FINAL FIELD OPERATION REPORT
MARINE SEISMIC REFLECTION SURVEY

Bass Strait Oil Company Ltd.
Moby, VIC/P47
Gippsland Basin Australia

WesternGeco Job No. 9438

ACQUIRED BY

Western Trident

From January 01st to 15th January, 2005

Report Compiled by Ian Halfpenny, Party Manager

The Survey Parameters and Job Configuration details listed in this report are for the purpose of reporting General information and should not be used for Data Processing Purpose.

Table of Contents

1. Survey Information and Objectives

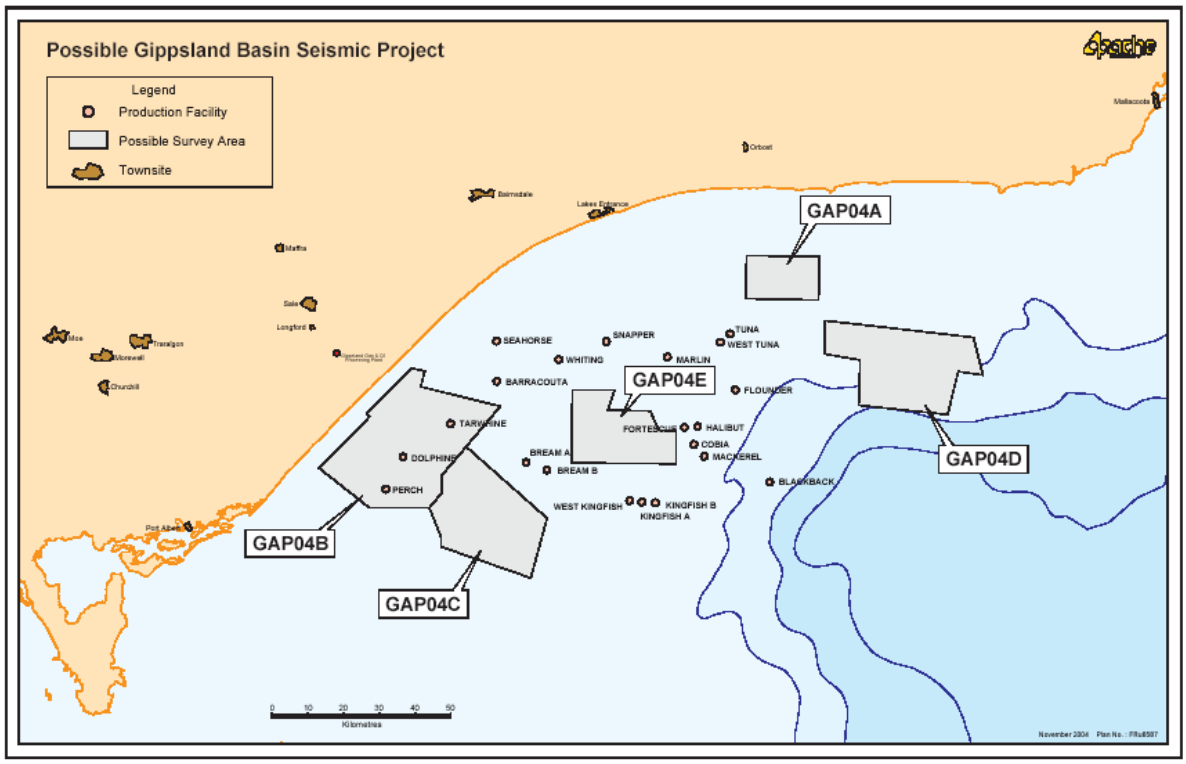
The M/V Western Trident was contracted to undertake a 3D Marine Seismic Survey for Bass Strait Oil Company Ltd in block VIC/P-47, Gippsland Basin, Australia.

The M/V Western Trident towed an in-sea configuration comprising of eight streamers, each 4800m long, with a separation of 100m and a depth of 8m. The energy source comprised of dual 3000 cubic inch sleeve airgun, clustered arrays, towed astern of the vessel at a depth of 7m. The energy was released from alternate arrays every 18.75m along the pre-plotted survey line. The operating pressure of the energy source was 2000 psi.

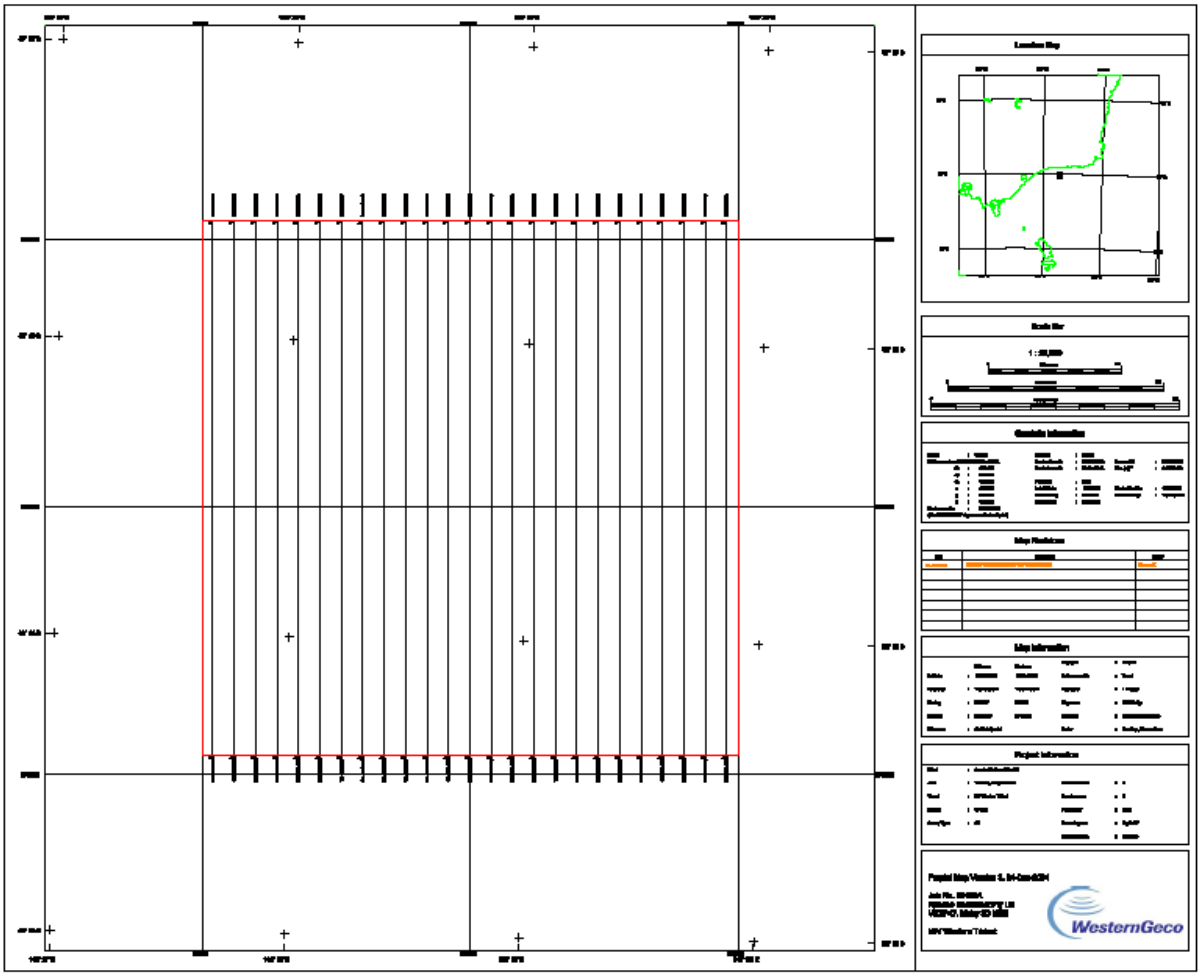
The M/V Western Trident is a purpose built vessel for seismic operations and is one of the largest vessels in the WesternGeco fleet. It was delivered in November 1999. The vessel has carried out many complex 3D surveys in various locations worldwide. It is capable of towing 12 x 6,000 metres of TMS Sentry Solid streamers with a maximum separation of 1,200m when using Monowings.

The vessel is built to DNV+1A1 ICE-1A, EO Helideck classification and to the satisfaction of the rules and regulations of SOLAS 1974. International load line requirements are according to international load line convention of 1966.

2. Area Map


Possible Gippsland Basin Seismic Project
Apache
Legend
Production Facility
Possible Survey Area
Townsite
GAP04A
GAP04B
GAP04C
GAP04D
GAP04E
SEAHORSE
SNAPPER
TUNA
WEST TUNA
WHITING
MARLIN
BARRACOUTA
FLOUNDER
TARWHINE
FORTESCUE
HALIBUT
COBIA
MACKEREL
DOLPHIN
BREAM A
BREAM B
PERCH
BLACKBACK
WEST KINGFISH
KINGFISH B
KINGFISH A
Port Albert
Orbost
Bairnsdale
Lakes Entrance
Maffra
Sale
Longford
Moe
Traralgon
Morwell
Churchill
Mallacoota
0 10 20 30 40 50
Kilometres
November 2004

3. Program Map



4. Job Book

Seismic Job Book
Version: 14

Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	23-Dec-04	cctee
Project Geo name:	**Project Geo email:**	**Project Geo telephone:**
Tee Chee Cherng	cctee@slb.com	+60 3 2730 8844

Survey Objectives

Survey purpose: Field development

Reservoir type:

Project location map (URL):

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9438/Acquisition_Information/Job_Book/Location_Moby_3DMSS.jpg

Targets: Not applicable

Comments:

To delineate the extent of the hydrocarbons encountered in the Moby-1 well drilled in October 2004 by Bass Strait Oil Company Ltd, east of the producing Patricia / Baleen Fields.

The survey will be used to map the identified reservoirs calibrated to the well and the amplitude anomaly on seismic to determine the full extent of this prospective resource over the Moby Structure

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Seismic Acquisition Parameters

General

Client:	APACHE
Vessel(s):	Western Trident
Bid reference:	
Job number:	9438
Contract number:	
Location:	Gippsland Moby VICP47
Country:	Australia (AUS)
Corporation code:	APACHE
Client reference:	
Type of survey:	3D marine streamer
Estimated start date:	29-Dec-04
Estimated duration (days):	14
SuperVISION required:	No
Project Geo:	
name:	Tee Chee Cherng
email:	cctee@slb.com
telephone:	+60 3 2730 8844
Nav supervisor:	
name:	Kumara Krishnasamy
email:	kkrishnasamy@slb.com
telephone:	+60 3 2730 8851

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Seismic Acquisition Parameters

Recording Parameters:

Recording system:	MSX
Recording format:	SegD 8058,Rev 1
Record length (binary sec.):	6.0
Sample rate (ms):	2
Lo-cut recording filter (Hz-dB/Oct):	2-12
Hi-cut recording filter (Hz-dB/Oct):	206-264
Recording system delay (ms):	0
Filter type:	Zero phase
Adjacent trace summation 6.25m to 12.5m:	No
Adjacent trace summation 12.5m to 25m:	No
Record auxiliary channels:	Yes
Dual recording/tape copies	
Group formed tapes:	Yes

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Seismic Acquisition Parameters

Survey Area

Area (km2):	100.0
Average line length (km):	9.94
Number of saillines:	25
Heading (deg):	90.0
Reciprocal heading (deg):	270.0

Streamer Parameters

Cable type:	MSX solid streamer
Module type:	MSX
Number of streamers:	8
Group length (m):	17.75
Number of phones per group:	14
Group interval (m):	12.5
Lo-cut analogue response:	2.5-6
Hydrophone sensitivity (V/B):	14.5
Pre-amplifier gains (dB or mB full scale):	6
Streamer length (m):	4800.0
Streamer depth (m):	7.0
Streamer separation (m):	100.0
Number of groups per streamer:	384
Requested source to receiver offset (m):	As Near As Possible/150

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Seismic Acquisition Product Delivery Information

Product type: Observer Logs (Client-Orig.)

Media: CD

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Observer

Comments:

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Seismic Job Book
Version: 14

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Seismic Acquisition Product Delivery Information

Product type: Observer Logs (Client-copy)

Media: CD

Number of copies: 1

Format: ascii

Ship when: End of survey

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Observer

Comments:

Seismic Job Book
Version: 14

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Tee Chee Cherng	cctee@slb.com	+60 3 2730 8844

Seismic Acquisition Product Delivery Information

Product type: SEG-D Field Tapes (Client-Copy)

Media: 3590

Number of copies: 1

Format: SegD 8058

Ship when: End of survey

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Observer

Comments:

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Seismic Acquisition Product Delivery Information

Product type: SEG-D Field Tapes (Client-Orig)

Media: 3590

Number of copies: 1

Format: SegD 8058

Ship when: When operationally efficient

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Observer

Comments:

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Seismic Acquisition Product Delivery Information

Product type: Tape Logs (Client-Copy)

Media: CD

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Observer

Comments:

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Seismic Job Book
Version: 14

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Ready for review	27-Dec-04	cctee
Project Geo name:	**Project Geo email:**	**Project Geo telephone:**
Tee Chee Cherng	cctee@slb.com	+60 3 2730 8844

Seismic Acquisition Product Delivery Information

Product type: Tape Logs (Client-Orig.)

Media: CD

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Observer

Comments:

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Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	28-Dec-04	kkrishnasamy
Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Parameters

Acquisition Geodetic Parameters

Work datum:

Work datum name:	GDA 94
Spheroid name:	GRS80
Semi major axis (m):	6378137.0
Inverse flattening (1/f) (m):	298.257222

Datum Transformation From WGS 84 to Local Datum (Bursa Wolf Convention):

dX (m):	0.0
dY (m):	0.0
dZ (m):	0.0
rX (arc secs):	0.0
rY (arc secs):	0.0
rZ (arc secs):	0.0
Scale (ppm):	0.0
Projection type:	UTM
Zone:	55S
Central meridian:	147° 0' 0.0"
Scale factor:	0.9996
False easting (m):	500000
False northing (m):	10000000
Latitude of origin:	0° 0' 0.0"

Datum Transformation and Test Point

Latitude in WGS 84:	-38° 1' 28.209"
Longitude in WGS 84:	148° 32' 17.157"
Northing in WGS 84:	5790350.0
Easting in WGS84:	635000.0
Latitude in local datum:	-38° 1' 28.209"
Longitude in local datum:	148° 32' 17.157"
Northing in local projection (m):	5790350.0
Easting in local projection (m):	635000.0

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Positioning Acquisition Parameters

Magnetic Variation and Geoidal Height

Location of prospect centre, latitude: -38° 1' 28.209"
Location of prospect centre, longitude: 148° 32' 17.157"
Magnetic variation: 0.0
Annual magnetic variation change: 0
Source of variation data: IGRF2000
Geoidal height data (m):
Source of geoidal height data: EGM96
Date for which values calculated:

Vessel Positioning

Integrated navigation system: TriNav 2.6

Primary navigation system:

Navigation system: Cnav
RTCM delivery system: Global Monitoring
Delivery method: Inmarsat
Survey and differential company: C&C Technologies
Contact person: Terry Tay , terry.tay@cctechnol.com
DGPS reference stations:

Via Global network
Contact details (in Singapore):
Terry Tay
Tel: +65 62959738
Mob: +65 91276385
Email: terry.tay@cctechnol.com

(Global 24-hr support):
Tel: +1 (337) 261-0660
email: cnav.support@cctechnol.com

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Positioning Acquisition Parameters

Vessel Positioning Continued

Secondary navigation system:

Navigation system: Fugro Multifix 4

RTCM delivery system: Global Monitoring XP

Delivery method: Inmarsat / Spotbeam

Survey and differential company: Furgo Survey

Contact person: Avezac, D Rene, rdavezac@FUGRO.com.sg

DGPS reference stations:

Via Global Monitoring
Skyfix NCC In Singapore
Tel: +65 6863 0604 (24-hr/365 days per year hotline)
Email: skyfix@omnistar.com.sg

Starfix NCC in Perth, Australia
Tel: +61 89 321 0284, +61 89 322 5295 (24-hr/365 days per year hotline)
Email: ncc@fugro.com.au
Tel: +65 6863 0604 (24-hr hotline)
Email: Skyfix Singapore <skyfix@omnistar.com.sg>

Tertiary navigation system:

Navigation system: Trinav GPS 2.6

RTCM delivery system: Fugro Skyfix

Delivery method: Inmarsat

Survey and differential company: Fugro Survey

Contact person: Singapore Network Control Centre (24hrs) +65 6863 0604

DGPS reference stations:

Please use all available Referance stations:
Adelaide
Sydney
Melbourne

Skyfix NCC In Singapore
Tel: +65 6863 0604 (24-hr/365 days per year hotline)
Email: skyfix@omnistar.com.sg

Starfix NCC in Perth, Australia
Tel: +61 89 321 0284, +61 89 322 5295 (24-hr/365 days per year hotline)
Email: ncc@fugro.com.au

Seismic Job Book
Version: 14

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Ready for review	28-Dec-04	kkrishnasamy
Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Parameters

Additional notes:

Both the Magnetic variation and Geoidal Height to be calculated onboard. See onboard Magnetic Variation spreadsheet mwwd/f043. The coordinates provided in the jobbook is the centre of prospect in GDA94 datum. Due to the limitation of the JB Tool all geograhical notations in the JB are in S and E.

No changes in datum transformation trail point because the datum has very minimal difference between GDA94 and WGS84 which is not critical for this survey.

No Gravity and Magnetic survey were required for this project.

Tidal information is yet to be confirmed by client.

No Sippican deployment is needed.

Note:
- Kindly notify Nav Supervisor once the Mag Dec value has been computed on board, so that the JB can be updated with the computed values.

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Positioning Acquisition Parameters

Gravity and Magnetics:

Gravity meter type: Not required

Gravity recording interval (sec):

Interface to navigation systems:

Interface to echo sounder:

Gravity sub-contractor:

- **name:**
- **email:**
- **telephone:**

Magnetometer type: Not required

Magnetometer recording interval (m):

Magnetometer sub-contractor:

- **name:**
- **email:**
- **telephone:**

Comments:

Gravity and Magnetics not requried for this survey

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Positioning Acquisition Parameters

Known Obstructions:

Based on the admiralty chart there are two buoys (Patricia & Baleen) with light on the Western boundary of the survey.

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Positioning Acquisition Parameters

Preferred Shooting Plan:

To be decided onboard and during startup meeting

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Positioning Acquisition Parameters

Streamer Parameters

Positioning:

Source surface positioning:	POSNET
Front-net in-sea positioning:	DigiCOURSE
Mid-streamer in-sea positioning:	DigiCOURSE
Tail-net in-sea positioning :	DigiCOURSE
Full streamer IRMA network:	No
Tailbuoy surface positioning:	Posnet
Compass bird type:	DigiCOURSE
Distance between adjacent compasses (m):	300

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Positioning Acquisition Parameters

3D Parameters:

Steering point: All offsets groups
Reference point for firing: First CMP

Water Depth and Processing

Minimum water depth (m): 40.0
Maximum water depth (m): 70.0
Echosounder standard velocity (m/s) 1500.0
Echosounder standard draft (m): 0.0
Vertical datum:
Apply velocity corrections in processing: Yes
Apply draft corrections in processing: Yes
Apply tidal corrections in processing: No
Tidal corrections source: To be confirmed by client
Supplied tidal file:

Tidal Prediction Settings

Standard port name:
Zo (m):
Seasonal variation (m):
Time zone:
Standard port
co-tide (s) / co-range (m): /
Survey area
co-tide (s) / co-range (m): /

M2 Phase (deg):	**M2 Amplitude (m):**
S2 Phase (deg):	**S2 Amplitude (m):**
K1 Phase (deg):	**K1 Amplitude (m):**
O1 Phase (deg):	**O1 Amplitude (m):**
F4 Phase (deg):	**F4 Amplitude (m):**
F6 Phase (deg):	**F6 Amplitude (m):**

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Positioning Acquisition Product Delivery Information

Product type: Nav PC Job Files (Office Copy)

Media: CD

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Attn: Edward Loh / K. Kumara
WesternGeco Support Services Sdn Bhd
11th Floor, Rohas Perkasa
8 Jalan Perak
50450 Kuala Lumpur
Malaysia
Tel: 60 3 2730 8800
Fax: 60 3 2715 5188

Notification upon shipment:

Edward Loh/Kumara

Shipped by:

Chief Navigator

Comments:

1x Office Copy containing Nav PC Job Files

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Positioning Acquisition Product Delivery Information

Product type: Other Office Deliverables as per TWI

Media: 3590

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Attn: Edward Loh / K. Kumara
WesternGeco Support Services Sdn Bhd
11th Floor, Rohas Perkasa
8 Jalan Perak
50450 Kuala Lumpur
Malaysia
Tel: 60 3 2730 8800
Fax: 60 3 2715 5188

Notification upon shipment:

Edward Loh/Kumara

Shipped by:

Chief Navigator

Comments:

1x Office Copy, using unix 'tar' command

Seismic Job Book
Version: 14

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Ready for review	28-Dec-04	kkrishnasamy
Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Product Delivery Information

Product type: P190 (Client Copy)

Media: 3590

Number of copies: 1

Format: ascii

Ship when: End of survey

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Navigator

Comments:

1x Client Copy of P190 Nav Data, using unix 'tar' command

Seismic Job Book
Version: 14

Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
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Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Product Delivery Information

Product type: P190 (Client Original)

Media: 3590

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Navigator

Comments:

1x Client Original of P190 Nav Data, using unix 'tar' command

Seismic Job Book
Version: 14

Job number:	Client:	Location:
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Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Product Delivery Information

Product type: P190 VSE (Client Copy)

Media: CD

Number of copies: 1

Format: ascii

Ship when: End of survey

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Navigator

Comments:

One copy on CD

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Positioning Acquisition Product Delivery Information

Product type: P190 VSE Record Only (Office Copy)

Media: CD

Number of copies: 1

Format: ascii

Ship when: End of survey

Shipping address:

Attn: Edward Loh / K. Kumara
WesternGeco Support Services Sdn Bhd
11th Floor, Rohas Perkasa
8 Jalan Perak
50450 Kuala Lumpur
Malaysia
Tel: 60 3 2730 8800
Fax: 60 3 2715 5188

Notification upon shipment:

Edward Loh/Kumara

Shipped by:

Chief Navigator

Comments:

1x Office copy on CD ROM

Seismic Job Book
Version: 14

Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	28-Dec-04	kkrishnasamy
Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Product Delivery Information

Product type: P190(Office Copy)

Media: 3590

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Attn: Edward Loh / K. Kumara
WesternGeco Support Services Sdn Bhd
11th Floor, Rohas Perkasa
8 Jalan Perak
50450 Kuala Lumpur
Malaysia
Tel: 60 3 2730 8800
Fax: 60 3 2715 5188

Notification upon shipment:

Edward Loh/Kumara

Shipped by:

Chief Navigator

Comments:

1x Office Copy of P190 Nav Data, using unix 'tar' command

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Seismic Job Book
Version: 14

Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	28-Dec-04	kkrishnasamy
Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Product Delivery Information

Product type: P294 (Client Copy)

Media: 3590

Number of copies: 1

Format: ascii

Ship when: End of survey

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Navigator

Comments:

1x Client Copy of P294 Nav Data, using unix 'tar' command

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Seismic Job Book
Version: 14

Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	28-Dec-04	kkrishnasamy
Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Product Delivery Information

Product type: P294 (Client Original)

Media: 3590

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Bass Strait Oil Company
Level 25, 500 Collins Street
Melbourne Victoria 3000

Notification upon shipment:

TBA

Shipped by:

Chief Navigator

Comments:
1x Client Original of P294 Nav Data, using unix 'tar' command

Seismic Job Book
Version: 14

Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	28-Dec-04	kkrishnasamy
Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Product Delivery Information

Product type: P294(Office Copy)

Media: 3590

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Attn: Edward Loh / K. Kumara
WesternGeco Support Services Sdn Bhd
11th Floor, Rohas Perkasa
8 Jalan Perak
50450 Kuala Lumpur
Malaysia
Tel: 60 3 2730 8800
Fax: 60 3 2715 5188

Notification upon shipment:

Edward Loh/Kumara

Shipped by:

Chief Navigator

Comments:

1x Office Copy of P294 Nav Data, using unix 'tar' command

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Seismic Job Book
Version: 14

Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	28-Dec-04	kkrishnasamy
Nav Supervisor name:	**Nav Supervisor email:**	**Nav Supervisor telephone:**
Kumara Krishnasamy	kkrishnasamy@slb.com	+60 3 2730 8851

Positioning Acquisition Product Delivery Information

Product type: Raw current meter data (Office Copy)

Media: CD

Number of copies: 1

Format: ascii

Ship when: When operationally efficient

Shipping address:

Attn: Edward Loh / K. Kumara
WesternGeco Support Services Sdn Bhd
11th Floor, Rohas Perkasa
8 Jalan Perak
50450 Kuala Lumpur
Malaysia
Tel: 60 3 2730 8800
Fax: 60 3 2715 5188

Notification upon shipment:

Edward Loh/Kumara

Shipped by:

Chief Navigator

Comments:

1x Office Copy of raw Current Meter data

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Seismic Job Book
Version: 14

Job number:	Client:	Location:
9438	APACHE	AUS / Gippsland Moby VICP47
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	28-Dec-04	kkrishnasamy
Project Geo name:	**Project Geo email:**	**Project Geo telephone:**
Tee Chee Cherng	cctee@slb.com	+60 3 2730 8844

Source Acquisition Parameters

Source type:	Tuned sleevegun array
Number of source arrays:	2
Source array separation (m):	50.0
Inline stagger required:	No
Shotpoint interval per source (m):	37.5
Array volume per source (In3):	3000.0
Operating pressure (psi):	2000
Source depth (m):	7.0
Number of subarrays per source:	4
Subarray separation (m)	6
Number of airguns per subarray:	8
Subarray length (m):	15.1
Gun timing specification (ms):	1.25
Alternatively fired sources (flip-flop):	Yes
Source control system:	SSS
CMS required:	No
Record nearfields:	Yes
Type of filter applied to signature:	
CMS filter delay (ms):	
CMS recorded to:	
Total SCFM required at 4.8 knots:	1420
Timebreak control:	Volume

Specification:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9438/Acquisition_Information/Job_Book/v3000d6SS6mDFSV_FDDrop_Out.pdf

Page 1

Seismic Job Book
Version: 4

Job number:	Client:	Location:
9429	APACHE	AUS / VicP58 - SUE
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Provisional	07-Dec-04	JobBook_initializer
Project Geo name:	**Project Geo email:**	**Project Geo telephone:**

Onboard QC

Products

Product	Summary	Frequency	Shot Freqency
Brute Stack		Per line	2
CMS Attribute Analysis			
Concatenated brute stacks			
FK plot		Every x shots	100
Line Averaged Trace Amplitude			
Near Trace Gathers			
Near Trace Navigation QC(LMO)			
RMS noise			
Relative Source Amplitude			
SegD Header Analysis(HAL)			
Shot RMS Analysis(Graph)			
Shot RMS Spatial Plot			
Shot gathers		Every x shots	100
Single Fold Near Trace Cube			
Single Fold Water Bottom Cube			
Smash Stack			
Standard attribute displays			
Trace RMS Analysis(Spatial Plot)			
Water bottom/near trace cube			

5. Vessel Description

5.1. Maritime Specifications / Particulars

5.1.1. Main Particulars

Ships Name	Western Trident
Call Sign	3FE09 (Three, Foxtrot, Echo Zero, Nine)
International Maritime Org. (Imo) No.	9187502
Owner	Seismic Shipping INC
Previous Name	N/A
Flag State & Port Of Registry	Panama, Panama
Panama Official No.	27927-Pext-2
Date Of Build	1-Mar-99
Yard No. And Type Of Vessel	Build 241, Type UT
Yard Built	Ulstein Shipyard, Ulsteinvik, Norway
Date Converted / Power Upgraded	11/2003 Monowing upgrade
Yard Converted	BMV Bergen
Classification Society And Class	DNV, +1A1, EO, HELDK, ICE-C
Class Id No.	20519
Classification Machinery System	PMS, CMS
Class Approved Maintenance System	TM-Master, Windows based
International Safety Management, (Ism) Code Compliance	DNV SMC. Valid until 05-Oct-06
Safe Manning Certificate (Minimum)	No.M3026 (10 crew)

5.1.2. Principal Particulars

Gross Tonnage (Grt)	8369
(Grt) National & International	8369
Gross Tonnage (Grt) Suez Canal	8862.6
Net. Reg.Ton (Nrt) Panama Canal	n/a
(Nrt) National & International	2511
Net. Reg. Ton (Nrt) Suez Canal	6913.12
Lightship Displacement	4667
Dead Weight	4568
Length Over All (Loa)	92.50 metre
Length Between Perpendiculars	80.10 metre
Breadth (Moulded)	23.00 metre
Breadth (Extreme)	25.00 metre
Depth (Moulded)	9.00 metre
Draft (Max)	7.30 metre (Summer)
Draft (Mean)	6.40 metre (Design)
Air Draft (To Highest Antenna)	32.70 metre (Summer draft)
Helicopter Deck Rating	Sikorsky S-61 / 9.3t Max
Helicopter Deck Diameter (D-Value)	22.80 metre
Helicopter Deck Markings Standard	CAA / CAP437 / BHAB

5.1.3. Capacities And Endurance's

Cable / Towpoints / Subarrays	TMS Solid / 16 Tow Points / 10 Sub arrays
Bollard Pull	142t x 100% power
Fresh Water Capacity	440 metre³
Fresh Water Maker Production	2 x 12 tons / 24 Hrs.
Potable Water System	Evaporators, 2 x Alfa Laval De-Salt.
Fuel Capacity, All Tanks Topped	3550 metre³
Fuel, Useful For 100 % Consumption	3250 metre³
Fuel Type	Gas oil
Fuel Tank Heating	N/A
Lub. Oil, Engine Oil (M³)	30 metre³
CYLINDER OIL, HP COMPRESSORS (M³)	7 metre³ cylinder oil, 7 metre³ screw compressor oil.
CABLE OIL, KEROSENE (Clean/Dirty)	11 metre³ clean / 7 metre³ dirty
BALLAST, SEA WATER (M³)	3150 metre³
Speed, Transit, Max. In Calm Sea	15 Knots
Speed, Transit Economy, Ditto	12 Knots
Consumption Of Fuel , Full Speed	36 metre³ / 24 Hrs
Consumption Of Fuel, Economy Speed	26 metre³ / 24 Hrs
Operational Endurance	86 Days (+4 days safety)
Endurance Of Fuel During Survey	85 days, operating with 10 streamers
Consumption Of Fuel In Port	3 metre³ / 24 Hrs
Safety Equipment Certificate	68 Persons

5.1.4. Bridge Navigation Equipment

Radar No 1	FURUNO FAR 2835S (s-band)
Radar No 2	FURUNO FAR 2825 (x-band)
Radar No 3	N/A
Ecdis	SIMRAD SPS COS-100
Gyro Compass	SIMRAD RGC 11
Auto Pilot	SIMRAD AP9 Mk3 / SJS500 Joystick/Autotrack System
Gps Receiver	1 x FURUNO GP80 + 1 x TRIMBLE NT300D
Speed Log	BEN ANTHEA Electro. Mag.
Echo Sounder	SKIPPER GDS 101
Radio's, Vhf, Gmdss*, Type 1	3 x SKANTI VHF 1000 DSC
Radio's, Vhf, Gmdss*, Type 2	3 x NAVICO AXIS 250 (portable)
Radio's, Vhf	6 x MOTOROLA GP340 (portable)
Radio's, Uhf	1 x Motorola GM 300
Radio Direction Finder	N/A
Weather Facsimile	FURUNO DFAX-208 Mk2
Navtex Receiver	ICS ELECTRONIC Nav5
Ups, Power Supply To All Gmdss Radio's	FN Electro Converter/Charger with lead acid battery back up.

5.1.5. Communication Equipment, Compliant With GMDSS Requirements

Radio Station Licence No.	06-11-2003/1 Panama
Class / Corr. Category	A1, A2, A3. GMDSS
Ship / Air Craft Radio	JOTRON TR-6101 (fixed) + Dittel FSG 5
Helicopter Beacon	SAC DS410 (410 KHz. I.D. 'T R I D')
Automatic Identification System (AIS)	
Transmitter / Receiver, Main (Mf)	SKANTI TRP 8251D
Transmitter / Receiver, Reserve (Mf)	N/A
Transmitter / Receiver, Main (Vhf)	3 x SKANTI VHF 1000 DSC
Transmitter / Receiver, Main (Dsc)	SKANTI DSC9000 MF/HF DSC CONTROLLER/RECEIVER
Ais. Automatic Identification System	SKANTI UAIS 2100
Radio, Portable, VHF	6 x MOTOROLA GP340 4 x MOTOROLA GP328
Booster Unit For Portable Radio (Uhf)	N/A
Emergency Radio Beacon (Epirb)	JOTRON TRON 40S 406/121.5 MHz
Radar Transponder	2 x JOTRON TRON SART 9 GHz
Radio, Lifeboat, Vhf	3 x NAVICO AXIS 250 (portable)

5.1.6. Satellite Communications

MMSI Number	357 270 000
Inmarsat Type B	NERA SATURN B. Tel:335 726 910 Fax:335 726 911 Data9600: 335 726 912
Inmarsat Type C	2 x SKANTI CAPSAT 435 726 910 and 920
V-Sat Uk	44-207 576 6870
V-Sat Usa	1-713 296 5370
Telefax Machine	SAME AS V-SAT THEN TRANSFERRED
Internal E-Mail & Pc-Network	Eudora, Ethernet
E-Mail Address To Vessel	captain@trident.vessel.int.slb.com

5.1.7. Safety Equipment Crew

Lifeboat Type / Capacity/ No. Of Boats	2 x Norsafe 70 Pers each.
Engine, Lifeboat	Sabb type 4L 186 LB
Liferafts Type /Capacity	Viking, 4 x 25 Pers and 2 x 20 Pers.+ 1 MOB raft x 6 Pax
Number Of Life Rafts	6 rafts total. + 1 MOB
Lifejackets Nos.	142 (Seamaster-1983)
Survival Suits, Thermo Insulated	68 (Koppernaes)
Working Suits, Thermo Insulated	30 x 'Mustang' + 10 'Aqua' Dry suits.
Man Overboard Boat (Mob) Type	Norsafe Magnum, 7.5 metre.
Engine, Mob And Speed Of Boat	Yanmar 4LH-STE 4 Cyl. Turbo. Appr. 25 knots
Waterjet And Gear Drive, Mob	Hamilton 212 water jet, ZF Hurth gear, HSW 630
Work Boats	CMV AND 25 FOOT NORPOWER WORKBOAT
Engine Work Boat And Speed Of Boat	CMV 2 X Mermaid Turbo-Four II engines 20Kn. Norpower NOGVA/CUMMINS type 6BT5.9M 210HP Speed 15Kn

5.1.8. Fixed Fire Extinguisher System

Engine Room	Inergen, Zenith Electro. 103 pcs. Bottles w/volume 50 ltr Pressure: 300 bar
Separator Room	N/A
Incinerator Room / Galley Ducting	Inc. Room: Inergen. / Galley: CO^2
Tape Store	Inergen, Zenith Electro
Cable Store	N/A
Steamer Winch Room	Streamers covered by fixed water fog system.
Helicopter Deck	AFFF 3%. Two Unitor FJM 80 foam monitors
Paint Store	Fixed water fog system.
Chemical Store	N/A
Main Foam Pump, Afff Foam Mixture	7.5 M^3/h, 11 Bar, Grundfoss CR8-100/9. 3% mix.
Main Fire Pump	1xAllweiler NB 40-200/01/194, 50 M^3/h at 7 Bar. 1x Allweiler NAM 80-250/01/208, 170M^3/h at 8 Bar
Water Spray Pumps For Streamers	2 x Allweiler NAM 125-315/01/326, 240M^3/h at 5 Bar
Emergency Fire Pump	1xAllweiler NB 40-200/01/189, 40 M^3/h at 7 Bar.
Fire Detection Monitoring System	1 x SERVOTEKNIK BMS-904

5.1.9. Hull Outfitting

Anchor	Maker: ABB Zamech Ltd. Type: SPEC 4320 1 x 4340 Kgs + 1 x 4320 Kgs
Windlass	1 x Ulstein Brattvaag BFM 22U.050, low pressure hydraulic (40 Bar)
Mooring Winches	N/A
Capstan No 1	2 x ODIM Type: 3M3117/OCF801 (Gun deck)
Capstan No 2	N/A
Decks Crane 1, Capacity/Reach/Location	1 x Norlift GPFO 250 0814, D-deck Ps, frame 36. Max. lift 8 tons
Decks Crane 2, Capacity/Reach/Location	1 x Norlift GPFO 250 0814, D-deck Stbd, frame 36. Max. lift 8 tons
Decks Crane 3, Capacity/Reach/Location	HYDRALIFT 1, KMCV 1400-6T (10M) RB600.
Decks Crane 4, Capacity/Reach/Location	N/A
Anti Rolling Damping System	Ulstein Passive Stabilisation System Tk.No.8 Roll Reduction Frd 398 $metre^3$ Tk.No.37 Roll Reduction Aft 312 $metre^3$
Heeling Tanks, Volume And Fuel/Fw/Sw	N/A
BUNKER CONNECTIONS, Locations	1 x forecastledeck centre, frame 117, 2 x main deck Stbd. and port side, frame 57.
BUNKER CONNECTIONS, Type(S)	1 x 4" pipes w. standard flanges on forecastle deck, 2 x 7" with std. flange on main deck. One fitted with 3" camlock female.
BUNKER HOSE Length And Dimension (Loose)	N/A
Crew Accommodation, No Of Bunks	64 bunks
Single Berths Cabins	21
Double Berths Cabins	20
Client Cabins, Single Berths	3
Business Conference And Training Rm	A -deck
Sauna And Fitness Room	A-deck

5.1.10. International Oil Pollution Prevention (IOPP) Equipment

Incinerator, Sludge And Waste Oil	Teamtec-Golar, OGS400C, 65 ltr IMO sludge/h. Max 400 litres solid waste / charge.
Bilge / Oily Water Separator	World Water Systems, 2500 OCD, 2.5 metre³/h, through 15 ppm unit.
Oily Water / Sludge Holding Tanks Cap.	Bilge W.tank:14 M³. Sludge/waste tk's.: 22 metre³
Sewage Disposal Plant	Hamworthy Super Trident, ST6A. Macerate, biological plant w. chem. Dosage facility. Max. flow 15 M³/24 Hrs. BOD5 6 Kg's/ 24 Hrs.
Oil Spill Absorbent / Damage Control	1 x Set Oil Spill Kit inc. sorbent booms/pads, granules & dispersant.

5.1.11. Machinery Equipment

Air Source, Hp Compressors	3 x LMF 57/138 - 207 - E60, 1 x LMF off-line compressor, V17/5518-E60, 75 cfm.
Air Capacity, Each And Total (Cfm)	3 x 2000 cfm, total 6000 cfm
Hp Compressor Drive Motors	3 x ABB motors, AMA450 L6L BAFMH, 1 MW, voltage / freq. Controlled.
Main Engine Or Electric Prop. Motors	2 x Bergen Diesel BRM9, 5400 BHP each (3975 Kw Ea)
Auxiliary Engines (Generator Drive)	2 x Caterpillar 3516 STD, 1.4 MW each. 440 V, 60 Hz
Redundancy Propulsion, Az-Thruster	N/A
Vessels Total Brake Hp / Kw For Prop.	10800 BHP, 7900 KW.
Main Engines, Power Supply	N/A
Propeller Type, Main Propulsion	2 x 4 blade CPP in nozzle, diam. 4.2 metre, 125 rpm
PROPELLER And THRUSTER CONTROL	Ulstein-Liaaen electro / hydraulic control.
Propeller Blade, Spare	N/A
Generators / Alternators	2 x A.van Kaick shaft gen's, DSG 114 M1-6W, 440V, 60 Hz, 3000 KVA each
El. Power, Useful, Out From M.S.Board	> 7000 KW
Ups Power To Instrument Room	1 x Siemens UPS Masterguard S5280, 73 KVA, 15 min. battery back-up.
Power Supply Instr.Room Back -Up	1 x Siemens UPS Masterguard S5280, 73 KVA, 15 min. battery back-up.
Emergency & Harbour Gen. Engine	1 x Caterpillar 3406 DITA, 345 KW
Emergency & Harbour Generator	1 x Caterpillar SR4-3450, 315 KW, 440V, 60 Hz
Fuel Back-Up System For Aux. Eng.	N/A
Cooling System For Aux. Engines	Independent FW cooling. 2 x Sondex FW / SW coolers
Bow Thruster	Ulstein-Liaaen 800 TV, 1.1 MW, 440Volt, 60 Hz.
Stern Thruster	N/A
Fresh Water Generator (Fwg)	2 x Alfa Laval De-Salt. 12 T/24hrs each
Boiler, Exhaust Gas & Oil Fired	1 x Pyro E 1130, 406 KW
Steering Gear	2 x Ulstein Tenfjord, type SR662

5.2. Seismic Specifications

5.2.1. Main Particulars

Streamers	12
Tow Points	16
Sub Arrays	8

5.2.2. Energy Systems

Gun Controller (Type & Manufacturer)	Source Synchronizer System (SSS), Input/Output
Guns (Manufacturer, Type & Capacities)	Input/Output, Sleeve-gun, type I, 40 cu. in. and type IIB, 55 cu. in. to 150 cu. in.
Nominal Source Pressure	2000 psi
Pressure Release	Electro-magnetic solenoid, inertial poppet and seat
Sensor Return	Inductive coil
Timing Resolution	0.1 milliseconds
Source	1 x 750 cu. in. compact sleeve gun source per sub-array, 4 sub-arrays per source (3000 cu.in. each) using dual source configuration
Total Compressor Capacity	6600 SCFM
Compressors (Manufacturer & Capacity)	3 x LMF Compressors
Near Field Phone (Manufacturer & Type)	Input/Output 2933008 or AG Geophysical 800-05
Far Field Phone (Manufacturer & Type)	NA
Depth Indicators	AG Geophysical model AG 3303, 3 per sub-array

5.2.3. Streamer Systems

Streamer (Manufacturer & Type)	Thompson Marconi, Sentry Solid Streamer
Streamer Deflector Type	Monowing MKI and MKII
Section Breaking Strength (Typical)	60 kN
Typical Towed-streamer Stress	1000-1818 kg
Streamer Capacity (Max)	
Sentry Solid Streamer	72,000 metre
Streamers vs. Length (Max)	
Sentry Solid Streamer	12 x 6,000 metre
Streamer Spread (Max spread Configuration)	1100 metre using Monowing (Presently capable of 900 metre)
Streamer Control Device (Manufacturer & Type)	DigiCourse, 5011
Recording System (Manufacturer & Type)	Input/Output MSX 24A

5.2.4. Navigation Systems

Instrument Room Gyrocompass (Manufacturer & Type)	Sperry, MK227
Source Positioning System (Manufacturer & Type)	WesternGeco, Posnet
Global Positioning System (GPS) Receivers (Manufacturer & Type)	1 x Fugro Starfix-Plus, dual frequency 2 x Trimble MS750, dual frequency 2 x Trimble 4000SSE, dual frequency 2 x C-Nav World DGPS.
DGPS QC System (Manufacturer & Type)	TRINAV 2.6
Integrated Navigation System (Manufacturer & Type)	TRINAV 2.6
3-D Quality Control System (Manufacturer & Type)	TRINAV 2.6
3-D Binning System	TRINAV 2.6
Tail Buoy (TB)	
Buoy (Manufacturer & Type)	T98
TB Navigation (Manufacturer & Type)	WesternGeco, Posnet Tailbuoy GPS Unit
Onboard TB Positioning (Manufacturer & Type)	WesternGeco, Posnet
Ultra-short Baseline (USBL) Acoustic Positioning System (Manufacturer & Type)	NA
Acoustic Positioning System (Manufacturer & Type)	Digicourse, System 3
Current Profiler (Manufacturer, Type & Frequency)	RDI, ADCP, 600kHz
Temperature/Salinity Dip Profiler (Manufacturer & Type)	1 x Sippican, Sippican 1 x Valeport, Mk600
Echo Sounder (Manufacturer & Type)	Simrad, EA500
Transducer Frequency & Theoretical Range	1 x 18 kHz to 8100 metre 1 x 200 kHz to 740 metre
Transducer Draft	-7.42 metre

5.2.5. Recording System

Format	4-byte SEG-D, demultiplexed data
Media	IBM 3590 tape
Device	EMASS Robotic tape library with 4 x 3590 IBM tape drives

5.2.6. Other Systems

Other Systems	MSX version 2.1 + PDL CRS Continuous Recording System. Allows acquisition to continue to record data if tape drive(s) fail.
Single & Multi-trace Plotter (Manufacturer & Type)	OYO, GS624

5.2.7. Onboard Seismic QC

System	SeisView
Software	Omega
Hardware	1 x IBM p Series 640 Model B80 with 4 x processors 8 Gb Ram 54 Gb hard drive

5.2.8. Onboard Seismic Processing

System	Omega
Software	Omega
Hardware	32 x IBM SP-2 UNIX based super computer nodes 2 x IBM p Series 640 Model B80 servers w/ 5.2 Tbyte hard disk space 22 x 3590 IBM tape drives 5.2 Tbyte total hard disk space EMASS Robotic tape library with 26 x 3590 IBM tape drives OYO GS-636 Thermal Plotter

Note: Additional system, equipment, hardware and, software information may be available. Please refer to the appropriate specification sheets and/or manuals for more information.

Table of Contents

6. List of Key Personnel

6.1. Onboard Personnel

POSITION	CREW 1
Party Manager	Ian Halfpenny
Captain	Paul Reid
Chief Engineer	Gordon Sanders
Chief Officer	Luc Defossez
Acq. Supervisor	Victor Lopes
Acq. Shiftleader	J.Q. Chandler Richard Morgan
Pos. Supervisor	Paul Melody
Pos. Shiftleader	Paul Farrell Mike Gors
Handling Supervisor	Paul May
Shiftleader Mechanic	Colin Robson Kendal Rawlings
Trilogy QC Leader	
Field Geophysicist	Jon De Haai

6.2. Office Support Personnel

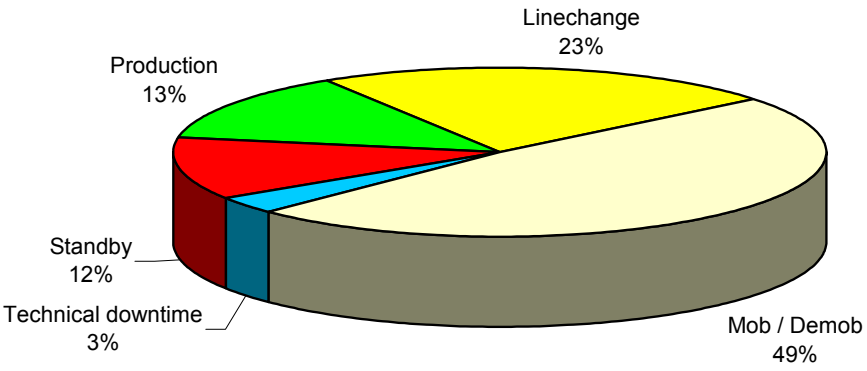
POSITION	NAME	OFFICE
Vessel Manager	Kiran Tuite	Kuala Lumpur
Maritime Superint.	John Hattendorf	Kuala Lumpur
Instrument Support	InTouch Global Operations Support.	Oslo
Navigation Support	InTouch Global Operations Support, Kumara Krishnasamy	Oslo Kuala Lumpur
Mechanical Support	InTouch Global operations Support Darren Parish / Simon Flack	Oslo
Trilogy QC Support	Tee Chee Cherng	Kuala Lumpur
OBP Supervisor		

7. Field Information and Observations

7.1. Production Statistics

PRODUCTION (Km)	
Prime Traverse Production	250.31250 Km
Infill Traverse Production	94.18130 Km
Total Traverse	427.89380 Km
Prime CMP Production	4005.00000 Km
Infill Production	1506.90000 Km
Total CMP Production	5511.90000 Km

TIME DISTRIBUTION (Hours)		
Production	50.9833 Hours	(13.3 %)
Linechange	88.4833 Hours	(23.1 %)
Mob / Demob	185.8500 Hours	(48.4 %)
Technical downtime	12.1167 Hours	(3.2 %)
Standby	46.2000 Hours	(12.0 %)
Total Survey time	383.6333 Hours	(100 %)



7.2. Daily Summary

Party Managers log in local time UTC + 11

7.2.1. 31st December 2004

The Trident rendezvoused with the chase vessel Lady Roula at 03:30 hrs to the south of Wilson's Promontory. Continued across the shipping separation lane and started to deploy streamers at 05:55 hrs once clear of the Hogan Islands and shipping traffic. Deployment has been delayed by a faulty module in streamer 8. As the sea conditions were not suitable for small boat work the streamer had to be recovered from section 3B to 18B to change the module. Deployment on streamer 1 has also been delayed due to a bird line fault that required systematic bypassing of the streamer to try and locate the fault, which wasn't located and is still inboard. The technical audit got underway with the auditor checking the source geometry, hydrophones, depth indicators and click testing the solenoids.

7.2.2. 01st January 2005

The Trident continued heading NE towards the prospect area on the outside of the shipping separation lane, sea conditions are too rough for small boat work. Bird line drop out faults have delayed deployment on all three streamers currently in the water. Streamer #8 had to be recovered due to a noisy bird line, which was eventually cured by fitting a repeater module at the tail of the first dummy section. This streamer was then deployed wide on wing 4. Streamer 1 which was already on its monowing had to be picked up due to an intermittent open circuit in the bird line which was causing bird line drop out. It was initially thought that adding a repeater module to the tail of the first dummy would solve streamer one's fault but this was not the case and the streamer was recovered to 18A to change the section. Streamer 7 also has a bird line fault and that had to be recovered again to 24A to change faulty sections. The Lady Roula departed from the Trident at 20:00hrs to seek shelter as sea conditions deteriorated, the front causing the rough conditions is due to pass to the east overnight and the weather is forecasted to improve on the 2nd.

7.2.3. 02nd January 2005

The day started with the Trident heading SW parallel to the shipping separation zone. Streamer #8 was fully deployed and streamers #1 and #7 were being deployed in tandem. Due to deteriorating weather conditions the Trident turned to the west at 07:30hrs to seek shelter in the lee of Wilson's Promontory. At 11:19 streamer #1 surfaced and became tangled with streamer #2. Various attempt at untangling the streamers proved unsuccessful and they had to be recovered in tandem up to tailbuoy #7 to separate them. Sea conditions are not suitable for dual streamer deployment due to the high swell, deployment will continue one streamer at a time until the weather improves.

7.2.4. 03rd January 2005

Trident continued deploying streamers in single mode waiting for the sea conditions to improve. By the afternoon the swell had dropped enough to allow small boat work. Both workboats were launched; the Norpower worked on streamer#8 changing section 11A, which had damaged around the aft boot exposing the core. The Norpower also changed birds 9 and 10 on streamer#8 and added floats to the mid net acoustic units. Weights were also added from bird #7 forward on streamer #8. The CMV ferried the spare section and birds to the Norpower. It also changed faulty modules #8 and # 20 on streamer 1. Bird 9 on streamer 2 was changed and bird 14 on streamer #1 had its front collar adjusted. The chase vessel Lady Roula returned to the Trident at 13:00 hrs.

7.2.5. 04th January 2005

The weather started to deteriorate in the early morning as the wind changed direction to the east ahead of the next low pressure, which is due to start passing through the area Wednesday. Fault finding bird line drop out on streamer #7 caused long delays today. After picking up streamer# 7 to the tailbuoy to check the STIC cable it was discovered that the terminator module used in the bypass when testing the streamer was faulty. Other delays on streamer #3 were caused when adding the new 1.2km front end of Guardian sections. The front navigation float towed from a "Tee" module was also fitted to the head of streamer #3 together with a tension meter. Tow points were added to lead-in #3 ready to take the extra flotation required for the Sue survey. At midnight streamers 1,2,3 & 7 were fully deployed, streamers 4 & 7 were being deployed in tandem.

7.2.6. 05th January 2005

As expected the wind and sea picked up in the early morning, the Trident shifted the eastern end of her racetrack course to get a better lee by moving inshore closer to the Dolphin and Perch platforms. Streamers 1,2,3,4,7, & 8 are now fully deployed. The poor sea conditions limit deployment to one streamer at a time, streamer 6 is 80% deployed and we expect to have the last remaining streamer deployed by tomorrow afternoon. If sea conditions are suitable the source will then be deployed.

7.2.7. 06th January 2005

Trident remains in a holding pattern to the SW of the Moby survey area in the lee of Wilson's Promontory deploying equipment. All 8 streamers were fully deployed by 19:30 hrs at which point the Trident stopped deployment due to adverse sea conditions. Streamer #5 still has to be connected to the cross tag from streamer #6 but to perform this operation in the present sea conditions would be hazardous. At 18:45 hrs the front navigation float on streamer 3 parted from its tow at position 38 41.578 S 147 21.430 E. The GPS on this float stopped working in the morning, which will make locating the drifting float difficult. The chase vessel Omnes Pioneer which had just arrive in the area was ask to try and recover the float as she was already astern of the Trident. In the present sea conditions recovery will be unlikely, AMSA and LPCR have been notified of the drifting float by fax.

7.2.8. 07th January 2005

Trident spent all day on weather standby waiting for an improvement in the sea conditions. The planned helicopter flight in the morning was cancelled as the Trident's movement in the rough seas was outside the safe operating limits for the helicopter. The forecast is for the wind and swell to drop overnight. Anticipating sea conditions will be suitable to restart operations on the 8th, the Trident moved from the lee of Wilson's Promontory to standby to the east of the MOBY survey area. When sea conditions allow we plan to recover the front of streamer #6 to investigate a power fault, which is thought to be caused by the front float.

7.2.9. 08th January 2005

The day started with the Trident standing by to the east of the Moby survey area waiting for the sea conditions to improve. Recovery of streamer #6 was able to commence at 06:55 hrs. The front float, "Tee" module, and tow adapter were removed from this streamer; the removal of these components cured the fault, which had been tripping off the power to streamer #6. The streamers were tagged together and deployed wide. There was a problem with the control system of monowing #3 in the morning, caused by leakage on the boom sensor line. A software patch was sent from support in Oslo to override the boom lock alarm allowing us to operate the wing again. The source was deployed in preparation for the source technical audit, which was still in progress at the end of the day.

7.2.10. 09th January 2005

Trident completed the mobilisation for the Moby survey in the morning after adjusting the source to as close to the required offset as possible. Production started just before midday but unfortunately the first sequence was scratched due to fiber optic problems on streamer #1. The odd and even optic lines were swapped in the streamer interface ODR panel (Sol-sp1206) & various small gaps due to missing Nav header. Sea conditions have been marginal all day with swell noise evident on all lines acquired. Small boat launches for streamer maintenance were not possible due to the sea conditions.

7.2.11. 10th January 2005

Production continued in marginal sea conditions. The wind increased in strength and started to shift around towards the NE in front of the low pressure system, which is forecasted, to pass through the area Tuesday night. An intermittent telemetry error in module 7 streamer #2 caused some missed shots during sequence 8 as the streamer had to be powered down to reset the module.

7.2.12. 11th January 2005

Trident continued production in the Moby survey area. The high winds and rough seas started to ease off as the wind moved around to the NE. Conditions were still too rough for small boat work so planned streamer maintenance had to be postponed. The faulty module on streamer #2 caused shots to be missed during sequences 14 & 11 when the MSX locked up during the power cycle to get streamer #2 back on line. Shots were also missed during sequences 14 & 10 when Trinav failed to send closures. A helicopter was taken on deck in the morning to deliver one maritime crewmember and take off the Veri-Fy technical auditor and 2 maritime crew.

7.2.13. 12th January 2005

Continuous production throughout the day. The wind swung around to the SW in the morning and freshened but not as bad as forecasted. Planned small boat trips to replace the faulty module on streamer #2 and other streamer maintenance had to be cancelled due to the freshening SW wind and swell.

7.2.14. 13th January 2005

The weather and sea conditions improved enough to allow the use of the small boats for streamer maintenance. The CMV was deployed in the mornings to change out two modules on streamer #2, which have been the cause of intermittent telemetry faults. The CMV also changed birds and performed some fine tuning of the ballast on streamer #1. In the afternoon both the CMV and Norpower workboat were launched. The Norpower changed section 11A on streamer #4, which had cross feed faults and failed the semi monthly tests. The CMV performed a video inspection of the front end towing configuration. Three birds were also changed, the Norpower checked the depths of the inner lead-ins, 3 & 6 were 10m and 4 & 5 were deeper at 22m. Extra buoyancy will be added to lead-ins 4 & 5 before starting the SUE survey. The boats were recalled due to deteriorating sea conditions when the offshore wind increased in strength. Unfortunately during the bird change on streamer #7 the tailbuoy of #7 became caught on the tailbuoy of streamer #6. Attempts to free them during the next turn were unsuccessful, they will be freed tomorrow using the CMV if sea conditions are suitable.

7.2.15. 14th January 2005

Today was spent on infill during which time we also managed to clear up some of the holes that had been left due to problems with the instruments. Acquisition looks very bitty due to non-chargeable reshoots that we were luckily able to acquire with infill lines. In the event this has probably saved time since the alternative of circling on each occasion could have resulted in more

delays with the possibility of additional infill resulting from different feather after circling, especially considering the very bad weather that was forecast. Infill has been concentrated on recovering gaps in the first 2 offset groups. The weather conditions in the morning were too rough to allow workboat use and it was not until afternoon that TBs 6 & 7 could be untangled. The tangle caused a little additional noise on the tails of streamers 6 & 7 but did not effect separations significantly, especially with regard to the infill acquisition on the first 3 groups.

7.2.16. 15th January 2005

Moby survey was completed in the afternoon after finishing the remaining infill and reshoot segments. Line changes were lengthy due to the proximity of the remaining line segments and accounted for some of the delayed finish although some of these were non-chargeable time periods due to reshoots for technical problems. On completion of the survey the workboat was launched to carry out a TS-Dip reading. TS-Dip Taken @ position 37 53.531 S 148 32.926 E. The source was brought on board by 17:45 in order to add additional flotation on the inner lead-ins. Heads of streamers 4 & 5 were brought in. All streamers were back in position by 21:45 hrs. VSAT communications have been disrupted all day due to problems in the system; Aberdeen ground station working on the problem.

7.3. Field Information and Encountered Problems

7.3.1. Obstructions / Installations on the Field

There were permanent obstructions with in the Moby survey area. The Baleen and Patricia wellheads approximately 2.5km from the western boundary are marked with lighted surface buoys. The presence of these marker buoys brought about a change in the line direction from the original orientation of east west to north south. 10km to the north of the survey area the seabed started to shoal as it closed in to the coast.

To the southeast of the survey area there were two platforms the most northerly was the Tuna platform with the West Tuna platform another 3 nautical miles to the southwest. These platforms did not interfere with the survey. A strict communication protocol had to be followed when approaching West Tuna as diving operations were in progress during the time of the survey. The vessel had to call the platform when entering and leaving the following restricted zones, 15km, 10km and 8km. No release of the energy source was allowed within the 8 km zone if divers were in the water.

7.3.2. Traffic / Shipping Lanes

There were no major shipping lanes through the survey. Occasional shipping was observed on route to and from the port of Lakes entrance and ports to the west and east but no conflicts were reported. The bridge was able to contact vessels using channel 16 and ask them to avoid the Western Trident and its towed equipment. The ASI (Automatic Ship Identification system) is now a great help in determining the name and call sign of vessels approaching with-in VHF range.

7.3.3. Fishing Activity

Occasionally fishing vessels from Lakes Entrance passed through the survey area but stayed well clear of the Trident and its towed equipment. Prior to the start of the survey a lot of time had been invested informing the local fishing fleet of the Western Trident's planned activities. This has clearly paid dividends with no lost time recorded for fishing activities during the survey.

7.3.4. Seismic Interference and Time Share

There was no seismic interference observed.

7.3.5. Environmental Obstacles

The climate of the Gippsland Basin can be described as moist cool temperatures having warm summers, with a regular winter-spring rainfall. The region is located on the northern edge of the westerly wind belt known as the roaring forties. Winds often freshen to gale force from the north and north-west, ahead of approaching fronts during all seasons. Once the fronts have passed they then swing abruptly southwest behind the front at similar speeds and abate until they again freshen ahead of the next front. Additionally, low pressure systems can generate wind systems known as the "East Coast Lows", which consist of strong south easterly winds. A total of 35.417 hours were lost as a result of the weather.

Regionally, Bass Strait has a unique geometry consisting of a broad shallow region, which descends abruptly to very deep water on each side. The Gippsland Basin is the broad shallow region on the eastern side of Bass Strait. The flux of water through the strait and its variations are key components of many physical and biological processes in the region. The currents within the Gippsland Basin region include components due to tides and wind stress. As a function of this in the open waters, tides generally result in an elliptical movement of the water mass. The East Australian current brings warmer waters into Bass Strait and influences water temperatures. Sea surface temperatures for Bass Strait range from 16 to 18^{o}C in February and 12 to 14^{o}C in August Wave energy is relatively low, particularly in the broader shelf area in the Gippsland Basin. However, stalled low-pressure systems in the Tasman Sea during the summer can generate higher wave energy at this time. Intermittent upwelling occur along parts of the east Gippsland coast. No time was lost due to currents but the infill was affected by the high feather angles, which varied from 0 up to 20^{o}C. The short line length made feather matching virtually impossible.

The water depth range for the survey varied from 40m in the line change area to the north to 70m in the line changes to the south.

7.3.6. Operational Observations

The Survey was started early in the season. The combination of 8m streamer depths and the use of solid streamers allowed production to continue in some very marginal sea conditions. The limiting factor regarding production was not the streamer noise but was in the ability to process the navigation data, as high swell conditions produces noisy compass data. Having to alter the survey orientation to north south meant the prevailing east west currents in the area had a greater affect on the streamers. The reason for the change was the marker buoys over the Baleen and Patricia wellheads. These bouys were 2.5km from the western boundary of the survey area.

The mobilsation time of 185.850 hours was almost twice as long as the original estimate. Delays were due in a large part to the poor sea conditions, which limited deployment to a single streamer at a time. When trying to deploy streamers in dual mode on the 2nd January streamer #1 surfaced and became tangled with streamer #7 both streamers had to be recovered to untangle them. The sea conditions also meant that small boats could not be launched, this resulted in streamers having to be recovered to the back deck to repair faults, which would under better conditions have been repaired via the small boats.

The greatest hazard on the survey was from the weather. Platforms and shoals in the area were all well marked on the charts.

Chase boat Performance:
The crew of the "Omnes Pioneer" and the "Lady Roula" performed up to expectations. The Omnes Pioneer did not arrive on prospect until the 6th of January.

8. HSE Summary

The survey was conducted in a safe and efficient manor with no lost time injuries taking place and no personal injuries.

The crew were encouraged to report all incidents and RIR's, Risk Identification Reports, were reported in QUEST. An action item (or items) was submitted for each report and reviewed before the report could be closed.

Risk Identification Reports

WG Trident (ASA)

Report #	Event Date	Description
20050119233100	Jan 14, 2005	Modified MSX Terminator module
20050119225857	Jan 10, 2005	Modified MSX Terminator module
20050119220728	Jan 01, 2005	No bend restrictor installed LOL to Stubby.
20050119215148	Jan 02, 2005	No safety rope (stubby)
20050119213225	Jan 04, 2005	Cumberland grip Sleeve
20050119153547	Jan 02, 2005	Streamer 2 – No safety rope (stubby)
20050117090757	Jan 12, 2005	Bridge officer did not slow speed in time
20050117001654	Jan 05, 2005	Access to light area Main Gun Deck
20050116235722	Jan 15, 2005	Accidentally tripping of breaker 211 in E.S.B.
20050116095243	Jan 05, 2005	Bottle containing cable oil found unlabelled
20050116094232	Jan 08, 2005	Deck cable bundle inside reel 13 broke free
20050116074119	Jan 15, 2005	Lack of PPE
20050116044848	Jan 15, 2005	Person hurt neck while sleeping
20050114203618	Jan 14, 2005	Under water video equip left over night CMV bay.
20050114051930	Jan 08, 2005	Drug Refrigerator
20050112212631	Jan 13, 2005	Streamer reel for headbouy not locked out
20050112062413	Jan 12, 2005	Observer Logs incorrect Client name
20050112024938	Jan 12, 2005	Items Hindering Fire Hydrant Access
20050111012003	Jan 07, 2005	Oil leak from streamer reel
20050110230813	Jan 11, 2005	Screwdriver left in vice
20050110053314	Dec 31, 2004	Loose sperators in Bain-marie
20050110051138	Jan 04, 2005	Dryer in Laundry not working
20050109233151	Jan 10, 2005	Poor Housekeeping on the streamer deck
20050109182308	Jan 08, 2005	Running on cable deck
20050109181540	Jan 10, 2005	Tools & rubbish left on lower streamer decks
20050108121256	Jan 06, 2005	Off cuts of rope to make up safety backup rope
20050107065319	Jan 07, 2005	Cut wires in Cable Head Module
20050107044909	Jan 07, 2005	Ash tray used as bin (trash can)
20050107025441	Jan 03, 2005	Bird / Compass 7862 Lost at sea

20050107022632	Jan 07, 2005	Lead-in not secured correctly on cable reel
20050106232805	Jan 06, 2005	Front navigation float lost at sea.
20050106123758	Jan 06, 2005	PPE not adequate
20050106001700	Jan 06, 2005	Ash dust layer being deposited on surfaces
20050105220331	Jan 06, 2005	Higher than normal oil consumption
20050104225650	Jan 04, 2005	Leg Injury Sustained from Slipping on Stairway
20050103093542	Jan 03, 2005	Norpower workboat painter too long.
20050103092605	Jan 03, 2005	Suspected Hydraulic oil leak
20050102031242	Jan 01, 2005	Faulty electrical cord/plug
20050101234407	Jan 02, 2005	Slipped on Oil dripping onto the deck.
20050101080825	Jan 01, 2005	Door constantly left open
20041231050018	Dec 31, 2004	Propeller guard on Nor power slightly damaged
20041230183230	Dec 31, 2004	Cardboard boxes in cable shop
20041230161208	Dec 31, 2004	Hardhats left in recording room

9. Shipment List

TDT-05001-AD-EXT	SEG D Original Tapes & P190 data	Seq 001-039
TDT-05003-AD-EXT	SEGD Field Tapes& client deliverables	Seq 001-039

10. Logs

10.1. Production and Timing Summary

Vessel	M/V Western Trident
Area	GAP04A - MOBY
Job no.	9438
Client	Apache Energy
MMM-YY	31/1/2005

TIMING & PRODUCTION SUMMARY

WesternGeco

	Accountable Time - Hours													Production - kms				
DATE	Mobilisation Demobilisation	Source vessel non productive time	WesternGeco Downtime	Source vessel chargable time	Other chargeable standby	Production Prime	Prime runout	Linechange Prime	Production Infill	Infill runout	Linechange Infill	Total Day Rate	Total Time	Prime Traverse km	Infill Traverse km	Prime FF CMP km	Infill FF CMP Km	Total CMP kms
31-Dec	18.083												18.083					
1-Jan	24.000												24.000					
2-Jan	24.000												24.000					
3-Jan	24.000												24.000					
4-Jan	24.000												24.000					
5-Jan	24.000												24.000					
6-Jan	19.500				4.500							4.50	24.000					
7-Jan					24.000							24.00	24.000					
8-Jan	17.083				6.917							6.92	24.000					
9-Jan	11.183		3.667			3.133	0.567	5.450				9.15	24.000	31.80000		432.00000		432.00000
10-Jan						6.867	1.783	15.350				24.00	24.000	69.67500		884.40000		884.40000
11-Jan						7.283	1.783	14.933				24.00	24.000	72.30000		926.40000		926.40000
12-Jan						6.983	1.650	15.367				24.00	24.000	74.47500		961.20000		961.20000
13-Jan						5.817	1.367	11.716	2.267	0.267	2.567	24.00	24.000	62.06250	21.84380	801.00000	311.10000	1112.10000
14-Jan			0.283						7.017	1.750	14.950	23.72	24.000		74.86880		938.70000	938.70000
15-Jan			8.167		5.233				1.900	0.550	8.150	15.83	24.000		20.86880		257.10000	257.10000
16-Jan					5.550							5.55	5.550					
17-Jan																		
18-Jan																		
19-Jan																		
20-Jan																		
21-Jan																		
22-Jan																		
23-Jan																		
24-Jan																		
25-Jan																		
26-Jan																		
27-Jan																		
28-Jan																		
29-Jan																		
30-Jan																		
31-Jan																		
Month	185.850		12.117		46.200	30.083	7.150	62.816	11.183	2.567	25.667	185.67	383.63	310.31250	117.58140	4005.00000	1506.90000	5511.90000
Prev Month																		
Job Total	185.850		12.117		46.200	30.083	7.150	62.816	11.183	2.567	25.667	185.67	383.63	310.31250	117.58140	4005.00000	1506.90000	**5511.90000**

Jon Evan Cook
Client Representative, Apache / Bass Strait Oil

Ian Halfpenny
Party Manager, Western Trident

10.2. Tape Log

Client: Apache Northwest
Project: 9438
Party: 147 Western Trident
Survey: VIC/P47, Moby 3D MSS

Box Summary for Shipment: 1 Shipment # 1 Box: 1
Tapes: 30

Line name	Reel #	TU #	Volser	First SP	Last SP	First File	Last File	Files
GAP04A1392P1001	29904	1	V29904	971	1146	118	293	176
GAP04A1392P1001	29905	2	V29905	1147	1389	294	534	244
GAP04A1392P1001	29906	3	V29906	1505	1619	650	764	230
GAP04A1392P1001	29907	4	V29907	1620	1668	765	813	50
GAP04A1200P1002	29908	1	V29908	1564	1381	48	231	184
GAP04A1200P1002	29909	2	V29909	1380	1151	232	461	230
GAP04A1200P1002	29910	3	V29910	1150	921	462	691	230
GAP04A1200P1002	29911	4	V29911	920	870	708	742	230
GAP04A1392P2003	29912	1	V29912	0	0	0	0	0
GAP04A1392P2003	29913	2	V29913	971	1113	89	231	143
GAP04A1392P2003	29914	3	V29914	1114	1343	232	461	230
GAP04A1392P2003	29915	4	V29915	1344	1575	462	691	230
GAP04A1392P2003	29916	1	V29916	1576	1666	692	782	92
GAP04A1184P1004	29917	2	V29917	1534	1387	34	231	178
GAP04A1184P1004	29918	3	V29918	1386	1157	232	461	230
GAP04A1184P1004	29919	4	V29919	1156	927	462	691	230
GAP04A1184P1004	29920	1	V29920	926	873	692	745	57
GAP04A1376P1005	29921	2	V29921	1001	1172	60	231	202
GAP04A1376P1005	29922	3	V29922	1173	1402	232	461	230
GAP04A1376P1005	29923	4	V29923	1403	1632	462	691	230
GAP04A1376P1005	29924	1	V29924	1633	1662	692	721	31
GAP04A1168P1006	29925	2	V29925	1534	1359	56	231	176
GAP04A1168P1006	29926	3	V29926	1358	1129	232	461	230
GAP04A1168P1006	29927	4	V29927	1128	899	462	691	230
GAP04A1168P1006	29928	1	V29928	898	873	692	717	26
GAP04A1360P1007	29931	1	V29931	0	0	0	0	0
GAP04A1360P1007	29929	2	V29929	1001	1177	55	231	207
GAP04A1360P1007	29930	3	V29930	1178	1205	232	259	28
GAP04A1360P1007	29932	1	V29932	1206	1435	260	199	230
GAP04A1360P1007	29933	2	V29933	1533	1665	297	429	230

Client: Apache Northwest
Project: 9438
Party: 147 Western Trident
Survey: VIC/P47, Moby 3D MSS

Box Summary for Shipment: 1 Shipment # 1 Box: 2
Tapes: 30

Line name	Reel #	TU #	Volser	First SP	Last SP	First File	Last File	Files
GAP04A1152P1008	29934	3	V29934	1564	1384	59	231	230
GAP04A1152P1008	29935	4	V29935	1383	1154	232	461	176
GAP04A1152P1008	29936	1	V29936	1153	922	563	691	230
GAP04A1152P1008	29937	2	V29937	921	871	692	742	51
GAP04A1344P1009	29938	3	V29938	971	1116	86	231	146
GAP04A1344P1009	29939	4	V29939	1117	1125	232	240	9
GAP04A1344P1009	29940	1	V29940	1126	1396	241	703	463
GAP04A1344P1009	29941	2	V29941	1397	1628	740	933	230
GAP04A1344P1009	29942	3	V29942	1629	1664	934	969	36
GAP04A1136P1010	29943	4	V29943	1564	1420	87	231	145
GAP04A1136P1010	29944	1	V29944	1419	1190	232	461	230
GAP04A1136P1010	29945	2	V29945	1189	958	462	693	232
GAP04A1136P1010	29946	3	V29946	957	873	694	778	85
GAP04A1328P1011	29947	4	V29947	971	1174	30	231	1
GAP04A1328P1011	29948	1	V29948	1175	1427	232	462	1
GAP04A1328P1011	29949	2	V29949	1428	1657	463	692	218
GAP04A1328P1011	29950	3	V29950	1658	1663	693	698	6
GAP04A1120P1012	29951	4	V29951	1564	1383	50	231	182
GAP04A1120P1012	29952	1	V29952	1382	1153	232	461	230
GAP04A1120P1012	29953	2	V29953	1152	923	462	691	230
GAP04A1120P1012	29954	3	V29954	922	873	692	741	62
GAP04A1312P1013	29955	4	V29955	0	0	1	2	2
GAP04A1312P1013	29956	1	V29956	971	1145	72	246	175
GAP04A1312P1013	29957	2	V29957	1146	1375	247	476	230
GAP04A1312P1013	29958	3	V29958	1376	1605	477	706	230
GAP04A1312P1013	29959	4	V29959	1606	1667	707	765	59
GAP04A1104P1014	29960	1	V29960	1564	1363	41	242	202
GAP04A1104P1014	29961	2	V29961	1362	1097	243	472	230
GAP04A1104P1014	29962	3	V29962	1096	864	473	699	227
GAP04A1296P1015	29963	1	V29963	971	1082	130	241	112

Client: Apache Northwest
Project: 9438
Party: 147 Western Trident
Survey: VIC/P47, Moby 3D MSS

Box Summary for Shipment: 1 Shipment # 1 Box: 3
Tapes: 30

Line name	Reel #	TU #	Volser	First SP	Last SP	First File	Last File	Files
GAP04A1296P1015	29964	2	V29964	1083	1324	242	471	230
GAP04A1296P1015	29965	3	V29965	1325	1558	472	701	230
GAP04A1296P1015	29966	1	V29966	1559	1669	702	810	109
GAP04A1088P1016	29967	2	V29967	1564	1342	23	245	223
GAP04A1088P1016	29968	3	V29968	1341	1112	246	475	230
GAP04A1088P1016	29969	1	V29969	1111	882	476	705	229
GAP04A1088P1016	29970	2	V29970	881	870	706	717	12
GAP04A1280P1017	29971	0	V29971	0	0	0	0	0
GAP04A1280P1017	29972	1	V29972	971	1166	50	245	196
GAP04A1280P1017	29973	2	V29973	1167	1399	246	475	230
GAP04A1280P1017	29974	3	V29974	1400	1629	476	705	230
GAP04A1280P1017	29975	1	V29975	1630	1664	706	740	35
GAP04A1072P1018	29976	2	V29976	1564	1362	29	231	203
GAP04A1072P1018	29977	3	V29977	1361	1123	232	461	230
GAP04A1072P1018	29978	1	V29978	1122	893	462	691	230
GAP04A1072P1018	29979	2	V29979	892	872	692	712	21
GAP04A1264P1019	29980	3	V29980	971	1163	45	237	193
GAP04A1264P1019	29981	1	V29981	1164	1393	238	467	230
GAP04A1264P1019	29982	2	V29982	1394	1623	468	697	230
GAP04A1264P1019	29983	3	V29983	1624	1666	698	739	42
GAP04A1056P1020	29984	1	V29984	1564	1394	61	231	171
GAP04A1056P1020	29985	2	V29985	1393	1164	232	461	230
GAP04A1056P1020	29986	3	V29986	1163	934	462	691	230
GAP04A1056P1020	29987	1	V29987	933	871	692	754	63
GAP04A1248P1021	29988	2	V29988	971	1134	79	231	153
GAP04A1248P1021	29989	3	V29989	1135	1364	232	461	230
GAP04A1248P1021	29990	1	V29990	1365	1594	462	691	230
GAP04A1248P1021	29991	2	V29991	1595	1665	692	762	71
GAP04A1040P1022	29992	3	V29992	1564	1394	61	231	171
GAP04A1040P1022	29993	1	V29993	1393	1164	232	461	230

Client: Apache Northwest
Project: 9438
Party: 147 Western Trident
Survey: VIC/P47, Moby 3D MSS

Box Summary for Shipment: 1 Shipment # 1 Box: 4
Tapes: 30

Line name	Reel #	TU #	Volser	First SP	Last SP	First File	Last File	Files
GAP04A1040P1022	29994	2	V29994	1163	934	462	691	230
GAP04A1040P1022	29995	3	V29995	933	871	692	754	63
GAP04A1232P1023	29996	1	V29996	1001	1178	54	231	208
GAP04A1232P1023	29997	2	V29997	1179	1408	232	461	230
GAP04A1232P1023	29998	3	V29998	1409	1638	462	691	230
GAP04A1232P1023	29999	1	V29999	1639	1663	692	716	25
GAP04A1024P1024	30000	2	V30000	1564	1360	27	231	205
GAP04A1024P1024	30001	3	V30001	1359	1130	232	461	230
GAP04A1024P1024	30002	1	V30002	1129	900	462	691	230
GAP04A1024P1024	30003	2	V30003	899	869	692	722	31
GAP04A1216P1025	30004	3	V30004	971	1124	79	232	154
GAP04A1216P1025	30005	1	V30005	1125	1354	233	462	230
GAP04A1216P1025	30006	2	V30006	1355	1584	463	692	230
GAP04A1216P1025	30007	3	V30007	1585	1669	693	775	83
GAP04A1008P1026	30008	1	V30008	1534	1378	75	231	157
GAP04A1008P1026	30009	2	V30009	1377	1148	232	461	230
GAP04A1008P1026	30010	3	V30010	1147	918	462	691	230
GAP04A1008P1026	30011	1	V30011	917	867	692	740	49
GAP04A1216J1027	30012	2	V30012	971	1133	69	231	163
GAP04A1216J1027	30013	3	V30013	1134	1363	232	461	230
GAP04A1216J1027	30014	1	V30014	1364	1593	462	691	230
GAP04A1216J1027	30015	2	V30015	1594	1669	692	765	74
GAP04A1008J1028	30016	3	V30016	1564	1389	56	231	176
GAP04A1008J1028	30017	1	V30017	1388	1159	232	461	230
GAP04A1008J1028	30018	2	V30018	1158	929	462	691	230
GAP04A1008J1028	30019	3	V30019	928	919	692	701	10
GAP04A1008J1028	30020	1	V30020	917	863	703	776	80
GAP04A1344J1029	30021	2	V30021	971	1177	25	231	207
GAP04A1344J1029	30022	3	V30022	1178	1407	232	461	230
GAP04A1344J1029	30023	1	V30023	1408	1637	462	691	230

Client: Apache Northwest
Project: 9438
Party: 147 Western Trident
Survey: VIC/P47, Moby 3D MSS

Box Summary for Shipment: 1 Shipment # 1 Box: 5
Tapes: 30

Line name	Reel #	TU #	Volser	First SP	Last SP	First File	Last File	Files
GAP04A1344J1029	30024	2	V30024	1638	1672	692	727	37
GAP04A1104J1030	30025	3	V30025	1564	1360	27	231	205
GAP04A1104J1030	30026	1	V30026	1359	1130	232	461	230
GAP04A1104J1030	30027	2	V30027	1129	900	462	691	230
GAP04A1104J1030	30028	3	V30028	899	863	692	733	42
GAP04A1360J1031	30029	2	V30029	0	0	1001	1006	6
GAP04A1360J1031	30030	2	V30030	971	1181	49	259	211
GAP04A1360J1031	30031	3	V30031	1182	1421	260	499	240
GAP04A1360J1031	30032	1	V30032	1422	1661	500	739	240
GAP04A1360J1031	30033	2	V30033	1662	1663	740	741	2
GAP04A1136J1032	30034	3	V30034	1564	1387	64	241	178
GAP04A1136J1032	30035	1	V30035	1386	1147	242	481	240
GAP04A1136J1032	30036	2	V30036	1146	907	482	721	240
GAP04A1136J1032	30037	3	V30037	906	868	722	758	38
GAP04A1248J1033	30038	1	V30038	971	1147	55	231	177
GAP04A1248J1033	30039	2	V30039	1148	1377	232	461	230
GAP04A1248J1033	30040	3	V30040	1378	1607	462	691	230
GAP04A1248J1033	30041	1	V30041	1608	1668	692	749	58
GAP04A1184J1034	30042	2	V30042	1564	1398	65	231	167
GAP04A1184J1034	30043	3	V30043	1397	1168	232	461	230
GAP04A1184J1034	30044	1	V30044	1167	938	462	691	230
GAP04A1184J1034	30045	2	V30045	937	871	692	758	67
GAP04A1328A1035	30046	3	V30046	1261	1354	32	131	100
GAP04A1072J1036	30047	1	V30047	1298	1080	13	231	219
GAP04A1072J1036	30048	2	V30048	1079	872	232	439	208
GAP04A1216J2037	30049	3	V30049	971	1173	29	231	203
GAP04A1216J2037	30050	1	V30050	1174	1403	232	461	230
GAP04A1216J2037	30051	2	V30051	1404	1633	462	691	230
GAP04A1216J2037	30052	3	V30052	1634	1666	692	724	33
GAP04A1136J2038	30053	1	V30053	1510	1331	63	242	180

Client: Apache Northwest
Project: 9438
Party: 147 Western Trident
Survey: VIC/P47, Moby 3D MSS

Box Summary for Shipment: 1 Shipment # 1 Box: 6
Tapes: 4

Line name	Reel #	TU #	Volser	First SP	Last SP	First File	Last File	Files
GAP04A1136J2038	30054	2	V30054	1330	1101	243	472	230
GAP04A1136J2038	30055	3	V30055	1100	871	473	702	230
GAP04A1136J2038	30056	1	V30056	868	868	703	704	2
GAP04A1296A1039	30057	2	V30057	1244	1315	68	137	70

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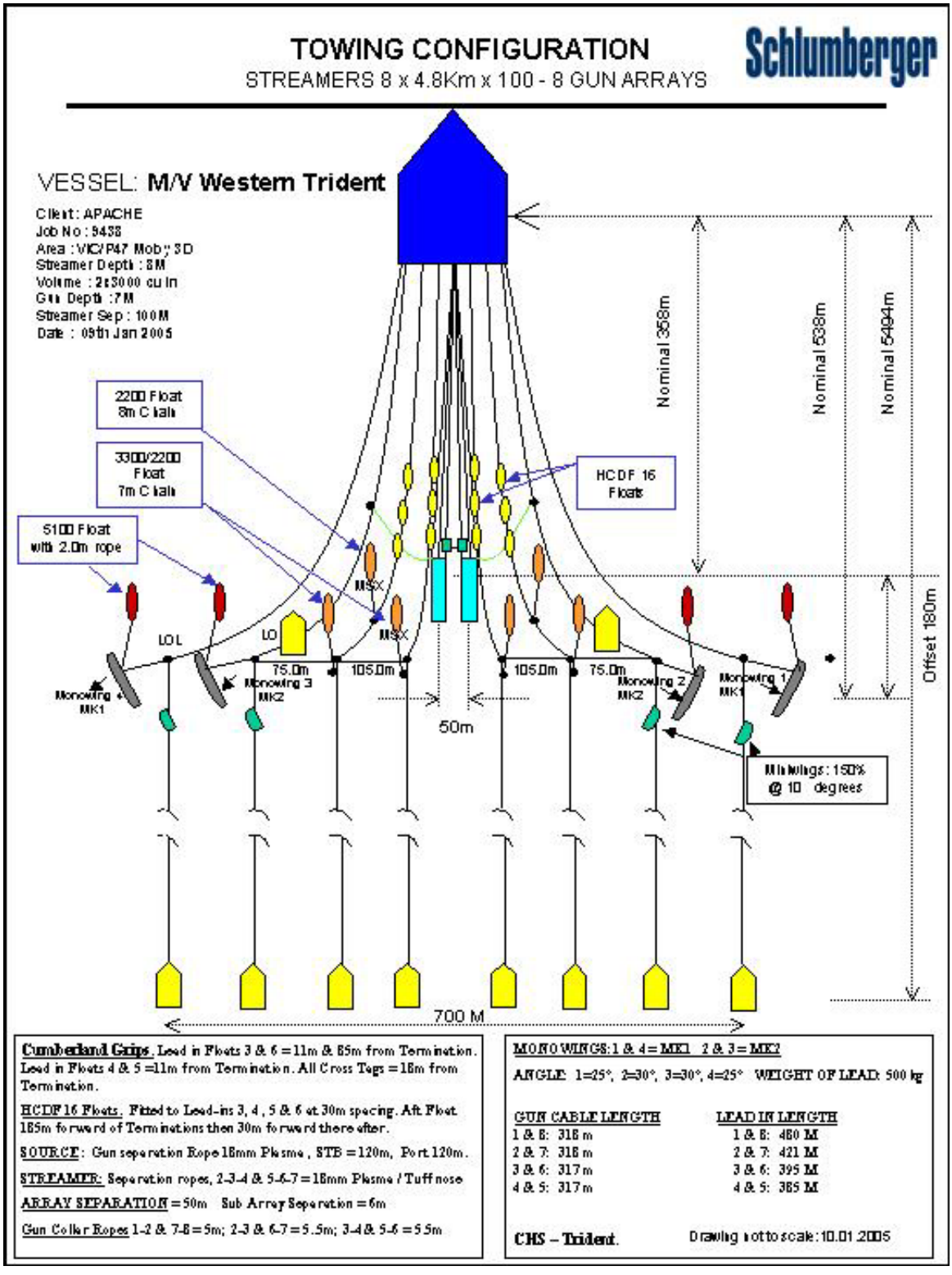
11. Towing Configuration

11.1. Towing System Layout



12. Streamer Configuration

12.1. Streamer System Description

Streamer System Parameters	
Number of Streamers	8
Type of streamer	Thompson Marconi Sentry Solid, and Guardian Solid
Streamer length	4800m
Groups per streamer	384
Group intervals	12.5m
Outside diameter	64mm
Jacket (type-thickness)	Polyurethane, 3.5mm
Breaking strength	60kN
Ballast fluid (fluid-quantity)	None
Modules (diameter-length)	Max. Dia 25cm, length 40cm
Channels per module	16
Data transmission link	Fibre Optic
Power	220 – 240 V AC
Active group lengths	17.75m
Nearest offset available	180m
Streamer depth	8m
Streamer separation	100m
Number of stretch sections	
in front of each streamer	0
end of each streamer	0
No of compasses per streamer	19
No of depth transducers per streamer	19

Trace allocation (example for 6 streamers)	**Location**	**Near**	**Far**
Streamer 1	Starboard Outer	1	384
Streamer 2	Starboard Middle Outer	385	768
Streamer 3	Starboard Middle Inner	769	1152
Streamer 4	Starboard Inner	1153	1536
Streamer 5	Port Inner	1537	1920
Streamer 6	Port Middle Inner	1921	2304
Streamer 7	Port Middle Outer	2305	2688
Streamer 8	Port Outer	2689	3072

Hydrophone Parameters	
Detector type	TMS Bender Hydrophone
Group interval	12.5m
Detectors per group	14
Group length	17.75m
No of groups per section	8
Hydrophones spacing	Centre Weighted
Maximum operating depth	85m
Group sensitivity (at 7m depth)	14 V/bar

12.2. Streamer Layout

12.2.1. STREAMER 1

CABLE 1
REEL 1

Loc	Serial #	Module	Bird	Acoustic	SRD	CHANNEL		Remarks		
LOL	003									
MWA		HSX- 80015								
Dum	6171	**CRX00120**	AB01-9430							
1A	6080	MSX- 62735		AA01-9430	SRD-	1	8			
1B	6078	CSX-70232	AB02 -9385			9	16			
2A	6025	MSX-60350		AA02-7927	SRD-	17	24			
2B	6036	CSX-71741	AB03 -19554			25	32			
3A	6037	MSX-62512		AA03-8486	SRD-	33	40			
3B	6201	CSX-73184	AB04 -19668			41	48			
4A	6195	MSX-60556			SRD-	49	56			
4B	6167	CSX-73091	AB05-21714			57	64			
5A	6199	MSX-60067			SRD-	65	72			
5B	6197	CSX-73084				73	80			
6A	6028	MSX-60423	AB06- 20375			81	88			
6B	6017	CSX-70831			SRD-	89	96			
7A	6217	MSX-60327				97	104			
7B	6218	CSX-70513	AB07-15550			105	112			
8A	6239	MSX-61844			SRD-	113	120			
8B	6264	CSX-71641				121	128			
9A	6255	MSX-60659	AB08-10464			129	136			
9B	6256	CSX-70594			SRD-	137	144			
10A	6259	MSX-60674				145	152			
10B	6287	CSX-70728*	AB09-12810			153	160			
11A	4122	MSX-60180			SRD-	161	168			
11B	4220	**CRX0012**		AA04-9048		169	176			
12A	4278	MSX-61362	AB10-7851			177	184			
12B	3379	CSX-70079		AA05-8814	SRD-	185	192			
13A	2720	MSX-60205				193	200			
13B	3861	CSX-71938	AB11-20916			201	208			
14A	3855	MSX- 61870			SRD-	209	216			
14B	3396	CSX-71735				217	224			
15A	3809	MSX -61858	AB12-17165			225	232			
15B	3331	CSX -72091			SRD-	233	240			
16A	3149	MSX -60075				241	248			
16B	2593	CSX -72233	AB13-27737			249	256			
17A	2764	MSX - 60700			SRD-	257	264			
17B	2664	CSX - 70123	**26833**	SPEED LOG		265	272			
18A	4007	MSX-61718	AB14-20941			273	280			
18B	2369	CSX-70598			SRD-	281	288			
19A	4062	MSX-60678				289	296			
19B	2184	CSX-70553	AB15-18386			297	304			
20A	4184	MSX-60218			SRD-	305	312			
20B	2365	CSX- 70056				313	320			
21A	4256	MSX-60693	AB16-13415			321	328			
21B	3450	CSX-70385			SRD-	329	336			
22A	3826	MSX-62488				337	344			
22B	3872	CSX-70539	AB17-7851			345	352			
23A	2709	MSX-60187			SRD-	353	360			
23B	2277	CSX-70084	AB18-19330			361	368			
24A	4134	MSX-60325		AA06-8987	SRD-	369	376			
24B	3997	CSX -72240	AB19-12203			377	384			
Dum	2446	TSX-90150		AA07-7119	SRD-					
TA	0895-015760-002									
STIC	0897-095470-03									

12.2.2. STREAMER 2

CABLE 2
REEL 2

LOL	Serial #	Module	Bird	Acoustic	SRD	CHANNEL		Remarks		
LOL	003									
MWA		HSX-80168								
Dum	6173	**CRX-001**	BB01 -9211							
1A	6203	MSX-60795		BA01-7260	SRD-	1	8			
1B	6187	CSX-71202	BB02 -20036			9	16			
2A	6190	MSX-61953		BA02-9142	SRD-	17	24			
2B	6200	CSX-70279	BB03-19864			25	32			
3A	6204	MSX-61416		BA03-8999	SRD-	33	40			
3B	6208	CSX-71871	BB04-16590			41	48			
4A	6198	MSX-61913			SRD-	49	56			
4B	6206	CSX-70211	BB05-13956			57	64			
5A	6207	MSX-62309			SRD-	65	72			
5B	6205	CSX-70113				73	80			
6A	6164	MSX-60311	BB06-11297			81	88			
6B	6062	CSX-70140			SRD-	89	96			
7A	6291	MSX-?????				97	104			
7B	6290	*CSX-70099	BB07-19702			105	112			
8A	4375	MSX-66267			SRD-	113	120			
8B	4483	CSX-71753				121	128			
9A	2393	MSX-60773	BB08-20323			129	136			
9B	2694	CSX-71670			SRD-	137	144			
10A	4458	MSX-61957				145	152			
10B	2028	CSX-70306	BB09-20235			153	160			
11A	3276	MSX- 61414			SRD-	161	168			
11B	4331	**CSX-71264**		BA04-8810		169	176			
12A	4421	MSX-60698	BB10-19838			177	184			
12B	4417	CSX-71693		BA05-7322	SRD-	185	192			
13A	4142	MSX-60337				193	200			
13B	2532	CSX-70183	BB11-19658			201	208			
14A	3391	MSX-60729			SRD-	209	216			
14B	3648	CSX- 70067				217	224			
15A	2550	MSX -62006	BB12-17361			225	232			
15B	4363	CSX -71629			SRD-	233	240			
16A	2606	MSX -61950				241	248			
16B	2668	CSX -71102	BB13-10823			249	256			
17A	3258	MSX-61209			SRD-	257	264			
17B	2538	CSX-71426				265	272			
18A	1980	MSX-60378	BB14-16646			273	280			
18B	4248	CSX-71978			SRD-	281	288			
19A	3038	MSX-60375				289	296			
19B	4189	CSX-71374	BB15-17528			297	304			
20A	3834	MSX-62021			SRD-	305	312			
20B	4410	CSX-71308				313	320			
21A	3475	MSX-60451	BB16-8905			321	328			
21B	2813	CSX-71986			SRD-	329	336			
22A	4047	MSX-60103				337	344			
22B	3959	CSX-70579	BB17-12791			345	352			
23A	3489	MSX-61834			SRD-	353	360			
23B	2528	CSX-70283	BB18-19759			361	368			
24A	2121	MSX-63133		BA06-8327	SRD-	369	376			
24B	6019	CSX-70284	BB19-27729			377	384			
Dum	3451	TSX- 90154		BA07-8339	SRD-					
TA	1097100780-02									
STIC	0104143815-01									

12.2.3. STREAMER 3

CABLE 3
Reel 3

Loc	Serial #	Module	Bird	Acoustic	SRD	CHANNEL		Remarks	
LI	3								
		HSX-80038 out-in 80019	Tension cell 17000006						
	mini-section	103003	T-Module	006					
Dum	6172	CSX-70050	CB01-10691						
1A	6339	MSX-61379		CA01-8330	SRD-	1	8		
1B	6329	CSX-72520	CB02-10082			9	16		
2A	6337	MSX-60101		CA02-9965	SRD-	17	24		
2B	6333	CSX-70566	CB03 -14196			25	32		
3A	6338	MSX-60155		CA03-8602	SRD-	33	40		
3B	6332	CSX-70146	CB04-13629			41	48		
4A	6325	MSX-62524			SRD-	49	56		
4B	6327	CSX-70730	CB05 -25704			57	64		
5A	6335	MSX-60369			SRD-	65	72		
5B	6348	CSX-70589				73	80		
6A	6237	MSX-60675	CB06-17368			81	88		
6B	6232	CSX-71704			SRD-	89	96		
7A	4366	MSX-62403				97	104		
7B	3126	CSX-70387	CB07 -15203			105	112		
8A	4245	MSX-62273			SRD-	113	120		
8B	4216	CSX-70073				121	128		
9A	4232	MSX-62011	CB08 -14602			129	136		
9B	4233	CSX-70196			SRD-	137	144		
10A	3355	MSX-60619				145	152		
10B	2572	CRX-00019	CB09-29100			153	160		
11A	2567	MSX-60607			SRD-	161	168		
11B	2608	CSX-70536		BA04-9409		169	176		
12A	4198	MSX-63717	CB10-10841			177	184		
12B	4273	CSX-72216		BA05-8607	SRD-	185	192		
13A	1942	MSX-60650				193	200		
13B	2757	CSX-71199	CB11-27769			201	208		
14A	4201	MSX-60755			SRD-	209	216		
14B	4475	CSX-70609				217	224		
15A	3478	MSX-60429	CB12-13773			225	232		
15B	4246	CSX-73856			SRD-	233	240		
16A	3407	MSX-60280				241	248		
16B	4508	CSX-70188	CB13-10497			249	256		
17A	3004	MSX-60111			SRD-	257	264		
17B	3924	CSX-70256				265	272		
18A	2690	MSX- 62726	CB14-17094			273	280		
18B	3784	CSX-71156			SRD-	281	288		
19A	3328	MSX-61865				289	296		
19B	3063	CSX-70089	CB15-27834			297	304		
20A	3708	MSX-61483			SRD-	305	312		
20B	2307	CSX-71990				313	320		
21A	4137	MSX-61747	CB16-10104			321	328		
21B	4252	CSX-73885			SRD-	329	336		
22A	2748	MSX-61387				337	344		
22B	4073	CSX-70362	CB17-15575			345	352		
23A	3330	MSX-60061			SRD-	353	360		
23B	6016	CSX-70732	CB18-19775			361	368		
24A	3647	MSX-61801		BA06-8338	SRD-	369	376		
24B	3657	CSX-72014	CB19-19943			**377**	**384**		
Dum	4435	TSX-90013		BA07-9461	SRD-				
TA	0497-094120-001								

STIC xxx 0598138970-4

12.2.4. STREAMER 4

CABLE 4 Reel 5

Loc	Serial #	Module	Bird	Acoustic	SRD	CHANNEL		Remarks		
LI	003									
		HSX-80018								
Dum	6135	CSX- 70072	DB01-20476							
1A	6042	MSX-60346		DA01-9499	SRD-	1	8			
1B	6030	CSX-70066	DB02-13172			9	16			
2A	6041	MSX-61902		DA02-9962	SRD-	17	24			
2B	6043	CSX-70548	DB03-17016			25	32			
3A	6038	MSX-60316		DA03-8376	SRD-	33	40			
3B	6058	CSX-70152	DB04-15396			41	48			
4A	6063	MSX-60229			SRD-	49	56			
4B	6084	CSX-70297	DB05-19492			57	64			
5A	6083	MSX- 61827			SRD-	65	72			
5B	6081	CSX-70503				73	80			
6A	6057	MSX-61954	DB06-19005			81	88			
6B	6054	CSX-71708*			SRD-	89	96			
7A	4213	MSX-60225				97	104			
7B	3998	CSX-70027	DB07-15747			105	112			
8A	4251	MSX-60126			SRD-	113	120			
8B	4250	CSX-71685				121	128			
9A	4249	MSX-61391	DB08-14103			129	136			
9B	4413	CSX-72005			SRD-	137	144			
10A	2665	MSX-60136				145	152			
10B	2966	CRX-00005	DB09-13380			153	160			
11A	3152	MSX-61417			SRD-	161	168			
11B	4085	CSX-71991		DA04-8342		169	176			
12A	4017	MSX-62347	DB10-8248			177	184			
12B	3939	CSX- ??		DA05-9437	SRD-	185	192			
13A	1665	MSX-62014				193	200			
13B	2522	CSX-72007	DB11-15668			201	208			
14A	2685	MSX-60863			SRD-	209	216			
14B	1714	CSX-72307				217	224			
15A	2674	MSX-62342	DB12-5624			225	232			
15B	4289	CSX-72229			SRD-	233	240			
16A	3843	MSX-63218				241	248			
16B	4362	CSX-73190	DB13-17803			249	256			
17A	6034	MSX-62721			SRD-	257	264			
17B	4023	CSX-71691				265	272			
18A	4469	MSX-60665	DB14-15422			273	280			
18B	4247	CSX-70257			SRD-	281	288			
19A	4013	MSX-60269				289	296			
19B	1868	CSX-70277	DB15-20020			297	304			
20A	3314	MSX-62005			SRD-	305	312			
20B	1746	CSX-71699				313	320			
21A	2751	MSX-60567	DB16-19403			321	328			
21B	4005	CSX-70301			SRD-	329	336			
22A	3992	MSX-61836				337	344			
22B	2977	CXS-72115	DB17-6374			345	352			
23A	6020	MSX- 60380			SRD-	353	360			
23B	2467	CSX-70568	DB18-13743			361	368			
24A	3847	MSX-62535		DA06-8566	SRD-	369	376			
24B	6039	CSX- 71271	DB19-27459			377	384			
DUM	1655	TSX-90200		DA07-9422	SRD-					
TAD	0297079080-7									
STC	0898157060-5									

12.2.5. STREAMER 5

Cable 5 Reel-8										
Loc	**Serial #**	**Module**	**Bird**	**Acoustic**	**SRD**	**CHANNEL**		**Remarks**		
LI	3									
		HSX-80049								
Dum	6018	CSX-70324	EB01-16858							
1A	6052	MSX-60076		EA01-9426	SRD-	1	8			
1B	6059	CSX-70395	EB02- 15169			9	16			
2A	6060	MSX-60782		EA02-7203	SRD-	17	24			
2B	6069	CSX-70601	EB03-19827			25	32			
3A	6153	MSX-60416		EA03-8333	SRD-	33	40			
3B	6170	CSX-70733	EB04- 22118			41	48			
4A	6168	MSX-62479			SRD-	49	56			
4B	6161	CSX-70302	EB05-14600			57	64			
5A	6186	MSX-61990			SRD-	65	72			
5B	6192	CSX-70391				73	80			
6A	6185	MSX-61940	EB06-14581			81	88			
6B	6184	CSX-71617*			SRD-	89	96			
7A	2832	MSX-60640				97	104			
7B	2924	CSX-70888	EB07-27834			105	112			
8A	3114	MSX-61370			SRD-	113	120			
8B	2604	CSX-72165				121	128			
9A	3996	MSX-60617	EB08-10180			129	136			
9B	4284	CSX-71989			SRD-	137	144			
10A	3107	MSX- 60457				145	152			
10B	4434	**CRX-00022**	EB09-17919			153	160			
11A	2707	MSX-61872			SRD-	161	168			
11B	3248	CSX- 70511		EA04-7395		169	176			
12A	2745	MSX-62533	EB10-21709			177	184			
12B	2618	CSX-70632		EA05-9444	SRD-	185	192			
13A	3384	MSX-60318				193	200			
13B	3433	CSX-71511	EB11-15478			201	208			
14A	3222	MSX-60358			SRD-	209	216			
14B	1931	CSX-71309				217	224			
15A	2036	MSX-60419	EB12-7059			225	232			
15B	3833	CSX-70407			SRD-	233	240			
16A	2342	MSX-61832				241	248			
16B	2642	CSX-72220	EB13-17421			249	256			
17A	2747	MSX-60090			SRD-	257	264			
17B	2643	CSX-70739				265	272			
18A	4359	MSX-60299	EB14-8519			273	280			
18B	2721	CSX-73448			SRD-	281	288			
19A	4447	MSX-61480				289	296			
19B	2686	CSX-73113	EB15-20227			297	304			
20A	4532	MSX-60314			SRD-	305	312			
20B	3859	CSX-70213				313	320			
21A	4072	MSX-60251	EB16-20368			321	328			
21B	3953	CSX-72126			SRD-	329	336			
22A	2761	MSX-63719				337	344			
22B	2735	CSX-73863	EB17-19214			345	352			
23A	4031	MSX-60768			SRD-	353	360			
23B	3943	CSX-70895	EB18-22609			361	368			
24A	2654	MSX-62417		EA06-9344	SRD-	369	376			
24B	6022	CSX -71254	EB19-20561			377	384			
DUM	2598	TSX-90010		EA07-7617	SRD-					
TAD	0497083840-07									
STC	1298103528-8									

12.2.6. STREAMER 6

CABLE 6 Reel 10										
Loc	**Serial #**	**Module**	**Bird**	**Acoustic**	**SRD**	**CHANNEL**		**Remarks**		
LI	3									
		HSX- 80202			103002					
dummy	6166	CSX-71997	FB01- 19887							
1A	6336	MSX-60252		FA01-9431	SRD-	1	8			
1B	6341	CSX-73353	FB02-16438			9	16			
2A	6334	MSX-61399		FA02-8527	SRD-	17	24			
2B	6340	CSX-70053	FB03 -20304			25	32			
3A	6347	MSX-61909		FA03-9956	SRD-	33	40			
3B	6370	CSX-70313	FB04 -18036			41	48			
4A	6357	MSX-60324			SRD-	49	56			
4B	6377	CSX-70535	FB05 -19228			57	64			
5A	6378	MSX-61365			SRD-	65	72			
5B	6355	CSX-70538				73	80			
6A	6056	MSX-60361	FB06 -20330			81	88			
6B	6066	CSX-71668*			SRD-	89	96			
7A	2661	MSX-60109				97	104			
7B	3842	CSX-73197	FB07-6458			105	112			
8A	3390	MSX-60201			SRD-	113	120			
8B	2864	CSX-72317				121	128			
9A	2981	MSX-61413	FB08 -19911			129	136			
9B	4043	CSX-72172			SRD-	137	144			
10A	2673	MSX-62495				145	152			
10B	4030	CRX-00016	FB09-13989			153	160			
11A	3865	MSX-60220			SRD-	161	168			
11B	3904	CSX-71726		FA04-8990		169	176			
12A	3468	MSX-61284	FB10-19963			177	184			
12B	4285	CSX-71318		FA05-7290	SRD-	185	192			
13A	3976	MSX-60343				193	200			
13B	2693	CSX-73186	FB11-6911			201	208			
14A	3699	MSX-60110			SRD-	209	216			
14B	2789	CSX-72343				217	224			
15A	2816	MSX-60115	FB12-13988			225	232			
15B	3483	CSX-71196			SRD-	233	240			
16A	6029	MSX-60104				241	248			
16B	2568	CSX-72157	FB13-13786			249	256			
17A	3692	MSX-62346			SRD-	257	264			
17B	4143	CSX-70537				265	272			
18A	2619	MSX-60192	FB14-14008			273	280			
18B	3825	CSX-70010			SRD-	281	288			
19A	2657	MSX-60290				289	296			
19B	2724	CSX-70534	FB15-15501			297	304			
20A	2872	MSX-61831			SRD-	305	312			
20B	2637	CSX-72015				313	320			
21A	2611	MSX- 62453	FB16-7904			321	328			
21B	3254	CSX-71719			SRD-	329	336			
22A	2725	MSX-61378				337	344			
22B	3517	CSX-71201	FB17-8882			345	352			
23A	6011	MSX-60740			SRD-	353	360			
23B	4075	CSX-71931	FB18-15407			361	368			
24A	4078	MSX-60174		FA06-8098	SRD-	369	376			
24B	4077	CSX-70361	FB19-8375			377	384			
DUM	1168	TSX-90152		FA07-8564	SRD-					
TAD	0898152570-05									
STC	0798148730-09									

12.2.7. STREAMER 7

CABLE 7 REEL 11										
Loc	**Serial #**	**Module**	**Bird**	**Acoustic**	**SRD**	**CHANNEL**		**Remarks**		
LI	3									
		HSX-80268								
Dum	6169	CRX-17	GB01-21475							
1A	6070	MSX-61754		GA01-7344	SRD-	1	8			
1B	6073	CSX-71182	GB02-16925			9	16			
2A	6154	MSX-60637		GA02-7393	SRD-	17	24			
2B	6152	CSX-73128	GB03-10250			25	32			
3A	6047	MSX-61851		GA03-8561	SRD-	33	40			
3B	6050	CSX-70934	GB04-26177			41	48			
4A	6086	MSX-61980			SRD-	49	56			
4B	6147	CSX-70562	GB05-18830			57	64			
5A	6145	MSX-63254			SRD-	65	72			
5B	6129	CSX-70575				73	80			
6A	6133	MSX-60273	GB06-6830			81	88			
6B	6146	CSX-71200*			SRD-	89	96			
7A	3263	MSX-62442				97	104			
7B	3801	CSX-73861	GB07-20938			105	112			
8A	2755	MSX-61894			SRD-	113	120			
8B	3832	CSX-71531				121	128			
9A	2601	MSX-61286	GB08-12750			129	136			
9B	4416	CSX-71311			SRD-	137	144			
10A	3486	MSX-61503				145	152			
10B	2722	CRX-00023	GB09-20273			153	160			
11A	3199	MSX-60707			SRD-	161	168			
11B	2786	CSX-71934		GA04-7344		169	176			
12A	4041	MSX-60170	GB10-16916			177	184			
12B	2333	CSX-71633		GA05-8905	SRD-	185	192			
13A	4387	MSX-62337				193	200			
13B	2213	CSX-72322	GB11- 9589			201	208			
14A	3569	MSX-61951			SRD-	209	216			
14B	2655	CSX-70253				217	224			
15A	2744	MSX-63190	GB12-19440			225	232			
15B	4066	CSX-70795			SRD-	233	240			
16A	2716	MSX-62022				241	248			
16B	4026	CSX-70592	GB13-27739			249	256			
17A	1741	MSX-60571,			SRD-	257	264			
17B	4453	CSX-70287				265	272			
18A	2359	MSX-60581	GB14-15592			273	280			
18B	2008	CSX-71872			SRD-	281	288			
19A	3480	MSX-62275				289	296			
19B	4307	CSX-71597	GB15-17784			297	304			
20A	3148	MSX-60389			SRD-	305	312			
20B	4361	CSX-71739				313	320			
21A	3117	MSX-60411	GB16-17162			321	328			
21B	4008	CSX-71210			SRD-	329	336			
22A	4006	MSX-62283				337	344			
22B	6013	CSX- 72112	GB17-21455			345	352			
23A	2905	MSX-61361			SRD-	353	360			
23B	4461	CSX-71626	GB18-6594			361	368			
24A	4356	MSX-61830		GA06-8326	SRD-	369	376			
24B	4478	CSX-71705	GB19-12259			377	384			
DUM	3687	TSX- 90159		GA07 9464	SRD-					
TAD	0698140840-4									
STC	0798148730-3									

12.2.8. STREAMER 8

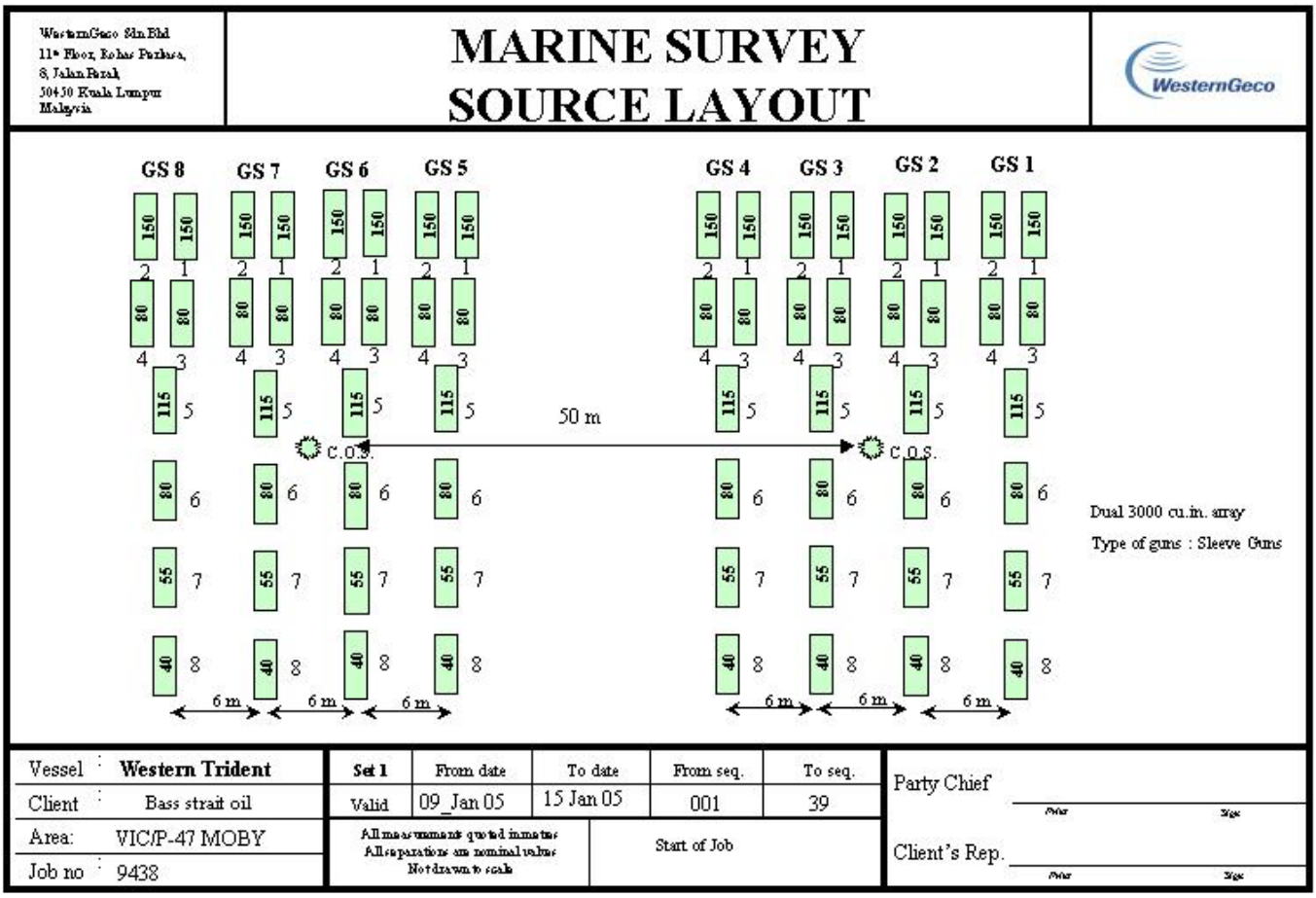
CABLE 8 Reel 12										
Loc	**Serial #**	**Module**	**Bird**	**Acoustic**	**SRD**	**CHANNEL**		**Remarks**		
LOL	003									
MWA										
		HSX-80202								
Dum	6027	**CRX-**	HB01-19965							
1A	6235	MSX-60653		HA01-8504	SRD-	1	8			
1B	6221	CSX-70316	HB02-18032			9	16			
2A	6227	MSX-61394		HA02-7306	SRD-	17	24			
2B	6213	CSX-71314	HB03-14138			25	32			
3A	6209	MSX-60191		HA03-9970	SRD-	33	40			
3B	6211	CSX-70329	HB04-17870			41	48			
4A	6033	MSX-61390			SRD-	49	56			
4B	6074	CSX-71596	HB05-5516			57	64			
5A	6040	MSX-60329			SRD-	65	72			
5B	6046	CSX-70400				73	80			
6A	6076	MSX-60484	HB06-11982			81	88			
6B	6053	CSX-70286			SRD-	89	96			
7A	6032	MSX-60449				97	104			
7B	6026	CSX-71233	HB07-20877			105	112			
8A	6031	MSX-60430			SRD-	113	120			
8B	6035	CSX-70244				121	128			
9A	6021	MSX-61855	HB08-21128			129	136			
9B	6065	*CSX-70521			SRD-	137	144			
10A	2825	MSX-60810				145	152			
10B	3502	CSX-70355	HB09- 20235			153	160			
11A	2545	MSX-62485			SRD-	161	168			
11B	1923	CSX-70184		HA04-8726		169	176			
12A	3218	MSX-62537	HB10-22006			177	184			
12B	3472	CSX-70080		HA05-9958	SRD-	185	192			
13A	4090	MSX-61868				193	200			
13B	2617	CRX-00018	HB11-17239			201	208			
14A	2503	MSX-62591			SRD-	209	216			
14B	2738	CSX-70160				217	224			
15A	2549	MSX-62036	HB12-20282			225	232			
15B	4183	CSX-70136			SRD-	233	240			
16A	3691	MSX-61774				241	248			
16B	3952	CSX-71590	HB13-17706			249	256			
17A	4208	MSX-61792			SRD-	257	264			
17B	3951	CSX-70243	25760	SPEED LOG		265	272			
18A	3950	MSX-60209	HB14-20882			273	280			
18B	3948	CSX-71606			SRD-	281	288			
19A	4403	MSX-61123				289	296			
19B	1367	CSX-71667	HB15-21180			297	304			
20A	4407	MSX-61759			SRD-	305	312			
20B	4304	CSX-70087				313	320			
21A	3973	MSX-62038	HB16-11930			321	328			
21B	4212	CSX-70057			SRD-	329	336			
22A	4211	MSX-63126				337	344			
22B	4382	CSX-73206	HB17-15501			345	352			
23A	4380	MSX- 61380			SRD-	353	360			
23B	4381	CSX-73866	HB18-19848			361	368			
24A	3358	MSX-60847		HA06-7329	SRD-	369	376			
24B	6023	CSX-73870	HB19-18861			377	384			
DUM	6067	TSX- 90078		HA07-8530	SRD-					
TAD	598-129990-02									
STC	1298-103092-04									

13. Source Configuration

13.1. Source System Description

Source Parameters	
Number of source arrays	2 (Dual source)
Array separation	37.5m
Array length	15.1m
Array width	18m
Number of strings/array	4
Separation from centre track	18.75m
Source volume	3000 cubic inches
Number of hydrophones per array	24
Number of depth transducers per array	12
Number of guns per array	32
Number of clusters per array	8
Airgun type	WesternGeco Sleevegun
Operating pressure	2000 psi
Depth of guns	7m
Peak to Peak amplitude	108.3 Bar-m
Primary to Bubble ratio	17.6

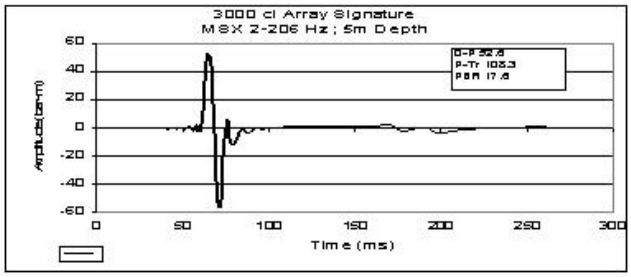
13.2. Source Layout

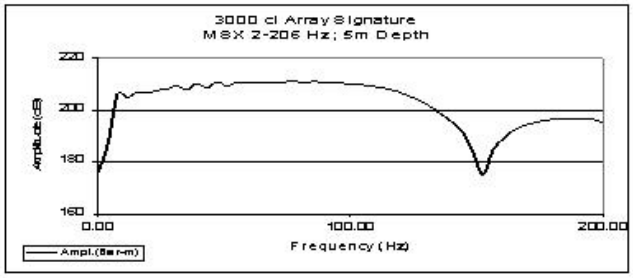


13.3. Pulse Response

WesternGeco Sdn.Bhd
11th Floor, Kohas Perkasa,
8, Jalan Razak
50450 Kuala Lumpur
Malaysia

MARINE SURVEY
PULSE RESPONSE





Vessel	Western Trident	Set 1	From date	To date	From seq.	To seq.
Client	Bass strait oil	Valid	09_Jan 05	15 Jan 05	001	39
Area:	VIC/P-47 MOBY	All measurements quoted in metres All separations are nominal values Not drawn to scale		Start of Job		
Job no	9438					

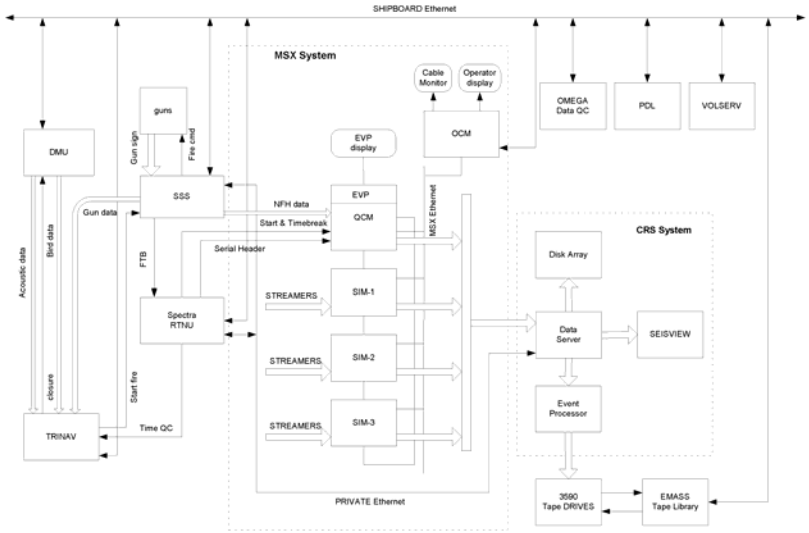
Party Chief _____ Print Sign

Client's Rep. _____ Print Sign

14. Instrumentation Room System Diagram

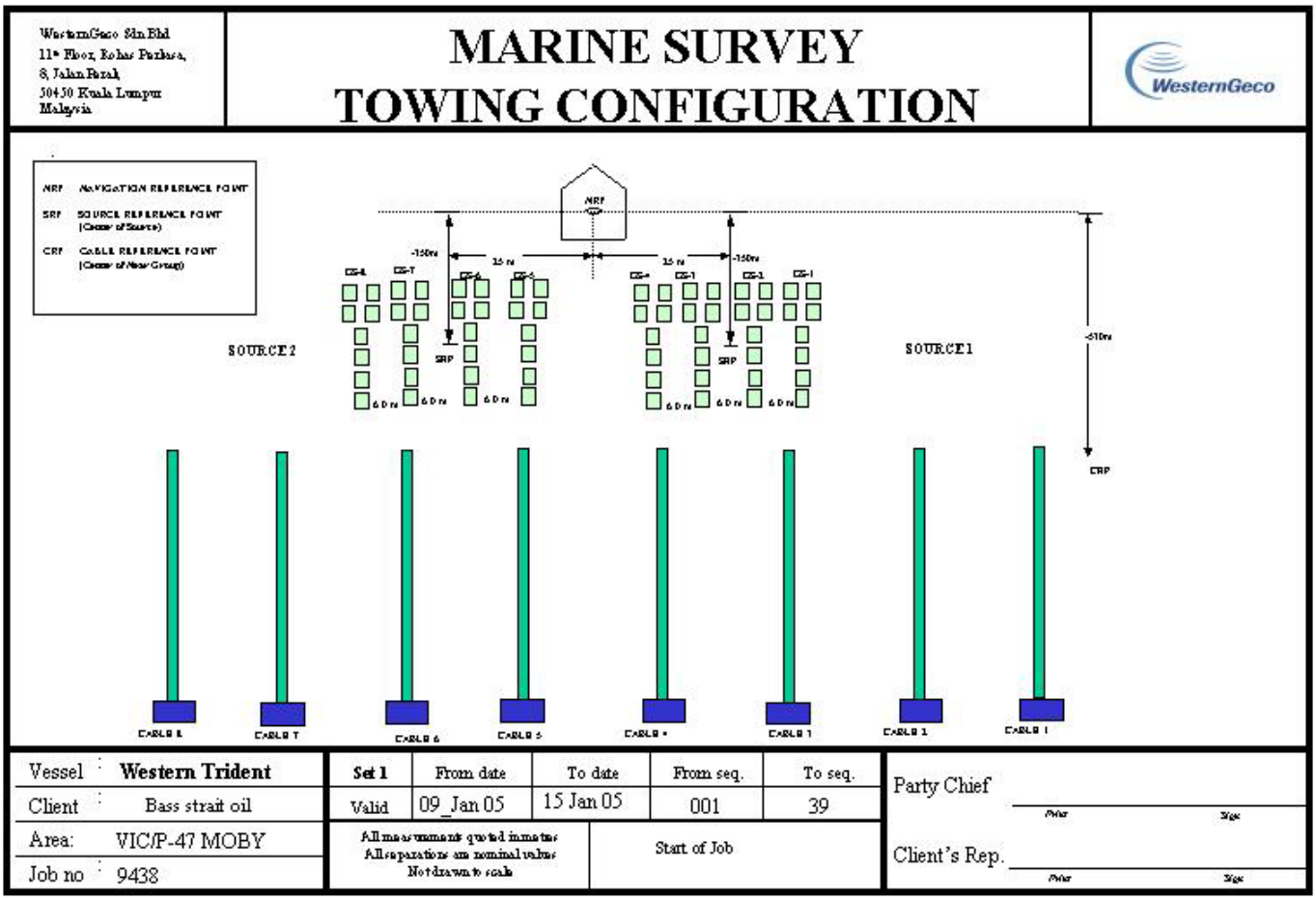
Western Geco Sdn Bhd
11th Floor, Rohas Perkasa,
8, Jalan Perak,
50450 Kuala Lumpur
Malaysia

MARINE SURVEY
INS. ROOM SYSTEM DIAGRAM



Vessel : **Western Trident**	**Set 1**	From date	To date	From seq.	To seq.	Party Chief _____ Print Sign
Client : Bass strait oil	Valid	09_Jan 05	15 Jan 05	001	39	
Area: VIC/P-47 MOBY	All measurements quoted in metres All separations are nominal values Not drawn to scale		Start of Job			Client's Rep. _____ Print Sign
Job no : 9438						

15. Equipment Offset Diagrams



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16. Navigation and Positioning System Description

16.1. System Configuration

16.1.1. Navigation Hardware and Software

System	Hardware (Type and Serial No.)	Software Version
TRINAV	WesternGeco TRINAV	TRINAV 2.6.0 patch 27 Sep 2004
Spectra	Concept Systems Spectra	9.8.04
Acoustic System	I/O Digicourse Digirange	System 3 version 4.42
TS-meter	Valeport 604 CTD	
Echo Sounder	Simrad EA 500	
Current Meter	Nortek ADCP at 500Khz.	SeisADCP Version 1.18

16.1.2. System Timing

TRINAV issued closures to the recording/source firing system 604 milliseconds before the predicted time of peak pressure. All TRINAV system positions are at the time of predicted peak pressure. The Spectra Real Time Navigation Unit (RTNU), a VME rack mounted system, performing data acquisition, validation and time stamping for the Spectra system, sends a latched TTL signal to the Source controller (SSS) to determine whether port or starboard source should fire. Spectra also handles the Ethernet communications between the third party MSX, SSS and PDL systems in order that they pass header information between themselves. Timing between the Trinav and Spectra was monitored and logged for each shot point using the two-boat TrueTime receiver to time tag the TRINAV closure and the Spectra CTB1 signal. No anomalies were observed.

Spectra and the MSX recording system utilise the UTC time standard for all time stamping of headers and records, whereas TRINAV utilises GPS time. Consequently there is a difference of 13 seconds between the records in the TRINAV database and those recorded by Spectra and MSX. This difference was corrected when the P1/90 and P2/94 were generated by TRINAV, thus all field tapes are in the UTC time standard, however, plots and logs etc. from TRINAV that are derived directly from the database remain in GPS time.

A further timing difference lies when the shot time recorded on the shot record in the P2 and P1 is compared with the time stamp recorded on with the seismic field tape: The TRINAV system correctly rounds the decimal seconds whereas the Spectra and MSX truncate the decimal seconds; this means that there is a 1 second difference in timing between the P1 record and the seismic file number for approximately half the shots.

16.2. Survey Positioning Method Used

This 3D survey was carried out using WesternGeco's standard mode of operation for 8 streamers and dual source surveys.

Positioning of the vessel was by differential GPS, utilizing TRINAV GPS, PosNet, Fugro Multifix DGPS with delivery of Skyfix differential correction data in RTCM SC104 format by Inmarsat B and Optus satellites. Additionally C&C Technologies CNAV DGPS system with a wide area correction not in RTCM format, was received by an integrated receiver.

The centre near group of each streamer and the sources were positioned relative to the vessel using a network consisting of four PosNet rGPS system units mounted on each source and two

PosNet rGPS system units mounted on floats towed wide from the vessel, via suspension points on lead-ins 2 and 7. These navigation points were integrated into a network of 116 Digicourse acoustic ranges, 20 baselines and 24 compass azimuths to produce a final position for the centre of source and the centre near groups of all cables.

The centre last group of each streamer was positioned using a network consisting of 8 PosNet rGPS system units, 8 compass azimuths, provided by streamer mounted compass heading units, and a network of 87 Digicourse acoustic ranges.

The mid streamer network consisted of 42 ranges between 16 acoustic transceivers mounted between 2100 and 2300 metres from the centre first group of each streamer.

The streamer shape was modelled by 19 Digicourse series 5000 combined streamer depth control and magnetic compass units per streamer.

Least square condition equations for each 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.

16.3. Surface Positioning

16.3.1. Vessel Navigation

System 1: C&C Technologies CNAV Version 13.3
RTG corrections via integrated receiver.

System 2: Multifix Version 1.05
Skyfix XP and Skyfix Standard via Inmarsat B and Optus sat

System 3: TRINAV GPS
Skyfix & Starfix corrections via Inmarsat B and Optus sat

System 4: PosNet 1
Virtual base station corrections from Cnav (in RTG mode)

System 5: PosNet 2
Virtual base station corrections from Cnav (in RTG mode)

Primary vessel positioning was provided by C-Nav.

C-Nav is a different concept in GPS positioning. It is based upon the Real Time Gypsy (RTG) technology developed over a ten-year period by NASA's Jet Propulsion Laboratory (JPL) to provide centimetre-level accuracy for space applications. C&C technology have assimilated this technology to provide worldwide horizontal accuracy of the order of 0.1 meter (1 sigma) so long as the user is within InMarsat and GPS satellite visibility.

C-Nav uses monitoring stations strategically located around the globe. These stations, equipped with dual-frequency geodetic-quality GPS receivers, simultaneously collect RAW GPS observable measurements for the entire GPS constellation and transmit these data to two separate Network Processing Hubs (NPHs) in real-time.

Orbit and clock corrections, resolved by the NPHs for each GPS satellite, are universally valid at any location on Earth. These orbit and clock corrections are transmitted to all C-Nav users within INMARSAT visibility (75° N to 75° S Latitude).

Each C-Nav unit applies the appropriate GPS corrections to the satellites being tracked at that user's location. Local ionospheric and tropospheric effects are eliminated by comparing the L-1 and L-2 frequencies.

Further C-Nav system description and the most current station information can be found at: http://www.cctechnol.com/site30.php

Secondary vessel positioning was provided by the third party multi-reference positioning system Multifix XP.

TRINAV GPS is a multiple reference station DGPS system with the capability to be used in dual frequency mode when required, and 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 an exclusive 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.

Pseudo-range observations undergo comprehensive checks of validity and consistency before they are used in the fix algorithm. Carrier smoothing reduces the random noise effects on the pseudo ranges, and aids in multipath detection.

Integrity checking is a fundamental part of the processing philosophy: a Fault Detection, Isolation and Correction (FDIC) algorithm checks the consistency of the fix, detects and rejects any outliers, and re-computes the solution. W-testing and F-testing are used to give the best protection against erroneous observations.

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 two independent 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.

Six different systems utilising two completely independent concepts for correcting the GPS data were used; thereby providing a high degree of redundancy to ensure continuous vessel positioning.

- **Further information about these systems is given in Navigation Exhibit 1.**

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

With the current increase in solar activity, users of the Global Positioning System can experience an increased level of instability in computed GPS positions in some geographical areas. For this project, WesternGeco provided a technical solution to this problem through the use of dual frequency receivers and dual frequency reference stations from Fugro.

16.3.2. Float Navigation

Float (tailbuoy, source and wide-towed front floats) surface navigation was provided by PosNet rGPS systems. The in-sea units incorporated a GPS receiver and interfacing for direct data transmission of the raw satellite pseudo-range data through the source cabling or by conventional UHF telemetry radio.

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 was better than 2m.

16.4. Streamer and Source Positioning

16.4.1. Acoustics

Acoustic data in the front, mid and tail networks was provided by I/O Digicourse System 3 version 4.42. This system comprises a rack mounted Controller (DMU), Processor and PC based interface which are located in the instrument room. The CTX (Gun Positioning System) transceivers mounted on each source, together with CMX transceivers mounted on the front of each streamer and front float provide a front network from which vessel relative source positioning is computed. CMX transceivers mounted on the streamers and tailbuoys provide vessel and tailbuoy relative streamer positioning.

16.4.2. Streamer Compasses

One hundred and fifty two (152) series 5000 Digibird combined magnetic compass and streamer depth controllers were attached to the eight streamers. They were controlled via the I/O Digicourse System 3 DMU as mentioned above.

Compass Sampling Rate	=	1 second
Averaging constant	=	7 seconds

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

16.4.3. Gyro Compass

The gyrocompasses used during the survey were:

Instrument Room Gyro	- Gyro 1 C Plath SR180 Mk1 Serial No 5029
Ships Gyro	- Gyro 2 C Plath SR180 Mk1 Serial No 5033

The gyro correction values as computed by RTCalib from previous survey were as follows:

Instrument Room Gyro 1	-1.44
Instrument Room Gyro 2	-0.10

16.4.4. Velocity of Sound in Water

The following type of TS-meter has been used to determine the speed of sound in water.

Type: Valeport 604 CTD

The model 604 measures Conductivity, Temperature and Pressure parameters and from these measurements Depth, Salinity, Density and Speed of Sound are calculated.

Velocity measurements could not be taken during the survey due to limitations imposed by the weather conditions. At the end of the survey, a Temperature/Salinity measurement was taken during a small weather window.

Web Based GDEM Profile Data

Velocity profile data was also used from the web based Generalized Digital Environmental Model database. This was only used as limitations imposed by weather conditions prevented a Temperature/Salinity measurement being performed by small boat.

16.4.5. 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. The speed of sound for the total water column was derived from a Generalised Database Environment Model from the World Wide Web. The computed speed of sound and draught value were used to produce water depth corrected P190s.

16.5. Auxiliary Navigation Sensors

16.5.1. Current Meter

Data from an Acoustic Doppler Current Profiler, or Current Meter, was acquired throughout the survey. This data was used to assist the survey planning throughout the operation and so reduce the infill. The sensor used was a Nortek ADCP operating at a frequency of 500 Hz. Data sets were regularly sent for test and correlation to ensure that the data was consistent and acceptable.

17. Navigation Systems Verification and Monitoring

17.1. Echo Sounder Verification

The verification was carried out to determine the draught of the transducer in use and to compute a correction for the scale error.

- **The dockside verification results are in Navigation Exhibit 2**

17.2. Gyro Monitoring

Continuous monitoring of the vessel gyros was performed using TRINAV's rtCalib utility program and a GPS baseline.

The gyro correction estimates provided by this program have been monitored and compared with previous dockside verification values and previous surveys.

A dockside verification was performed in one direction at Dampier Cargo Wharf, Dampier, Western Australia on the 11th February 2004.

- **The gyro verification results are in Navigation Exhibit 3**

17.3. GPS Monitoring

Continuous monitoring using the Integrity Monitor was carried out offshore to verify that the installation was satisfactorily operational (data reception, transmission, processing and logging were verified) and that the operational settings were correct**.** Each system to be used, including duplicates, was verified.

rGPS Health Check was carried out with the use of TRINAV GPS's Re-Radiation kit.

- **The TRINAV GPS Integrity Monitor station in use is described in Exhibit 1.**
- **The Health Check results are in Exhibit 3**

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.

DGPS Health check onshore using the Integrity Monitor was carried out.

17.4. Current Meter Monitoring

To confirm that the Acoustic Doppler Current Profiler ADCP is operating correctly, with optimum configuration and, in so doing, providing a high quality data set for real-time and post-survey use, a test data set was sent weekly to an external contractor, Fugro GEOS. This process provided the onboard operation with a high level of confidence in the validity of the data being gathered, thereby increasing its value for survey planning.

18. Navigation Processing

18.1. The TRINAV System

TRINAV consists of a network of SUN SPARC workstations, external mass-data storage and hard-copy facilities running WesternGeco proprietary software on the UNIX operating system. Positioning sensors are interfaced to TRINAV through two VME sub systems.

The positions for each vessel/float are passed through a Kalman filter, where they may be integrated with speed and heading inputs. The output of the primary vessel Kalman filter is used for predicting the time when the first CMP position will be at the required distance along the preplot line. Relays are closed a fixed time prior to the estimated time of peak pressure. The raw, decoded data strings, and computed positions are stored to disk/tape.

The raw sensor data and Kalman filtered surface positions are passed from the Real Time acquisition system (TRINAV RT) to a near real time source and receiver positioning system (TRINAV QCPR). TRINAV QCPR computes positions online and provides facilities for any post processing required.

The data received by QCPR is immediately stored in a Techra relational database with directories for raw, filtered and processed data. Front, middle and tail networks are solved by least square adjustment at every shot-point. In-sea measurements are 'clipped' to remove large spikes. Statistical models are used to test the results of the adjustment, by detection of outliers. If the first iteration fails then the adjustment is repeated after the largest outlier has been removed. This routine is repeated until a satisfactory adjustment is achieved.

The quality of the data is then evaluated with the TRINAV application Diagnostics, against a set of standard criteria. WesternGeco's PAC, or **P**osition **A**cceptance **C**riteria, comprises of a set of tolerances on specified statistics, which allow this objective assessment of the positioning quality to be made.

The resulting node positions are then smoothed using Kalman filters. From the source node, the centre of source position is computed. The streamer cable shapes are computed from filtered compass data in order to establish positions for all the receiver groups. Wherever possible, the results of the real-time source and receiver positioning were used to make the final positioning data set. When the results from the online solution exceed the PAC additional processing was carried out on the 'off-line' system.

Final and raw navigation data in UKOOA standard formats was generated directly from the database on the off-line system. Available media are 3590 cartridges.

The technique for these is described in **WesternGeco's Navigation systems – a Technical Introduction,** which is available upon demand.

18.1.1. Shot Editor

The Shot Editor was available for use on all lines as follows:

- Editing of non-production shot-points at the start and end of each line.
- Interpolation of missing shot-points.

18.1.2. Gun Editor

The Gun Editor was available for use on all lines as follows:

- The Gun Editor was used on shot-points interpolated by the Shot Editor to generate the missing gun mask. The gun mask is normally relayed to TRINAV via the External Header.

- The Gun Editor was used to change the status of the sources to non-firing for any NTBP sections of the lines.

18.1.3. Recompute

The vessel system position was computed and the positions saved at one second intervals to disk/tape by TRINAV RT. The positions of all objects at the predicted time of peak pressure were passed to TRINAV QCPR and stored in the database online.

Diagnostics were used on each line to decide if the real time Kalman filtered positions were acceptable. If the positions were not acceptable, the Recompute program was used to select different positions for each object or to merge different DGPS systems for parts of the line.

If new positions were selected in the Recompute these were Kalman filtered in the Smoother program using a forward backward Kalman filter.

The following plots were available for examination and comparison of the positioning systems:

- User selected track plot display of color-coded positions.
- Inline and Crossline time series shot to shot plots for selected positions.
- Inline and Crossline time series difference plot between selected positions and a reference position.
- Time series plots giving stochastic analysis of position quality for selected positions.

18.1.4. Smoother

The Smoother program is used for smoothing of surface positions offline and for smoothing of tracking nodes both online and offline.

When QCPR is acquiring data online the tracking node positions are smoothed using a forward Kalman filter. If the tracking node positions exceeded the PAC tolerances, they were re-smoothed offline using a Forward-Backward Kalman Filter. If new positions were selected in the Recompute program these were smoothed and time adjusted to shot time using the Kalman Forward-Backward filter.

Kalman filter

This filter assumes that between any two shot points there will be zero average acceleration but some oscillation (noise) around the average.

Forward-Backward (FB) Kalman Filter

All smoothing in post processing was performed using a Forward-Backward Kalman filter. This is essentially the weighted average of the raw data and two individual Kalman filters running in opposite directions through the data set.

This filter has the same acceleration parameters as the online Kalman filter but has separate rejection window parameters (for X and Y) thus enabling the user to model the expected motions independently. The FB Kalman filter for surface positions works in the area relative co-ordinate frame, while the FB Kalman and Kalman filters applied to the tracking nodes work in a vessel relative coordinate frame.

The quality of the smoothing was checked using the following difference plots:

- Difference between smoothed and un-smoothed data was checked to see the effect of the filter settings applied.
- Velocity cross-line and in-line plots indicate the amount of noise in the smoothed position.
- Variance Factor plot indicates the fit between the predicted and raw positions.

18.1.5. Filtering

Compass Processing

The compasses were filtered online using two successive Kalman filters to avoid introducing any lag in the data. The difference between the predicted compass reading and the actual compass reading is tested at each shot. If the residual exceeds twice the standard deviation for two successive shots the online compass filtering was flagged as requiring post processing. If the online compass filtering failed, the data was analyzed by viewing time-series plots of raw and filtered data. Filter parameters were chosen to remove spikes and noise from the compasses. In the first instance the Kalman filter parameters were tuned to match the specific data set. If this did not achieve the desired result the following filters were used: -
For front compasses a median filter or a combination of median and mean filters.
Mid streamer and tail filters normally required a longer median depending on noise and movement.

Gyro Filtering

No gyro filtering was carried out.

Acoustic Filtering

The acoustic networks were designed with maximum redundancy to ensure that positioning specifications could be maintained in case of range dropouts due to mechanical or electrical failure, noise or interference. All acoustic data was investigated using time-series plots.

The survey program is designed to identify by means of statistical testing where spikes and reflected ranges are corrupting the data as long as there is sufficient redundancy. On occasions it was necessary to apply clipping filters to remove large spikes which tended to degrade the solution of the tracking nodes. It was necessary to condition the data using some median/mean filters also.

18.1.6. Reprocessing

The source and receiver position computation is divided into a number of discrete steps. These steps are executed automatically online. If post processing is required the operator is able to change parameters and examine the output between steps.

The processes are:

1. Least Squares solution of front and tail networks.
2. Kalman/Kalman FB smoothing of front and tail network tracking nodes
3. Computation of the streamer shape: receiver group lengths and sensor offsets are modified using a streamer tension model. Least squares condition equations are then used to compute corrections to the receiver group intervals and compasses in order to best fit the front and tail tracking nodes. The amount of stretch/compression permissible is user specified. The computation of positions and estimation of variances of the mid streamer network nodes is included in this process.
4. Least squares solution of the mid streamer network
5. Smoothing of the mid streamer tracking nodes
6. Step (3) is repeated using the front, middle and tail tracking nodes.

The least squares solutions include statistical testing and automatic rejection of outliers on a shot by shot basis.

18.2. Quality Control

Navigation post-processing was carried out on-board through to UKOOA P1/90 and P2/94 tape production.

18.2.1. First Line Test Data

After the first line was shot and processed, a test line was sent electronically to an external contractor, ECL. The data sent comprised:

1. All offset diagrams (vessel, streamer, source and float)
2. Offset spreadsheets
3. Velocity Profile Spreadsheet,
4. 100 shot points of P1 and P2 data
5. ASCII file of Diagnostics for this line
6. ASCII file of LAF for this line
7. ASCII files of Surface and Insea Survey Definitions
8. Job Book (as supplied from the supporting office)
9. Minutes from Start-up meeting (if relevant)
10. PFM Magnetic Variation Spreadsheet

A thorough QC of this test line was undertaken. The following checks were carried out:

- Strict compliance with published UKOOA P1 and P2 header and data format and generation of Format Check Reports.
- Graphical display of source and receiver towing geometry and comparison with WesternGeco office and vessel generated diagrams/documentation.
- Full vessel Configuration Report, as defined in the P2 header.
- Check P2 header defined Tow Points, Geodetic Parameters, etc. against WesternGeco Job Book and/or published values.
- List P2 header differences from a prior line sequence (if required).
- Raw data display and analysis
- Automated and manual (if required) data conditioning.
- Data processing to independently resolve vessel, source and receiver co-ordinates.
- Full position comparison report with WesternGeco P1/90 co-ordinates.
- Investigation of unacceptable position comparison results.
- Data Check and Statistics Report for compliance testing with survey contractual standards and specifications.
- Generation of statistics, error reports, test results, displays etc. as deemed necessary to highlight problem areas.
- Generation of QCPro P1/90 file, if desired.
- Check P2 file compliance with WesternGeco standard survey definition naming conventions.
- Check P1/90 and P2 file data compliance with WesternGeco standard numbering conventions.
- Comparison of vessel survey definitions with supplied offset spreadsheet and diagrams.
- Conduct Parameter Confirmation following the Parameter Confirmation Check Lists, MWWD/F012 and MWWD/F013.
- Other Survey Start-Up tests and checks as required and directed by WesternGeco.

When all the checks were performed a feedback report was published on ECL's secure web site. Any corrections required were made by the vessel. The Supporting Office and ECL then received a confirmation from the vessel that all updates had been completed.

18.2.2. Initial QC

The post-processing procedures included the following checks:

- QC checks on all survey parameters.
- Generation of correct survey definitions.
- Completion of shot point edits.
- P2/94 production.
- Completion of gun edits.
- QC of system positions and recomputed positions if required.
- Smoothing of the vessel and buoy positions if required.
- Selective check and filtering if required, of the observations including:
  - Acoustic ranges.
  - Compass bearings.
  - Gyro heading.
- Least squares adjustment of front and tail network if required.
- Smoothing of source/streamer tracking nodes if required.
- Cable shaping to determine final source/receiver positions if required.
- Final QC of all lines
- P1/90 production.

The following documentation was produced for onboard QC:

- Navigation reports detailing information about the survey parameters, calibrations and continuing daily logs.
- A series of statistics and plots from on-line data acquisition:
  - Navigation line logs detailing performance and parameters used for the surface positioning, acoustics and compasses for each line.
  - Seismic observer's logs detailing gun information.
  - Edits list from the seismic observers detailing gun information.

18.2.3. Final QC

The post network solution QC plots and statistical printouts detailed in the previous section were examined and compared to WesternGeco specifications. In addition, trend analysis plots were created and updated after each line. They were analyzed daily to ensure consistency throughout the data set.

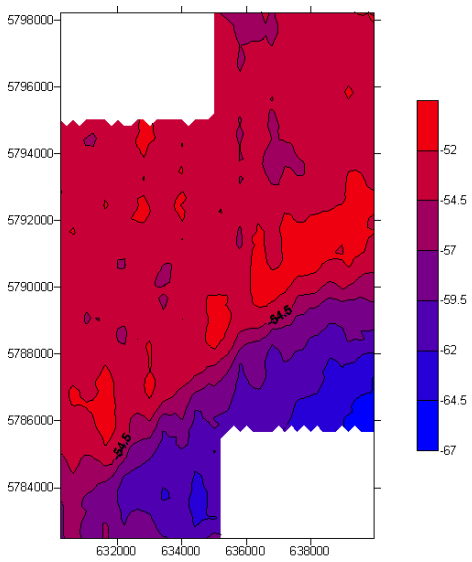
18.3. Water Depth Processing

Water depth processing was done on the raw water depth data onboard the vessel.

The water depth data was reduced to Mean Sea Level and then:

- corrected for draught
- filtered to de-spike and interpolate missing data
- corrected for the measured sound velocity in water

The final data was dispatched on 3590 tape direct from the vessel.



Bathymetry plot for Survey

19. Observations

19.1. Navigation Summary

All systems performed well, however during acquisition the below systems required further detail.

19.1.1. TRINAV RT/QCPR & Spectra

There were two instances where TRINAV did not issue Fire Command to the SSS which caused small reshoots. This was pinpointed to a bad connection in one timing cable out of the TRINAV VME chassis and corrected.

19.1.2. rGPS (Sources, Head and Tail Buoys)

All source and tail buoy floats were operational throughout the survey. The Stbd head buoy rGPS was not operational for sequence 018. Marginal weather conditions affected the data quality at times especially on the gun string rGPS units as waves can swamp the antennas mounted 0.8m above the water line.

19.1.3. Acoustics

Acoustic performance throughout the survey was generally good. Ranges from the guns were generally poor as were the cross streamer ranges between streamers 4 and 5 as they passed through the gun bubble.

19.1.4. Compasses

The compass data was affected by swell on a several sequences, throughout the job. Spikes were observed of up to 15° in a background “noise” of 1° to 2°. The inspection of the data and subsequent filtering provided for smooth lines, although there remained some positioning uncertainty on the worst affected lines of the prospect.

19.2. Processing and QC Summary

All lines have been processed to pass the Trinav PAC (Position Acceptance Criteria). Data quality in general was good but due to the 8m streamer depth allowing acquisition to continue in moderately rough sea conditions the compass data was noisy on several sequences and heavier filters were required. Online compass calibrations for individual compasses also failed on some of these sequences.

Acoustic data was poor in the cross streamer ranges between cables 4 and 5 – this was a result of a combination of the gun bubbles and the propeller wash. Nevertheless, the acoustic network was very well behaved and the redundancy that is always built in served to provide a very solid network solution on all lines.

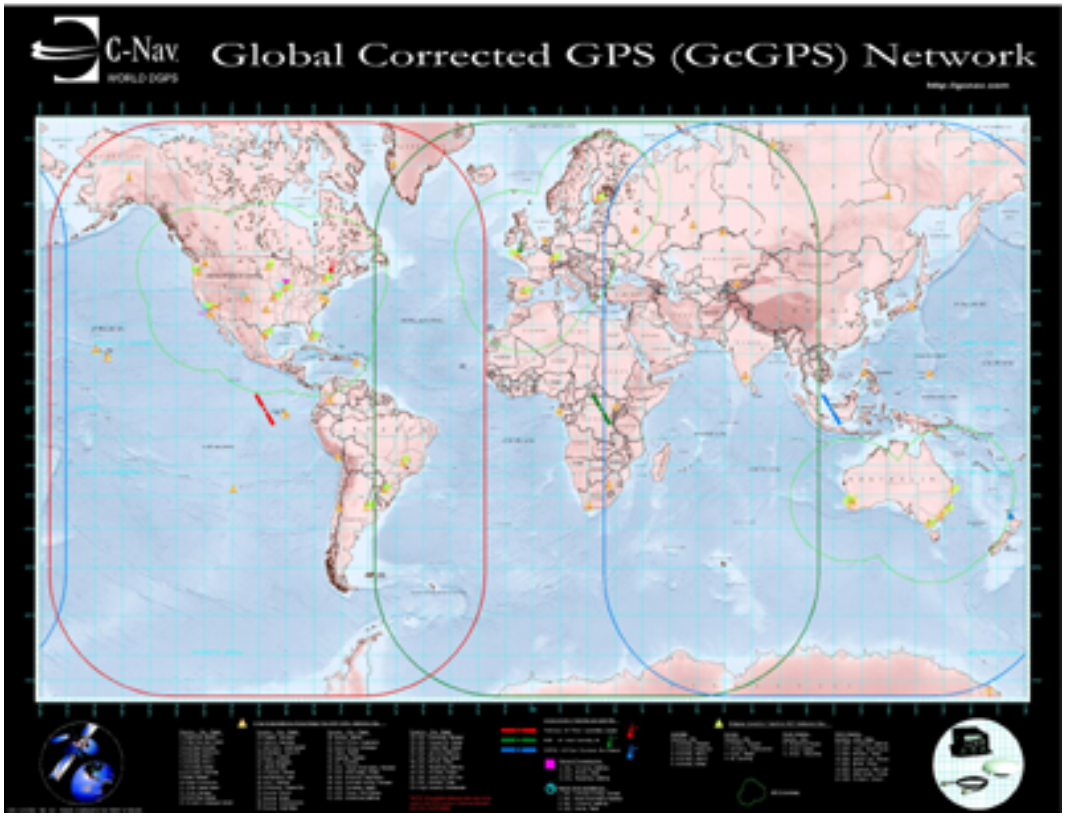
19.3. Conclusions

An acceptable data set was acquired and all the client's requirements were met for the survey.

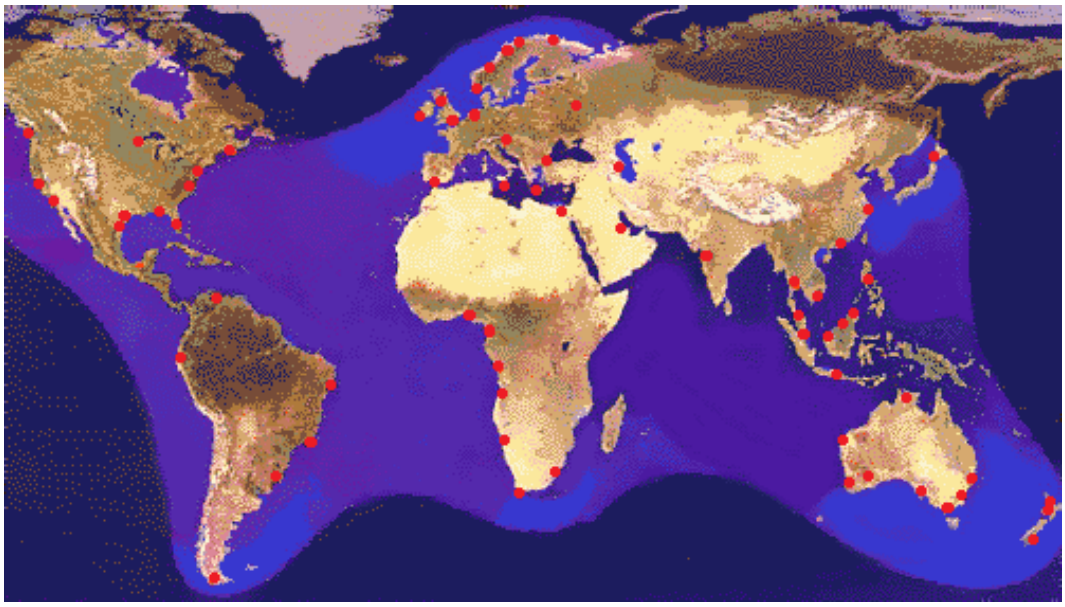
20. Navigation Exhibits

Exhibit 1 : **Navigation System**

DGPS Coverage Maps for RTCM Sources



OmniStart Reference Stations for MultiFix Standard



GPS System Installation Notes

20.1.1.1.1 WesternGeco GPS Receivers

TRINAV GPS

Novatel Millennium Receiver

- Serial number CGY00180002
- Hardware revision: 2.03
- Firmware revision: 4.503/2.03
- Receiver connected to the GPS splitter for the forward Trimble antenna

PosNet-1 Trimble

- Model: Trimble SSI
- Serial number: 3839A23949
- Software: Posnet version 1.81
- Firmware: Version 7.29
- Connected to the splitter for the aft Trimble antenna

PosNet-2 Trimble

- Model: Trimble SSI
- Serial number: 3807A21806
- Software: Posnet version 1.81
- Firmware: Version 7.29
- Connected to the splitter for the aft Trimble antenna

rtCalib

- Model: Leica MX9400
- Serial number: 312
- Firmware: version 1.59A
- Connected to the splitter for the aft Trimble antenna

20.1.1.1.2 Third Party GPS

Multifix Main

- Model: Ashtech
- Serial number: ZE1200337006
- Software: Multifix 4 version 1.05
- Firmware: Version ZE00
- Connected to the splitter for the aft Trimble antenna

Skyfix Main

- Model: Ashtech
- Serial number: SPM-236
- Software: Starfix HPM vers 4.03
- Connected to the splitter for the aft Trimble antenna

CNAV Main

- Model: 53220-00 Rev X
- Serial number: 250334
- Software: 13.3
- Firmware:
- Connected to the splitter for the aft Trimble antenna

TrueTime Receivers

There are two TrueTime receivers in use. One of them is a standard integrated timing receiver (ITR) being used to provide an IRIG-B timing reference signal for TRINAV. The other is a two-boat timing receiver that is being used as a Timing QC tool to time stamp the TRINAV closure and CTB1 time break signal from the Spectra for comparison purposes.

ITR

- Model: XL-DC-151-601
- Serial number: 9617419
- Software: TrueTime mk III sys ver 020
- Firmware: GPS XL V1.036 182-6111V003
- Connected to the splitter for the aft Trimble antenna.

Timing QC

- Model: 151-602-708
- Serial number: 012117249
- Software: TrueTime XL Ace3 sys ver 029
- Firmware: GPS XL V1.049 182-6483V008
- Connected to the splitter for the aft Trimble antenna.

TRINAV GPS Integrity Monitor Station Description

Station Name: SALE
Location: South East Asia / ASA
Country: Australia

Latitude	38° 06' 06.273" S
Longitude	147° 05' 21.199" E
Ellipsoid	WGS-84
Semi Major Axis	6378137.0 m
Inverse flattening	1/298.257 223 563
Datum:	WGS-84
Ellipsoid Height	21.44m

Station Description	The Station is located at the Schlumberger OFS Office at Raglan Street, Sale, Victoria AUSTRALIA
Antenna:	The antenna in use is a Model 502 L1/L2 GPS Dual Frequency Antenna from Novatel. The antenna is mounted on a pole on the front of the building, giving a height above ground of approximately 10m. The Receiver is located in the Server Room Racks. Cable run from Antenna to receiver is approx 15m. (LMR-195 cable)
Receiver unit:	The unit in use at the Integrity Monitor is a Novatel Power Pak II dual frequency receiver. Installation was on the 10 May 2002
Observation and Processing method:	The Antenna Position was Surveyed by Kluge Jackson consultants using standard survey methods. Height was derived through measurement on the Australian Height Datum AHD (15.64m) and addition of AUSGEOID98 Model Geoidal Separation value (5.8m).
Date of Survey:	10th May 2002
Comments:	None.

Exhibit 2 : **Echo Sounder Calibration**

Echo Sounder Check (In Port)

Vessel:	Western Trident	**Date :**	23/12/2004
Client:	Apache	**Check started (GMT):**	
Job no.	9438	**Check ended (GMT):**	
Location:	Freemantle	**E/S draught:**	7.65 m
E/S type:	Simrad EA500	**Vertical offset keel to E/S:**	0.00 m
Serial no:	4139	**Bridge E/S reading**	N/A

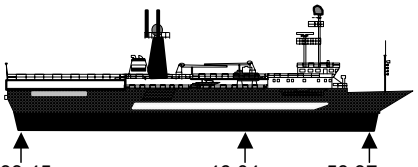
Observed				
Draught (m)			Lead Line Depth (m)	
Bow	Mid-ships	Stern	Stbd (1)	Port (2)
6.90		7.60	10.65	13.50
Draught at E/S		**6.99**	LL Depth at E/S	**12.08**

Echo Sounder Readings	
Freq 1 (m) 18 MHz	Freq 2 (m) 200MHz
4.80	4.90
4.80	4.90
4.80	4.90
4.80	4.90
Average =	**4.80**	**4.90**
+ vertical offset keel to E/S transducer	0.00	0.00
+ draught (keel to sea surface)	6.99	6.99
Total water depth (m)	**11.79**	**11.89**

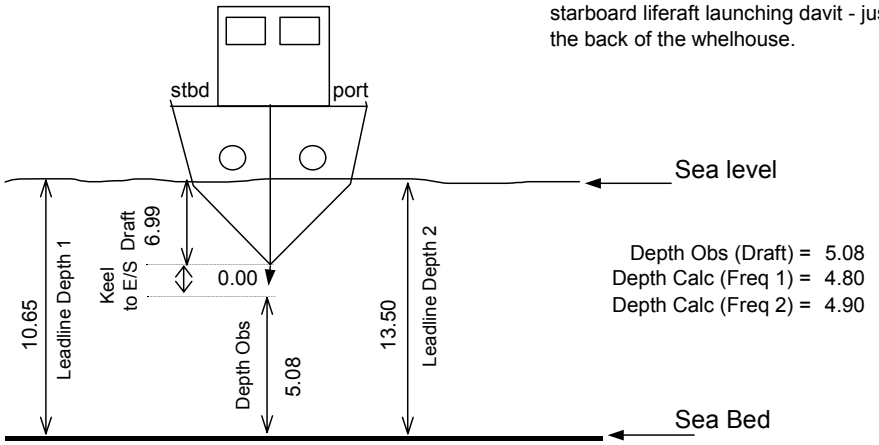
Observed - Echo Sounder = **0.28 m** Freq 1

Observed - Echo Sounder = **0.18 m** Freq 2

Sounder Settings Check:	**Factory Defaults (from manual)**	**Check**
RangeA	xx.xx	
Absorption coefficient	3 dB/Km	
Transmit power	2000 W	
Transducer Depth	0.00	
Speed of sound	1500 m/s	
two way beam angle	-17 dB	
Transducer gain	25 dB	
Sample distance	0.25	



Offsets above are relative to VRP
Echosounder probe is directly below the starboard liferaft launching davit - just behind the back of the whelhouse.



Depth Obs (Draft) = 5.08
Depth Calc (Freq 1) = 4.80
Depth Calc (Freq 2) = 4.90

Exhibit 3 **: GPS and Gyro Calibration**

Offshore Calibration Report

OFFSHORE CALIBRATION REPORT

Table of Contents

I. Introduction and Abstract of Results

During the seismic survey undertaken by M/V Western Trident for Apache from December 30th 2004 to January 15th, 2005 on the VIC/P47, Moby 3D prospect (WesternGeco job number 9438), the DGPS, rGPS and Gyro positioning systems were monitored continuously throughout acquisition. This allowed C-O values to be computed, monitored and modified, if necessary, whilst offshore. These offshore calibration techniques have been developed by WesternGeco – the principal components comprise:

- The Integrity Monitor, one of several shore reference stations where a GPS receiver and data link are established at a known co-ordinated point allowing comparisons of the vessel GPS receiver performance against the reference receiver.
- The Re-radiation Kit which enables rGPS systems to be fed the same GPS signal as the vessel receiver, thus allowing performance evaluation to be undertaken by means of a zero baseline test.
- The RT Calib system that uses the Primary vessel GPS together with a second GPS installation at a predetermined point on the vessel to determine a heading vector against which the vessels Gyros may be calibrated.

The technique for these is described in **WesternGeco's Navigation systems – a Technical Introduction,** which is available upon demand.

The report presents the observations and results from these offshore calibrations.

Abstract of Results

Value		C-O	SD
Gyro 1 (mean)		-1.27°	0.57°
Gyro 2 (mean)		0.00°	0.57°
GPS Integrity Monitor Results	Delta Easting	0.91m	0.84m
	Delta Northing	0.28m	0.67m

Navigation System Average Radial Differences

	Diff	SD
TriGPS	0.65m	0.10m
C-Nav	0.53m	0.11m
Posnet 1	0.58m	0.10m
Posnet 2	0.76m	0.16m
Multifix	7.48m	12.02m

II. Differential GPS Verification

M/V Western Trident utilised the following DGPS systems throughout the survey:

Primary vessel positioning was provided by C&C Technologies' CNav with RTG corrections via an integrated receiver.

Secondary vessel positioning was provided by Multifix 4 with direct injection of Skyfix XP and Skyfix Standard RTCM corrections delivered by Inmarsat B and Optus sat.

A Novatel Millennium Dual Frequency GPS receiver provided raw pseudo range data to WesternGeco's TRINAV GPS 2.6 for tertiary vessel positioning with Skyfix RTCM corrections delivered by Inmarsat B and Optus sat and RTCM corrections generated by CNAV.

Data transfer between the vessel and the Integrity Monitor Receiver was achieved using the vessel's VSAT satellite data link.

Method used

Refer to **WesternGeco's Navigation systems – a Technical Introduction**, DGPS Calibrations Integrity Monitor section.

A dual frequency receiver on board combined with a dual frequency Integrity monitor allowed the computation a DF vector between vessel and monitor station which provided positioning integrity irrespective of whether a single or dual frequency solution was used for the vessel positioning.

Results

Chapter VI contains a summary of the statistics taken from the diagnostics files and derived from the data logged by rtDisplay.

Chapter VII contains numerical data from rtcalib for the integrity monitor.

Figure 1 shows an example of the Integrity monitor QC plot created for each sequence. Figures 2 and 3 show the trend analysis for the compete survey.

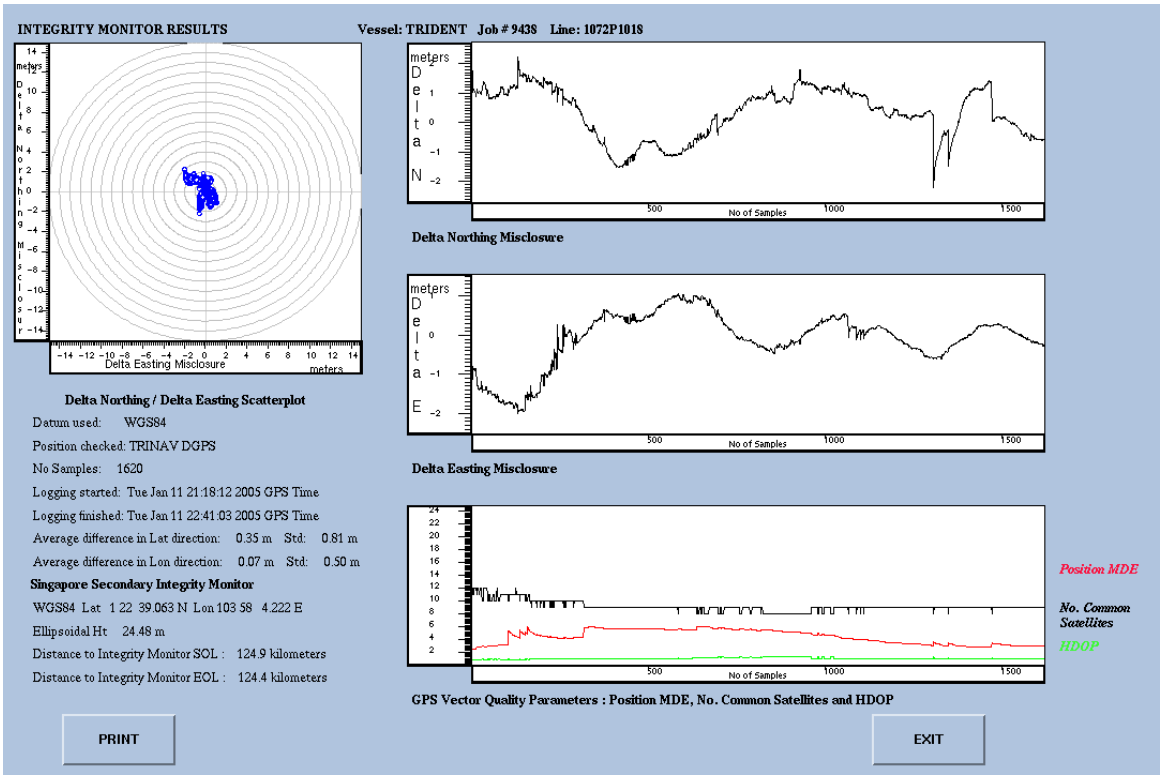


Figure 1: Integrity Monitor Plot to demonstrate GPS quality

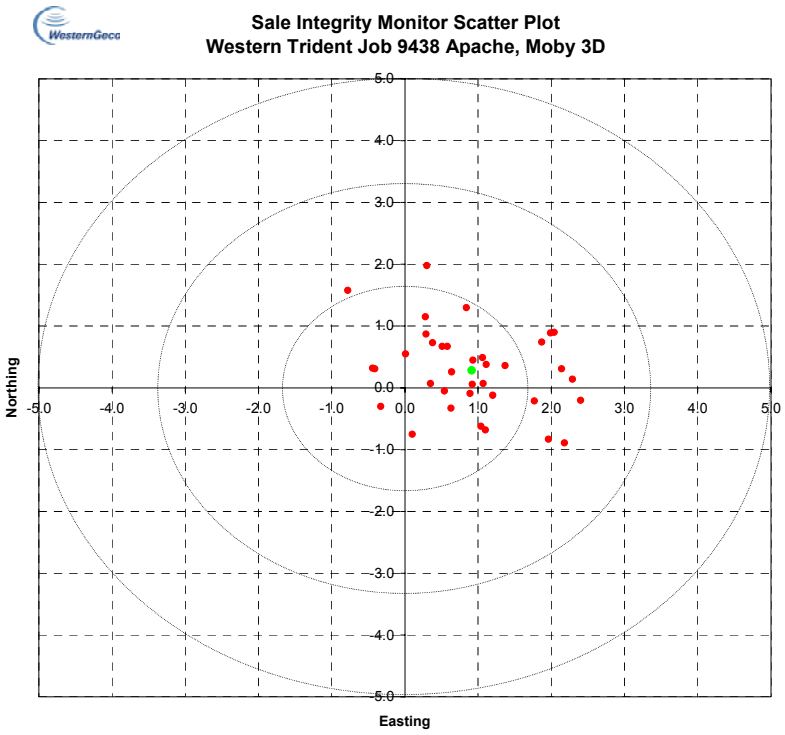


Figure 2: Integrity Monitor Delta Easting - Delta Northing Scatter Plot

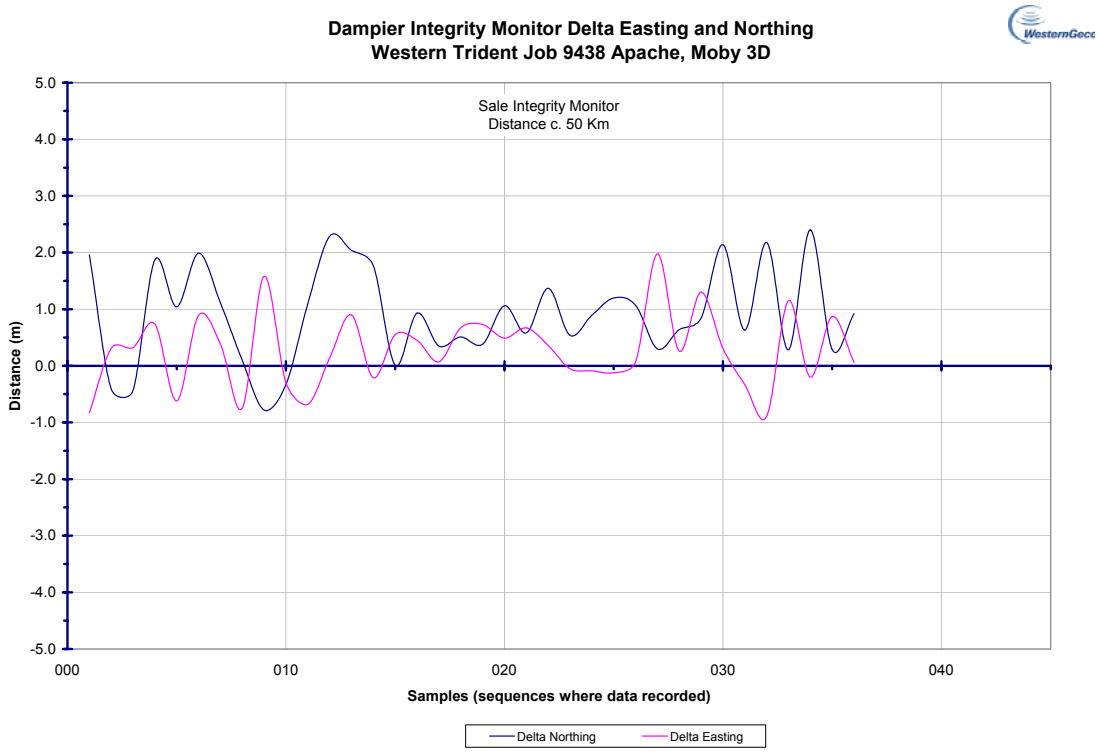


Figure 3: Integrity Monitor Delta Easting – Delta Northing Trend

III. rGPS Verification

M/V Western Trident utilised WesternGeco's TRINAV GPS 2.6 rGPS system throughout this survey for Float and Source positioning. The GPS signal received by the main TRINAV GPS vessel receiver is split using a purpose designed GPS splitter from WR systems inc. It is then used by both the main vessel receiver and transferred to a re-radiating antenna on the back deck, allowing use of a near identical GPS signal by float and vessel receivers simultaneously.

Method used

Refer to **WesternGeco's Navigation systems – a Technical Introduction**, rGPS Calibrations section.

Results

The table below shows a summary of the statistics taken from plots within TRINAV GPS for all float units. This table contains collated data from the re-radiation tests done at the start of the survey.

	Lat	Lon
F001	0.47	-1.02
F002	-0.71	-0.01
F003	-0.10	0.58
F004	-0.50	0.06
F005	0.47	0.67
F006	-0.44	0.20
F007	-0.70	0.11
F008	-0.34	0.24
FG01	0.56	0.36
FG02	0.55	-1.30
FG03	-0.19	-0.64
FG04	0.22	0.52
FG05	0.47	0.67
FG06	-0.13	-0.57
FG07	0.42	-0.56
FG08	0.66	-0.59
FF01	1.10	1.24
FF02	-0.41	-0.88

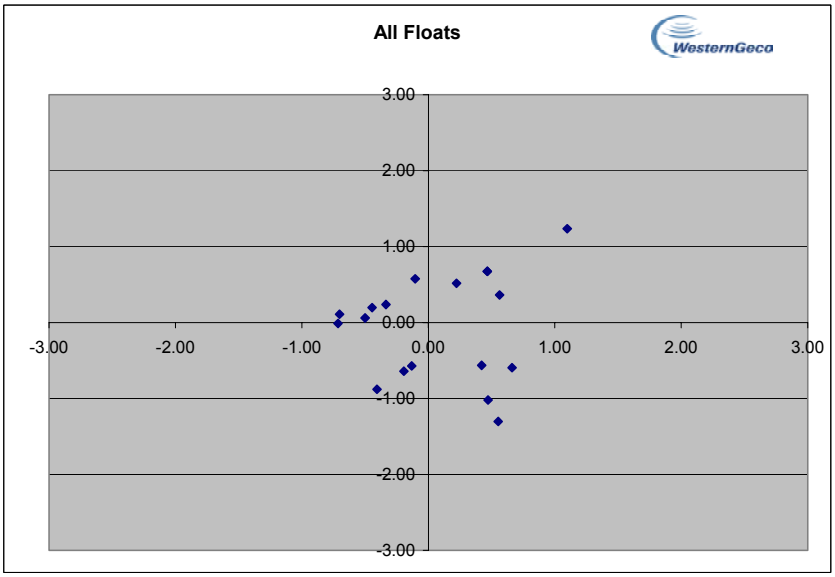


Table 1: rGPS verification test data from re-radiation tests

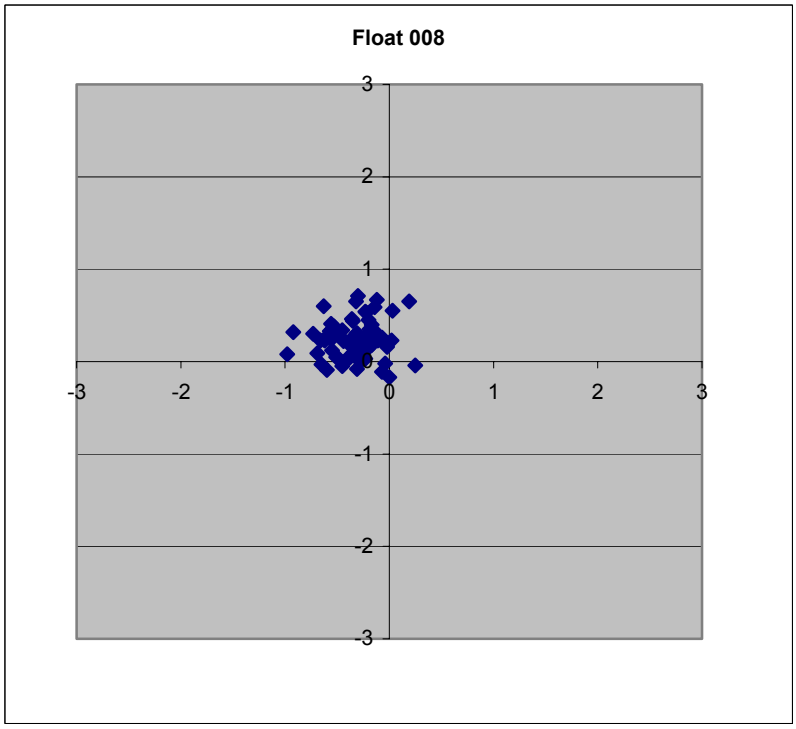


Figure 4: A typical data sample for a unit

IV. Gyro Calibration

M/V Western Trident is fitted with two gyro compasses of type SR-180 MK1, a main survey gyro and a secondary gyro for comparison and backup use. TRINAV GPS is used to determine the heading vector, for comparison with the Gyro headings. This utilises the standard vessel receiver as described above and a second MX 9400 receiver. The second receiver's antenna is mounted 17.3 m ahead of the primary receiver's, with the minimum practicable difference in height. The positions of all antennas used in the Gyro calibration process are determined during a high precision Offset Measurement Survey, performed by an independent contractor, whilst the Vessel is in dock or alongside.

Method used

Refer to **WesternGeco's Navigation systems – a Technical Introduction**, Gyro Calibrations section.

Results

Results from RT Calib are available in several formats, both graphical and tabular. Figure 5 is an example of the QC plot created for each sequence to monitor the Gyro performance. Figure 6 shows the average C-O for each of the gyros in graphical form for all the sequences acquired.

Numerical results for RT Calib are shown in chapter VII.

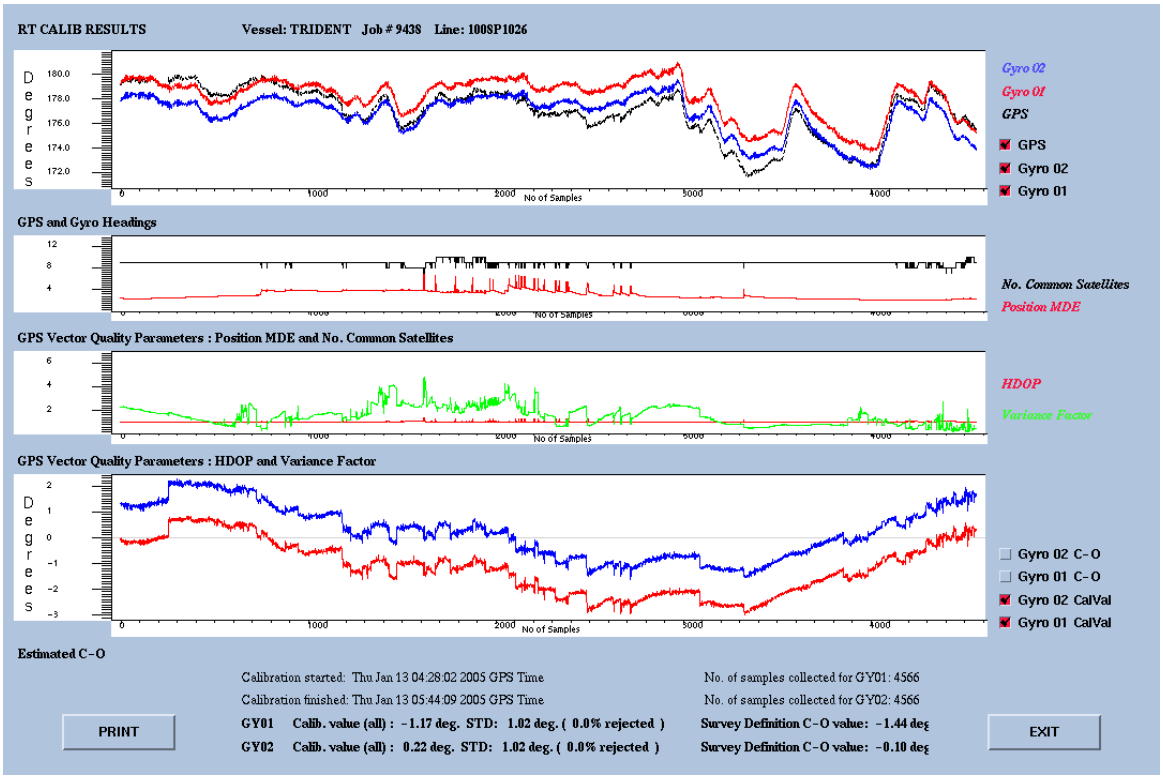


Figure 5: Example of rtcalib plot for a singe sequence

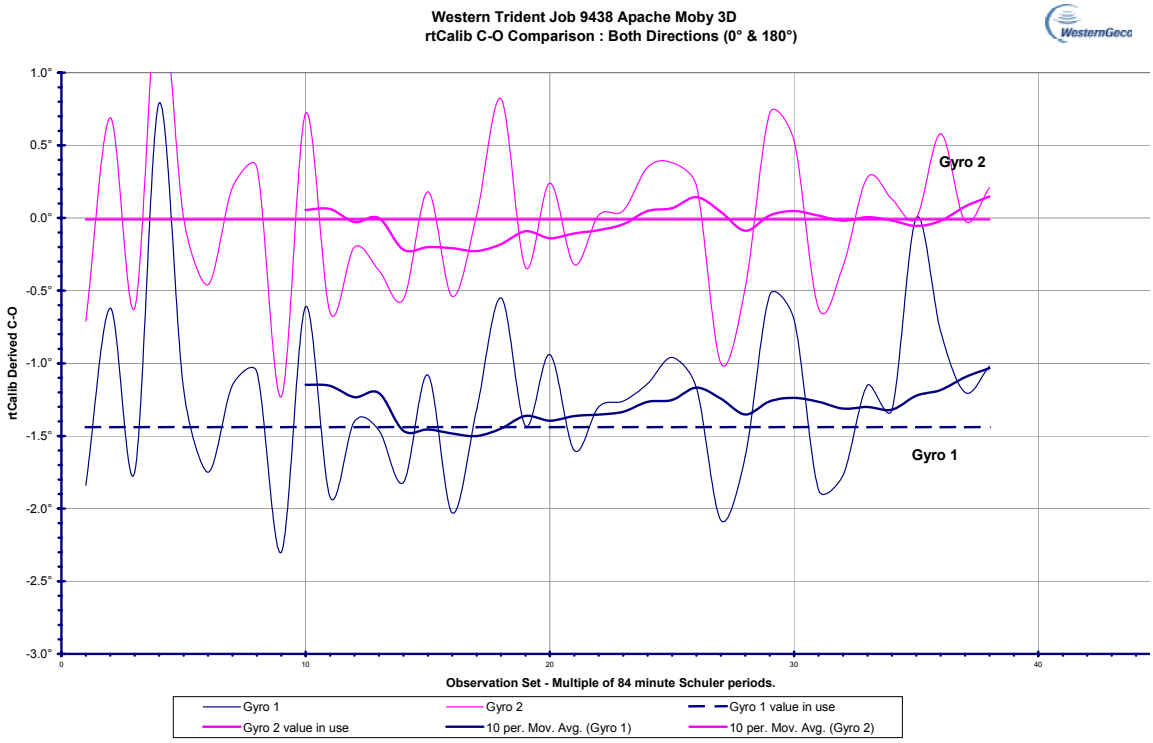


Figure 6: Gyro Calib Trends

V. Conclusions and Comments on Data Quality

The primary gyro calibration value computed from the previous survey and used for this survey agrees well with the offshore calibration results of this survey (as seen in the numerical results in chapter VII).

The re-radiation tests conducted at the start of the job showed no significant deviations thus confirming performance of individual rGPS units.

The GPS positions throughout the survey were reliable and in good agreement with one another (figure 7) with the exception of MultiFix which had an intermittent equipment fault during the survey period. MultiFix was not used in the Primary estimator.

VI. Secondary & Tertiary DGPS System Differences to TRINAV GPS

The following table contains a summary of the statistics taken from the diagnostics files and derived from the data logged by rtDisplay.

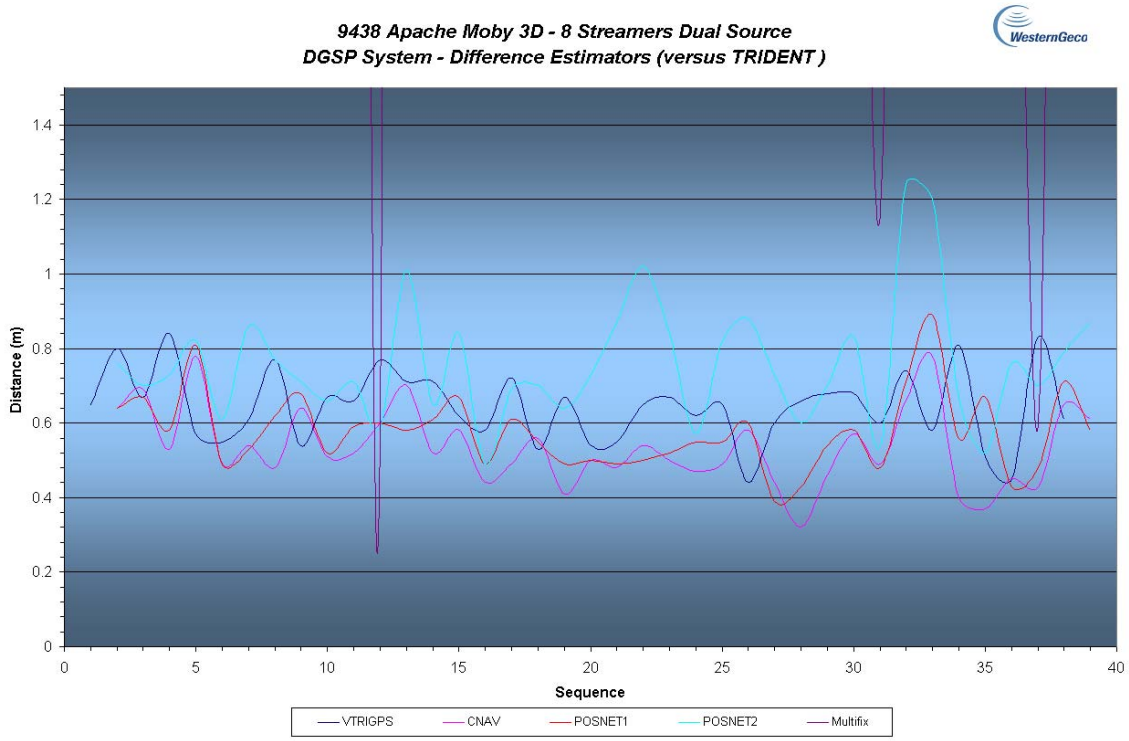


Figure 7: Differences between GPS systems during the survey

VII. Line by Line Results from RT Calib for Gyros and Integrity Monitor

Available Gyros: GY01 Surveydef Corr: -1.44 deg

GY02 Surveydef Corr: -0.10 deg

Gyro Calibration Results:

Western Trident Job 9438 Apache Moby 3D
rtCalib C-O Comparison : Both Directions (0° & 180°)

Seq	Line Name		C-O	Std	Samples		C-O	Std	Samples
1	1392P1001	GY01	-1.84	0.70	3791	GY02	-0.71	0.85	4098
2	1200P1002	GY01	-0.62	0.40	3815	GY02	0.69	0.44	3825
3	1392P2003	GY01	-1.75	0.50	4188	GY02	-0.62	0.49	4188
4	1184P1004	GY01	0.79	1.21	3794	GY02	1.61	0.86	3192
5	1376P1005	GY01	-1.18	0.59	4788	GY02	0.00	0.60	4788
6	1168P1006	GY01	-1.75	0.61	3661	GY02	-0.46	0.61	3661
7	1360P1007	GY01	-1.15	0.34	4770	GY02	0.21	0.34	4770
8	1152P1008	GY01	-1.06	0.78	3783	GY02	0.35	0.81	3821
9	1344P1009	GY01	-2.30	0.45	4393	GY02	-1.23	0.71	5022
10	1136P1010	GY01	-0.61	0.80	3843	GY02	0.72	0.79	3843
11	1328P1011	GY01	-1.92	0.45	5222	GY02	-0.65	0.43	5222
12	1120P1012	GY01	-1.40	0.80	3872	GY02	-0.20	0.78	3872
13	1312P1013	GY01	-1.46	0.87	4876	GY02	-0.36	0.90	4941
14	1104P1014	GY01	-1.82	0.76	3153	GY02	-0.56	0.75	3170
15	1296P1015	GY01	-1.08	0.53	4903	GY02	0.18	0.53	4903
16	1088P1016	GY01	-2.03	0.78	4246	GY02	-0.54	0.76	4246
17	1280P1017	GY01	-1.32	0.93	5034	GY02	0.02	0.93	5034
18	1072P1018	GY01	-0.55	0.20	4378	GY02	0.82	0.20	4378
19	1264P1019	GY01	-1.43	0.78	3406	GY02	-0.34	1.02	3819
20	1056P1020	GY01	-0.94	0.67	4637	GY02	0.24	0.69	4637
21	1248P1021	GY01	-1.60	0.46	4250	GY02	-0.32	0.46	4250
22	1040P1022	GY01	-1.30	0.69	4880	GY02	0.02	0.68	4880
23	1232P1023	GY01	-1.26	1.16	4300	GY02	0.05	1.17	4308
24	1024P1024	GY01	-1.14	0.51	4563	GY02	0.35	0.52	4563
25	1216P1025	GY01	-0.96	1.06	4471	GY02	0.38	1.08	4539
26	1008P1026	GY01	-1.17	1.02	4566	GY02	0.22	1.02	4566
27	1216J1027	GY01	-2.08	0.91	3920	GY02	-1.00	1.09	4550
28	1008J1028	GY01	-1.64	0.87	4549	GY02	-0.48	0.92	4664
29	1344J1029	GY01	-0.53	0.80	4519	GY02	0.72	0.76	4519
30	1104J1030	GY01	-0.70	0.51	3901	GY02	0.53	0.65	4039
31	1360J1031	GY01	-1.87	0.86	4513	GY02	-0.62	0.84	4567
32	1136J1032	GY01	-1.77	0.79	4303	GY02	-0.33	0.82	4359
33	1248J1033	GY01	-1.15	0.50	5001	GY02	0.28	0.50	5005
34	1184J1034	GY01	-1.32	0.46	4971	GY02	0.13	0.46	4971
35	1328A1035	GY01				GY02			
36	1072J1036	GY01	-0.78	0.37	2454	GY02	0.58	0.37	2454
37	1216J2037	GY01	-1.20	0.32	4748	GY02	-0.02	0.30	4748
38	1136J2038	GY01	-1.02	1.39	3839	GY02	0.21	1.41	3896
	Average C-O Gyro 1		**-1.27**		**Average C-O Gyro 2**		**0.00**		
	STD Gyro 1		**0.57**		**STD Gyro 2**		**0.57**		

GPS Integrity Monitor Results:

Seq	Line Name		C-O Northing	Std [m]		C-O Easting	Std [m]
2	1200P1002	IM_dn	1.96	0.39	IM_de	-0.83	1.14
3	1392P2003	IM_dn	-0.41	1.66	IM_de	0.31	0.6
4	1184P1004	IM_dn	-0.44	0.74	IM_de	0.32	0.52
5	1376P1005	IM_dn	1.87	1.33	IM_de	0.74	0.85
6	1168P1006	IM_dn	1.04	1.32	IM_de	-0.62	1.02
7	1360P1007	IM_dn	1.99	1.44	IM_de	0.89	0.56
8	1152P1008	IM_dn	1.11	2.21	IM_de	0.38	0.59
9	1344P1009	IM_dn	0.1	0.79	IM_de	-0.75	0.49
10	1136P1010	IM_dn	-0.78	1.37	IM_de	1.58	1.02
11	1328P1011	IM_dn	-0.33	0.68	IM_de	-0.3	1.07
12	1120P1012	IM_dn	1.1	1.48	IM_de	-0.68	1.1
13	1312P1013	IM_dn	2.29	1.38	IM_de	0.14	0.93
14	1104P1014	IM_dn	2.04	2.61	IM_de	0.9	0.95
15	1296P1015	IM_dn	1.77	1.69	IM_de	-0.21	0.76
16	1088P1016	IM_dn	0.01	2.05	IM_de	0.55	0.89
17	1280P1017	IM_dn	0.93	1.01	IM_de	0.45	0.93
18	1072P1018	IM_dn	0.35	0.81	IM_de	0.07	0.5
19	1264P1019	IM_dn	0.51	1.02	IM_de	0.67	0.7
20	1056P1020	IM_dn	0.38	0.8	IM_de	0.73	0.52
21	1248P1021	IM_dn	1.06	0.77	IM_de	0.49	0.74
22	1040P1022	IM_dn	0.58	1.14	IM_de	0.67	0.62
23	1232P1023	IM_dn	1.37	0.84	IM_de	0.36	0.72
24	1024P1024	IM_dn	0.54	0.95	IM_de	-0.05	1.25
25	1216P1025	IM_dn	0.89	0.84	IM_de	-0.09	0.31
26	1008P1026	IM_dn	1.2	1.12	IM_de	-0.12	1.47
27	1216J1027	IM_dn	1.07	0.73	IM_de	0.07	0.63
28	1008J1028	IM_dn	0.3	0.72	IM_de	1.98	1.1
29	1344J1029	IM_dn	0.64	1.08	IM_de	0.26	1.21
30	1104J1030	IM_dn	0.84	1.87	IM_de	1.3	0.93
31	1360J1031	IM_dn	2.14	1.48	IM_de	0.31	0.7
32	1136J1032	IM_dn	0.63	1.49	IM_de	-0.33	0.84
33	1248J1033	IM_dn	2.18	2.43	IM_de	-0.89	1.1
34	1184J1034	IM_dn	0.28	1.52	IM_de	1.15	0.79
35	1328A1035	IM_dn	2.4	0.13	IM_de	-0.2	0.11
36	1072J1036	IM_dn	0.29	0.86	IM_de	0.87	0.83
37	1216J2037	IM_dn	0.92	1.2	IM_de	0.06	0.42
		Average dn	**0.91**		**Average de**	**0.28**	
		STD dn	**0.84**		**STD de**	**0.67**	

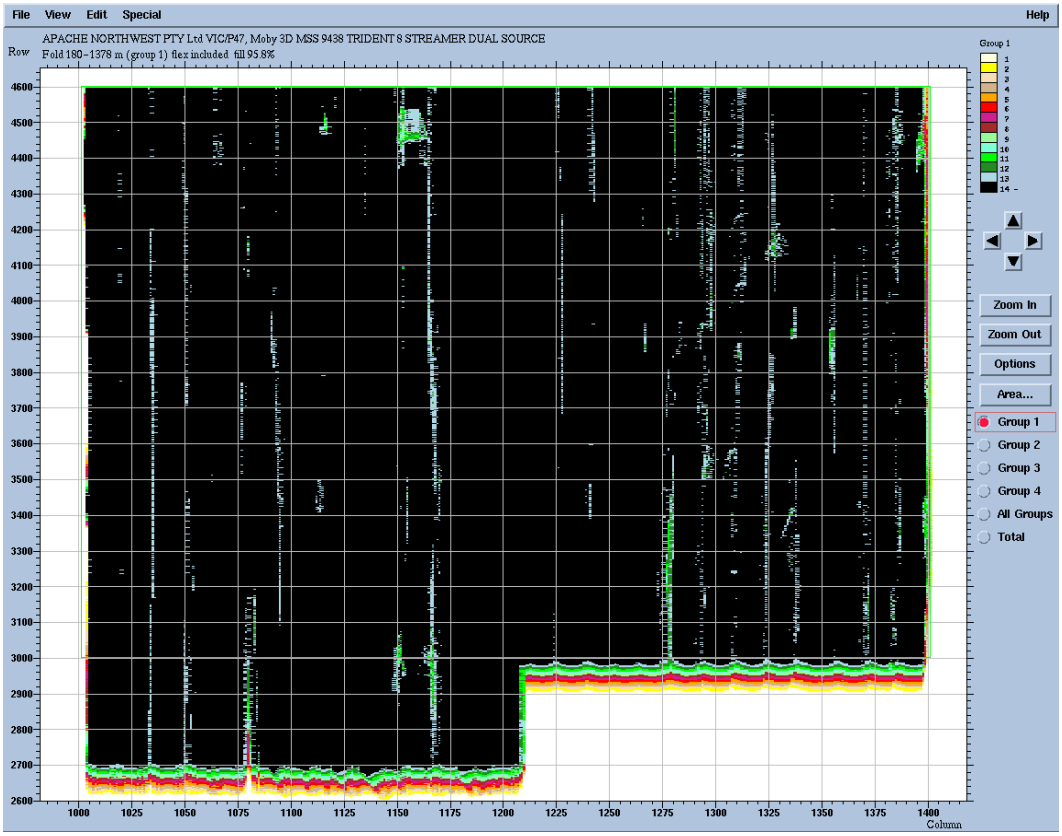
GPS Radial Difference Results

	Estimator Difference				
Line	**TRIGPS**	**CNAV**	**POSNET1**	**POSNET2**	**MFIX**
1200P1002	0.65	0.64	0.64	0.76	73.54
1392P2003	0.80	0.69	0.67	0.70	9.76
1184P1004	0.67	0.53	0.58	0.73	14.30
1376P1005	0.84	0.78	0.81	0.82	15.13
1168P1006	0.57	0.49	0.49	0.61	3.36
1360P1007	0.55	0.54	0.53	0.86	15.97
1152P1008	0.61	0.48	0.62	0.77	4.75
1344P1009	0.77	0.64	0.68	0.71	10.46
1136P1010	0.54	0.51	0.52	0.66	11.45
1328P1011	0.67	0.52	0.59	0.71	9.43
1120P1012	0.66	0.60	0.60	0.59	0.60
1312P1013	0.77	0.70	0.58	1.01	22.96
1104P1014	0.71	0.52	0.61	0.65	3.62
1296P1015	0.71	0.58	0.67	0.84	3.66
1088P1016	0.62	0.44	0.49	0.49	2.68
1280P1017	0.58	0.49	0.61	0.69	4.35
1072P1018	0.72	0.56	0.55	0.70	2.82
1264P1019	0.53	0.41	0.49	0.64	4.63
1056P1020	0.67	0.50	0.50	0.73	3.34
1248P1021	0.54	0.48	0.49	0.87	2.90
1040P1022	0.55	0.54	0.50	1.02	2.86
1232P1023	0.65	0.50	0.52	0.84	3.24
1024P1024	0.67	0.47	0.55	0.57	3.03
1216P1025	0.62	0.49	0.55	0.82	5.11
1008P1026	0.65	0.58	0.60	0.88	4.85
1216J1027	0.44	0.44	0.39	0.73	2.79
1008J1028	0.60	0.32	0.43	0.60	5.80
1344J1029	0.66	0.46	0.54	0.70	3.28
1104J1030	0.68	0.57	0.58	0.83	3.46
1360J1031	0.68	0.49	0.48	0.54	1.17
1136J1032	0.60	0.66	0.71	1.24	5.64
1248J1033	0.74	0.78	0.89	1.20	7.96
1184J1034	0.58	0.40	0.56	0.67	2.62
1328A1035	0.81	0.37	0.67	0.52	2.57
1072J1036	0.51	0.45	0.43	0.76	3.09
1216J2037	0.45	0.43	0.48	0.70	0.60
1136J2038	0.83	0.65	0.71	0.79	4.74
1296A1039	0.61	0.61	0.58	0.87	1.57
Average	0.65	0.53	0.58	0.76	7.48
STD	0.10	0.11	0.10	0.16	12.02

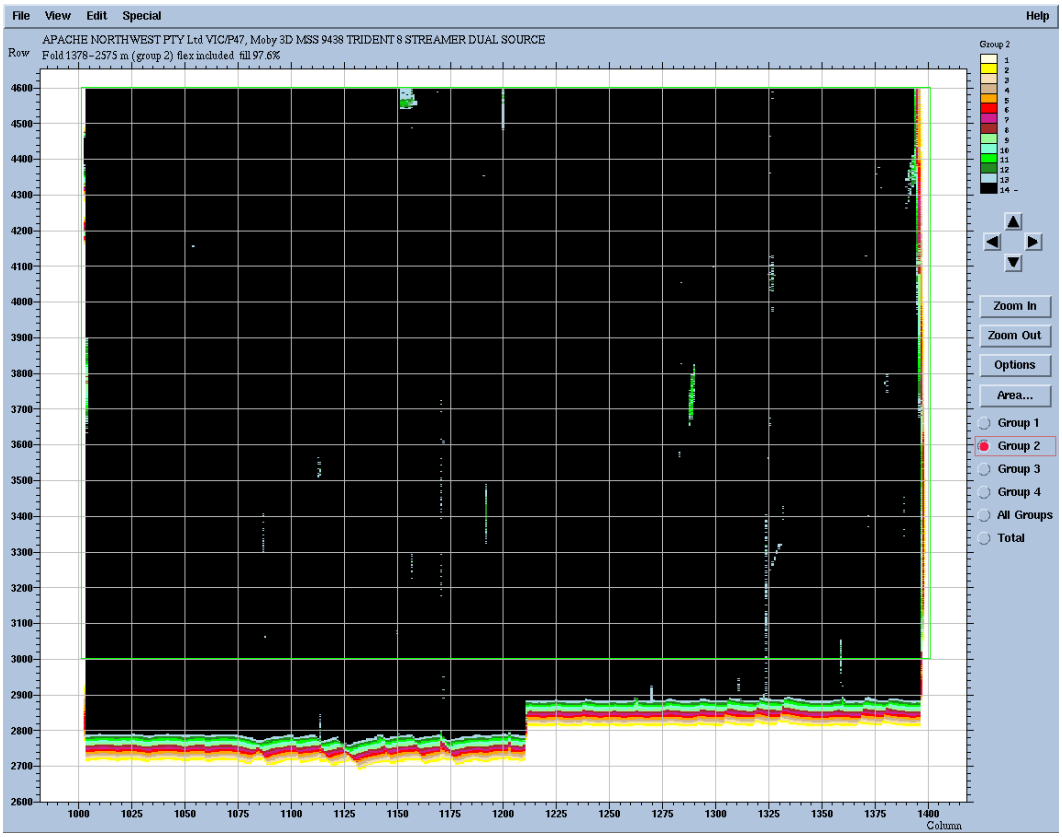
Exhibit 4 : **Coverage Maps**

Final flex parameters are a stepped expansion from 100% to 400% bin width i.e. bin width tapering from 50m wide at the head of the cable to 125m wide at the tail:

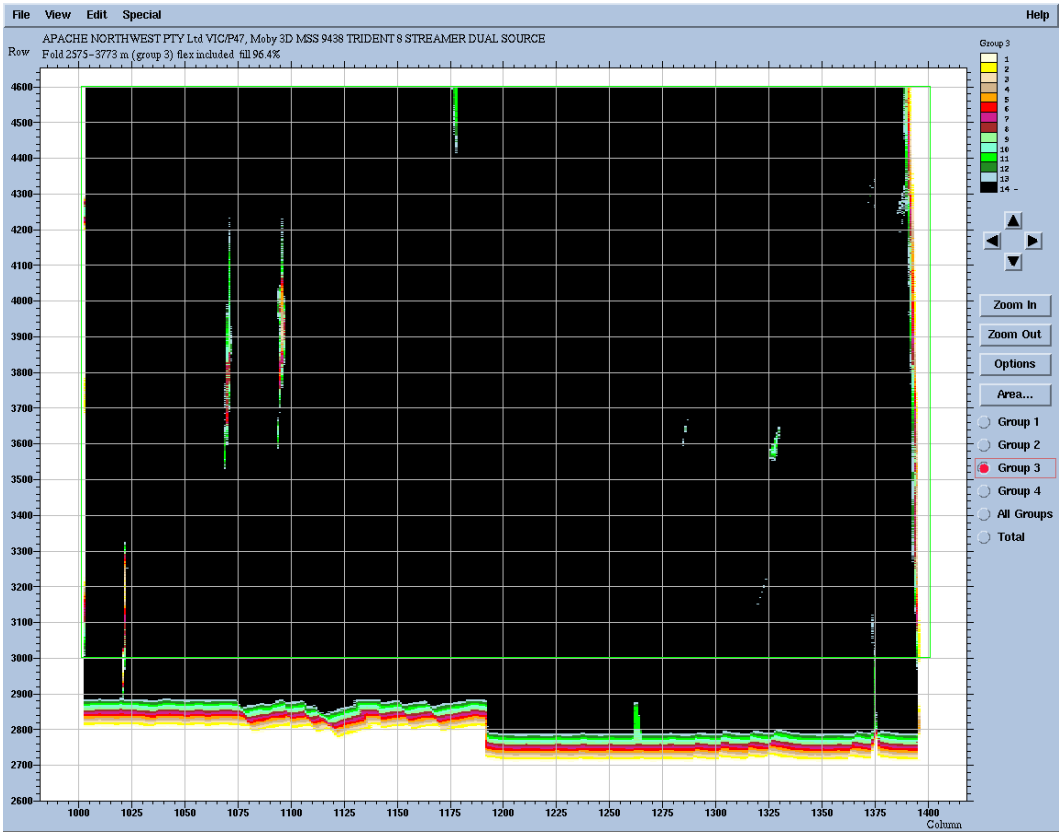
Group	bin width at head	bin width at tail	per side expansion
1	50.0	62.5	18.75
2	62.5	75.0	25.00
3	75.0	87.5	31.25
4	87.5	125.0	50.00



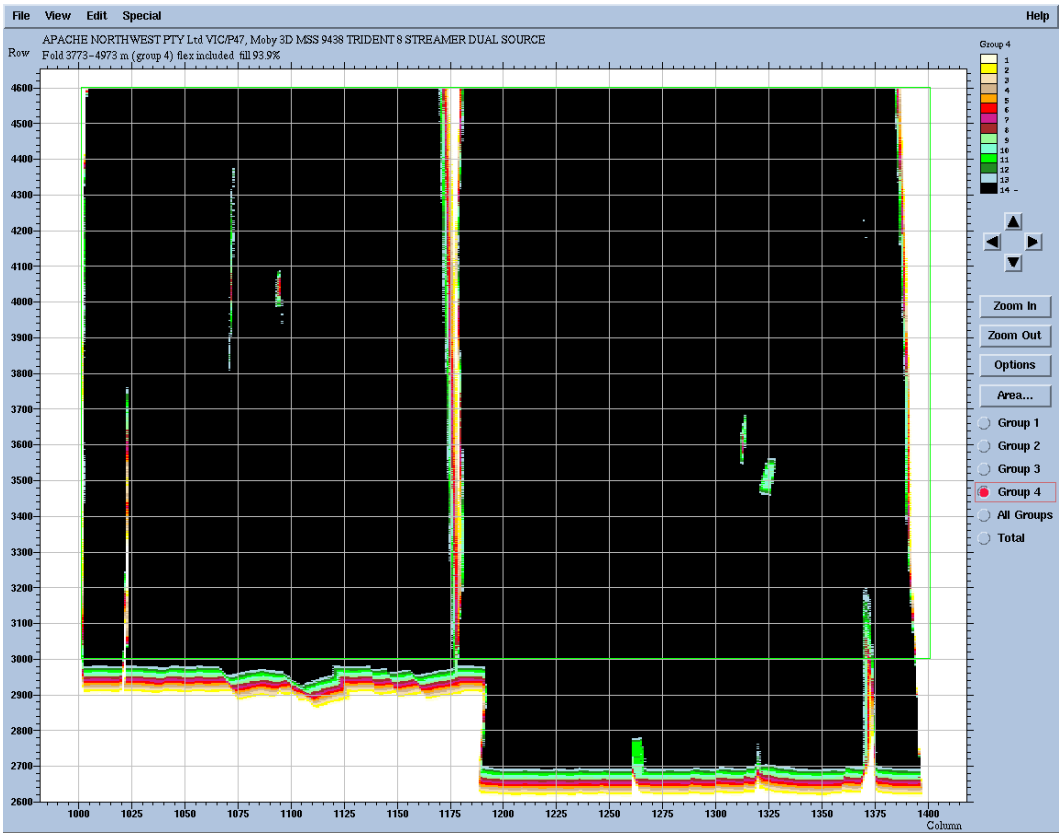
Group 1 (nears) flex included



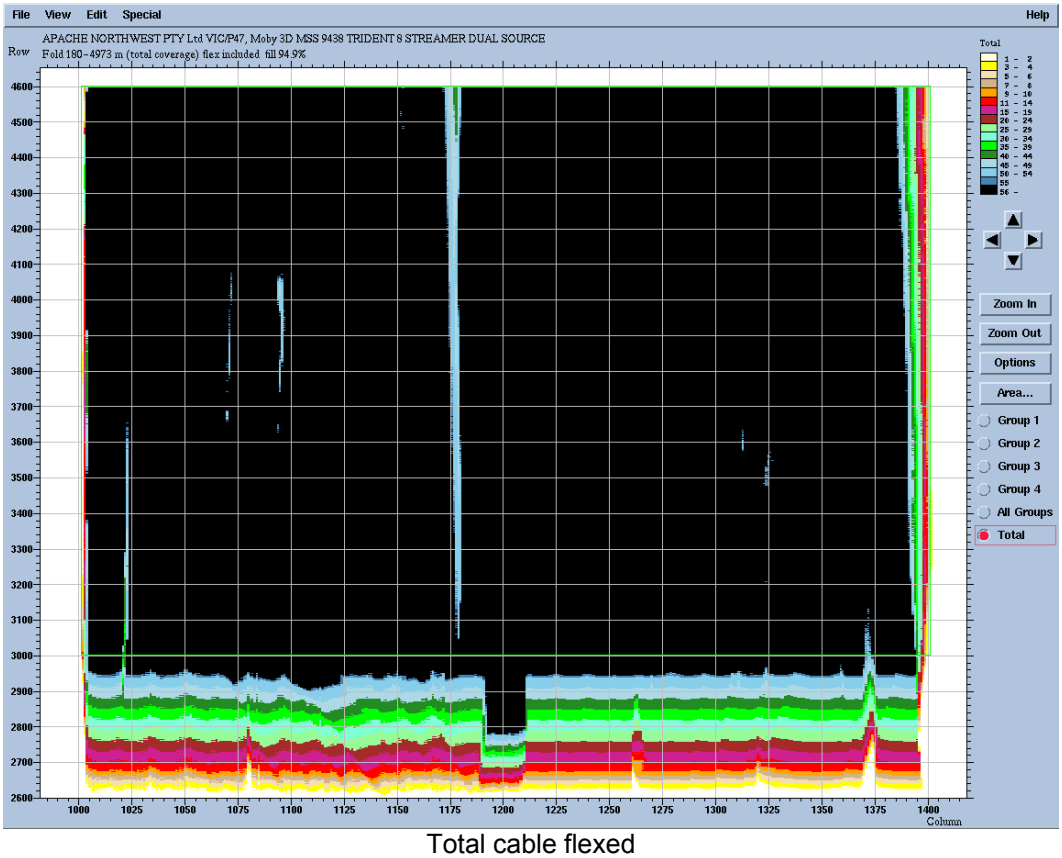
Group 2 (near mids) flexed



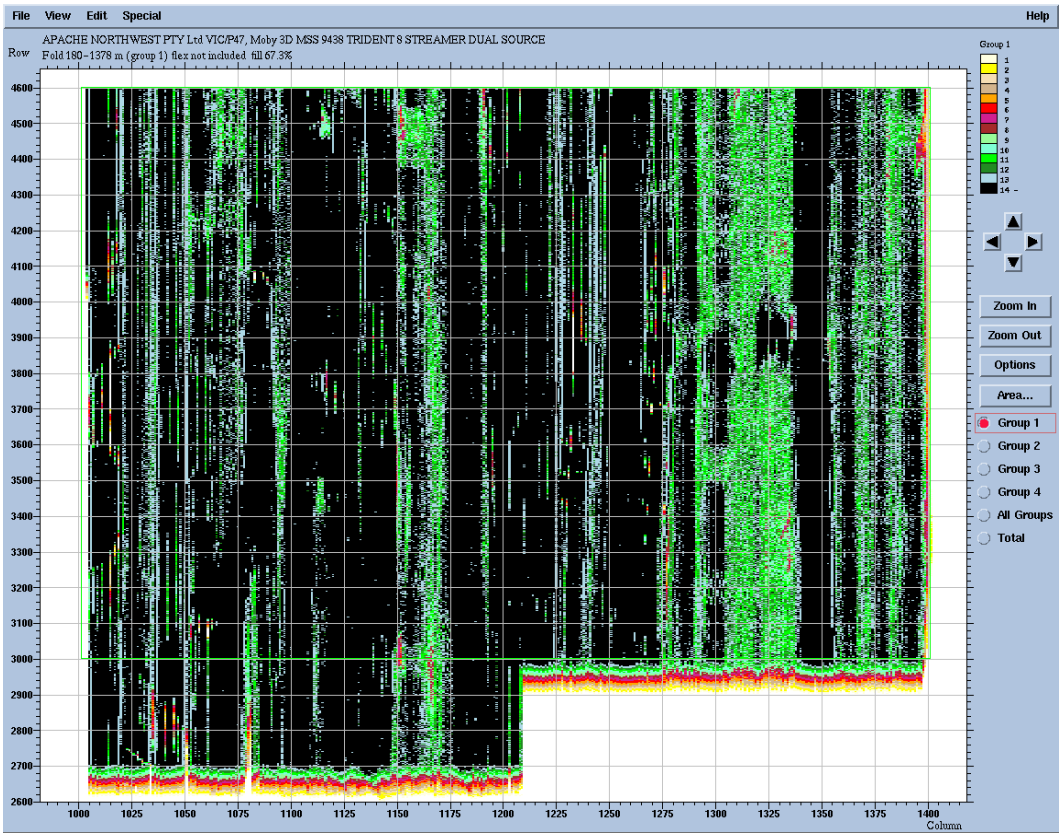
Group 3 (far mids) flexed



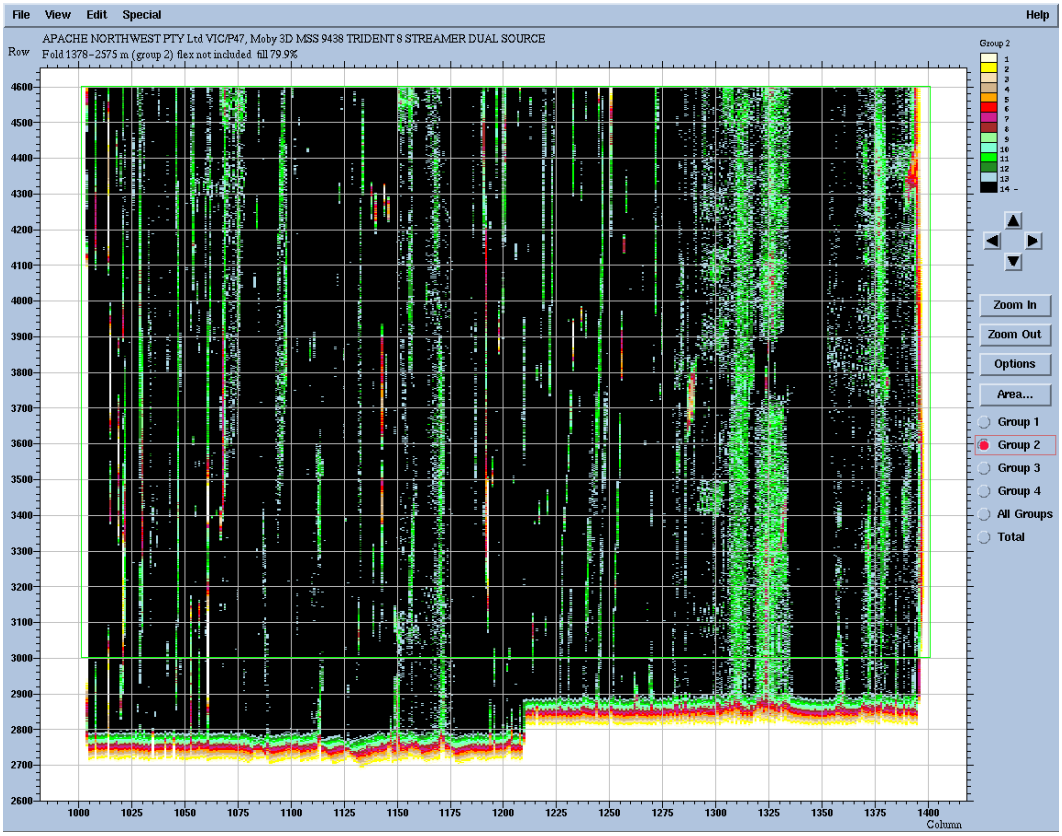
Group 4 (fars) flexed



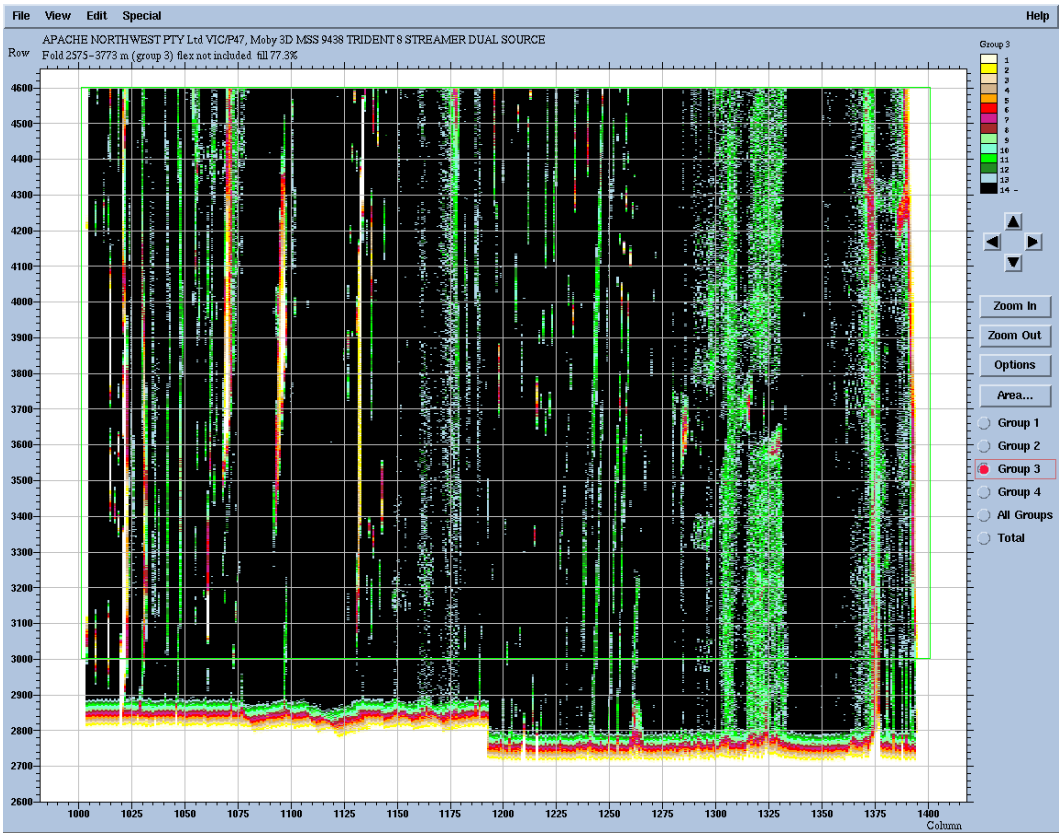
Total cable flexed



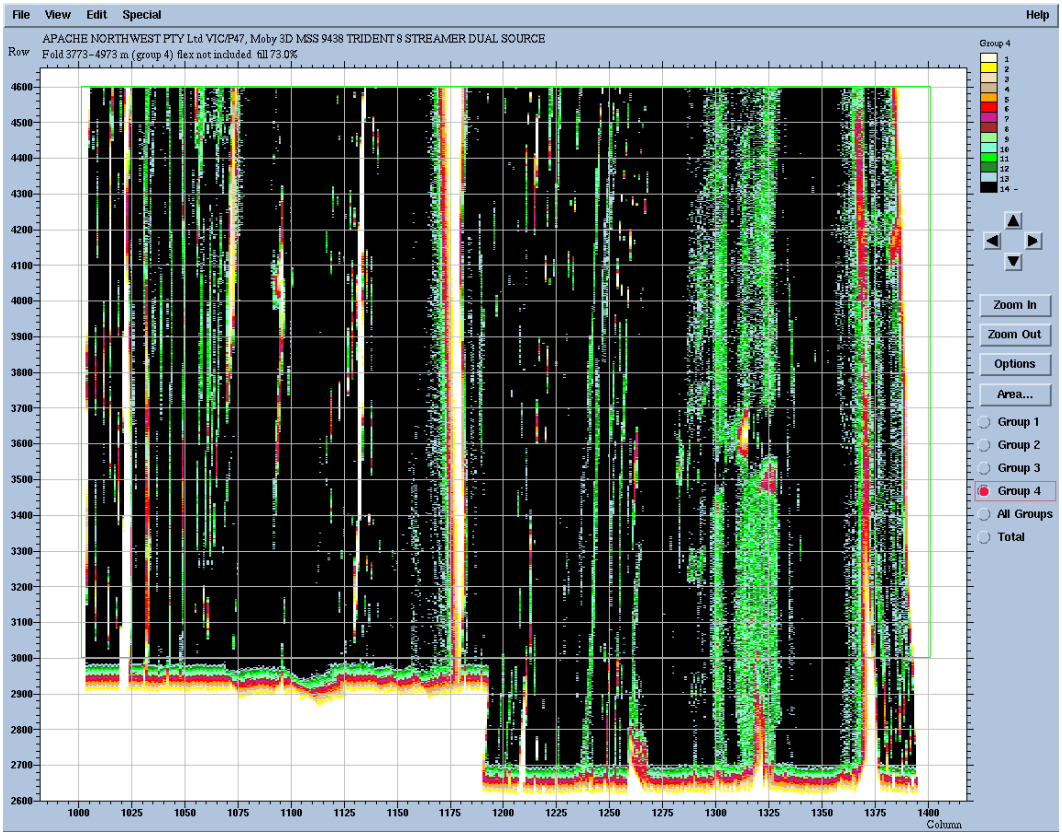
Group 1 (nears) no flex included



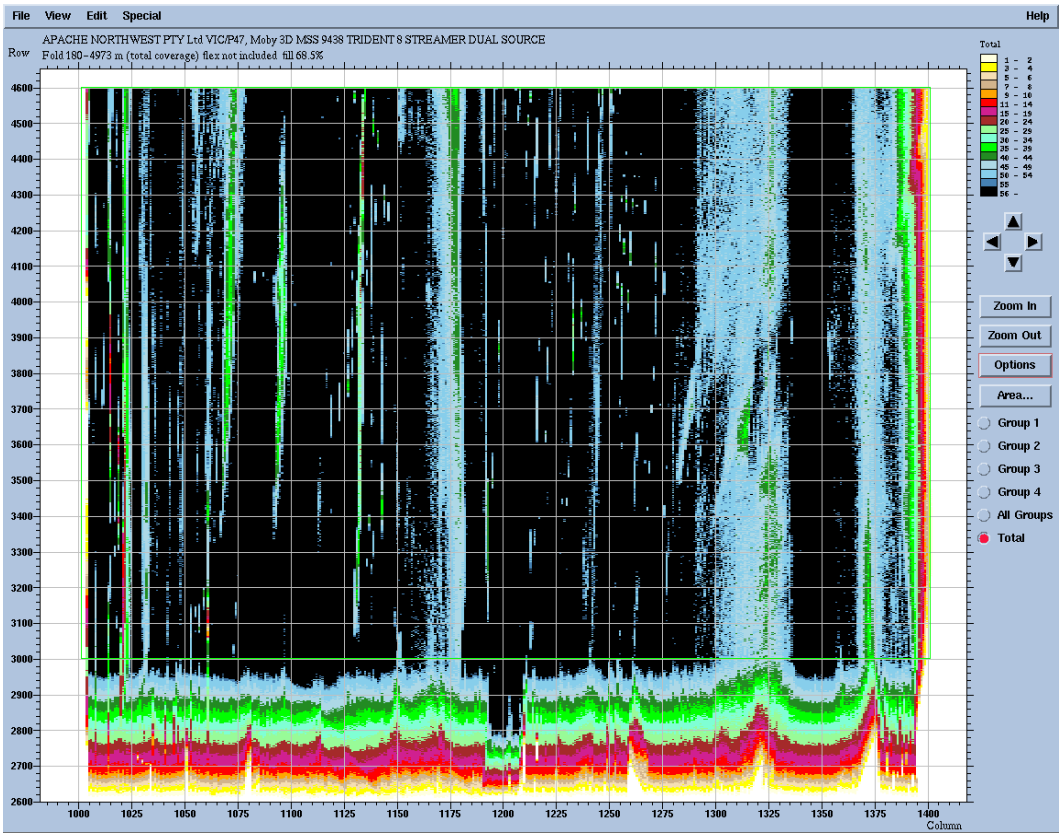
Group 2 (near mids) no flex included



Group 3 (far mids) no flex included

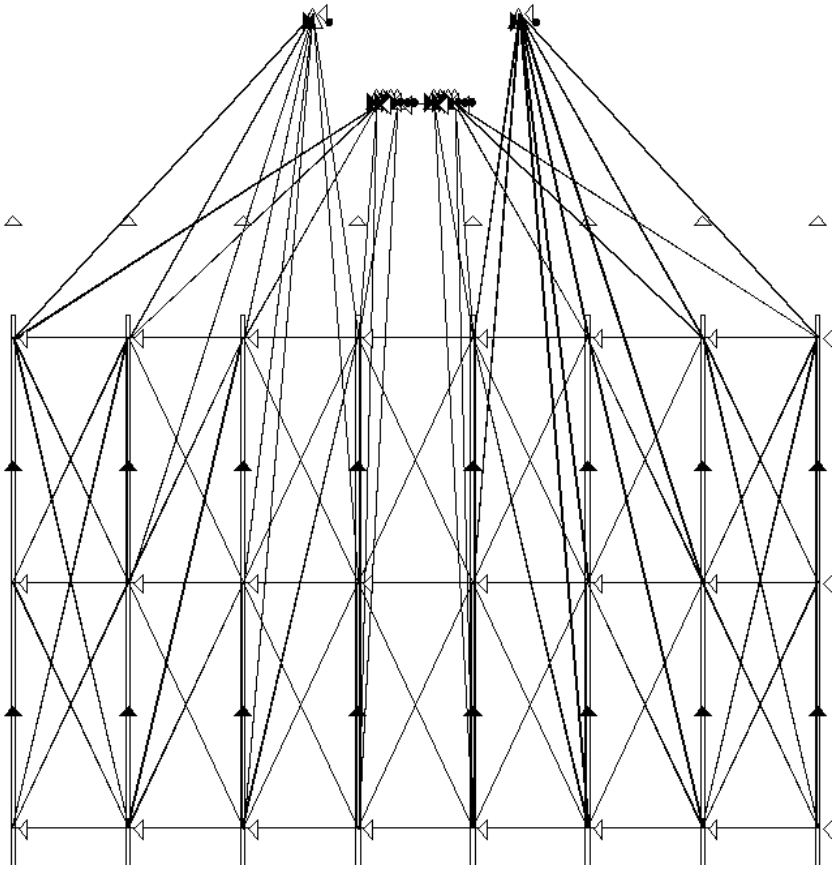


Group 4 (fars) no flex included

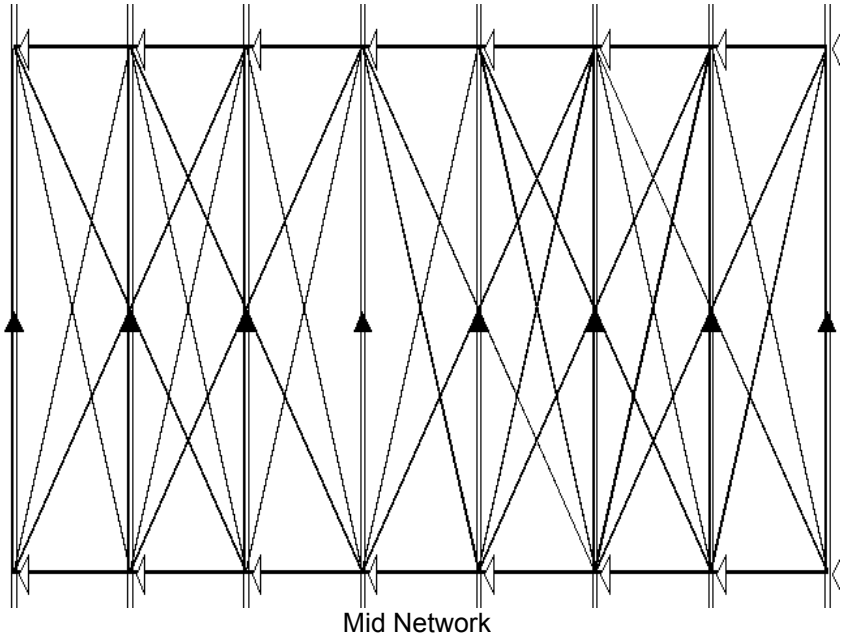


Total cable no flex included

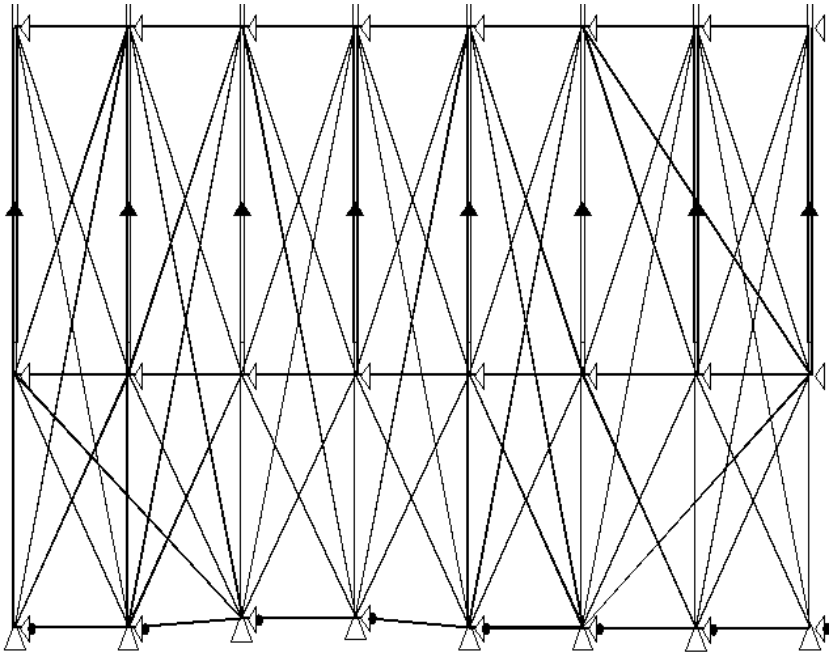
Exhibit 5 **: Acoustic Range System**



Front Network



Mid Network



Tail Network

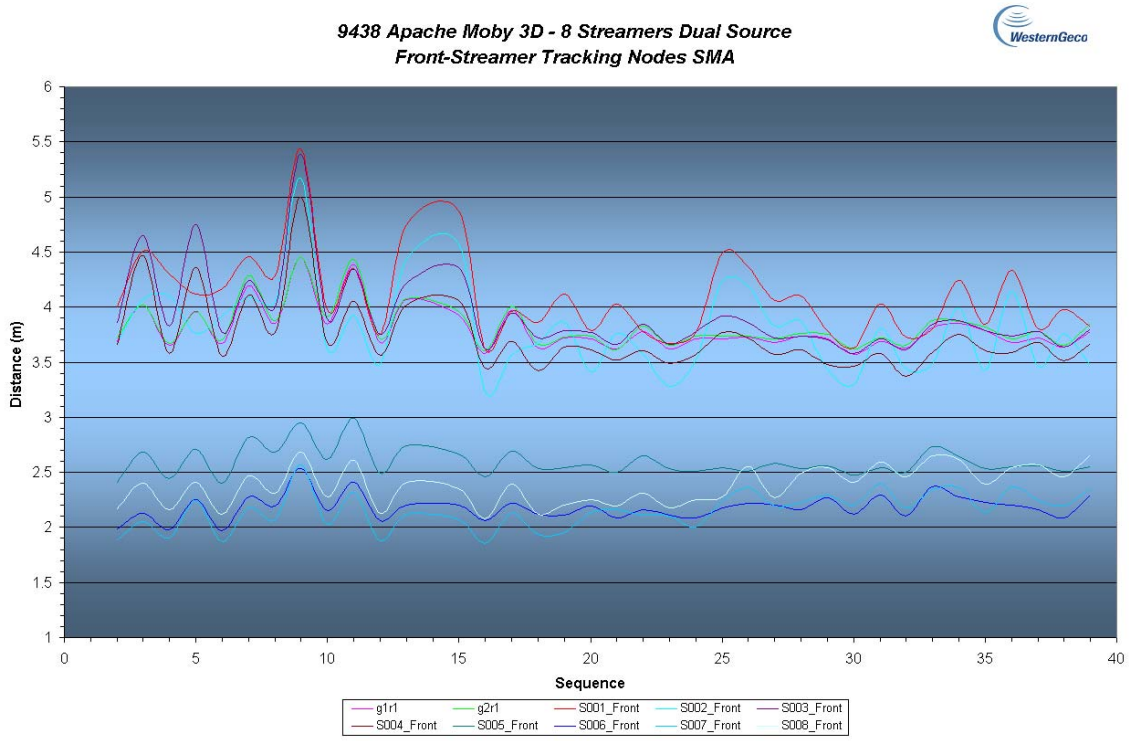
Exhibit 6 : **Survey Definition Changes Summary**

20.1.1.1.2.1.1.1	*Client*	20.1.1.1.2.1.2	Apache	20.1.1.1.3	Vessel	**Western Trident**
20.1.1.1.3.1.1.1		20.1.1.1.3.1.2		20.1.1.1.4		
Area		20.1.1.1.4.1.1	Moby	**Start Date**		**9th Jan 2005**
Job No.		**9438**		**End Date**		**15th Jan 2005**

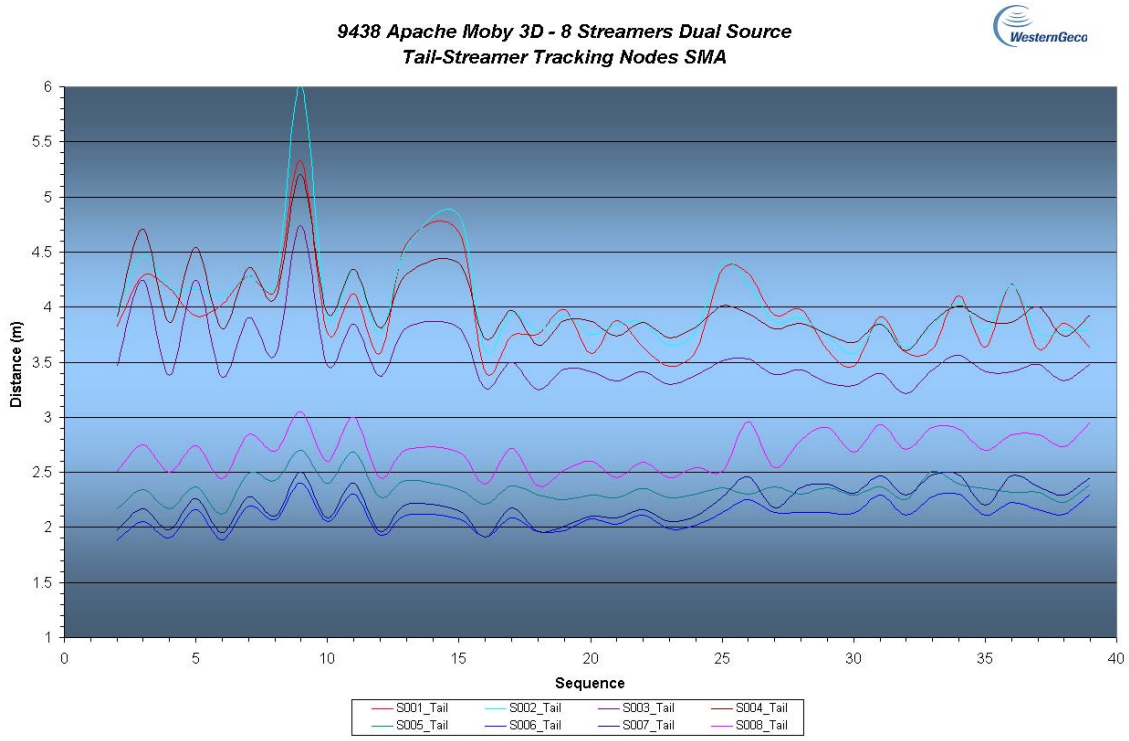
Date	Surdef in use (mas9438_)	From Seq	To Seq	Offset Database	Description
09-Jan-05	01	001	024	01	
13-Jan-05	02	0025	025		New Bird S1C11 SN# 20916 was SN# 19997 New Bird S1C9 SN# 12810 was SN# 12669 New Bird S1C14 SN# 20941 was SN# 10238 New Bird S5C7 SN# 27834 was SN# 16947 New Bird S8C9 SN# 20235 was SN# 6860
13-Jan-05	03	0026	039		New Bird S8C08 SN# 21128 was SN# 17024 New Bird S4C12 SN# 5624 was SN# 9644 New Bird S7C16 SN# 17162 was SN# 17890

Exhibit 7 : **Trend Analysis**

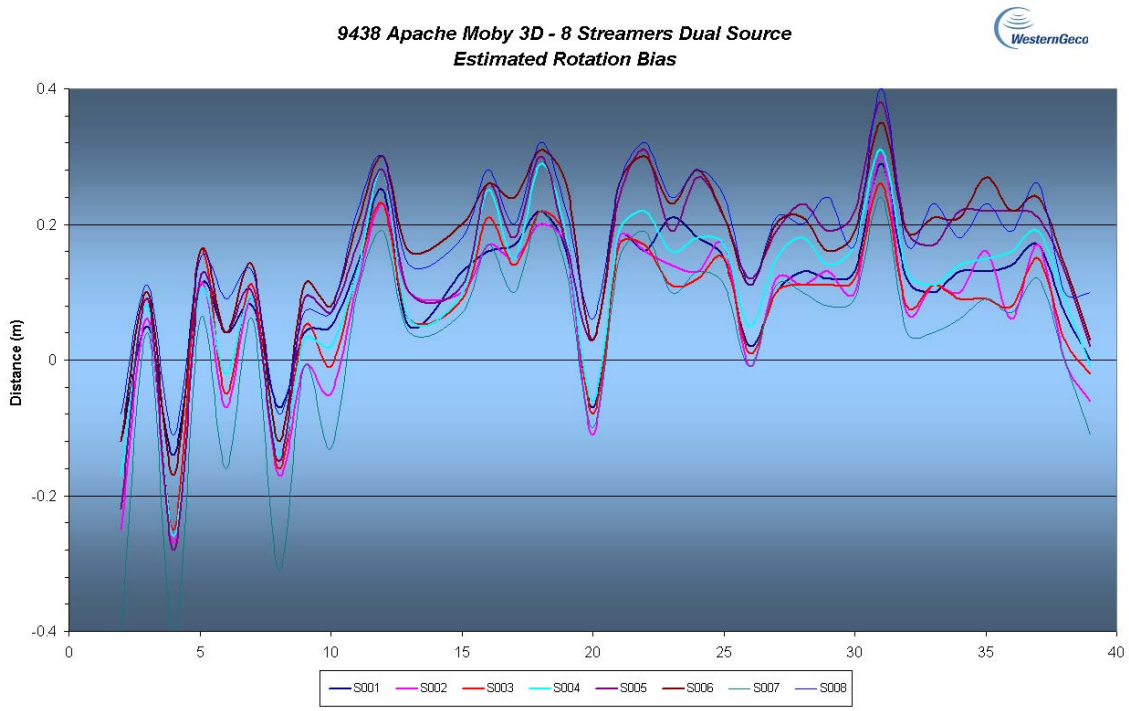
Tracking Node (Front) Error Ellipse Semi-major Axis (95%)



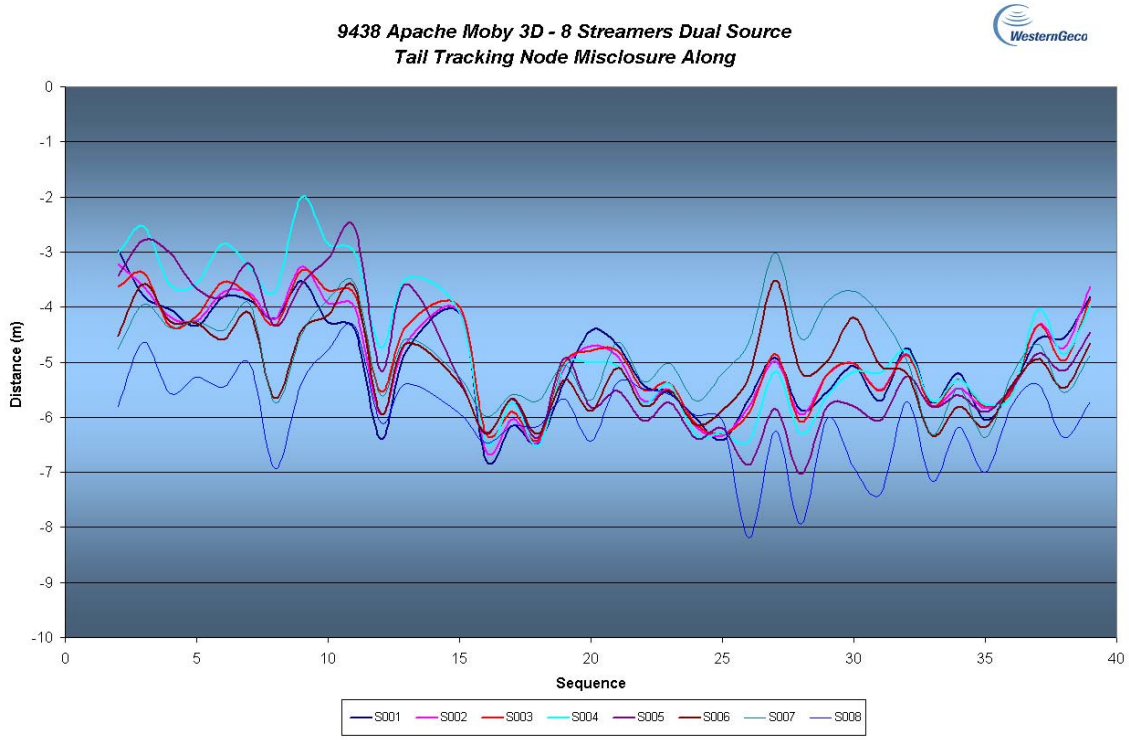
Tracking Node (Tail) Error Ellipse Semi-major Axis (95%)



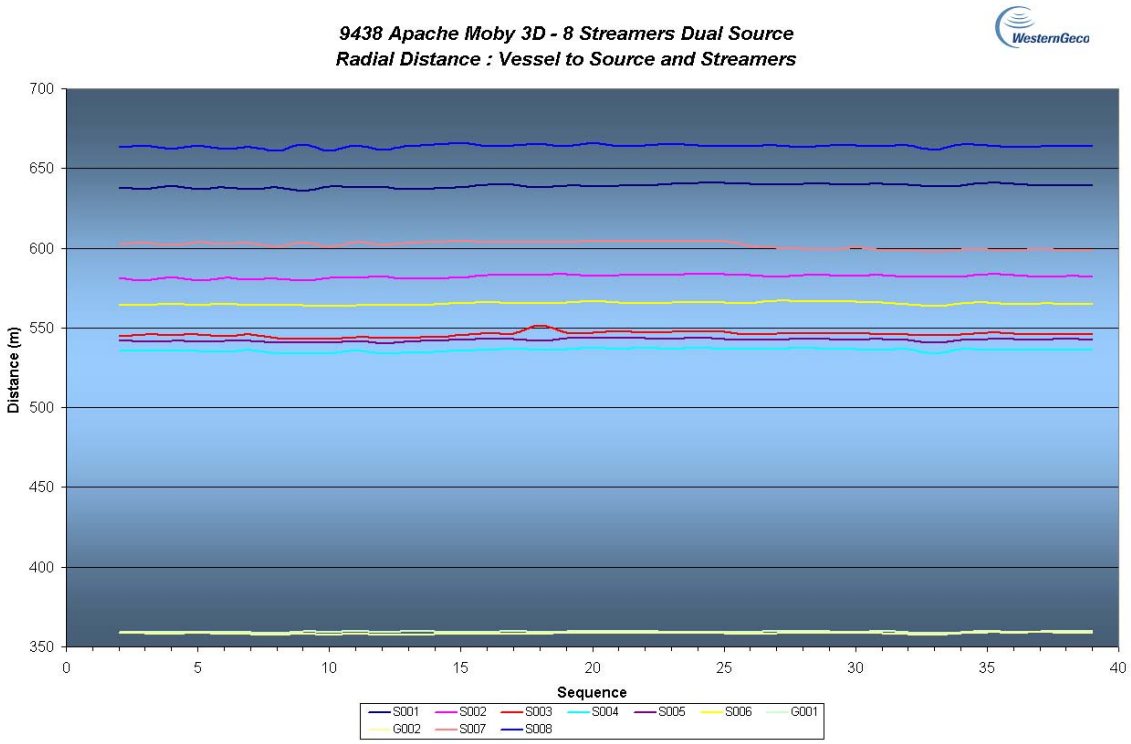
Estimated Rotation Bias



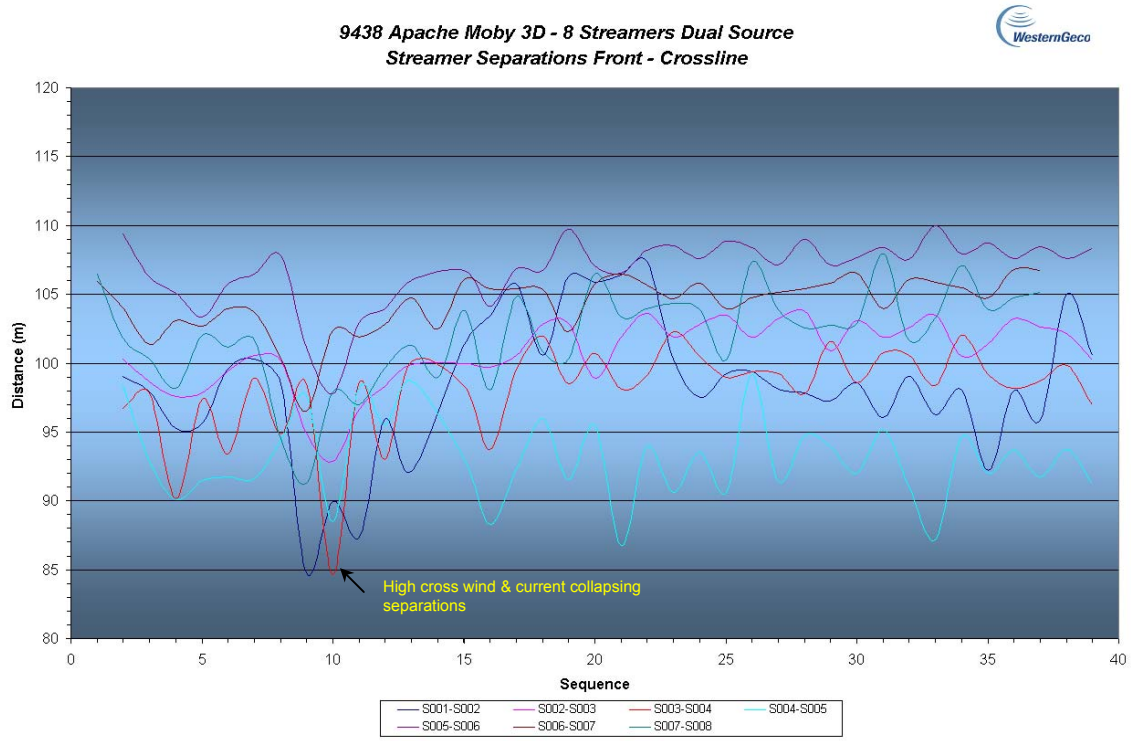
Tail Tracking Node Misclosure Along



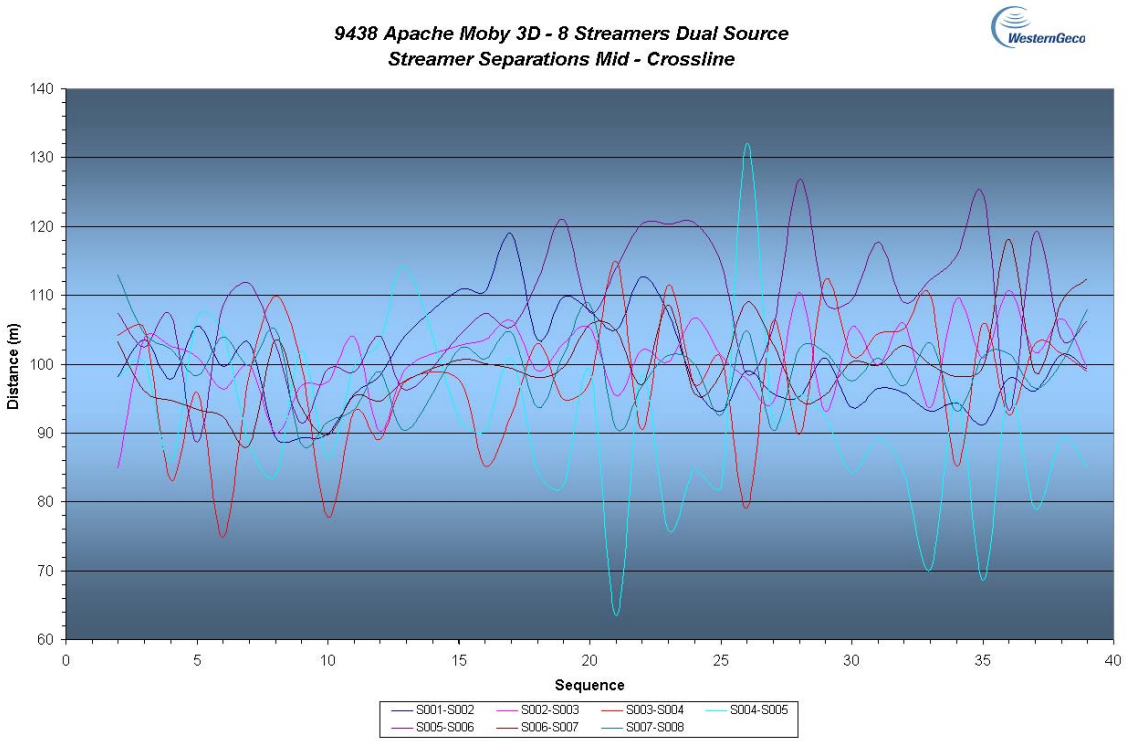
Radial Separation (Vessel to all streamers and sources)



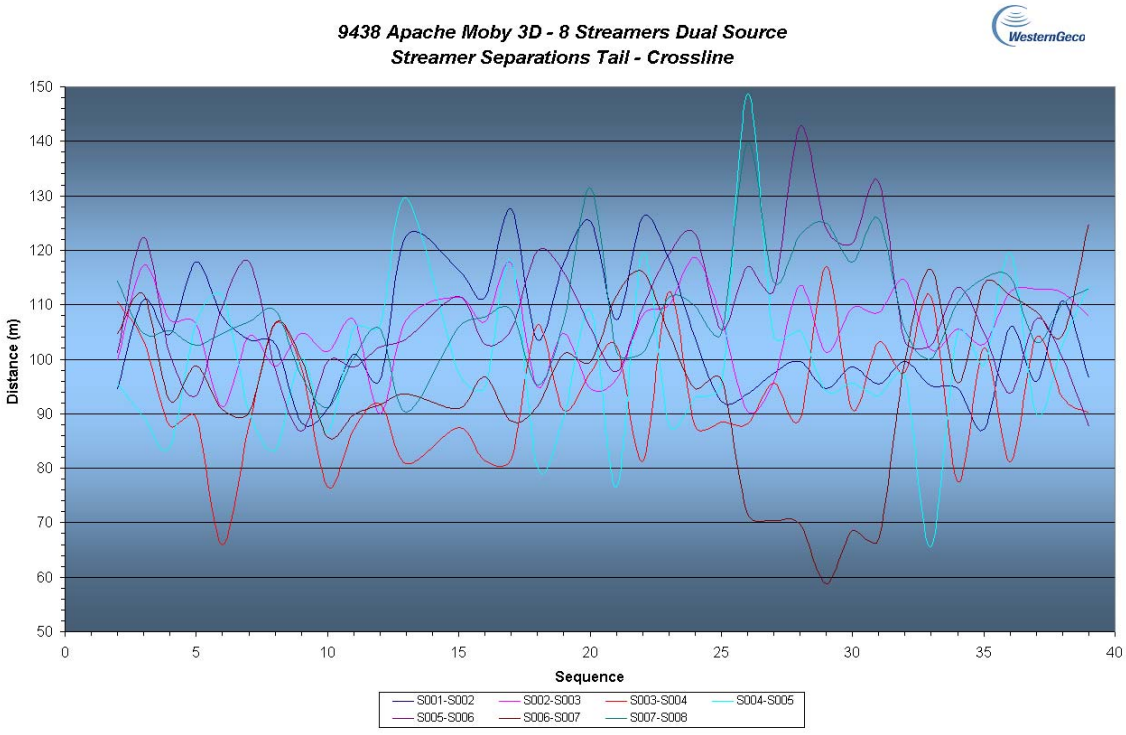
Cross Separation (All streamers to front)



Cross Separation (All streamers to middle)



Cross Separation (All streamers to tail)



Cross Separation (Sources)

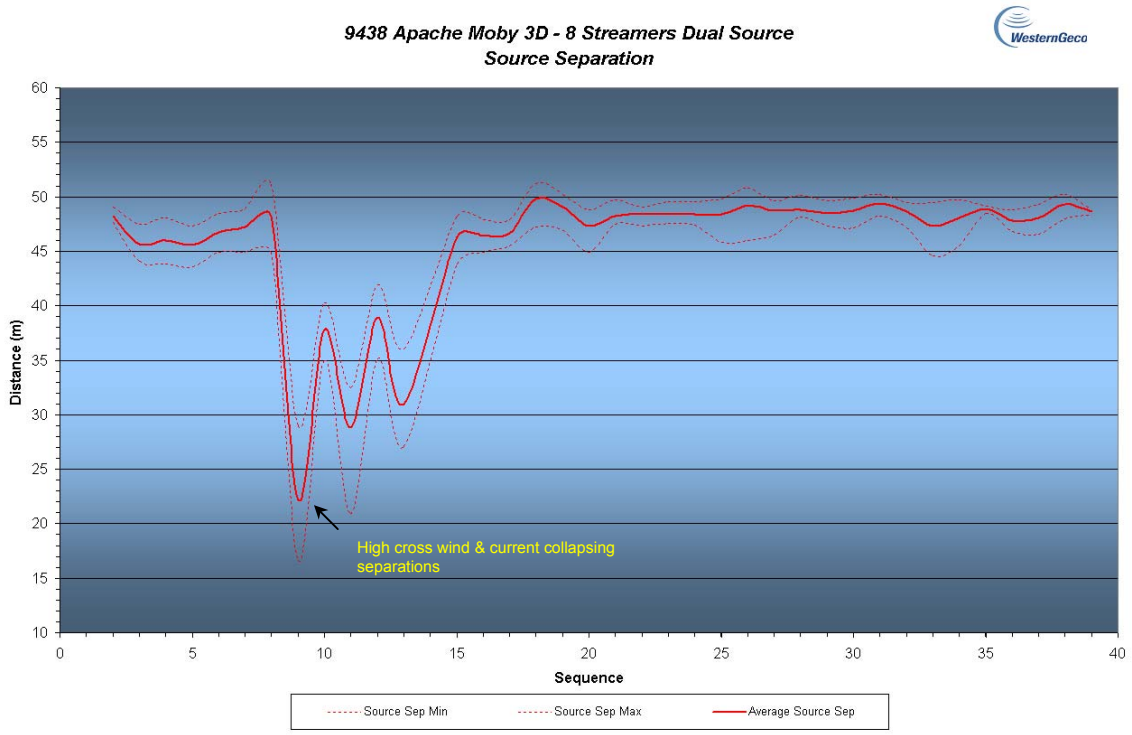
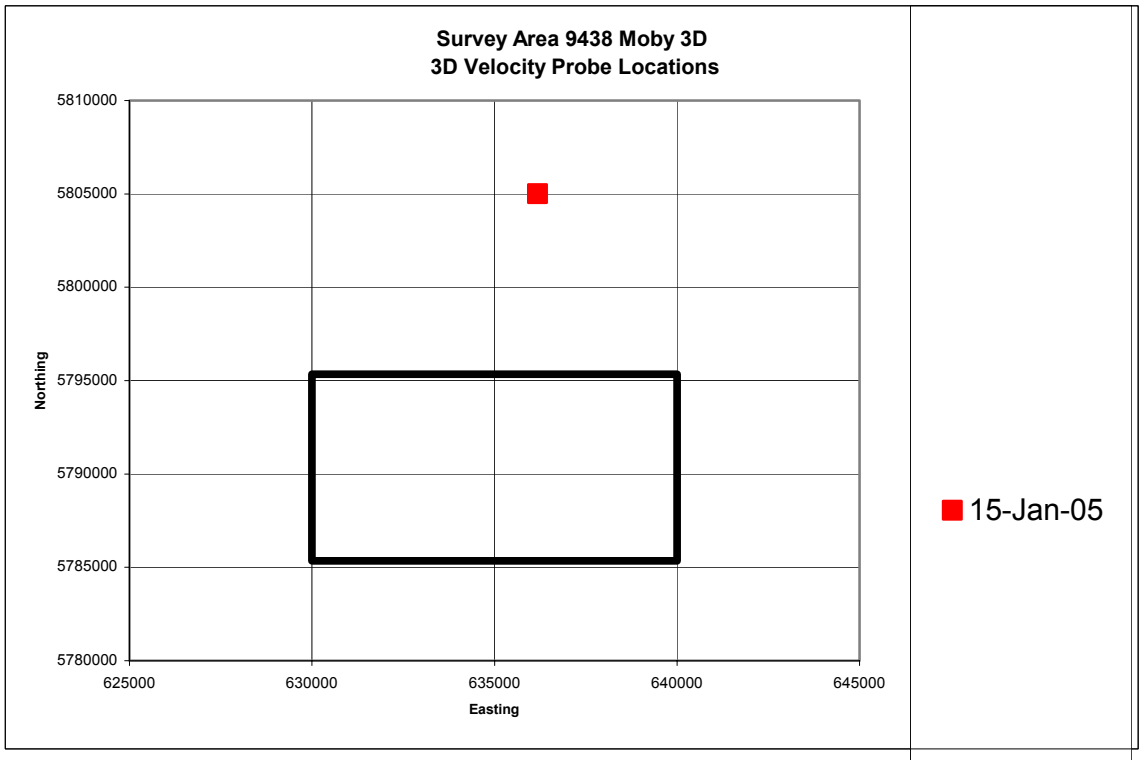


Exhibit 8 : **Temperature & Salinity Measurements**

Measurement Locations



Measurement Results

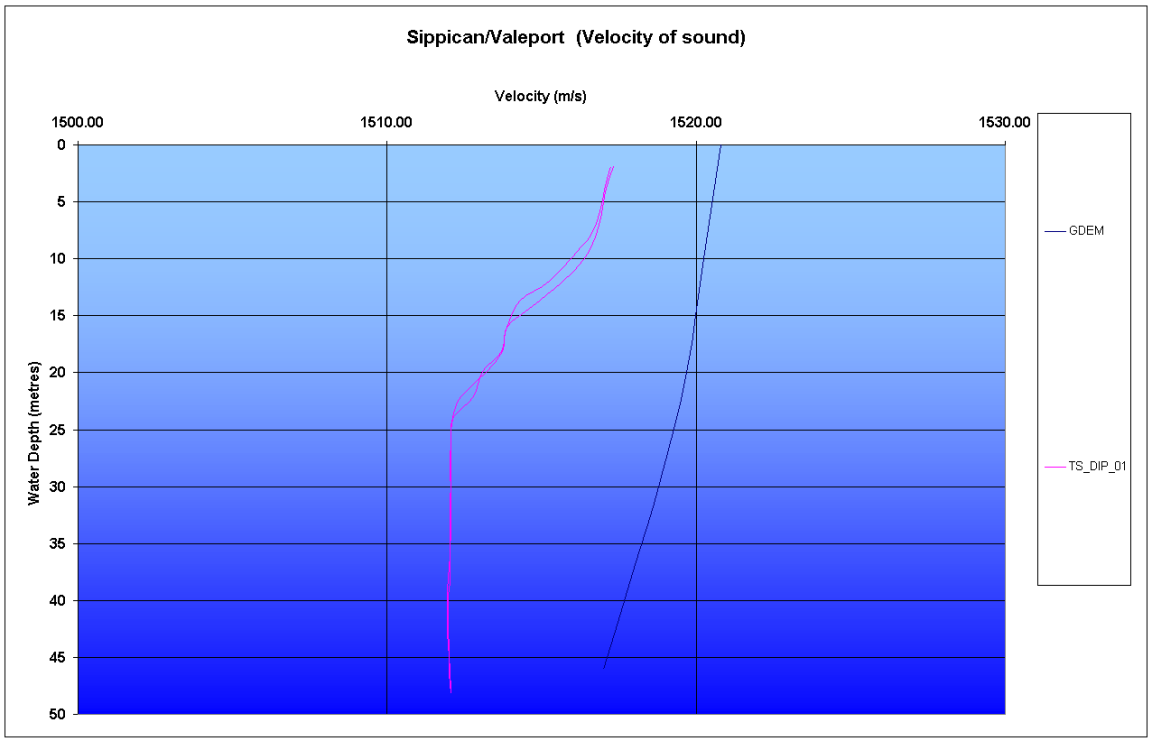


Table of Contents

21. Instrumentation, QC and Processing System

System	Hardware	Software
Recording	Input/Output MSX system IBM RS/6000 B80	Version 2
Tape drives	4 each IBM 3590 cartridge	
Plotter	OYO Geospace: 24 inch	
Onboard QC	Seisview via the CRS	Omega 1.8.1
Source Controller	Input/Output Source Synchronisation System	Version 2.1
Auxiliary Systems	WesternGeco Continuous Recording System	Version 4.2
External Header	SEG-D 8058 Format	
Tension Monitor	WesternGeco CTM	
Bird Controller	Digicourse System 3 DMU	Version 4.31

The onboard data quality control functions were performed both online and offline. Seisview was used for online QC displays such as RMS noise analysis, gun pressures/depths display, shot gathers display and areal rms. On-line QC allowed monitoring of data quality in real time and the ability to make immediate decisions if necessary.

The majority of the QC products, less limited by processing time comparatively to on-line processing were created offline, using the Omega Processing System configured as a small dedicated processing centre with all necessary facilities.

The processing system was connected to the other onboard departments through the vessel network which also provided an easy access to/from onshore processing centre for all required data transfer as well as for onshore support and/or hardware maintenance works. Following is a description of the onboard quality control and processing system instruments.

21.1. Off-Line QC System

System	Hardware	Software
OMEGA SPS Onboard Processing (IBM operating System)	IBM RS/6000 B80s • 1.00 TBytes data disk 2 × Tektronics work stations 1 × 36” OYO plotter	OMEGA version 1.8.3
EMASS Silo Tape System PC EMASS (OS/2 operating system)	16 × 3590 Tape drives connected to SILO.	

22. Instrumentation and QC Tests

22.1. Semi-Monthly 08 Jan 05

SemiMonthly Test Results 8th January 2005

					File 1001	File 1002	File 1003	File 1004	File 1005	File 1006	File 1007	File 1008	File 1009	File 1010	File 1011	File 1012	File 1013	File 1014	File 1015	File 1016	File 1017	File 1018	File 1019	File 1020	File 1021	File 1022	File 1023
Cable	Location	SG	Trace	Channel	T13	T13	T13	T13	T2 @ 0 dB Harmonic Distortion	T2 @ -10 dB Harmonic Distortion	T2 @ -20 dB Harmonic Distortion	T2 @ -30 dB Harmonic Distortion	T2 @ -40 dB Harmonic Distortion	T2 @ -50 dB Harmonic Distortion	T2 @ -60 dB Harmonic Distortion	T2 @ -70 dB Harmonic Distortion	T2 @ -80 dB Harmonic Distortion	T2 @ -90 dB DRD 4%	T2 @ -100 dB DRD 4%	T5 Pre-Amp Noise	T10 Common Mode .7250	T11 Cross-Feed (odd) <2.3 mv	T12 Cross-Feed (even) <2.3mv	T 6 Impulse response 2Hz	T7 Impulse Response 8/18	T7 Step Function 8/18	T4 DRD 8/18
					All Ones	50/50	All Zeros	Sine 15.625	< 0.0005%	< 0.002%	< 0.005%	< 0.016%	< 0.05%	< 0.16%	< 0.5%	< 1.6%	< 5%	+/- 4.0%	+/- 4.0%	< .210 uB	<66dB FS	<56dB FS	<56dB FS	+/- 7.0%	+/- 7.0%	+/- 7.0%	+/- 7.0%
1																											
	6b		91	91																	0.7562						
	12b		186	186																			54.1				
	15a		225	225																						14.9	
	15a		227	227																					274.6	40	73.24
	16b	SG	256	256																						29.6	68.12
2																											
	9b		523	139																						29.2	7.15
	13a	SG	584	200																					7.22	24.5	
	13b		589	205																			44.8				
	15a		615	231																					7.09	7.1	7.89
	15a	SG	616	232																		35.3					
	15b		617	233																			29.8				
	15b		622	238																			41.8				
	15b		623	239																		31.74					
	16a		627	243																					248	36.4	72.58
	18a		661	277																					8.08	7.9	
	24a		755	371																					9.66	9.5	
3																											
	10a		919	151																					7.13	7.1	7.7
	10b		924	156																					8.6	8.6	
	12b		953	185																			48.1				
	12b		959	191																		33.303					
	13b	SG	976	208																		43.87					
	14a		978	210																			39.3				
	15a		993	225																						20.7	59.7
	16b		1017	249																					9.96	10	7.3
	16b		1020	252																					8.96	8.9	
	16b		1023	255																					8.8	8.8	
	19a		1057	289																					8.33	8.1	
	22b		1113	345																					8.8	8.5	
	22b		1119	351																					7.5	7.4	
	23a		1124	356																					24.8	30.2	64.1

SemiMonthly Test Results 8th January 2005

					File 1001	File 1002	File 1003	File 1004	File 1005	File 1006	File 1007	File 1008	File 1009	File 1010	File 1011	File 1012	File 1013	File 1014	File 1015	File 1016	File 1017	File 1018	File 1019	File 1020	File 1021	File 1022	File 1023
Cable	Location	SG	Trace	Channel	T13 All Ones	T13 50/50	T13 All Zeros	T13 Sine 15.625	T2 @ 0 dB Harmonic Distortion < 0.0005%	T2 @ -10 dB Harmonic Distortion < 0.002%	T2 @ -20 dB Harmonic Distortion < 0.005%	T2 @ -30 dB Harmonic Distortion < 0.016%	T2 @ -40 dB Harmonic Distortion < 0.05%	T2 @ -50 dB Harmonic Distortion < 0.16%	T2 @ -60 dB Harmonic Distortion < 0.5%	T2 @ -70 dB Harmonic Distortion < 1.6%	T2 @ -80 dB Harmonic Distortion < 5%	T2 @ -90 dB DRD 4% +/- 4.0%	T2 @ -100 dB DRD 4% +/- 4.0%	T5 Pre-Amp Noise < .210 uB	T10 Common Mode .7250 <66dB FS	T11 Cross-Feed (odd) <2.3 mv <56dB FS	T12 Cross-Feed (even) <2.3mv <56dB FS	T 6 Impulse response 2Hz +/- 7.0%	T7 Impulse Response 8/18 +/- 7.0%	T7 Step Function 8/18 +/- 7.0%	T4 DRD 8/18 +/- 7.0%
4																											
	8b		1273	121																			53.88		7.29		
	8b	SG	1280	128																					7.22	7.2	
	10a		1297	145																			36.5				15.4
	10a		1302	150																			40.8				
	11a		1313	161																			14.5		11.12	19.7	34.9
	11a		1314	162																			1.5		22.1	31.5	53.3
	11a		1315	163																		0.768			8.7	12.3	30.8
	11a		1317	165																			45				
	13a		1345	193																			35.4				
	13a		1349	197																			38				
	16b		1407	255																		44.4					
	19b		1449	297																			34.5				
	20a		1462	310																					12.33	12.2	10.07
	23b		1518	366																					8.3	8.1	
	24b		1533	381																			52.7				
	24b	SG	1536	384																		40.4					8.3
5																											
	7a		1633	97																			42.3				
	7a		1634	98																			46.44				
	7a		1635	99																		54					
	10a		1687	151																					9.6	9.65	7.2
	10b		1692	156																					7.8	7.63	
	16a		1783	247																					7.8	7.75	
	17b		1806	270																					13.7	13.7	11.4
	18a	SG	1816	280																					265.1		
	19a		1826	290																			36.1				
6																											
	6a	SG	2008	88																		48.8			17.1	17.2	17.97
	8b		2047	127																					8.05	8.07	
	24b	SG	2304	384																					71.97	34.08	66.34

SemiMonthly Test Results 8th January 2005

					File 1001	File 1002	File 1003	File 1004	File 1005	File 1006	File 1007	File 1008	File 1009	File 1010	File 1011	File 1012	File 1013	File 1014	File 1015	File 1016	File 1017	File 1018	File 1019	File 1020	File 1021	File 1022	File 1023
Cable	Location	SG	Trace	Channel	T13	T13	T13	T13	T2 @ 0 dB Harmonic Distortion	T2 @ -10 dB Harmonic Distortion	T2 @ -20 dB Harmonic Distortion	T2 @ -30 dB Harmonic Distortion	T2 @ -40 dB Harmonic Distortion	T2 @ -50 dB Harmonic Distortion	T2 @ -60 dB Harmonic Distortion	T2 @ -70 dB Harmonic Distortion	T2 @ -80 dB Harmonic Distortion	T2 @ -90 dB DRD 4%	T2 @ -100 dB DRD 4%	T5 Pre-Amp Noise	T10 Common Mode .7250	T11 Cross-Feed (odd) <2.3 mv	T12 Cross-Feed (even) <2.3mv	T 6 Impulse response 2Hz	T7 Impulse Response 8/18	T7 Step Function 8/18	T4 DRD 8/18
					All Ones	50/50	All Zeros	Sine 15.625	< 0.0005%	< 0.002%	< 0.005%	< 0.016%	< 0.05%	< 0.16%	< 0.5%	< 1.6%	< 5%	+/- 4.0%	+/- 4.0%	< .210 uB	<66dB FS	<56dB FS	<56dB FS	+/- 7.0%	+/- 7.0%	+/- 7.0%	+/- 7.0%
7																											
	11a	SG	2472	168																		55.7					
	11b		2478	174																			51.3				
	16a		2546	242																			51				
	16a		2548	244																		39					
	16a		2549	245																			40.4				
	16a		2550	246																			23.2				
	16a		2551	247																		18.4					
	16b		2553	249																			49.5				
	18b		2588	284																		46.8			60.33	60.8	62
	23a		2658	354																			37.6				
	23b		2667	363																		55.5					
	23b		2671	367																		39.6					
	24a	SG	2680	376																		49.4					
	24b		2681	377																			20.4			7.3	16.1
	24b		2682	378																			0.396		56.27	69.11	64.9
	24b		2683	379																		16.52			21.95	40.6	54.4
	24b		2684	380																		6.4				10.1	22
	24b		2685	381																			28.4		8.55	18.22	33.4
	24b		2686	382																			16.7		8.48	15.76	37.5
	24b		2687	383																		5.2				10.55	
	24b	SG	2688	384																		24.2			966.4	9.8	
8																											
	10a		2837	149																						7.9	14.9
	10b		2842	154																						15.8	7.7
	11a	SG	2856	168																		44.9					
	11b		2860	172																		52.8					
	11b		2861	173																			25.1				
	19a		2978	290																			50.1				

NOTE :
Section 24B Cable 7 changed on 17 Jan 2005, Seq 007 Job 9429
Section 11A Cable 4 changed on 13 Jan 2005, Seq 026 Job 9438

22.2. QC Tests

22.2.1. Gain Correction Test.

The set of tests was run to derive a gain correction function to be applied in Brute Stack job flow. The parameters were tested using data of the line GAP04A1200P1001.

The table below represents the parameters of tests.

Gain Correction Tests.

Test #	Gain Correction Function
1	Geospread compensation using the single velocity function; Exponential gain correction 2 dB/sec, window length 2000 ms, start time 1500 ms
2	Geospread compensation using the single velocity function; Exponential gain correction 1.5 dB/sec, window length 2000 ms, start time 1500 ms
3	Geospread compensation using the single velocity function; Exponential gain correction 1.0 dB/sec, window length 2000 ms, start time 1500 ms
4	Geospread compensation using the single velocity function; Exponential gain correction disabled

Conclusion.

The parameters of the test 4 were accepted for the production.

Single Velocity Function used for Geospread Compensation and Normal Move Out Correction:

TIME(ms)	Velocities (m/s)
0	1500
70	1500
200	1750
400	1850
700	2000
1100	2400
1600	2900
3100	4300
3900	4900
5000	5500
6000	6000

22.2.2. Swell Noise Attenuation Test.

Swell noise attention tests were performed on sequence 004. The main aim of these tests was to remove as much swell noise as possible by filtering out the unwanted low frequencies. The analysis was done using the seismic data of line 1552P1004 (seq. 004).

The application of the swell noise attenuation sfm (SWATT) within the Omega Processing System was performed on CMP NMO corrected gathers. Various parameters were tried with the best results containing the following:

- width of spatial median filter 21 traces;
- maximum frequency to process12 Hz;
- application gate 100– 6144 ms;
- threshold at 1000 ms = 3.0, threshold at 6144 ms = 2.5.

Figure 1 shows a stack with a 6Hz low cut filter and gain correction applied.

Figure 2 shows the same stack after swell noise attenuation has been applied.

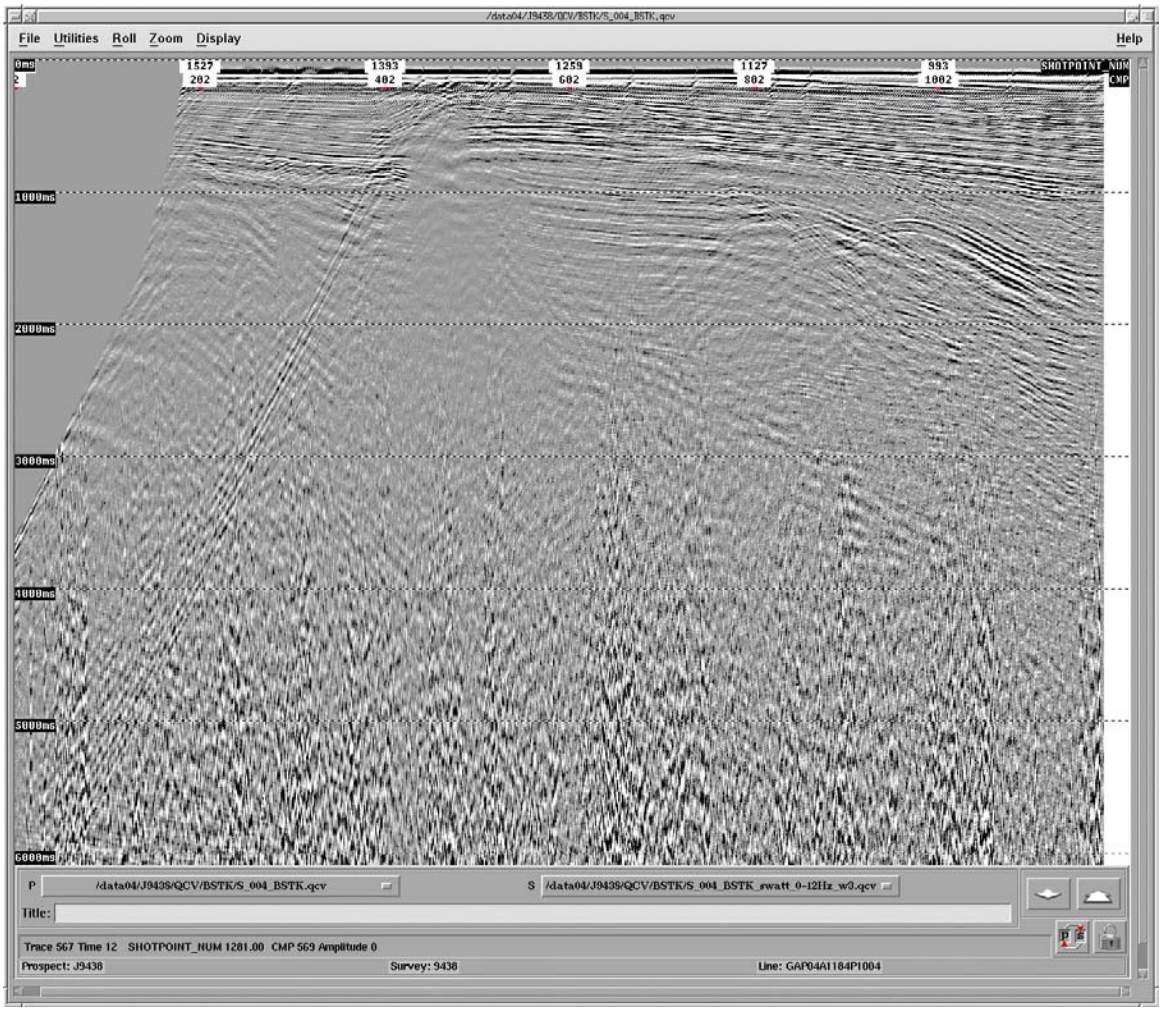


Figure 1. Stack affected by swell noise.

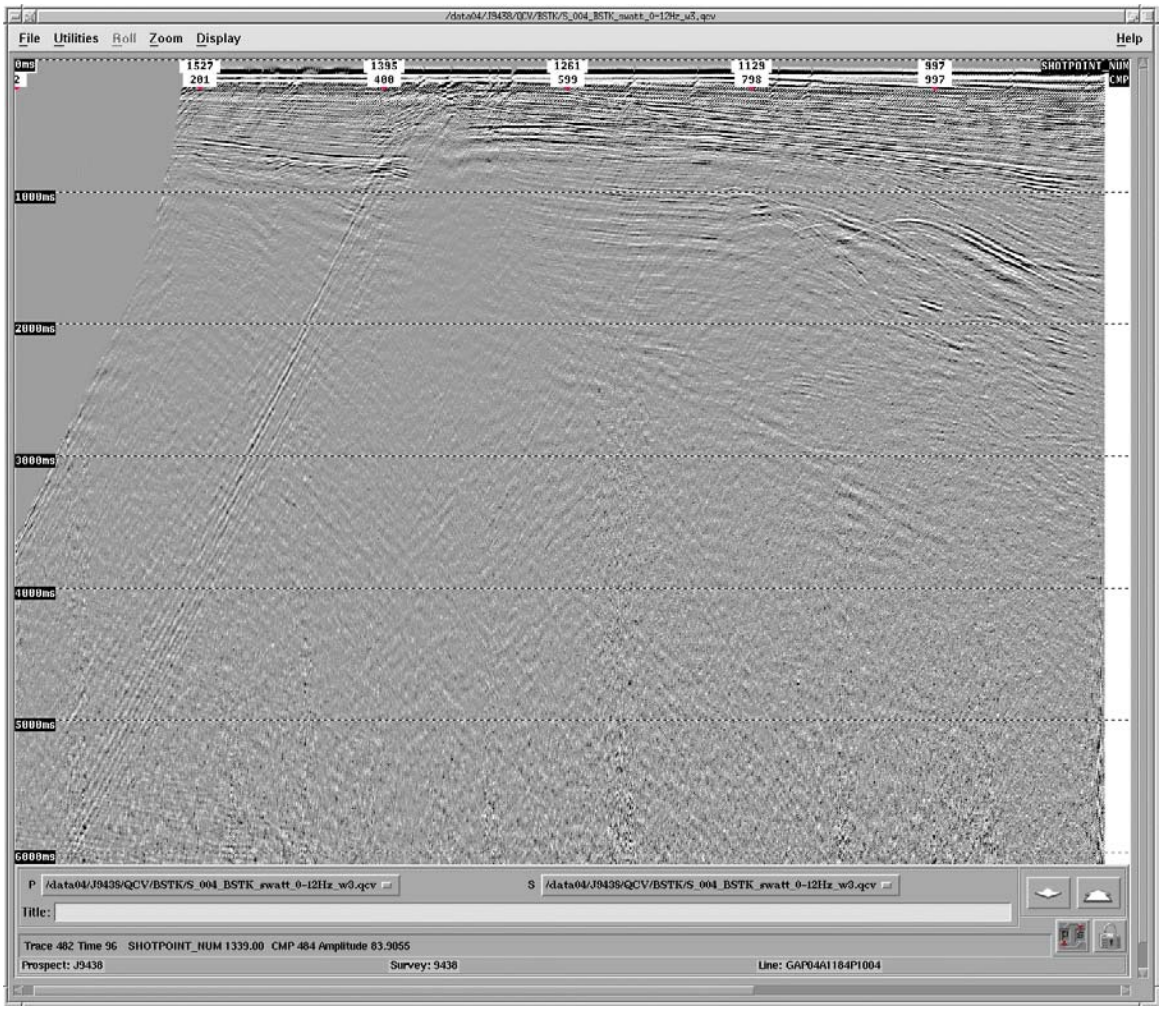


Figure2. Stack after swell noise attenuation.

23. QC Products and Processing Sequence

- For on-line QC analysis seismic data was re-sampled to 4 milliseconds.
- Seismic data for off-line QC analysis had a 2 millisecond sample rate.
- Water Bottom Cube also was produced with a 2 millisecond sample rate.

23.1. Shot and FK Analysis

Shot records were displayed online by rotating cable/source combinations. Paper plots were also produced for every 113th shot during the line to check noisy and spiking channels, swell noise, seismic interference and other types of noise encountered. This helped to identify noise sources and QC data outside the windows used for Attributes analysis.

Shot records were also displayed offline within the Omega Processing System. Every 105th shot, all cables were written to a QC-Viewer file that could be displayed on screen for identifying noisy traces and interference.

For the same shots FK analysis was performed. FK displays were used as an extra tool helping to identify the different kind of noise that could affect seismic records.

For every line, Shot and FK displays of the first good shot point were saved in gif format.

23.2. RMS Analysis

23.2.1. Deep RMS Window

Calculating RMS values with a time window analysis from 5500 – 6000 milliseconds of the records. RMS values were calculated for every trace, each shot.

Processing Sequence

1. Data Input: All shots, all channels, window 5500 - 6000 ms.
2. Scaling: By 71.428571 to convert amplitudes to microbars.
3. RMS Analysis: One trace is output for each shot containing the RMS amplitude over the window for each channel.
4. Low Frequency RMS Analysis: One trace is output for each shot containing the RMS amplitude over the window for each channel.
   Minimum phase low pass filter at 8 Hz 18 dB/Oct was applied.
5. Mid Frequency RMS Analysis: One trace is output for each shot containing the RMS amplitude over the window for each channel.
   Minimum phase band pass filter was applied:
   Low cut 8 Hz 18 dB/Oct;
   High cut 70 Hz 72 dB/Oct.
6. High Frequency RMS Analysis: One trace is output for each shot containing the RMS amplitude over the window for each channel.
   Minimum phase low cut filter at 70 Hz 72 dB/Oct was applied.

23.2.2. RMS Displays

The output analysis generated various displays, allowing analysis of the level of noise for each channel for entire sail line in different frequency bands, to identify noise source (sometimes with combination of information from Shot display and/or BSTK), to detect bad channels and detect or confirm shots, affected by external or electrical noise.

The first three displays, described below, are based on the same Raw Deep RMS data.
The reason to produce all of them is that each of them better highlight some of the events that may be difficult to be spotted or measured on other plots.

The fourth display combines data, measured in different time windows and in different frequency diapasons.

Arial RMS display.

Represents channel numbers versus shotpoints with colour-coded RMS values; shows signal amplitude in microbars. This display gives a general overview of noise level through the sail line and allows determination of noisy or dead channels, as well as noisy shots.

The display was produced both on-line with Raw RMS data (2 Hz / 12 dB/Oct LCF) and off-line with both Raw RMS data (2 Hz / 12 dB/Oct LCF) and Mid-High Frequency data (8 Hz 18 dB/Oct LCF).

Average RMS values of each trace for the entire line.

The Display helps to identify noisy, weak, and dead traces. The display was produced off-line for the Deep Analysis window for Raw RMS data (2 Hz / 12 dB/oct LCF).

Average RMS values of each cable versus Shotpoint.

The Display was generated in order to identify noisy areas throughout the sail line; to detect shots, affected by electrical noise (example: telemetry error), direction of any interfering external noise.

The display was produced both on-line and off-line with Raw RMS data (2 Hz / 12 dB/Oct LCF).

Bandpass Average Deep and Ambient RMS values versus Shotpoint.

For each shot RMS values were averaged and plotted versus Shotpoint. Correspondingly to 23.2.1, five graphs were presented on display: Raw Deep, Low frequency, Mid frequency and High frequency Deep RMS, Raw Ambient (consisting of a the last 100 traces of each cable over a window of 500-1000milliseconds).

A possibility to observe and analyse together the RMS, registered in different time and frequencies windows, helps to identify the cause of noise and separate the real noise, particularly swell noise, from noise, caused by geological events (strong seismic signal at deep times).
This display was produced off-line.

An on-line modification produced only a pair of Raw Deep RMS and Raw Ambient RMS as a main identifier of the level of swell noise.

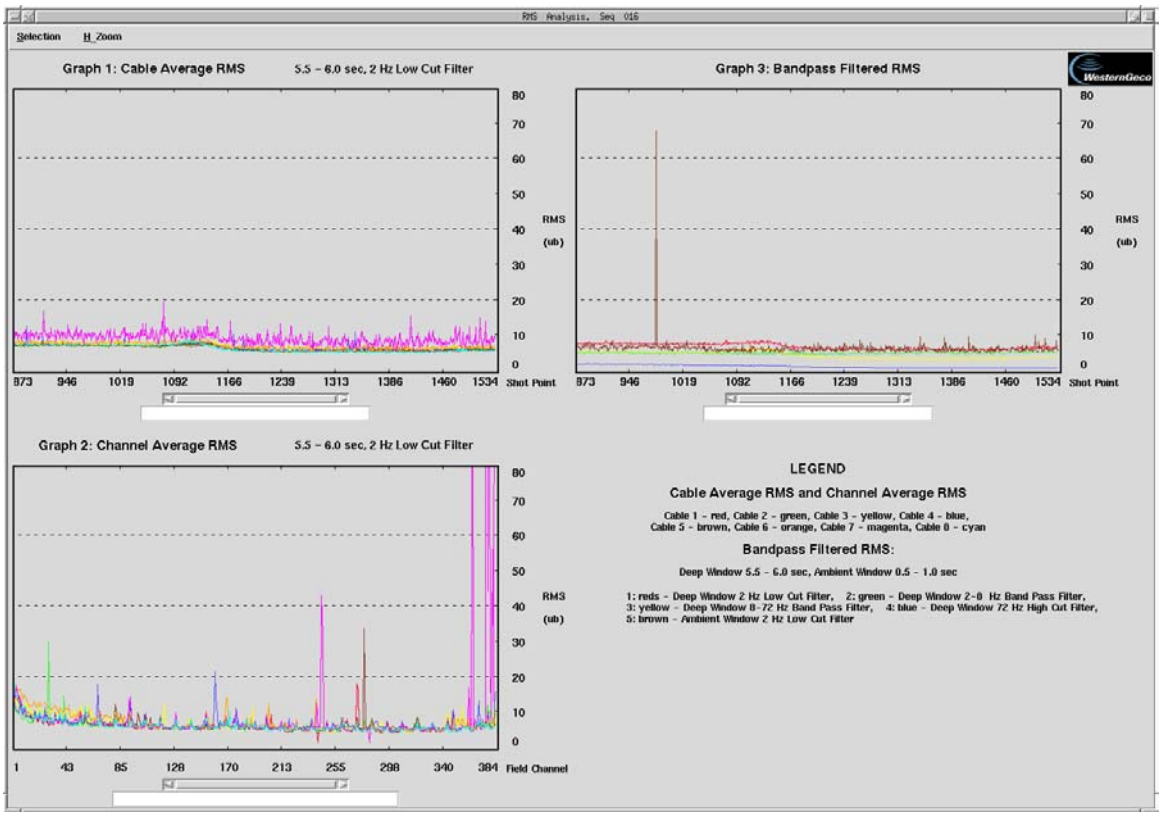


Figure 3. RMS Attribute Display.

GIF files were created for this off-line RMS display and delivered to a client's representative on-board. These were also uploaded to the Supervision server in Oslo to allow for client viewing from ashore.

23.3. Bad Traces Editing

Analysis of Shots and RMS data allowed us to identify bad traces to write into two different Edits Files.

Zeroed, distorted, noisy and weak traces were identified as bad and included in the acquisition log as edits. Any shots with parity or Telemetry errors were identified and noted in the acquisition log as a shot edit for that streamer. All shots affected by misfires, low or high pressure, or shots where synchronisation error exceeded 1.25 ms for any gun, also were added to the Edits File.

In addition, extra traces that fell out of depth specification were detected from P1/90 and output into a text file in a form “Shotpoint” – “Trace”. These depth edits also were added to a “bad traces” file.

To be able to visualize the depth edits text file and final edits file for better inspection a plot Traces vs Shotpoints with colour-coded depth were produced for each line (figure 4).

Finally, all edits from “bad traces” file also were produced as a plot: Traces vs Shotpoints (figure 5). These plots were presented to client’s representatives on board.

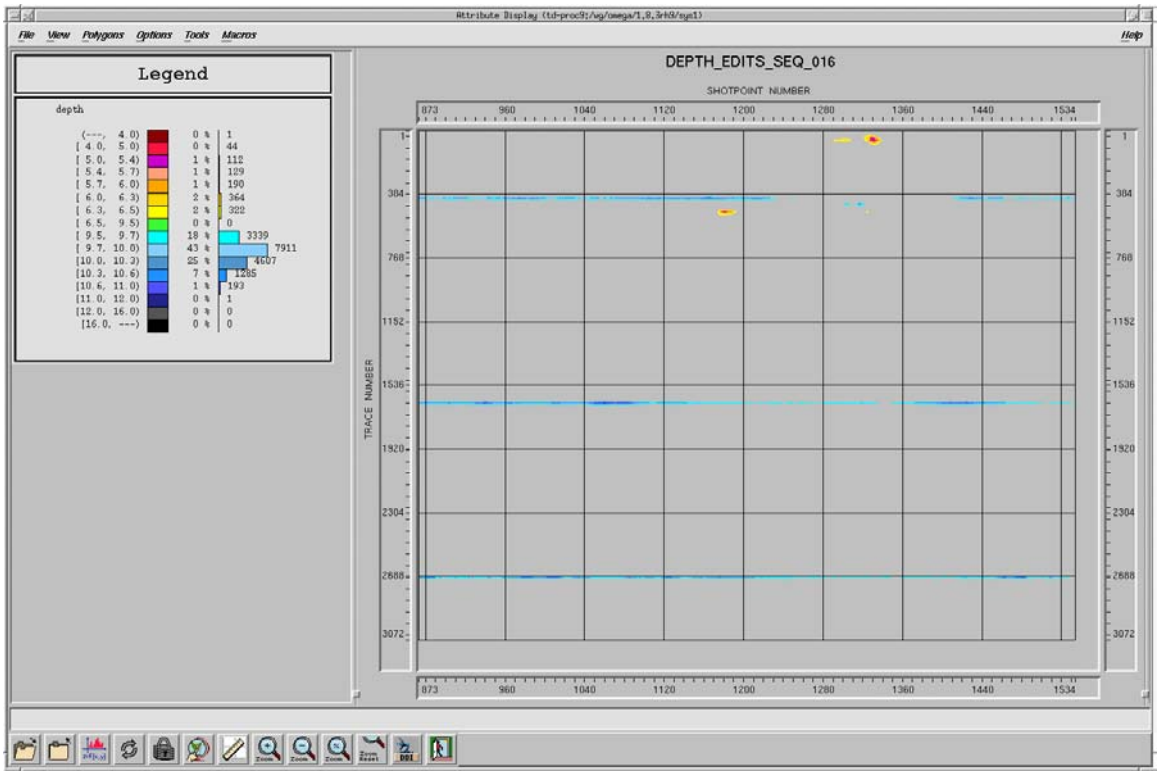


Figure 4. Depth Edits Display.

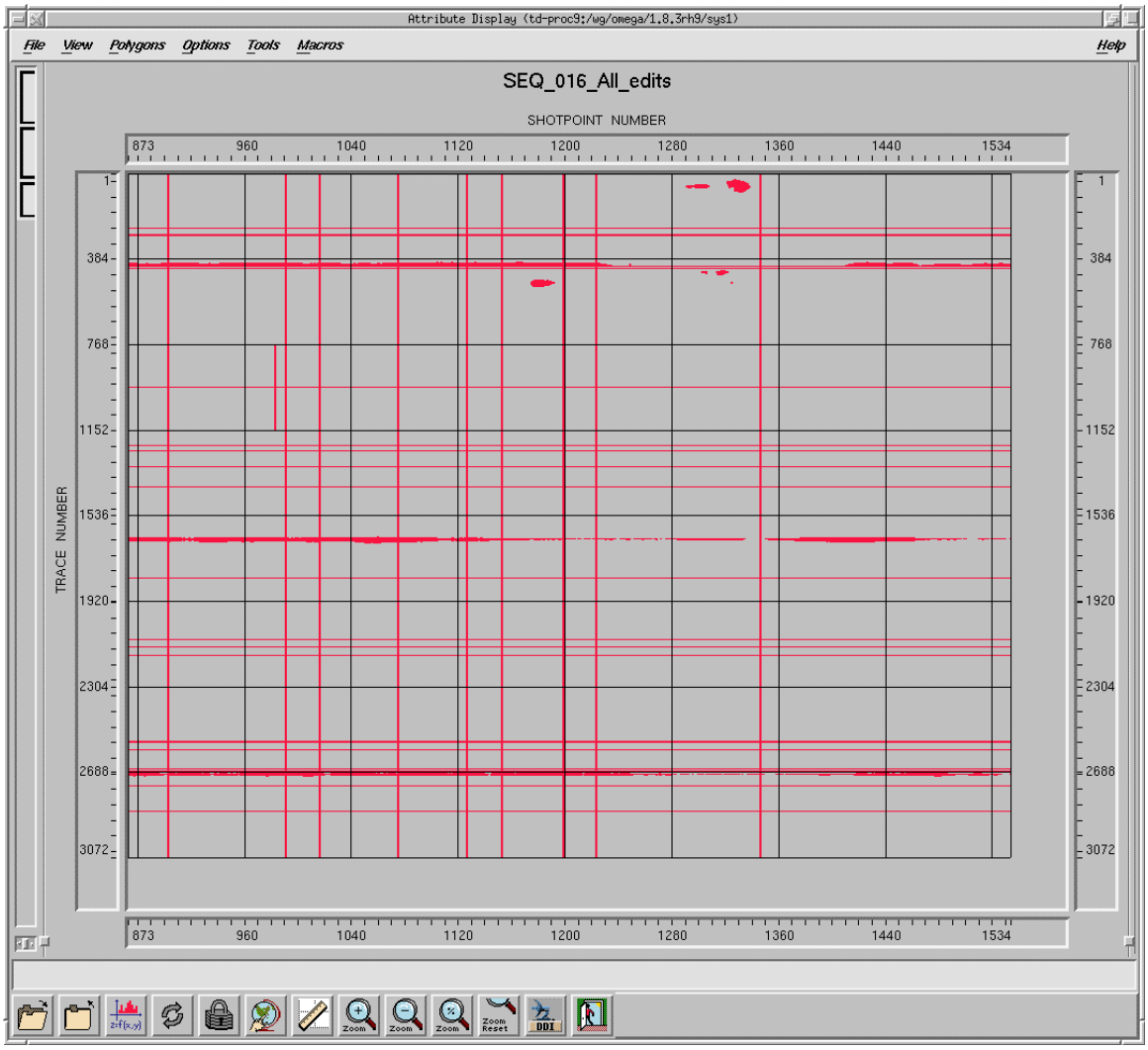


Figure 5. All Edits Display.

23.4. Near Trace Display

As part of the quality control process, near trace data with streamer rotation per sail line were selected for every sail line acquired. The first second of data was displayed to allow for detection of autofires. These were displayed using QCViever and gif files were delivered to the onboard client and uploaded to the Supervison server in Oslo.

Processing sequence:

1. Collect near traces :	Field channel 9, selected source (Port or Starboard) and streamer combination.
2. Bandpass frequency filter	Low cut filter 2 Hz. 12dB/oct
3. Gain recovery: - Geospread compensation; - Exponential Gain Correction	Geospread compensation using the single velocity function (for velocity function see 22.4.1) --- Exponential gain correction: 4 dB/sec, window length 1500 ms, start time 400 ms
4. Output to QCV Display :	Scale: horizontal = 35 traces/cm: vertical=23 cm/sec.

23.5. Source Attributes

Source analysis of each substring was performed for every line to determine possible air leakages and any drop in source energy, detect the sources depth and guns firing time. Header information was read from a single trace to detect the required information.

Correspondingly, three attribute displays were produced on-line and off-line:

- guns pressure vs shotpoint for each bundle (one sensor per substring);
- guns depth vs shotpoint for each bundle (three sensors per substring);
- guns firing time vs shotpoint for each gun.

Additionally, an attribute display with sources comparison information was produced off-line.
For comparison, 50 near traces from two inner streamers (streamers 4 and 5) were extracted.
For these traces for every shot RMS was calculated in the time window from Water Bottom Time + 500 ms to Water Bottom Time + 3000 ms. The values, represented averaged values for Port and Starboard sources and their difference, were produced for every shotpoint (figure 6).

Only source comparison displays were produced for undershoot lines as guns related information was not written into SEG-D headers. The guns related information was recorded separately by undershooting vessel Pacific Copper.

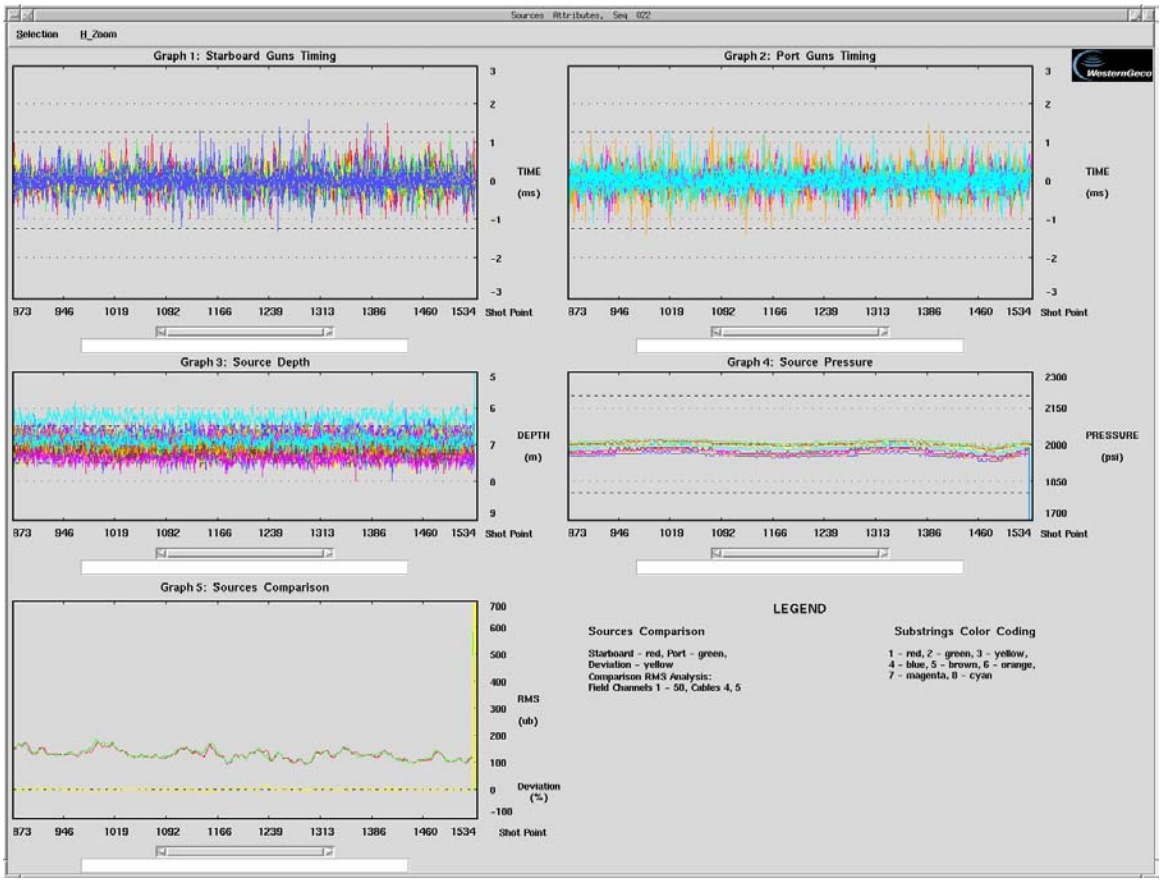


Figure 6. Sources Attribute.

23.6. Brute Stack

For each sail line a different source / streamer combination was used to generate a brute stack for one subsurface CMP line.

On-line Brute Stack.

A real time Terminal display was generated for every line. It involved selection of every second trace. At the end of the line acquisition, the QC group was able to generate paper plot with brute stack. This intended to give a much faster guide in identifying the extent of external noise in the data acquired until a full off-line brute stack was produced later.

Off-line Brute Stack

Was generated after bad shots and traces, derived from shots / RMS analysis, were removed from processing sequence. A GIF file of Brute Stack was created for every line and placed in Supervision. A paper plot also was generated for every line.

Processing sequence:

	OFF-LINE	**ON-LINE**
Input 1 cmp line per sail line	384 channels	128 channels (3:1 traces decimation).
Line edits applied	Delete bad shots/traces derived from Observers Log file and form shots / RMS analysis	Delete spiky / noisy traces, determined from previous lines
Gain Recovery	Geospread Compensation	Single Velocity Function
Low Cut Minimum Phase Frequency Filter	3 Hz 18 dB/Oct 3 Hz 18 dB/Oct from seq 073 onwards (Client's request)	3 Hz 12 dB/Oct
Nominal Marine Geometry	2D geometry using nominal offsets Group Interval 12.5 m	Group Interval 37.5 m
Adjacent Traces Summation (2:1) with Differential Move Out Correction	Single Velocity Function	Not Applied
Nominal Marine Geometry	2D geometry using nominal offsets. Group Interval 25 m	
Normal Move Out Correction	Single Velocity Function	
Pre-stack Outside Mute with offset/time pairs:	Distance(m) / Time(ms) 200 / 4 500 / 220 700 / 629 1560 / 1580 5000 / 3620	

Stack Root N scaling	64 fold	
Gain Correction	Not Applied	Not Applied
Output	To disk file in OMEGA format	
Output	To disk file in SEGY format	Not Applied
Trace scaling	Window length 1000 ms 50% overlap. (applied only to a screen output)	Window length 6000 ms
Screen Output	Output to QCV file for QCViewer	Output to a Terminal Display
Output to Paper Plot	36" OYO Plotter 20 traces/cm 10 cm/sec	Not required for this project

23.7. First Break QC (P190 QC) Display

The main purpose of this QC tool is to confirm the positioning of the source and near trace of each cable within the P190. This is done by calculating the distances between the source and the near trace of each cable using the x-y coordinates in the P190. Using this distance and a water velocity of 1500 m/s, a calculated time is derived from the equation distance = velocity x time. This calculated time, or nav spike, was superimposed onto the seismic trace and shifted 50ms earlier so that it could be compared from SP to SP. An incorrect source position in the P190 would be represented by a shift of roughly 10-30ms or 70-90ms depending on which streamer was being viewed. If this occurred, it was obvious by the way the traces were displayed for QC purposes and that SP was edited. The other purpose of this QC tool is to check the consistency of the navigation network from shot to shot. Any slight movements in the nav spikes could represent a weak network solution if proportional movements are not seen with the first breaks of the seismic trace.

Field channel number 3 from each streamer was selected. As soon as the final navigation data (P190) was available, the near traces were merged with the processed navigation data. The x / y source and receiver positions were written to the trace headers and analysed.

1. Collect near traces :	Select field channel 3 from each cable
2. Geometry update	Merge selected traces with final P190 headers. A shift of 50 ms was used to offset seismic and navigation data prior to display.
3. Truncate data	Truncate data below 500 ms.
4. Display	Display seismic and navigation data for each subsurface line. Data was output to disk in CGM format, and also viewed via QCviewer interactive display.

23.8. Water Bottom Cube

The main purpose of this QC tool is to check for erroneous positioning during the acquisition by analysis of in-line, cross-line, and time-slices plots. The seismic and navigation data were merged after final navigation P190 data was available. The x / y source and receiver positions were written to the trace headers. This information was then used to assign true offsets, select traces with offset between 430 and 490 m., and grid the selected near traces.

The processing flow included:

- Input selected traces,
- Bad traces/shot edited,
- Progressive stack file created,
- Geospread compensation using single velocity function Single Velocity Function NMO (normal moveout) corrected using a 1538 m/s function
- Writing into OmegaVu cube for visual inspection on screen and on paper plots.

Cube Parameters:

Inlines	: 933 - 1467	Increment:	1
Crosslines	: 851 - 1684	Increment:	1
Cell Size	: 18.75 m x 25.00 m		
Rotation	: 0.0 degrees		
Corners Coordinates			
933 / 851	: X = 628300.00 Y = 5782537.50		
933 / 1684	: X = 628300.00 Y = 5798156.25		
1467 / 851	: X = 641650.00 Y = 5782537.50		
1467 / 1684	: X = 641650.00 Y = 5798156.25		
Data Length	: 1000 ms.		
Sample Rate	: 2 ms.		

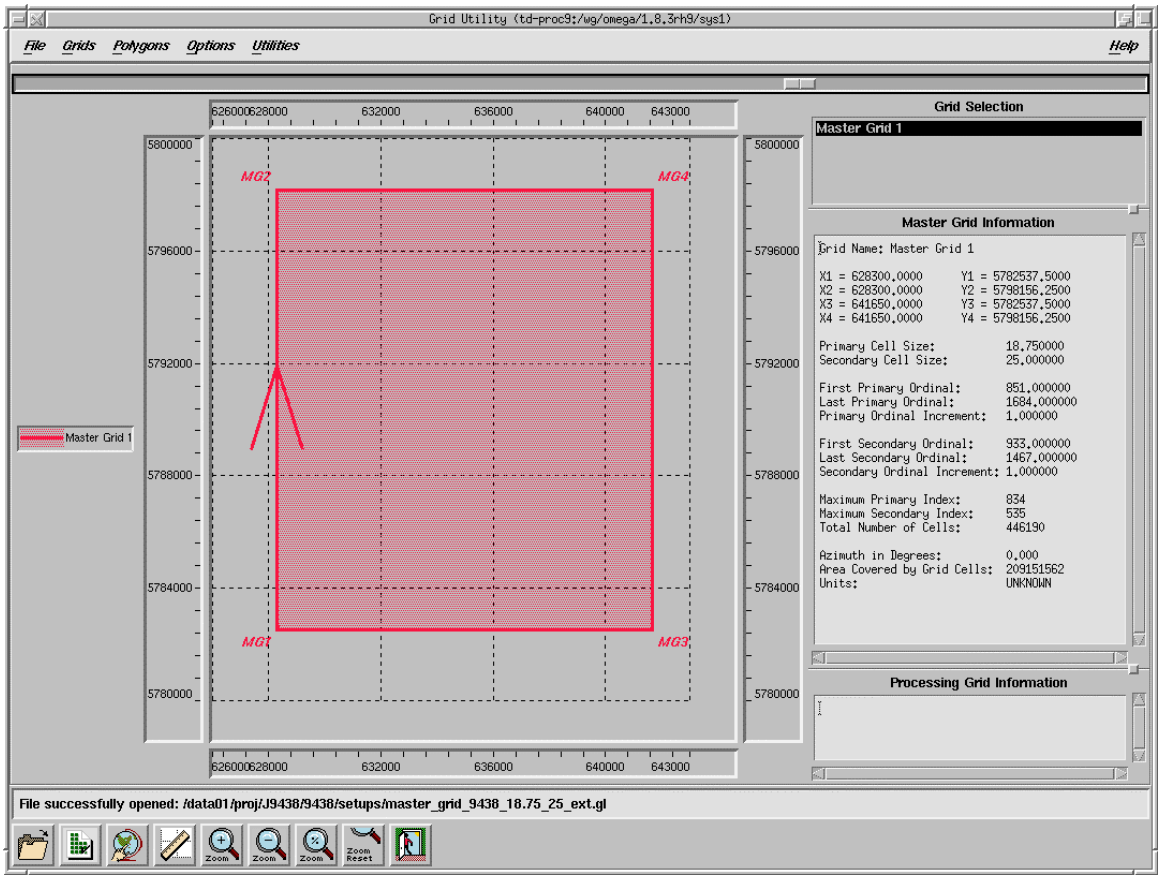


Figure 7. The Grid used for Water Bottom Cube.

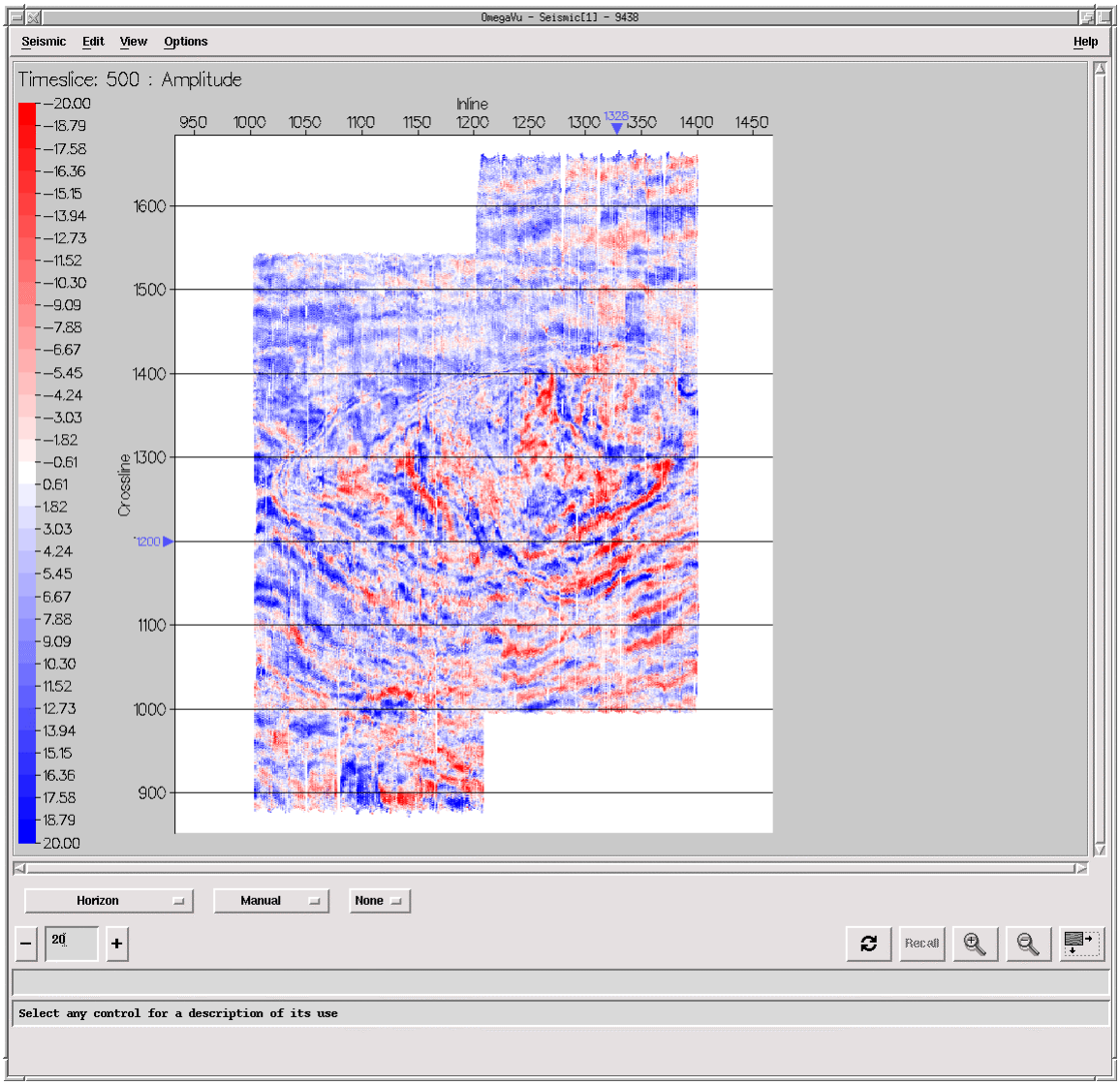


Figure 8. Water Bottom Cube. Time Slice at 500 ms.

24. Data Quality / Observations

24.1. Quality Control Summary

24.1.1. QC Outputs

A significant number of plots and displays were produced for quality control of each sequence, allowing rapid and accurate delineation of noise types and their associated effects on data quality. A dedicated local disk directory was provided so that gif files of these displays were provided regularly after end of each acquisition line for the onboard client to evaluate. Most of the products were created offline, but a chosen number of displays were generated online in order to provide a much quicker appraisal of the data quality, using Shot display, Brute Stack display, attributes such as RMS noise level, source pressure, depth for each string. Also a gun timing display presenting firing time versus Shotpoint for each gun was produced in real time and off-line.

RMS analysis on deep and ambient windows provided very useful information for the client and crew in determining the amount of swell noise, ship's noise and other types of noise present in the data. Analysis of RMS level for each channel, averaged for the entire line, helped to identify noisy or weak channels.

Shot gathers were plotted on the OYO plotter with an interval 2118 metres (every 113th shot, for different cable/source combination), which were being checked by the acquisition group. In addition, shot records were output offline every 105th shot which were viewed through Omega QC-Viewer to identify noisy channels and electrical spikes. FK analysis was performed on these shots. A RMS source comparison was performed on every sequence to identify any serious problems with the source output.

As an extra quality control, allowed to visualise depth edited traces, (8 metre target streamers depth, +/- 1.5 m allowed depth variations), two Attribute Displays were produced:

- Depth edited traces versus Shotpoint with colour-coded depth;
- All edits versus Shotpoint.

The visualisation of text files allowed to observe and analyse the edited areas much more easier.

The monitoring of quality of navigation data was performed by producing First Break QC plot and by analysis of cross-lines, in-lines, time-slices of Water Bottom Cube.

24.1.2. Noise encountered

Swell Noise

The swell noise was significant during the first 10 sequences of the survey with sequence 004 being the worst by far. The onboard client representative was satisfied with the results of the swatt performed on this line and accepted the data. Fair weather was encountered for the remainder of the survey in which swell noise did not present a problem.

Ship Noise

There was no ship noise encountered during this survey.

Strumming Noise

The towing noise slightly affected the front of streamers 4 and 6 throughout the entire survey. There was about a 5 uBar difference noticed on the front parts of these streamers with streamer 6 being a little worse than streamer 4.

Seismic Interference

There was no seismic interference encountered during this survey.

Rig noise

There was no rig noise encountered during this survey.

Source problems, autofires

Occasional misfires or timing synchronization errors resulted in shot edits for some sequences.

The First Break QC and guns timing displays were used to confirm which guns fired at the time, and both the P1/90 and observers log updated to reflect this problem.

Parities Problems

Any shots with parity or Telemetry errors were identified and noted in the acquisition log as a shot edit for that streamer. Streamer 2 in particular had a power problem that resulted in lost data for small shot point ranges on sequences 003, 008, 009, 011, 014, 015, 017 and 021.

24.2. Instrument Summary

There were a few sequences at the beginning of the survey that had significant edits due to the recording system. The problems were system lock-ups, which were traced to a poor network configuration. Sequences 003, 007, 008, 009, 010, 014, 015 and 021 were all affected.