11.4 Computer systems

Viper QC system:

Three IBM x335 slim nodes running RedHat Linux V7.3 and Viper (PGS proprietary) software:

Mamba : 3.2GHz CPU, 2GB RAM, 2x 282GB SCSI disks
Cpu01 : 2.8GHZ CPU, 2GB RAM, 2x 282G SCSI disks
Cpu02 : 3,066GHZ CPU, 2GB RAM, 2x 282GB SCSI disks

HP Procurve 2708 network switch - 8x 10/100/1000Mbps Ethernet ports.

3x 3590 tape drives connected to 2 nodes via Differential SCSI adapters.

One node has a gigabit Ethernet connection to the gAS recording system for real-time transfer of SEGD data.

ProMAX Off-line System:

IBM RS/6000 595 running AIX and ProMAX 2D version 1998.1

2 x 256 Mb Physical memory, 2 x 73 Gb Disk, 2 x 9 Gb Disk, 2 x IBM GTX150M Graphic Adapter.

Plotter:

Oyo GS 624 thermal plotter

12 Appendix

12.1 Data shipments

Data dispatches			Place:	Burnie				
PO/CI #	Dept	Contents	To	# Boxes	Weight	Date Sent	Date Rx	
OR112801029A	Seismic	Seg D 3590s, monthly tests, QC plots, Nav P190s & P294s, line logs.	PGS, Perth	9	71 kg	16.11.05		

12.2 Additional navigation deliverables

The following deliverables were issued from PGS offices in Oslo after the survey was completed.

- Vessel position tapes, PJ05V011, PJ2DV011
- Processed water depth tape PJ05E011, with corrected water depths (corrected for draft, sound velocity & tide).
- P6/98 binning grid tapes PJ05_P6/98
- Vessel pos. plots Scale 1:50 000.
- Contour plot, Scale 1:50 000.
- Coverage maps, all zones unflexed scale 1: 50 000.

The plots were delivered on paper and CD-Rom in cgm format. The CD-Rom file also included P6/98 binning grid file.

12.3 Source modelling



SIGNATURES FROM MARINE AIRGUN SOURCE LIBRARY

NUCLEUS - Marine Source Modeling 4.3.1

Modeling by Steve Campbell, PGS Technology - Geophysical Support, September 16, 2005

Survey name	:	Benaris Energy NV
PGS project No	:	2005103
Survey area	:	PJ3D/PJ2D
Vessel	:	M V ORIENT EXPLORER
Array	:	2500LB_60_1800_100
Source type	:	Bolt 1500/600B
Source volume	:	2500 cu.in.
Air pressure	:	1800 psi
Source depth	:	6.0 m
Subarray separation	:	10.0 m
Recording filter	:	Syntrak-24bit system, 3(12) - 206(276) Hz (dB/oct.)
Receiver depth	:	8 m
Hydrophone group length	:	12.5 m
Compensating p-plugs	:	in
Full system response* filter name	:	S-24 g-6.25
Sea temperature	:	15° C

Enclosed are:

Figure 1: Array configuration top view, i.e. positive Y denotes starboard.

Figure 2: Modeled far-field signature and amplitude spectrum with 24bit recording filter (without receiver ghost).

Figure 3: Modeled far-field signature and amplitude spectrum with DFS-V recording filter (without receiver ghost).

Figure 4: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (without receiver ghost).

Figure 5: Far-field signature listing with 2 ms sampling interval (without receiver ghost).

Figure 6: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (with receiver ghost).

Figure 7: Far-field signature listing with 2 ms sampling interval (with receiver ghost).

Figure 8: Directivity plot for constant azimuth of 0° and 90°.

* Full system response contains the effect of the recording filter including the effects due to the hydrophone capacitors connected in parallel.

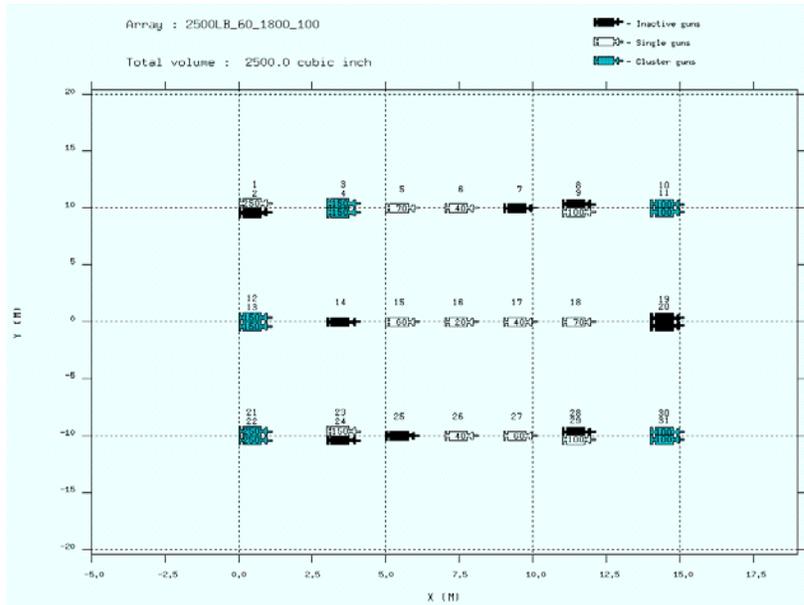


Figure 1: Array configuration top view, i.e. positive Y denotes starboard.

ARRAY LISTING

GUN #	GUN TYPE	X (m)	Y (m)	Z (m)	VOLUME (cu.in)	PRESSURE (psi)	WSK	DELAY (ms)	CLUSTER NUMBER
1	13	0.00	10.40	6.00	250	1800	1.00	0.00	0
2	13	0.00	9.60	6.00	250	SPARE	1.00	0.00	0
3	13	3.00	10.40	6.00	150	1800	1.00	0.00	1
4	13	3.00	9.60	6.00	150	1800	1.00	0.00	1
5	13	5.00	10.00	6.00	70	1800	1.00	0.00	0
6	2	7.00	10.00	6.00	40	1800	1.00	0.00	0
7	13	9.00	10.00	6.00	60	SPARE	1.00	0.00	0
8	13	11.00	10.35	6.00	100	SPARE	1.00	0.00	0
9	13	11.00	9.65	6.00	100	1800	1.00	0.00	0
10	13	14.00	10.35	6.00	100	1800	1.00	0.00	2
11	13	14.00	9.65	6.00	100	1800	1.00	0.00	2
12	13	0.00	0.40	6.00	150	1800	1.00	0.00	3
13	13	0.00	-0.40	6.00	150	1800	1.00	0.00	3
15	13	5.00	0.00	6.00	60	1800	1.00	0.00	0
16	2	7.00	0.00	6.00	20	1800	1.00	0.00	0
17	2	9.00	0.00	6.00	40	1800	1.00	0.00	0
18	13	11.00	0.00	6.00	70	1800	1.00	0.00	0
21	13	0.00	-9.60	6.00	250	1800	1.00	0.00	4
22	13	0.00	-10.40	6.00	250	1800	1.00	0.00	4
23	13	3.00	-9.60	6.00	150	1800	1.00	0.00	0
24	13	3.00	-10.40	6.00	150	SPARE	1.00	0.00	0
25	13	5.00	-10.00	6.00	70	SPARE	1.00	0.00	0
26	2	7.00	-10.00	6.00	40	1800	1.00	0.00	0
27	13	9.00	-10.00	6.00	60	1800	1.00	0.00	0
28	13	11.00	-9.65	6.00	100	SPARE	1.00	0.00	0
29	13	11.00	-10.35	6.00	100	1800	1.00	0.00	0
30	13	14.00	-9.65	6.00	100	1800	1.00	0.00	5
31	13	14.00	-10.35	6.00	100	1800	1.00	0.00	5

THE GUN TYPES ARE: 13: BOLT 1500 LL 2: BOLT 1900C

"WSK" IS THE RATIO BETWEEN THE PRIMARY VOLUME AND TOTAL CHAMBER VOLUME IN A BOLT 1500C GUN (TYPE 1) WITH WAVESHAP KIT

N.B: Spare guns 14, 19 and 20 in the diagram on page1 of this document are not present, and have therefore been removed from this listing.

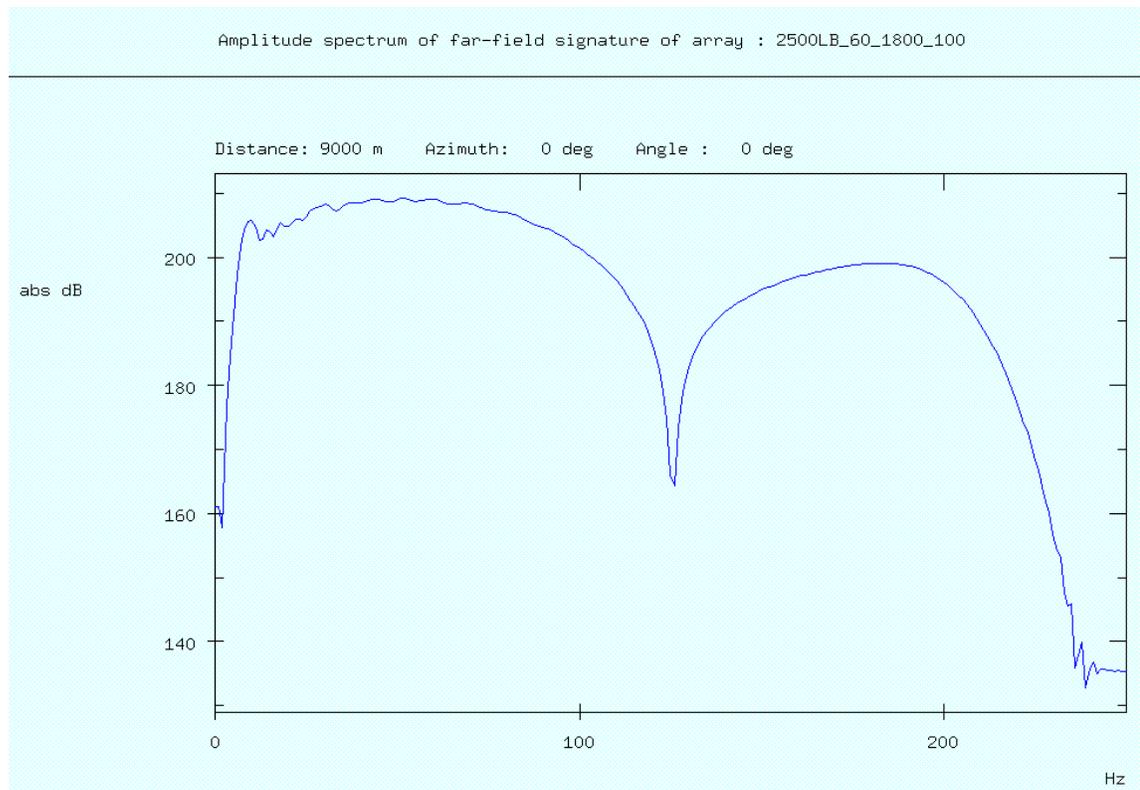
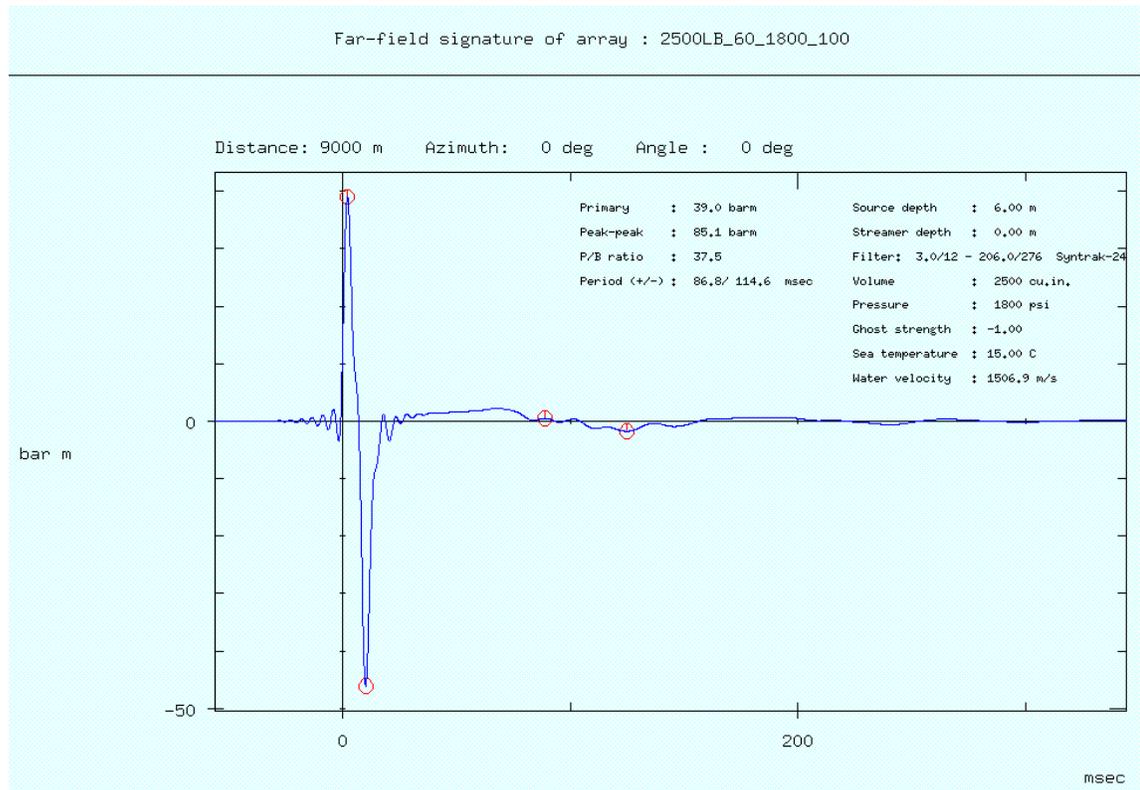


Figure 2: Modeled far-field signature and amplitude spectrum with 24bit recording filter (without receiver ghost).

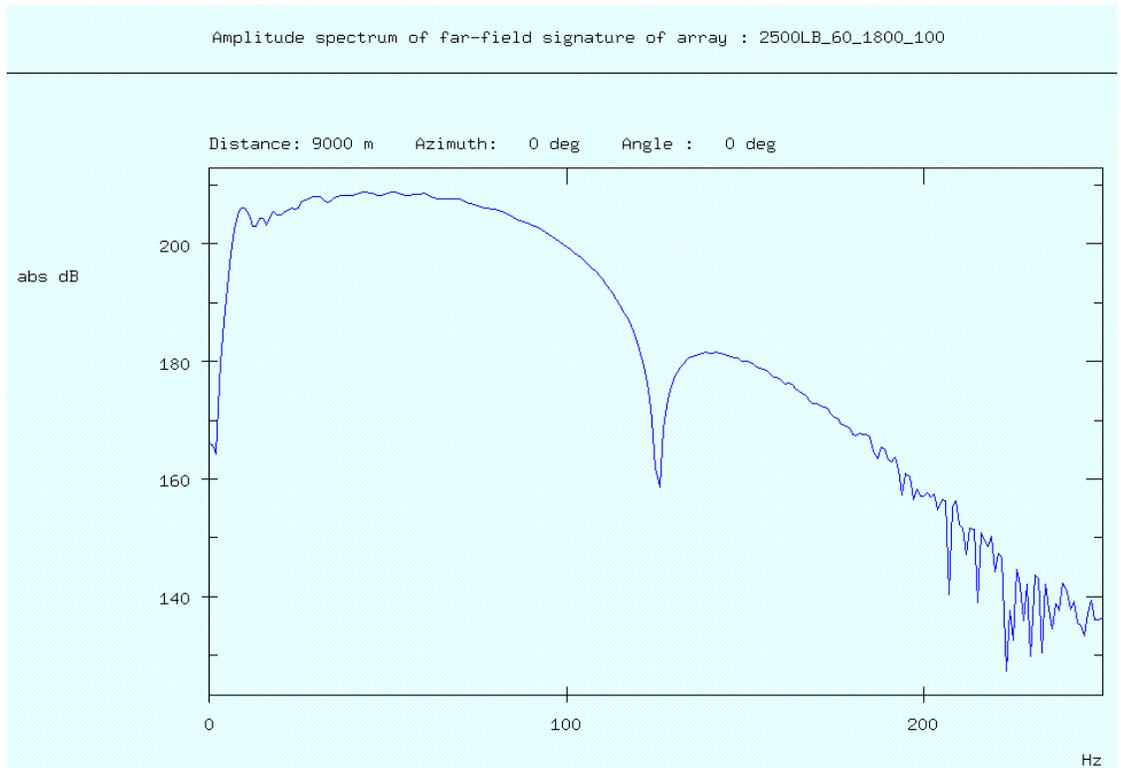
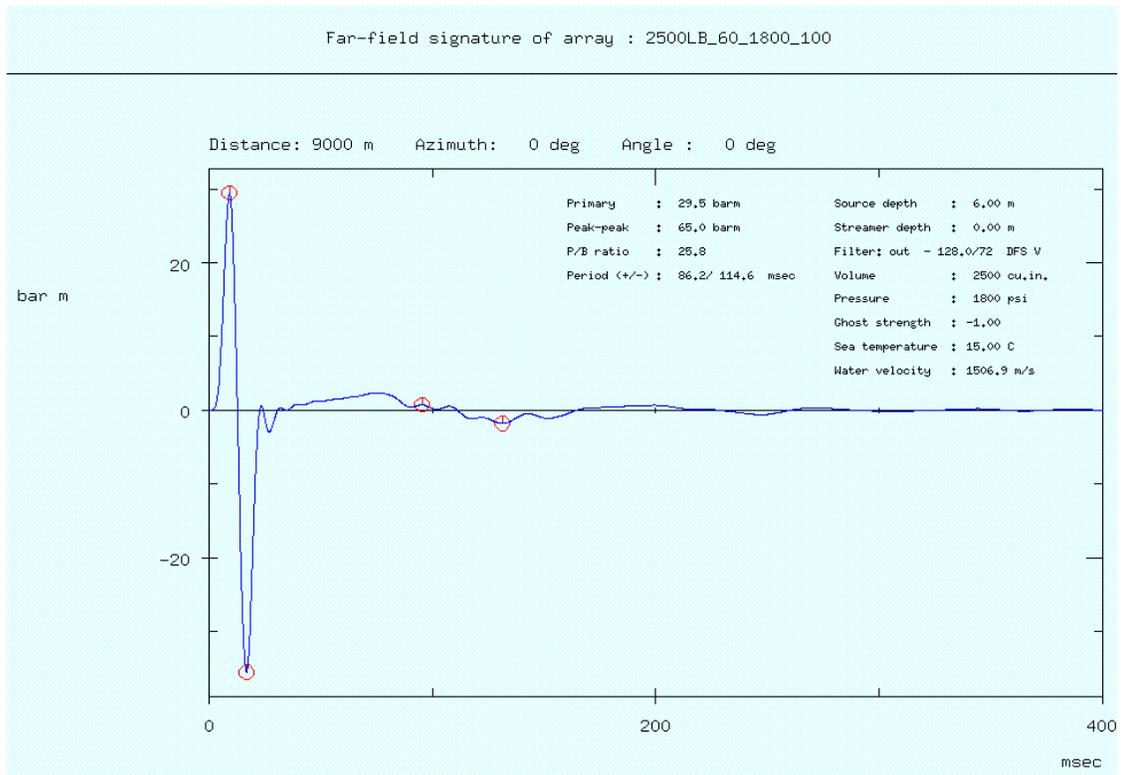


Figure 3: Modeled far-field signature and amplitude spectrum with DFS-V recording filter (without receiver ghost).

Full system response with source ghost only

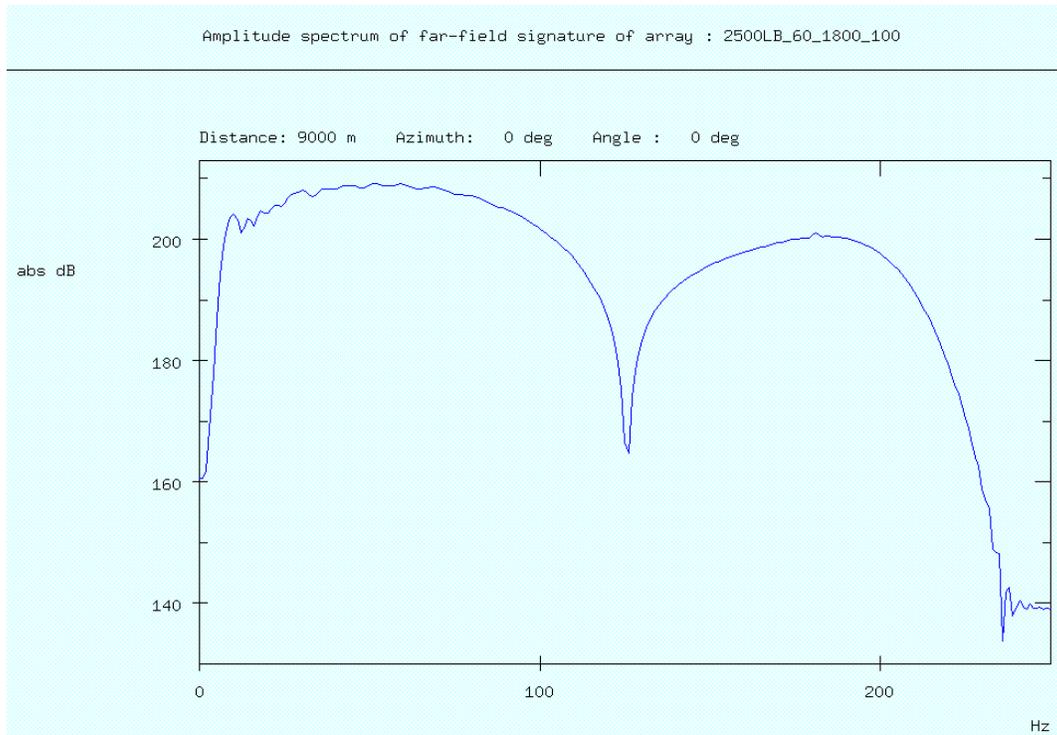
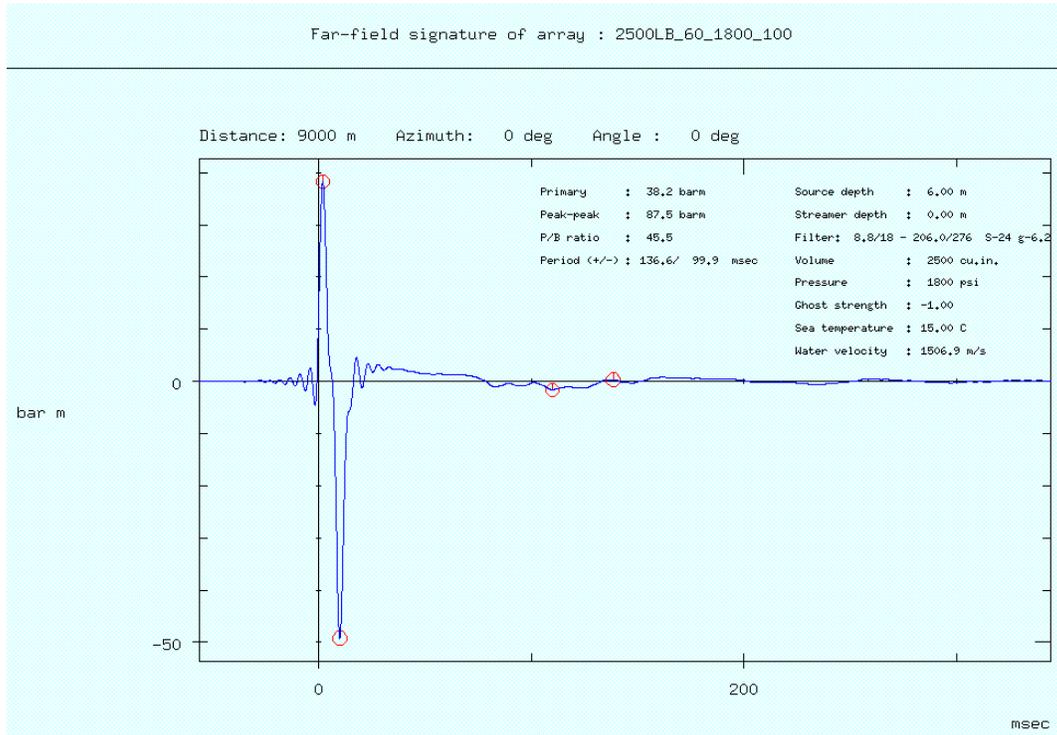


Figure 4: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (without receiver ghost).

Full system response with source ghost only

FAR-FIELD SIGNATURE LISTING

Array name : 2500LB_60_1800_100
 Total volume : 2500 cu.in.
 Source depth : 6.00 m
 Streamer depth : 0.00 m
 Group length : 0.00 m
 Average pressure : 1800 psi
 Ghost strength : -1.00
 Seawater temperature: 15.00 C
 Seawater velocity : 1506.9 m/s
 Filter :
 Low-cut frequency : 8.80 Hz
 Low-cut slope : 18.00 dB/oct
 High-cut frequency: 206.00 Hz
 High-cut slope : 276.00 dB/oct
 Instrument : S-24 g-6.25
 Time of 1st sample: -56.00 msec i.e. index of time zero = 29.0
 Sample interval : 2.00 msec **resampled from 0.5 ms.**
 Far-field position :
 Distance : 9000.00 m
 Azimuth : 0.00 deg
 Angle of vertical : 0.00 deg

Amplitudes are in bar m

Time is increasing horizontally

0.000	0.000	0.000	0.002	0.004	-0.026	-0.006
0.019	-0.024	0.056	-0.029	-0.040	0.094	-0.051
0.162	-0.021	0.039	0.012	-0.252	0.236	-0.567
0.554	-0.390	0.094	0.727	-1.538	2.634	-4.287
13.711	38.135	13.096	1.336	-22.219	-49.137	-21.579
-5.870	-1.368	4.466	-1.026	1.970	2.842	1.983
3.247	2.259	2.577	2.562	2.225	2.345	2.205
1.947	1.842	1.741	1.510	1.475	1.425	1.344
1.442	1.372	1.294	1.366	1.269	1.270	1.299
1.079	0.977	0.814	0.452	0.119	-0.468	-0.977
-0.958	-0.773	-0.478	-0.365	-0.688	-0.857	-0.824
-0.681	-0.307	-0.246	-0.556	-0.903	-1.390	-1.599
-1.392	-1.259	-1.081	-1.019	-1.247	-1.289	-1.289
-1.233	-0.858	-0.563	-0.223	0.202	0.291	0.310
0.215	-0.129	-0.237	-0.280	-0.333	-0.085	0.093
0.273	0.612	0.688	0.751	0.834	0.680	0.688
0.706	0.595	0.681	0.643	0.538	0.598	0.466
0.406	0.499	0.401	0.439	0.501	0.380	0.421
0.361	0.162	0.144	0.001	-0.134	-0.091	-0.206
-0.215	-0.147	-0.238	-0.136	-0.092	-0.193	-0.125
-0.230	-0.346	-0.308	-0.497	-0.576	-0.527	-0.628
-0.530	-0.439	-0.471	-0.302	-0.246	-0.223	0.006
0.075	0.179	0.379	0.349	0.420	0.483	0.339
0.384	0.355	0.225	0.294	0.189	0.096	0.152
0.000	-0.035	-0.008	-0.148	-0.109	-0.124	-0.245
-0.179	-0.243	-0.291	-0.158	-0.189	-0.134	-0.022
-0.099	-0.056	-0.054	-0.155	-0.060	-0.019	0.001
0.140	0.136	0.149	0.213	0.133	0.139	0.167
0.111	0.159	0.148	0.085	0.106		

Figure 5: Far-field signature listing with 2 ms sampling interval (without receiver ghost).

Full system response with source and receiver ghost

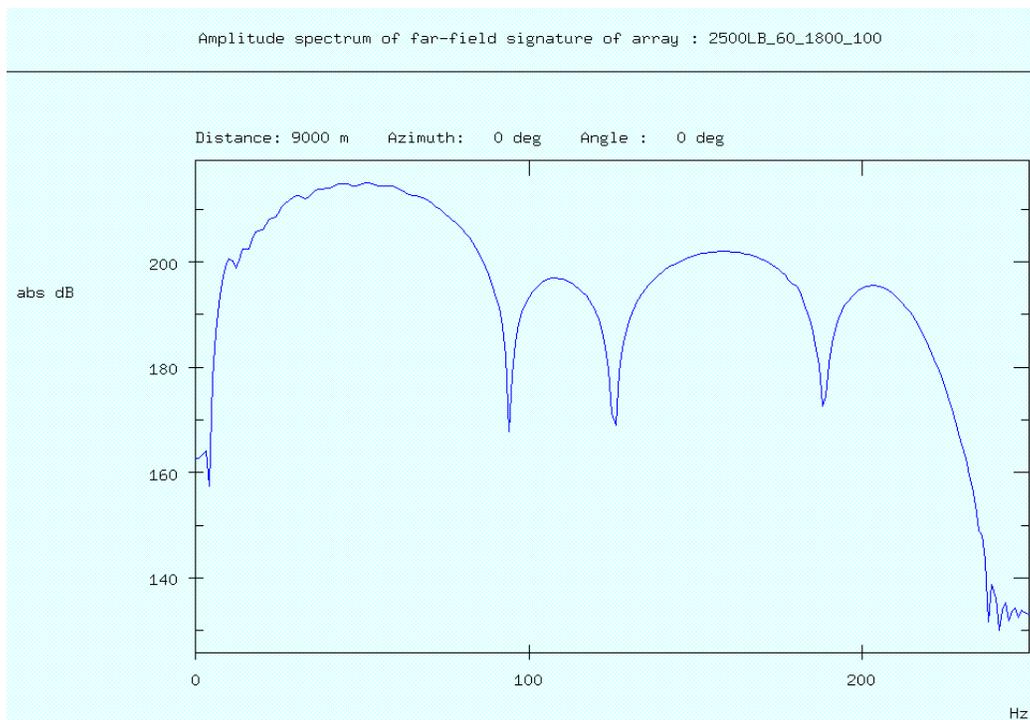
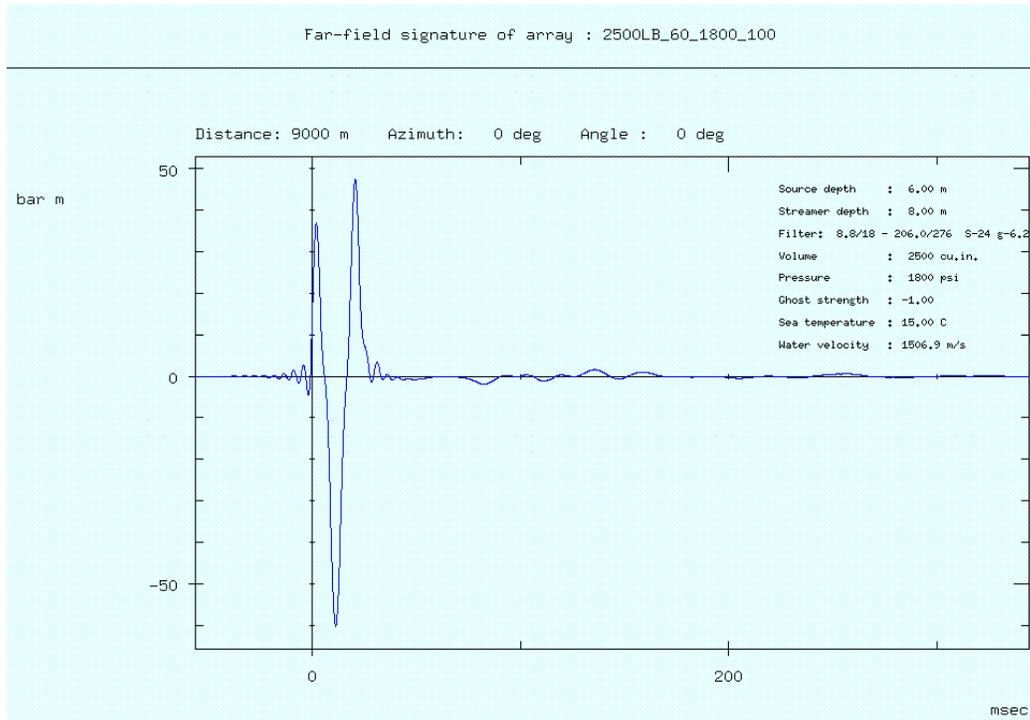


Figure 6: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (with receiver ghost).

Full system response with source and receiver ghost

FAR-FIELD SIGNATURE LISTING

Array name : 2500LB_60_1800_100
 Total volume : 2500 cu.in.
 Source depth : 6.00 m
 Streamer depth : 8.00 m
 Group length : 0.00 m
 Average pressure : 1800 psi
 Ghost strength : -1.00
 Seawater temperature: 15.00 C
 Seawater velocity : 1506.9 m/s
 Filter :
 Low-cut frequency : 8.80 Hz
 Low-cut slope : 18.00 dB/oct
 High-cut frequency: 206.00 Hz
 High-cut slope : 276.00 dB/oct
 Instrument : S-24 g-6.25
 Time of 1st sample: -56.00 msec i.e. index of time zero = 29.0
 Sample interval : 2.00 msec **resampled from 0.5 ms.**
 Far-field position :
 Distance : 9000.00 m
 Azimuth : 0.00 deg
 Angle of vertical : 0.00 deg

Amplitudes are in bar m

Time is increasing horizontally

0.000	0.000	0.000	0.002	0.004	-0.026	-0.006
0.019	-0.024	0.051	-0.013	-0.018	0.070	-0.032
0.133	-0.042	0.118	-0.076	-0.229	0.151	-0.656
0.617	-0.528	0.404	0.521	-1.165	2.534	-4.525
14.349	36.824	14.734	-0.557	-20.252	-52.817	-57.136
-28.466	-4.004	15.226	45.207	34.375	10.227	5.879
-0.954	1.837	2.195	-0.775	0.447	-0.747	-0.352
-0.412	-0.847	-0.513	-0.803	-0.797	-0.591	-0.509
-0.348	-0.197	-0.171	-0.090	-0.077	-0.139	-0.115
-0.211	-0.374	-0.493	-0.791	-1.196	-1.619	-1.966
-1.852	-1.334	-0.710	-0.107	0.183	0.141	0.011
-0.104	0.041	0.328	0.283	-0.069	-0.638	-1.178
-1.185	-0.808	-0.297	0.216	0.344	0.173	-0.001
-0.088	0.138	0.611	1.075	1.476	1.573	1.294
0.852	0.225	-0.331	-0.571	-0.629	-0.365	0.119
0.506	0.862	1.032	0.929	0.775	0.489	0.169
0.018	-0.116	-0.152	-0.086	-0.122	-0.126	-0.149
-0.238	-0.183	-0.146	-0.145	-0.023	-0.011	-0.063
-0.076	-0.240	-0.364	-0.411	-0.527	-0.501	-0.414
-0.359	-0.213	-0.119	-0.038	0.068	0.047	0.023
-0.016	-0.159	-0.233	-0.321	-0.428	-0.356	-0.290
-0.224	-0.017	0.112	0.222	0.353	0.360	0.447
0.549	0.542	0.617	0.604	0.483	0.411	0.218
0.049	-0.013	-0.150	-0.199	-0.189	-0.257	-0.241
-0.244	-0.306	-0.253	-0.243	-0.257	-0.183	-0.194
-0.186	-0.133	-0.153	-0.066	0.036	0.070	0.180
0.204	0.137	0.113	0.020	-0.025	0.054	0.086
0.170	0.273	0.250	0.227	0.155	0.038	0.016
-0.017	-0.047	-0.014	-0.036	-0.067		

Figure 7: Far-field signature listing with 2 ms sampling interval (with receiver ghost).

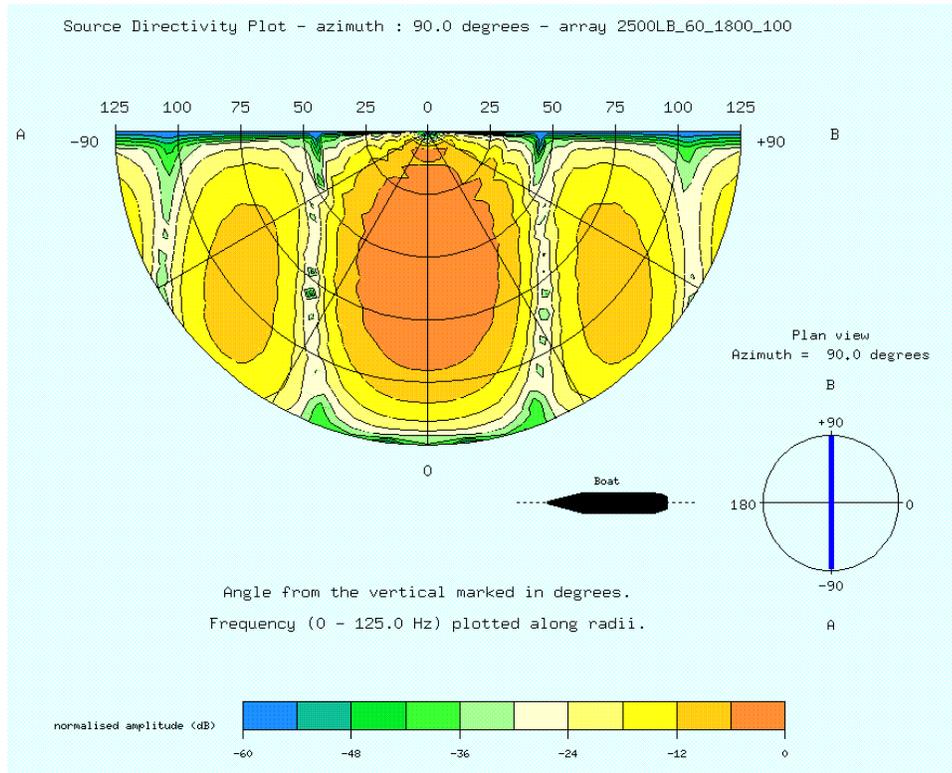
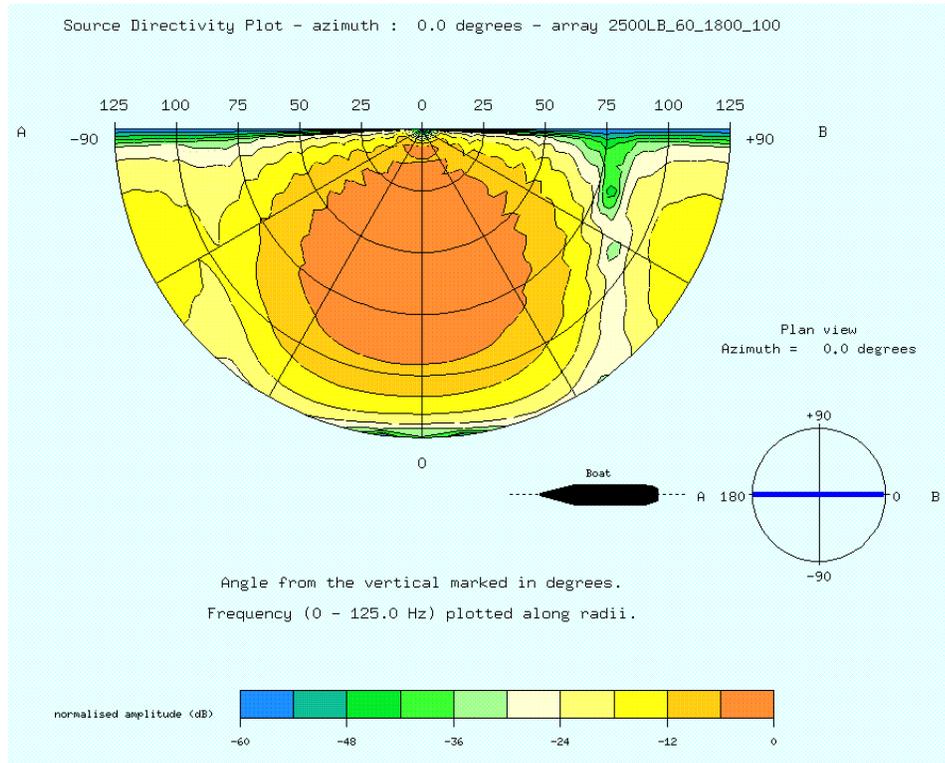


Figure 8: Directivity plot for constant azimuth of 0° and 90°.

12.4 SEG-D header**Orient Explorer****MSRS 960-24 External header information.**

Number of Streamer(s): **4** Total nav header: **1672** bytes
 Number of sub arrays: **6**
 Number of guns: **66**

Navigation and source information

BYTES					Format +
Start	End	Definition	Comment		# of bytes
1	2	Master ID	(S1)		A2
3	6	Length of message	Length of block AFTER byte	6	I4
7	10	Program revision			A4
11	12	Shot switch	01=offline, 02=approach, 3=online, 4=runout		I2
13	36	Shot time, UTC	hhmmss.μμμμμ.yyymmdd + 3 blank spaces		A17
37	42	Shot number			I6
43	58	Line name			A16
59	69	Master lat.	Decimal degrees		F11.6
70	80	Master long.	Decimal degrees		F11.6
81	86	Water depth	Meters		F6.1
87	97	Source lat.	Decimal degrees		F11.6
98	108	Source long.	Decimal degrees		F11.6
109	113	Master gyro	Degrees		F5.1
114	118	Master CMG	Degrees		F5.1
119	122	Master speed	Knots		F4.1

General gun information

BYTES					Format +	
Start	End	Definition	Comment		# of bytes	
123	128	ID string	*GCS90		A6	6
129	132	Record length (length of block)	Length of remaining block		I4	4
133	138	Line number	Sequence number		I6	6
139	142	Gun controller SP			I4	4
143	144	Active array mask	38 = stbd, 07 = port, 3F = all		I2	2
145		Trigger mode	E = External, I = Internal		A1	1
146	147	Gun sequence	01 = Stbd, 02 = Port		I2	2
148	150	# of sub arrays			I3	3
151	153	# of guns in array			I3	3
154	156	# of active guns			I3	3
157	159	# of delta errors in shot			I3	3
160	162	# of auto fires in shot			I3	3
163	165	# of misfires in shot			I3	3
166	168	Delta spread for total array			I3	3
169	174	Volume fired			I6	6
175	188	Spare			I14	14
189	192	Manifold pressure			I4	4
193	196	Deep Tow			I4	4
197	220	Subarray string pressure *)			I4	24

*) This sequence of 4 bytes is repeated for each of the subarrays; The number of bytes are:

4* 6

Single gun information

Each gun got 22 bytes for information as listed below .

There are 62 guns in total, and they are listed in the header as in table 1 (see below) with #57 first and #8 last.

BYTES					Format +
Start	End	Definition	Comment		# of bytes
221	222	Physical port #	see table below		A2
223		Gun mode	A=Auto, M=Manual, O=Off, S=St.by		A1
224		Detect mode	Z=Zero, P=Peak		A1
225		Sequence number			I1
226		Autofire	Y / N		A1
227		Blank			A1
228	230	Static offset	1/10 msec		I3
231	233	Gun delay	1/10 msec		I3
234	236	Fire time	1/10 msec		I3
237	239	Delta error	1/10 msec		I3
240	242	Depth *)	1/10 meter		I3
243	1672	Remaining single gun information	Bytes: 22 x Guns: 65		1430

) There are two depth sensors at each sub array. These depths can be found at the first and the last gun in the sub array, marked with "" in the table. The other gun depths are not used.

12.5 P1/90 header

```

H0100 AREA                                BLOCK PJ3D, BASS STRAIT, AUSTRALIA
H0101 GENERAL SURVEY DETAILS              3D SINGLE VESSEL, DUAL SOURCE, FOUR STREAMERS
H0102 VESSEL DETAILS                      M/V ORIENT EXPLORER          1
H0103 SOURCE DETAILS                      STBD SOURCE                  1 1
H0103 SOURCE DETAILS                      PORT SOURCE                   1 2
H0104 STREAMER DETAILS                   STREAMER 1 348CH (STBD)     1 1 1
H0104 STREAMER DETAILS                   STREAMER 2 348CH            1 2 2
H0104 STREAMER DETAILS                   STREAMER 3 348CH            1 3 3
H0104 STREAMER DETAILS                   STREAMER 4 348CH (PORT)    1 4 4
H0105 OTHER DETAILS                      N/A
H0200 DATE OF SURVEY                     08 OCT 2005 - CONTINUING
H0201 DATE OF ISSUE OF TAPE              ?? OCTOBER 2005
H0202 TAPE VERSION IDENTIFIER            PJ05P011
H0203 LINE PREFIX                         PJ05
H0300 CLIENT                             BENARIS PETROLEUM N.V
H0400 GEOPHYSICAL CONTRACTOR             PGS GEOPHYSICAL, MARINE ACQUISITION
H0500 POSITIONING CONTRACTOR              FUGRO-SURVEY AS
H0600 POSITIONING PROCESSING              PGS GEOPHYSICAL, MARINE ACQUISITION
H0700 POSITIONING SYSTEM                   NAV SYSTEM I: SKYFIX XP
H0700 POSITIONING SYSTEM                   NAV SYSTEM II: STARFIX
H0700 POSITIONING SYSTEM                   INTEGRATED NAV SYSTEM : SPECTRA VERSION 10.9.1
H0800 COORDINATE LOCATION                CENTER OF SOURCE
H0900 OFFSET SYSTEM TO SOURCE 1          1 2 25.00 -196.00
H0901 OFFSET SYSTEM TO SOURCE 2          1 2 -25.00 -196.00
H0902 OFFSET SYSTEM TO E/S               1 2 0.00 18.60
H0903 OFFSET SYS TO NAV REF PT           1 2 0.00 0.00
H1000 CLOCK TIME                         GMT
H1100 RECEIVER GROUPS PER SHOT           1392
H1400 GEODETIC DATUM AS SURVEY           GDA94 GRS1980 6378137.000 298.2572221
H1401 GDA94 TO WGS84                     0.0 0.0 0.0 0.000 0.000 0.000 0.0000000
H1500 GEODETIC DATUM FOR POST            GDA94 GRS1980 6378137.000 298.2572221
H1501 GDA94 TO WGS84                     0.0 0.0 0.0 0.000 0.000 0.000 0.0000000
H1600 DATUM SHIFT H1400-H1500           0.0 0.0 0.0 0.000 0.000 0.000 0.0000000
H1700 VERTICAL DATUM                     ES ECHO SOUNDER POSITION
H1800 PROJECTION                          002 UTM SOUTH
H1900 ZONE                                55S
H2000 GRID UNITS                          1 INTERNATIONAL METERS 1.0000000000000
H2001 HEIGHT UNITS                        1 INTERNATIONAL METERS 1.0000000000000
H2002 ANGULAR UNITS                       1 DEGREES
H2200 CENTRAL MERIDIAN                    147 0 0.000E
H2600
H2600*****
H2600
H2600 THE SOUND VELOCITY SET IN THE ECHO SOUNDER WAS 1500 METERS/SECOND.
H2600
H2600 THE Z OFFSET OF THE ECHO SOUNDER TRANSDUCER IS -5.8 METRES FROM THE
H2600 VESSEL REFERENCE POINT AT SEA LEVEL.
H2600
H2600 THE ECHO SOUNDER DEPTH DATA WAS CORRECTED FOR PITCH, ROLL AND HEAVE
H2600 PRIOR TO BEING PASSED TO THE INTEGRATED NAVIGATION SYSTEM.
H2600
H2600*****
H2600
H2600          FORMAT OF SHOT RECORDS
H2600          COLUMN          DESCRIPTION
H2600          1              'V', 'E', 'Z', 'S' OR 'T'
H2600                          V=VESSEL REFERENCE POINT
H2600                          E=ECHOSOUNDER POSITION
H2600                          S=CENTER OF SOURCE
H2600                          Z=INDIVIDUAL SOURCE POSITON
H2600                          T=TAILBUOY POSITION
H2600          2-13          LINE NAME
H2600          17              VESSEL IDENTIFIER
H2600          18              SOURCE IDENTIFIER
H2600          19              TAILBUOY/OTHER IDENTIFIER

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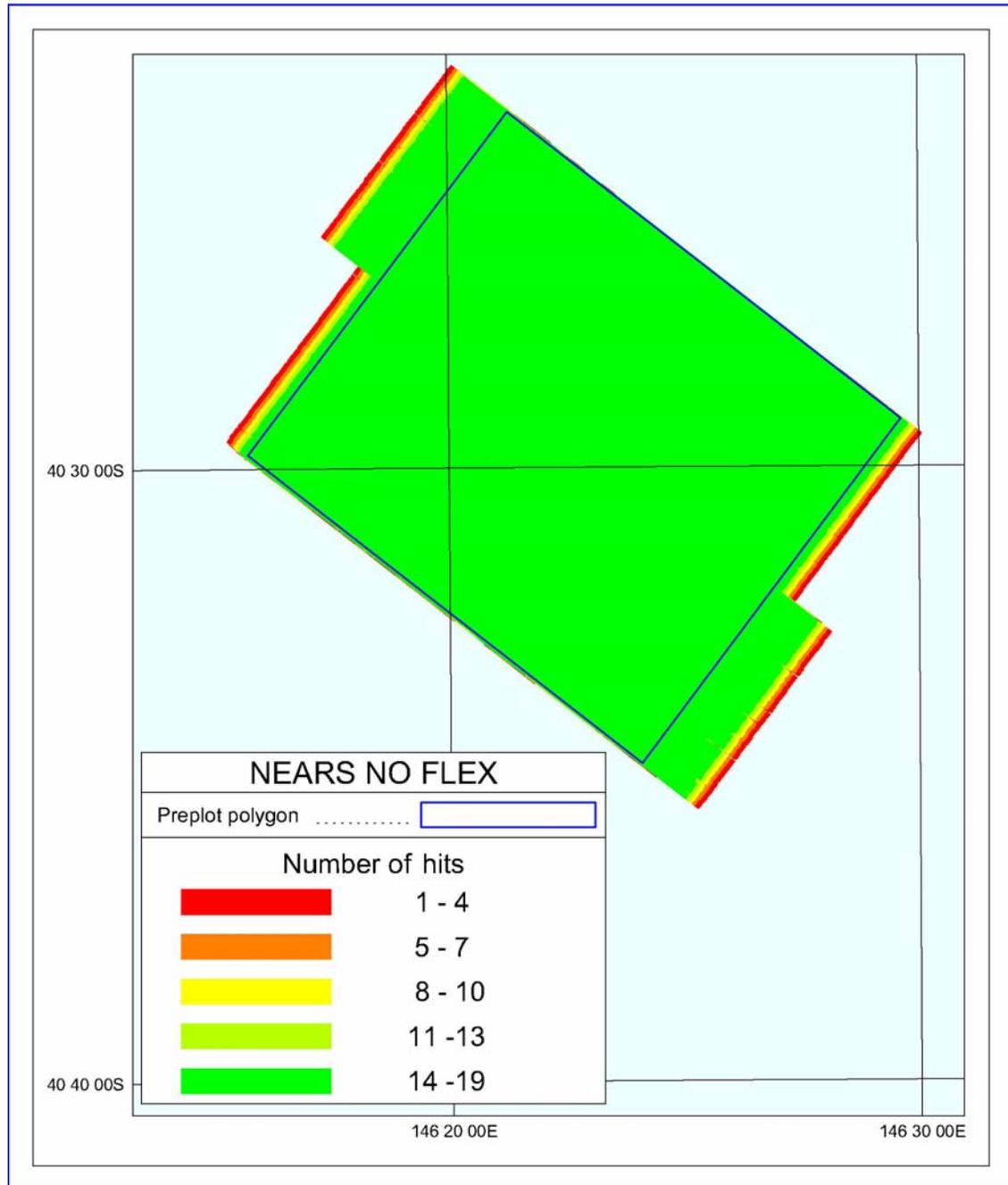
```

H2600      20-25      SHOT POINT NUMBER
H2600      26-35      LATITUDE (DDMMSS.SS)
H2600      36 46      LONGITUDE (DDMMSS.SS)
H2600      47-55      MAP GRID EASTING IN METERS
H2600      56-64      MAP GRID NORTHING IN METERS
H2600      65-70      WATER DEPTH
H2600      71-73      JULIAN DAY
H2600      74-79      TIME HHMMSS
H2600
H2600          FORMAT OF RECEIVER RECORD
H2600          1      'R'
H2600          2-5      RECEIVER NUMBER
H2600          6-14     MAP GRID EASTING IN METERS
H2600          15-23    MAP GRID NORTHING IN METERS
H2600          24-27    RECEIVER DEPTH REFERENCED TO SEA LEVEL
H2600          28-31    RECEIVER NUMBER
H2600          32-40    MAP GRID EASTING IN METERS
H2600          41-49    MAP GRID NORTHING IN METERS
H2600          50-53    RECEIVER DEPTH REFERENCED TO SEA LEVEL
H2600          54-57    RECEIVER NUMBER
H2600          58-66    MAP GRID EASTING IN METERS
H2600          67-75    MAP GRID NORTHING IN METERS
H2600          76-79    RECEIVER DEPTH REFERENCED TO SEA LEVEL
H2600          80      STREAMER CODE
H2600
H2600*****
H2600
H2600 STREAMER AND TAILBUOY NUMBERING INCREMENTS FROM STARBOARD TO PORT.
H2600
H2600 STREAMER 1: RECEIVERS NUMBERED 1 (FAR) TO 348 (NEAR)
H2600 STREAMER 2: RECEIVERS NUMBERED 349 (FAR) TO 696 (NEAR)
H2600 STREAMER 3: RECEIVERS NUMBERED 697 (FAR) TO 1044 (NEAR)
H2600 STREAMER 4: RECEIVERS NUMBERED 1045 (FAR) TO 1392 (NEAR)
H2600
H2600 STREAMER ROTATIONS HAVE BEEN APPLIED ON A SHOT BY SHOT BASIS.
H2600
H2600 SPRINT CALCULATED INLINE MISCLOSURES ARE DERIVED ON A SHOT BY SHOT BASIS.
H2600 THESE INLINE MISCLOSURES ARE DISTRIBUTED LINEARLY OVER THE ACTIVE
H2600 STREAMER LENGTH. THE CORRECTED STREAMER LENGTH IS USED TO COMPUTE THE
H2600 FINAL RECEIVER POSITIONS.
H2600
H2600 SPRINT VERSION 3.1.20 USED FOR ONBOARD NAVIGATION PROCESSING
H2600
H2600 PGS JOB NUMBER 2005103
H2600
H2600 ALL SHOTS FOR ALL STREAMERS ARE INCLUDED ON THIS TAPE, DATA NOT TO BE
H2600 PROCESSED (NTBP) IS INDICATED BELOW AS NECESSARY.
H2600
H2600 LINES CONTAINED IN THIS FILE:
H2600
H2600 LINE: ???          SEQUENCE: ???   FSP:   ????   LSP:   ????
H2600

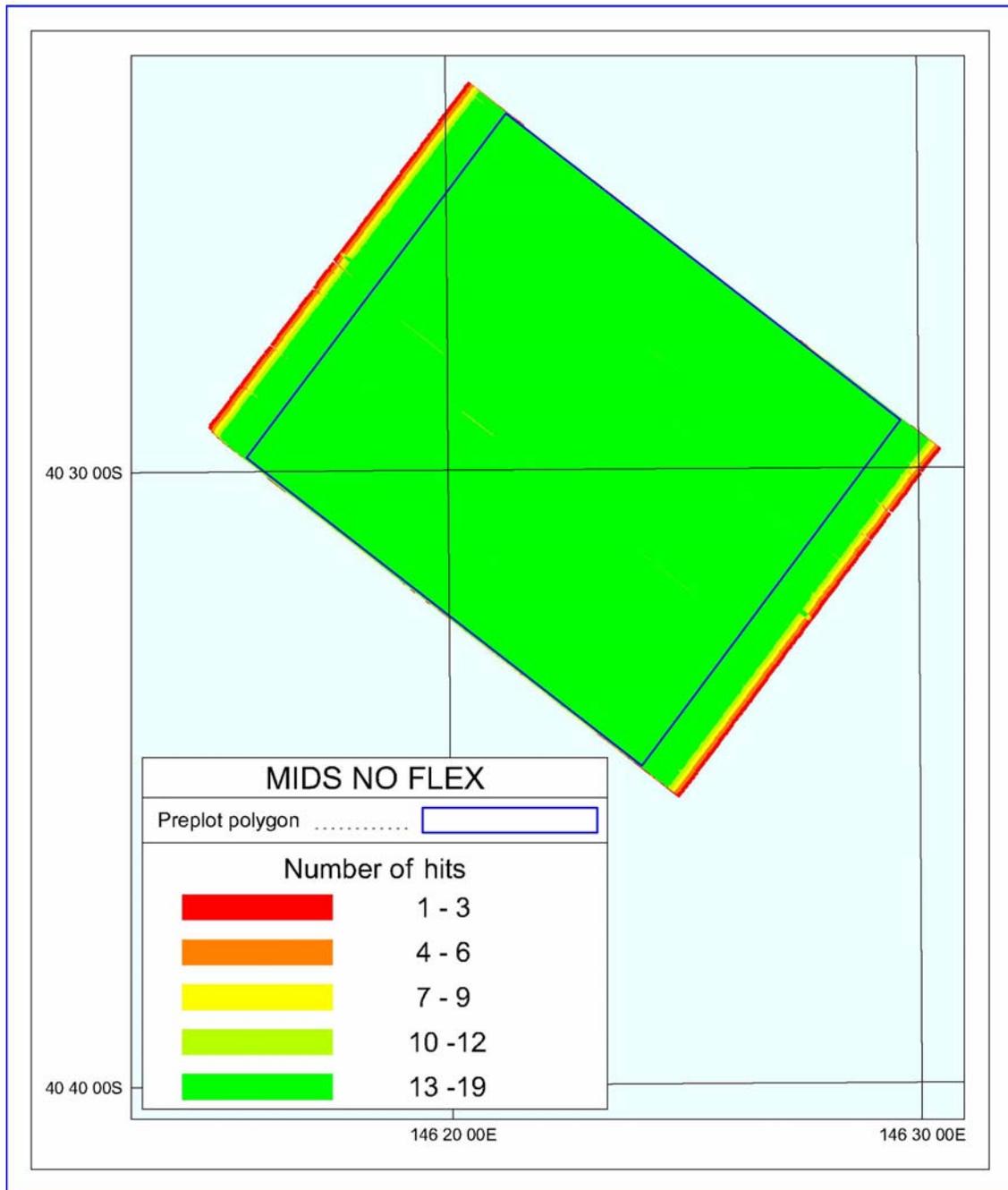
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12.6 Coverage plots

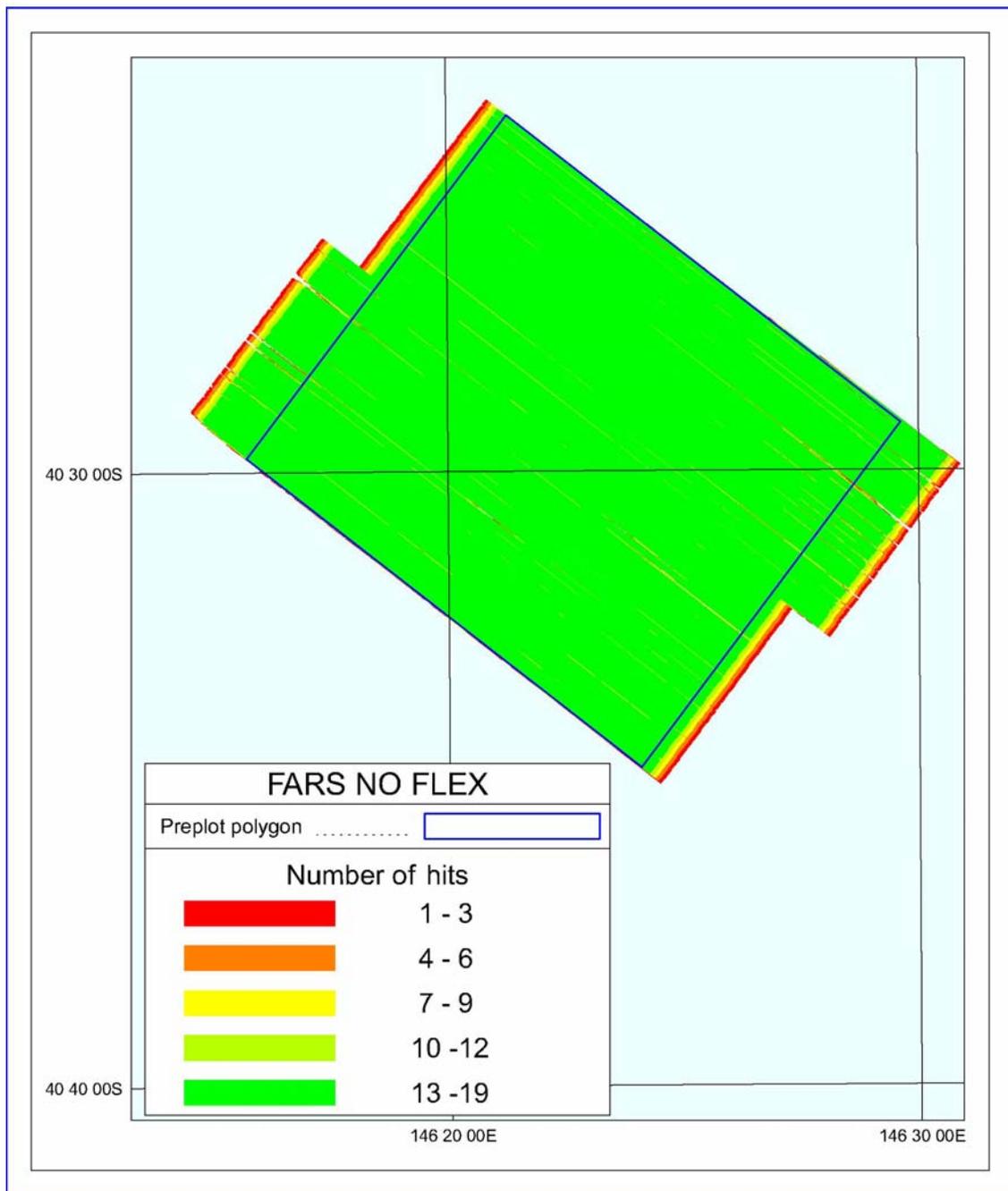
12.6.1 Nears no Flex



12.6.2 Mids no Flex



12.6.3 Fars no Flex



12.6.4 Alls no Flex

