Essential Petroleum

Otway Basin, W. Victoria, Australia

MGC Job : 6151

Final Report

from

M/V Polar Duke

05th November to 23rd November 2002

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Prepared by: Geoff Clarke Party Manager / Polar Duke

Approved by: Kai Aasebø / MGC Operations Sign.

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1. Survey Information and Objectives

This program for **Essential Petroleum** (Australia) comprised 780km of full fold 2D seismic in Victorian Water Block VIC/P46. Water depths range from 25 to 500m. This area is west of Portland in Discovery Bay. The programme consisted of 2 strike lines, 24 dip lines and one well tie line through **Normanby 1** and **Discovery Bay 1** wells. The dip lines ran SW to NE with the shore close to the NE ends of lines. The two westernmost dip lines were cancelled part way through the survey and replaced with one equal length strike line.

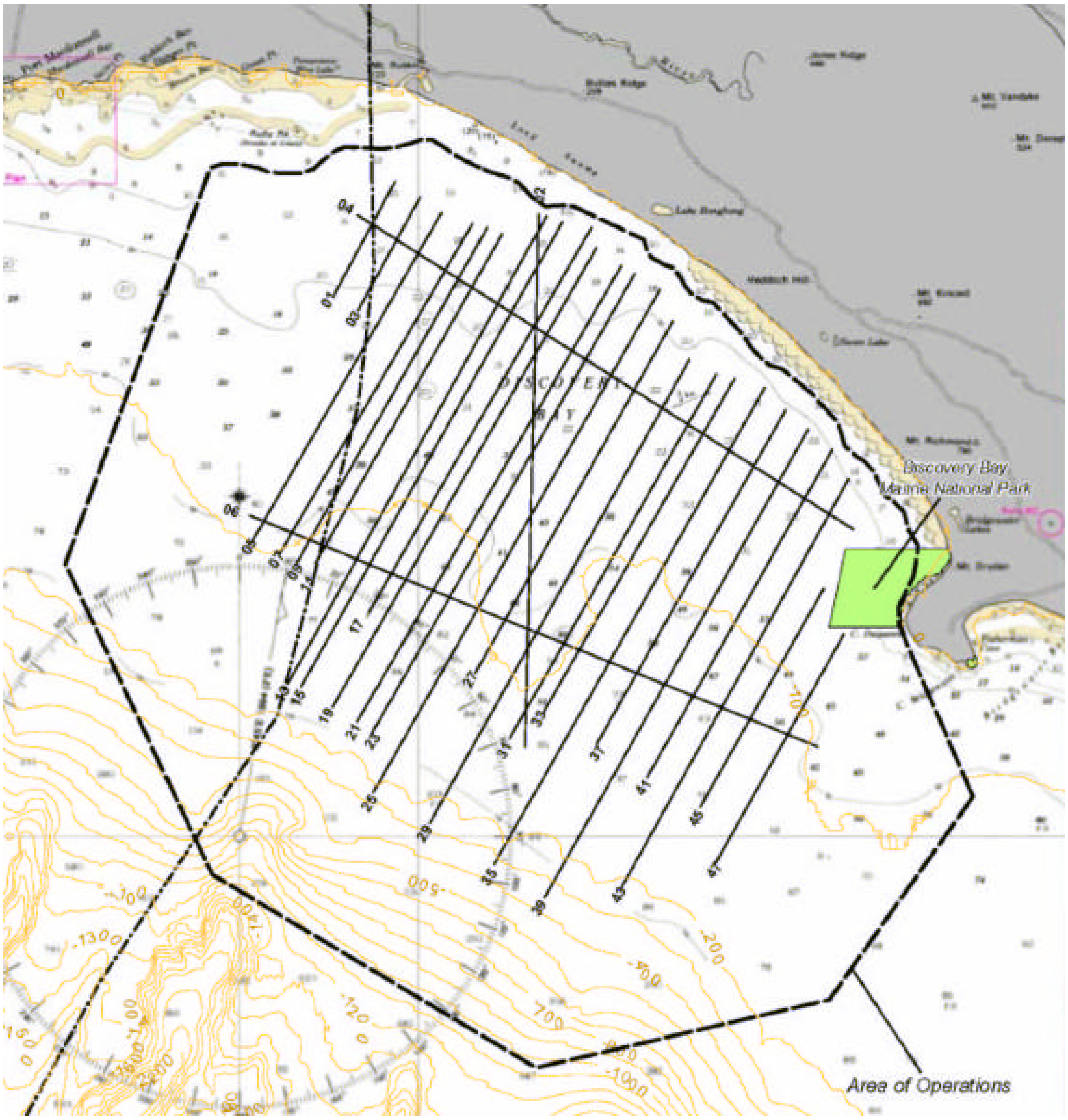
Essential Petroleum conducted the survey in this area of high interest for gas field location in the Otway Basin, off the border between Victoria and South Australia, just west of Portland.

The ***Polar Duke*** carried out the acquisition for **Multiwave Geophysical Company ASA.** Acquisition equipment included a sleeve air gun source array of 3500 cubic inches and a single digital streamer, configured for 444 data traces and a length of 5550m. Positioning was by Differential GPS and onboard Quality Control maintained using a ProMAX QC system.

The vessel mobilized for the project in Cairns, Australia on the 5th of November and commenced production on the 15th of November. The 27 lines of seismic data acquisition were completed in 28 line sequences by the 23rd of November 2002.

2. Area location map

3. Prospect Map



This is the Original Preplot (before Lines 01 + 03 were cancelled and Line 08 added)

4. Survey Parameters and Original Line Coordinates

Survey Report

Date Generated: 01/11/2002
Time Generated: 11:21:44

PSD Details

Projection Type: Transverse Mercator
Origin Longitude: 1410000.000E
Origin Latitude: 0000000.000N
Scale Factor: 0.9996000000
False Easting: 500000.00E
False Northing: 10000000.00N

Spheroid Name: GRS 80
Semi Major Axis: 6378137.000
Inverse Flattening: 298.2572221

Datum Name: GDA-94
Dx (m): 0.0
Dy (m): 0.0
Dz (m): 0.0
Rx (sec): 0.0
Ry (sec): 0.0
Rz (sec): 0.0
Ds (ppm): 0.0

Units: meters

2D Survey

Survey Name:

2D Line Name:	OEP02-01		
FSP:	1001	**LSP:**	1341
Segment: 1			
Start Easting:	498509.01	**Start Longitude:**	140°58'58.768"E
Start Northing:	5781298.96	**Start Latitude:**	38°6'58.097"S
End Easting:	494330.84	**End Longitude:**	140°56'06.965"E
End Northing:	5773900.64	**End Latitude:**	38°10'58.080"S
Azimuth/Bearing:	209.466		
Distance:	8500 m		

2D Line Name:	OEP02-02		
FSP:	1001	**LSP:**	2401
Segment: 1			
Start Easting:	508036.99	**Start Longitude:**	141°5'30.152"E
Start Northing:	5779176.01	**Start Latitude:**	38°8'06.853"S
End Easting:	506238.77	**End Longitude:**	141°4'17.393" E
End Northing:	5744236.23	**End Latitude:**	38°27'00.518"S
Azimuth/Bearing:	182.889		
Distance:	35000 m		

2D Line Name:	OEP02-03		
FSP:	1001	**LSP:**	1345
Segment: 1			
Start Easting:	500148.04	**Start Longitude:**	141°00'06.080"E
Start Northing:	5780284.97	**Start Latitude:**	38°7'31.001"S
End Easting:	495857.71	**End Longitude:**	140°57'09.706"E
End Northing:	5772835.51	**End Latitude:**	38°11'32.669"S
Azimuth/Bearing:	209.938		
Distance:	8600 m		

2D Line Name:	OEP02-04		
FSP:	1001	**LSP:**	2537
Segment: 1			
Start Easting:	495989.03	**Start Longitude:**	140°57'15.232"E
Start Northing:	5779104.98	**Start Latitude:**	38°8'09.254"S
End Easting:	528344.78	**End Longitude:**	141°19'27.350"E
End Northing:	5758453.29	**End Latitude:**	38°19'17.720"S
Azimuth/Bearing:	122.577		
Distance:	38400 m		

2D Line Name:	OEP02-05		
FSP:	1001	**LSP:**	2015
Segment: 1			
Start Easting:	501545.03	**Start Longitude:**	141°1'03.468"E
Start Northing:	5779253.95	**Start Latitude:**	38°8'04.448"S
End Easting:	488457.99	**End Longitude:**	140°52'04.598"E
End Northing:	5757555.08	**End Latitude:**	38°19'48.209"S
Azimuth/Bearing:	211.084		
Distance:	25350 m		

2D Line Name:	OEP02-06		
FSP:	1001	**LSP:**	2611
Segment: 1			
Start Easting:	488362.02	**Start Longitude:**	140°52'00.754"E
Start Northing:	5759377.99	**Start Latitude:**	38°18'49.061"S
End Easting:	525640.04	**End Longitude:**	141°17'37.824"E
End Northing:	5744241.26	**End Latitude:**	38°26'59.107"S
Azimuth/Bearing:	112.182		
Distance:	40250 m		

2D Line Name:	OEP02-07		
FSP:	1001	**LSP:**	2020
Segment: 1			
Start Easting:	503612.96	**Start Longitude:**	141°2'28.428"E
Start Northing:	5778584.02	**Start Latitude:**	38°8'26.164"S
End Easting:	490409.27	**End Longitude:**	140°53'24.932"E
End Northing:	5756809.77	**End Latitude:**	38°20'12.473"S
Azimuth/Bearing:	211.207		
Distance:	25475 m		

2D Line Name:	OEP02-09		
FSP:	1001	**LSP:**	2027
Segment: 1			
Start Easting:	504617.01	**Start Longitude:**	141°3'09.684"E
Start Northing:	5778258.96	**Start Latitude:**	38°8'36.694"S
End Easting:	491329.52	**End Longitude:**	140°54'02.819"E
End Northing:	5756330.92	**End Latitude:**	38°20'28.043"S
Azimuth/Bearing:	211.182		
Distance:	25650 m		

2D Line Name:	OEP02-11		
FSP:	1001	**LSP:**	2006
Segment: 1			
Start Easting:	505450.96	**Start Longitude:**	141°3'43.956"E
Start Northing:	5777896.96	**Start Latitude:**	38°8'48.422"S
End Easting:	492490.0	**End Longitude:**	140°54'50.627"E
End Northing:	5756384.79	**End Latitude:**	38°20'26.333"S
Azimuth/Bearing:	211.03		
Distance:	25125 m		

2D Line Name:	OEP02-13		
FSP:	1001	**LSP:**	2420
Segment: 1			
Start Easting:	508500.0	**Start Longitude:**	141°5'49.178"E
Start Northing:	5779029.97	**Start Latitude:**	38°8'11.576"S
End Easting:	490691.34	**End Longitude:**	140°53'36.150"E
End Northing:	5748365.32	**End Latitude:**	38°24'46.458"S
Azimuth/Bearing:	210.086		
Distance:	35475 m		

2D Line Name:	OEP02-15		
FSP:	1001	**LSP:**	2418
Segment: 1			
Start Easting:	509536.98	**Start Longitude:**	141°6'31.795"E
Start Northing:	5778658.0	**Start Latitude:**	38°8'23.608"S
End Easting:	491440.2	**End Longitude:**	140°54'07.024"E
End Northing:	5748220.68	**End Latitude:**	38°24'51.178"S
Azimuth/Bearing:	210.667		
Distance:	35425 m		

2D Line Name:	OEP02-17		
FSP:	1001	**LSP:**	2182
Segment: 1			
Start Easting:	511539.0	**Start Longitude:**	141°7'54.066"E
Start Northing:	5778231.01	**Start Latitude:**	38°8'37.378"S
End Easting:	496244.44	**End Longitude:**	140°57'25.225"E
End Northing:	5752990.07	**End Latitude:**	38°22'16.558"S
Azimuth/Bearing:	211.132		
Distance:	29525 m		

2D Line Name:	OEP02-19		
FSP:	1001	**LSP:**	2409
Segment: 1			
Start Easting:	511847.0	**Start Longitude:**	141°8'06.799"E
Start Northing:	5776908.98	**Start Latitude:**	38°9'20.257"S
End Easting:	493707.95	**End Longitude:**	140°55'40.490"E
End Northing:	5746758.98	**End Latitude:**	38°25'38.669"S
Azimuth/Bearing:	210.949		
Distance:	35200 m		

2D Line Name:	OEP02-21		
FSP:	1001	**LSP:**	2399
Segment: 1			
Start Easting:	513464.98	**Start Longitude:**	141°9'13.363"E
Start Northing:	5775726.0	**Start Latitude:**	38°9'58.558"S
End Easting:	495361.14	**End Longitude:**	140°56'48.653"E
End Northing:	5745846.57	**End Latitude:**	38°26'08.308"S
Azimuth/Bearing:	211.116		
Distance:	34950 m		

2D Line Name:	OEP02-23		
FSP:	1001	**LSP:**	2405
Segment: 1			
Start Easting:	514269.02	**Start Longitude:**	141°9'46.440"E
Start Northing:	5775261.05	**Start Latitude:**	38°10'13.598"S
End Easting:	496160.54	**End Longitude:**	140°57'21.614"E
End Northing:	5745209.3	**End Latitude:**	38°26'28.997"S
Azimuth/Bearing:	210.971		
Distance:	35100 m		

2D Line Name:	OEP02-25		
FSP:	1001	**LSP:**	2539
Segment: 1			
Start Easting:	515902.03	**Start Longitude:**	141°10'53.638"E
Start Northing:	5774224.02	**Start Latitude:**	38°10'47.147"S
End Easting:	496125.7	**End Longitude:**	140°57'20.099"E
End Northing:	5741267.73	**End Latitude:**	38°28'36.876"S
Azimuth/Bearing:	210.855		
Distance:	38450 m		

2D Line Name:	OEP02-27		
FSP:	1001	**LSP:**	2074
Segment: 1			
Start Easting:	516843.96	**Start Longitude:**	141°11'32.539"E
Start Northing:	5772061.02	**Start Latitude:**	38°11'57.264"S
End Easting:	503130.93	**End Longitude:**	141°2'09.096"E
End Northing:	5749018.43	**End Latitude:**	38°24'25.423"S
Azimuth/Bearing:	210.638		
Distance:	26825 m		

2D Line Name:	OEP02-29		
FSP:	1001	**LSP:**	2414
Segment: 1			
Start Easting:	517751.98	**Start Longitude:**	141°12'10.091"E
Start Northing:	5769635.02	**Start Latitude:**	38°13'15.913"S
End Easting:	499587.78	**End Longitude:**	140°59'42.983"E
End Northing:	5739354.35	**End Latitude:**	38°29'38.983"S
Azimuth/Bearing:	210.832		
Distance:	35325 m		

2D Line Name:	OEP02-31		
FSP:	1001	**LSP:**	2116
Segment: 1			
Start Easting:	519611.02	**Start Longitude:**	141°13'26.648"E
Start Northing:	5768620.03	**Start Latitude:**	38°13'48.706"S
End Easting:	505236.51	**End Longitude:**	141°3'36.029"E
End Northing:	5744750.13	**End Latitude:**	38°26'43.868"S
Azimuth/Bearing:	210.918		
Distance:	27875 m		

2D Line Name:	OEP02-33		
FSP:	1001	**LSP:**	2022
Segment: 1			
Start Easting:	520681.01	**Start Longitude:**	141°14'10.684"E
Start Northing:	5768393.01	**Start Latitude:**	38°13'55.985"S
End Easting:	507492.99	**End Longitude:**	141°5'09.049"E
End Northing:	5746550.8	**End Latitude:**	38°25'45.390"S
Azimuth/Bearing:	210.976		
Distance:	25525 m		

2D Line Name:	OEP02-35		
FSP:	1001	**LSP:**	2457
Segment: 1			
Start Easting:	522708.04	**Start Longitude:**	141°15'34.132"E
Start Northing:	5767784.97	**Start Latitude:**	38°14'15.536"S
End Easting:	503927.24	**End Longitude:**	141°2'42.180"E
End Northing:	5736621.09	**End Latitude:**	38°31'07.630"S
Azimuth/Bearing:	210.914		
Distance:	36400 m		

2D Line Name:	OEP02-37		
FSP:	1001	**LSP:**	2019
Segment: 1			
Start Easting:	524108.04	**Start Longitude:**	141°16'31.908"E
Start Northing:	5766265.01	**Start Latitude:**	38°15'04.720"S
End Easting:	511009.03	**End Longitude:**	141°7'34.187"E
End Northing:	5744456.69	**End Latitude:**	38°26'53.200"S
Azimuth/Bearing:	210.82		
Distance:	25450 m		

2D Line Name:	OEP02-39		
FSP:	1001	**LSP:**	2429
Segment: 1			
Start Easting:	525602.02	**Start Longitude:**	141°17'33.544"E
Start Northing:	5764978.98	**Start Latitude:**	38°15'46.296"S
End Easting:	507216.71	**End Longitude:**	141°4'58.105"E
End Northing:	5734393.67	**End Latitude:**	38°32'19.820"S
Azimuth/Bearing:	210.829		
Distance:	35700 m		

2D Line Name:	OEP02-41		
FSP:	1001	**LSP:**	2002
Segment: 1			
Start Easting:	527077.04	**Start Longitude:**	141°18'34.416"E
Start Northing:	5763710.01	**Start Latitude:**	38°16'27.311"S
End Easting:	514262.52	**End Longitude:**	141°9'48.575"E
End Northing:	5742226.37	**End Latitude:**	38°28'05.394"S
Azimuth/Bearing:	210.623		
Distance:	25025 m		

2D Line Name:	OEP02-43		
FSP:	1001	**LSP:**	2246
Segment: 1			
Start Easting:	528153.0	**Start Longitude:**	141°19'18.980"E
Start Northing:	5761744.03	**Start Latitude:**	38°17'30.977"S
End Easting:	512207.96	**End Longitude:**	141°8'24.241"E
End Northing:	5735027.77	**End Latitude:**	38°31'59.052"S
Azimuth/Bearing:	210.63		
Distance:	31125 m		

2D Line Name:	OEP02-45		
FSP:	1001	**LSP:**	1667
Segment: 1			
Start Easting:	526264.98	**Start Longitude:**	141°18'02.214"E
Start Northing:	5754597.03	**Start Latitude:**	38°21'23.062"S
End Easting:	517743.46	**End Longitude:**	141°12'12.398"E
End Northing:	5740300.57	**End Latitude:**	38°29'07.649"S
Azimuth/Bearing:	210.611		
Distance:	16650 m		

2D Line Name:	OEP02-47		
FSP:	1001	**LSP:**	1701
Segment: 1			
Start Easting:	527454.01	**Start Longitude:**	141°18'51.613"E
Start Northing:	5751696.0	**Start Latitude:**	38°22'57.054"S
End Easting:	518469.76	**End Longitude:**	141°12'42.721"E
End Northing:	5736686.22	**End Latitude:**	38°31'04.858"S
Azimuth/Bearing:	210.708		
Distance:	17500 m		
Total 2D Line Length:	779.88 km		

5. Contract Work Order

CONTRACT WORK ORDER

	CONTRACT
Client:	Santos (Essential Petroleum)
Vessel(s):	Polar Duke
Job number:	6151
Bid number	
Client contract number/ref:	OEP02
Location:	Otway Basin
Area:	W.Victoria
Type of survey:	2D
Area, or total kms:	780 km
Line heading:	Various
Number of lines:	27 lines
Line length:	Various
Acquisition method:	Single streamer / single source
Estimated start date:	14th November 2002
Estimated duration:	14 days
QHSE checklists completed	Yes
	STREAMER
Type of streamer	SYNTRAK RDA Streamer
Number of streamers	1
Separation	n/a
Streamer length	5550 m
No. of channels	444
Group interval	12.5 m
Streamer depth	6 m +/- 1 m
Water Depth	50-300 m
	RECORDING
Instrument type	SYNTRAK 960-24
Record length	6 sec
Sample rate	2 ms
Recording filter: Hi-cut	206 Hz @ 276 dB/ Octave
Recording filter: Lo-cut	Out: 3 Hz @ 6 dB/ Octave , In 3 Hz @ 12 dB/ Octave
Filter type	Linear
Pre-Amplifier Gain	12 dB
Tape format	Seg D Ver.1.00 8058 - 32 Bit IEEE
Recording media	IBM 3590
Tape Copy	Via ProMAX QC
	SOURCE
Source type	Airgun
Source controller	GCS-90
Number of sources	1
Source separation	n/a
Volume per source	3500 cu.in. (minimum 3400 cu in)
Source depth	**5 m** +/- 0.5 m
Source pressure	2000 psi
Source length	11.78 m
Number of subarrays per source	4
Subarray separation	6, 13, 6 m
Flip/Flop	No
Shot point interval per shot	**25 m**
Shot point location	Common Midpoint
Near fields to be recorded?	Yes
Total SCFM required at 5.0 knots	1540
Source firing specifications	+/- 1.25 ms
Signed:	Operation Manager

6. Seismic & Vessel Particulars

Streamer and Sensors Details

Item	description	type	amount	remark
Streamer	24 bit, digital distributed electronic	SYNTRAK RDA	Up to 7.2km active	
Depth Control	Digicourse	5011	26	Located every 300 m along the streamer
Buoyancy	Kerosene	Isopar M		
Retrievers	Concorde		6	Evenly distributed
Streamer skin	Polyurethane			
Section Length	75 m			
Lead-in	300 m			
Group Length	12.5 m			
Max number of channels			960	6.25 m @ 2 ms

Recording System Details

Item	description	type	amount	remark
Acquisition	SYNTRAK	960-24		
Format	SEG D	De-multiplexed		
Recording	3590 cartridge	IBM comp.	4	
Bird Controller	Digicourse	293B		
Sampling				2 ms
Plotter	24”	OYO Geospace	1	
Printer	A4	Epson	3	Label
Printer	A4	HP	2	Logs, tests etc.

Seismic QC Details

item	description	type	amount	remark
QC	ProMAX	2D		
Plotter	24”	OYO Geospace	1	

Navigation Details

Item	description	type	amount	remark
Integrated Navigation	Concept	Spectra		
Compasses	Digicourse	5011		Every 300m along the streamer
Streamer positioning	RGPS	Various	1	Geotrack
Source Positioning	RGPS	Various	2	Geotrack, on outer sub-arrays
Data logging	UKOOA	P2/94 P1/90		3590, Exabyte, CD Rom
Echo Sounder	Simrad	EA500	1	Deep-water transducer
Gyro				As vessel description
Helmsman Steering display	Robertson	Robtrack Helmsman		

Vessel Specifications

M/V Polar Duke

Main Particulars

Loa	66.65m
L.p.p.	61,44m
B.mld.	13.00m
Draft	5.80m
Draft mld sh.deck	9.50m
Deadweight	1119mt
Fuel Oil	1000cbm
Aviation fuel	50cbm
Fresh water	85cbm
IMO No	8200838
P & I Club	Skuld
Call sign	LACS4
Built	1983
Gross/net tonnage	1646.49/493.95
Flag	Norwegian

Class
DnV no: 13520
DnV + 1Aa-E0-HELDK-Sealer
Classed for Worldwide trade and registered in Norwegian International Ship Register

Offshore survey
Designed for offshore survey, core drilling and hydrographic survey.
Separate joystick manoeuvring.
Can be arranged for ROV handling, towed vehicle, bottom sampling, site survey.
Moonpool. Ø 36 inch.

Research facilities
Research facilities are designed for scientific and/or logistic expeditions in Antarctic and Arctic areas.
Lab. survey area - Dry Lab. and Wet. Lab. with uncontaminated sea water system.
Separate climate control and power supply.
Separate store. High-pressure hydraulic system for additional scientific winches. TV-monitoring aft deck.
Heavy duty Mob boat for assistance.
Spare Ø16 inch bottom valve for sonar etc.
Electric and mechanical workshop facilities.
1 PC CTD Winch with 3500m wire ø 10mm speed 50m/min @ 120l/min

Cargo Logistics
Under deck bale capacity of about 1385cbm
Arctic fuel in ships ordinary fuel tanks.
Jet A1 fuel in separate ships tank (56cbm)
12t - 15m / 22t - 8m crane with 100m/50m wire
Provision crane 1.5t – 7.5m

Electronics
Navigation and communication equipment to highest international standards, conventional as well as satellite equipment.

Environment

Equipped with oily water separator and incinerator for garbage. Waste water treatment arrangement. Fuel oil storage arrangement to minimize risk of accidental oil spill. Separate tank for storing bilge water when in Antarctic and Arctic waters

Accommodation

Crew:	11 cabins, 15 berths
Charterer:	15 cabins, 27 berths
Common:	Hospital, 3 berths

Icegoing

DnV "Sealer class", hull strength as icebreaker.
Proven icegoing capability and manoeuvrability during numerous expeditions to Antarctic.
De-icing in foreship and superstructure.
All equipment well suited to harsh conditions.
Machinery cooling standby arrangement.
Impact resistant low friction paint on underwater hull
Proven rudder and propeller protection.

Seismic Exploration Facilities

2 pc MPD Dual Umbilical winches
1 PC MPD Streamer Winch cap. 7200m + 72mm streamers
2 pc Hamworthy compressors each 800 scfm
2 pc Hamworthy compressors each 400 scfm

Electrical power

1 x E.C.C. 1640kVA shaft generator
1 x Stamford MC 334C - 112,5kVA aux generator
1 x Stamford MC 534C - 305 kVA aux. generator
440/220V 60Hz

Machinery

Main engine:
2 off MAK 6M 453aK 1650 kW / 2250 bhp each at 600RPM

Side thrusters:
Bow 1 x 425 kW / 570 bhp
Stern 1 x 425 kW / 570 bhp

Helicopter Deck

Bell 212, Max 5,08 T. Not currently certified for use in Australia.

Safety

Built according to DnV, Solas and Norwegian Ship Control rules. Enclosed lifeboats. Inflatable life rafts. Survival suits for all personnel. Fire detection and monitoring to highest available standard. Special helicopter deck protection arrangement. Internal communication and p.a. system. Q.A. according to highest standard (DnV-SEP). Safety and contingency manuals onboard and in use. Hospital facilities.

Table of Contents

1 List of Key personnel

1.1 Onboard Personnel

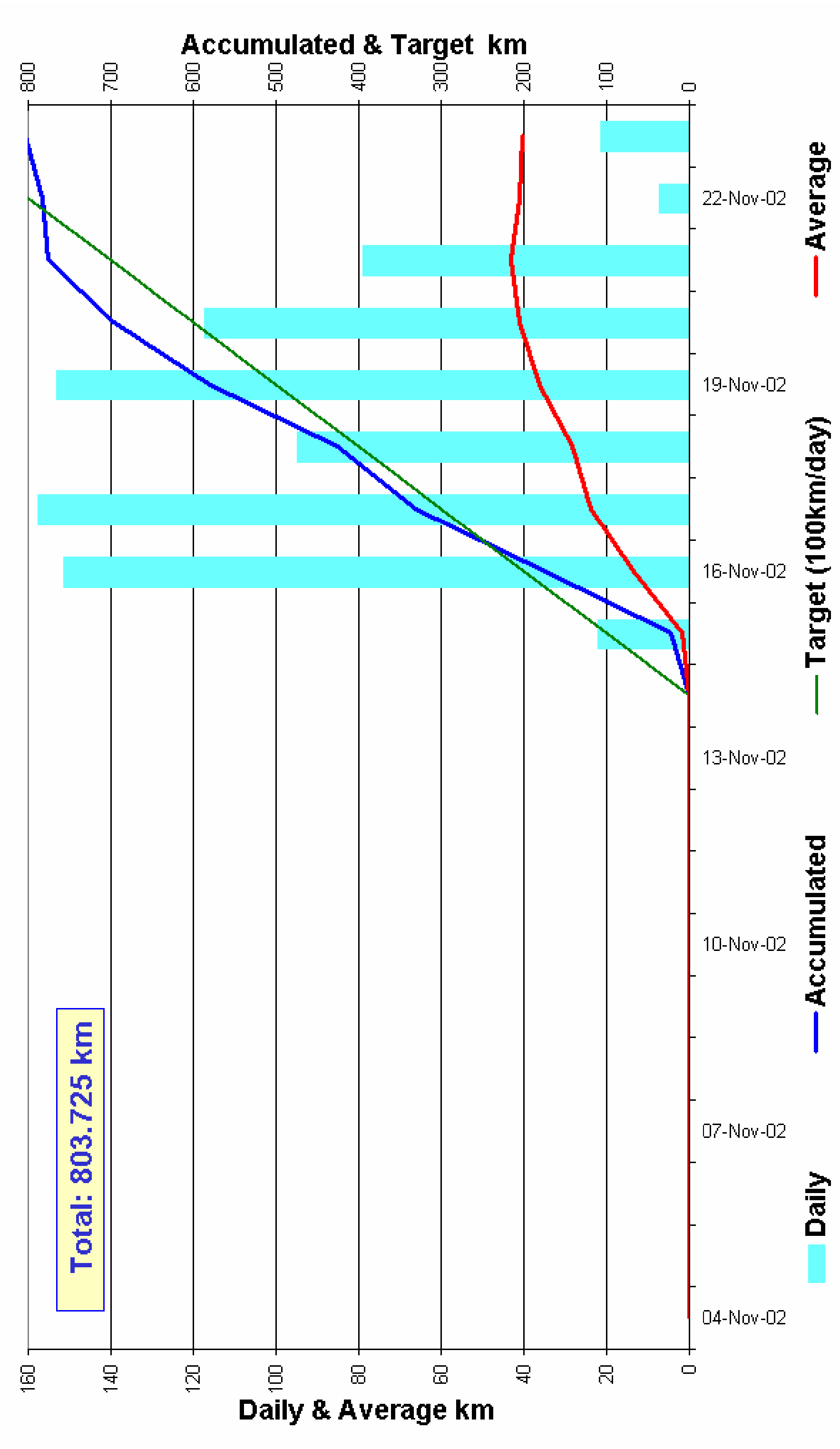
POSITION	CREW 1
Party chief	Geoff Clarke
Captain	Palmar Slettebakk
Chief Engineer	Earl O'Callaghan
Chief Observer	Cliff Gobbitt
Chief Navigator	Lars Roes
Chief Mechanic	Tore Nygård
QC leader	Stuart Kelly
Client Representative	Drew Murray

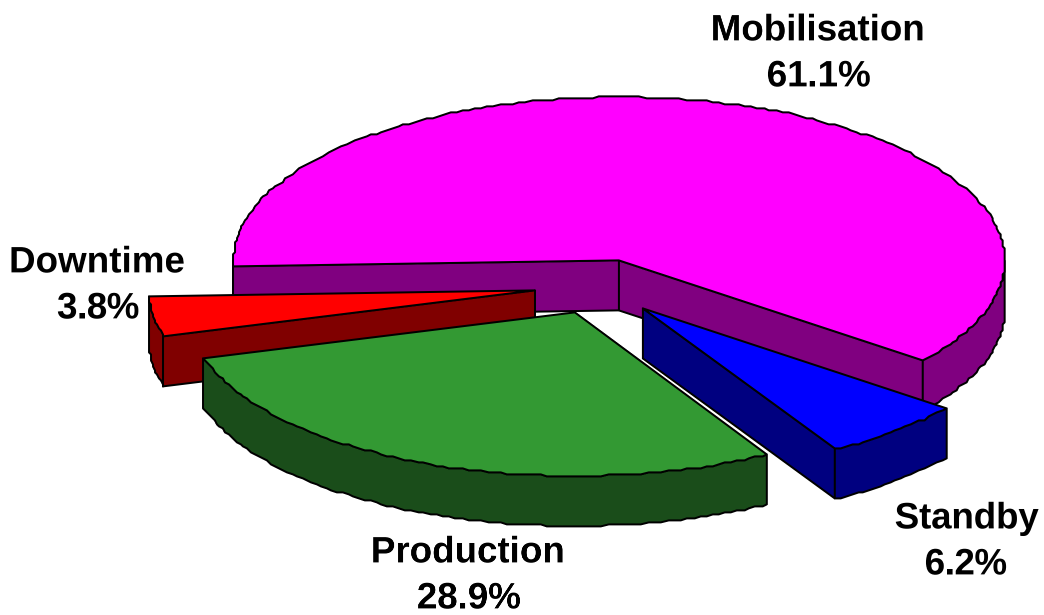
1.2 Office Support Personnel

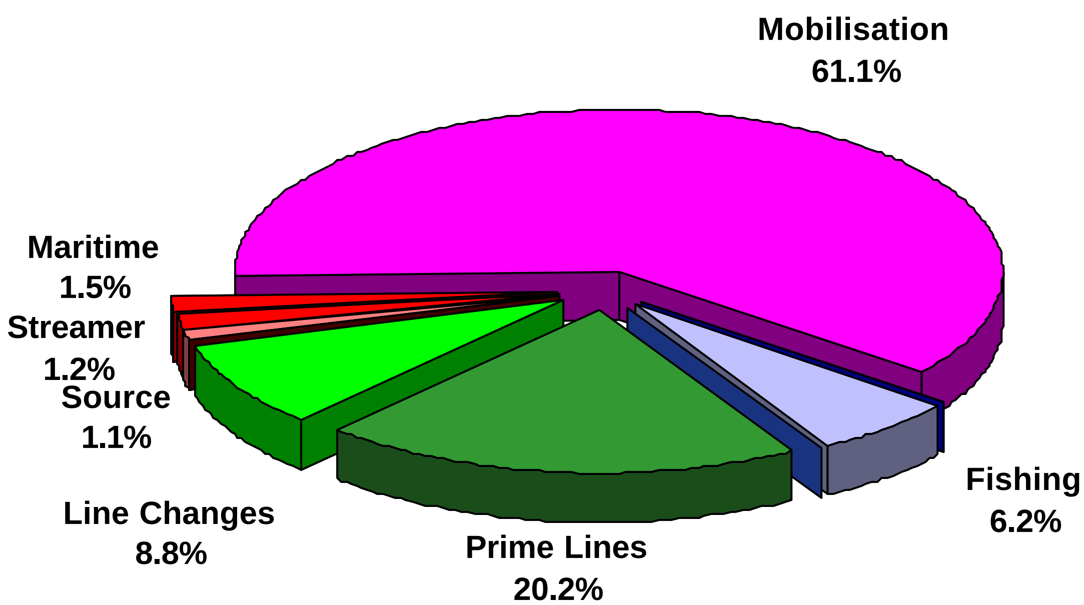
POSITION	NAME	OFFICE
Operation Manager	Atle Jacobsen	+ 47 55 94 77 65
Operation Supervisor	Kai Aasebø	+ 47 55 94 77 59
Technical Manager	Jan-Åge Langeland	+ 47 55 94 77 53
Instrument Support	Franck Andersen	+ 47 55 94 77 54
Navigation Support	Willy Forland	+ 47 55 94 77 63
Mechanical Support	Eivind Haavik	+ 47 55 94 77 57
QC Support	Christophe Massacand	+ 47 55 94 77 68

2 Field Information and Observations

2.1 Production Statistics




Mobilisation
61.1%
Downtime
3.8%
Standby
6.2%
Production
28.9%


Mobilisation
61.1%
Maritime
1.5%
Streamer
1.2%
Source
1.1%
Fishing
6.2%
Line Changes
8.8%
Prime Lines
20.2%

2.2 Daily Summary

Tuesday 5th November 2002
Bunkering completed alongside Cairns and moved to town berth for Santos mobilisation. This included a Client start-up meeting, gyro calibration and DGPS verification.

Wednesday 6th November 2002
Departed Cairns en transit to prospect, via Brisbane to pick up and some personnel and spares. Position at midnight: 19°25'S 147°42'E.

Thursday 7th November 2002
Continued transit south. Position at midnight UTC: 22°20'S 150°15'E.

Friday 8th November 2002
Continued transit south. Toolbox meeting held prior to streamer length reconfiguration to 5550m. Position at midnight UTC: 26°08'S 153°20'E.

Troy Hackett nominated as Seismic Crew Safety Representative.

Saturday 9th November 2002
Continued transit south. Picked up hydraulics engineer offshore Brisbane at midday and continued transit. Local time changed to +11 hours. Commenced a streamer test deployment, for adjustments to the hydraulic system. Position at midnight UTC: 30°50'S 153°24'E.

A toolbox meeting was held prior to streamer deployment.

Sunday 10th November 2002
Streamer deployment continued to test the hydraulic system. This opportunity was taken to remove weight from the streamer, to balance for colder waters on prospect. Two kilometres of the streamer were deployed before some further mechanical problems developed with the drive system, possibly due to the reel-motor alignment. Some investigation was carried out prior to streamer recovery. All 5550m of active streamer wound off onto helideck by hand, in preparation for alignment adjustments alongside. Continued transit to Newcastle and arrived alongside.

Toolbox meetings were held prior to streamer recovery and removal to helideck.

Position at midnight UTC: Alongside Newcastle.

Monday 11th November 2002
Continued alongside Newcastle for repairs to the streamer reel hydraulics system. The motor and drive gear and mounting were taken apart, cleaned and reassembled.

It was not possible to get the synchronisation fault on the 10cm radar fixed, due to lack of locally available spares. These will be ordered and ready for the next port call.

Continued transit to prospect area and position at midnight UTC: 35°10'S151°20'E.

Tuesday 12th November 2002

Continued transit to prospect. A toolbox meeting was held prior to the transfer of the streamer from the helideck back to the main reel.

New personnel were given a safety briefing tour of the vessel.

Vessel speed reduced by severe weather during the night, causing a slight delay of arrival at prospect.

Position at midnight UTC: 38°55'S 147°45'E.

Wednesday 13th November 2002

Vessel continued to prospect at slower speed due to severe weather. Sea conditions improved slightly during the afternoon allowing an increase in ship's speed through the night.

Position at Midnight: 39°10'S 145°25'E.

Thursday 14th November 2002

Continued to prospect and arrived in a position to the SE in deeper water to start streamer deployment. Swell conditions were at maximum for operations throughout the evening as streamer deployment continued.

A toolbox meeting was held prior to the TS Dip and streamer deployment.

Friday 15th November 2002

The streamer was fully deployed in the early hours. However module #12 failed tests and recovery was required for repairs. The streamer was fully deployed again, and good by late afternoon. Swell noise levels were high but accepted by the client with the streamer at 9m on the northerly heading. The source was deployed and production on line OEP02-02-001 commenced, continuing though midnight.

Toolbox meetings were held prior to the streamer recovery and source deployment.

Saturday 16th November 2002

Line OEP02-02-001 was stopped early due to the approaching shallow water and a quick turn made onto line OEP02-13-002. Production commenced some 5km down the line but still achieved a good tie onto the strike line. This line was successfully completed and source maintenance carried out during a slightly extended line change.

Swell and resulting noise was at a high level but steadily decreased during the morning as a NE wind knocked down the long SW swell.

Line OEP02-17-003 was stopped early at the coast and a quick turn made onto line OEP02-15-004. Minor adjustments were made to the source towing ropes during the normal line change.

Line OEP02-19-005 was shot at 8m as the swell had decreased significantly through the afternoon. This line stopped again at the coast and a quick turn made onto OEP02-21-006, which continued through midnight. Sequence 006 was shot at 7m in steadily improving sea conditions.

Two toolbox meetings were held prior to work on the source sub-arrays.

Sunday 17th November 2002

Production continued on line OEP02-21-006, with the streamer depth set at 7m, and was completed. Source maintenance was carried out at the open sea end during the line change, which was slightly extended as a result. Line OEP02-23-007 was shot into the coast and terminated early again.

Line OEP02-25-008 started slightly late at the coast end and was complete in continuing good sea conditions. There was then a quick turn around onto shorter line OEP02-25-009 into the coast again.

There was enough sea room for production to commence at the first shot point of line OEP02-29-010, with the first half of the streamer straight. This line was stopped shortly before midnight due to a source air leak, requiring a circle for repairs.

Toolbox meetings were held before work on the source. A Fire Drill was held after lunch, simulating a fire in the lounge, followed by a debrief.

Monday 18th November 2002

Production resumed on the second part of the line as OEP02-29-011, which was successfully completed. There was a normal turn around onto OEP02-33-012, which again stopped early at the coast. There was a very strong cross current during the inshore turn that caused some steering difficulties at the start of line OEP02-31-013.

A south-westerly swell started to develop during the morning but did not affect data quality to a significant degree. Streamer depth was at 7m.

Two circles were required at the start of line OEP02-37-014. This was due to a delay in starting up the compressors, caused by a low lube oil pressure problem, requiring a pump change. The line was stopped early at the coast again, and line change continued through midnight.

Tuesday 19th November 2002

Line OEP02-35-015 was completed, after a short turn on, at the beach end of the line. Sea conditions were good but a long swell was developing. The streamer depth set at 8m for line OEP02-39-016, heading back into the coast. Line OEP02-43-017 was shot in full, out from the beach.

Received confirmation from clients that line 01 and 03 were not to be shot. A new strike line running parallel to 04 and 1.5km south was to be inserted and named 08.

Line OEP02-41-018 was shot into the beach, and OEP02-47-019 in its entirety out again. Line change continued through midnight.

A toolbox meeting was held prior to source recovery for maintenance.

Wednesday 20th November 2002

Line OEP02-45-020 was shot in its entirety towards the coast and a slightly extended line change required back out to OEP02-06-021. Two poorly responding birds and some noisy traces indicate that some fishing gear may have been picked up while passing by the Discovery Bay Marine Park.

Line OEP02-05-022 was shot towards the beach and terminated early on the advice of the guard boat, which reported pinnacle soundings just beyond the end of the pre-plotted line.

Line OEP02-07-023 was started slightly late as the vessel turned back out from the shore but had a full run-out to the south. The ***Polar Duke*** ran through an area of lobster pots mid-line and some were caught on the head float and front-end birds. The line was successfully completed but it was decided to recover the streamer to inspect the damage as several birds were riding badly. Four lobster pots and buoys were recovered from birds 18, 13 and 2 with a total catch of two small rock lobsters and one hermit crab. Only one bird safety strop was broken. Amazingly there was no damage to the streamer sections. Recovery was completed shortly after midnight.

Toolbox meetings were held prior to source and streamer head recovery.

Thursday 21st November 2002

The streamer was re-deployed quickly after removal of the fishing gear and production resumed early morning on line OEP02-11-024. The guard boats ***Aquamarine*** and ***Perfect Lady*** were again actively lifting pots ahead of the ***Polar Duke*.** This line ran into the coast and was stopped early and a quick turn around taken onto OEP02-09-025 out.

There was then a long transit to the remaining inshore strike lines. Line OEP02-08-026 was shot to the west and the final line OEP02-04-027 to the east. Three pots were picked up on the streamer during this last turn. Streamer depth control and noise levels were good enough to continue the line. Line OEP02-04-027 continued for 10km but then streamer telemetry was lost at a module, close to where a buoy was caught. There was no cleared exit route through the prospect other than out on line 47. Full equipment recovery commenced for repairs. Recovery continued through midnight.

Toolbox meetings were held prior to source and streamer head recovery.

Friday 22nd November 2002

All equipment was recovered and four pots removed from the head buoy and birds 18, 13 and 8. The vessel headed south into clear water, prior to re-deployment. The only damage was to one active section at bird 18, which required to be changed out. Streamer module 9 failed once the streamer was fully deployed and another recovery was required. This second deployment was delayed by 1.5 hours due to a replacement of a badly leaking hydraulic pipe.

The ***Polar Duke*** finally approached line 04 by coming in along line 09. Part line OEP02-04-028 to complete the survey continued through midnight.

Four toolbox meetings held prior to source and streamer recovery.

Saturday 23rd November 2002

Line OEP02-04-028 was completed shortly after midnight and this time taken as the end of timing for this OEP02 prospect. The ***Polar Duke*** turned south on line 47 to exit the high risk potting area by the Discovery Bay Marine Reserve. The source and streamer head were recovered, for streamer reconfiguration on the transit to the next prospect.

2.3 Field Information and Encountered Problems

2.3.1 Obstructions / Installations on the Field

There were no man-made obstructions or offshore oil installations in the survey area. Water depths ranged from 25-500 m. There were no known physical obstructions. The dip lines ended close inshore at their NE ends in shallower water and some were terminated slightly early as a result.

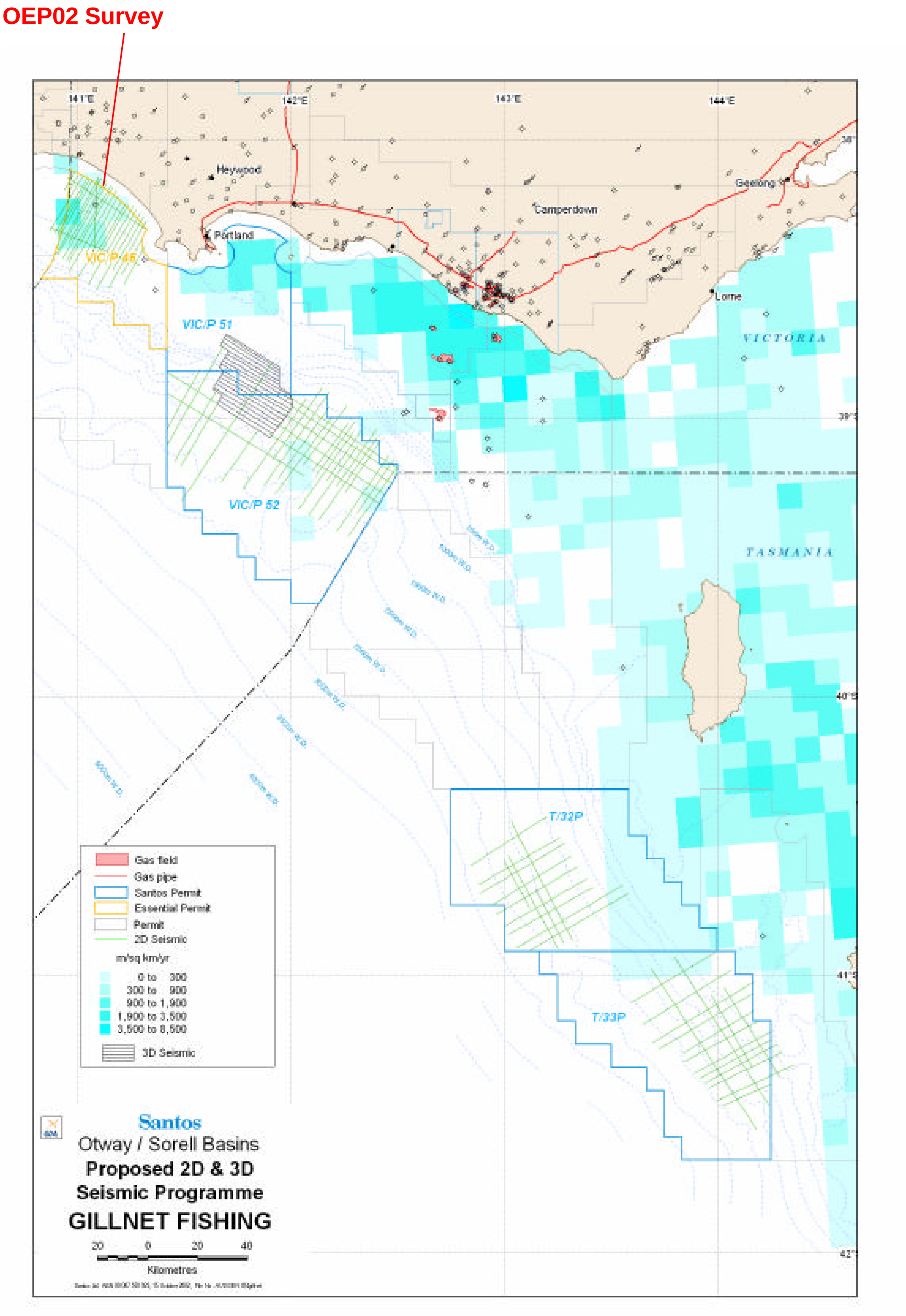
2.3.2 Traffic / Shipping Lanes

There were no designated shipping lanes in the prospect area. However the prospect was across the local shipping route between Melbourne and Adelaide. There were two or three ships per hour passing at only the busiest time but it was often completely quiet particularly during the weekend periods. All shipping responded quickly to the VHF radio and there were no problems with merchant shipping at all.

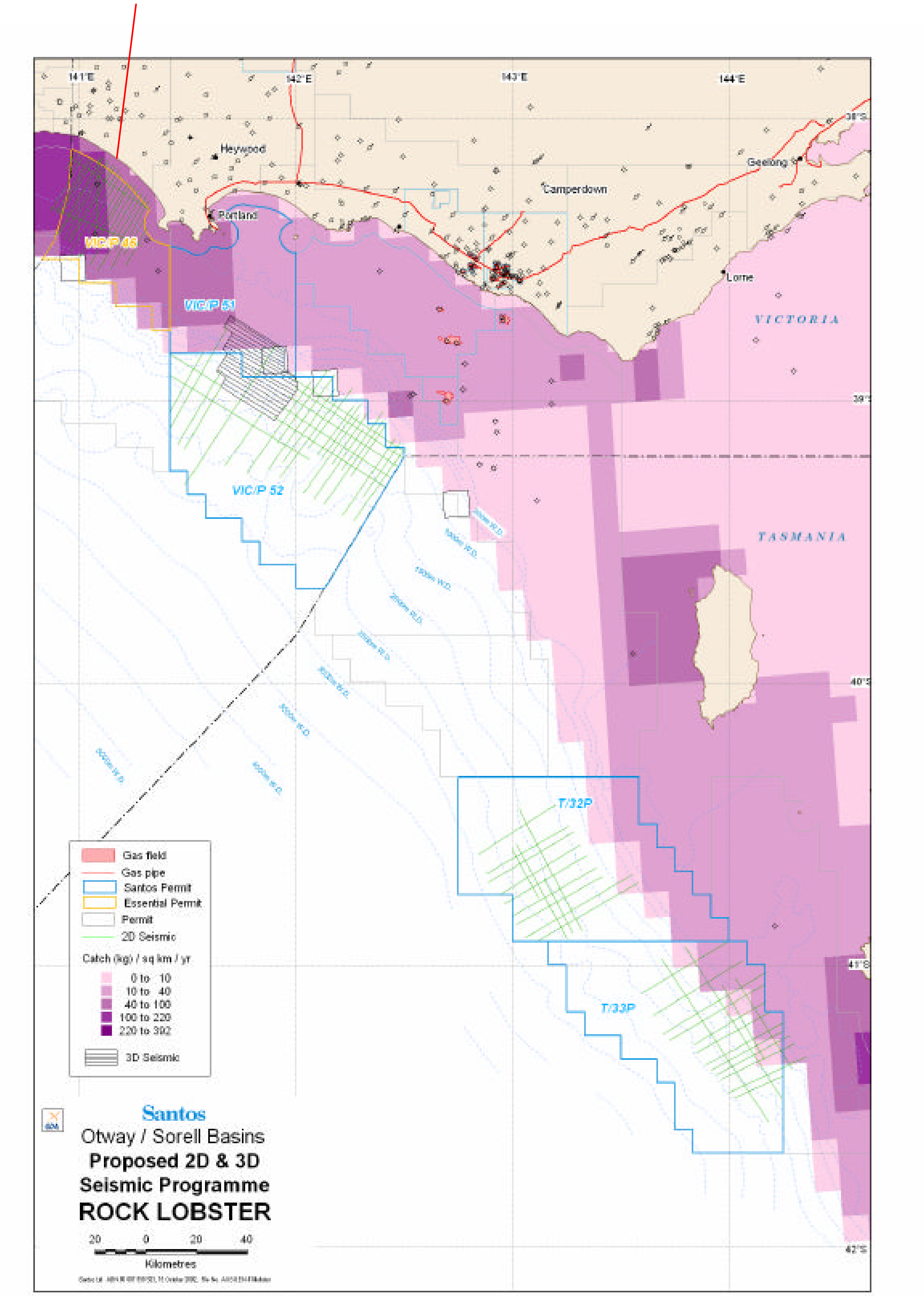
2.3.3 Fishing Activity

Fishing activity in the prospect area was mostly by small boats, using static buoyed pots for crab and lobster fishing. The client had prepared the prospect well in advance, and there was very good cooperation with the fishing fleet. Two local vessels with 20 knots top speed, the ***Aquamarine*** and the ***Perfect Lady***, accompanied the ***Polar Duke*** during this survey and were a great help in scouting obstructions ahead. They were also licensed to lift and move static gear as required. There were occasions when the fishing fleet was confused about the shooting plan and up to 40-50 pots found on line ahead. These needed to be lifted, and there were two occasions when pots were caught on the streamer, resulting in a total of 28 hours downtime.

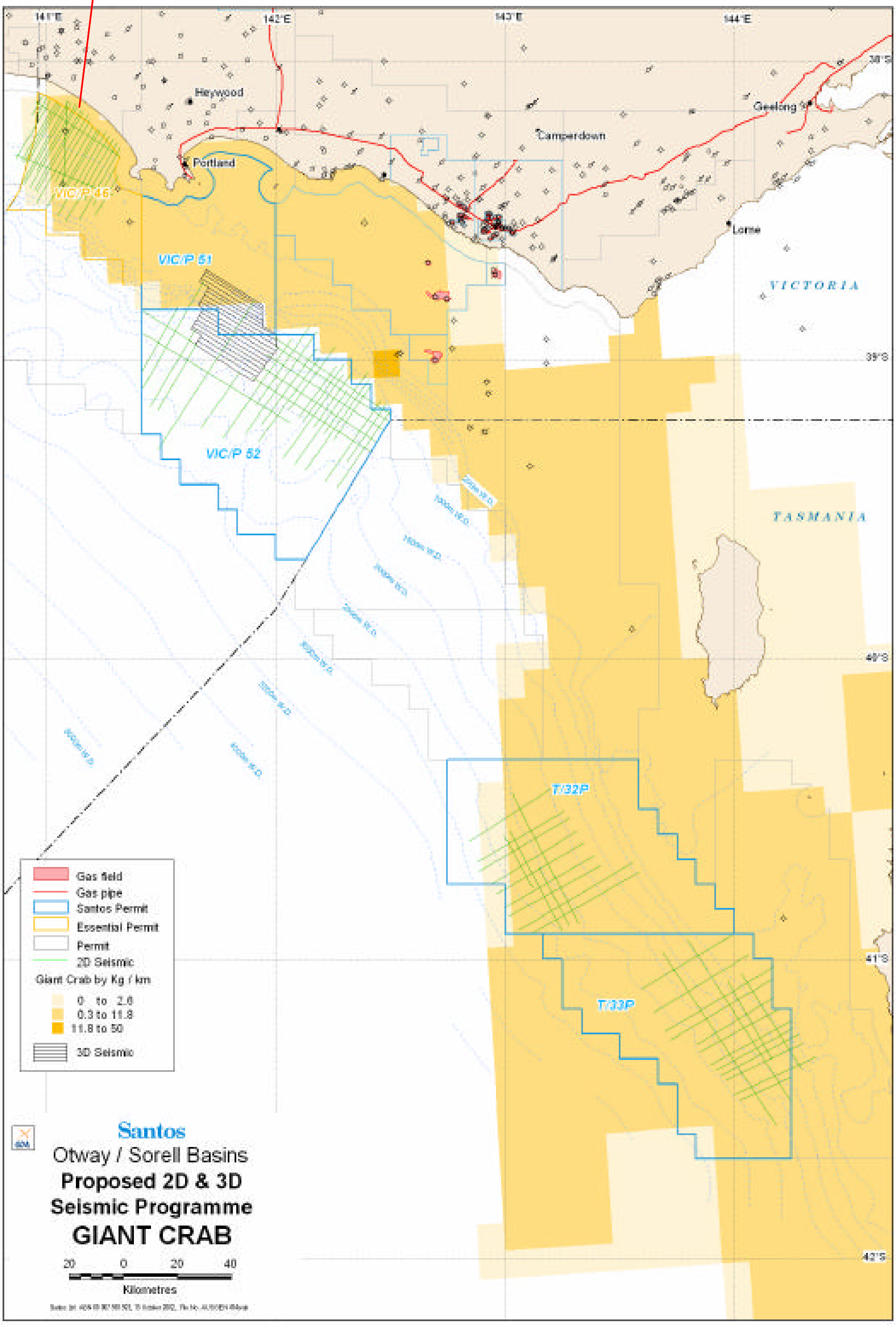
The following charts show the main types of fishing in the prospect area.



OEP02 Survey



OEP02 Survey



2.3.4 Seismic Interference and Time Share

There was no seismic interference on any of the data nor was there any requirement for timesharing operations on this program.

2.3.5 Environmental Obstacles

The survey area was strongly affected by oceanic swells from the SW. Strong currents tended to run along the coast and were highly variable in nature on the prospect due to back currents close inshore. Overall current direction was frequently affected by the local weather situation.

2.3.6 Operational Observations

Daily production rates were good during calmer weather periods. The good preparation carried out by the client prior to the survey meant that there was very limited conflict of operations with the fishing activity in the region. An improvement in future would be to supply the fishing community with overlays of the line plan, showing the lines as a broad band rather than a thin line. Pots were occasionally laid within 300m of the line and no allowance made for feathering.

2.3.7 Cetacean Activity

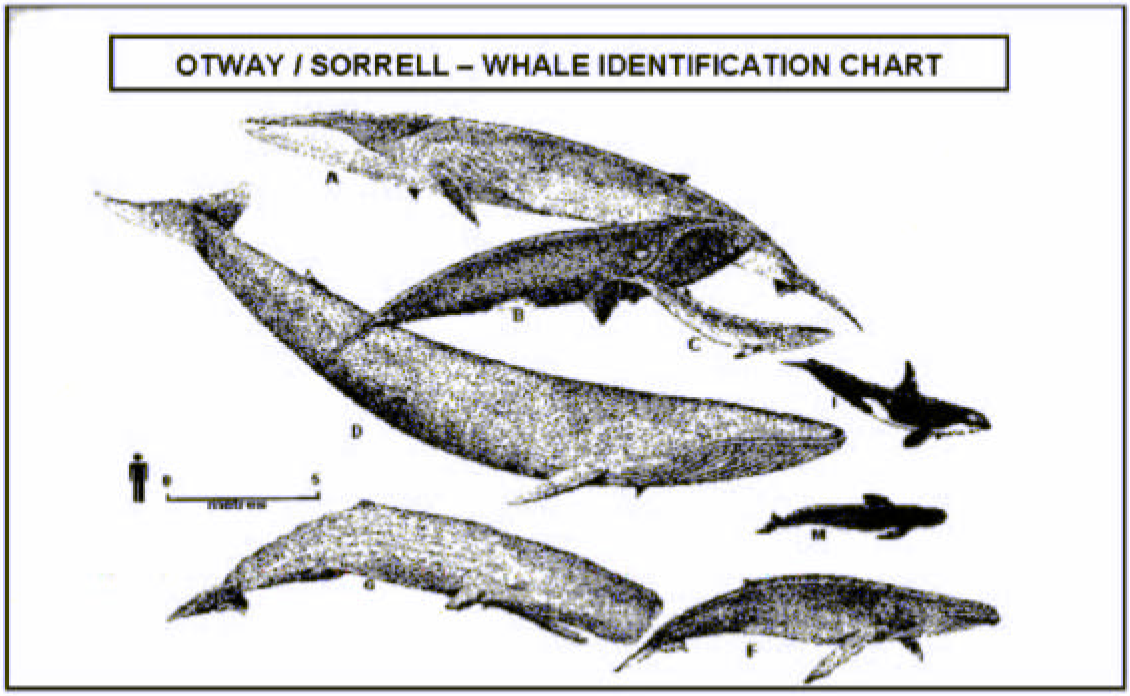
The survey area is known to be in an area of high whale activity. Standard company precautions were taken to minimise any disturbance, as set out in the flow diagram below. The survey was timed to be between whale migration periods through the Straits.

FIN WHALE (A)
24m long; triangular 0.5m dorsal fin set well back near the tail; series of folds or pleats under the throat; short, flat head; small mouth with shorter baleen; sharp ridge down the back; colouring asymmetrical - right side of lower jaw is white, left side is dark, tongue and baleen are also bicoloured; fast swimmers.

SOUTHERN RIGHT WHALE (B)
Usually found close to shore; seen "sailing" by holding their tails at right angles to the wind; breaching; 15m long; newborn calves up to 6m long; very large head and robust body; long turned-down mouth and long baleen plates between the jaws; large white bumps or collosities on the top of the head and below the jaws which form a different pattern for each individual; no dorsal fin; twin blowholes producing an easily identifiable "V" shaped spout; black colour.

MINKE WHALE (C)
Triangular, high and curved dorsal fin, set well back near the tail; series of folds or pleats under the throat; short, flat head, small mouth with less baleen which is yellowish/white fringed; fast swimmers; 6m long; blue-grey above and white below; distinctive white patch on the outer side of each flipper; pointed snout; small schools.

BLUE WHALE (D)
30m long, females slightly longer than males; gigantic head a quarter of total length; streamlined body; column-like spout 10m high; solitary and easily frightened; slate-blue above and lighter below, underside is often yellowish due to growths of distoms on the pleated or grooved undersurface (100 or more pleats); small triangular dorsal fin set well back near the tail.



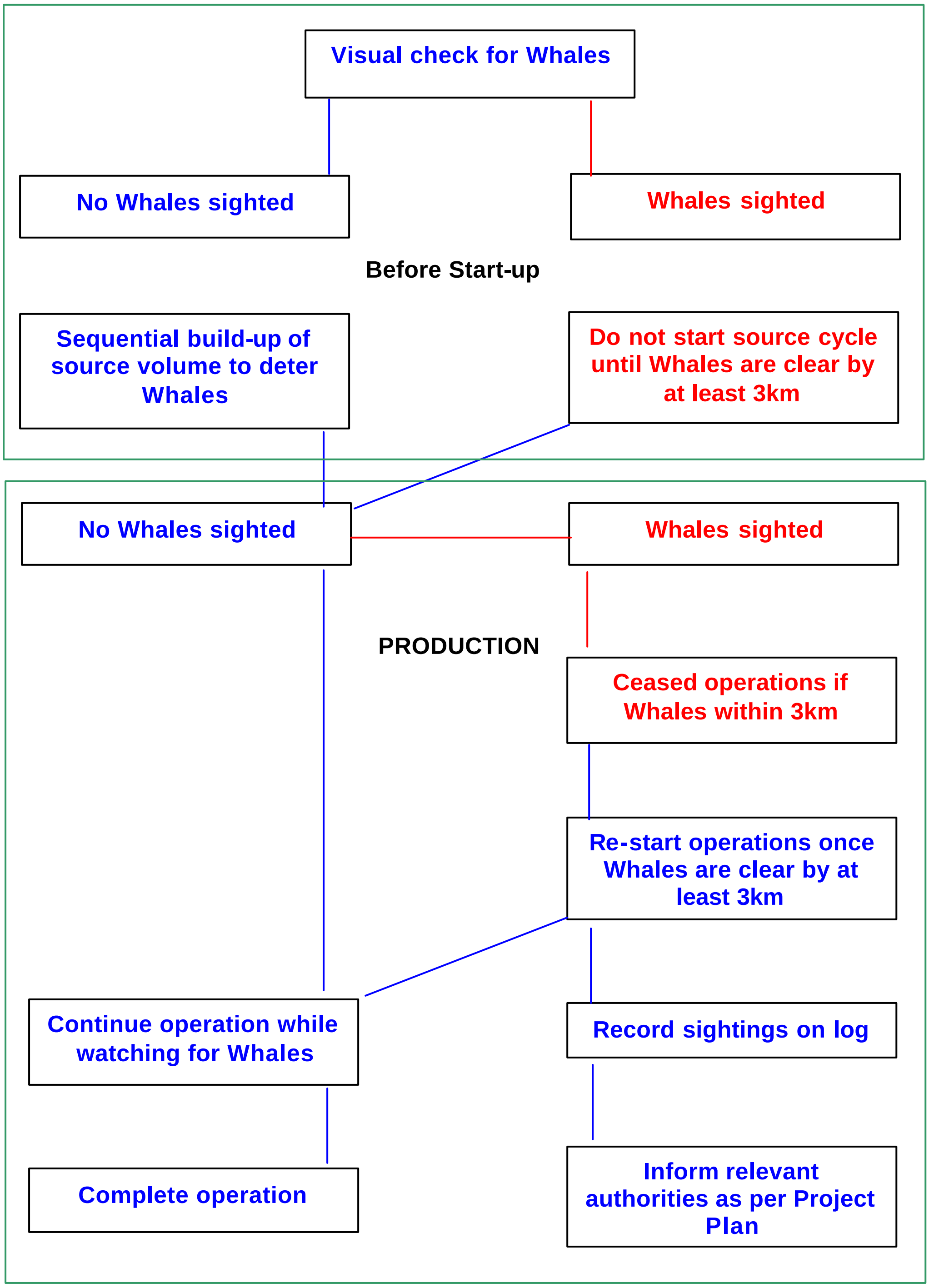
HUMPBACK WHALE (F)
15m long; black above and whitish below; baleen grey-black; large head (1/3 of length); "warts" on head; up to 25 throat grooves or pleats; small dorsal fin slightly aft of midpoint between head and tail; exceptionally long flippers (3.5m+) scalloped on their front margins; sometimes leaps completely out of the water (breaching) and its body is "humpbacked" on re-entering; beats surface with flukes (lobtailing); spout is spherical and about 3m high.

SPERM WHALE (G)
High square fronted head, a third of total length, and the lower jaw does not extend as far forward as the front of the head, directs the spout forward at an angle; no dorsal fin, only a series of bumps, the first and most prominent located about two-thirds of the way from the snout to the tail; flippers relatively extremely small; black or nearly black colour.

KILLER WHALE (I)
Predator which travels in packs; can "stand" on its tail sticking its head out of the water; 10m long (females a third smaller); very large dorsal fin - 2m; flippers are blunt; flukes are very broad; black colour with lens-shaped white spot behind each eye and patches of white under the chin, on the belly and behind the dorsal fin on each side of the streamlined boby.

PILOT WHALE (M)
6m long; uniform black colour except for white patch under the chin which narrows to a slim white line along the stomach; high broad-based dorsal fin located almost exactly in the middle of the back; flippers are lsim and melon-like bulge; travel in schools.

Cetacean Encounter Procedure



3 HSE Summary

Toolbox meetings were held whenever a task involving major equipment and several crew members was about to be carried out. This included but was not limited to work on the seismic source and streamer, and operations with the ship's workboat. All toolbox meetings were noted in the Bridge Log Book and the daily number of meetings held logged by the Party Chief.

New members of the crew were given safety orientation tours of the vessel at the start of the survey, and regular safety drills, SOLAS Training and meetings held.

The following table lists the HSE activities in chronological order during this short survey period.

Date	Action	Hours	Number of crew
06 Nov	Safety Induction Tour for new personnel.	0.5	13
07 Nov	Abandon ship and fire alarm musters.	0.75	29
07 Nov	Safety Induction Tour for new personnel.	0.5	3
12 Nov	Safety Induction Tour for new personnel.	0.5	2
17 Nov	Fire muster and drill, simulating fire in the video lounge. All squads participated in running hoses, donning BA suits etc. Full post drill debrief.	0.5	29

There were no Near Misses, Incidents, or cases requiring medical treatment during the survey period.

The following table shows a listing of **Observation Cards** issued during the survey.

OC	Date	Time	Location	Observer	Type	Description	Immediate Action	Corrective Action	Other Reference
49	21108	20:00	Accom	G.Clarke	House	Fire extinguisher used as hanger for overall.	Removed overall.	Remind crew to keep all extinguishers clear with free access at all times.	
50	21109	07:00	Hold	G.Clarke	House	Watertight door from laundry "To be kept closed at Sea".	Closed it.	Remind all crew to keep this door shut.	
51	21110	19:00	Helideck	G.Clarke	House	Deck very slippery when damp, due to recent touchup paint not being "anti-skid".	Warn all crew, particularly joggers, of slipping danger.	Repaint with sanded or non slip type at first opportunity.	
52	21111	04:30	Accom	M.Tate	House	Toilet and shower doors banging because there are no clip back retaining hooks.		Fix hooks at earliest opportunity.	
53	21114	14:00	Incinerator	A.James	House	Aerosol cans put in rubbish and exploded in incinerator.	Inform all crew AGAIN about this hazard.	Remind all crew to keep glass, metal and large plastic items separate. These are landed ashore. Other rubbish can be burnt.	
54	21114	14:45	Gym	T.Hackett	T+E	Fire alarm bell did not ring in gym during false alarm.	Informed Bridge Officer.	This problem fixed by ship's crew.	
55	21115	03:00	Back Deck	P.Thompson	T+E	Drive chain on level winder broke at point of previous repair. Could have caused nasty head wound if someone had been standing underneath.	Repaired broken link.	Drive chain needs thorough inspection at next portcall and probably replacement.	Spare links to be ordered by engineers.
56	21115	09:00	Back Deck	S.Fresson	House	Back deck very slippery in rough/wet weather caused by using gloss paint	Warned all crew of slipping risk and to take extra caution.	Re-paint with suitable non-skid paint ASAP. Remind all to use non-skid paint on all work deck areas.	
57	21117	07:00	Hold	P.Thompson	T+E	No fire extinguisher located near source storage container.	Informed deck crew, and mounted spare unit there.	No further action required.	
58	21117	10:00	General	F.Lear	T+E	Extinguisher colour coding is not consistent.	Advise all crew to inspect and familiarise with different types.	Over 50% of extinguishers recently replaced in NZ. Labels to be used where there is any confusion.	
59	21117	08:00	ER + Bosun	E.O'Callaghan	T+E	Grinders in Bosun's store and ER have been used to grind wood. Bearing on Bosun's badly worn.	Crew informed of dangerous conditions of grinders. GRINDERS MUST NOT BE USED FOR WOOD!!	Both stones should be replaced ASAP and the Bosuns overhauled or replaced.	Engineers to order replacement parts.
60	21117	18:00	Back Deck	H.Almuete	House	Hydraulic oil leak from corroded pipework.	Temporary repaired with rubber and hose clip.	Further work on hydraulic pipework needed to reduce number of leakages, slip hazards etc.	Item raised for attention at next yard stay.
61	21118	10:30	Outside Incinerator room.	A.James	House	Benched used for welding should have fire-proof curtain to prevent sparks getting to hydraulic unit and rubbish awaiting burning.	All welding operations onboard require a hot work permit and firewatch man on duty.	This bench is not an official 'welding bay' and work there needs to be permitted in the same way as anywhere else.	Permit to Work System
62	21118	16:00	Hold	G.Clarke	T+E	CO2 extinguisher #40 hidden in cupboard bay and behind garbage can.		Bracket needs to be moved to the other side of the cupboard unit for easy access.	
63	21122	13:30	Back Deck	G.Clarke	WP	Observer stepping over the streamer while it is being recovered.	Stopped operation to explain the risk in doing this…genital injury.	Remain all crew to be aware of the danger of their actions.	

4 Shipment List

4.1 Seismic and Navigation Data

Original Tapes

MGC

PD-2002-091

23/ Nov. 2002

SENDER: M/V Polar Duke
C/o Beaufort Shipping Agency Company
99,Queensbridge Street, Southbank, Vic. 3006
GPO Box 88A, Melbourne, Victoria 3001
E-Mail beaufort.melb@beaufortshipping.com
Attn. J. Duncan Tel: +61 3 9254 1599
Fax : +61 3 9696 9267

CONSIGNEE:
Robertson Research Australia Pty Ltd.'
69, Outram Street'
West Perth
Western Australia 6005

Attention Kelly Buglehole

ORIGINAL TAPES

Type of freight:
Sea/Land/Air

Box	Item	Serial no.	General description of content	Weight(kg)	Value(US)
1	1	n/a	Containing 28 Original Magnetic Data Cardridges (Sequence 001-028) (Reel 137-164)	6kg	$2,500
	2		CD containing Navigation P1, P1 processed, P2, and Associated files.		
2	1	n/a	CD containing Obs logs and tape logs, for original and copy tapes. Seq. 001-028 ,(Excel)		
			Containing Observers paper Line Logs Sequence 001-028,	12kg	$1,000
			1x Mag. Tapes with System test, and monthly and daily test printouts.		

Total weight: 24kg

Total boxes: 3

Total value: $3,500.00

For custom purposes only

Certified true and correct for MGC AS

Geoff Clarke - Party Chief, M/V Polar Duke

Collected from the Polar Duke by

Name:

Signature

Copy Tapes

PD-2002-092

23/ Nov. 2002

SENDER: M/V Polar Duke
C/o Beaufort Shipping Agency Company
99,Queensbridge Street, Southbank, Vic. 3006
GPO Box 88A, Melbourne, Victoria 3001
E-Mail beaufort.melb@beaufortshipping.com
Attn. J. Duncan Tel: +61 3 9254 1599
Fax : +61 3 9696 9267

CONSIGNEE:
Robertson Research Australia Pty Ltd.'
69, Outram Street'
West Perth
Western Australia 6005

Attention Kelly Buglehole

Fax : +61 3 9696 9267

COPY TAPES

Type of freight: **Land**	

Box	Item	Serial no.	General description of content	Weight(kg)	Value(US)
1	1	n/a	Containing 28 Original Magnetic Data Cardridges (Sequence 001-028) (Reel 137-164) **(COPY)**	7	$2,500
			CD containing Observers Logs and tape Log data		

Total weight: 7

Total boxes: 3

Total value: $2,500.00

For custom purposes only

Certified true and correct for MGC AS

Geoff Clarke - Party Chief, M/V Polar Duke

Collected from the Polar Duke by

Name: ____________________

Signature ____________________

4.2 Processing Data

PD-2002-093

Date: **25/ Nov. 2002**

SENDER: M/V Polar Duke
C/o Beaufort Shipping Agency Company
99,Queensbridge Street, Southbank, Vic. 3006
GPO Box 88A, Melbourne, Victoria 3001
E-Mail beaufort.melb@beaufortshipping.com
Attn. J. Duncan Tel: +61 3 9254 1599
Fax : +61 3 9696 9267

CONSIGNEE:
Robertson Research Australia Pty Ltd.'
69, Outram Street'
West Perth
Western Australia 6005

Attention Kelly Buglehole

Type of freight:
Air/Land

Box	Item	Serial no.	General description of content	Weight(kg)	Value(US)
1	1-28	N/A	Paper plots (Brute stacks, Raw stacks, NTG, RMS Seq 001-028)	4	NCV
	29-32	N/A	4 x 8mm tapes of SEGY stack data, ProMAX archives & UNIX archive of line data	0.5	$10
	33	N/A	1 x floppy disk of line stacking velocities		

Total weight: 4.5

Total boxes: 1

Total value: $10.00

For custom purposes only

Certified true and correct for MGC AS

Collected from the Polar Duke by

Name:

Geoff Clarke - Party Chief, M/V Polar Duke

Signature

5 Shipment Address

Robertson Research Australia Pty Ltd **69 Outram Street** **West Perth** **Western Australia   6005** **Attention: Kelly Buglehole**

6 Tape Logs

Polar Duke Data Tape Log							
Prospect	Santos-OEP02						
Box	001						
Original/Copy	Original						
Shipment No.	PD-2002-091						
Line Name	**Seq**	**Reel**	**FSP**	**LSP**	**FF**	**LF**	**Status**
OEP02-02-001	001	137	1001	2388	1000	2389	Complete
OEP02-13-002	002	138	2207	882	2207	881	Complete
OEP02-17-003	003	139	1001	2122	1000	2123	Complete
OEP02-15-004	004	140	2265	882	2265	881	Complete
OEP02-19-005	005	141	1001	2408	1000	2409	Complete
OEP02-21-006	006	142	2335	882	2335	881	Complete
OEP02-23-007	007	143	1001	2405	1000	2406	Complete
OEP02-25-008	008	144	2450	882	2450	881	Complete
OEP02-27-009	009	145	1001	2116	999	2117	Complete
OEP02-29-010	010	146	2414	1325	2415	1324	Incomplete
OEP02-29-011	011	147	1466	882	1467	881	Complete
OEP02-33-012	012	148	1001	2065	1000	2066	Complete
OEP02-31-013	013	149	2100	882	2100	881	Complete
OEP02-37-014	014	150	1001	2040	999	2041	Complete
OEP02-35-015	015	151	2410	882	2410	881	Complete
OEP02-39-016	016	152	1001	2432	1000	2433	Complete
OEP02-43-017	017	153	2246	882	2246	881	Complete
OEP02-41-018	018	154	1001	1978	999	1979	Complete
OEP02-47-019	019	155	1701	882	1702	881	Complete
OEP02-45-020	020	156	1001	1786	1000	1787	Complete
OEP02-06-021	021	157	2611	882	2612	881	Complete
OEP02-05-022	022	158	1001	2056	1000	2057	Complete
OEP02-07-023	023	159	2017	882	2020	888	Complete
OEP02-11-024	024	160	1001	2010	999	2011	Complete
OEP02-09-025	025	161	1947	882	1948	882	Complete
OEP02-08-026	026	162	1638	994	1640	993	Complete
OEP02-04-027	027	163	1001	1439	1001	1439	Incomplete
OEP02-04-028	028	164	1318	2585	1316	2586	Complete

Polar Duke Data Tape Log

Prospect	Santos-OEP02
Box	001
Original/Copy	Copy
Shipment No.	PD-2002-092

Line Name	Seq	Reel	FSP	LSP	FF	LF	Status
OEP02-02-001	001	137	1001	2388	1000	2389	Complete
OEP02-13-002	002	138	2207	882	2207	881	Complete
OEP02-17-003	003	139	1001	2122	1000	2123	Complete
OEP02-15-004	004	140	2265	882	2265	881	Complete
OEP02-19-005	005	141	1001	2408	1000	2409	Complete
OEP02-21-006	006	142	2335	882	2335	881	Complete
OEP02-23-007	007	143	1001	2405	1000	2406	Complete
OEP02-25-008	008	144	2450	882	2450	881	Complete
OEP02-27-009	009	145	1001	2116	999	2117	Complete
OEP02-29-010	010	146	2414	1325	2415	1324	Incomplete
OEP02-29-011	011	147	1466	882	1467	881	Complete
OEP02-33-012	012	148	1001	2065	1000	2066	Complete
OEP02-31-013	013	149	2100	882	2100	881	Complete
OEP02-37-014	014	150	1001	2040	999	2041	Complete
OEP02-35-015	015	151	2410	882	2410	881	Complete
OEP02-39-016	016	152	1001	2432	1000	2433	Complete
OEP02-43-017	017	153	2246	882	2246	881	Complete
OEP02-41-018	018	154	1001	1978	999	1979	Complete
OEP02-47-019	019	155	1701	882	1702	881	Complete
OEP02-45-020	020	156	1001	1786	1000	1787	Complete
OEP02-06-021	021	157	2611	882	2612	881	Complete
OEP02-05-022	022	158	1001	2056	1000	2057	Complete
OEP02-07-023	023	159	2017	882	2020	888	Complete
OEP02-11-024	024	160	1001	2010	999	2011	Complete
OEP02-09-025	025	161	1947	882	1948	882	Complete
OEP02-08-026	026	162	1638	994	1640	993	Complete
OEP02-04-027	027	163	1001	1439	1001	1439	Incomplete
OEP02-04-028	028	164	1318	2585	1316	2586	Complete

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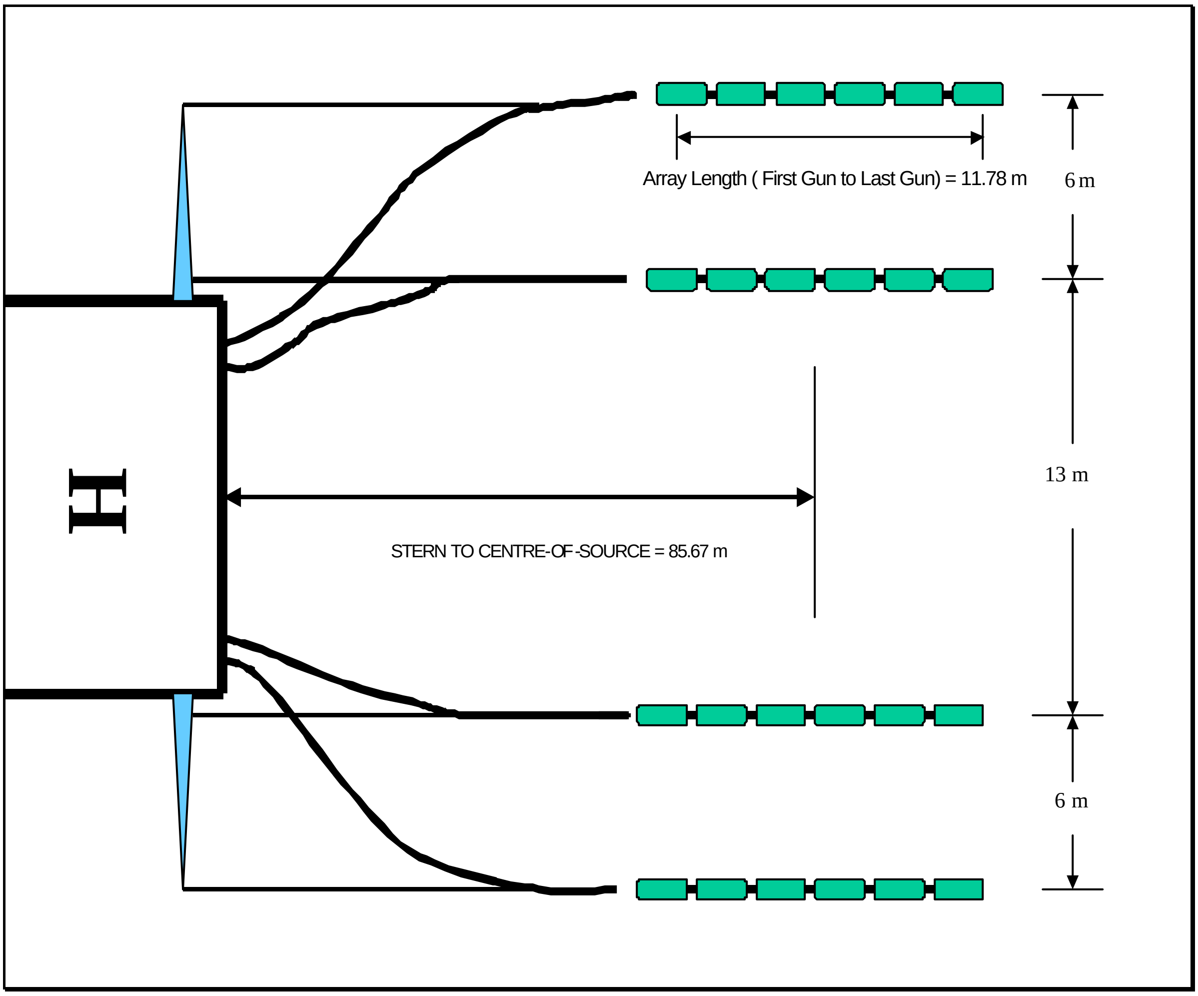
1 Towing Configuration

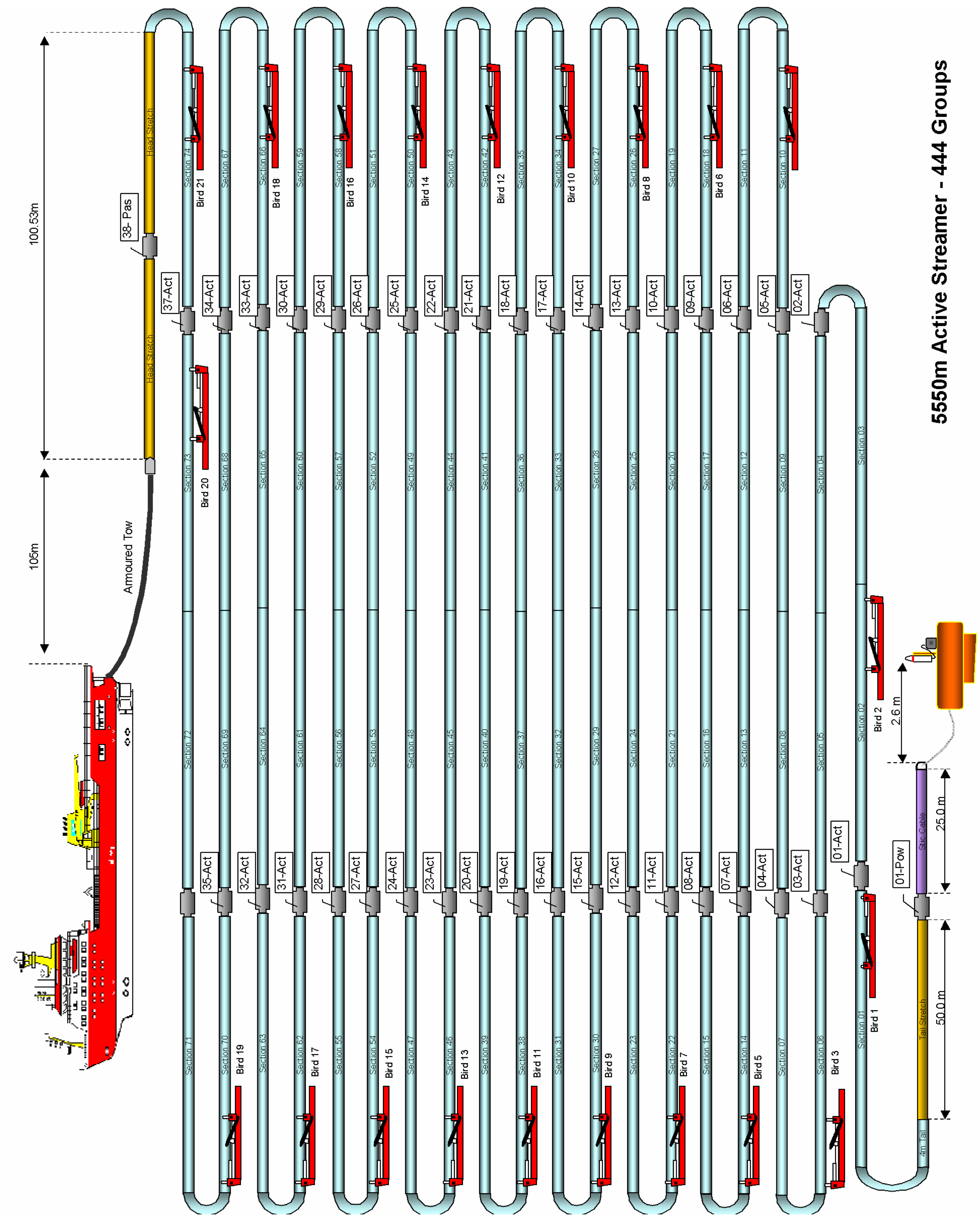


2 Streamer Configuration

2.1 Streamer System Description

Syntrak 480 Streamer Details	
Number of Streamers	1
Type of streamer	Syntrak 960-24, RDA 1
Maximum Capacity	960 Hydrophone / 12.5-m
Numbering Convention	1 Tail – 444 Vessel
Section Length	75 m nominal
Streamer length	5550 m
Groups per streamer	444 Groups
Group intervals	12.5 m / 16 phones
Hydrophones spacing	0.78125 m
Jacket Type	Polyurethane, 4 mm wall
Hydrophone Array	Benthos RDA split group
Ballast fluid (fluid-quantity)	Isopar-M (200 litres/active sect)
Number of Hydrophones	8 phones / 6.25 m
Channels per module	12
Data transmission link	Twin Axial Pair
Active group lengths	12.5 m
Streamer depth	10 m
Group Capacitance	0.128 uF/6.25
Group Sensitivity	20 Volts/Bar
Active Data Acquisition Modules	37
Passive Data Acquisition Modules	2
Passive Power Module	1
Number of stretch sections	3
in front of each streamer	2
end of each streamer	1
No of compasses per streamer	21
No of depth transducers per streamer	21

2.2 Streamer Layout 5550m



2.3 Streamer Configuration 5550m

POLAR DUKE **STREAMER DIAGRAM**

STREAMER 5550m
GROUP INT 12.5m **DATE** 8th Nov 2002
BIRD COILS Head
MODULES 37 Leadin 116m Deployed

	Section	Patch	Ser. No	Mdl	clip on	Lead	Weight	Chann.	Bird	S/N	Fin	SRD
	Lead In											
	Slip Ring		10286	2-P								
	Armored		0398-10020									
	Stretch	H	0694-10222SE				60.kg					
			10291	1-P								
	Stretch		0498-10554 HS									
T	74		0397-10543		4	0	4.kg	439\444	21	12024		SRD
			3122	37								
H	73		0297-10477		4	0	4.kg	433\438	20	19247		SRD
T	72	C	0297-10496		3	1	3.6kg	427\432				
			3133	36								
H	71	C	0297-10474		4	0	4.kg	421\426				
T	70		0397-10557		4	0	4.kg	415\420	19	6962		
			1907	35								
H	69		0397-10588		4	0	4.kg	409\414				
T	68		0397-10546		4	0	4.kg	403\408				
			3143	34								
H	67	C	0397-10577		4	0	4.kg	397\402				
T	66		0397-10563		4	0	4.kg	391\396	18	18332		
			3245	33								
H	65	C	0397-10542		4	0	4.kg	385\390				
T	64		0297-10524		3	1	3.6kg	379\384				
			3238	32								
H	63	C	0397-10538		4	0	4.kg	373\378				
T	62		0397-10554		4	0	4.kg	367\372	17	19568		SRD
			2579	31								
H	61	C	0397-10548		3	0	3.kg	361\366				
T	60		0397-10568		3	0	3.kg	355\360				
			3237	30								
H	59		0197-31025		4	0	4.kg	349\354				
T	58		0397-10533		1	0	1.kg	343\348	16	7224		
			3139	29								
H	57		0297-10489		3	0	3.kg	337\342				
T	56		0197-10395		4	0	4.kg	331\336				
			2578	28								
H	55		0397-10579		3	0	3.kg	325\330				
T	54		0297-10527		5	0	5.kg	319\324	15	22741		
			3126	27								
H	53	C	1197-20983		4.5	0	4.5kg	313\318				
T	52		0397-10580		3	0	3.kg	307\312				
			2583	26								
H	51		0397-10570		3	0	3.kg	301\306				
T	50		0297-10500		3	0	3.kg	295\300	14	8087		

Section 3: **Equipment Configuration**

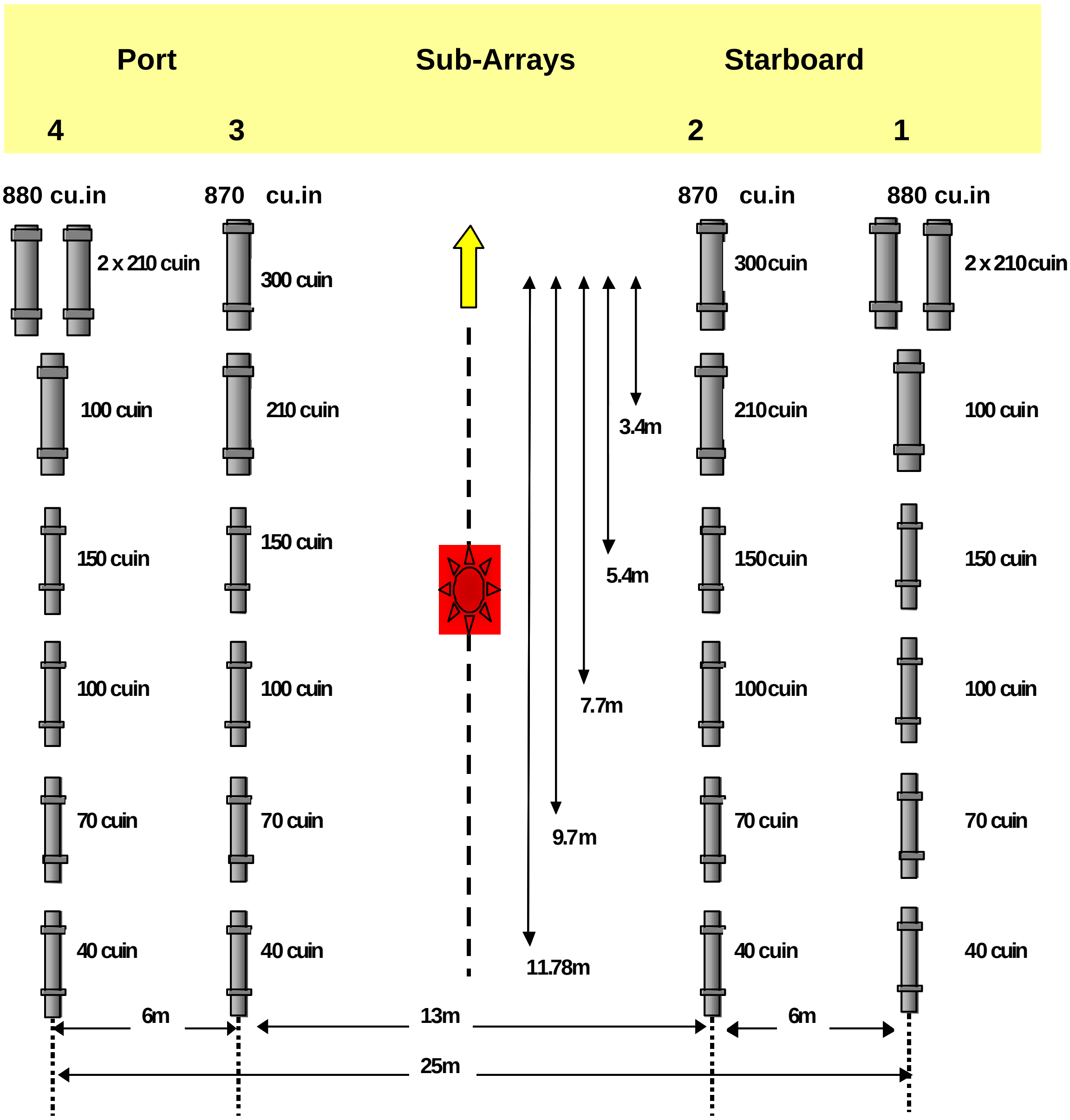
	Section	Patch	Ser. No	Mdl	clip on	Lead	Weight	Chann.	Bird	S/N	Fin	SRD
T	30		0397-10540		3	0	3.kg	175\180	9	18424		
			2593	15								
H	29		0297-10498		3	0	3.kg	169\174				
T	28		0397-10575		3	0	3.kg	163\168				
			3145	14								
H	27		0397-10561			0		157\162				
T	26		0397-10559		3	0	3.kg	151\156	8	19014		R2
			3124	13								
H	25		0397-10586		3	0	3.kg	145\150				
T	24		0397-10573		3	0	3.kg	139\144				
			1889	12								
H	23		0397-10607		3	0	3.kg	133\138				
T	22		0397-10560		2	0	2.kg	127\132	7	8494		
			3233	11								
H	21		0397-10585		3	0	3.kg	121\126				
T	20		0397-10576		3.5	0	3.kg	115\120				
			3242	10								
H	19		0397-10537		3	0	3.kg	109\114				
T	18		0397-10584		3.5	0	2kg	103\108	6	7584		
			1904	9								
H	17		0297-10521		3	0	2kg	97\102				
T	16		0397-10587		3		3.kg	91\96				
			3123	8								
H	15		0297-10522		3	0	3.kg	85\90				
T	14		0297-10475		3	0	3.kg	79\84	5	14895		
			2576	7								
H	13		0397-10534		3	0	3.kg	73\78				
T	12		0397-10581		3	0	3.kg	67\72				
			1839	6								
H	11		0397-10558		3	0	3.kg	61\66				
T	10		0198-10845		3	0	3.kg	55\60	4	18848		
			3246	5								
H	9		0397-10574		3	0	3.kg	49\54				
T	8		0297-10516		3	0	3.kg	43\48				
			3127	4								
H	7	C	0397-10590		1	6	4.6kg	37\42				
T	6	C	0297-10512		1	5	4.kg	31\36	3	15223		
			1930	3								
H	5	C	0297-10517		1	7	5.2kg	25\30				
T	4	C	0397-10572		1	6	4.6kg	19\24				
			1875	2								
H	3	C	0397-10591		1	5	4.kg	13\18				
T	2	H	0397-10556		3	0	3.kg	7\12	2	20006		
			2580	1								
H	1		0397-10549		1	5	4.kg	1\6	1	7606		
	4metre	1097-10024-4T										
	Stretch	SS1-0297-1388HS										
			12125	PP								
	Stic											

3 Source Configuration

3.1 Source System Description

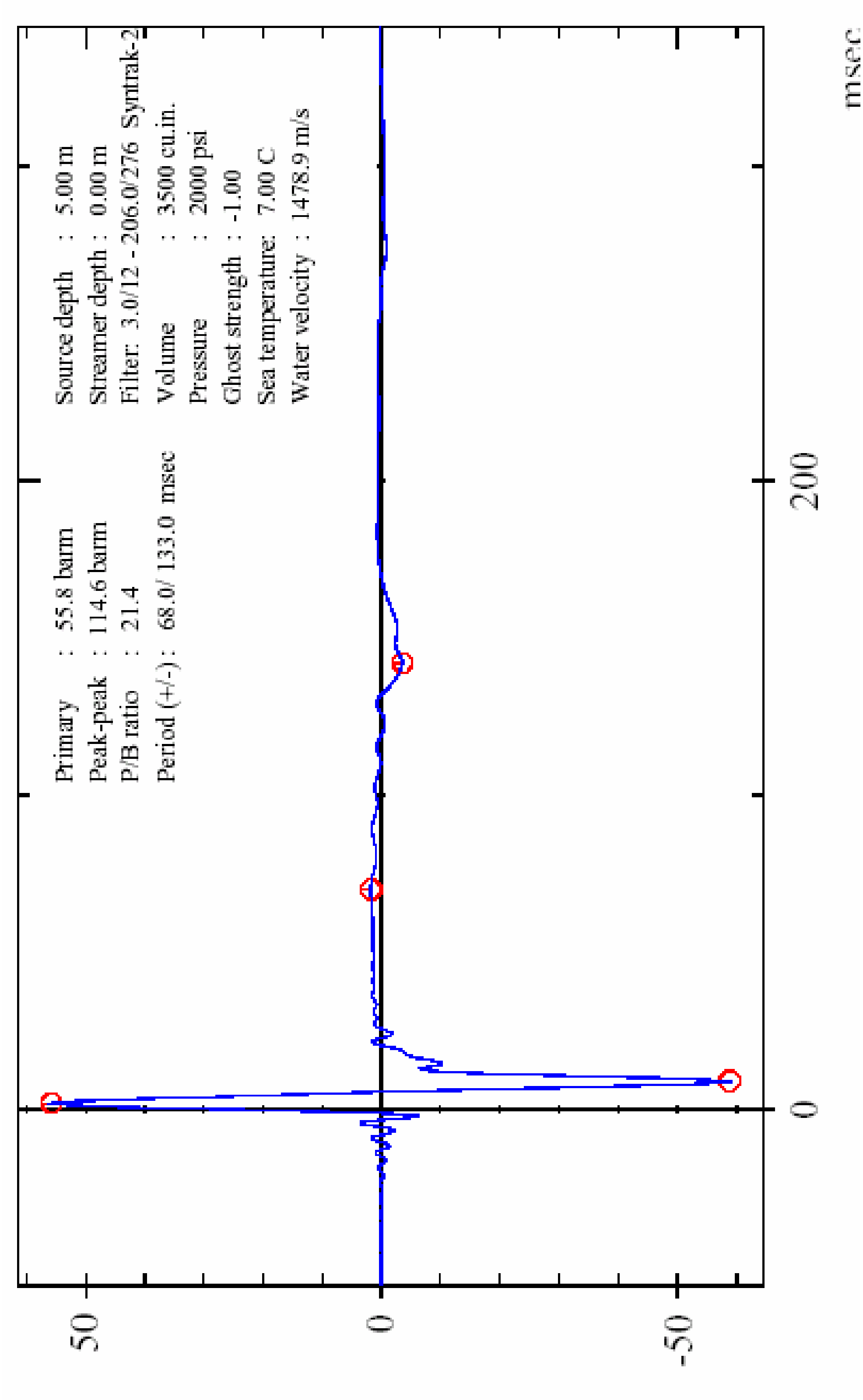
Source Parameters	
Number of source arrays	1
Array separation	N/A
Array length	11.78 m
Array width	25 m
Number of strings/array	4
Source volume	3500 cubic inches
Number of hydrophones per array	4
Number of depth transducers per array	12
Number of guns per array	26
Number of clusters per array	2
Airgun type	VS-X Sleeve Air Gun
Operating pressure	2000 psi. (Nominal)
Depth of guns	5 m
Peak to Peak amplitude	114.6 barm
Primary to Bubble ratio	21.4

3.2 Source Layout

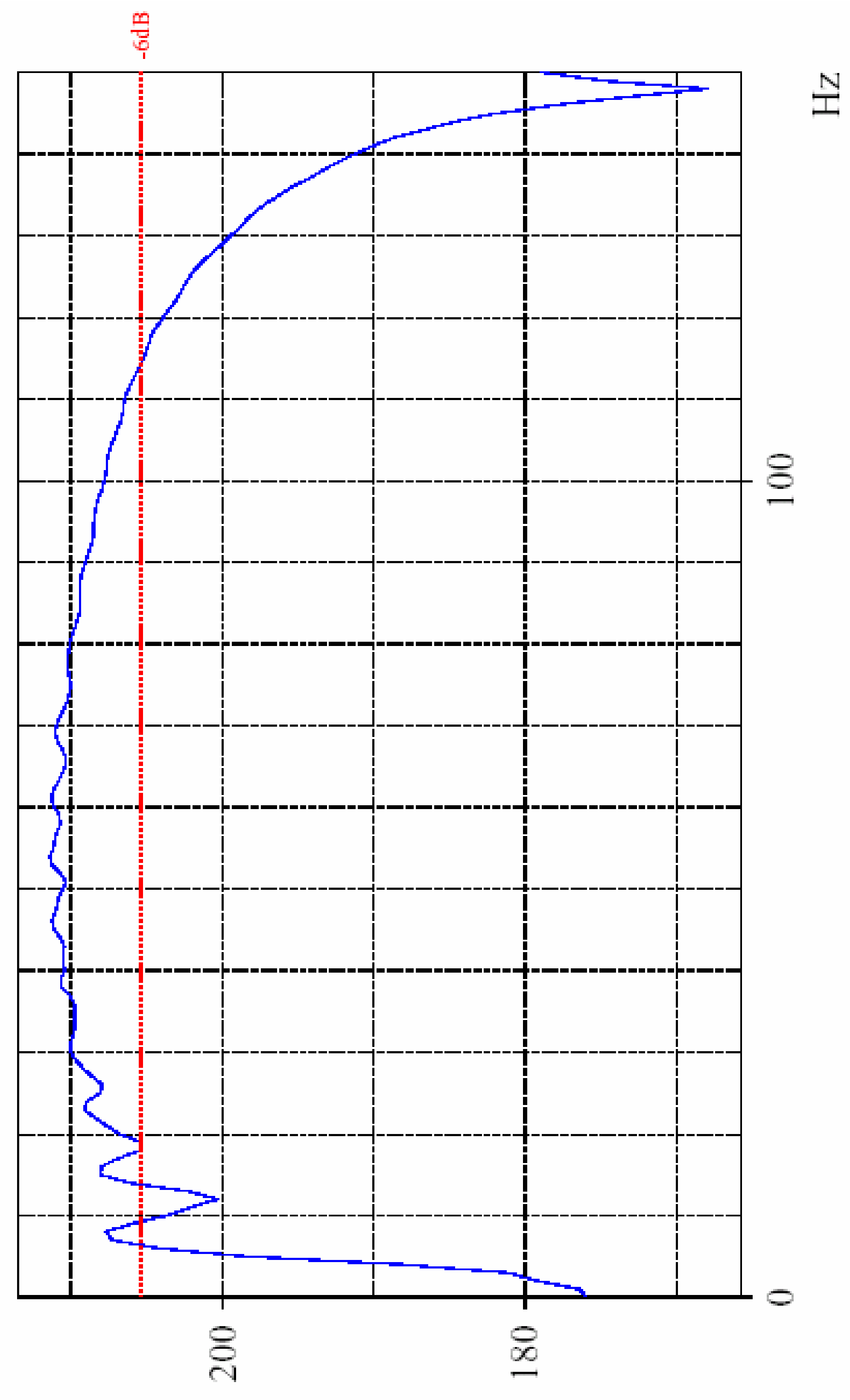


The source array consists of 4 sub-arrays with a total volume of 880 cu.in. for each outer array, and a total volume of 870 cu.in. for each inner array. Each outer sub-array contains 6 gun locations with a total of 7 guns per sub-array. Each inner array consists of only 6 guns.

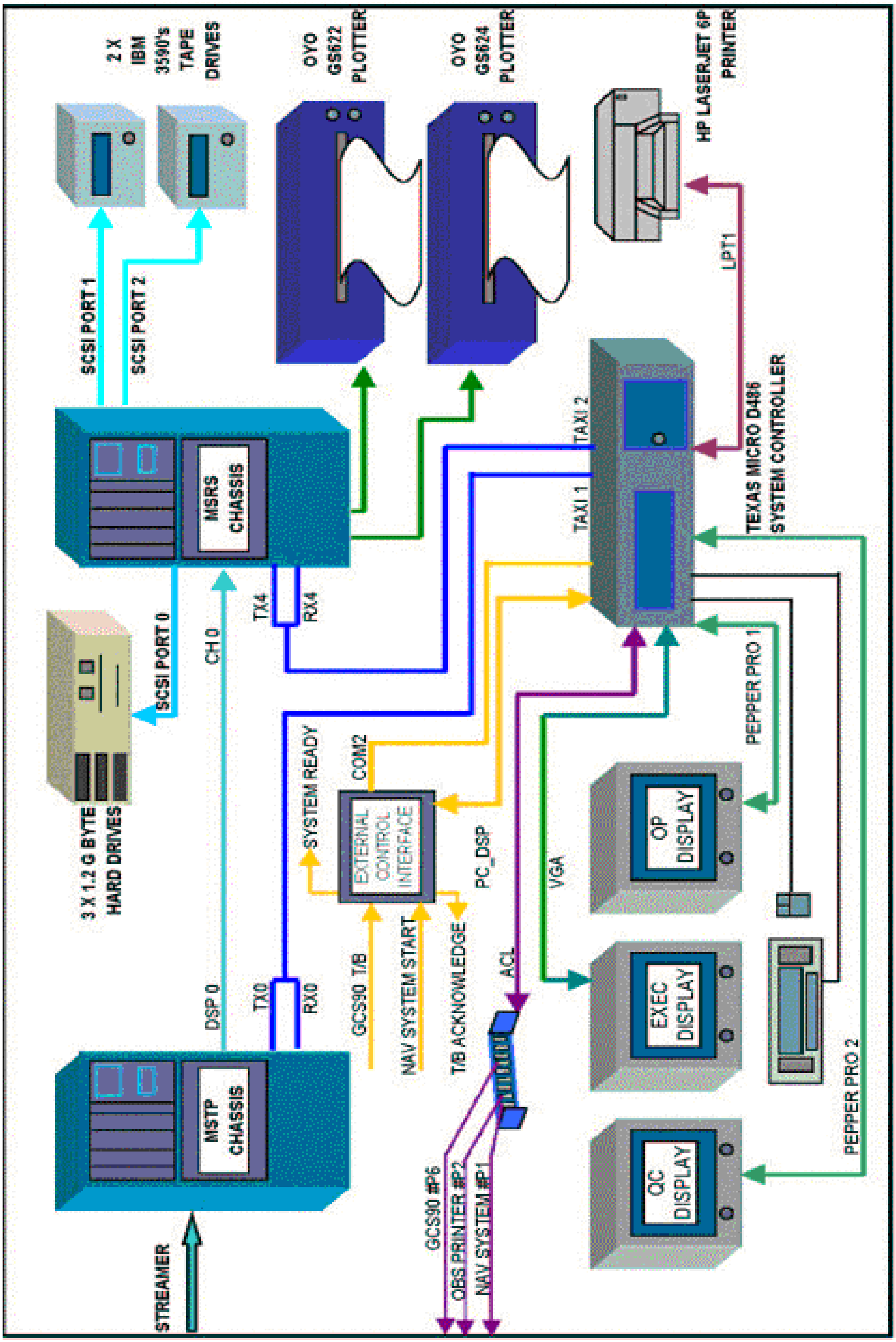
3.3 Far Field Signature



3.4 Amplitude Spectrum



4 Instrument Room System diagram



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1 Navigation and Positioning System Description

1.1 System Configuration

1.1.1 Navigation Hardware and Software

System	Hardware (Type and Serial No.)	Software version
CONCEPT	Spectra Integrated Navigation Sys.	9.8.03
FGPS	SeisPos navigation processing sys	10.80/11.00
External Header	General Header	Syntron v2
Acoustic System	None	
TS-meter	SD204	Minisoft 200W
Echo sounders	Simrad EA-500 12Khz Furuno FCN-271	
Gravity sensor	N/A	
Current Meter	None	

1.2 Survey Positioning Method Used

The survey was carried out using MGC's standard mode of operation for single streamer and single source surveys. Positioning of the vessel was by differential DGPS, with delivery of differential correction data in RTCM-104 format.

Source and front-end streamer positions were computed by gyro compass orientated layback from the reference point to tow-point, and first compass from the tow-point to the centre of source and centre of the near group. The offset from the centre of source to centre of the near group was verified by use of waterbreaks. Streamer tail end positioning was accomplished by compass streamer modelling and an active GPS tailbuoy.

1.3 Surface Positioning

1.3.1 Vessel Navigation

Summary:

System 1: Trimble 4000SSi receiver
RTCM Delivery System: Fugro SPOT and Dual-Frequency Starfix+ via Fugro Starfix+ system.
Computation Software: Fugro MRGPS version 2.4.09

System 2: Trimble 4000SSi receiver
RTCM Delivery System: Inmarsat
Computation Software: Fugro MRGPS version 2.4.09

Fugro Starfix interfaced to the Spectra System provided primary vessel positioning.

The two sources of corrections were transmitted to and received onboard the vessel by independent means thereby providing a high degree of redundancy to ensure continuous vessel positioning.

Although Selective Availability was turned off in May 2000 differential corrections are still required in conjunction with GPS positioning to provide a high quality continuous vessel position.

Reference Stations Used (Primary System) Source: Spot Optus

Name	ID	Latitude	Longitude	Distance	Comments
Melbourne	385	037°48'29.014" S	144°57'48.027" E	325 kms	Selected constantly
Bathurst	336	033°25'46.902" S	149°34'01.960" E	930kms	Selected constantly
Brisbane	275	027°28'38.507" S	153°01'37.338" E	1640kms	Selected constantly
Dunedin	026	045° 52'10.214" S	170°30"39.315" E	2550kms	Selected constantly
Broome	185	017°57'36.389" S	116°04'32.992" E	2900kms	Selected constantly

Reference Stations Used (Secondary System) Source: Inmarsat POR + Spot ApSat

Name	ID	Latitude	Longitude	Distance	Comments
Melbourne	385	037°48'29.014" S	144°57'48.027" E	325 kms	Selected constantly
Bathurst	336	033°25'46.902" S	149°34'01.960" E	930 kms	Selected constantly
Kalgoorlie	315	030°45'06.959" S	121°28'49.881" E	2000 kms	Selected constantly
Townsville	195	019°15'52.647" S	146°48'44.108" E	2200 kms	Selected constantly
Darwin	125	012°22'25.628" S	130°52'17.261" E	3100 kms	Selected constantly

1.3.2 Float Navigation

Source surface navigation was provided by the MRDGPS software and interfaced to Spectra. The in-sea units incorporated a GPS receiver and interfacing for direct data transmission of the raw satellite position by conventional UHF telemetry radio.

Raw GPS position from the floats was compared against the GPS position of the vessel and a range and bearing calculated. These range / bearing values were input into Spectra with a resultant relative position better than 3 metres.

1.4 Streamer and Source Positioning

1.4.1 Streamer Compasses

5550m Configuration

21 units of series 5211 Digibird/Syntron combined magnetic compass and streamer depth controllers were attached to the streamer.

Compass Sampling Rate	=	1 per shot
Averaging constant	=	20 seconds

Magnetic Declination entered into Spectra for this Prospect was:
10.01° at Position: 038°20'00.000"S 141°07'00.000"E

The computation was performed using GeoMag V2.2.0.0 for 2002-09-01 and verified by Ship's Charts.

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

1.4.2 Gyro Compass

The gyrocompass used during the survey was:

Primary Gyro 1:	Anschutz Kiel Type:110-310 Serial No: 3974
Secondary Gyro 2:	Anschutz Kiel Type:110-310 Serial No: 5185

1.4.3 Velocity of sound in water

The CTD Sound Velocity Probe was used to measure the velocity of sound on the prospect and was measured at 1494.20 m/s at position 38°34'37" S 141°37'12" E.

1.4.4 Echo sounders

Primary Echo sounder:	Simrad Model EA500 12KHz
Secondary Echo sounder:	Furuno Model FCN-271

The echo sounders speed of sound was set to 1494.2 m/s. A draught correction of ZERO was entered in both Echo sounders.

2 Navigation Systems Verification and Monitoring

2.1 Echo Sounder Verification

The Primary Echo sounder, Simrad EA-500 12khz, was installed and tested by qualified technicians January 15th 2002 while in port Singapore.

A lead line verification was carried out on the Secondary Furuno FCN-271 Echo sounder while alongside East Arm Wharf in Darwin, December 2001. Two tests were carried out at one-hour intervals:

Test 1 : 18.5m / 18.0m	*Echo sounder reading of 12.1m*
Test 2 : 18.2m / 18.0m	*Echo sounder reading of 12.1m*

Average lead-line distance = 18.17m

All depths recorded are based on the position of the Fathometer's transducer on the vessel's Hull. Depths are NOT draught corrected and all depths should have 5.65m added to the depth to give the true water depth from the surface.

2.2 Gyro Monitoring

C&B Survey Group was appointed to carry out the Gyro calibration work on ***Polar Duke*** at Cairns dock in Australia. The datum point for GPS observations was PSM no.52097 and verified with measurements to PSM no.45129. The true bearing between the 2 points was calculated from the measured co-ordinates. Two independent RTK measurements were taken at each of the 2 control points and compared to ensure the accuracy of the derived bearing. A Leica TC1010 Total Station was then used to take simultaneous readings to the centres of the stern and bow of the vessel and the UTC time of each observation recorded. Gyro readings onboard were recorded and later compared between the surveyed azimuths and hence a difference was derived. This difference was then applied to both gyros in Spectra as a correction. The Gyro Calibration was performed in a southwesterly direction. The results are shown below:

Gyro calibration results for the 05th of November 2002.

The results were as follows:

Gyro 1 Primary	*Ship Heading @ 192°:*	*-0.90 Degree C-O*

Applied Ships gyro Correction: ***(minus) -0.90 Degrees***

Gyro 2 Secondary	*Ship Heading @ 192°:*	*-1.80 Degree C-O*

Applied Ships gyro Correction: ***(minus) –1.80 Degrees***

2.3 GPS Monitoring

DGPS verification was carried out after the gyro calibration. The primary and secondary GPS antennas were checked before and after a 20 minute logging session using the Differential GPS systems onboard the vessel. The mean of the 2 RTK measured positions for each antenna was compared to the mean of the Differential GPS position logged over the 20-minute period to verify the GPS systems.

The results are shown below:

GPS1	*Latitude*	*Longitude*
Differential GPS Position	*-16.927426*	*145.780393*
RTK Surveyed Position	*-16.927410*	*145.780393*
Difference	*0.000016 (~1.7m)*	*0.00m*

GPS2	*Latitude*	*Longitude*
Differential GPS Position	*-16.927427*	*145.780392*
RTK Surveyed Position	*-16.9274135*	*145.7804085*
Difference	*0.0000135 (~1.5m)*	*0.0000165 (~1.8m)*

2.4 rGPS Monitoring

While alongside in Cairns, an integrity check of the rGPS pods was carried out. A coordinated point was established on the quayside, which was surveyed by taking the mean of 3 independent RTK measurements. Each pod was then positioned upon this point with range/bearing data to each pod being recorded for 10 min sessions. dGPS data was simultaneously recorded during each session. The range/bearing was computed between the vessel's dGPS position and the coordinated point, and then compared with the observed range/bearing to each rGPS pod. The C-O difference for each pod is shown below:

Pods in use	*C-O Difference (Range/Bearing)*
Pod 689	*0.49m / 1.11°*
Pod 869	*0.98m / 0.49°*
Pod 870	*0.12m / 0.68°*

Spare	*C-O Difference (Range/Bearing)*
Pod 1065	*1.10m / 1.12°*
Pod 864	*1.99m / 3.18°*

3 Navigation Processing

Navigation post-processing was carried out on-board through to UKOOA P1/90 final data format.

3.1 The *SeisPos* System

Created and Supported by Fast Geophysical Positioning Solutions (FGPS) in Swanley, Kent, UK.

SeisPos is a Windows NT/2000/98/95 software program, which enables processing of raw navigation data for marine seismic streamer surveys from UKOOA P2 raw data format to UKOOA P1/90 final data format. ***SeisPos*** supports simultaneous multiple projects and background processing. Data formats supported are UKOOA P2/91 and P2/94. The following Modules are used:

Input: reads the data stored in UKOOA P2 format and compiles a log of warnings. Implicitly alerts the user of format integrity problems. Stores all data in a proprietary format relational database.

Precondition: applies user defined gating, filtering and interpolation/extrapolation parameters to all data and presents interactive time series plots enabling quality appraisal and manual editing and rejection. All raw data is *read only*.

Adjust Network: performs a fully integrated weighted least squares adjustment of the positioning network. This includes LS estimates of streamer rotation and stretch and revised compass offsets and bearings for the interpolation of receiver group positions based on the concatenation of circular arcs between all nodes (compass or other) along the streamers.
The adjustment computation outputs final node coordinates and corrected compass positions and bearings along with QC data using a staged process enabling the survey line to be processed in as many sections as may be required according to data quality.

Output: interpolates receiver group positions and outputs selected records to file in UKOOA P1/90 format.

QC: allows analysis and manipulation (comparisons, rate of change etc.) of time series plots of all data and adjustment statistics (coordinates, error ellipse semi-major axes, processed observations, SD's, residuals, rotation, stretch, unit variance, redundancy, number of iterations. Shot time and distance interval).

Database: allows analysis, editing and textual output of all header and data tables stored in the database at all stages of the process.

3.2 Quality Control – *P1Tools*

P1Tools is a quality appraisal and utilities package for the QC of final data stored in UKOOA P1/90 format. The package operates on the Windows platforms. The modules incorporated are:

QC Nodes: enables time series analysis of shot to shot user specified node movement along orthogonal and radial axes. Outputs summary statistics to .csv file.

QC Offsets: enables time series analysis of shot to shot user specified node offsets along orthogonal and radial axes. Also provides integrity check for the type and number of nodes, the source firing sequence and the shot point range. Outputs summary statistics to .csv file.

Compare: enables time series analysis of position differences for user specified nodes between two P1/90 data sets along orthogonal and radial axes. Outputs summary statistics to .csv file.

Extract: outputs user selected data to ascii file for further analysis and third party software use.

Replay: two-dimensional replay of the vessel, source, receiver groups and tailbuoy.

4 Observations

4.1 Navigation Summary

All systems performed well throughout the survey period except for ramp in Position Dilution of Precision (PDOP) during which there was a reduced number of satellites in view.

4.1.1 DGPS (Primary)

V1G1 Primary dGPS System using SCF corrections from stations Melbourne SF (385), Bathurst (336), Brisbane (275), Dunedin (026) and Broome SF (185) performed well throughout the whole survey.

V1G2 Secondary dGPS System using corrections from Melbourne (385), Bathurst (336), Kalgoorlie (315) , Townsville (195) and Darwin (125) performed well throughout the whole survey.

Both systems had periods of high PDOP from 1630 to 1730 hours local time due to the occurrence of poor satellite geometry and low number of satellites in view.

4.1.2 rGPS (Tailbuoy)

Throughout the survey the active tailbuoy was in use and performed without any trouble.

5 Conclusions

In total there were 28 sequences shot, with all navigation systems working well throughout the survey. This survey entailed lines being shot into shallows; hence lines were stopped short (those shot into the beach) and those that started late or with the streamer in a bend at the start of line (those shot away from the beach), did not fulfil the pre-plotted line lengths. The first 4 sequences were shot in rough sea conditions inducing above average noise in the raw data.

The Transverse Mercator used for this survey centred around 141° E with the Survey Datum being GDA-94 in the GRS-80 spheroid. Final p190's were provided in the GDA-94 datum.

5.1 Navigation System

The navigation system is made up of two GPS (Global positioning system) units with differential corrections and an integrated navigation package (Spectra). The GPS are Trimble 4000SSi units. Differential corrections are supplied by Spot satellite for the primary system whereas the secondary system consists of corrections from Inmarsat. The navigation package allows a great deal of flexibility and reliability.

5.1.1 Spectra Integrated Navigation System

General

Spectra, a real-time navigation system, sends and receives information via two acquisition systems referred to as Runts which contain interfaces to communicate with the vessel's navigation system. Using triggers (both internal and external), Spectra can synchronize systems with events generated inside and outside of Spectra. Hence data can be conveyed for successful acquisition.

File and Menu Structure

Spectra logs a P294 raw data file and a processed P190 data file, along with quality control and audit files, to a directory that is user selected via a system boot file which, when manually started, instructs Spectra which configuration files to use in the boot process. These configuration files are contained in a user created directory.

Displays

Spectra enables operator configurable displays that are adjustable in size and content. The display system enables the operator to monitor all attached devices, data quality in real-time as well as multiple video displays of lines being tracked and online statistics. Spectra offers a real-time steering display, which is utilized by the bridge and is a direct representation of the current location.

Survey Line Tracking

Survey pre-plots were supplied using GDA-94 co-ordinates.
The projection used:

Transverse Mercator
Origin Longitude 141°E
Origin Easting: 500000.000
Origin Latitude 000°
Origin Northing: 10000000
Scale factor: 0.9996

Semi-major Axis: 6378137.000
Inverse Flattening: 298.257222100
(No datum shifts were incurred from WGS-84 to GDA-94).

Spectra uses a cocktail of the positions from both navigation systems to derive a weighted real-time position, which can be compared to a predictive position, for the next successive position for the shotpoint.

Data Logging

Spectra was configured to generate a data logging event mark based on a distance of 25 metre spacing. Spectra is configurable to record either all possible records or selected position records. Data is stored in a directory in standard comma delimited ASCII format, allowing files to be easily read by any popular spreadsheet or text editor. Primary media for data storage is hard disk whilst the secondary system consists of a Mammoth Exabyte tape drive.

System Timing

Timing is achieved via independent, stand-alone GPS receivers that are directly interfaced to each of the Runts. Each separate GPS receiver also offers a stand-alone (non-differential) position input in circumstances where either primary or secondary position systems are unavailable. During this survey, a differentially corrected position was available all the time.

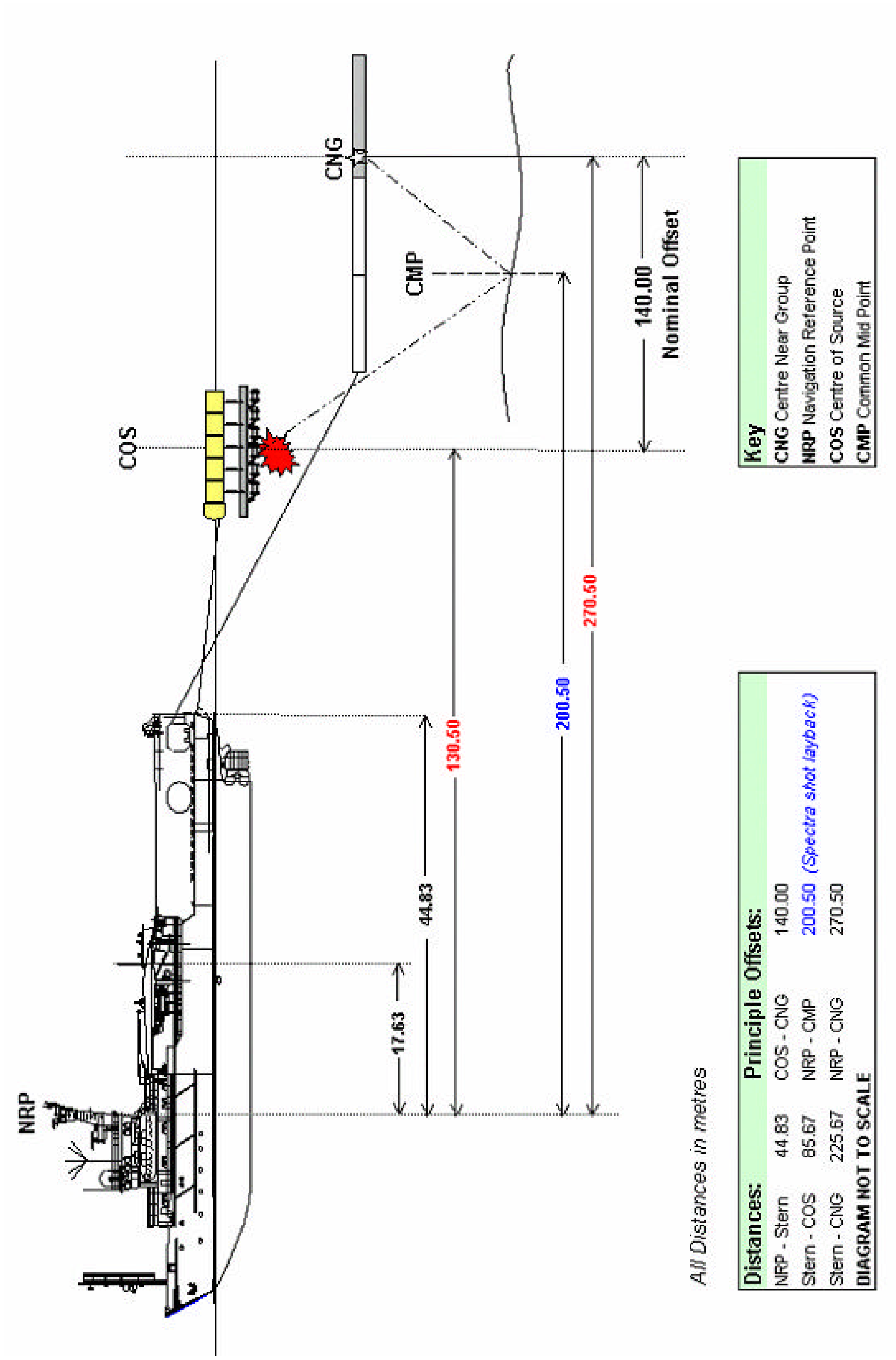
Streamer Modelling

Spectra is able to perform streamer modelling in real time and calculate the associated P190 format for direct logging to disk or output via serial port. The streamer is shown on the graphics window in real time.

Compass Device

The current streamer modelling capability requires the interface to the Digicourse 293A bird surface unit. The configuration of the interface is a typical serial port configuration. Communication can be bi-directional enabling Spectra to query the Digicourse unit as well as receive data from it.

5.2 Offset Diagram



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1 Instrumentation and QC System Description

System	Hardware	Description
Recording System	Syntrak 960-24 Bit	Version 3.60B
	Processor	80486DX4
System Controller	CPU Memory	32 Mbytes
	Disk Storage	1.0 Gigabyte
	Input Voltage	90-132 Vac or 180-264 Vac
	Frequency	47-63 Hz
	VME Link	DSP-Controller, 55-mbps serial link
	Graphics Display, High Res.	Two 1280x1024 Graphic Card
	Graphics Display, VGA Res.	One 800x600 Graphic Card
Tape drives	IBM 3590 (10 Gb)	
Plotter	OYO 624 & 622	
Onboard QC	ProMAX	
		Version 4.76
Source Controller	GCS90	Intel 486DX @ 33 MHz
	Processor	32 Mb
	DRAM	40 Megabytes, IDE
	Hard Disk	
Bird Controller		Version 2.72A
	DigiSCAN Model 293	Am5x86-P75-S @ 133 MHz
	Processor	64 Mbytes
	DRAM	1.0 Gigabyte
	Hard Disk	
SAGE Gravity Data Acquisition System.	LaCoste & Romberg Gravity Meter / gyro stable platform. Hard Disk drive	N/A this contract.
SeaSPY Marine Magnetometer	Proton Precession Marine Magnetometer Sensor	N/A this contract.

2 Instrumentation and QC Start up Tests

A complete set of instrument tests was performed at the start of the survey, and all tests were well inside the manufacturer's specifications.

Date	DCR	CGA	HD	CMR	IR	CIO	CIE	HL	RMS	COMMENTS
16/11	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	CH # 137 319 Leakage CH # 439 Dead

2.1 Daily and Monthly Tests

The daily test produced 9 files and the Monthly test 36 files.
Abbreviations used for test names in the test sequence tables:

- ✓ **DCR** **DCO/Noise/Range**: Performs three tests. DC offset checks the value of the residual voltage remaining across the amplifier's output terminal when the input voltage is zero. Internal Noise Test checks the value of the internal noise level in the module with inputs grounded. Dynamic Range Test checks the ratio of the maximum to the minimum signal input power levels over which the amplifier can operate.

- ✓**CGA** **Channel Gain Accuracy** introduces a known square wave into the amplifier and compares the sampled output signal with the known input.

- ✓**HD** **Harmonic Distortion** test measures amplitude versus frequency characteristics and checks for any undesired harmonics introduced by the modules.

- ✓**CMR** **Common Mode Rejection** test provides synthesized sine waves to both inputs of the preamplifier and measures the rejection of this common signal by the amplifier. The amplitude of the sine wave is 0.8 full scale.

- ✓**IR** **Impulse Response** test measures the response of the system to the low-cut and high-cut as well as the mid-band pass.

- ✓**CIO** **Crosstalk Isolation** (Odd Channels are grounded) test measures the noise appearing in one signal path as the result of coupling from other signal paths.

- ✓**CIE** **Crosstalk Isolation** (Even Channels are grounded) – same as above.

- ✓**HL** **Hydrophone Leakage** test measures the electrical resistance in the phone.

- ✓ **RMS** Checks the noise level in the streamer.

2.2 Daily Tests

Date	DCR	CGA	HD	CMR	IR	CIO	CIE	HL	RMS	COMMENTS
17/11	OK	OK	OK	OK	OK	OK	OK	OK	OK	CH # 137 319 Lkg CH # 439 Dead
18/11	OK	OK	OK	OK	OK	OK	OK	OK	OK	CH # 137 319 Lkg CH # 439 Dead
19/11	OK	OK	OK	OK	OK	OK	OK	OK	OK	CH # 137 319 Lkg CH # 439 Dead
20/11	OK	OK	OK	OK	OK	OK	OK	OK	OK	CH # 137 319 Lkg CH # 439 Dead
21/11	OK	OK	OK	OK	OK	OK	OK	OK	OK	CH # 137 319 Lkg CH # 439 Dead
22/11	OK	OK	OK	OK	OK	OK	OK	OK	OK	CH # 137 319 Lkg CH # 439 Dead
23/11	OK	OK	OK	OK	OK	OK	OK	OK	OK	CH # 137 319 Lkg CH # 439 Dead

2.3 End of Job Test

Date	DCR	CGA	HD	CMR	IR	CIO	CIE	HL	RMS	COMMENTS
23/11	OK	OK	OK	OK	OK	OK	OK	OK	OK	CH # 137 319 Lkg CH # 439 Dead

2.4 Instrument Summary

The Recording instruments suffered no technical down time during the survey.

Full System tests were carried out and recorded to tape at the start and finish of the contract. Further daily tests were carried out when the opportunity arose, to verify continued system performance. Some days, shooting was continuous with tight inshore turns and short approaches to lines. The tests showed that the Syntrak system was stable and well in specification throughout the contract. At the beginning of the job there were two bad hydrophone groups in the streamer, channels 137 and 319, both with hydrophone leakage and Channel 439 was dead.

Nominal streamer/gun offset distance was confirmed using a test shot from a single gun in the centre of the array. Distance to the centre of the first active group was near 140m. These measurements were made regularly to confirm consistent offset positioning throughout the survey.

3 QC Products and Processing Sequence

3.1 General

The stand-alone ProMAX system was used for QC purposes. The system was not connected on line. Therefore data for each sequence was read from the tapes. Two 3590 drives were used for this purpose. The processing sequence was followed in order to produce raw and brute stacks plots, near trace displays and RMS plots.

3.2 Raw/Brute Stacks

Raw and brute stacks were produced for each line. Paper plots of both stacks were made at the end of line.

3.3 Processing Sequence for Raw Stack:

Input 1 cmp line per sail line:	*444 channels*
Data reduction	*Re-sampled from 2ms to 4ms; Marine Trace Decimation (2:1 trace summation)*
Edits:	*Exclude bad shots, noisy/spiking channels*
Filter:	*Single bandpass filter: Ormsby 4-8-90-120 Hz*
Gain recovery:	*Spherical divergence: 1dB/s from water bottom to 6.0 s*
Normal Move-out Correction:	*Velocities picked for each line every 4km and written to velocity database*
Pre-stack mute:	*Tied to water bottom times*
Stack:	*Mean method for trace summing*
Stack Root N scaling	*111 fold*
Bulk shift static	*9 ms*
Output:	*To disk file*
Method of scaling:	*Un-scaled*
Display:	*Paper plots: 8 cm/s, 20 traces/cm*

3.4 Processing Sequence for Brute Stack:

Input 1 cmp line per sail line:	*444 channels*
Data reduction	*Re-sampled from 2ms to 4ms; Marine Trace Decimation (2:1 trace summation)*
Edits:	*Exclude bad shots, noisy/spiking channels*
Filter:	*Bandpass filter:* *Ormsby 4-8-90-120 Hz*
Gain recovery:	*Spherical divergence: 1dB/sec from water bottom to 6.0 s*
Pre-stack mute:	*Pre-decon mute; Tied to water bottom times*
Minimum phase predictive deconvolution	*Operator length = 240 ms* *Operator prediction distance = 24 ms* *Deconvolution gate, tied to water bottom times*
Filter:	*Bandpass filter:* *Ormsby 4-8-90-120 Hz*
Normal Move-out Correction:	*Velocities picked for each line every 4km and written to velocity database*
Pre-stack mute:	*Post NMO mute;* *Tied to water bottom times*
Stack:	*Weighted method for trace summing, based on square root of offset*
Stack Root N scaling	*111 fold*
Bulk shift static	*9 ms*
Output:	*To disk file*
Method of scaling:	*AGC with operator of 1000ms*
Display:	*Paper plots:* 8 cm/s, 40 traces/cm

3.5 FK, FT and Spectral Analysis

This helped to identify noise sources and QC data. The analysis was performed in a window of 500-6000ms. Although FK and FT plots/displays were produced for a number of lines, the spectral analysis proved to be the most useful to determine the frequency range for noise and data.

3.6 RMS Analysis

3.6.1 Deep RMS Window

RMS values from 5000ms to 5500ms of the record were calculated for every trace and each shot. These values were displayed for identification of noise sources and noisy traces. Filtered shot vs. trace RMS values were produced by applying a bandpass filter prior to the RMS calculation. Cable averaged RMS values were stored on disk for the later use.

3.6.2 Processing Sequence:

1. Data Input: All shots, all channels, window 5000-5500ms.
2. Scaling: By 50 to convert amplitudes from millivolts to microbars.
3. RMS analysis: RMS values calculated for each channel over the range of all shots.
4. Output: To disk file.
5. Bandpass Filter: Ormsby: 4-8-90-120 Hz
6. Output: To disk file.

3.7 Near Trace Displays, Offline Plots

Near trace data were displayed and annotated with direct arrival times.

1. Collect near traces:	444 channels
2. Display:	0-5000 ms 10 cm/s, 20 traces/cm.

3.8 Attributes, Online Analysis

ProMAX was set up as an off-line system; therefore real-time data feed was not available.

4 Data Quality / Observations

4.1 Quality Control Summary

The ProMAX system proved to be extremely reliable for checking data quality. The content of all field tapes was checked for each line. Different types of noise were identified and noted in the Observer's Logs where appropriate.

- ✓ Ship Noise
- ✓ Spikes and noisy channels
- ✓ Geological effects (water bottom multiples)
- ✓ Swell Noise
- ✓ Source problems (auto-fires, misfires, changes in gun volume)
- ✓ Parities Problems
- ✓ Earth Leakage

Table of Contents

1 Introduction

Seismic processing was carried out in order to QC the seismic data acquired by the vessel ***Polar Duke*** on behalf of **Santos** (for **Essential Petroleum)**. Acquisition was implemented using a source array of 3500 cu in. volume and a single streamer with 444 primary and 12 auxiliary channels.

The survey commenced recording on the 15th November 2002, and was completed on the 23rd November 2002. A total of 28 sequences and approximately 800 km of full fold seismic data were acquired. Raw and Brute 2D Stacks were processed for all of these lines. On board processing maintained an average processing throughout of 90.1 kilometres per day of 2D, 6000ms record length, 111 fold data.

The data quality was generally very good throughout the survey, with extraneous noise coming primarily from swell. Seismic reflections were easily visible throughout the sections and sharply defined. Multiple energy was also readily apparent. Brute stack processing included an offset weighted stack. The weather conditions were generally good during the survey.

The deliverables for this project were paper copies of QC plots including Raw Stacks, Brute Stacks, Near Trace Displays and RMS plots. 8mm Exabyte tape copies of raw stacks and brute stacks were made in SEG-Y format. Velocities were saved as ASCII files, which were then UNIX tarred to Exabyte tape as well as copied to floppy disk at the end of the survey.

The ProMAX system was a stand-alone machine, with a single operator and two 3590 tape drives. The system performed well throughout the survey with no system or processing problems. Field tape copies were generated in SEG-D format on 3590 tapes, using the ProMAX tape copying utility.

Although the ProMAX was not set up as an on-line system, it was still possible to process every sequence through to brute stack, and produce all the necessary QC plots at a fast enough rate to keep close behind the data acquisition. The two 3590 tape drives proved to be adequate for both tape copying and data loading operations.

The ProMAX system and QC processing consultants were provided by Exploration Partners International Ltd of Mannez Alderney, Channel Islands, UK. Eurotech Computer Services Ltd of Cranleigh, Surrey, UK, set up the computer system and Landmark Graphics Corporation Ltd installed the ProMAX software.

2 Acquisition Parameters

Recording Instruments

Recording System	:	Syntrak
Source controller	:	Syntron GCS-90
Recording format	:	3590 SEG-D 8058 Rev 1
Record length	:	6000 ms
Sample rate	:	2 ms
Low cut filter	:	Out
High cut filter	:	206 Hz - 276 dB/oct
Channel set 1	:	444 Seismic channels
Channel set 2	:	12 Auxiliary channels

Streamers

Streamer type	:	Syntron
Number of streamers	:	1
Active length	:	5550 m
Number of groups	:	444
Group interval	:	12.5 m
Near trace	:	444
Streamer depth	:	7.0-9.0 m +/- 1m
Near trace offset from source	:	140 m

Source

Array type	:	Airgun
Total volume	:	3500 cu in
Air pressure	:	2000 psi
Gun depth	:	5.0 m +/- 0.5 m
Number of sub arrays	:	4
Shot point interval	:	25 m

Navigation

Primary Navigation	:	Fugro MRDGPS: Starfix+ Dual frequency
Secondary Navigation	:	Fugro MRDGPS Inmarsat Direct Injection

3 Personnel and ProMAX QC System

EPI Consultant Processing Geophysicists

15th November 2002 to 23rd November 2002: Stuart Kelly

Onboard Processing Hardware

Machines	:	*1 SUN Ultra 60 (2xUltraSPARC-II 450MHz)*
Memory	:	*1024 Mb*
Monitor	:	*Iiyama*
Hard Disk Drives	:	*70 GB*
Tape Drives	:	*2 x 3590 IBM tape drives*
	:	*2 x 8mm, Exabytes, Artecon*
CD Drives	:	*1 x DVD*
Plotters	:	*1 OYO GS-624 thermal plotter (24 inch)*

Software

ProMAX 2D	:	Version 1998.6
IBM Operating System	:	UNIX (SunOS Rel 5.6)

Data loading was accomplished entirely via 3590 copy tapes. There was no on-line connection of the ProMAX to the data acquisition system.

As there was no on-line SEGD tape copying, the ProMAX system had to be used for all the Tape Copying operations. Copy tapes were generated in SEG-D format on 3590 tapes using the ProMAX tape copy utility. Copy tapes were used for data loading and seismic processing for verification of original as well as copy tapes.

4 Raw Stack Processing Sequences

SEG-D Input From Tape
Reformat to ProMAX internal format — Read 444 chans + 12 auxiliary channels. Input 6000ms
↓
Resample / De-sample — From 2 to 4 ms. Hi-Fi anti-alias filter applied in module
↓ ——→ **Auxiliary Channel QC** — On screen QC. All auxiliary channels
↓ ——→ **Near Trace Display** — On screen QC. Ch 444
Pick WBT
↓ ——→ **HARDCOPY (with direct arrival RMS)**
Marine Trace Decimation — 2:1 trace summation after differential NMO
2D Marine Geometry — Spreadsheet / Database preparation
Bulk Shift Static — 0ms for instrument filter delay
↓ ——→ **RMS Shot Analysis** — Shot RMS, Av. RMS for chans 110-130
↓ Shallow RMS window 100-600ms
↓ Conversion factor from µV to µbar=50
↓ ——→ **STACK HEADERS & PLOT**
↓ ——→ **Raw Shots Display** — Every 4 km, 6000 ms, 444 chans
↓ ——→ **ON SCREEN QC DISPLAY**
Trace / Shot Kill — Edits based on Observer's Logs
Band-pass Filter
Type of filter specification — Ormsby band-pass
Details of filter — Minimum Phase, 4-8-90-120 Hz
True Amplitude Recovery
Apply dB/sec corrections — Spherical Div. 1 dB/sec from water bottom to 6000ms
Maximum application time — 6000 ms
↓ ——→ **Velocity Analysis** — Every 4 km, Semblance,Gathers,Function Stack
↓ ——→ **ASCII FILE**
Normal Move-out Correction
↓ ——→ **NMO Corrected Gathers** — Every 4 km, 6000 ms
↓ ——→ **ON SCREEN QC DISPLAY**
NMO Stretch Mute — Top mute picked from CDP gathers and tied to WBT
CDP / Ensemble Stack
METHOD for trace summing — Mean
Root power scalar for stack normalisation — 0.5
Gun and Cable Static — + 9 ms
Display Stack ——→ **Raw Stack** — 6000 ms. Unfiltered, Unscaled.
——→ **SEG-Y TAPE**
——→ **HARDCOPY PLOT** + Shot RMS values

5 Brute Stack Processing Sequences

SEG-D Input From Tape	
Reformat to ProMAX internal format	Read 444 chans + 12 auxiliary channels. Input 6000ms
↓	
Resample / De-sample	From 2 to 4 ms. Hi-Fi anti-alias filter applied in module
Spike to Median Ratio editor	Automatic spike / Noise Burst edit. Used only when needed.
Marine Trace Decimation	2:1 trace summation after differential NMO
2D Marine Geometry	Spreadsheet / Database preparation
Bulk Shift Static	0ms for instrument filter delay
Trace / Shot Kill	Edits based on Observer's Logs
Band-pass Filter	
Type of filter specification	Ormsby band-pass
Details of filter	Minimum Phase, 4-8-90-120 Hz
True Amplitude Recovery	
Apply dB/sec corrections	Spherical Div. 1 dB/sec from water bottom to 6000ms
Maximum application time	6000 ms
Pre-de-convolution First Break Mute	Picked from CDP gathers + tied to Water Bottom Times
Spiking / Predictive De-convolution	
TYPE of de-convolution	Minimum phase predictive
Decon operator length	240 ms
Operator prediction distance	24 ms
Operator white noise level	0.1 %
Design gate	Single gate & tied to WBT
Band-pass Filter	
Type of filter specification	Ormsby band-pass
Details of filter	Minimum Phase, 4-8-90-120 Hz
↓ ——→ **Velocity Analysis**	Every 4 km, Semblance, Gathers, Function Stack
↓	——→ **ASCII FILE**
Normal Move-out Correction	
↓ ——→ **NMO Corrected Gathers**	Every 4 km, 6000 ms
↓	——→ **ON SCREEN QC DISPLAY**
NMO Stretch Mute	Top mute picked from CDP gathers and tied to WBT
Inner Trace Mute	Bottom Mute picked from CDP gathers and tied to WBT
CDP / Ensemble Stack	
METHOD for trace summing	Weighted. Weight factor = sqrt(offset)
Gun and Cable Static	+ 9 ms
Display Stack ——→ **Brute Stack**	6000 ms. Unfiltered. Unscaled.
	——→ **SEG-Y TAPE**
	——→ **HARDCOPY PLOT** 6000ms, 1000ms op AGC

6 Start of Line Noise Record RMS Analysis (Appendix C)

Using the start of line noise record, channel RMS values were computed for all 444 channels.

The data was not re-sampled, and no filter was applied. The RMS values for each individual channel were computed using a gate of 500-6000ms to look at the ambient noise levels.

The plots were analysed in conjunction with the colour RMS displays to check for dead or noisy channels, and these were then crosschecked with the edits in the Observer's logs.

These RMS values also gave a good indication as to the amount of swell noise at the start of each line, and the results could be analysed as soon as the first tape was available.

The average ambient noise from this unfiltered RMS analysis was normally around 3-4 µbar on the noise record, and similar values were observed on the shot records. A 3-6-100-120Hz filter was applied to the data before prior to this RMS analysis.

A scaling factor of 50 was used to convert from millivolts to microbars, and hardcopy plots were included in each of the line files.

Sometimes when shooting out from the shoreline, following a tight turn, it was not feasible to make a noise file at the beginning of the line. In these instances, the noise file recorded at the end of line was utilised.

7 Auxiliary Channel QC (Appendix D)

All 12 auxiliary channels were input from tape during the SEGD tape loading procedure. The auxiliary channels were then separated from the data channels and stored in a separate data file, which could have been used for on screen analysis.

Unfortunately not all the gun hydrophone channels were connected during this survey. Auxiliary channels 1 (Gun 1-1), 2 (Gun 2-1), 5 (Gun 3-1) and 6 (Gun 4-1) were good, and were quality controlled on screen using colour amplitude displays, to monitor gun volumes and pressures. Gun performance was also monitored using a direct arrival RMS QC on the near trace displays. Appendix D shows the example of drop in pressure/volume due to the gun air leak.

8 Near Trace Displays (Appendix E)

Near traces were displayed on screen routinely at the end of each line. This proved to be useful in quickly determining any possible errors with acquisition. They revealed gun volume changes, bad records, internal time break problems and any auto-fires not reported by the recording system.

In addition to looking at the entire near trace display, an averaged direct arrival RMS was computed over the 10 nearest traces. An RMS window of 12-30ms was used after the 10 near traces were LMO corrected. The direct arrival RMS was plotted along the top of all the near trace displays. Variations in source volume and pressure were visible on the direct arrival graph, but the amplitude of the direct arrival was often variable due to vessel speed, feather angle and cable jerk. This display was really only useful when used in conjunction with the gun hydrophone channels to QC any undetected source anomalies.

RMS amplitude and dominant frequency statistics were also calculated for the direct arrival. These were viewed on screen whenever further investigations were required.

The near traces also provided a good indication of the geological conditions including strength of the water bottom multiples, remnant multiple interference and reflection data.

Hardcopy plots of the near trace displays were made for all lines. Plots were generated using a high level of gain, which helped to show up any amplitude variations in the direct arrival, and also assisted in the assessment of the level of swell noise whenever the weather condition deteriorated.

9 Shot vs Channel Colour RMS Displays (Appendix F)

RMS and trace statistics were calculated for every shot and all 444 channels. A deep analysis window of 5000-5500 ms was used, and RMS values were computed for both unfiltered and filtered data. The band-pass filter was a 4-8-90-120 Hz Ormsby.

Colour RMS amplitude displays were made for all 444 channels for the entire line. These display were used as channel QC, and also to identify noise trends as the line progressed. For example swell noise deterioration, water currents or external seismic interference. In each case the affected shot point range was listed in the comments section in the Observer's Log. Only shots that were significantly affected were listed as bad shots.

In addition to the RMS computations further trace statistics included:

Trace amplitude - *Average trace energy.*

Spikiness - *Ratio of max magnitude sample to trace signal amplitude.*

Dominant Frequency - *Based on a count of zero crossings within signal window.*

Frequency Deviation - *Based on statistical scatter of frequency estimates.*

Amplitude Decay - *Estimated late trace energy decay rate (in dB/sec).*

These statistics were averaged within the ProMAX database for the source, CDP and channel domains, where they could be viewed in the various different domains using the ProMAX database display tools.

In addition to a colour plot being generated for all shots for every sequence, a sequence-by-sequence RMS display was also generated. This involved extracting 200 shots from each sequence, and then displaying the colour RMS side by side. These displays enabled a direct comparison of bad traces and noise conditions from sequence to sequence.

All filtered colour RMS displays were saved to disk as GIF image files, and these were Unix tarred to Exabyte tape. The images were included in the data shipments and a final copy tape was generated at the end of the survey.

10 Shot RMS

Shot RMS values were calculated by averaging the RMS values for the central 11 channels (after 2:1 summation) from the streamer. RMS values were calculated using a fixed shallow window at 100-600 ms to look at ambient noise. The central 11 channels were chosen to avoid contamination by the direct arrival and any shallow water bottom events.

Ambient noise RMS values were also calculated using 3 different filters. A band-pass filter of 3-6-70-90 Hz was used to look at ambient noise levels within the signal bandwidth, and a 6-9 Hz high cut filter was used to look at the amplitude of the lower frequency swell noise. A further low cut filter of 50-70 Hz was used to look at ambient noise levels at the high frequency end of the spectrum. The ambient noise remained around 3-6 µbar.

This shallow window RMS provided a good estimation of the background ambient noise levels for each line. Increases in swell noise could be clearly identified on the ambient noise RMS plots above the raw stack, which also had a more spiky appearance whenever the swell noise picked up.

Noise levels in microbars provided a good statistical means of confirming the amount of swell noise interference visible on both the raw shot records and stack. One of the main advantages of using these RMS values to assess the swell noise, was that they could be processed during the SEGD tape loading operation if necessary, and were therefore available well before the raw stack could be processed.

A scaling factor of 50 was used to convert from millivolts to microbars. This is the conversion factor used for the recording system, which has a sensitivity of 20 Volts per Bar.

Noise (6-70Hz), Noise (<6Hz), Noise (>70Hz), Signal (6-70Hz) and signal to noise ratio RMS graphs were plotted above all Raw stacks, so any noise contamination on the stack could be verified statistically on the RMS plots. All CDP averaged RMS values were written into the SEGY brute stack headers as a backup.

11 Raw Shot Displays

Shot records were filtered to the signal bandwidth and balanced with a true amplitude gain recovery. Shot records were displayed at 3 km intervals for each line. Hardcopy displays were produced when necessary, and individual records were examined on screen if there was felt to be a problem with acquisition, or to investigate the source of anomalous seismic energy. This was useful in confirming the start of any seismic interference or for confirming auto-fires, which could be identified on the near trace displays.

The raw shot displays were used to estimate the amplitude and amount of swell noise on the raw shot records, prior to further processing. Consistently noisy channels were also identified on the raw shot displays, and any edited channels on the observer's logs were verified.

12 Velocity Analysis (Appendix G)

Velocities were picked at regular 4 km intervals along every line, using one of the ProMAX's on screen interactive velocity picking utilities.

The ProMAX velocity-picking module included a semblance display; CDP super gather, which could have NMO applied instantly, a series of Function Stack Panels and an interval velocity graph. To improve the signal to noise ratio super-gathers were formed by combining 5 adjacent CDP gathers, and these CDP's also made up the Stack panels.

A regional velocity function was used as the central guide function for the stack panels. A total of 11 stack panels were processed using a +/- 10% velocity variation.

To speed up the on screen velocity picking procedure the velocity analysis displays were pre-computed. When primary velocities were clearly defined they were normally picked off the semblance display, and Normal Move-out was applied to the gather to check that the events were lining up well. Velocities could also be picked off the Function stacks whenever the velocities were poorly defined on the Semblance display.

Velocities were generally poorly defined, with multiple energy being dominant below a couple of seconds. For final velocity analysis an FK de-multiple or Radon demultiple filter may be required in order to pick reliable velocities. Unfortunately the increased run times required for the radon filter, meant that it was not a practical option for normal QC processing.

Velocity functions were output to ASCII file for every line, and then put on 8mm Exabyte tapes as well as floppy disk for data shipments.

13 CDP Gather Displays

These displays were essentially used to verify the velocity picking. On screen displays and sometimes hardcopy plots were made of NMO corrected gathers with an NMO stretch mute applied. The gathers were displayed at 4 km intervals. When swell noise levels were high they also provided a good indication as to whether the swell noise would stack out or not. They were also useful for identifying consistently spiking traces.

All mutes and time gates were picked interactively on screen using CDP gathers sorted into water bottom time order. By picking all the mutes and time gates in this manner it was possible to tie them all to water bottom depth, and therefore make the gates and mutes extremely accurate. As all the gates were tied to water bottom depth, this in turn speeded up the picking of mutes considerably and enabled the mutes and gates to be carried over from one line to the next. All gates were carefully quality controlled on screen before running the stack processing flows.

14 Raw and Brute Stack Processing (Appendix H)

The main objective of onboard QC processing is to stack each line with minimal processing to enable a thorough QC of the data onboard.

Normally, the general aim of the QC processing is not to attenuate noise but to show the data as it is recorded, or how it would be presented to a shore or vessel based processing centre. This means that band-pass filtering is normally confined to the anti-alias filter prior to re-sampling to 4ms, and a wide band-pass filter at the signal bandwidth after de-convolution to clean up the high frequency noise introduced by the de-convolution operator. It is also important to avoid using an AGC as this tends to soften and hide background noise, so raw stacks were always plotted out without any AGC scaling.

For all lines a basic raw stack with minimal processing, and a brute stack with de-convolution and some de-multiple attenuation were processed. The raw stack was essentially used for QC purposes only and the brute stack was used more to look at the geological structure.

The SEG-D data was input from 3590 copy tapes, re-sampled to 4ms and output to hard disk as 16 bit data. An anti-alias filter was applied internally within the ProMAX resample module to prevent aliasing of frequencies above 125 Hz.

Minimum Phase Predictive De-convolution and True Amplitude Recovery tests were carried out on the first sequence, and the parameters for the entire survey were set up at this time. De-convolution parameters were picked off CDP gathers, with corresponding autocorrelations plotted along the bottom of the display. Analysis of the results indicated that an operator length of 240ms and gap of 24ms would provide a good average for the entire survey. Due to the length of the lines, further more detailed testing will reveal more optimal spatially variable de-convolution parameters. The de-convolution gates were picked from the CDP gathers and tied to water bottom times, the start of the gate being approximately 20ms below the water bottom and the end of the gate being close to the bottom of the record. De-convolution was only used for the brute stack processing, and no de-convolution was applied to the raw stack.

True Amplitude Recovery tests indicated that the data was better balanced when the dB/sec amplitude recovery started at the water bottom, rather than at T0. The optimal parameters were Spherical Divergence correction followed by a 1dB/sec correction tied to the water bottom time. These parameters resulted in a reasonably well-balanced stack, however as the water depth became shallower the amplitudes of the deeper data often dropped off significantly. For QC purposes the True Amplitude of the stacked data was preferred, but for interpretation purposes a post-stack AGC would be very beneficial to suppress the high amplitude events near the water bottom and bring up the amplitudes of the weaker events at depth.

As for the band-pass filter, it was decided to leave this as open as possible for QC purposes. For this reason little testing was carried out apart from some initial spectral analyses, and the band-pass filter was set at 4-8-90-120 Hz. Spectral Analysis of the data revealed that this filter would not affect the data in any way, and would remove only a minimal amount of swell noise contamination. A filter was applied prior to TAR and de-convolution to clean up any high amplitude low frequencies, and then again after de-convolution to remove any noise that might be introduced by the de-convolution process itself.

Noisy and dead traces were killed, as well as bad shots noted in the Observer's Logs. The brute stack was run after QC had been completed and the data had been thoroughly analysed. Any additional shots with time-break errors, gun problems and any new noisy traces were edited from the brute stacks.

Full details of all the processing flows and parameters are listed in section 4 of this report.

An un-scaled, unfiltered raw stack was plotted out on board of the vessel for every line. A fairly high level of gain was sometimes applied to the raw stack plot to boost up the amplitudes of the deep data, but this had the adverse effect of over scaling the water bottom and near surface events. Trace equalisation was occasionally added to the plotting routine to improve the brute stack plots. Shot ambient noise RMS values were plotted above the raw stack, as already discussed in the shot RMS part of this report. The raw stack plot was intended solely for QC purposes.

In addition to the un-scaled raw stack plot generated for every sequence, a brute stack was plotted out with an AGC operator of 1000ms, to look at the geological structures along the line.

All shot points with misfires, spread errors or timing errors over 1.0 millisecond were killed. In addition to this all dead or noisy channels were eliminated from the stack.

The CDP to station tie used for brute stacks in this prospect was

Station= first SP + ((CDP-222)/2).

The results of all stacked sections were discussed with the onboard Santos representative. A processing log was maintained throughout the survey with notes concerning noise problems and data quality (Appendix A).

All raw stacks and brute stacks were backed on 8mm Exabyte tapes in SEGY format, and shipped to the client office at the end of the survey. The SEGY headers include the shot point numbers, CDP numbers and complete listing of the acquisition and data processing parameters. The water bottom times and CDP averaged RMS values are also included in the SEGY trace headers for convenience.

15 Additional QC Displays (Appendix I)

Spectral analysis displays were generated for several lines to evaluate the power and frequency content of the data.

FK plots and FT displays were also occasionally displayed, but the spectral analysis displays were found to be more useful for analysing the frequency range of both noise and data.

16 Tape Copying

As there were insufficient 3590 tape-drives available on the Syntrak recording system, it was necessary to use the ProMAX system to generate copy tapes. Tape copies were generated by the ProMAX system in SEG-D format on 3590 tapes.

17 Summary

Many potential problems were analysed using ProMAX including checking bad field tapes or whether a tape had closed properly; checking shot records for noise bursts, swell noise or auto-fires; confirming bad or noisy channels, etc. It was also useful for investigating data problems whilst acquisition was still in progress.

Although the ProMAX was not an online system, it still managed to carry out a full and thorough QC of every sequence. Tape loading was a time consuming procedure, but the benefits were that every single field tape could be independently verified and checked. In addition to this, any errors in the Observer's Logs such as incorrect file numbers or incomprehensible logs were detected, and corrected.

Data quality was good in this area but swell noise was the major concern. Multiple energy and other extraneous sources of noise were not considered to be a major problem. Factors affecting data quality included the following:

- ✓ Ship noise
- ✓ Spikes / noisy channels
- ✓ Geological noise
- ✓ Swell noise
- ✓ External seismic noise

Ship noise - Although the centre of source to centre of first group was 140m, ship noise was visible on the noise records. Spectral analysis and FK analysis of this noise revealed what was thought to be propeller noise with 5Hz harmonics, within the 10-70Hz frequency range. FK analysis revealed that the move-out of this noise was 1500m/s. As would be expected for ship noise, the strength of these frequencies was strongest on the near offset traces and minimal at the far offsets.

Spikes / noisy channels - Most of the time all 444 channels were good. The spiking/noisy channel was dealt with by editing in processing and later in acquisition by replacing streamer sections.

Geological noise - Water bottom multiples were apparent on the shot records.

Diffractions were often visible and were probably caused by the prodigious faulting apparent in many of the sections.

Swell Noise – Was the major cause of noise and affected most of the sequences. This low frequency noise was peaking up to 10-20μbars on the most sequences.

External Seismic interference – No other seismic surveys were conducted in the area; therefore no external seismic interference is present in the records.

18 Conclusion

The ProMAX system proved to be extremely reliable and performed extremely well. There was not a single system crash or hardware malfunction that could have resulted in loss of processed data on the hard disk.

The survey averaged approximately 90.1 km per day. Data processing also averaged approximately 90.1 km per day. The ProMAX system was more than capable of keeping pace with these acquisition rates, and as a result it was possible to thoroughly QC and stack every line.

19 APPENDICES

APPENDIX A

PROMAX PROCESSING LOG

Seq	Line	Dir	Date	FSP	LSP	FFID	CDP's Processed	Noise Record RMS	SOL FK Analysis	SOL Spectral Analysis	Tape Copy	SEG-D Input	2D Geom S/Shheet	Near Trace	Plot Near Traces	2:1 Sum / Geom Assign	Near Trace WBT Pick	Database Fill WBT	WBT to Trace Headers	444 Channels Col RMS	Auxiliary QC	Delete Raw Shots	Pick Decon / Mute Gates	Velocity Analysis	RMS for Stack	Pick NMO Mute	Raw Stack	Brute Stack + Decon	Plot Raw Stack + RMS	Merge Stacks	Plot Brute Stack	Delete Geom Shots	Stack to Archive	Vel to ASCII	Archive / Delete Line	SegY Stack to Tape	Shipment Date	Notes
001	OEP02-02	003	16/11/02	1001	2388	1001-2388	1-2996	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Poor-Fair.** Ambient RMS noise at SOL 2-10µbar with swell noise bursting up to 40µbar. Swell noise breaking through the events throughout the stacked section along its entirety. Stacks show good resolution with defined events but are noisy.
002	OEP02-13	210	16/11/02	2207	882	2207-882	239-2872	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Cable bent at SOL causing increased noise levels. Swell noise beginning to diminish affecting 10-15% of traces with noise up to 20µbar. Stacked sections look good with strong events. Deep data often obscured by refractions from extensive faulting, a
003	OEP02-17	031	16/11/02	1001	2122	1991-2122	1-2464	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Ambient RMS noise at SOL 5-10µbar with swell noise bursting up to 60µbar in isolated instances. Some minor ship noise noted but is not very evident within the RMS plots and is attenuated by stacking. Stacked sections are good.
004	OEP02-15	210	16/11/02	2265	882	2265-882	239-2988	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Good.** Streamer bent at SOL producing elevated ambient noise levels in the first half of the cable. Stacked sections show good detail with little noise.
005	OEP02-19	031	16/11/02	1001	2408	2408-1001	1-3036	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Good.** Streamer bent at SOL but the RMS noise levels remain at 1-6µbar down the cable. Swell noise is minimal with shot records now appearing quite clean. Stacked sections show good imaging of events with little noise.
006	OEP02-21	211	17/11/02	2335	882	2335-882	239-3128	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Good.** RMS noise levels at SOL at 2-5µbar down the cable. Swell noise is minimal and data is quite clean. Geological horizons can be resolved down to below 2 seconds with good resolution.

007	OEP02-23	031	17/11/02	1001	2405	1001-2405	1-3030	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Good.** RMS noise levels at SOL at 2-5µbar down the cable. Swell noise is minimal and data appears quite clean. Geological horizons can be resolved down to 2 seconds with good resolution.
008	OEP02-25	211	17/11/02	2450	882	2450-882	239-3358	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Good.** RMS noise levels at SOL at 2-5µbar down the cable. Swell noise is minimal and data is quite clean. Geological horizons can be resolved down to below 2 seconds with good resolution.
009	OEP02-27	031	17/11/02	1001	2116	1001-2116	1-2452	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Good.** RMS noise at 1-8µbar down the length of the cable. Minimal swell noise with good, clean data acquisition.
010	OEP02-29	210	17/11/02	2414	1325	2414-1325	887-3286	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	11/12/02	**Good.** Cable bent at SOL which is apparent in elevated RMS levels. RMS noise at EOL is a consistent 1-5µbar along the cable. Data quality is good but the line was terminated owing to an air-leak. LGSP 1346 but the whole of the acquired data were processed.
011	OEP02-29	211	18/11/02	1466	882	1466-882	239-1390	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	11/12/02	**Good.** RMS noise levels at SOL vary from 2-6µbar along the cable. Some swell noise beginning to make itself apparent on the shot records but is minimal and has little effect on the processed sections. This second part of line OEP02-29 was successfully merg
012	OEP02-33	031	18/11/02	1001	2065	1001-2065	1-2350	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Good.** Some swell noise apparent at SOL, with RMS levels at 1-10µbar down the cable. Otherwise, the recorded data is of good quality.
013	OEP02-31	211	18/11/02	2100	881	2100-881	241-2660	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Good.** Cable bent at SOL which is apparent in elevated RMS levels. RMS noise at EOL is variable from 4-14µbar down the cable, and peaking at 22µbar in the front section of the cable where ship noise is apparent. This ship noise is readily seen in the line
014	OEP02-37	031	18/11/02	1001	2040	1001-2040	1-2300	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair - Good.** RMS noise at EOL is variable from 4-14µbar, peaking at 20-30µbar where the streamer is bent coming onto the line. Swell noise is also strarting to increase slightly, affecting about 10% of traces. Data still looks quite good when processed.

015	OEP02-35	211	19/11/02	2410	882	2410-882	239-3278	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair - Good.** RMS noise at SOL is variable from 2-5µbar, peaking at 25µbar during random bursts of swell noise.
016	OEP02-39	031	19/11/02	1001	2432	1001-2432	1-3084	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair - Good.** RMS noise at SOL is variable from 2-5µbar, peaking at 15µbar during random bursts of swell noise. Data is still good.
017	OEP02-43	211	19/11/02	2246	882	2246-882	239-2950	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Cable bend at SOL. Swell noise now affecting 30% of traces up to 30µbar. EOL noise record is 2-10µbar with random swell bursts greater than this. Data quality is still good for the first two seconds after which moise starts to become apparent.
018	OEP02-41	031	19/11/02	1001	1978	1001-1978	1-2176	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Swell noise apparent on all records. SOL noise recordshows ambient levels of 2-8µbar, with swell randomly up to 30µbar.
019	OEP02-47	211	19/11/02	1701	882	1701-882	239-1860	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Swell noise apparent on all records. SOL noise record shows ambient levels of 1-5µbar, with swell noise apparent mid-cable at 20µbar. Stacked sections still look quite acceptable.
020	OEP02-45	031	20/11/02	1001	1786	1001-1786	1-1792	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Swell noise apparent on all records. SOL noise record shows ambient levels of 1-5µbar, with swell noise apparent mid-cable at 20µbar. Stacked sections still look quite acceptable.
021	OEP02-06	292	20/11/02	2611	882	2611-882	239-3680	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Swell noise diminishing. SOL noise record shows ambient levels of 1-3µbar, with swell noise manifested at peaks up to 15µbar. Reported ship noise has negligible effect on data and is not easily discernible. RMS line plots show debris picked up at tw
022	OEP02-05	031	20/11/02	1001	2056	1001-2056	1-2332	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** At SOL, RMS noise levels and 2-10µbar with random swell up to 20µbar. Stacked sections show good resolution of intricate fautling and associated diffractions.
023	OEP02-07	211	20/11/02	2017	882	2020-890	1-2472	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Cable bent at SOL producing RMS noise levels up to 40µbar at the front of the cable. The rest of the cable has ambient levels of 2-8µbar. Data is still fairly good.
024	OEP02-11	031	21/11/02	1001	2010	1001-2010	1-2350	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Swell noise present at 10-15µbar.

025	OEP02-09	211	21/11/02	1947	882	1947-882	237-2352	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Random swell noise at 10-30+µbar, ambiant levels are otherwise 2-8µbar. Records otherwise show good resolution and frequency content. Stacked sections are relatively clean and well-resolved.
026	OEP02-08	303	21/11/02	1638	994	1638-994	1-1510	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X		X	X	X	X	11/12/02	**Fair.** Swell noise present randomly up to 20µbar, ambient levels are otherwise 2-5µbar. Shot records show high amlitude ground roll caused by the shallow depths and geology. This is readily apparent on the RMS plots and aso the stacks where it is not comp
027	OEP02-04	123	21/11/02	1001	1438	1001-1438	1-1096	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	11/12/02	**Fair.** Streamer bent at SOL causing increased noise levels. Groundroll is present again. Fishing gear became entangled o n the streamer causing localised elevated noise. Line terminated at SP 1438 owing to loss of telemetry. Stacked sections look good.
028	OEP02-04	123	22/11/02	1318	2585	1318-2585	635-3390	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	11/12/02	**Fair.** Streamer bent at SOL causing increased noise levels in the centre of the cable to over 60µbar. Ambient noise levels are about 5µbar. Swell noise and groundroll is still evident on shot records but the stacked sections are quite acceptable. This seq

APPENDIX B

DATA DELIVERIES

List of Delivered Products

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The following final data shipment was sent off by guard boat on 26th November 2002.

1. Paper Displays for Otway Basin OEP02 Survey (Sequences 001-028):
Start of line RMS noise, Near Trace displays, Raw Stacks and Brute Stacks.

2. 1 x 8mm tape containing SEGY format Raw Stacks for Otway Basin OEP02 Survey.
Seq. 001-028 (SEGY files 1-28)

3. 1 x 8mm tape containing SEGY format Brute Stacks for Otway Basin OEP02 Survey.
Seq. 001-028 (SEGY files 1-28)

4. 1 x 8mm tape for seq. 001-018 of Otway Basin OEP02 Survey containing:
Velocities. (ASCII files, UNIX tar –cvf format).
Colour RMS, Start of Line RMS Noise. (GIF files, UNIX tar –cvf format).

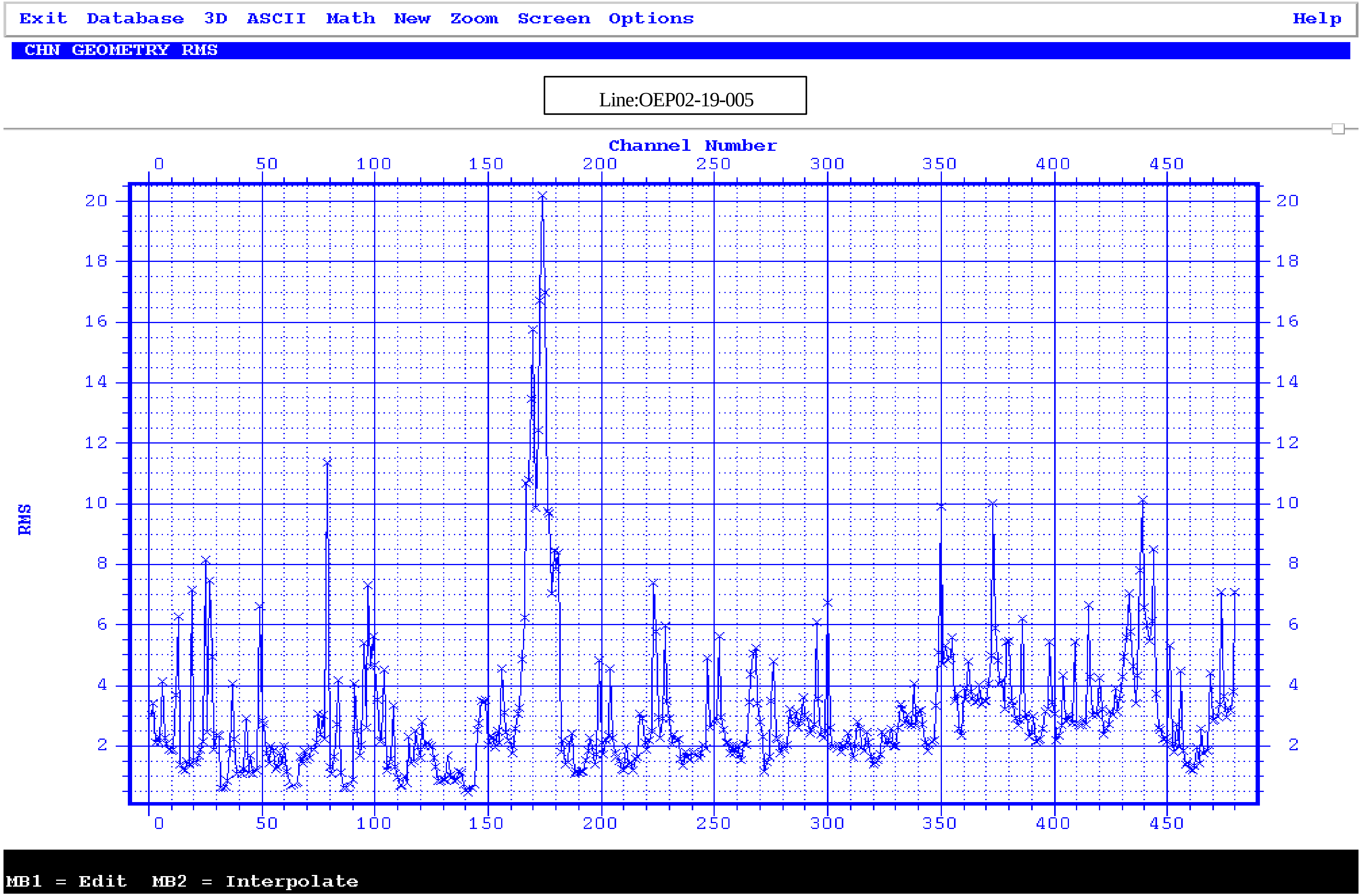
5. 1 x 8mm tape for seq. 001-028 of Otway Basin OEP02 Survey containing:
Master flows, Stacks, Near Traces, Shot vs. Chan RMS
(ProMAX archive format).

6. 1 x floppy disk for seq. 001-028 of Otway Basin OEP02 Survey containing:
Velocity files (ASCII format).

APPENDIX C

START OF LINE NOISE RECORD

RMS ANALYSIS

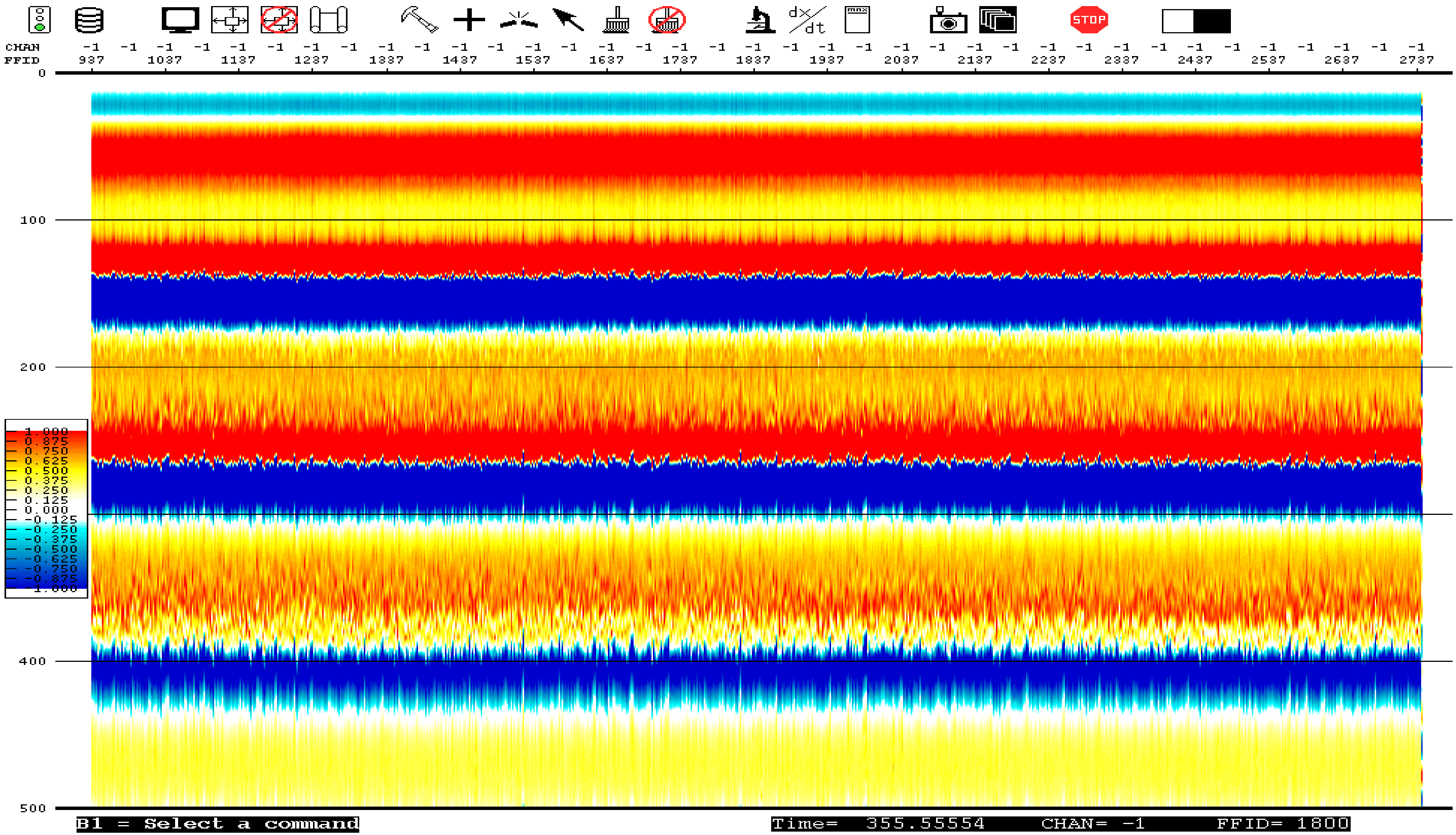


Exit Database 3D ASCII Math New Zoom Screen Options Help
CHN GEOMETRY RMS
Line:OEP02-19-005
Channel Number
RMS
0 50 100 150 200 250 300 350 400 450
2 4 6 8 10 12 14 16 18 20
MB1 = Edit MB2 = Interpolate

APPENDIX D

AUXILIARY CHANNELS DISPLAY

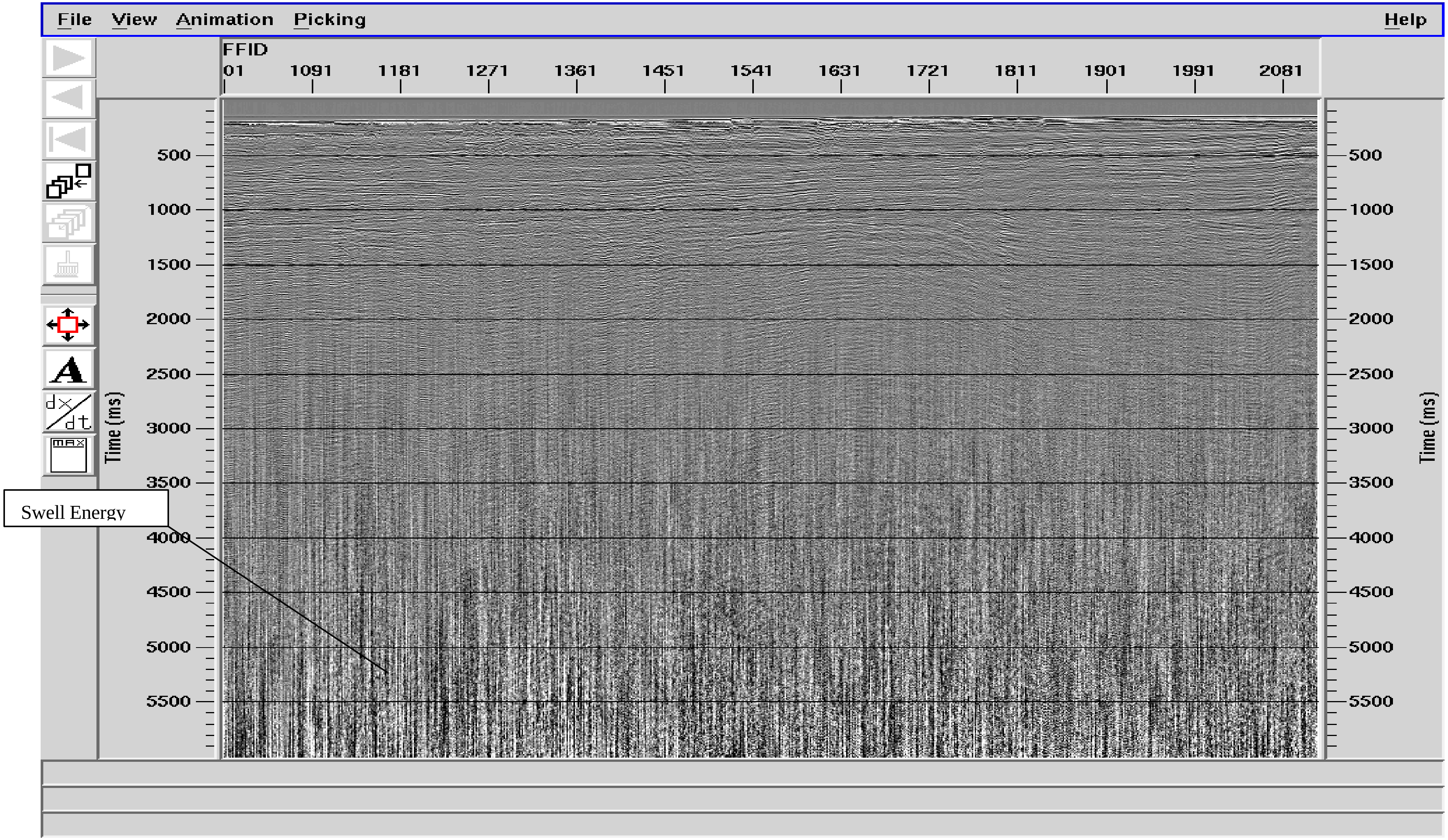
Display of auxiliary channel mounted on Gun 1-1. Line: OEP02-37-014.



APPENDIX E

NEAR TRACE DISPLAY

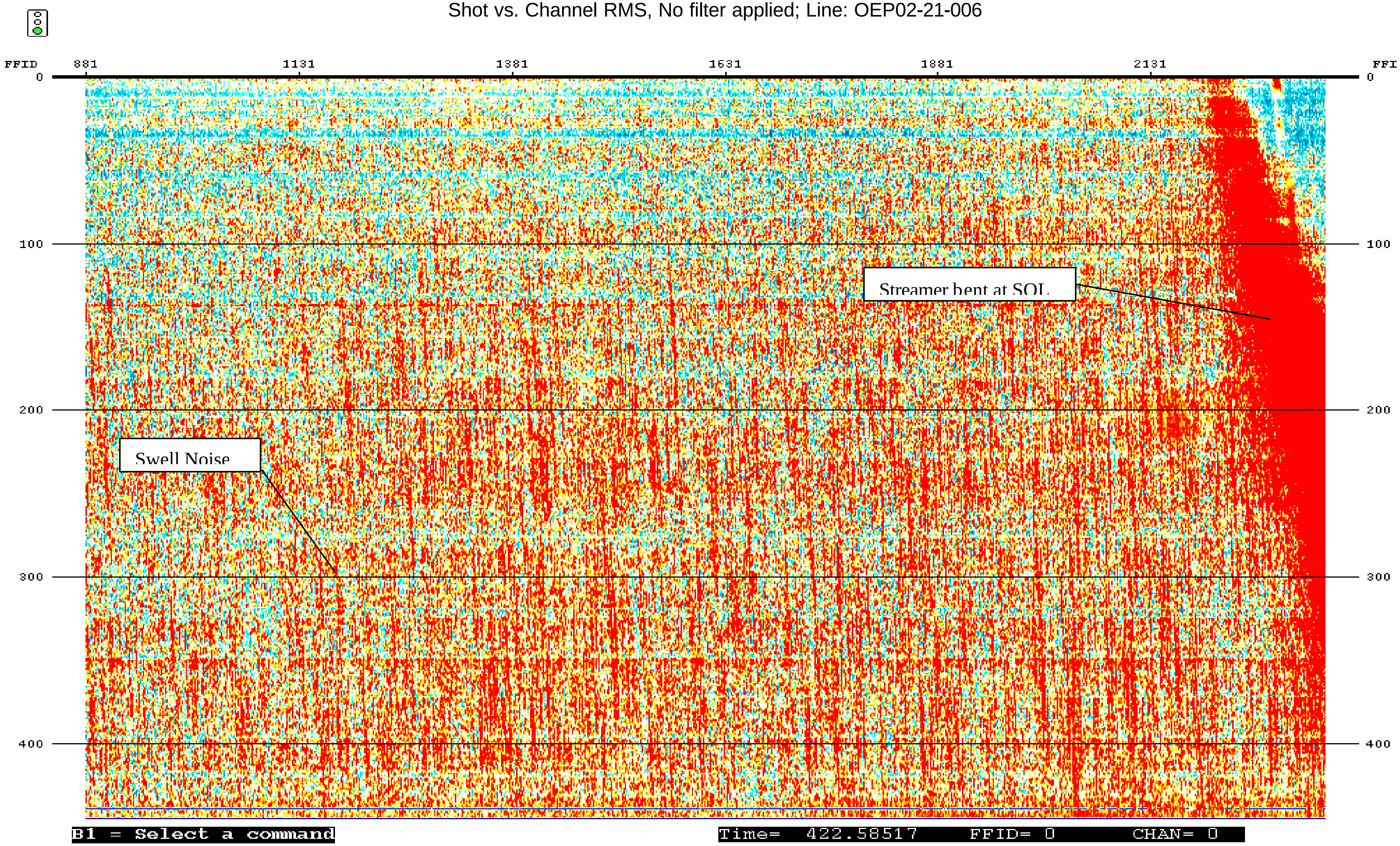
Near trace gather; Line: OEP02-31-009



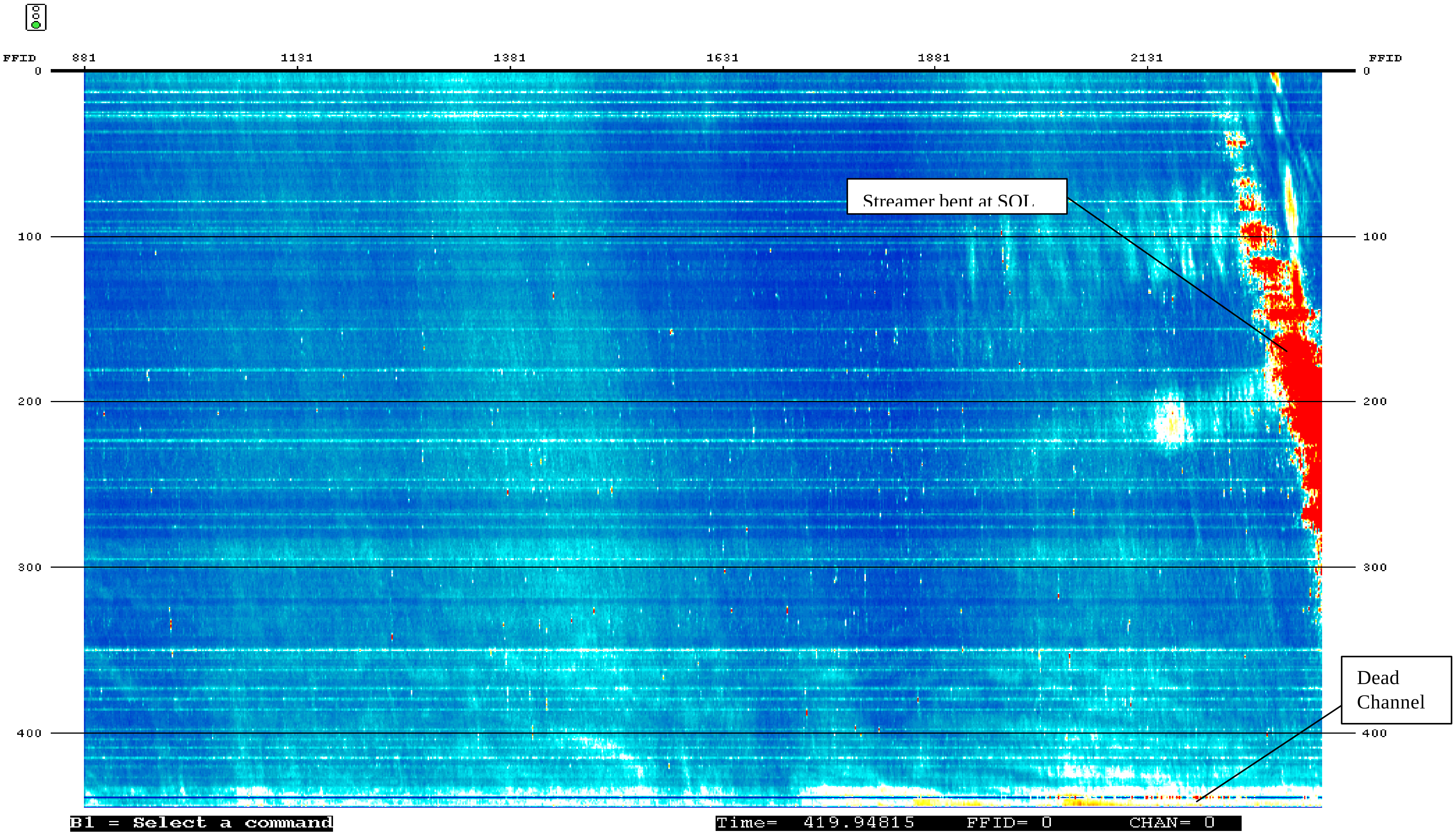
APPENDIX F

SHOT vs. CHANNEL COLOUR RMS DISPLAYS

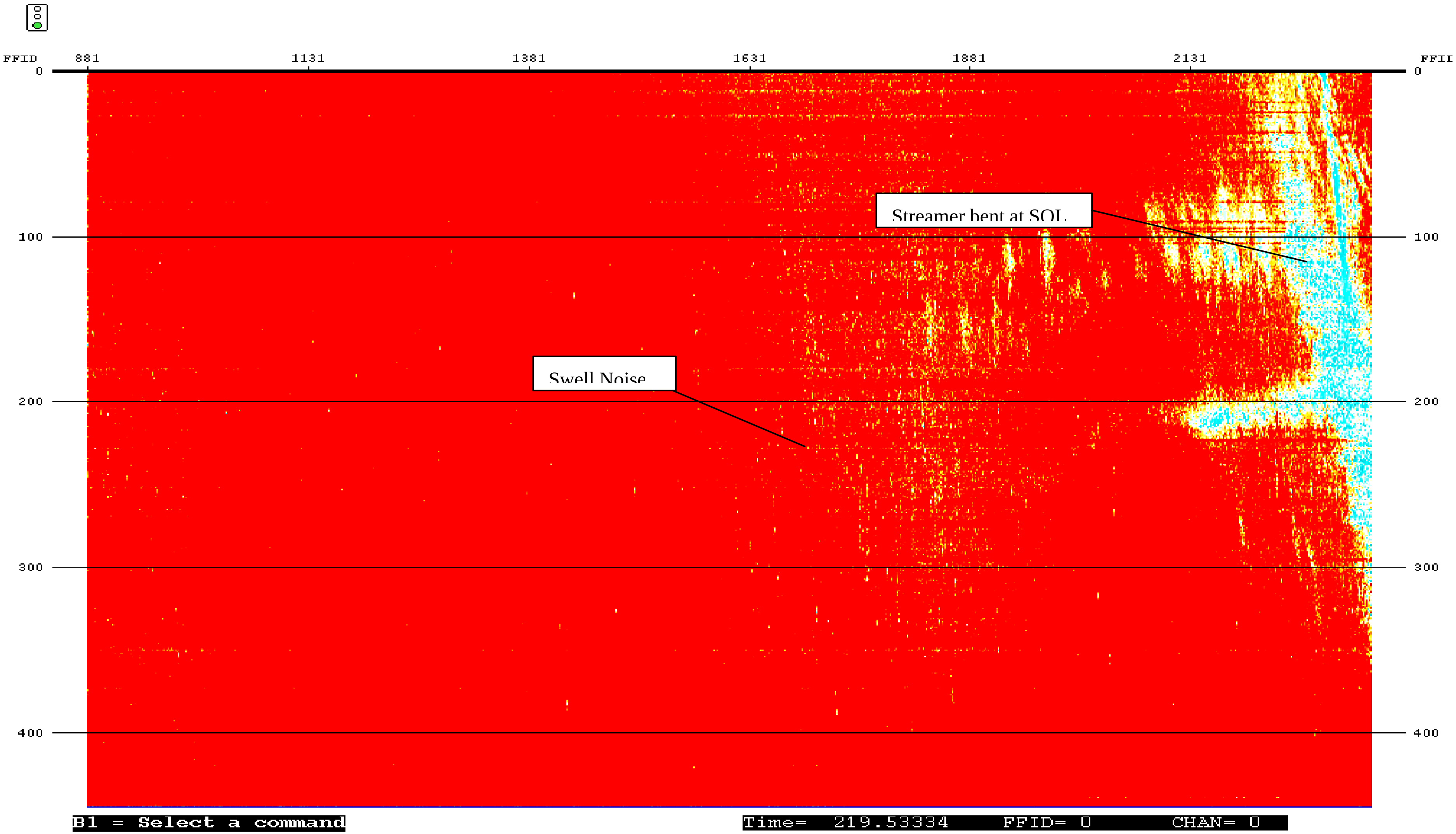
Shot vs. Channel RMS, No filter applied; Line: OEP02-21-006



Shot vs. Channel RMS, Ormsby bandpass filter 4-8-90-120 Hz applied; Line: OEP02-21-006.



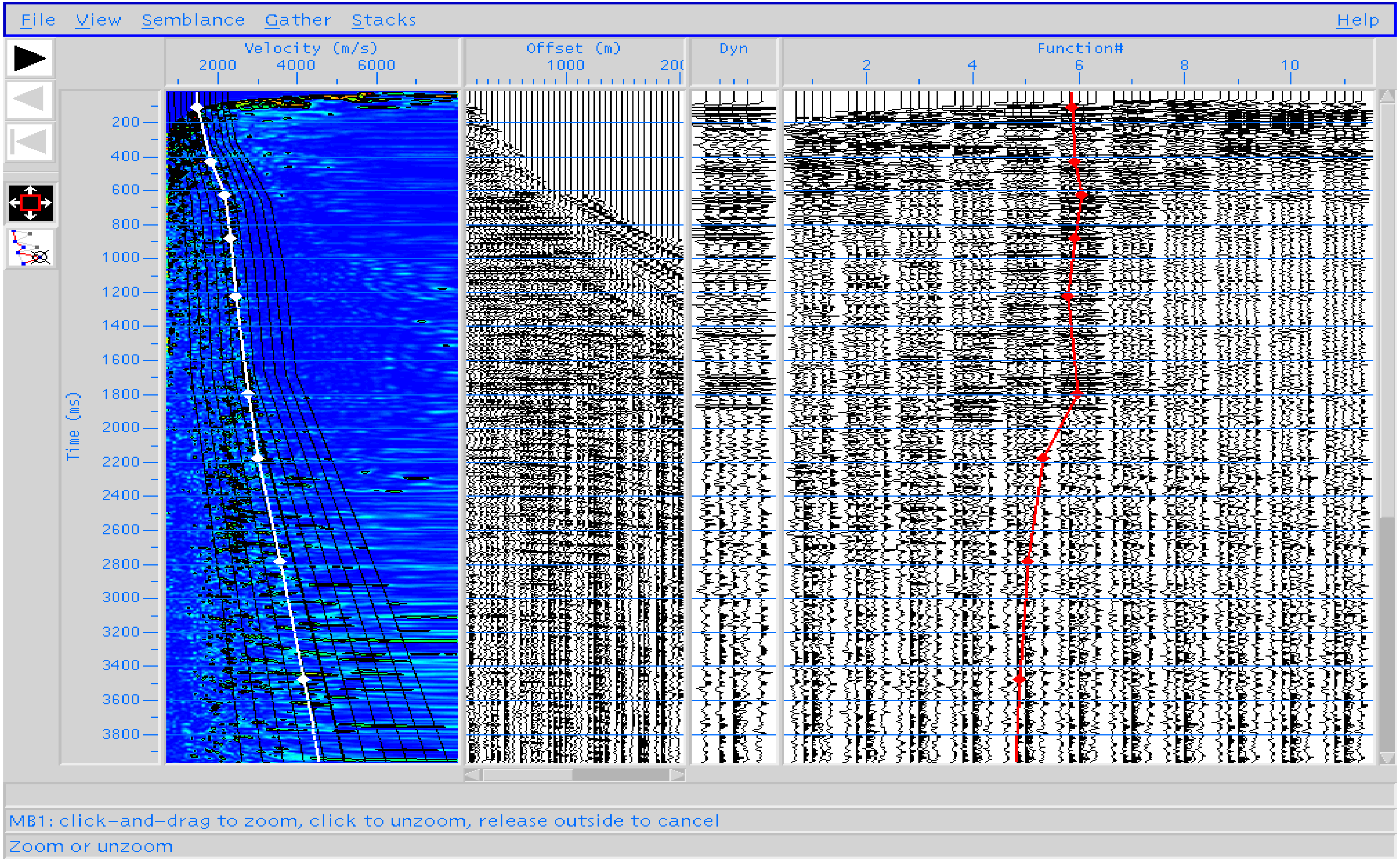
Shot vs. Channel RMS, Dominant frequency; Line: OEP02-21-006.



APPENDIX G

VELOCITY ANALYSIS

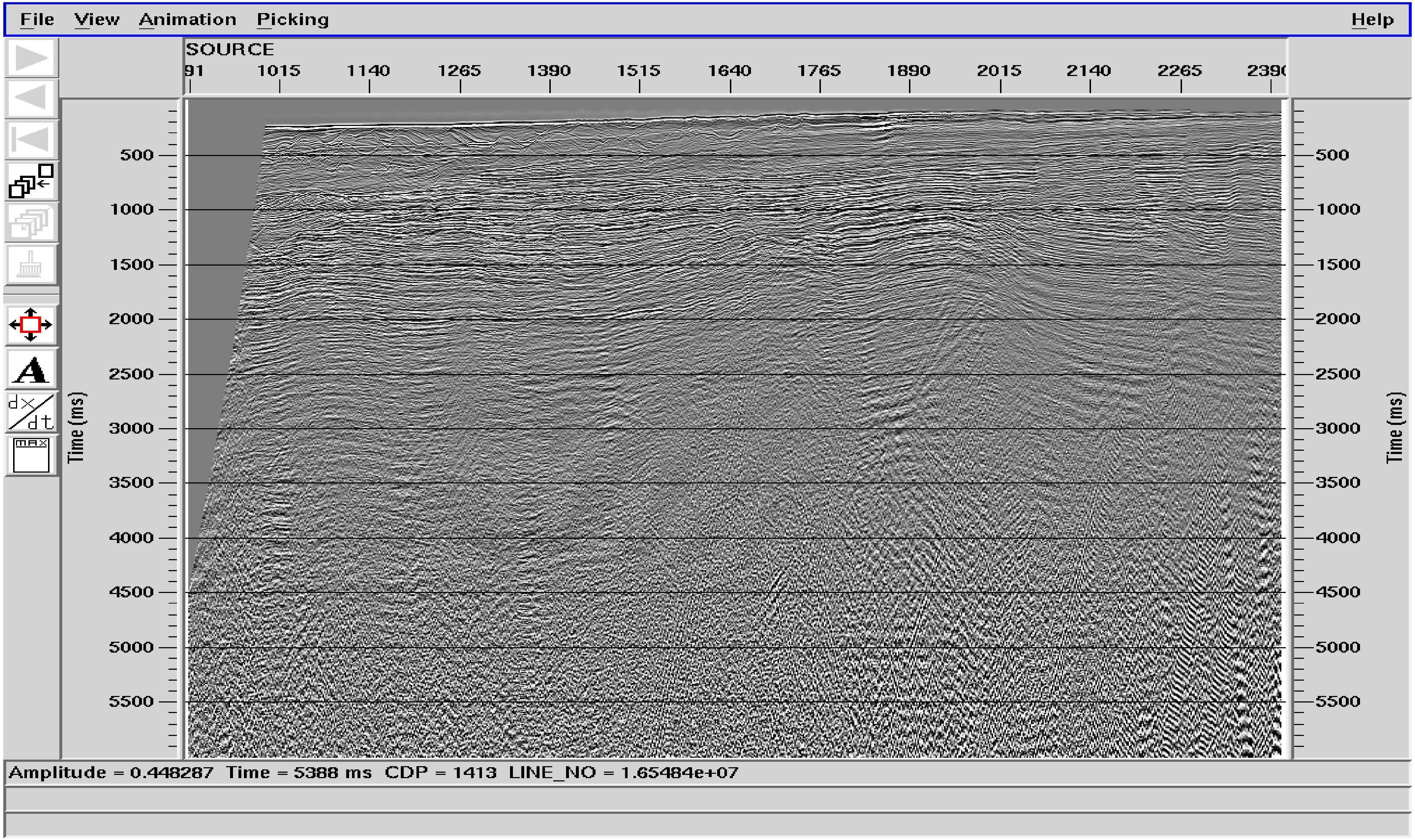
Line OEP02-21-006



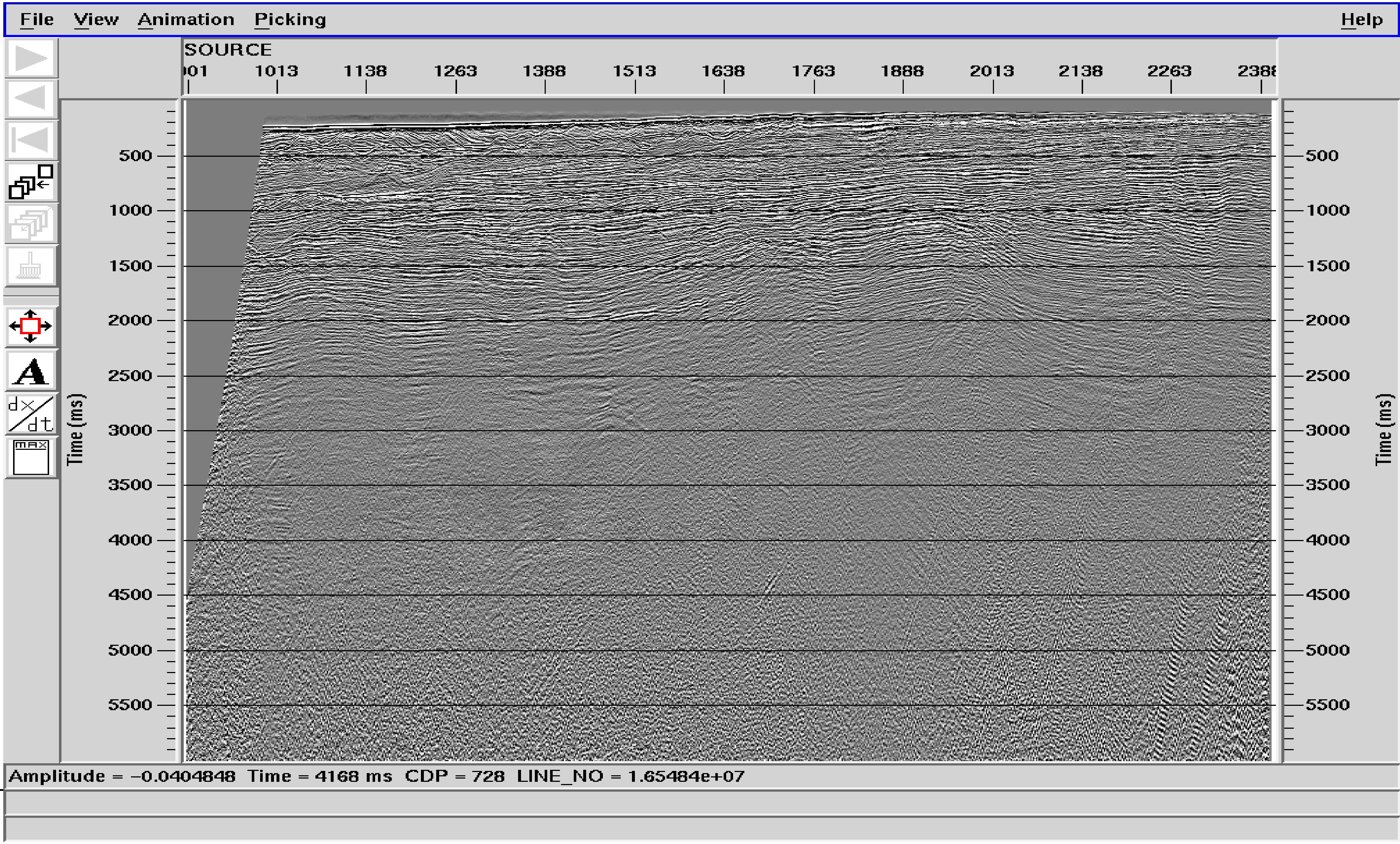
APPENDIX H

RAW & BRUTE STACK PROCESSING

Raw stack: Ormsby bandpass 4-8-90-120 Hz filter applied; Line: OEP02-23-007.



Brute stack: Ormsby bandpass filter, inside trace mute and predictive deconvolution applied; Line: OEP02-23-007.



APPENDIX I

SPECTRAL ANALYSIS

Line OEP02-13-002