ESSENTIAL PETROLEUM RESOURCES LTD

Otway Basin, Victoria, Australia
Southern Margins Marine Seismic Survey

MGC Job No: 6251

FINAL SURVEY REPORT

From

M/V Pacific Titan

23rd June to 26th June 2006

MULTIWAVE
A member of the CGG Group

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1. Survey Information and Objectives

Essential Petroleum Resources Ltd have agreed to enter into a service contract for the purpose of acquisition of a marine seismic 2D survey of app.303 km. Full Fold km in the southwest of Victoria Australia

The survey was located in the Otway Basin off Portland Australia.

Water depth in the survey area was a minimum of 200 mtrs to a maximum of 2500 mtrs.

The Acquisition was performed by the seismic survey vessel Pacific Titan, owned by Swire Pacific Offshore.

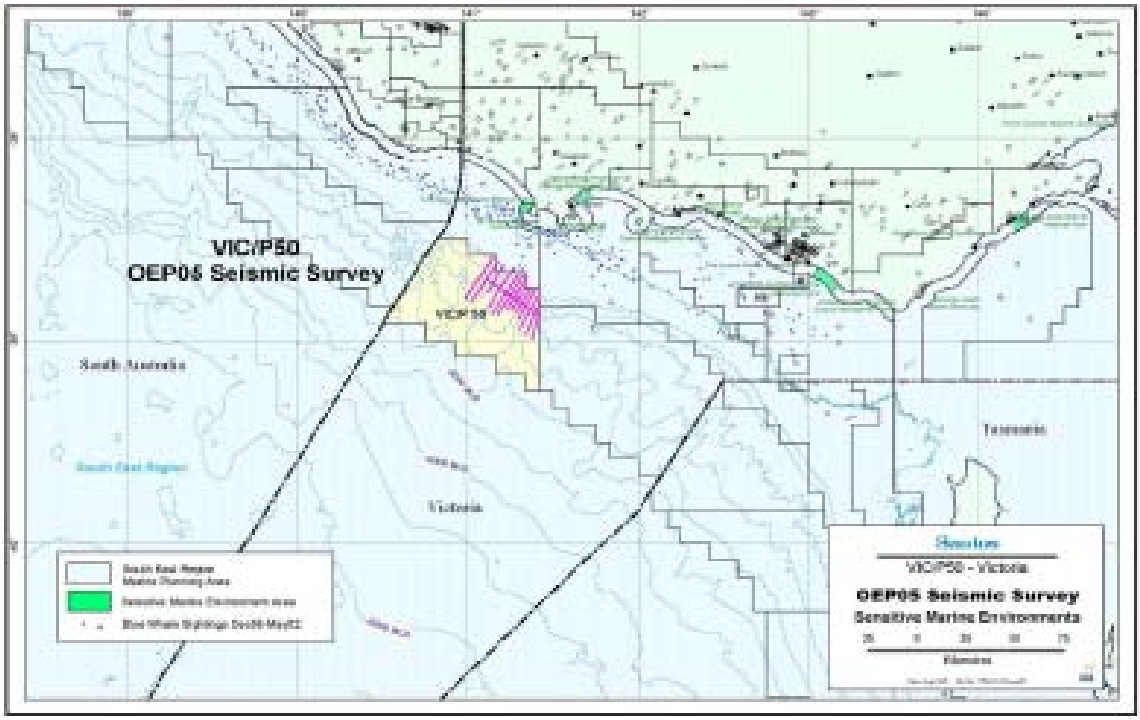
Source volume was 3040 cubic inches at a depth of 5 m.
Streamer length 6000 m, towed at a depth of 7 m.
Recording length 8 sec.

Chargeable production started on the 23rd June at 23:24 and completed 26rd June at10:55 local Australian east coast time.

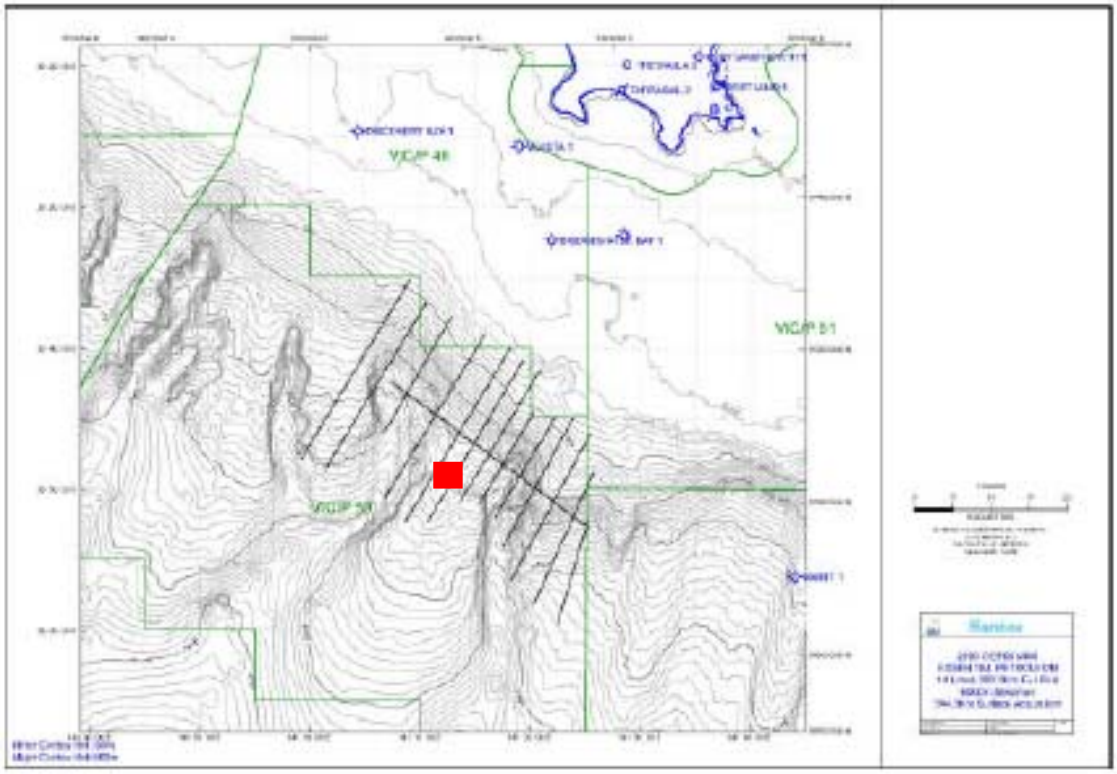
All lines were pre-fixed with OEP06-

Upon survey completion, Pacific Titan recovered all in water equipment and departed the area.

2. Survey Area



2.1. Survey Map.



2.2. Acquistion Parameters

Number of Streamers	1
Streamer Type/Instruments	Digital/ Sercel SEAL
Streamer Length	6000 metres
Groups/Streamer	480
Group Interval	12.50 metres
Sample Rate	2 msec
Record Length	8 Seconds
Recording Filters Lo-cut	2 Hz (6 dB/Octave)
Recording Filters Hi-Cut	206 Hz (276 dB/Octave)
Streamer Depth	7 metres average (down to 9m)
Recording media	3590 Cartridge in SEGD Format
	2 outputs required – tape copy
Source Type	Tuned airgun array
Source array volume	3040 cu inches
Number of Sources	1(3 subarrays)
Source Array depth	5 metres (+/- 1m)
Source operating pressure	1800-2000 psi
Shotpoint interval	25 metres
Required nominal offset	100-130 metres
Navigation System	DGPS
Recording direction	At contractor's discretion

3. Vessel Description

3.1. Vessel Specifications – Pacific Titan

M/V Pacific Titan is capable of doing both 2D and 3D seismic data acquisition work. For 2D work the vessel can tow 12 000 meters streamers. For 3D seismic work the vessel can do dual source/dual streamer (2X8000m) or dual source/three streamer (3X4000m) operation providing high quality 2D and 3D seismic data for the industry. Features include a SEAL-24 system configurable for multiple streamers. Options include real-time seismic processing, acoustic source positioning, acoustic streamer positioning and onboard navigation. The following are general specifications for the vessel and seismic equipment on board.

Vessel Information

Description:	6,400 BHP Seismic Survey Vessel
Classification:	A1 (E) Seismic Research AMS ACCU
Built:	Japan, 1982, Conversion later in Seattle
Flag:	Singapore
Call Sign:	9V5935
IMO No. :	8208385

Dimensions

Length, overall:	64.5 m
Length BP:	55.2 m
Breadth, moulded:	18.5 m
Depth, moulded:	6.0 m
Summer Draft:	5.18 m
GRT:	3211.0
NRT:	963.0

Machinery

Main engines:	4 x 1,600 BHP, 6Z-ST Total 6,400 BHP Propellers in Kort Nozzles
Bow Thruster:	420 BHP Yanmar 6LAAL-DTN 5 tones thrust, CP propeller
Rudders:	Trailing Flap
Generator:	3 x 280 kW Yanmar 6LAAL-DTN
Speed:	4 x engines, Max: 12.0 kts/14 tons/day Service: 10 kts/10 tons/day 2 x engines: 9.0 kts/9 tons/day

Electronics

Radar:	Furuno FR 1505 Mk III ARPA
Secondary Radar:	Furuno FR 1510 Mk III
GPS:	Furuno GP 30
Echo Sounder:	Simrad ED-162 and Simrad EA 600
Communications:	G.M.D.S.S. Skanti SSB, VHF, Inmarsat C 456304540 / 456304550
Weather Fax:	Furuno 207
Satcom B:	NERA Inmarsat phone/fax Tel (870) 356 304 510
Vsat:	Instrumentroom +47 51 40 76 11 Party Chief +47 51 40 76 12 Chiefs office +47 51 40 76 13 Bridge/Fax +47 51 40 76 14
High Speed data link:	NERA Inmarsat system: Tel (870) 356 304 510

Miscellaneous:

Fire monitoring and detection to all work areas
USCG approved sewage treatment plant.
Incinerator, macerator and compactor.
Six man inflatable Man-overboard boat on quick release davit
LSA equipment for 45 persons excluding survival suits.
Foam deluge system covering streamer winches, streamer storage reels and helideck.
P.A. System
Stainless steel gun deck.
Helideck rated for Bell 212 or equivalent with lights.
FRC: 21 feet Nor Power.

3.2. Seismic Particulars

3.2.1. Streamer and Sensors Details

Item	Description	Type	Amount	Remark
Streamer	24 bit, digital distributed electronic	Sercel solid SEAL	Up to 12 km active	64 mm diameter
Depth Control	Digicourse	5011	22	Located every 300 m along the streamer
Buoyancy		Foam		
Retrievers	Concorde	500	7	1 every 900 meters
Streamer skin	Polyurethane	Solid		3.5 mm thickness
Hydrophones	Sercel Radial	Piezoelectric		Sercel 12-element radial
Section Length	150 m			
Section diameter	64 mm			
Lead-in	Sercel	Armoured	350 m.	
Group Length	12.5 m			
No of hydrophones per group	8	Sercel 12 element radial.		790 nF Group capacitance 21.5 V/Bar sensitivity
Max number of channels	2000			12.5 m @ 2ms
Telemetry data link	Dual twisted quartet	AWG 22		
Aux. Data link	4 twisted pair	AWG 22		
Power lines	Dual	AWG 14		
Connectors	28 points	AWG 16		

3.2.2. Recording System Details

Item	Description	Type	Amount	Remark
Acquisition	SEAL V 5.0	Sercel	1	Max 10 000 channels
Format	SEG D Vs1	De-multiplexed		
Recording	IBM via Argus	IBM computer	4	3590 cartridges
Computer	Sun	Blade 2000	2	
Bird Controller		Digicourse	22	
Graphic user I/F	Unix/Seapro	X11 Ultra 5		Sercel
Terminal	Sun	21”	2	
Sampling				¼,1/2,1,2,4 ms
Aux channels			36	Max 255
Plotter	24”	Veritas	1	On-line
Printer	A4			Label
Printer	A4			Logs, tests etc.
Network	Ethernet	Twisted pair		Category 5 TCP/IP
Argus Raid	Intel Xeon	Raid drive		Data storage/Backup

3.2.3. Seismic QC Details

Item	Description	Type	Amount	Remark
Online Qc	SEAPRO QC Vs 4.0	Sercel	1	Online seismic QC, fully Integrated with recording system.
Offline Qc	ProMAX	Landmark	1	Brute stacks, etc
Plotter	24”	Veritas	1	
Computer	Sun	Blade 2000		
Terminals	Sun	21”	2	
Graphic user interface	Unix	X11 Ultra 5		
Remote	X terminal			Sat. link
Network	Ethernet	Twisted pair		Category 5 TCP/IP
Product options		High resolution seismic record display. Pre-filtering of seismic data. Attribute calculation First break picking. Signal to noise ratio. Seismic trace energy. Noise level. Seismic trace frequency analysis. Single trace displays. Attribute db generation		

3.2.4. Navigation Details

Item	Description	Type	Amount	Remark
Navigation online	Concept Systems	Spectra		
Navigation offline	FGPS	Seispos		
Work Stations	PC workstations	Shuttle	2	
Network	Ethernet	Twisted pair		Category 5 TCP/IP
PC workstation	Sony	Shuttle		
Printer	HP	Laser		Network to 12”
Compasses	Digicourse	5011	22	Every 300 meter along the streamer + more in the front and tail end.
Streamer positioning	RGPS	Geotrack 220	1	Tracks
Source Positioning	RGPS	Geotrack 320	3	1 on each sub-array.
Acoustics	N/A			
Data logging	UKOOA	P2/94 P1/90		3590, CD-Rom, Online hard disk
Echo Sounder	Simrad	EA600		12 KHz & 200 KHz
Gyro	Simrad HS 50			GPS Gyro
Autopilot	Robertson	AP9 Mk III		
Steering	RobTrack	STS500		
Helmsman Steering display	Spectra	Sony Shuttle	1	Located on the bridge

3.2.5. Source and Mechanical Department Details

Item	Description	Type	Amount	Remark
Acoustic source	Long Life	Bolt		6 acoustic positions per sub-array 8 sources per sub-array
Hanging Plates	Multiwave design	Multiwave		
Chambers	40 – 300 cu. inch.			
Cluster	8-ea clusters	Bolt		3 clusters on the outmost sub-arrays, 2 on the centre sub-array
Near field hydrophones	2540	I/O		3 per sub-array
Depth/pressure Sensors	2527B	I/O		3 per sub-array
Source	Varying configuration	Multiwave / Bolt	Single /dual	Typical: 90-110bar output
Compressors	Frick	TDSB 355	3	Capacity 3 x 2000 cu.ft/min
	Aerial	JGA4	3	
	Caterpillar	Prime mover	3	1 for ea. set of Frick/Aerial
Source controller	Gunlink 2000	Seamap		32 guns, expandable
Solenoid Power Supply	Gunlink 2000	Seamap		25 ms fire pulse width
Deflector	Multiwave	6 foils	2	
Gun Winches	Single	Odim remote ctrl.	5	Slip-ring, Air
Streamer winches	Single	Odim remote ctrl.	4	Each 9000 m (50 mm)
Spooling Device	Marine Project Development	Linear	4	Spooling on each streamer winch individually
Tow Points	Odim	Flexible	4	
Winch Control	Odim		2	

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1. List of Key Personnel

1.1. Onboard Personnel

POSITION	Crew 1
Party Chief	Haydn Brook
Captain	Bruce Wallis
Chief Engineer	John Gleeson
Chief Observer	Tyrone Hackett
Shift Leader Observer	Adam Powell
Chief Navigator	Mark White
Shift Leader Navigation	Steven Ryan
Chief Mechanic	Robert Lamplough
Shift Leader Mechanic	Peter Thompson
QC leader	Emma Buckingham
Client Representative	Robert Luff

1.2. Office Support Personnel

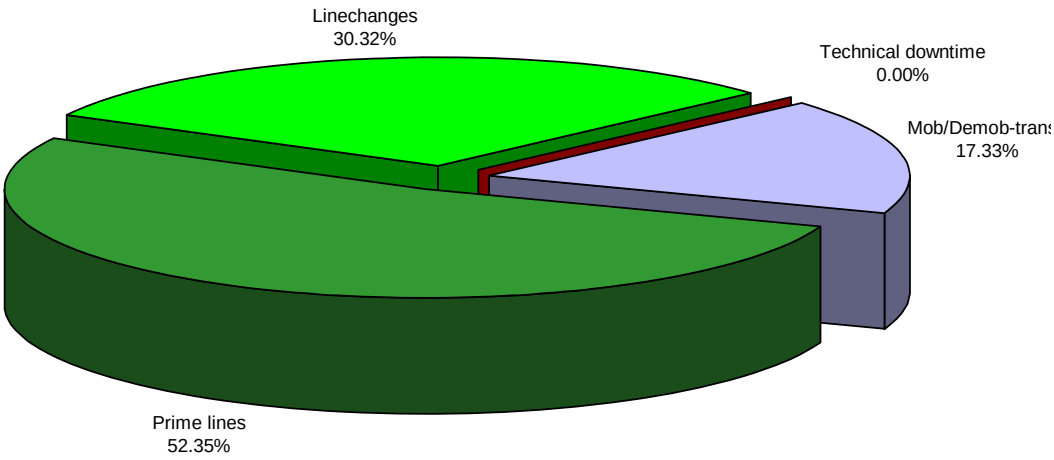
POSITION	NAME
Vice President Operation	Torgeir Nilsen
Operation Manager	Terje Kristiansen
Instrument Manager	Franck Andersen
Navigation Manager	Stephen Isherwood
Mechanic Manager	Steinar Hovland
QC support	Christophe Massacand

2. Field Information and Observations

2.1. Time Statistics

6251	JOB TOTAL		
72.00	Total Time		100.0%
37.69	Prime lines		52.3%
21.83	Linechanges		30.3%
0.00	Technical downtime		0.0%
12.48	Mob/Demob-transit		17.3%
0.00	Weather		0.0%
0.00	Other Obstructions		0.0%
0.00	Sea Mammals		0.0%

TIMING STATISTIC Essential Petroleum Job 6251



2.2. Production Statistics

2.3. Daily Summary

23rd June 2006
Weather: SW 16kt, Seas 2m , Swell 2m

HSE Activity:
Total number of persons onboard : 32
3 toolbox meetings at shift change.
1 toolbox meeting for Gun deployment
1 toolbox meeting for Streamer deployment
1 toolbox meeting for Paravane deployment

Daily Summary (GMT + 10H):
Vessel underway towards Essential Petroleum Prospect. Cable deployment commenced approximately 35km from the first line. 1 Section was changed on deployment due to failing QC test previously. Channels 97 failed Start of Job QC test but was accepted by the client to start production. Weather conditions remain favourable and the outlook is good for the next 3 days. Production commenced just before midnight with minimal swell noise evident on the streamer.

Fuel balance at midnight 735.61m3, consumption 13.93m3
24th June 2006
Weather: SW 16knots, Seas 2m , Swell 2m

HSE Activity:
Total number of persons onboard : 32
6 toolbox meetings at shift change.
1 toolbox meeting for Gun deployment\recovery
1 J.S.A for proposed personal transfer on the 26th June 06.

Daily Summary (GMT + 10H):

Slight turn noise on the tail of the streamer is evident at the start of line on most sequences due to a 5km run in. The 5km run in was agreed with by the client to maximise production due to the good weather we are currently having for this region.
From Seq 2, compass 9 motor module failed causing the depths on that compass to be erratic. This is accepted by the client.
Approximately 15km into seq 5 the cable was put to 8m due to the sea conditions increasing. Cable remained at 8m for the rest of the day.

Fuel balance at midnight 721.8m3, consumption 13.81m3
25th June 2006
Weather: W 18kt, Seas 1.5m , Swell 2.5m

HSE Activity:
Total number of persons onboard : 32
6 toolbox meetings at shift change.

Daily Summary (GMT + 10H):

Cable remained at 8m for the day to reduce swell noise on the streamer aswell as maintaining cable depth control.
A steady days production.

Fuel balance at midnight 708.19m3, consumption 13.61m3

26th June 2006

Weather: W 18kt, Seas 1.5m , Swell 2.5m

HSE Activity:
Total number of persons onboard : 32
3 toolbox meetings at shift change.
1 toolbox meeting for gun recovery

Daily Summary (GMT + 10H):

Cable remained at 8m for the morning to reduce swell noise on the streamer as well as maintaining cable depth control. Once the final line was acquired guns were recovered and the vessel departed the area.

Field Information and Encountered Problems

2.3.1. Obstructions / Installations in the Field

No obstructions of any kind observed within the survey area.

2.3.2. Traffic / Shipping Lanes

Minimal commercial shipping traffic was observed thought out the duration of the survey.

2.3.3. Fishing Activity

No fishing activity present throughout survey

2.3.4. Seismic Interference and Time Share

No seismic interference observed

2.3.5. Environmental Obstacles

There were no environmental issues during the survey.

2.3.6. Operational Observations

No observations interfering with the survey progress was encounted.

3. HSE Summary

There were no accidents or environment incidents during the Essential Petroleum Southern Margins survey.

Prior to the Survey start all new crew members were given a safety introduction tour to get familiarized with the vessel's safety details.

Prior to all safety critical operations, i.e. deploying and recovery of seismic equipment, a "Toolbox Meeting" was held to verify and eliminate any hazards related to the operation.

Each operation has its own dedicated procedures, laid down in the Multiwave TQM system and these were carefully followed throughout the survey.

EXPOSURE HOURS-PACIFIC TITAN

JOB	Month	Maritime	Seismic	3rd pary	Chase boat	Total
6251	June	1152	1008	144		2304

3.1. Observation Cards during the Survey:

Nil observation cards logged during the survey

3.2. Production-Log

Essential Petroleum

Otway Basin, Australia **Job # 6251**

Local Time Difference to GMT: 10:00

Line	Seq	Type	Date (GMT)	Status	Dir	Appr. Shots	FSP	SOL Line Start FGSP	SOL TIME GMT	EOL Line End LGSP	EOL TIME GMT	Prod. Km	LOCAL TIME SOL	LOCAL TIME EOL	Line Duration hh:mm	Average Speed Line	Line Change Time	Feather SOL °	Feather EOL °	Remarks
				In Progress																
				Complete																
				DNP																
				Incomplete																
				InFill																
				Now Complete																
												SP Interval :- 25.000 m.								
OEP06-07-P001	1	2D	23 Jun	Complete	211°	20	981	**1001**	13:24	**2118**	16:27	27.950	**23:24**	**02:27**	03:03	4.95 kts	n/a	-21.3°	4.1°	
OEP06-13-P002	2	2D	23 Jun	Complete	031°	20	981	**1001**	18:27	**1928**	21:11	23.200	**04:27**	**07:11**	02:44	4.58 kts	02:00	-1.0°	9.3°	
OEP06-15-P003	3	2D	23 Jun	Complete	211°	20	981	**1001**	22:49	**1697**	00:36	17.425	**08:49**	**10:36**	01:47	5.28 kts	01:38	-8.7°	-4.3°	
OEP06-17-P004	4	2D	24 Jun	Complete	031°	20	981	**1001**	01:49	**1737**	03:48	18.425	**11:49**	**13:48**	01:59	5.02 kts	01:13	-13.6°	8.0°	
OEP06-19-P005	5	2D	24 Jun	Complete	208°	20	981	**1001**	05:09	**1877**	07:27	21.925	**15:09**	**17:27**	02:18	5.15 kts	01:21	8.5°	1.8°	
OEP06-21-P006	6	2D	24 Jun	Complete	031°	20	981	**1001**	08:59	**1995**	11:41	24.875	**18:59**	**21:41**	02:42	4.97 kts	01:32	-12.6°	6.5°	
OEP06-23-P007	7	2D	24 Jun	Complete	203°	20	981	**1001**	13:32	**1878**	15:53	21.950	**23:32**	**01:53**	02:21	5.04 kts	01:51	-11.7°	2.1°	
OEP06-25-P008	8	2D	24 Jun	Complete	016°	20	981	**1001**	17:25	**1676**	19:13	16.900	**03:25**	**05:13**	01:48	5.07 kts	01:32	-15.5°	-0.9°	
OEP06-02-P009	9	2D	24 Jun	Complete	306°	20	981	**1001**	21:18	**2415**	01:29	35.375	**07:18**	**11:29**	04:11	4.57 kts	02:05	8.2°	-0.6°	
OEP06-05-P010	10	2D	25 Jun	Complete	030°	20	981	**1001**	03:54	**1817**	06:02	20.425	**13:54**	**16:02**	02:08	5.17 kts	02:25	-14.5°	9.5°	
OEP06-09-P011	11	2D	25 Jun	Complete	211°	20	981	**1001**	07:41	**2118**	10:49	27.950	**17:41**	**20:49**	03:08	4.82 kts	01:39	1.4°	-0.5°	
OEP06-07-P012	12	2D	25 Jun	Complete	021°	20	981	**1001**	12:10	**2118**	15:12	27.950	**22:10**	**01:12**	03:02	4.98 kts	01:21	0.9°	7.1°	
OEP06-03-P013	13	2D	25 Jun	Complete	211°	20	981	**1001**	17:05	**2135**	20:08	28.375	**03:05**	**06:08**	03:03	5.02 kts	01:53	-16.0°	1.6°	
OEP06-01-P014	14	2D	25 Jun	Complete	031°	20	981	**1001**	21:28	**2221**	00:55	30.525	**07:28**	**10:55**	03:27	4.78 kts	01:20	8.7°	6.3°	
				End of Survey																

4. Shipment List

Proforma invoice nr.	Date	Job#	Description	Receiver	Destination
PT-2006-053	27/06/2006	6251	Essential Petroleum 6251 Primary Seq 1-14	Essential Petroleum Resources Ltd.	Australia
PT-2006-054	12/07/2006	6251	Essential Petroleum 6251 Copy Seq 1-14	Operations Geophysics, Santos Ltd.	Australia

4.1. Shipment Details

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PT-2006-053

Date: 27-Jun-06

SENDER

M/V Pacific Titan IN TRANSIT

Consignee:

Essential Petroleum Resources Ltd.
Level 2, 226 Albert Rd.
South Melbourne, Victoria, 3205
Australia

Attn: John Remfry, Managing Director
Phone: 61 3 9699 3009
Fax: 61 3 9699 3110

Type of freight:	Comments:
Air	**Primary 3590 Seismic Data Tapes (Essential Petroleum - 6251, Otway Basin, Victoria, Australia)**

Box	Item	General description of content	Weight(kg)	Value(USD)
1	1-17	3590 Data tapes containing seismic data (Tapes 001 - 017) (Sequence 001 - 014)	4	100
		Observers' data		
	18	1 x CD containing observers/source/tape logs/Timing diagram, Shipping Proforma	0.1	10
	19	1 x 3590 Data tape containing Start and End of Job Test (Tape 018)	0.2	10
		Nav data		
	20	1 x DVD Navigation data containing: finalP1/90, Raw P294, Production/Processing Log	0.1	10
		QC data		
	21-22	1 x 3590 QC deliverables, 1 x CD QC deliverable	0.2	15
	23-36	14 Paper Brute Stacks	0.2	10
		Please confirm receipt of goods to chobs.titan@mgc.no		
			4.8	

Total boxes **1** Total value: **155**

Certified true and correct
Multiwave Geophysical Company A.S
R/V Pacific Titan

Sign Tyrone Hackett
Chief Observer

MULTIWAVE
A member of the CGG Group

PT-2006-054

Date: 12-Jul-06

SENDER

M/V Pacific Titan IN TRANSIT

Consignee:

Nick Papanicolaou
Operations Geophysics, Santos Ltd.
Delmont Building
c/- Toll Priority,
Basement, 191 Pultney Street
Adelaide, SA, 5000

Type of freight:	Comments:
Air	**Copy 3590 Seismic Data Tapes (Essential Petroleum - 6251, Otway Basin, Victoria, Australia)**

Box	Item	General description of content	Weight(kg)	Value(USD)
1	1-17	3590 Data tapes containing seismic data (Tapes 001 - 017) (Sequence 001 - 014)	4	100
		Observers' data		
	18	1 x CD containing observers/source/tape logs/Timing diagram, Shipping Proforma	0.1	10
	19	1 x 3590 Data tape containing Start and End of Job Test (Tape 018)	0.2	10
		Nav data		
	20	1 x DVD Navigation data containing: finalP1/90, Raw P294, Production/Processing Log	0.1	10
		QC data		
	21-22	1 x 3590 QC deliverables, 1 x CD QC deliverable	0.2	15
		Please confirm receipt of goods to chobs.titan@mgc.no		
			4.6	

Total boxes **1** Total value: **145**

Certified true and correct
Multiwave Geophysical Company A.S
R/V Pacific Titan

Sign Tyrone Hackett
Chief Observer

5. Crew Lists

Swire Pacific Offshore

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Pacific Titan Crew List

Date: 07 June 2006

No	Name	Rank	D.O.B.	Citizen	Passport no.	Exp.date
1	Bruce Wallis	Capt	24.08.53	Australian	**L8924123**	25.01.11
2	Steve Miller	Ch. Off	10.12.49	Australian	**L1032656**	15.04.07
3	William Shelley	2nd Mate	23.07.64	Australian	**L0992219**	02.04.07
4	John Gleeson	Ch. Eng	08.07.50	Australian	**L900746**	
5	Robert Chapman	1st Engineer	23.05.55	N.Z.	**N382532**	21.04.08
6	Michael Dare	2nd Engineer	07.12.72	Australian	**L4060514**	27.02.13
7	Mark Gordon	I.R.	28.07.61	Australian	**L3972284**	20.01.13
8	Michael Weeks	I.R.	09.12.61	N.Z.	**AA152537**	06.06.11
9	Christopher Parmenter	I.R.	19.11.69	Australian	**E75146256**	26.08.07
10	Vernon Everett	I.R.	26.02.58	Australian	**M2363286**	28.12.14
11	Alan Gray	C.Cook	20.02.60	Australian	**L1299933**	17.03.08
12	Phillip Littlejohn	2/Cook	08.08.56	Australian	**L7602866**	08.07.09
13	Donald James Crawford	Ch Stwd	13.04.46	Australian	**L5460283**	20.09.06
14	Jamie Dent	2nd Stwd	21.09.61	Australian	**L8494325**	22.05.10
15	Ken Stephens	Comp Mech	17.09.51	Australian	**M1851602**	27.09.14
16	Eric Hackett	Comp Mech	22.05.67	NZ	**N119290**	15.01.08
MULTIWAVE GEOPHYSICAL						
17	Haydn Brook	PC	10.07.73	Australian	**E1024451**	10.03.15
18	Tyrone Hackett	Ch. Obs	19.12.71	Canadian	**BD106336**	16.06.10
19	Adam Michael Powell	Sl. Obs	11.04.71	Australian	**E7534193**	23.06.08
20	John Shannon Gracey	Obs	18.07.59	British	**500328449**	26.07.10
21	Mark P.F. White	Ch. Nav	06.08.68	New Zealand	**AA527436**	16.08.07
22	Steven Ryan	Sl. Nav	10.08.81	Australian	**L3099345**	04.01.12
23	Christopher Hernandez	Nav Trainee	05.12.83	Filipino	**SS0131590**	08.12.10
24	Robert Lamplough	Ch. Mech	13.02.55	British	**500269115**	14.05.08
25	Peter Thompson	Sl. Mech	25.06.60	New Zealand	**N160152**	20.08.08
26	Jovito Opina	Mech	08.01.62	Filipino	**QQ0240873**	22.04.10
27	Agacoili William	Mech	18.11.51	Filipino	**PP0392003**	11.11.09
28	Derrien Regis	Mech	15.02.69	French	**02YD55942**	06.08.12
29	Emma Buckingham	Sr. field geoph	28.08.76	British	**93010020**	26.02.11
30	Mylene Militante	Field geoph. tr.	20.11.78	Filipino	**QQ0072660**	14.03.10
31	Robert Luff	Client Rep	05.04.52	Australian	**E 7514844**	10.03.10
32	Andrew Levings	MMO	29.03.52	Australian	**L6248657**	13.03.08

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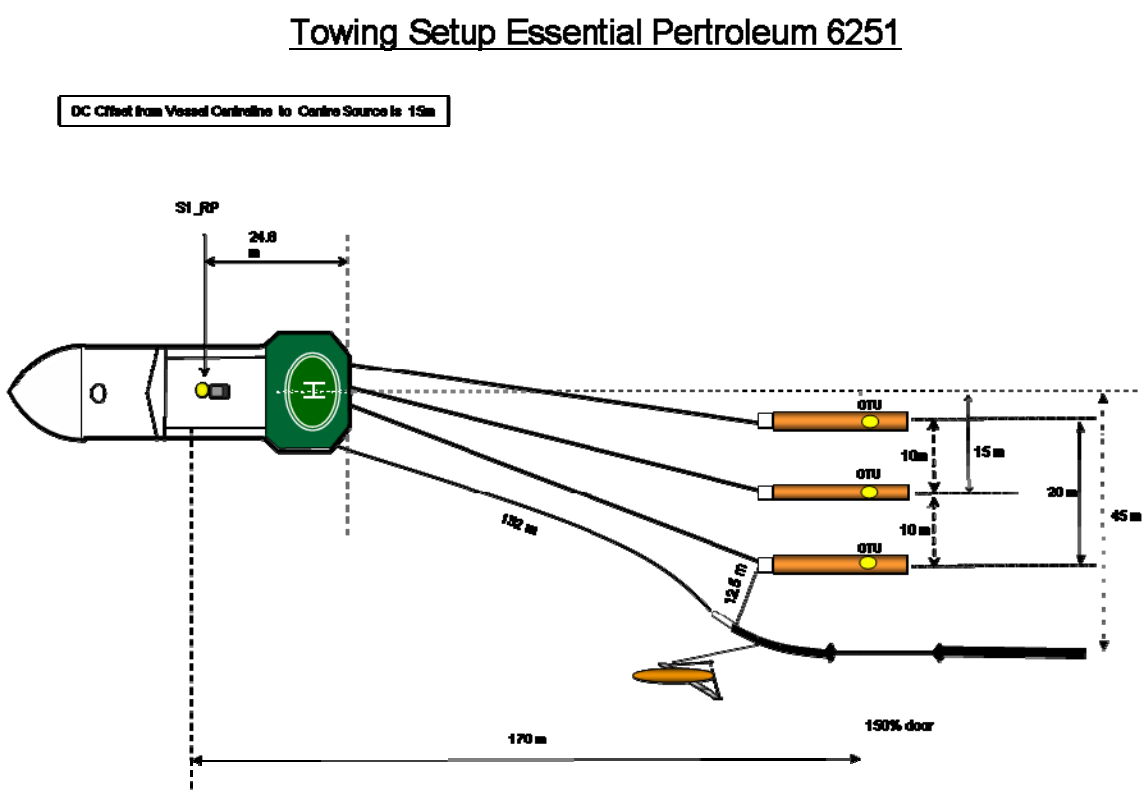
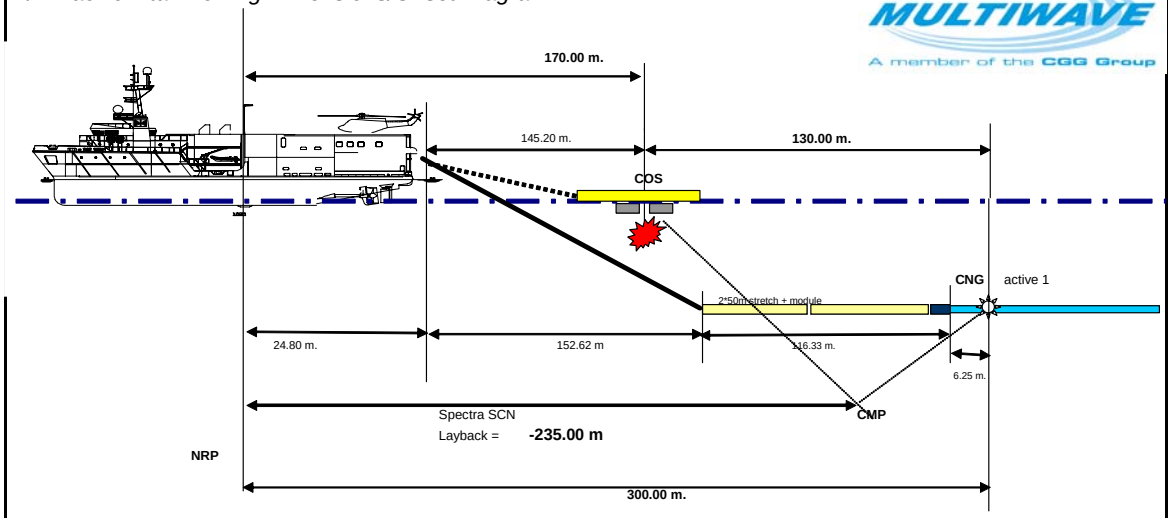
1. Towing Configuration



1.1. Towing Offset Diagram

M/V Pacific Titan Towing Dimensions/Offset Diagram



Principal Distances:			Principal Offsets:		Used as:
NRP-Stern	24.80 m.		COS-CNG	130.00 m.	
Stern-COS	145.20 m.		**NRP-CMP**	**-235.00 m**	**Spectra SCN Layback**
Stern-CNG	275.20 m.				
NRP-COS	**170.00 m.**		**NRP-CNG**	**300.00 m.**	**Offset from NRP**

Centre near group derived from Seal manuals = 6.25m from coupling

Key:	
NRP	Navgation reference point (centre of mast @ sea level)
COS	Centre of source
CNG	**Centre of near group (Trace # 001)**
CDP	Common depth point
NTRP	Near trace reflection point

1.2. Streamer System Description

Streamer System Parameters	
Number of Streamers	1
Type of Streamer	Seal Solid
Streamer Length	6000m
Number of channels	480
Groups per Section (150 m)	12
Group Intervals	12.5 m (no overlap)
Active Group Array Length	12.5 m
Outside Diameter	64 mm
Solid Streamer Material	Outer 3.5mm Polypropylene
Normal maximum towing tension	55.6kN Ultimate breaking at 278kN
Connectors (Pins)	28
Channels per Module	60 at 2 ms
Data Transmission Link	Dual twisted Quarte AWG 22
Power	+/- 360 V DC

Leakage	30 mA differential circuit breaker
Near Offset (centre source – centre near group)	130 m nominal
Streamer Depth	7m +/- 1.0 m
Number of Front 50 m Stretch Sections	2 (85 mm diameter)
Number of Tail 50 m Stretch Sections	1 (50 mm diameter)
Number of Compasses per Streamer	22 (within digibirds)
Number of Depth Sensors per Streamer	22 (within digibirds)

Trace allocation	**Near**	**Far**	**Aux**
Streamer 1	1	480	481 - 501

Hydrophone Parameters	
Hydrophone Specification	Sercel 12 element radial
No of Channels per Section	12
No of Hydrophones per Channel	8 in parallel
Active Length of Channel	12.5m
Channel Centre Spacing	12.5 m under a 1000daN load
Hydrophone Spacing	1.78m
Low Frequency Cut	3 Hz
Nominal Sensitivity, without electronics @ 1 bar @ 20°C	20 V/bar
Nominal Hydrophone Sensitivity	21.5 v/bar
Capacitance per Group	790 nF +/-10% at 22°C
Minimum Leakage Resistor	500 Mohm under 50 V

1.3. Streamer Layout

PORT REEL AFT						
Item	Position	S/N	RDU	Bird Collar	SRD Collar	Trace N.O
DCXU		**166**				
Slip ring						
PORT AFT REEL						
Lead-in		**n/a**				
SHS		**1350**				
HAU		**124**				
HESE		**1665**				
HESE		**1339**	**1**	15797		
HESA		**1332**				
SSAS	01	**30313**	**2**	31775		1-12
SSAS	02	**30554**				13-24
SSAS	03	**30343**	**3**	30232		25-36
SSAS	04	**30297**				37-48
SSAS	05	**30543**	**4**	31736	**36208**	49-60
LAUM	01	**509**				
SSAS	06	**30501**				61-72
SSAS	07	**30529**	**5**	29839		73-84
SSAS	08	**30528**				85-96
SSAS	09	**30526**	**6**	29835		97-108
SSAS	10	**30515**				109-120
LAUM	02	**513**				
SSAS	11	**30394**	**7**	30952	**9112**	121-132
SSAS	12	**30521**				133-144
SSAS	13	**30429**	**8**	30327		145-156
SSAS	14	**30149**				157-168
SSAS	15	**30535**	**9**	29096		169-180
LAUM	03	**515**				
SSAS	16	**30553**				181-192
SSAS	17	**30447**	**10**	29016	**36206**	193-204
SSAS	18	**30544**				205-216
SSAS	19	**30454**	**11**	31044		217-228
SSAS	20	**30517**				229-240
LAUM	04	**715**				
SSAS	21	**30445**	**12**	29799		241-252
SSAS	22	**30411**				253-264
SSAS	23	**30509**	**13**	30423	**36213**	265-276
SSAS	24	**30538**				277-288
SSAS	25	**30534**	**14**	26502		289-300
LAUM	05	**734**				
SSAS	26	**30330**				301-312
SSAS	27	**30556**	**15**	31120		313-324
SSAS	28	**30118**				325-336
SSAS	29	**30504**	**16**	29829	**36203**	337-348
SSAS	30	**30533**				349-360
LAUM	06	**566**				
SSAS	31	**30160**	**17**	31652		361-372
SSAS	32	**30522**				373-384
SSAS	33	**30362**	**18**	27832		385-396
SSAS	34	**30557**				397-408
SSAS	35	**30251**	**19**	31309	**36200**	409-420
LAUM	07	**775**				
SSAS	36	**30270**				421-432
SSAS	37	**30518**	**20**	30692		433-444
SSAS	38	**30563**				445-456
SSAS	39	**30561**	**21**	29984	**36202**	457-468
SSAS	40	**30558**	**22**	31507		469-480
TAPU	08	**157**				
TES	1	**1335**				
Tailbuoy	1					

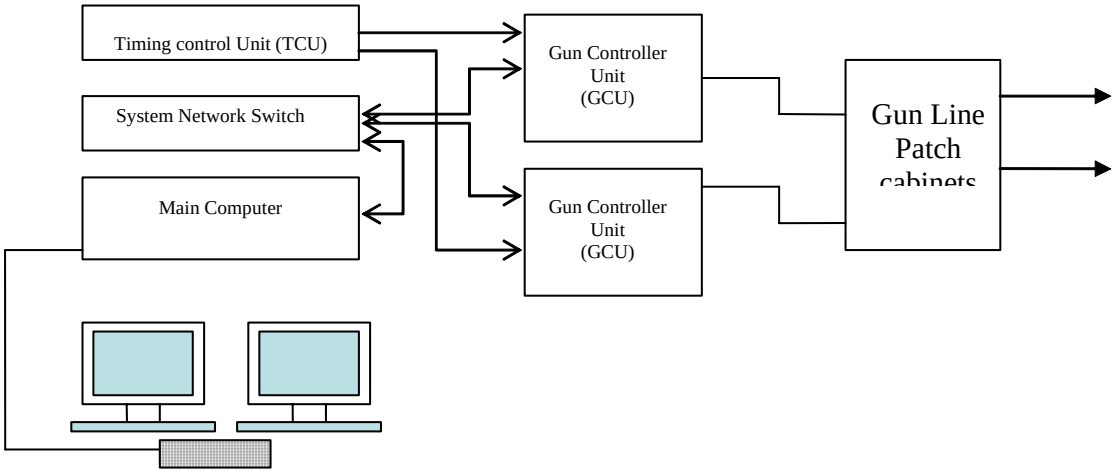
2. Source Configuration

2.1. Source System Description

Source Parameters	
Source Controller	Gunlink 2000
Number of Sources	1
Number of Sub-Arrays (Strings) per Source	3
Array Length	14.7 m
Sub-Array Separation	10 m
Source Width	20 m
Source Separation	n/a
Source Volume	3040 Cubic inches
Number of Hydrophones per String	3
Number of Depth Transducers per String	3
Number of Pressure Transducers per String	1
Number of Guns per String	String 1 & 3 = 9 / String 2 = 8, includes spares
Number of Clusters per String	String 1 & 3: 3 clusters / String 2: 2 clusters
Airgun Type	Bolt, 1500 & 1900 Long Life
Operating Pressure	2000 PSI
Depth of Guns	5.0 m +/- 1.0m
Peak to Peak Amplitude	88.01 barm
Primary to Bubble Ratio	24.97

Gun Controller Description
The Gunlink 2000 Seismic Source Control and Acquisition System is the first phase of Seamap's range of new generation seismic gun controller systems.
The system uses the latest high speed micro processors to provide onboard firing control and sensor timing monitoring, continuous monitoring of near field phones and interrogation of depth and pressure sensors.
In addition the system monitors the voltage and current of the firing pulses applied to the gun solenoids allowing the user to monitor variations in the performance of the guns and improve maintenance schedules.

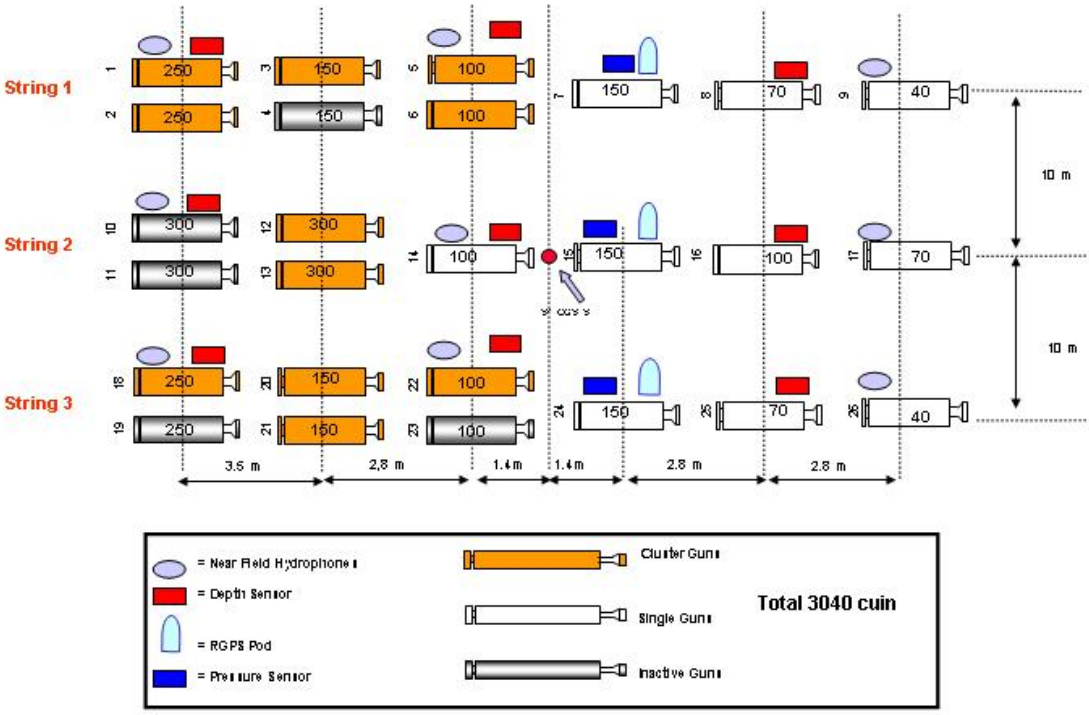
An innovated Graphical User Interface (GUI) makes use of the latest advances in software design to provide the operator with maximum information on the operation and performance of the system without the clutter of text.
An internal database maintains records of all system statistics and the data can be accessed via the in built web server using standard web browser programs.
To further reduce operator fatigue, the system draws the operator's attention to gun misfires, auto-fires and other faults by use of voice alerts issued from the system speakers.



2.1.1. Gun Controller Specifications

Channels available	
Monitored Variables	Gun Fire time Near field Hydrophone Data Depth Sensor value Gun air pressure Value Solenoid coil current
Controlled Variables	Gun Fire time Gun Firing pulse length and Voltage
System Timing	0.01 ms
Fire Detect Window	120 ms
Synchronization Mode	Automatic
Fire Detect Method	Sensor
Fire Time Pick Method	Peak detect
Near Field Hydrophone S.I.	0.1 ms
Near Field Hydrophone Res.	16 Bit
Software	Ver. 2.3.0

2.1.2. Source Layout

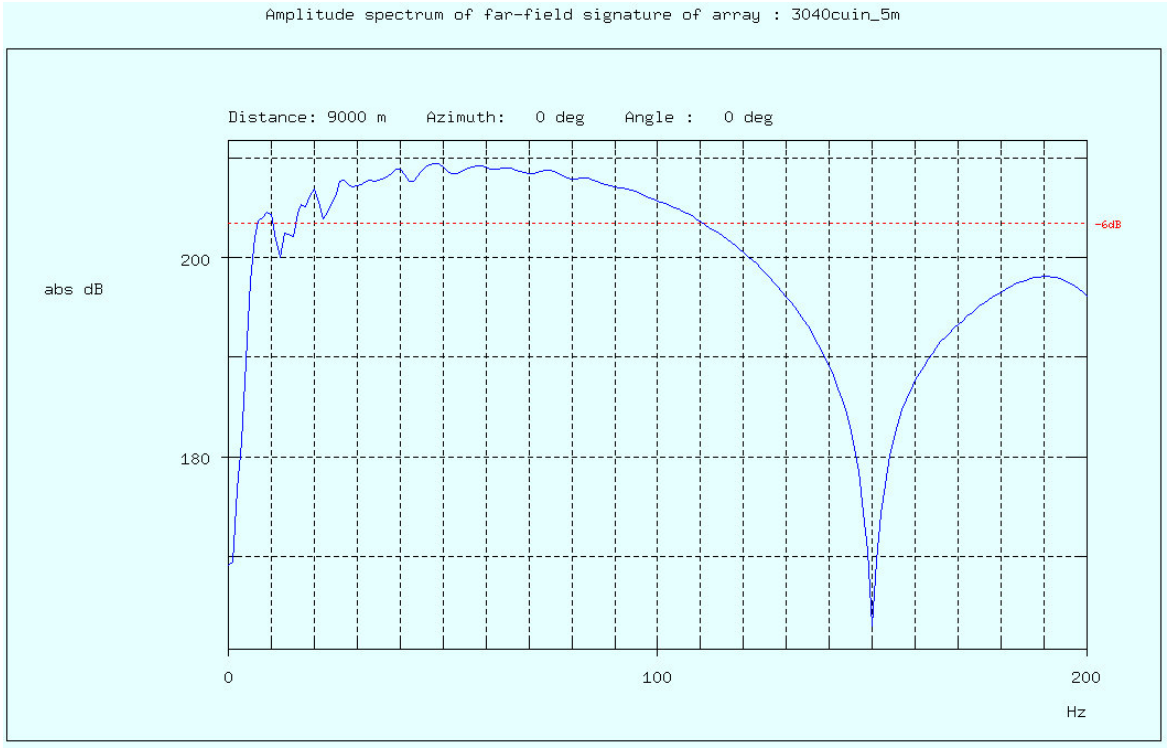


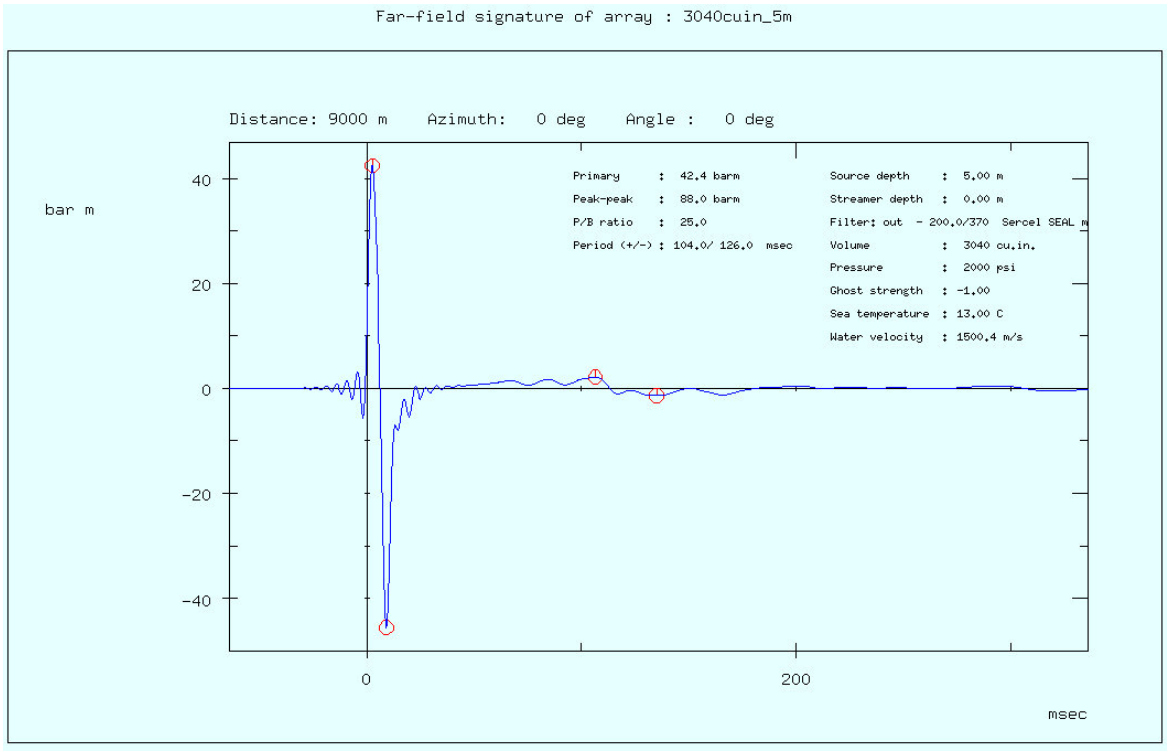
2.1.3. Array Listing

Total active volume: 3040 in^3 Nominal pressure 2000 psi.

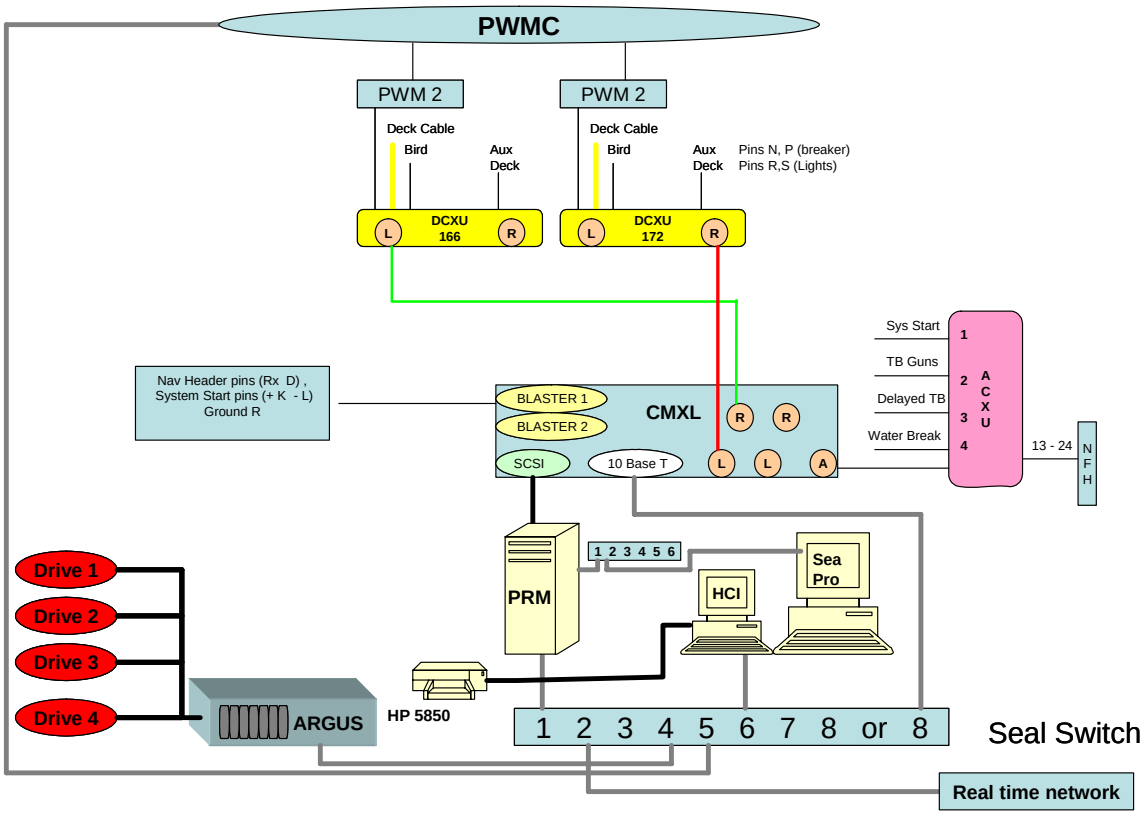
GUN#	GUN TYPE	Dist X (m)	Dist Y (m)	Dist Z (m)	Volume	Active / Spare	Sub-array#
1	1500LL	0	10.5	5	250	Active	1
2	1500LL	0	9.5	5	250	Active	1
3	1900LLX	3.5	10.4	5	150	Active	1
4	1900LLX	3.5	9.6	5	150	Spare	1
5	1900LLX	6.3	10.4	5	100	Active	1
6	1900LLX	6.3	9.6	5	100	Active	1
7	1900LLX	9.1	10	5	150	Active	1
8	1900LLX	11.9	10	5	70	Active	1
9	1900LLX	14.7	10	5	40	Active	1
10	1500LL	0	0.5	5	300	Spare	2
11	1500LL	0	-0.5	5	300	Spare	2
12	1500LL	3.5	0.5	5	300	Active	2
13	1500LL	3.5	-0.5	5	300	Active	2
14	1900LLX	6.3	0	5	100	Active	2
15	1900LLX	9.1	0	5	150	Active	2
16	1900LLX	11.9	0	5	100	Active	2
17	1900LLX	14.7	0	5	70	Active	2
18	1500LL	0	-9.5	5	250	Active	3
19	1500LL	0	-10.5	5	250	Spare	3
20	1900LLX	3.5	-9.6	5	150	Active	3
21	1900LLX	3.5	-10.4	5	150	Active	3
22	1900LLX	6.3	-9.6	5	100	Active	3
23	1900LLX	6.3	-10.4	5	100	Spare	3
24	1900LLX	9.1	-10	5	150	Active	3
25	1900LLX	11.9	-10	5	70	Active	3
26	1900LLX	14.7	-10	5	40	Active	3

2.2. 3040 Cu-Inch Pulse Response and Spectrum at 5m.





3. Instrumentation 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	RTNμ (30/207P & 30/208P)	Spectra 10.9.01.10
	IBM E Server Workstations	Red Hat ELWS3.6
External Header	N/A	Gcs90v2
Acoustic System	N/A	
TS-meter	Saiv AS STD/CTD model SD 204	
Echo sounder	Simrad EA600	

1.1.2 System Timing

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

An addition trigger was issued from spectra 450 milliseconds after time zero, this was sent to the recording system as a timing verification. The trigger was 5 milliseconds in duration.

1.2 Survey Positioning Method Used

This survey was carried out using Multiwave's standard mode of operation for single streamer/single source surveys.

Positioning of the vessel was by 3 Single frequency differential GPS systems using a delivery of differential correction data in RTCM 104 format and recorded in the P2/94 files.

The sources were positioned relative to the vessel using a network consisting of rGPS units mounted on sub-arrays 1, 2 and 3.

The centre near group of the streamer was positioned by a combination of compass heading units and nominal offsets from the vessel.

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

The streamer shape was modelled by 22 Digicourse series 5011 combined streamer depth control and magnetic compass units on the streamer.

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

1.3 Surface Positioning

1.3.1 Vessel Navigation

Summary

System 1: Fugro Multifix 4 Standard Version 1.09
Differential correction delivery via Starfix Spotbeam and Inmarsat B.

System 2: Fugro Multifix 4 Standard Version 1.09
Differential correction delivery via Starfix Spotbeam and Inmarsat B.

System 3: Fugro MRDGPS Standard Version 3.03.02
Differential correction delivery via Starfix Spotbeam and Inmarsat B.

Differential Correction Systems: Fugro Skyfix via Spot Beam (OCSAT) satellite and Fugro Starfix via Inmarsat (POR).

All systems had the same accuracy and were set to have the same weight in the solution.

Fugro Multifix is a multiple reference station DGPS system tailored for the specific needs of seismic surveying. State-of-the art algorithms combine reference station data and pseudo range measurements into the best position estimates.

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

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

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

- **Further information is given in Appendix 1.**

Although Selective Availability was turned off in May 2000 differential corrections are still required to provide a high quality continuous vessel position. Less frequent updates are required however.

1.3.2 Float Navigation

Source and Tailbuoy surface navigation was provided by Seatex Seatrack relative GPS. The in-sea units incorporated a GPS receiver and interfacing for direct data transmission of the raw satellite pseudo-range data via UHF link to the vessel.

On board the vessel, the raw pseudo-range data from the float unit was matched with simultaneously received data at the vessel's GPS receiver to compute a vector describing the location of the float unit relative to the vessel from which the float position was derived. Relative positioning CEP was better than 2 m.

1.4 Streamer and Source Positioning

1.4.1 Streamer Compasses

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

Compass Sampling Rate	=	2 second
Averaging constant	=	14 seconds

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

1.4.2 Gyro Compass

The gyrocompasses used during the survey were:

Gyro 1	- Simrad HS50 GPS
Gyro 2	- Tokyo Keiki MK.ES

The gyro correction values as computed during the mobilisation calibration were as follows:

Gyro 1	- plus 1.10 degrees
Gyro 2	- plus 1.74 degrees

1.5 Auxilliary Navigation Sensors

1.5.1 Echo Sounder

The echo sounder speed of sound was set to 1500 m/s. A draught correction of zero was entered in the echo sounder. Depth data was recorded throughout the survey using a dual transducer/dual frequency (12 KHz, 200 KHz) Simrad EA600 Echo sounder.

2 Survey Pre-plots

2.1 Projection

Projection Type:	Universal Transverse Mercator 54° S
Origin Longitude:	141.000E
Origin Latitude:	0000.00S
False Easting:	500,000.00E
False Northing:	10,000,000.00N
Spheroid Name:	WGS84
Semi Major Axis:	6378137.0
Inverse Flattening:	298.2572236
Datum Name:	WGS84
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

3 Navigation Systems Verification and Monitoring

3.1 Gyro Monitoring

Dockside verification was performed in two opposite directions in Fremantle, Western Australia on 1st December 2005.

- **The gyro verification results are in Appendix 3**

3.2 GPS Monitoring

Health checks onshore were carried out to verify that the installation was satisfactorily operational (data reception, transmission, processing and Logging were verified) and that operational settings were correct**.** Each system used, including duplicates was verified.

- **The onshore Health Check results are in Appendix 3**

3.3 RGPS Health Checks

The last RGPS verification was held in Fremantle, Western Australia on the 1st of December 2005 to verify installation and operational settings where satisfactory.

- **The onshore Health Check results are in Appendix 3**

4 Navigation Processing

4.1 The FGPS Seispos System

SeisPos is an off-line navigation QC and post-processing system for 2D and 3D streamer surveys supplied by Fast Geophysical Processing Services. It runs under various Windows operating systems and has a graphical front end. A relational database management system is used for data storage. SeisPos is capable of automatic filtering and gating of the observations in addition to manual editing, before new adjustments are calculated. There is a comprehensive set of QC tools available such as graphical plots of any node or observation parameters and combinations of these, comparison of online and processed P1/90.

4.2 First Line Test data

A water-break analysis was performed during the first line to confirm the nominal offsets for the front end of the streamer. An offset shot was also performed after any streamer re-deployment.

4.3 Initial QC

Initial QC consisted of on-line monitoring of the systems and of producing an end of line QC report utilising the Spectra QCN (Quality Control Node). The report was generated as a PDF document. If any discrepancies were found, they would be further investigated and any problems were noted in the navigation logs.

The report included comparisons between the systems, plots of network reliability, SMA (Semi Major Axis), MDE (Mean Detectable Error) and TS-plots of compasses, depths and source separation.

4.4 Post-processing Flow

The lines were post processed using Multiwave's standard 2D processing flow consisting of the following stages:

- Import P2/94 to database and check for header changes.
- Check for missing shots and perform shot edits.
- Update a-priori SD's and magnetic declination if required.
- Pre-process data applying standard gating and filtering, hand-edit any remaining observation spikes.
- Compass calibration and bias check.
- Network adjustment
- Processing QC report generation.
- Export final P1/90
- QC of final P1/90
- Comparison of online and final P1/90

4.5 Final QC

Final QC was performed during the post processing and consisted of checking the various reports and plots generated by SeisPos, checking consistency of logs and P1/90 QC and comparison. Any discrepancy was noted in the processing log.

4.6 Water Depth Processing

The recorded water depth data was corrected for vessel draught, and a speed of sound correction was also applied to the processed water depth.

Corrections for draft and water velocity were carried out in post-processing.

5 Observations

5.1 Navigation Summary

All systems performed very well throughout the survey. Each systems performance is described in further detail below.

5.1.1 DGPS Systems

All DGPS systems performed well during this survey.

5.1.2 Echo Sounder

The 12 kHz transducer generally worked well throughout the survey although it occasionally had poor sea bed tracking when faced with steep slopes and heavy sea conditions.

5.1.3 Gyro

The primary and secondary gyro performed well during the survey, with no problems.

5.1.4 RGPS

During the survey all gun pods worked well throughout.

5.2 Processing and QC Summary

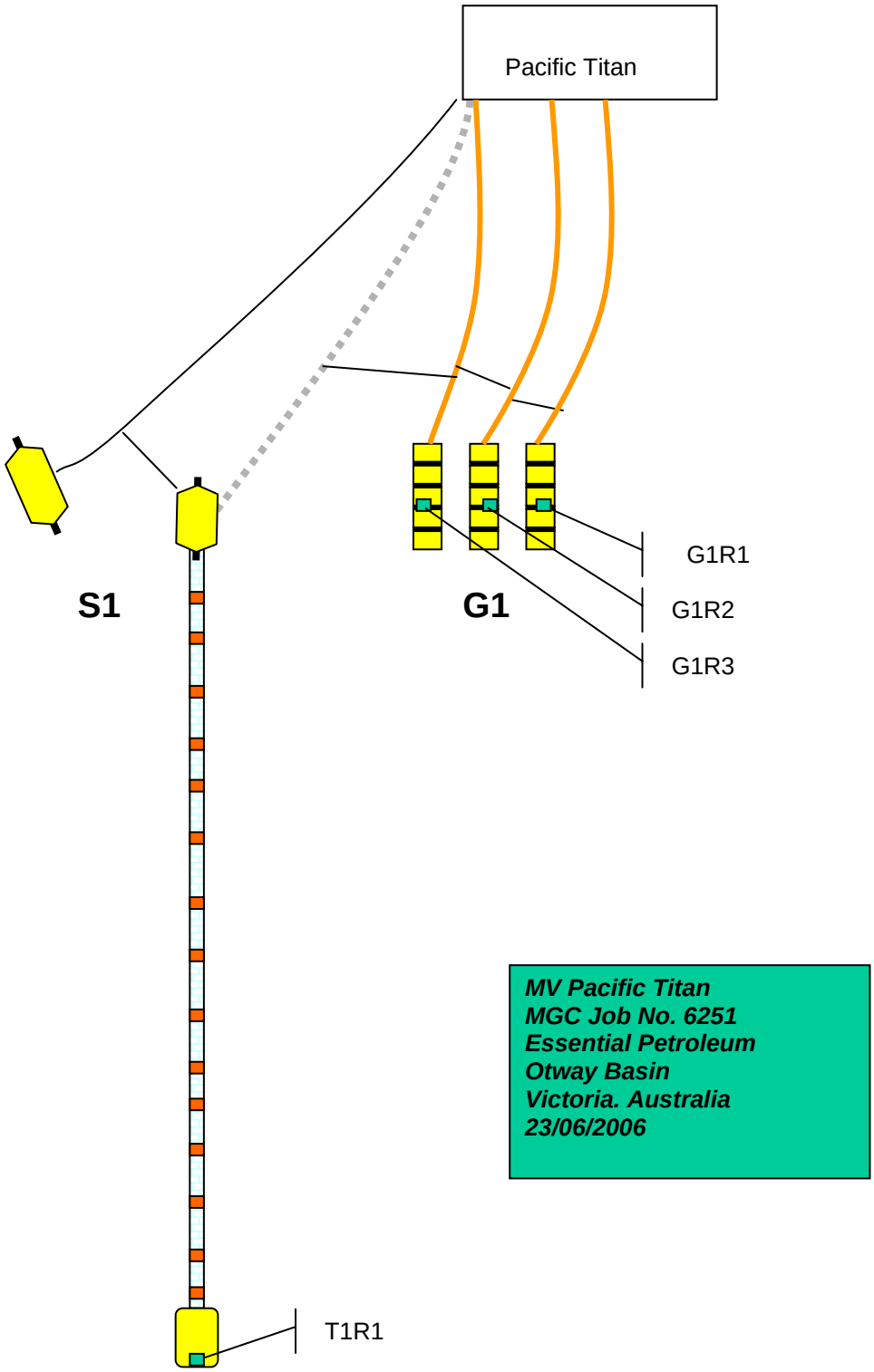
The data quality during this survey was generally good and the client's specifications for the survey were met and there are no significant problems to report.

Appendix 1 Navigation Systems & Diagrams

DGPS Reference Stations

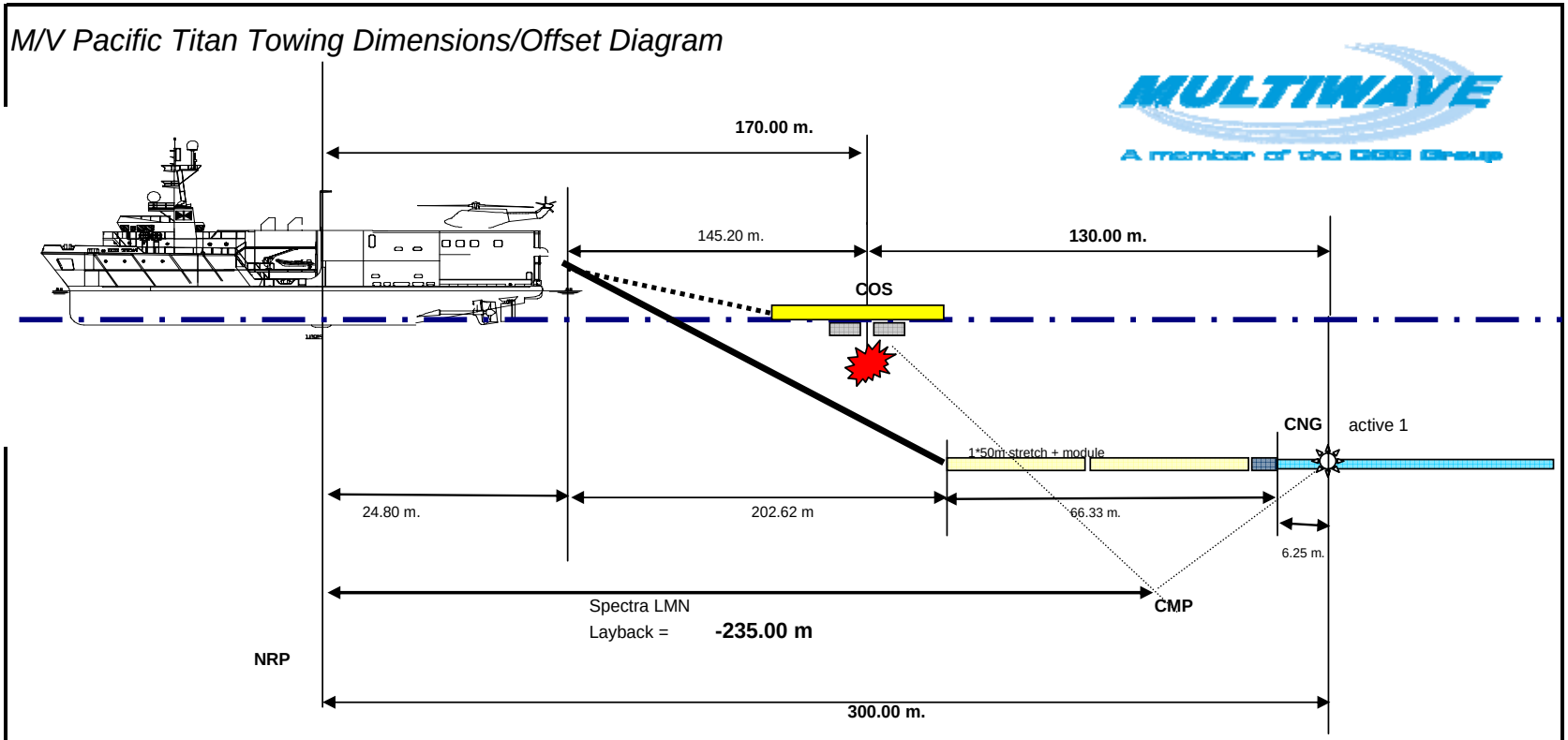
WGS84				
Ref. St. Name	**No.**	**Latitude**	**Longitude**	**Height (m)**
Cobar	316	031° 29’ 57.43’’S	145° 50’ 20.34’’E	270.16
Ceduna	355	032° 07’ 03.05’’S	133° 41’ 22.85’’E	7.27
Melbourne	385	037° 48’ 29.00’’S	144° 57’ 48.03’’E	82.05
Bathurst	336	033° 25’ 46.88’’S	149° 34’ 01.97’’E	756.65

Towing Arrangement



Offset Diagram

M/V Pacific Titan Towing Dimensions/Offset Diagram

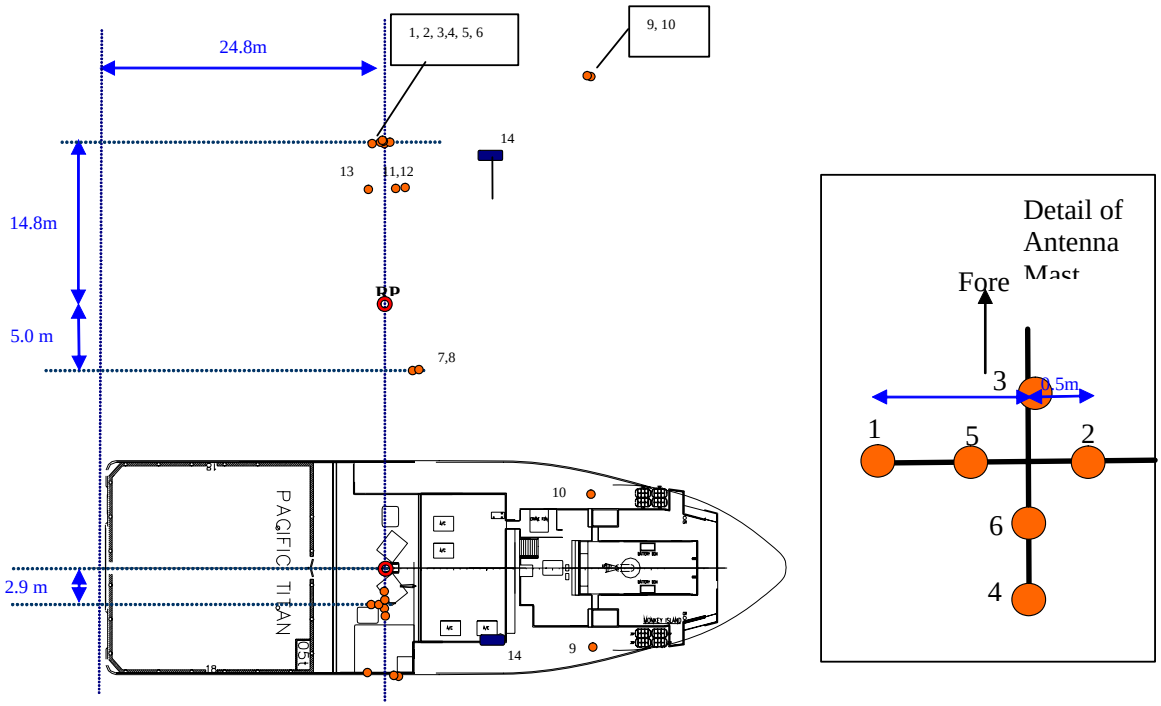


Principal Distances:			Principal Offsets:		Used as:
NRP-Stern	24.80 m.		COS-CNG	130.00 m.	
Stern-COS	145.20 m.		**NRP-CMP**	**-235.00 m**	**Spectra LMN Layback**
Stern-CNG	275.20 m.				
NRP-COS	**170.00 m.**		**NRP-CNG**	**300.00 m.**	**Offset from NRP**

Centre near group derived from Seal manuals = 6.25m from coupling

Key:	
NRP	Navgation reference point (centre of mast @ sea level)
COS	Centre of source
CNG	**Centre of near group (Trace # 001)**
CDP	Common depth point
NTRP	Near trace reflection point

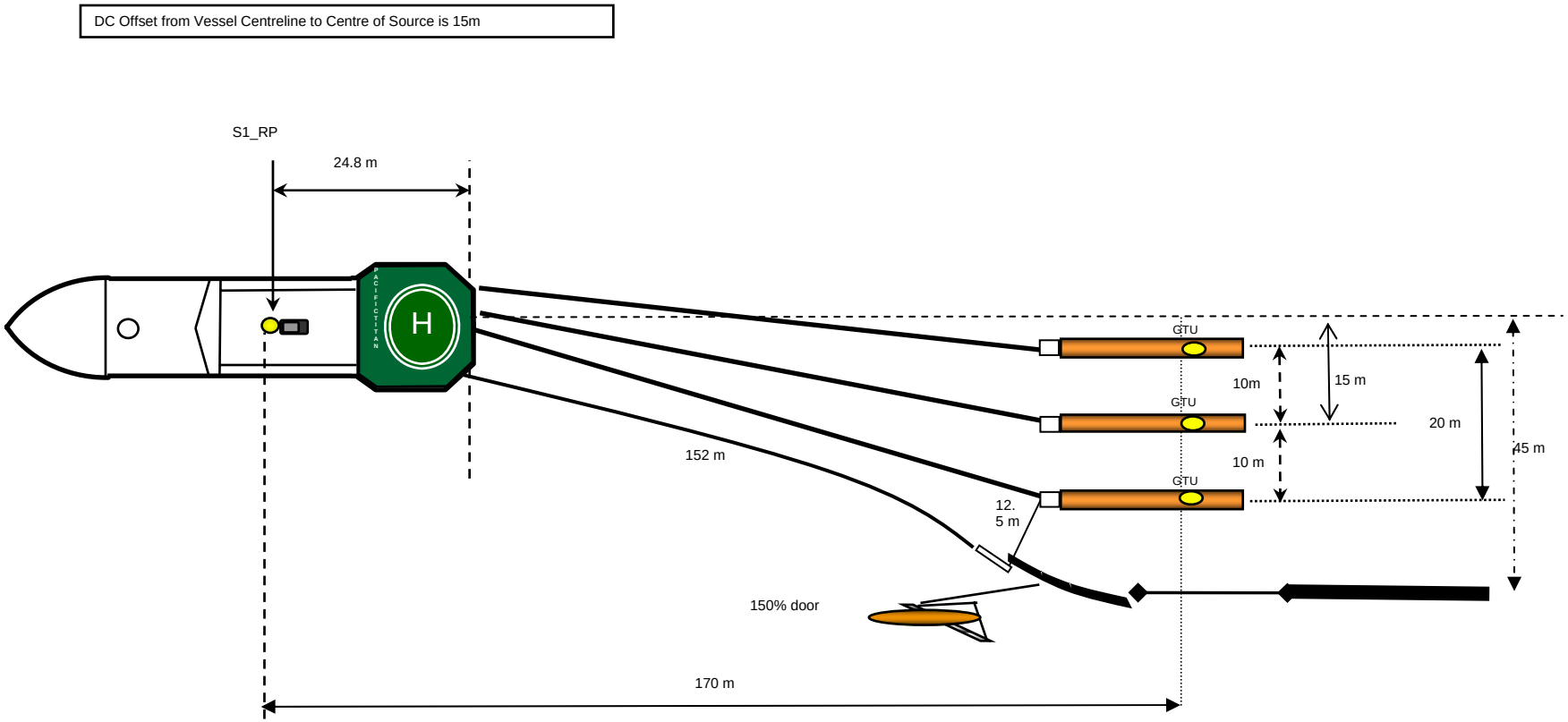
Antenna Offsets



No.	Node/Name	X	Y	Z	Description	Cable ID
0	S1_RP	0	0	0	Vessel Reference point	
1	V1G1	2.0	0	14.8	GPS Antenna	4 Rings
2	V1G2	3.4	0	14.8	GPS Antenna	3 Rings
3					Motorola UHF Radio Antenna	
4	Spot1				SkyFix Antenna	6 Rings
5					Yagi VCU UHF Antenna	
6					TB VCU UHF Antenna	5 Rings
7	V1E1	1.4	2.7	-5.0	Simrad EA600 12khz Transducer	
8	V1E2	-1.2	3.0	-5.0	Simrad EA600 200khz Transducer	
9	Freewave				900Mhz Antenna	
10	Speedlan				1.4Ghz Antenna	
11	Runt 1				Trimble Bullet III GPS Antenna	
12					Spare Simrad VCU UHF Antenna	No. 9
13					Sailor VHF Radio Antenna	No. 20
14	V1GY1				Simrad GPS Gyro	

Offset for 2D Acquisition

Towing Setup Essential Petroleum Resources Ltd 6251



Appendix 2 Essential Petroleum Limited Navigation Processing Log

Line Name	Seq	Database	FGSP	LGSP	P190	QC	P1 Comp	Comments
OEP06-07-P001	001	6251DB-fr-002	1001	2118	Y	Y	Y	
OEP06-13-P002	002	6251DB-fr-002	1001	1928	Y	Y	Y	V1G1,V1G2 taken out d/t high SOL UV
OEP06-15-P003	003	6251DB-fr-002	1001	1697	Y	Y	Y	
OEP06-17-P004	004	6251DB-fr-002	1001	1737	Y	Y	Y	
OEP06-19-P005	005	6251DB-fr-002	1001	1877	Y	Y	Y	
OEP06-21-P006	006	6251DB-fr-002	1001	1995	Y	Y	Y	
OEP06-23-P007	007	6251DB-fr-002	1001	1878	Y	Y	Y	G1R3 GPS reset near SOL
OEP06-25-P008	008	6251DB-fr-002	1001	1676	Y	Y	Y	V1G1,V1G3 taken out d/t high UV sp's 1300-1400
OEP06-02-P009	009	6251DB-fr-002	1001	2415	Y	Y	Y	
OEP06-05-P010	010	6251DB-fr-002	1001	1817	Y	Y	Y	
OEP06-09-P011	011	6251DB-fr-002	1001	2118	Y	Y	Y	
OEP06-07-P012	012	6251DB-fr-002	1001	2118	Y	Y	Y	
OEP06-03-P013	013	6251DB-fr-002	1001	2135	Y	Y	Y	V1G1,V1G3,V1G5 taken out d/t high UV
OEP06-01-P014	014	6251DB-fr-002	1001	2221	Y	Y	Y	

Appendix 3 Calibrations and tests

Introduction

Fugro Survey Pty Ltd (Fugro) was contracted by Multiwave Geophysical Company AS (MGC) to provide surveying services on board the *MV Pacific Titan* for the calibration of two gyro compasses, together with the verification of five differential GPS systems and eight RGPS tailbuoys.

The calibrations and verifications were carried out while the vessel was alongside Henderson Wharf, Tenix Shipyard, Western Australia between 28 November and 1 December 2005. All observations made by Fugro and MGC have been recorded in GPS/UTC Time. Western Standard Time (WST) is +8:0 hours ahead of GPS/UTC Time.

GEODESY AND SURVEY CONTROL

Geodetic Parameters

All coordinates supplied in this report are referenced to the World Geodetic System 1984 (WGS84) except where indicated. The Global Positioning System (GPS) operates on the World Geodetic System 1984 (WGS84) datum.
Operations and calculations were undertaken using the following datum parameters:

Datum: WGS84

Reference Spheroid: World Geodetic System 1984
Semi-major Axis: 6378137m
Inverse Flattening (1/f): 298.257223563

Projection: Universal Transverse Mercator (UTM)

Grid: Universal Transverse Mercator (UTM)
Latitude of Origin: 0°
Central Meridian: 117° E (Zone 50)
Central Scale Factor: 0.9996
False Easting: 500000m
False Northing: 10000000m
Units: Metres

Survey Control

All coordinated survey marks were already established on Henderson Wharf. The coordinated information was obtained from a Fugro Survey Control Report (August 2003).
The survey marks utilised are presented in the Table 2-1, below

WGS84, CM 117°E		
Name	**Easting (m)**	**Northing (m)**
DC01	383612.279	6441844.694
DC02	383475.613	6441845.063
DC03	383532.749	6441815.312
DC04	383508.693	6441815.388
DC06	383613.791	6441815.653

TABLE 2-1: SURVEY MARKS – HENDERSON WHARF
Details of the Survey Marks are shown in Appendix B of the calibration report.

SURVEY PROCEDURES

Differential GPS Verification

The differential GPS verification of the five DGPS systems on board the *MV Pacific Titan* was undertaken between 2:37 and 3:07 (UTC) on 29 November 2005.

A Total Station (Wild TC1010) was set up over DC01 using DC06 as the reference object (RO). Sixty observations were made to a prism attached to the centre of the antenna mast at 30 second intervals during the observation period. These observations were synchronised with the navigation computer on board the *MV Pacific Titan.* The MGC on board navigation system was set to log WGS84 coordinates for the V1G1, V1G2, V1G3, V1G4 and V1G5 systems at one second intervals.

A Total Station was used to observe a series of bearings and distances from survey station DC01, to the antenna mast. These observations were used to compute the calculated position of the V1G1, V1G2, V1G3, V1G4 and V1G5 antennae. WGS84 differentially corrected coordinates for the five systems were extracted from the on board navigation system logs. They were matched for time with the Total Station observations, and entered as Positioning System DGPS Coordinates into Fugro's Static DGPS Verification – Single Total Station Method Sheet. Offsets from the prism to each of the antenna were taken and used for the spreadsheet. The Static Differential GPS Verification - Single Total Station Method sheets for V1G1, V1G2, V1G3, V1G4 and V1G5 showing the differences between calculated and observed values are shown in Appendix C of the calibration report.

Gyro Compass Calibration

Gyro compass calibrations were conducted by time coordinated, simultaneous observations, using two Total Stations. Observations were made to reflecting prisms secured to the centre bow and stern of the *MV Pacific Titan*.
The MGC on board navigation system was set to log raw un-corrected gyro compass headings for Gyro 1 (Simrad HS50) and Gyro 2 (Tokyo Keiki AD100) at one second intervals. Two rounds of synchronized observations were taken every 30 seconds between 4:01 and 4:31 (UTC) on 29 November 2005; and between 3:32 and 4:02 (UTC) on 1 December 2005, whilst the vessel was moored alongside Henderson Wharf. The first set of observations was taken whilst the ship was on a heading of 270°, with two Total Stations set over stations DC01 and DC04 referenced to DC06 and DC02 respectively. A second set of observations was conducted with the ship on a heading of 090°, with two Total Stations set over stations DC01 and DC02 referenced to DC03. The vessel had been tied up alongside the wharf for two hours prior to each set of observations, allowing each gyro compass to settle. Raw values for the gyro compass were entered onto the calculation sheets as the observed true heading (O). Observations to the prisms located at the bow and stern were used to compute the calculated vessel heading (C). The calculated vessel heading (C) was compared to the observed vessel heading (O) to determine the calculated minus observed (C-O) value for each gyro compass. The C-O determines the correction to be added to the gyro compass raw output values.
The Gyro Compass Calibration - Dual Total Station Method sheets for Gyro 1 (Simrad HS50) and Gyro 2 (Tokyo Keiki AD100) are shown in Appendix E of the calibration report.

RGPS Tailbuoy Unit Verification

RGPS verification for the tailbuoy units was conducted between 9:20 (UTC) and 11:00 (UTC) on 28 November 2005. Eight tailbuoy units were setup on Henderson Wharf. A range and bearing was then taken from DC03, using DC01 as the RO, to each tailbuoy. A position for each unit was then computed. Results can be found in summary of results, overleaf. Range and bearing of the tailbuoys from the V1G1 DGPS antenna were logged at 30 second intervals. These values were then reduced to produce observed coordinates which were compared to the actual coordinate to give a C-O for each of the tailbuoys.

The RGPS Tailbuoy Verification results for each of the tailbuoys are shown in Summary of Results section on the next page.

Summary of Results

Gyro Compass Calibration

Corrections for the Gyro are shown

	Gyro 1 (Simrad HS50)		Gyro 2 (Tokyo Keiki AD100)	
	Mean C-O	**SD**	**Mean C-O**	**SD**
Heading090°	0.88°	±0.51°	2.26°	±0.83°
Heading 270°	1.32°	±0.52°	1.21°	±0.62°
Final C-O	**1.10°**		**1.74°**	

Differential GPS

The mean Calculated minus Observed (C-O) values for the Differential GPS verifications are shown below

System	Mean C-Om (E)	SD	Mean C-Om (N)	SD
V1G1	0.0	±0.04	0.1	±0.04
V1G2	0.1	±0.06	0.1	±0.04
V1G3	0.7	±0.34	2.3	±0.38
V1G4	0.6	±0.34	0.9	±0.38
V1G5	0.5	±0.14	0.7	±0.16

RGPS Tailbuoy Unit Verification

In total eight tailbuoys were checked, the results of which are shown in Table 4-3.

Tailbuoy	Easting (C O)	SD	Northing (C O)	SD
V1R2	0.2	±0.89	1.8	±0.82
V1R3	2.3	±0.59	1.2	±1.08
V1R4	1.7	±0.32	0.1	±0.37
V1R5	0.2	±1.08	0.1	±1.49
TB1R1	1.7	±1.28	0.5	±1.67
G1R1	1.3	±0.38	0.2	±0.39
G1R2	1.4	±0.59	0.9	±0.65
G1R3	0.3	±0.76	0.7	±0.42

TABLE 4-3: RGPS TAILBUOY VERIFICATION

The observations and results of each unit are shown in the Tailbuoy Verification results sheets provided in Appendix F of the calibration report.

SURVEY EQUIPMENT AND PERSONNEL

Equipment

Survey equipment used for the calibration of the *MV Pacific Titan* was as follows:

Fugro Equipment

2 x Wild TC1010 Total Stations
2 x Tripods
8 x Prisms
2 x 30m Tape Measures
2 x Laptop Computers

MV Pacific Titan Equipment

5 x DGPS Navigation Systems
1 x Simrad HS50 Gyro
1 x Tokyo Keiki AD100 Gyro
8 x RGPS Tailbuoy Pods

Personnel

Fugro personnel involved in the calibration operations were as follows:

M. Yorath Party Chief/Surveyor 28 November - 1 December 2005
L. Arrowsmith Surveyor 28 November -29 November 2005
J. McCawley Surveyor 1 December 2005
MGC was represented during the calibrations by:
M. White Chief Navigator 28 November – 1 December 2005

ECHOSOUNDER CALIBRATION - m/v. PACIFIC TITAN

Alongside:- **Hobart Fuel Dock** (after taking on fuel Bunkers).
Taken in position: **42° 50' 40.8" S 147° 19' 50.0" E**

Date: **30 May 06**

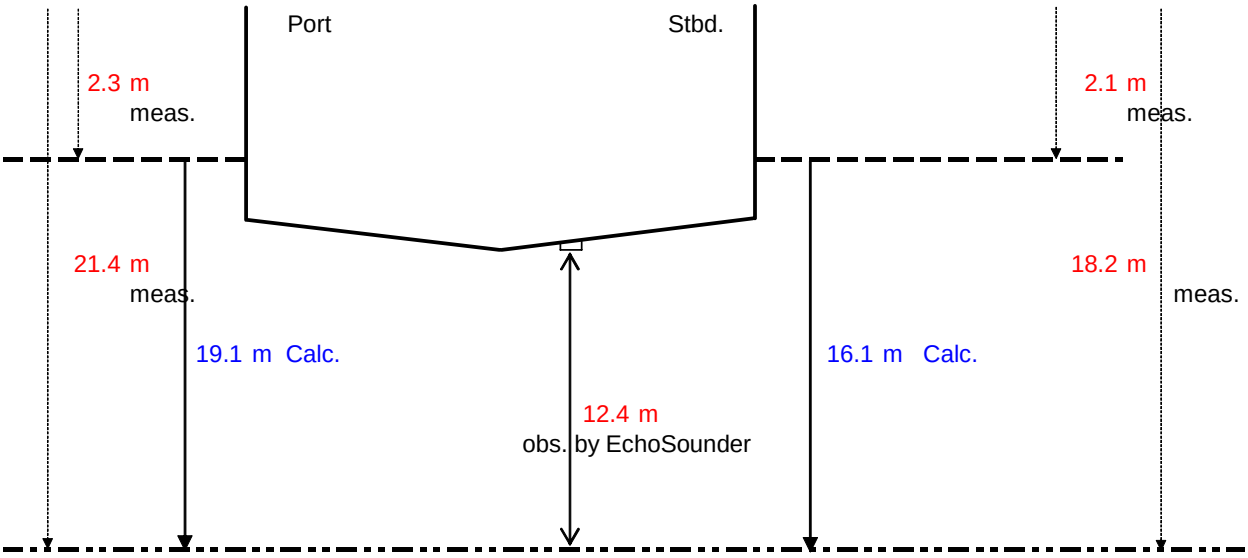
Time: **20:15** GMT **6:15 Local Time**

Job: **6251**

Client: **Santos / Essential / Oilex**

Measurements taken:- metres

Port Freeboard	**2.3**	Stbd Freeboard	**2.1**
Port Lead-Line	**21.4**	Stbd Lead-Line	**18.2**
EchoSounder Reading	**12.4**	Fwd Draught marks:	**5.1**
Time	**20:15**	Aft Draught marks:	**5.5**



Draught Marks:
Aft : 5.5 m
Forward : 5.1 m Theoretical Draught = 5.3 m

Electronic Depth + Theoret. Draught = 17.7 m
True Measured Water depth = 17.6 m

Difference = 0.1 m

TEXT = Measured
TEXT = Calculated
TEXT = Observed
TEXT = Results

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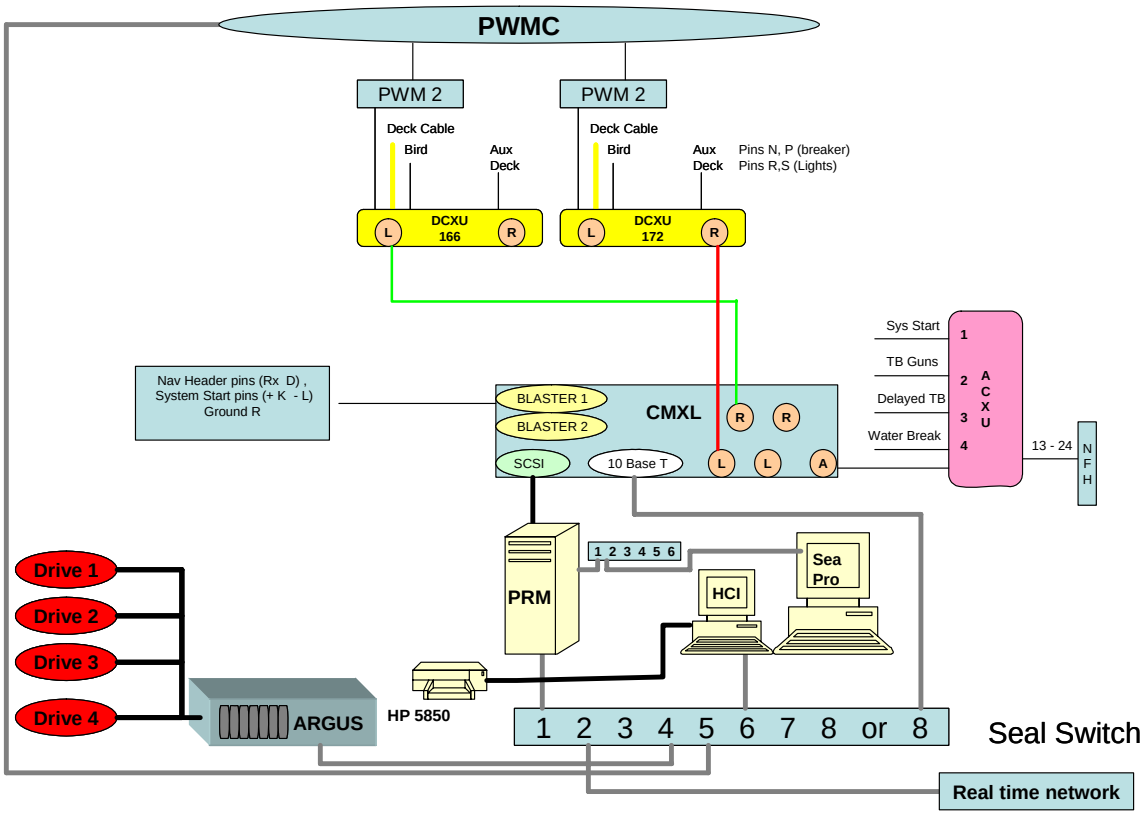
1. Instrumentation and QC System Description



Unit Type	Manufacturer	Software version
Recording	Sercel Seal	Version 5.0.15
Argus	Profocus: Raid disk and data management	Version 4.0
Tape drives	IBM 3590E	
Plotter	Versatech 24inch	
Onboard QC	Seal Seapro QC and ARGUS QC	Version 4.0.8
Source Controller	Seamap Gunlink2000	Version 2.3.0
Auxiliary Systems	48 channel Appended to port strm.	
Bird Controller	Digicourse DMU + PC	Sys 3v01
Bird Type	Digicourse 5011E	Sys 3v01

2. Instrumentation and QC tests

2.1. Start-up tests

Before the beginning of the survey started, and after the streamer was deployed, a complete set of instrument tests was performed.

These tests were as follows:

Instrument tests
1 Harmonic distortion
2 System noise
3 Common mode rejection ratio
4 Gain error/ phase error
5 Cross talk

Sensor tests
6 Hydrophone capacitance
7 LF cut-off
8 Leakage resistance

The start of contract tests were recorded to tape, and sent to the processing centre together with the seismic data. The result of the Start of Job Instrument test was good with 1 channel failing Cut Off (Hz).

2.2. Additional client tests

Polarity tests were carried out at the start of contract and verified on Promax.

2.3. Daily Instrument and Sensor tests

The daily instrument and streamer test consisted of the same 8 tests which were used to verify Seal and Streamer performance at the Start and throughout the contract. Results were printed out daily and also recorded to Tape at start-up and end of contract. These tests were run daily to confirm that the Seal recording system and streamer performance were in specification.
The series of tests results showed the recording system to be in specification throughout the survey. The overall system performance was stable throughout the survey with test performance repeatable from day to day.

2.3.1. Seal tests performed daily

The following page shows the tests performed daily and their results.

Instrument tests
1 Harmonic distortion
2 System noise
3 Common mode rejection ratio
4 Gain error/ phase error
5 Cross talk

Sensor tests
6 Hydrophone capacitance

7 LF cut-off
8 Leakage resistance

2.3.2. Seal system and streamer test results

	System tests						Sensor tests			
Date	HD	Sys noise	CMRR	Gain err	X talk odd	X talk even	Cap	LF cut-off	Leakage	Remarks
23-Jun-06	OK	OK	OK	OK	OK	OK	OK	1	OK	SOJ Test. Ch. 97 fails cut off
24-Jun-06	OK	OK	OK	OK	OK	OK	OK	1	OK	Ch. 97 fails cut off
25-Jun-06	OK	OK	OK	OK	OK	OK	OK	1	OK	Ch. 97 fails cut off
26-Jun-06	OK	OK	OK	OK	OK	OK	1	1	OK	EOJ Test Ch. 97 fails cut off / Ch. 105 fails Capacitance

End of job test
At the end of the Discovery Geo survey a complete set of instrument tests was performed. These tests were as follows:

Instrument tests
1 Harmonic distortion
2 System noise
3 Common mode rejection ratio
4 Gain error/ phase error
5 Cross talk

Sensor tests
6 Hydrophone capacitance
7 LF cut-off
8 Leakage resistance

The tests listed above were recorded to tape, and sent to the processing centre together with the Seismic data.

The result of the End of Job Instrument test was good, with 1 channel failing Cut Off (Hz) and 1 failing Capacitance (nF).

The overall Seal and Solid streamer system performance was stable and repeatable throughout the survey.

2.3.3. QC Processes

Seismic Observer QC displays

Seal system QC displays showing shot records and rms residual noise were used to monitor seismic data shot by shot. RMS levels were colour scaled to give good visual assessments to the operator of sea and swell noise effects on the streamer.

QC products and processing sequence

A Promax system was in use during the survey to further monitor the quality of the Seismic data, and to produce Gathers, Brute and Raw stacks.

2.3.4. Production tape logs

Client	Essential Petroleum						BOX	1
Area	Otway Basin, Victoria, Australia							
Survey	2D Seismic Survey						Vessel	M/V Pacific Titan
Job #	6251							
Date	Line Name	Tape	Seq	FF	LF	FSP	LSP	Comments
23 June 2006	OEP06-11-P001	1	1	979	2119	981	2118	SOL/Complete
24 June 2006	OEP06-13-P002	2	2	979	1929	981	1928	SOL/Complete
24 June 2006	OEP06-15-P003	3	3	979	1698	981	1697	SOL/Complete
24 June 2006	OEP06-17-P004	4	4	979	1738	981	1737	SOL/Complete
24 June 2006	OEP06-19-P005	5	5	979	1878	981	1877	SOL/Complete
24 June 2006	OEP06-21-P006	6	6	979	1996	981	1995	SOL/Complete
24 June 2006	OEP06-23-P007	7	7	979	1879	981	1878	SOL/Complete
25 June 2006	OEP06-25-P008	8	8	979	1677	981	1676	SOL/Complete
25 June 2006	OEP06-02-P009	9	9	979	2166	981	2166	SOL
25 June 2006	OEP06-02-P009	10	9	2167	2416	2167	2415	Line Complete
25 June 2006	OEP06-05-P010	11	10	979	1818	981	1817	SOL/Complete
25 June 2006	OEP06-09-P011	12	11	979	2166	981	2166	SOL
25 June 2006	OEP06-09-P011	13	11	2167	2185	2167	2184	Line Complete
25 June 2006	OEP06-07-P012	14	12	979	2120	981	2119	SOL/Complete
26 June 2006	OEP06-03-P013	15	13	979	2136	981	2135	SOL/Complete
26 June 2006	OEP06-01-P014	16	14	979	2166	981	2166	SOL
26 June 2006	OEP06-01-P014	17	14	2167	2222	2167	2221	Line Complete
26 June 2006	SOJ-EOJ-TEST	18		1	12			Test Passed
End of Survey								

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1 Onboard Processing Personnel and System

Operators

23rd June 2006 - 26th June	:	Emma Buckingham	Multiwave, Chief Field Geo
		Mylene Militante	Multiwave, Trainee Geo

Hardware Description

Machines	:	1 x SuperMicro (2x3.2GHz CPU, 4.0 GB RAM)
Monitors	:	2 x 19" LCD Monitor
Hard Disk Drives	:	1.5 TB internal RAID Disk & 70 GB internal Disk
Tape Drives	:	2 x IBM 3590 tape drives
Plotters	:	1 x Isys V24 24" Thermal Plotter

Software Description

Processing software	:	ProMAX2D version 2003.12.1Patch 1
Operating System	:	Linux Red Hat Enterprise WS 3.0 Update 6
Plotting software	:	ZehPlot Express 4.6

2 Objectives

2.1 Geophysical Objectives

The survey comprised of 14 lines covering approximately 370 kilometres of full fold data acquired off the coast of Victoria, Australia. The purpose of this survey was to increase the knowledge and understanding of the Otway Basin.

2.2 Processing Objectives

The main objective of the onboard QC processing was to assess the impact of noise in the data, to check for problems associated with acquisition and recording on a line-by-line basis and to give an overall impression of the data quality.

Various QC methods, including RMS noise displays, single and multi-trace displays, gun hydrophone channels and stacks were to be used to assess compliance with various acceptance criteria and to isolate any other acquisition issues.

The general aim of the QC processing was not to attenuate noise but to show the data as it was recorded, or how it would be presented to a shore or vessel based processing centre. A brute stack was produced every line with minimal processing to enable a thorough QC of the data onboard. In addition to brute stack processing, gun hydrophone channels were checked to QC the performance of the source. Raw shot, near trace and various RMS displays were also generated and examined to identify any noise problems.

3 Processing Sequence

3.1 Parameter Testing

Parameter testing was limited to checking suitability of the parameters on the first sequence. Thereafter only minor adjustments were done in regards to changing of mutes.

3.2 Main Seismic Processing Parameters

Upon completion of a line, the 'original' tape was read to confirm the integrity of the tape. All SEG-D data on this tape was extracted from tape and written to the ProMAX system disk. A listing of the field file (FFID), shot point number (SP) and number of channels was printed to clearly identify any lost shots or shots with missing navigation headers.

The streamer consisted of 150 meter solid SEAL sections containing 12 channels each, and the survey was acquired with an active length of 6000m, i.e. 480 channels. All data, including all 480 seismic channels, start of line noise records and auxiliary channels (-1 to –21), were input to a record length of 8000ms. A bulk shift static correction was applied to the data to correct for the 50ms instrument delay of the recording system.

A simple 2D geometry was applied to all the seismic trace data, and offset / CDP binning calculations were then loaded into the seismic trace headers

The data was re-sampled from 2 ms to 4 ms, with a minimum phase, high fidelity anti-alias filter applied prior to resample.

Trace editing involved killing any bad traces or shots based on observer log comments and results of the QC.

To balance the shot records, true amplitude recovery using a spherical divergence correction was used and applied to the shot record.

Minimum phase deconvolution and Band pass filtering were also applied to the data, prior to NMO and stacking.

3.3 Velocity Work

Velocities were picked for every line at a 2 km intervals using ProMAX's interactive velocity analysis package. This comprised of a semblance display with rms stacking velocity graph and interval velocity graph, CDP super gather panel and function stack panels. To improve the signal to noise ratio, super gathers were formed by combining fifteen adjacent CDP gathers. Stack panels were created from these 15 CDP's using 15 functions varying +/- 25% from the regional velocity function.

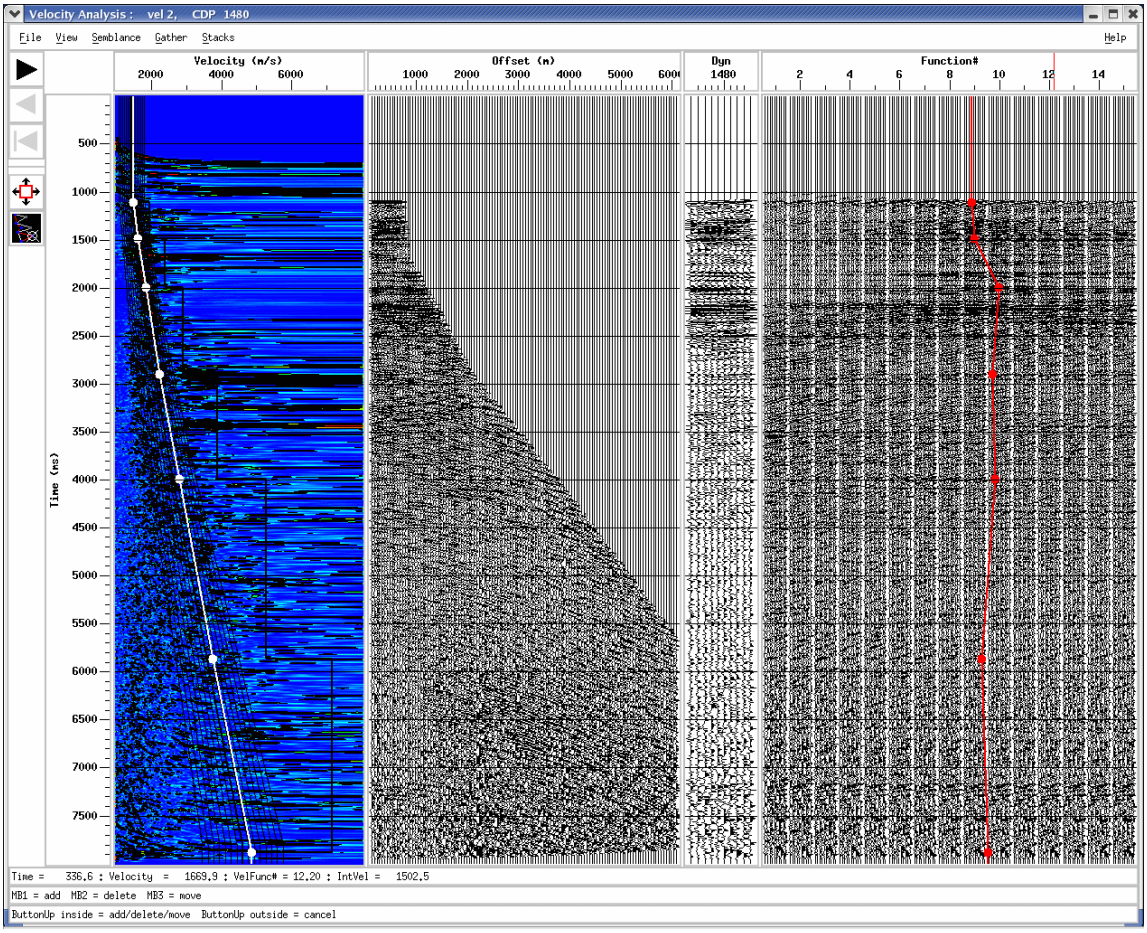

Figure 1.Velocity analysis interface with semblance, super-cdp gather and function stacks. Line OEP06-05-P010.

To speed up the on screen velocity picking procedure the velocity analysis displays were pre-computed. Normal move-out was applied to the gather to check that the events were lining up well.

NMO corrected gathers were also displayed on screen both at and between velocity locations for further verification.

After velocity picking, velocities were viewed and QC'd on screen using the ProMAX velocity viewer module, which provided an iso-velocity display together with rms stacking velocities. This module was most useful for editing any stray velocity picks. NMO corrected gathers were also displayed on screen both at and between velocity locations for further verification.

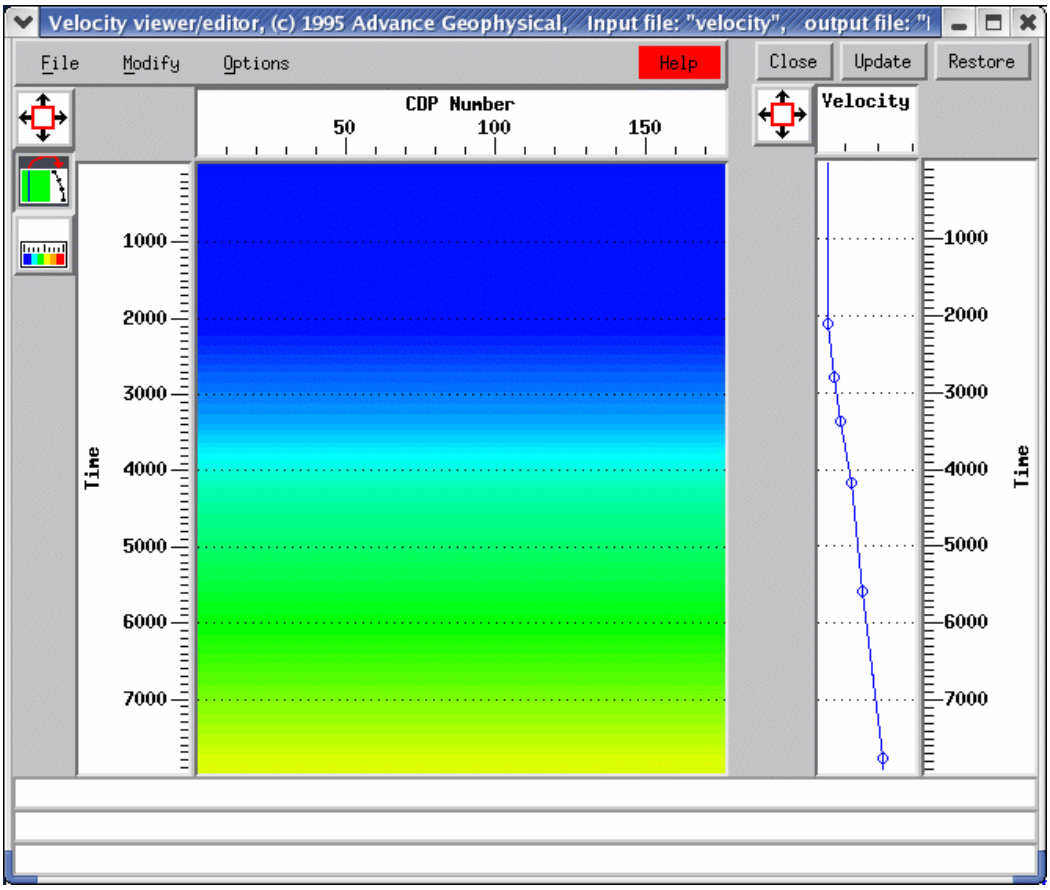

Figure 2. Iso-velocity display in ProMAX velocity viewer. Line OEP06-05-P010.

3.3.1 CDP Gather Displays

CDP gathers were regularly displayed on screen to QC the velocities after NMO correction and ascertain the impact of swell noise and cable impacts on the pre-stack data. The CDP gathers were NMO corrected using the picked RMS stacking velocities.

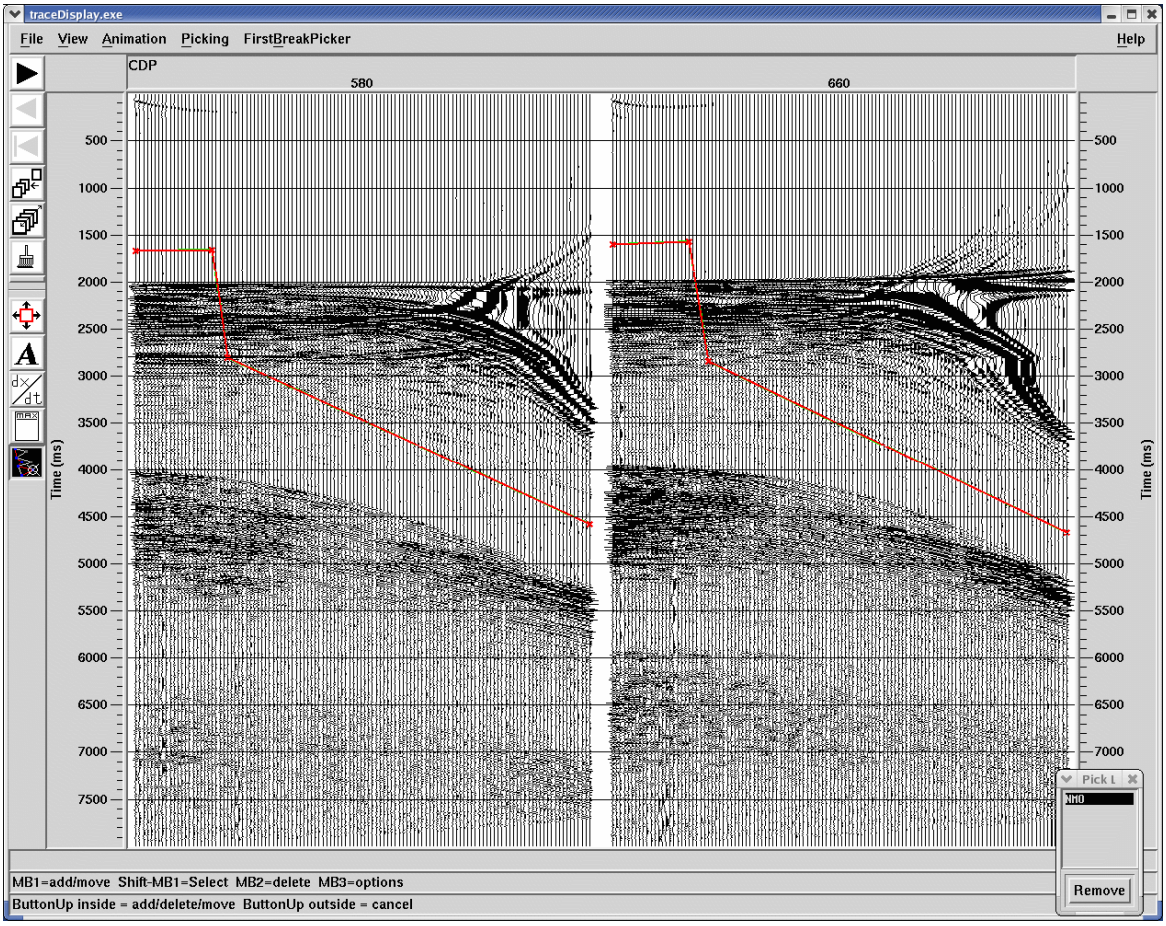

Figure 3. CDP gather to confirm the velocity picks. Note strong multiples present for most of the lines during this survey. Line OEP06-02-P009

3.3.2 Brute Stack

Brute stacks were produced as soon as possible after each line and presented to the onboard client to assess the noise impact on the data.

Prior to stacking, the data went through a minimum phase predictive de-convolution with 240ms operator length and 24ms prediction distance.

De-convolution was followed by a 3-90 Hz minimum phase Butterworth band pass filter, to clean up low frequency noise, and any high frequency noise introduced by the de-convolution operator.

A straight mean vertical stack algorithm was used for CDP stacking, with a root power scalar for normalization of 0.5.

A bulk shift static correction was applied post-stack to correct for the gun and cable depths. Filtering was limited to a 3-90 Hz broadband filter.

The brute stacks were then output to SEG-Y file, captured to jpg, plotted to paper and saved to CGM format files. The brute stack headers contain all relevant CDP and line information.

The hardcopy and CGM file brute stack contained an additional post stack 3-90Hz filter, followed by Time Variant Scaling.

An average Shot RMS from a shallow time window was plotted along the top of the stack to monitor ambient and external noise levels. A 3Hz low cut filter was applied to the data prior to RMS computations.

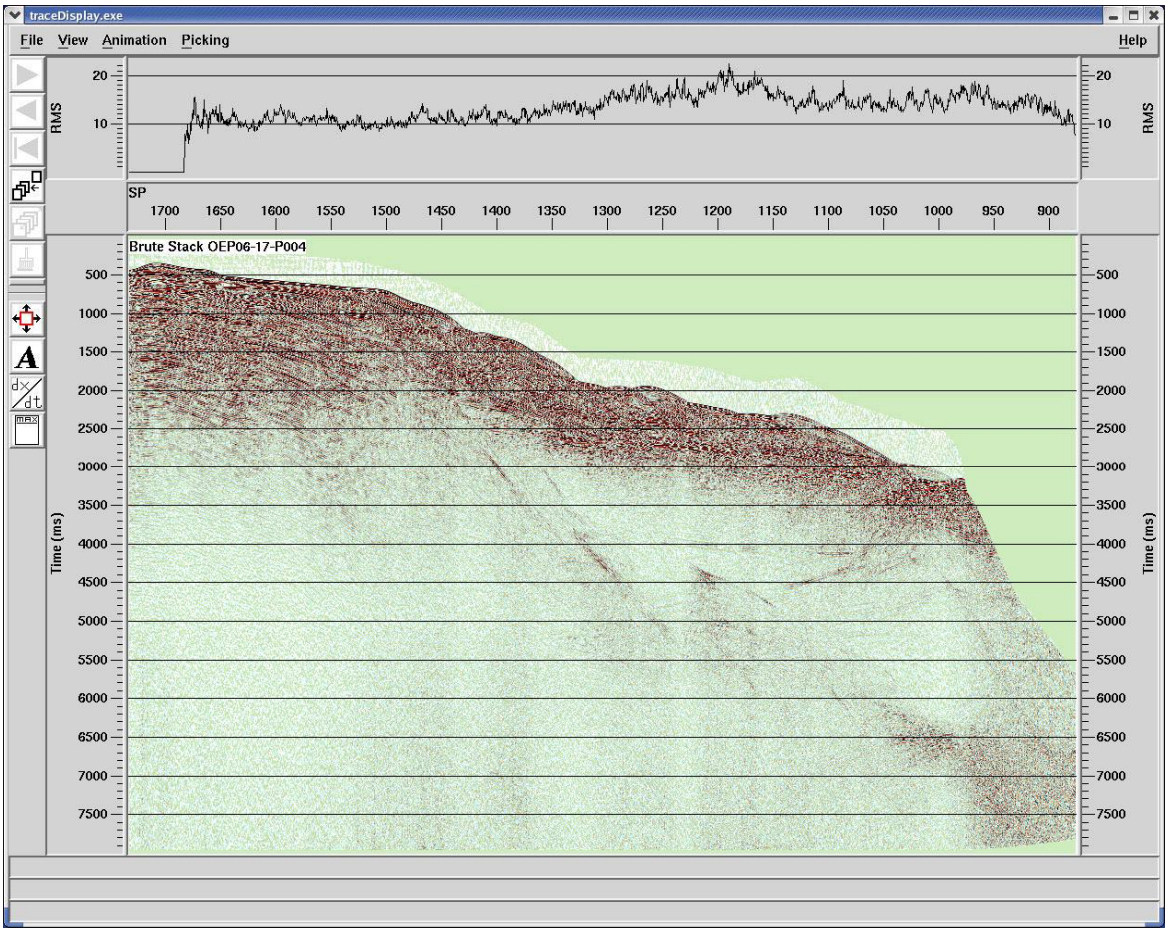

Figure 4. Brute stack. Line OEP06-17-P004.

3.4 Processing Flow & Quality Control

3.4.1 Quality Control of Processing Steps

At every stage of the processing sequence the data was QC'd on screen to ensure that there were no problems. RMS analyses were used to check for noisy or spiking channels. The final QC involved close examination of the brute stack.

Processing Flow Chart

Processing-flow	QC-flow	Description	QC
SEG-D Input from 3590 tape		Reformat all files to ProMAX internal format, 8000ms @2ms sample rate, 480 channels + 21 aux channels	FFID – SP integrity SEG-D Nav headers
	Noise Record	Start of line, ambient RMS	On screen display GIF
	Shot gather	Every 160th	On screen display
	Direct RMS	On screen	On screen display GIF
	Shot Vs Chan Colour RMS Analysis	Ambient noise, in shallow and deep window.	On screen display GIF
	Auxiliary Channels	On screen QC. Aux channels 1-21	On screen display
	Near Traces	1st trace of every shot	On screen display GIF
Static shift		-50ms to correct for instrument delay	
Resample / Desample		From 2ms to 4ms. Hi-Fi anti-alias filter applied	
2D Marine Geometry		Applied to trace headers	
Band-pass Filter		Butterworth, minimum phase, 3-90Hz	
	Navigation P190 merge	Near traces plotted along with P190 derived first break headers for QC.	On screen display
True Amplitude Recovery		Spherical divergence 1/ t*V2 using regional velocities.	
	Velocity Analysis	Every 2km, iterated as necessary. Semblance view, cdp gather and 10 function stacks	On screen ASCII velocity files
Trace/shot edit		Based on obs logs and QC observations	
Deconvolution		Min phase 240ms operator length, 24ms prediction distance	
Band-pass Filter		Butterworth, minimum phase, 3-90Hz	
NMO correction		Using picked velocities	
	CDP gathers	Every 2km	On screen

↓ Top mute		Picked from CDP gathers	
↓ CDP stack		Mean root power scaling for normalization 0.5	
↓ Gun/cable static		+8ms	
↳	Brute Stack	Traces balanced for on screen display.	On screen JPEG SEGY CGM Paper Plot

3.5 Acquisition QC Processing

3.5.1 Noise Record and Channel RMS

The noise records were displayed at the start of every line for QC. Channel RMS values were computed for all 480 channels over the entire record for noise analysis.

Swell noise was the most frequently identified noise anomaly during this survey. There was sometimes evidence of front end noise and some tail buoy jerk, which was occasionally visible on the noise records.

For every sequence one noise record screen display was captured and archived to GIF file.

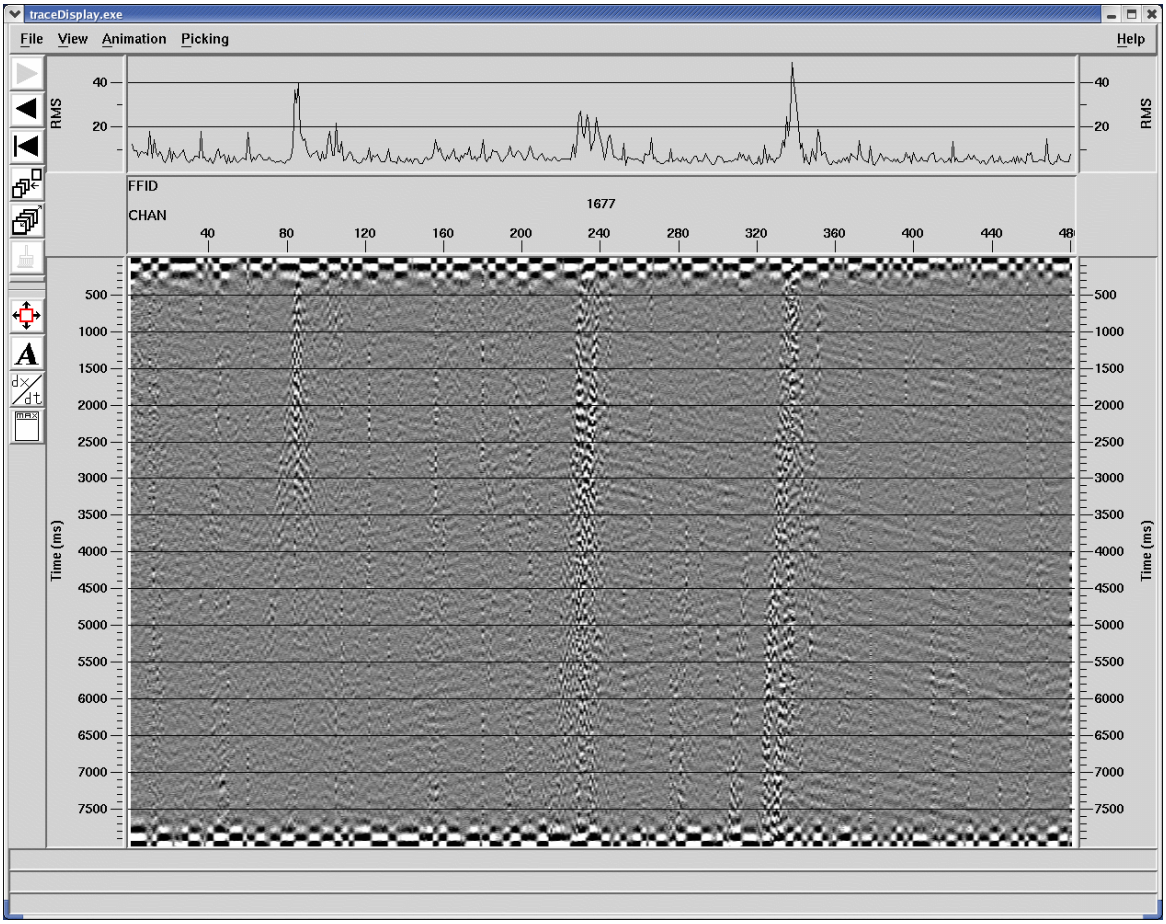

Figure 6. Noise Record and Channel RMS. Line OEP06-25-P008.

3.5.2 Ambient noise - Shot Versus Channel Colour RMS Amplitude Display

Colour displays of shot vs. channel RMS values were produced for every line. Raw data with a sample rate of 2 ms was used to calculate the RMS values for every channel on every shot. A deep window of 7450-7950ms was used for calculation of RMS values.

A shallow window RMS was also reviewed on screen, but was not as useful as it was difficult to avoid the high amplitude direct arrivals and refracted events in the shallow water.

For all RMS computations a scaling factor of 46.5 was used to convert from millivolts to microbars.

The shallow and deep colour RMS displays were viewed on screen, and screen images were then saved as GIF files. The displays are useful in showing noise trends along the line such as swell noise, noisy/bad channels, bird noise, cable tug, front end noise, cable strikes, auto-fires and misfires, multiple interference, etc. The on screen analysis also allowed the exact shot and channel location of any noise trend to be located and investigated. The average RMS value for each sequence was noted in the QC log spreadsheet.

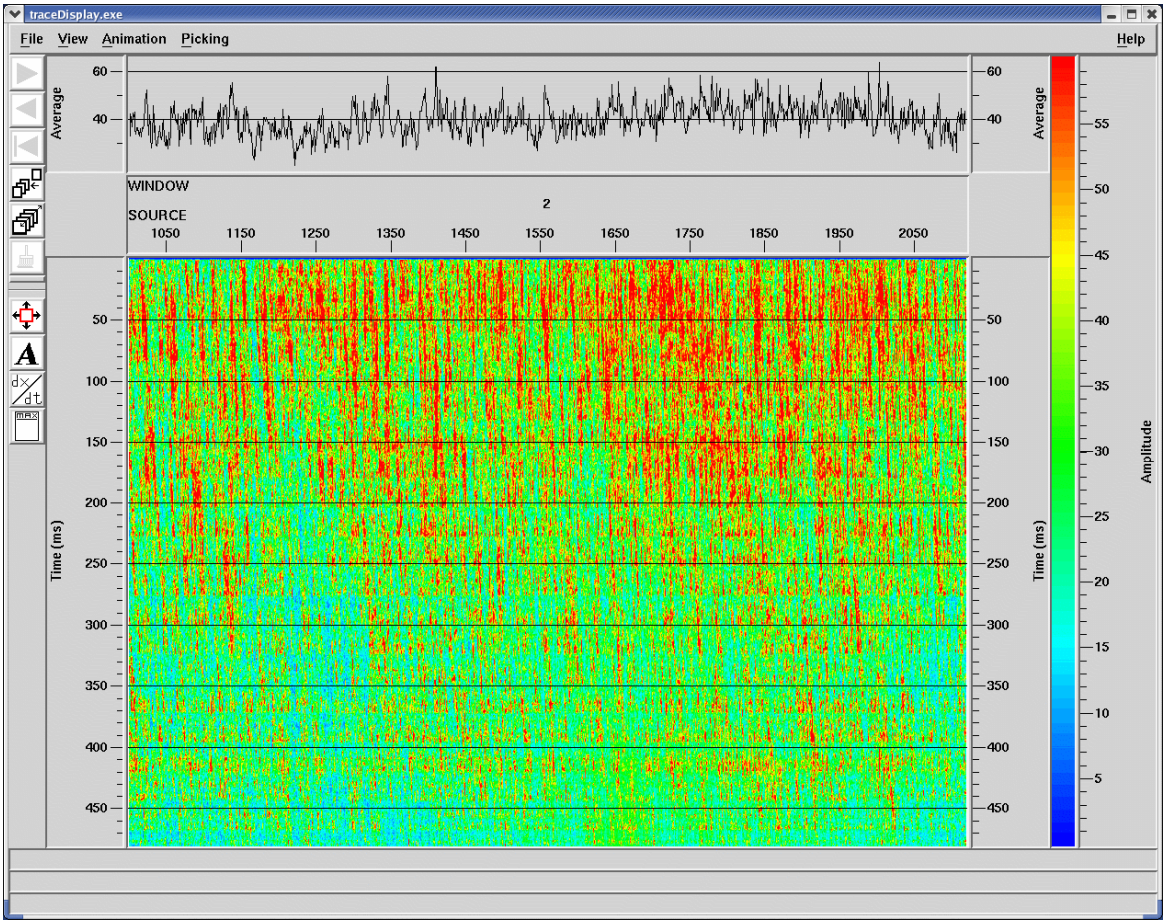

Figure 7. Example above of a line containing swell noise. Ambient noise - shot vs. channel colour RMS Amplitude display, Deep Window, Line OEP06-11-P001.

3.6 Near Trace Display

Near traces were displayed on screen for every line in order to quickly determine any possible errors with acquisition, e.g. gun volume changes, bad records, time-break problems and any auto-fires not reported by the recording system. The near traces also provided a good indication of the geological conditions including strength of the water bottom multiples, residual seismic multiple energy, front end noise and swell noise contamination.

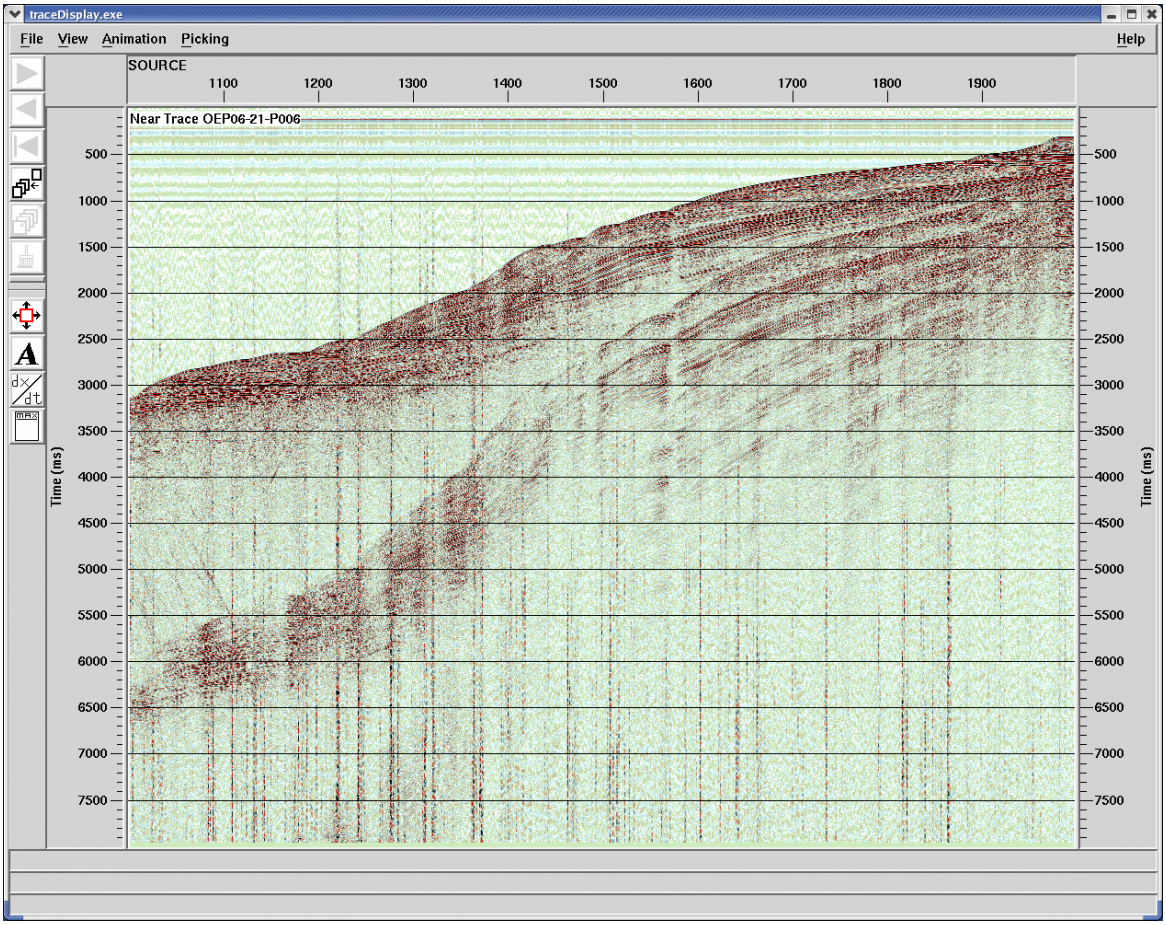

Figure 8. Near trace display. Line OEP06-21-P006.

3.6.1 Auxiliary Channel QC

The 21 auxiliary channels loaded during the SEG-D read, were separated from the 480 data channels, stored in a separate data file, and used for on screen analysis. These records consisted of the time break, the water break, and 9 near-field hydrophones for the three gun sub-arrays.

Time break and water break channels were displayed as a single trace display on screen.

Each gun hydrophone was also displayed as a single trace display on screen. Additionally, the first 250ms of the 3 hydrophones from a single sub-array were stacked vertically and displayed. This proved useful in determining whether spurious signals were genuine gun timing problems or just electrical noise on the signal.

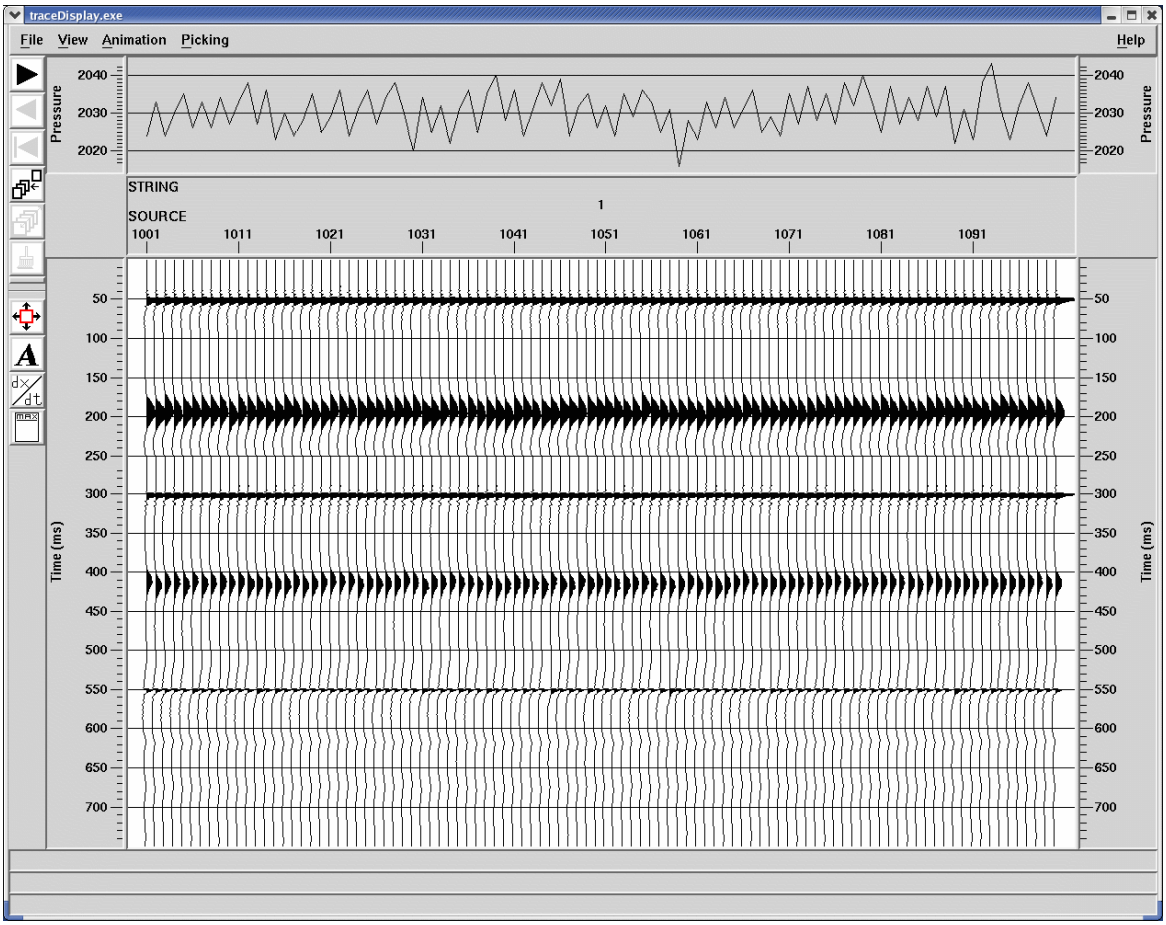

Figure 9. Near Field Hydrophones. Gun Array 1. Line OEP06-05-P010.

An additional colour amplitude display of the gun hydrophone channels was also found to be very useful in identifying gun problems. All anomalies were cross-checked against the Observers Logs and Gun QC Logs.

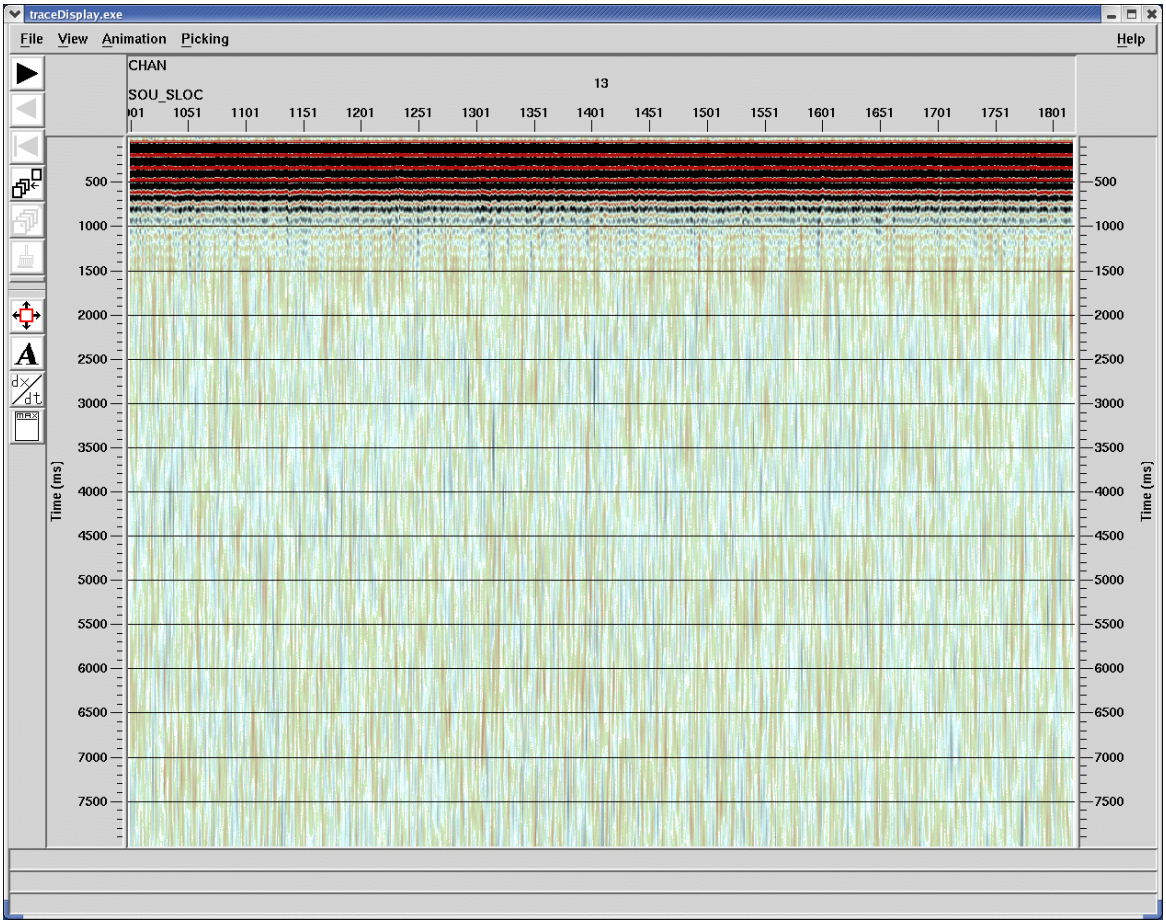

Figure 10. Near Field Hydrophones. Channel 13 = Gun Array 1. Line OEP06-05-P010.

3.6.2 Shot Record Displays

Shot records were filtered to the signal bandwidth and balanced with a true amplitude gain recovery. They were displayed on screen at 4 km intervals for each line. Individual records were examined on screen if an issue with acquisition was suspected, such as noise, residual seismic energy or auto-fires. The colour RMS displays were used to pinpoint bad/suspicious shots, whose shot gathers were subsequently investigated on screen.

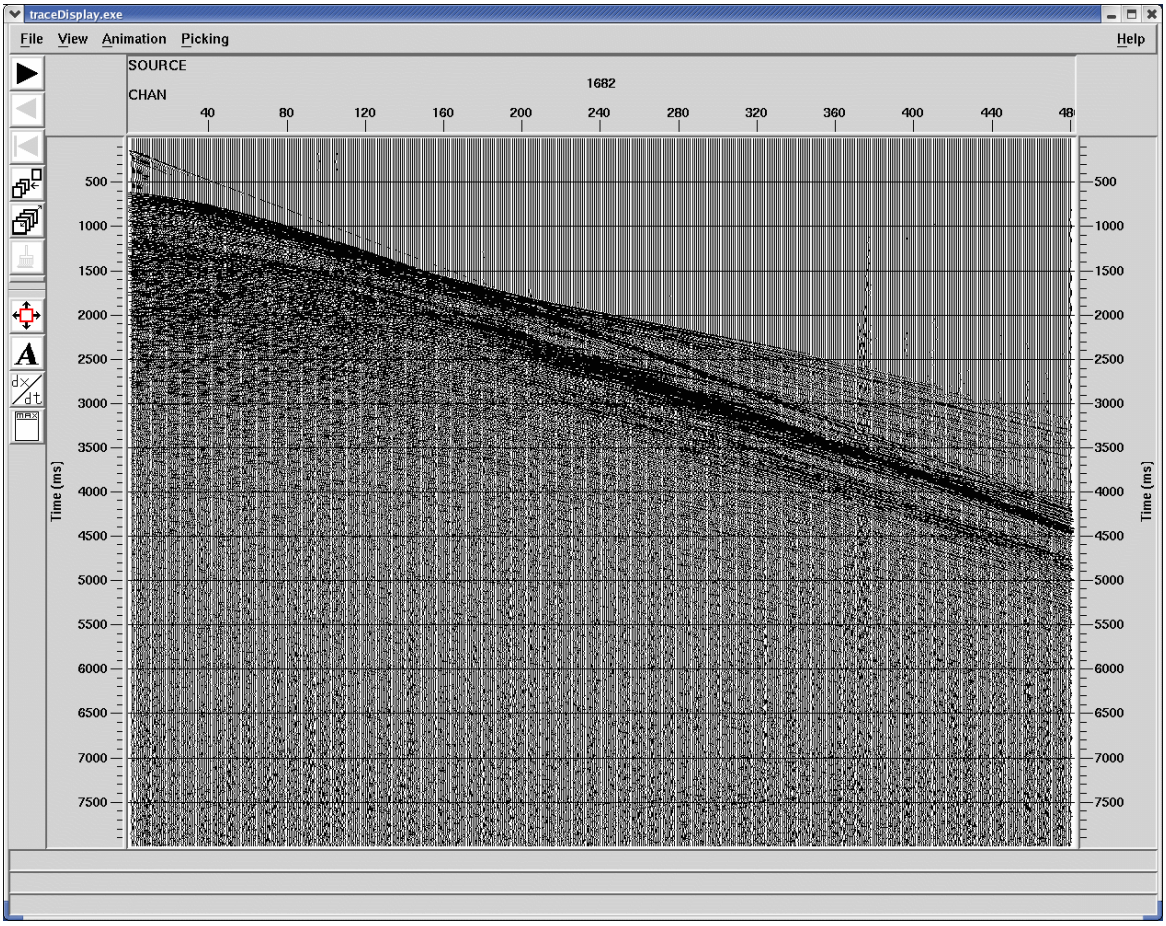

Figure 11. Shot gather. Line OEP06-05-P010.

The raw shot displays could also be used to estimate the amplitude and amount of any external noise on the 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.

3.6.3 Direct Arrival RMS

A direct arrival source RMS was also output to check the source energy for the direct arrival. The direct arrival energy was graphically displayed together with the average operating pressure of the guns. The example below shows a corresponding decrease in amplitude due to a decrease in gun pressure.

Normally these displays show little variance between each shot. However, due to the shallow water, the direct arrival and water bottom reflection were mixed creating far higher values than normal on some lines. Also, the amplitude varied according to water bottom geology.

Vessel speed is another factor which can cause fluctuations in direct arrival amplitude and pressure.

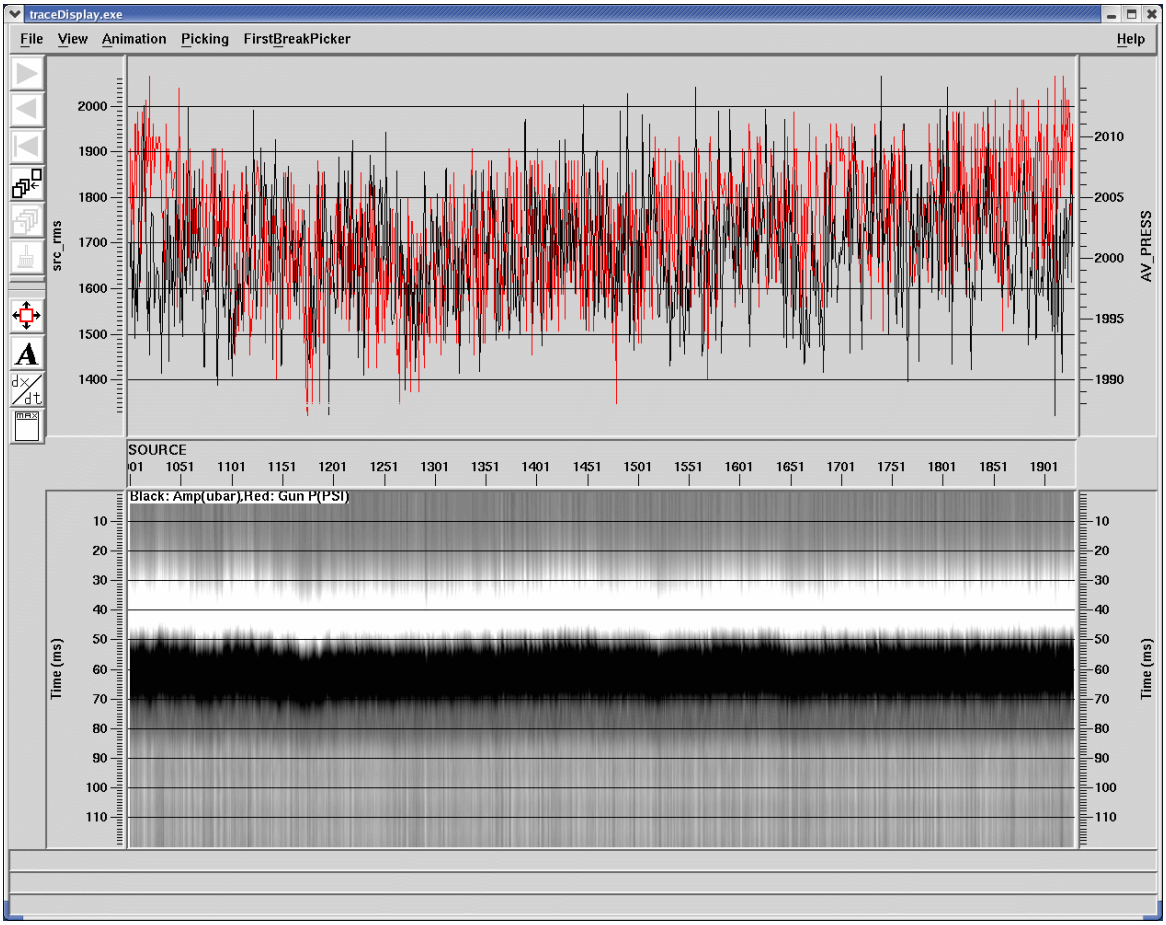

Figure 12. Direct Arrival RMS. Line OEP06-13-P002.

3.6.4 Additional QC Displays

Spectral analysis displays were generated for occasional lines to evaluate the power and frequency content of the data and noise. FK plots and FT displays were also occasionally displayed.

3.7 Navigation Processing

In order to QC navigation data, the final processed P190 navigation files were merged with the near trace. The theoretical first break time was then computed using a water velocity of 1516m/s overlaid on the near trace as seen below.

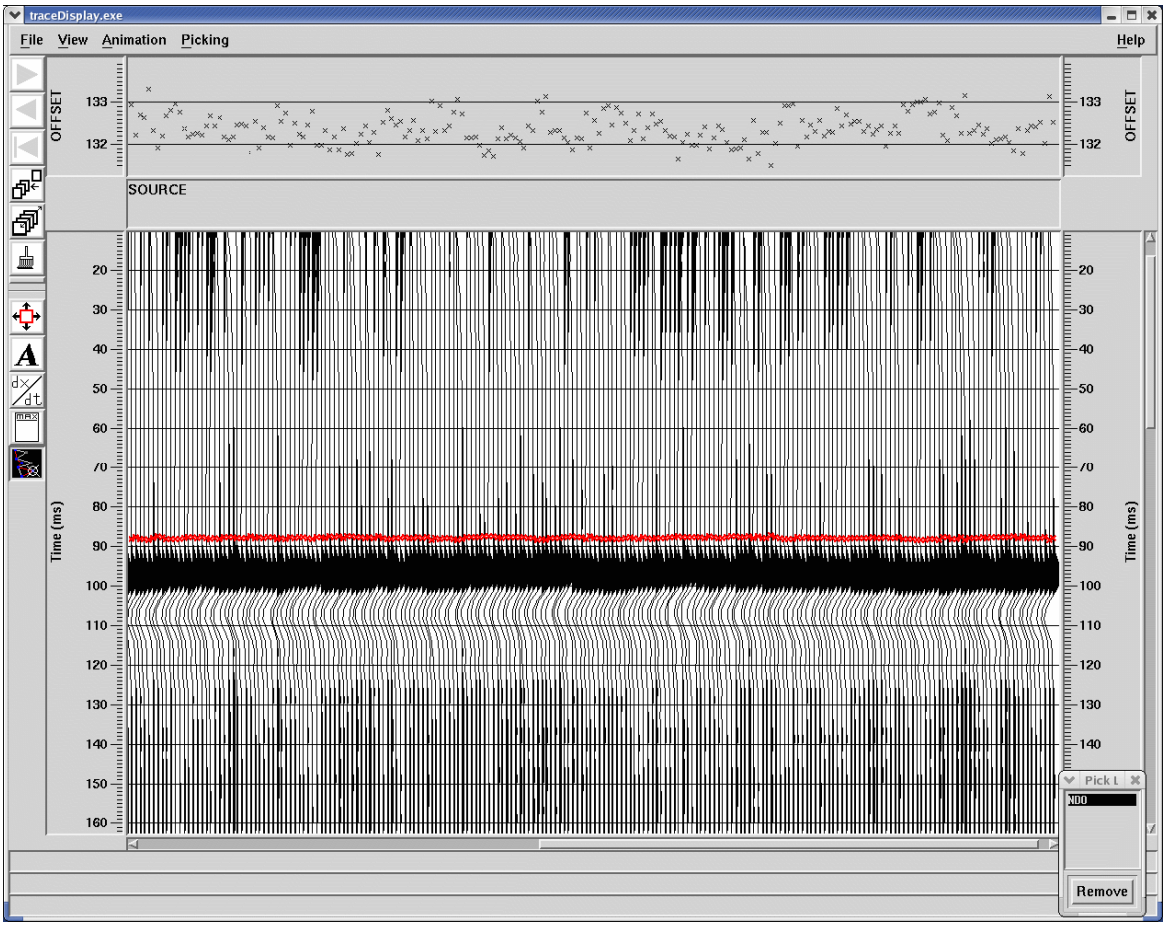

Figure 14. QC of consistency between first breaks and navigation derived first breaks (red). Line OEP06-23-P007.

4 Summary

The weather condition during the survey consisted of good to marginal weather. Most lines contained swell noise, varying in intensity though not severe enough to affect the stack data. Swell noise affecting a line had up to an average of 70µbar on the worst affected line. Due to swell and sea conditions the streamer depth was set to 8m (deeper than the nominal 7m) for sequence 005 onwards for the survey. At 8m there was better streamer control and less affect due to the sea state and swell noise.

Swell was the main source of noise, with also bend noise affecting some sequences due to boat steering, strong currents and short line run-ins. Average ambient noise levels were generally of 25-30µbar with the max rms of 70µbar due to excessive swell noise present. The RMS history picture provides a good visualization of noise levels throughout the prospect.

Seismic reflections were good with some refracted arrivals and diffractions visible on stacks. Strong water bottom multiples and reverberations were also present, though otherwise stacks exhibited good clean data. Swell noise did not have a big influence on the stacks, as the noise was found to be cancelled out.

5 Appendices

5.1 ProMAX QC Log

Line Information															Displays					Comments
															Screengrab					
Seq	Line	Date	Dir	SPs	CDPs	SEGD Input	Noise Records	Raw Shot Display	Near Trace QC	RMS Shot V Chan	Auxiliary QC	Trace Decimation & Edits	Velocity Analysis	NMO Gather Display	Stack	RMS Deep Window	Direct Arrival RMS	Near Trace	Stack	Ambient Noise (Ubar)	Data Quality Comments
001	OEP06-11-P001	23.06.06	211°	1001-2118	241-2714	X	X	X	X	X	X	X	X	X	X	X	X	X	X	27-63	Average RMS 40ub. Swell noise bursts throughoutline. Good data on stack, some remnants of multiple aliasing evident around cdp: 1200+1500 at 4 Secs.
002	OEP06-13-P002	24.06.06	031°	1001-1928	241-2334	X	X	X	X	X	X	X	X	X	X	X	X	X	X	23-65	Bend noise from SOL-1455 seen in rms. Swell noise throughout line with average rms 30ub. Good stack data.
003	OEP06-15-P003	24.06.06	211°	1001-1697	241-1872	X	X	X	X	X	X	X	X	X	X	X	X	X	X	26-83	Swell noise increasing towards EOL. Average RMS 45ub.
004	OEP06-17-P004	24.06.06	031°	1001-1737	241-1952	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33-79	Swell noise decreasing towards EOL. Average RMS 40ub. Large swell burst of average RMS 70ub around SPs 1130 to 1270.

005	OEP06-19-P005	24.06.06	208°	1001-1877	241-2232	X	X	X	X	X	X	X	X	X	X	X	X	X	X	36-71	Strong swell noise throughout line with average rms 40ub. Chan 362 noisy from sp 1641 - EOL. Streamer set to 8m.
006	OEP06-21-P006	24.06.06	028°	1001-1995	241-2468	X	X	X	X	X	X	X	X	X	X	X	X	X	X	18-58	Chan 362 noisy for line. Swell noise decreasing towards EOL with am average rms of 30ub. Streamer set to 8m
007	OEP06-23-P007	24.06.06	203°	1001-1878	241-2234	X	X	X	X	X	X	X	X	X	X	X	X	X	X	18-53	Swell noise throughout line. Average rms of 30ub. Chan 362 slightly noisy. Streamer set to 8m
008	OEP06-25-P008	25.06.06	016°	1001-1676	241-1830	X	X	X	X	X	X	X	X	X	X	X	X	X	X	15-40	Average rms of 25ub for line, with swell noise bursts throughout line. Streamer set to 8m
009	OEP06-02-P009	25.06.06	306°	1001-2415	241-3308	X	X	X	X	X	X	X	X	X	X	X	X	X	X	11-21	Minimal swell noise throughout line. Average rms of 17ub with occasional swell burst increasing the rms maximum. Streamer set to 8m
010	OEP06-05-P010	25.06.06	030°	1001-1817	241-2112	X	X	X	X	X	X	X	X	X	X	X	X	X	X	10-27	Streamer set to 8m. Average rms 15ub. Energy from deep water bottom multiples and diffractions affecting deep window rms from SOL-1400. Minimal bursts of swell evident.
011	OEP06-09-P011	25.06.06	211°	1001-2184	241-2846	X	X	X	X	X	X	X	X	X	X	X	X	X	X	16-61	Streamer set to 8m. Bad auxilliary 18 from SP 1123 to EOL, but gun is firing ok. Swell noise increasing from SOL to SP 1650 then decreases towards EOL. RMS average is 30 ub.
012	OEP06-07-P012	25.06.06	031°	1001-2119	241-2716	X	X	X	X	X	X	X	X	X	X	X	X	X	X	13-66	Streamer set to 8m. Bad auxilliary 18 for the whole line. Swell noise present throughout line with average RMS of 40ub.
013	OEP06-03-P013	25.06.06	211°	1001-2135	241-2748	X	X	X	X	X	X	X	X	X	X	X	X	X	X	19-55	Streamer set to 8m. Bad auxilliary 18 for the whole line. Swell noise present throughout line with average RMS of 30ub.
014	OEP06-01-P014	25.06.06	031°	1001-2221	241-2920	X	X	X	X	X	X	X	X	X	X	X	X	X	X	13-42	Streamer set to 8m. Bad auxilliary 18 for the whole line. Swell noise present throughout whole line, with an average rms of 20ub. Bend noise from SOL to sp 1520of avergage rms of 30ub.

5.2 RMS History Display

The following display shows the noise records collected during the survey compressed into a single display.

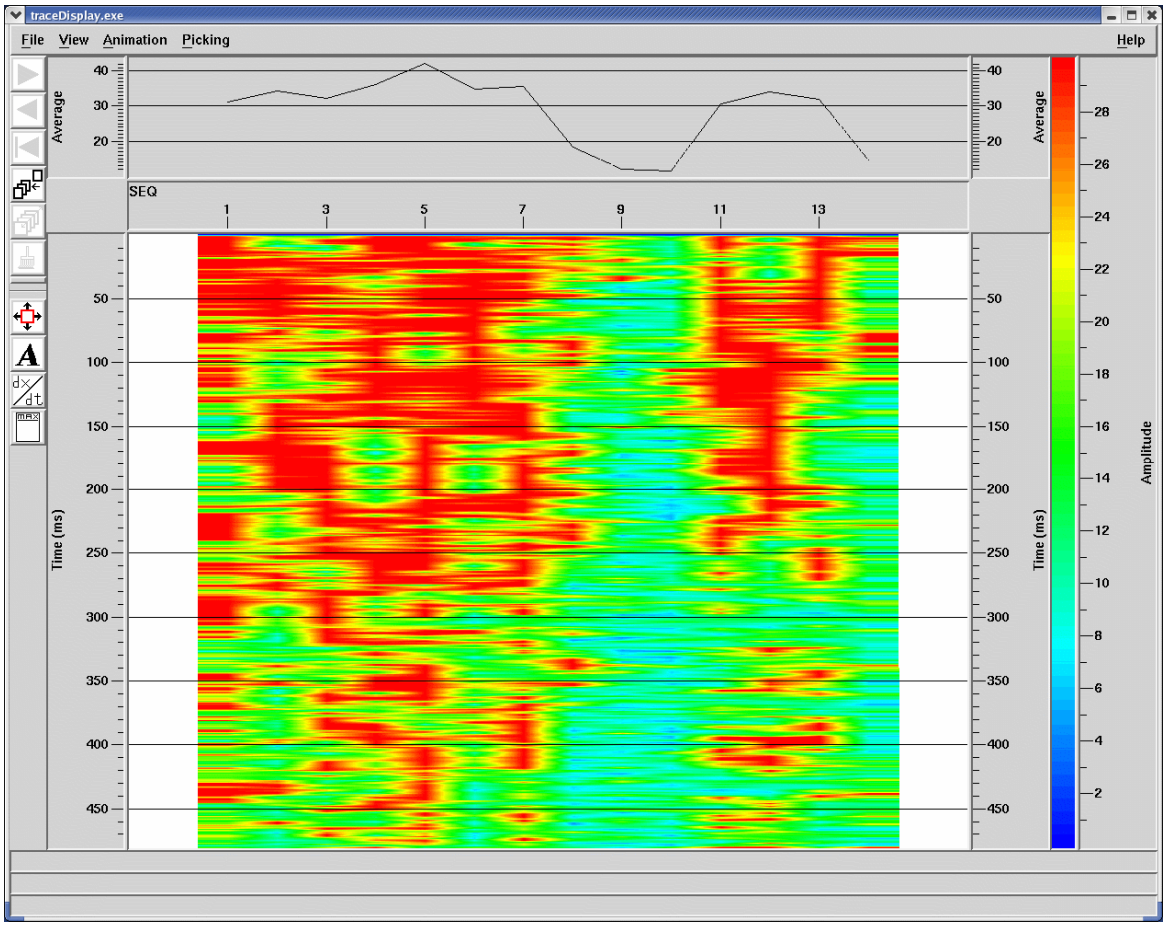

Figure 15. RMS Noise record history display. A good tool for comparing noise levels sequence-to-sequence and identifying faulty channels.

Another similar display to evaluate swell noise levels and noisy channels is shown below. This RMS analysis takes a representative sample of 10 shots from each sequence, and displays them side by side.

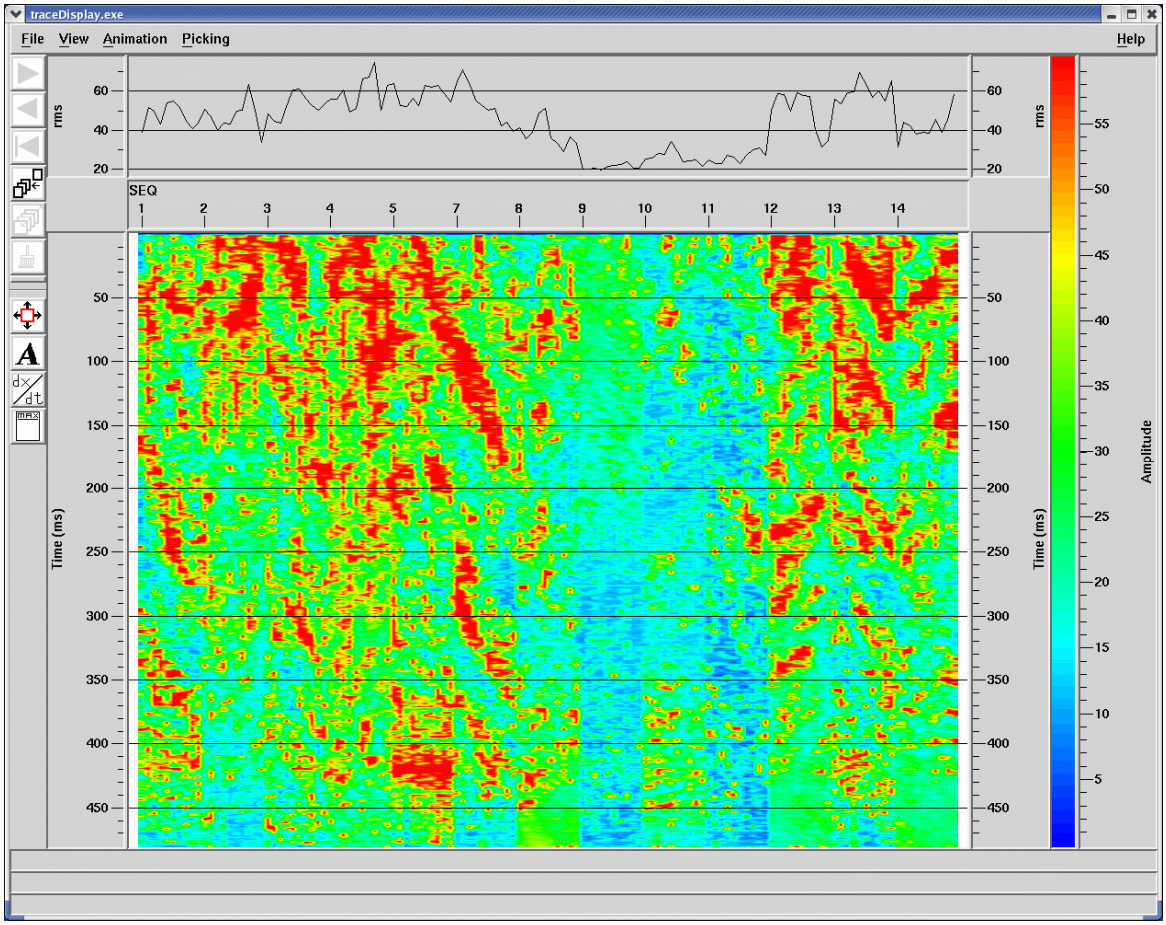

Figure 16. Shot Vs Channel RMS history display.

5.3 Shipment

To:

Essential Petroleum Resources Ltd
Level 2, 226 Albert Rd
South Melbourne
Victoria, 3205
Australia
Att: John Remfry

Shipment PT-2006-053:

Contents:

-Brute stack paper plots, sequences 001-014.

-3590 tape 'UNIX tar' archive, containing stacks (SEGY & CGM) sequences 001-014.

-CD, containing all RMS displays (GIFs), Near Trace displays (GIFs), Noise Record displays (GIFs), Direct RMS displays (GIFs), Brute Stacks (GIFs), RMS History display (GIF), RMS Sequential display (GIF), QC sheet & final velocities (ASCII files) from sequence 001-014.

ESSENTIAL PETROLEUM RESOURCES LTD

Otway Basin, Victoria, Australia

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