FINAL FIELD OPERATION REPORT
MARINE SEISMIC REFLECTION SURVEY

Santos Ltd.
Champion South and Hercules
BHP
Labella 2D
Otway Basin Block VIC-P44

WesternGeco Job No. 9614

ACQUIRED BY

M/V Western Trident

Santos from April 29th to June 26th, 2007
BHP from June 26th to July 1st, 2007

Report Compiled by M/V Western Trident

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.

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General Information

Table of Contents

1. Survey Information and Objectives

WesternGeco was contracted by Santos Ltd., to conduct a 3D seismic survey using the seismic survey vessel M.V. Western Trident over the Champion South & Hercules prospects in the petroleum title VIC/P-44, Otway Basin, Australia. The programme acquired 660 square kilometres of conventional 3D seismic data. Under an Agency Agreement by Santos, WesternGeco was requested to acquire 5 additional 2D lines for BHP after Hercules survey.

The main objective of the survey was to provide high quality 3D seismic data to enable detailed structural and stratigraphic analysis of the prospects.

Waarre Formation is the primary reservoir rock. The overlying Belfast Mudstone acts as the seal. The target range for the Waarre reservoir ranges from 1200ms in the north to about 2000ms in the south of the survey area. Waarre reservoir units typically between 10 – 30m.

Mobilisation for the Champion South survey began on the 29th April 2007. Trident's first production line on the Champion South survey was acquired on the 2nd May 2007. The survey was split into two phases. The first phase was the most Northern Swath of the Champion South area. This was to be acquired first to ensure the survey would not interfere with a whale migration which was predicted to start at the end of May. On completion of the Northern Swath in the Champion South area the survey was suspended in an agreement with Beach Oil who then took over the contract of the Trident to acquire their survey. On completion of the Beach Oil survey on the 7th of June crew the Trident returned to finish off the Champion South and Hercules surveys. Crew change was carried out on Saturday the 11th for the seismic and OMS Marine crew using 6 Helicopter trips from Jayrow's Tooradin Base. On completion of crew change the Trident turned back to the SW and headed back towards the Santos prospect area. Production recommenced on the 11th of June 2007. The final production line for both the Santos survey area was acquired on the 26th of June.

After completion of Hercules survey, the vessel moved down and commenced production on the 2D lines for BHP. The 2D acquisition details for the BHP project are exactly the same as the one used by the Santos project, except with single source. Therefore, no configuration was change during the production switch.

The M.V. Western Trident is a purpose built seismic vessel and was delivered in 1999. She has successfully completed various seismic survey programs around the world and has been working in the Asia Pacific region since 2004.

The Western Trident towed a configuration of 8 x 5000m streamers with 100m separation at 8m depth, together with dual energy sources each with a volume of 3147 cu.in. At a depth of 7m. The vessel navigated along a preplotted survey line within the survey area as shown in figure 3.1. Energy from the two sources was released alternatively every 18.75m along the line. The acoustic pulses are directed downward through the water column and into the underlying seabed and sedimentary strata. The reflected signals from changes in subsurface geological structures are then recorded by the hydrophone arrays within the towed streamers. The hydrophones collect the returning signal which is stored in the vessels on board computers for subsequent processing and analysis. The return times and character of the signals are used to plot the underlying geological strata.

The Western Trident had two support vessels during the survey. The MV OMS Pioneer which is a rig tender and was used as a chase / standby boat and also for refuelling & re-supply of the Western Trident. The other vessel was a local fishing vessel, the MV Kingfisher which acted a liaison between the western Trident and the local fishing vessels.

2. Area Map

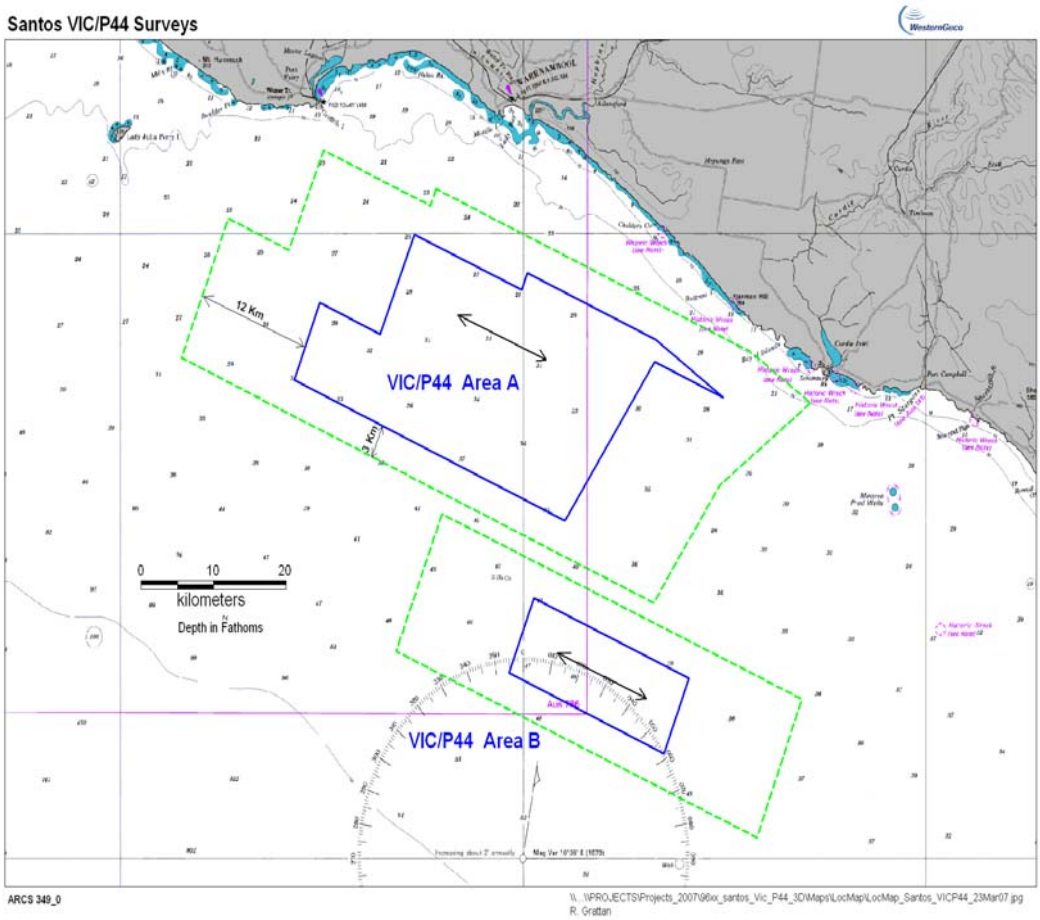

Fig 1: The map above shows the location of the Santos Ltd 3D seismic surveys.

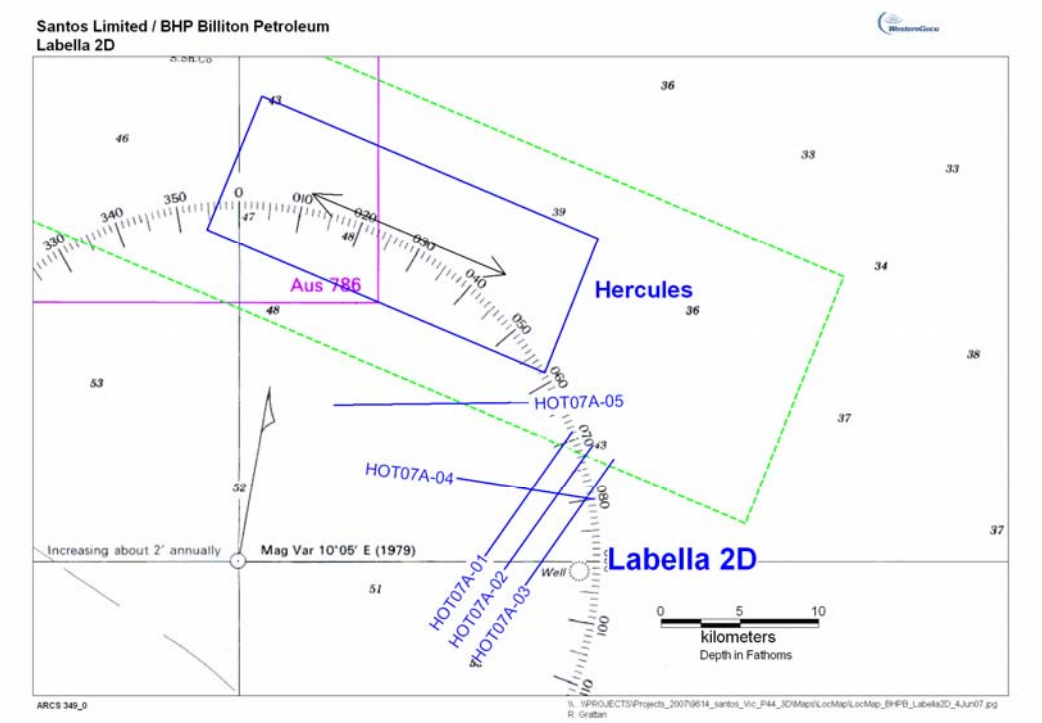

Fig 2: The map above shows the location of the BHP Labella 2D seismic survey.

3. Program Map

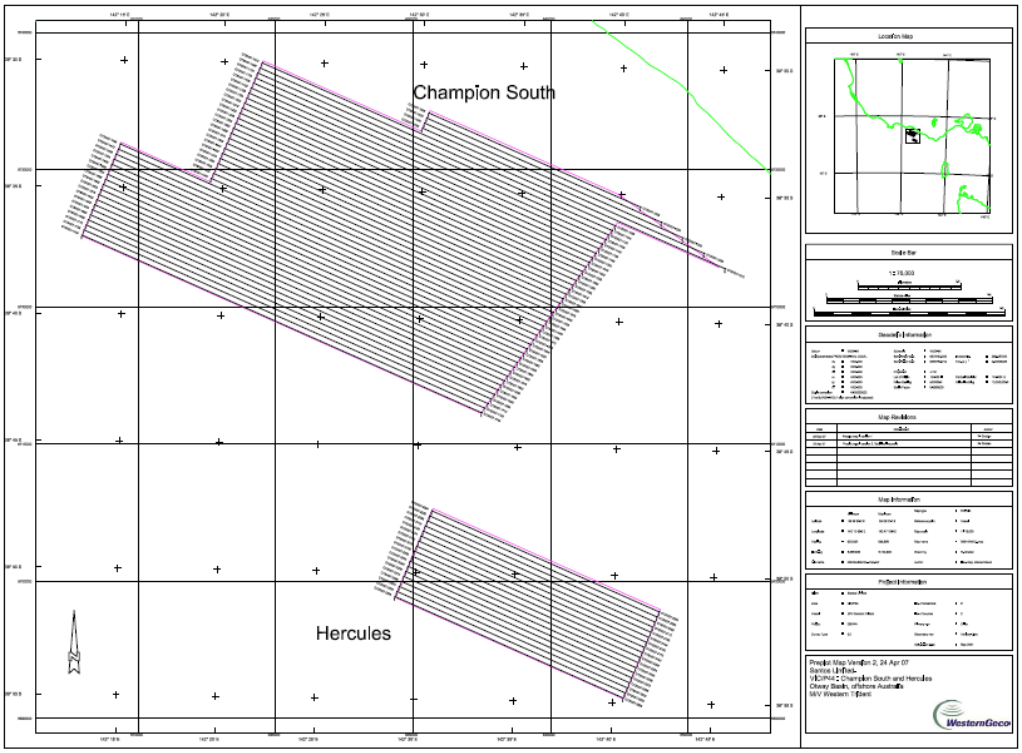

Fig 3: The map above shows the preplotted vessel sail lines for the Santos Ltd 3D seismic surveys.

4. Job Book

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
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Project Geo:
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)

Revision History

	Date	Sections	Change description	Changed by
9	12-Jun-07	Preplot, Binning, Line & shotpoint numbering	Preplots and comments regarding BHPB 2D work	rgrattan
8	12-Jun-07	Seismic Acquisition Parameters	Preplots and comments regarding BHPB 2D work	rgrattan
7	21-May-07	Seismic Acquisition Parameters, Positioning Acquisition Parameters, Onboard QC	Updated delivery information	rgrattan
6	03-May-07	Preplot, Binning, Line & shotpoint numbering	New flex parameters for infill allocation. Client binning spreadsheet uploaded to the Linked Files Directory.	rgrattan
5	30-Apr-07	Positioning Acquisition Parameters, Preplot, Binning, Line & shotpoint numbering	Mag dec & Geoid height. Version 2 preplots approved.	rgrattan
4	25-Apr-07	Preplot, Binning, Line & shotpoint numbering	Referenced Documents Additional Preplot Information Section updated to Hercules preplot	mhutahaean
3	24-Apr-07	Seismic Acquisition Parameters, Positioning Acquisition Parameters, Onboard QC, Preplot, Binning, Line & shotpoint numbering	Update as per startup meeting on 23rd April 2007.	mhutahaean
2	16-Apr-07	General Parameters, Survey Objectives, Seismic Acquisition Parameters, Positioning Acquisition Parameters, Source Acquisition Parameters, Onboard QC, Seismic Processing, Technical Specification, Preplot, Binning, Line & shotpoint numbering	Ready for review	ho3
1	19-Mar-07	Survey Objectives, Seismic Acquisition Parameters	Updated from survey booking tool.	barsch2

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9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	16-Apr-07	ho3
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Survey Objectives

Survey purpose: Exploration
Reservoir type: Structural and stratigraphic
Reservoir lithology: Clastic
Reservoir thickness (m): 20
Project location map (URL):

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/LocMap_Santos_VICP44_23Mar07.jpg

	Depth from:	Depth to:	Two-way time from:	Two-way time to:
Target 1:			1.2	2.0

Comments:
Waarre Formation is the primary reservoir rock. The overlying Belfast Mudstone acts as the seal.
The target range for the Waarre reservoir ranges from 1200msec in the north to about 2000msec in the south of the survey area.
Waarre reservoir units typically between 10 - 30m.

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9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Seismic Acquisition Parameters

General

Client:	Santos Ltd.
Vessel(s):	
Bid reference:	
Job number:	9614
Contract number:	
Location:	VIC/P44, Otway Basin, offshore Australia
Country:	Australia
Corporation code:	Santos
Client reference:	
Type of survey:	3D marine streamer
Estimated start date:	30-Apr-07
Estimated duration (days):	30
SuperVision required:	Yes

Project geo:	
name:	Ho Koon Hong
email:	ho@kuala-lumpur.westerngeco.slb.com
telephone:	+60 3 2730 8881
Nav supervisor:	
name:	Richard Grattan
email:	rgrattan@slb.com
telephone:	+60 3 2730 8814
Sales contact:	
name:	Ryan Taylor-Walshe
email:	walshe1@perth.westerngeco.slb.com
telephone:	+61 8 9420 4618
Vessel manager:	
name:	Vinh Quoc Ly
email:	vly@kuala-lumpur.westerngeco.slb.com
telephone:	+61 8 9420 4668

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Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Seismic Acquisition Parameters

Survey Area

Area (km2):	667.306
Average line length (km):	26.041
Number of saillines:	65
Heading (deg):	114.0
Reciprocal heading (deg):	294.0

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 (Hz-dB/Oct):	2.5-6
Hydrophone sensitivity (V/B):	13.8
Pre-amplifier gains (dB or mB full scale):	6
Streamer length (m):	5000.0
Streamer depth (m):	8.0
Streamer separation (m):	100.0
Number of groups per streamer:	400
Requested source to receiver offset (m):	Approx 200m

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Ready for review	12-Jun-07	rgrattan
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Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Seismic Acquisition Parameters

Recording Parameters:

Recording system:	MSX
Recording format:	SegD 8036, Rev 2
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 12.5m to 25m:	No
Record auxiliary channels:	Yes
Offline tape copy required:	No
Dual recording/tape copies (Group formed tapes):	Yes

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Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Seismic Acquisition Parameters

Additional Notes

1. The project comprises of two areas : Champion South - 9614A and Hercules - 9614B
2. FFOR - 3 hard copies & 3 electronic copies within 45 days of the completion of the survey.
3. The most Northern Swath of Campion South is to be acquired first to give way to whale migration.
4. Priority order for infil, refer to ChampionSouth3D_PriorityAreasAnnotated.jpg for location detail :
4.1 - Champion South prospect area
4.2 - Champion-1 well control.
4.3 - West flank of Pecten high ie western end of Henry prospect
5. Shooting arrangement as per startup meeting on 23rd Apr 07:
5.1. Northern Swath of Champion South, then
5.2. Beach Petroleum Job 9615, area VIC-P46
5.3. Southern Swath of Champion South
5.4. Hercules Block

Labella 2D Acquisition for BHP Billiton Petroleum

Location map (included in 09614CV1_Version1_2D_4Jun07.zip) have been uploaded to the Linked Files Directory.

2D Acquisition Details;

- WG job # 09614C
- Single source, 8 streamer
- Shot point interval : 25m
- Either stbd or port source can be used at the current 3D offset
- Vessel to be steered to DC 0
- Line prefix : HOT07A-
- There is no need to have a separate FFOR. However, BHPB name for the 2D portion of work should be mentioned in all reports. BHP then can prove to the government that they have made some commitment.

Shipment address for the Labella data is as follows:

BHP Billiton Petroleum Pty Ltd
Central Park
152-158 St Georges Terrace
Perth, Western Australia, 6000

Attention: Karl Bauer
Region Manager Perth

Both tape shipments are to go to the same address at BHP with the second set to be despatched after you receive notification the first set is rec'd OK (as per usual).

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Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Seismic Acquisition Product Delivery Information

Product name	*Media*	*Format*	*Nof copies*	*Ship when*	*Address tag*	*Notify*
Observer Logs (Client-Orig.) -Client-orig.-Obs-logs+aux.-data	CD	HTML	1	When operationally efficient	Orignal	
Tape Logs (Client-Orig.) -client-orig-tape-logs	CD	XL	1	When operationally efficient	Orignal	
Tape Logs (Client-Copy) -client-copy-tape-logs	CD	XL	1	End of survey	Copied	
Observer Logs (Client-copy) -Client-copy-Obs-logs+aux.-data	CD	HTML	1	End of survey	Copied	
SEG-D Field Tapes (Client-Orig) -SEG-D Field Tapes (Client-Orig)	3590	segD 8036	1	When operationally efficient	Orignal	
SEG-D Field Tapes (Client-Copy) -SEG-D-Seismic-Field-Tapes-Client-Copy	3590	segD 8036	1	End of survey	Copied	
FFOR -FFOR Hardcopy	HardCopy	WinWord	3	End of survey	Orignal	
FFOR -FFOR CD	CD	ascii	3	End of survey	Orignal	

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Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Seismic Acquisition Delivery Addresses

Copied	Santos Ltd. c/- Toll Priority Basement, 191 Pultney Street Adelaide, South Australia, 5000 Attention: Nick Papanicolaou, Operations Geophysics
Orignal	WesternGeco (A) Pty Ltd Level 5, The Capital Centre 256 St Georges Terrace Perth, Western Australia, 6000 Attention: Mr Paul Tredgett

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Seismic Job Book
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Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Parameters

Acquisition Geodetic Parameters

Work datum: EPSG:4326
Work datum name: WGS84 (World Geodetic Datum)
Spheroid name: WGS84
Semi major axis (m): 6378137.0
Inverse flattening (1/f) (m): 298.257224
Datum Transformation From WGS 84 to Local Datum (Bursa Wolf Convention): N/A

Projection type: UTM

Zone: 54S
Central meridian: 141° 0' 0.0" E
Scale factor: 0.9996
False easting (m): 500000
False northing (m): 10000000
Latitude of origin: 0° 0' 0.0" N

Test Point

N/A

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Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Parameters

Magnetic Variation and Geoidal Height

Location of prospect centre, latitude:	38° 35' 11.26" S
Location of prospect centre, longitude:	142° 28' 42.02" E
Magnetic variation:	10.769
Annual magnetic variation change:	0.007
Source of variation data:	IGRF-10
Geoidal height data (m):	-2.406
Source of geoidal height data:	EGM96
Date for which values calculated:	01-May-07

Vessel Positioning

Integrated navigation system:	TriNav 3.0
Number of independently positioned vessels:	1

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Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Parameters

Vessel Positioning

Vessel name : Western Trident

Primary navigation system

Vessel position computation system:	Cnav
RTCM delivery system:	Global Monitoring
Delivery method:	Inmarsat (109 East)
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

Secondary navigation system

Vessel position computation system:	Veripos
RTCM delivery system:	Veripos(SUBSEA 7) Ultra PPP
Delivery method:	Inmarsat (POR)
Survey and differential company:	SUBSEA 7
Contact person:	Chng.WuiHuan@subsea7.com
DGPS reference stations:	

Via Global Monitoring.

Contact details (in Singapore):
Chng Wui Huan
Tel +65 6329 7673, Mob: +65 8121 8978, Fax: +65 6323 0182
E-Mail: Chng.WuiHuan@subsea7.com or veripos.helpdesk@subsea7.com

Tertiary navigation system

Vessel position computation system:	Trinav GPS 3.0
RTCM delivery system:	Veripos(SUBSEA 7) Dual Freq
Delivery method:	Inmarsat (POR)

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9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Parameters

Survey and differential company: SUBSEA 7

Contact person: Chng.WuiHuan@subsea7.com

DGPS reference stations:

Please use all available reference stations;
Perth, Melbourne, Hobart, New Plymouth
For the DGPS Coverage Chart and station information, please refer the Veripos_Ref_Stations.pdf file that has been uploaded to the Linked Files Directory.

Contact details (in Singapore):
Chng Wui Huan
Tel +65 6329 7673, Mob: +65 8121 8978, Fax: +65 6323 0182
E-Mail: Chng.WuiHuan@subsea7.com or veripos.helpdesk@subsea7.com

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Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Parameters

Streamer Parameters

Positioning:

Source surface positioning:	Seatrack 330
Front-net in-sea positioning:	SIPS2
Mid-streamer in-sea positioning:	SIPS2
Tail-net in-sea positioning :	SIPS2
Full streamer IRMA network:	No
Tailbuoy surface positioning:	Seatrack 220
Compass bird type:	DigiCOURSE
Distance between adjacent compasses (m):	300

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Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Parameters

Preferred Shooting Plan:

See SurvOpt files (SurvOpt_Santos_Champion South_26Mar07.zip and SurvOpt_Santos_Hercules_26Mar07.zip) that have been uploaded to the linked files directory for details. The plan should be followed as closely as possible. The on board client rep should be consulted before deviating from the plan.

The most Northern Swath of Champion South is to be acquired first. Please see the email extract below from Santos dated 27th Mar 07.

Shooting arrangement as per startup meeting on 23rd Apr 07:
1. Northern Swath of Champion South, then
2. Beach Petroleum Job 9615, area VIC-P46
3. Southern Swath of Champion South
4. Hercules Block

We definitely need to acquire the most inshore racetrack first and we wish to acquire the racetrack from the coast outwards such that, as May progresses, we will be operating further from the coast (and hence the Southern Right whales if they arrive early). I doubt we'll have significant feather matching problems - infill has been relatively low on past surveys conducted in the area. Any current is parallel to the coast and direction of recording.

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Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Parameters

Known Obstructions:

There are no known obstructions within the project operations area as per Admiralty Chart 349_0

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Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Parameters

3D Parameters:

Steering point:	Near / Mids (group 2)
Reference point for firing:	First CMP

Water Depth and Processing

Minimum water depth (m):	35.0
Maximum water depth (m):	90.0
Echosounder standard velocity (m/s)	1500.0
Echosounder standard draft (m):	0.0
Vertical datum:	MSL
Apply velocity corrections in processing:	Yes
Apply draft corrections in processing:	Yes
Apply tidal corrections in processing:	Yes
Tidal corrections source:	Metocean

Supplied tidal file:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/TIDE_GMT_MSL_20Apr_31Jul07.zip

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Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

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 job book are the prospect mid point in local datum.

No datum transformation, trial point required as the working and acquisition datum is WGS-84,
No Gravity and Magnetic survey were required for this project.

The spread should be steered to maximise the coverage on the Near/Mids segment (group 2).

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.
These files are uploaded onto the Linked_Files directory.

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Positioning Acquisition Product Delivery Information

Product name	*Media*	*Format*	*Nof copies*	*Ship when*	*Address tag*	*Notify*
P190(Office Copy) -P190(Office Copy)	3590	ascii	1	When operationally efficient	WG KL	Edward Loh/Richard Grattan
P294(Office Copy) -P294(Office Copy)	3590	ascii	1	When operationally efficient	WG KL	Edward Loh/Richard Grattan
P190 VSE Record Only (Office Copy) -P190 VSE Record Only (Office Copy)	CD	ascii	1	End of survey	WG KL	Edward Loh/Richard Grattan
Nav PC Job Files (Office Copy) -Nav PC Job Files (Office Copy)	CD	ascii	1	When operationally efficient	WG KL	Edward Loh/Richard Grattan
Other Office Deliverables as per PFM -Other Office Deliverables as per PFM	3590	ascii	1	When operationally efficient	WG KL	Edward Loh/Richard Grattan
Raw current meter data (Office Copy) -Raw current meter data (Office Copy)	CD	ascii	1	When operationally efficient	WG KL	Edward Loh/Richard Grattan
P190 (Client) -P190 (Client Original)	3590	ascii	1	When operationally efficient	Orignal	
P190 (Client) -P190 (Client Copy)	3590	ascii	1	End of survey	Copied	

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Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore Australia
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Product Delivery Information

Product name	*Media*	*Format*	*Nof copies*	*Ship when*	*Address tag*	*Notify*
P294 (Client) -P294 (Client Original)	3590	ascii	1	When operationally efficient	Orignal	
P294 (Client) -P294 (Client Copy)	3590	ascii	1	End of survey	Copied	
P698 (Client) -P698 (Client Original)	CD	ascii	1	When operationally efficient	Orignal	
P698 (Client) -P698 (Client Copy)	CD	ascii	1	End of survey	Copied	
P190 VSE Record Only (Client) -P190 VSE Record Only (Original)	CD	ascii	1	When operationally efficient	Orignal	
P190 VSE Record Only (Client) -P190 VSE Record Only (Copy)	CD	ascii	1	End of survey	Copied	
Post Plot -Post plot client copy	CD	ascii	1	End of survey	Copied	

WesternGeco

Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	21-May-07	rgrattan
Nav Supervisor:		
Richard Grattan (phone : +60 3 2730 8814, email : rgrattan@slb.com)		

Positioning Acquisition Delivery Addresses

Copied	Santos Ltd. c/- Toll Priority Basement, 191 Pultney Street Adelaide, South Australia, 5000 Attention: Nick Papanicolaou, Operations Geophysics
Orignal	WesternGeco (A) Pty Ltd Level 5, The Capital Centre 256 St Georges Terrace Perth, Western Australia, 6000 Attention: Mr Paul Tredgett
WG KL	Attn: Edward Loh / R. Grattan 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

WesternGeco

Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	16-Apr-07	ho3
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Source Acquisition Parameters

Source type:	Tuned boltgun array
Number of source arrays:	2
Alternatively fired sources (flip-flop):	Yes
Source array separation (m):	50.0
Inline stagger required:	No
Shotpoint interval (m):	18.75
Shotpoint interval per source (m):	37.5
Array volume per source (In3):	3147.0
Operating pressure (psi):	2000
Source depth (m):	7.0
Number of subarrays per source:	3
Subarray separation (m)	8
Number of airguns per subarray:	8
Subarray length (m):	15.0
Gun timing specification (ms):	1.25
Source control system:	TriSor
Record nearfields:	Yes
CMS required:	No

Total SCFM required at 4.8 knots:	1984
Timebreak control:	Fixed

Specification:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/v3147_d7p0_s8-MSX_GD51i.doc

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	21-May-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Onboard QC

Products

Product	*Summary*	*Frequency*	*Shot Frequency*
SegD Header Analysis(HAL)		Once per line	
Tar or Concatenated QC stacks		Once per survey	
FK plot		Every x shots	200
Online QC Stack	- Trace Decimation - Gain Recovery - DBS - NMO correction - using either a regional function or supplied by client - Post NMO mute - picked by onboard contractor processing staff - Stack - Gun and Cable correction - TVF - Amplitude balancing and display	Once per line	
Shot gathers		Every x shots	100
RMS noise	- Computed in two rectangular time/trace window - One of the time trace windows is further anaylysed in three frequency windows	Once per line	
Near Trace Navigation QC(LMO)		Once per line	
Relative Source Amplitude			
Standard attribute displays		Once per line	
Single Fold Cube		Once per survey	

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	21-May-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Onboard QC

Additional notes:

1. Verify the regional vel. Pick one line if the given velocity is not suitable.

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore Australia
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	21-May-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Onboard QC Product Delivery Information

Product name	*Media*	*Format*	*Nof copies*	*Ship when*	*Address tag*	*Notify*
Tar or Concatenated QC stacks -QC Stack -SEGY	3590	segY	1	End of survey	QC	
Near Trace Navigation QC(LMO) -LMO QC -CGM	3590	CGM	1	End of survey	QC	
Single Fold Cube -Single Fold Cube -SEGY	3590	segY	1	End of survey	QC	

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	21-May-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Onboard QC Delivery Addresses

QC

WesternGeco (A) Pty Ltd
Level 5, The Capital Centre
256 St Georges Terrace
Perth, Western Australia, 6000

Attention: Mr Paul Tredgett

WesternGeco

Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin,
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	16-Apr-07	ho3
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Seismic Processing

Products

Product	*Summary*

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	16-Apr-07	ho3
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Technical Specifications

These tables are for the purpose of summary only. Reference should be made to the contractual technical specifications:
https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/WesternGecoSantosContractVICP44_EDITED_P2.pdf

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Preplot, Binning, Line and shotpoint numbering

Preplot references:

Binning document:

P190 file:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/09614AV2pr_Version2_Champion_South_24Apr07.zip

Pre-plot print-out file:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/09614AV2pr_Version2_Champion_South_24Apr07.zip

P698 file:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/09614AV2pr_Version2_Champion_South_24Apr07.zip

.193 file:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/09614AV2pr_Version2_Champion_South_24Apr07.zip

PrePlot drawing:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/09614AV2pr_Version2_Champion_South_24Apr07.zip

Additional PrePlot file:

https://www.vessel.int.slb.com:181/gpclient/vessels/Western_Trident/9614/Acquisition_Information/Job_Book/.Linked_Files/09614BV2pr_Version2_Hercules_24Apr07.zip

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Preplot, Binning, Line and shotpoint numbering

Offset Segment Specification

	Min (m):	Max (m):	No. hits required (%)
Offset segment 1:	0	1250	90.0
Offset segment 2:	1250	2500	90.0
Offset segment 3:	2500	3750	90.0
Offset segment 4:	3750	5000	90.0

Flex parameters specified as linear taper:

Flex at near offset (%):	50.0 *
Flex at far offset (%):	300.0 *

*) *Flex is specified as a percentage of the total bin width. For example 50% flex of a 25 m. bin will result in a 37.5 m. flexed bin size.*

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Preplot, Binning, Line and shotpoint numbering

Bin Grid set-up:

Bin width (X-line):	25.0
Bin length (in-line):	6.25
First line number:	1008
Columns covered by first line:	1001-1016
Line increment:	16
Cells per shotpoint:	3.0
Intersection method:	Full
True origin northing:	5772730.4
True origin easting:	606367.96
P1 reference shotpoint number:	1.0
P1 reference line number:	1.0
Rotation (deg):	114.0
Bin grid entry method:	By corner points
P1 northing:	5772730.4
P1 easting:	606367.96

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Preplot, Binning, Line and shotpoint numbering

Line naming and shotpoint numbering:

Line prefix streamer:	OTSN07-
Line suffix start character - prime:	P
Line suffix start character - reshoot:	A,B,C....
Line suffix start character - infill:	J,K,L....
Line name example - prime:	OTSN07-1008P001
Line name example - reshoot:	OTSN07-1008A002
Line name example - infill:	OTSN07-1008J004
Value to add to 1st reshoot SP no.:	0
Value to add to 2nd reshoot SP no.:	0
Value to add to 1st infill SP no.:	0
Value to add to 2nd infill SP no.:	0
Stbd source firing on:	Odd shotpoints
SP numbering along primary direction:	Incrementing
Incrementing/Decrementing factor:	1.0
Source line run-in/run-out:	7500 / 2500 (run-in to be decided on board)

Comments:
-Line naming convention- Proposed By Client

PPPPPPPLLLLXSSS
where
PPPPPPP is the Line prefix = OTSN07-
LLLL is the 4-digit sail line number
X denotes line type with P for Prime; A,B,C.... for Reshoots and J,K,L.... for Infill passes
SSS is the 3-digit sequence number
Examples:
OTSN07-1008P001 is 1st Prime line for sail line 1008 at sequence 001
OTSN07-1008J028 is 1st Infill pass for sail line 1008 at sequence 028
OTSN07-1008B039 is 2nd reshoot pass for sail line 1008 at sequence 039

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Preplot, Binning, Line and shotpoint numbering

Additional notes:

Version 2 of the 3D preplots have been approved by Santos.

The project comprises of two areas (Champion South and Hercules). The preplots for both areas have been designed using the same True Origin and rotation so that line numbers and shots points are consistent.

The preplots for Champion South have been created using job number 09614A and Hercules have been created using job number 09614B. The Champion South preplot information includes the preplot maps for both areas. The Hercules preplots have been uploaded in the Referenced Documents Additional Preplot Information Section.

Both areas are to be included in the one FFOR.

For crew's info only:

True Origin is the Offset Origin.

Labella 2D Acquisition for Santos Limited and BHP Billiton Petroleum

Version 1 of the Labella 2D preplots have been approved by Santos and BHPB.

Version 1 of the preplots, preplot map and location map (09614CV1_Version1_2D_4Jun07.zip) have been uploaded to the Linked Files Directory.

2D Acquisition Details;

- WG job # 09614C
- Single source, 8 streamer
- Shot point interval : 25m
- Either stbd or port source can be used at the current 3D offset
- Vessel to be steered to DC 0
- Line prefix : HOT07A-
- There is no need to have a separate FFOR. However, BHPB name for the 2D portion of work should be mentioned in all reports. BHP then can prove to the government that they have made some commitment.

Shipment address for the Labella data is as follows:

BHP Billiton Petroleum Pty Ltd
Central Park
152-158 St Georges Terrace
Perth, Western Australia, 6000

Attention: Karl Bauer
Region Manager Perth

Both tape shipments are to go to the same address at BHP with the second set to be despatched after you receive notification the first set is rec'd OK (as per usual).

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Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
Ready for review	12-Jun-07	rgrattan
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Preplot, Binning, Line and shotpoint numbering

Client specific requirements:

3D Binning
The following cross line flex should be used during acquisition and steering the spread
Q1 Q2 Q3 Q4
Front 50% 112.5% 175% 237.5%
Tail 112.5% 175% 237.5% 300%

Total Bin Width flexed (meters)
Q1 Q2 Q3 Q4
Front 37.5 53.1 68.8 84.4
Tail 53.1 68.8 84.4 100

For display during infill allocation the following parameters should be applied;

Q1 Q2 Q3 Q4
Front 100% 125% 150% 175%
Tail 150% 175% 200% 225%

Total Bin Width flexed (meters)
Q1 Q2 Q3 Q4
Front 50 56.3 62.5 68.8
Tail 62.5 68.8 75.0 81.3

WesternGeco

Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
---	---	---
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Delivery Summary

	Copied	Orignal	QC	WG KL	Supervision
Seismic Acquisition					
Observer Logs (Client-Orig.)		1 CD (HTML)			
Tape Logs (Client-Orig.)		1 CD (XL)			
Tape Logs (Client-Copy)	1 CD (XL)				
Observer Logs (Client-copy)	1 CD (HTML)				
SEG-D Field Tapes (Client-Orig)		1 3590 (segD 8036)			
SEG-D Field Tapes (Client-Copy)	1 3590 (segD 8036)				
FFOR		3 HardCopy (WinWord) 3 CD (ascii)			
Positioning Acquisition					
P190(Office Copy)				1 3590 (ascii)	
P294(Office Copy)				1 3590 (ascii)	
P190 VSE Record Only (Office Copy)				1 CD (ascii)	
Nav PC Job Files (Office Copy)				1 CD (ascii)	
Other Office Deliverables as per PFM				1 3590 (ascii)	
Raw current meter data (Office Copy)				1 CD (ascii)	
P190 (Client)	1 3590 (ascii)	1 3590 (ascii)			
P294 (Client)	1 3590 (ascii)	1 3590 (ascii)			
P698 (Client)	1 CD (ascii)	1 CD (ascii)			
P190 VSE Record Only (Client)	1 CD (ascii)	1 CD (ascii)			
Post Plot	1 CD (ascii)				
Onboard QC					
SegD Header Analysis(HAL)					Supervision (GIF)

WesternGeco

Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
---	---	---
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Delivery Summary

Tar or Concatenated QC stacks			1 3590 (segY)		
FK plot					Supervision (GIF)
Online QC Stack					Supervision (GIF)
Shot gathers					Supervision (GIF)
RMS noise					Supervision (GIF)
Near Trace Navigation QC(LMO)			1 3590 (CGM)		
Relative Source Amplitude					Supervision (GIF)
Standard attribute displays					Supervision (GIF)
Single Fold Cube			1 3590 (segY)		

WesternGeco

Seismic Job Book
Version : 9

Job number:	Client:	Location:
9614	Santos Ltd.	AUS / VIC/P44, Otway Basin, offshore
Chapter status:	**Chapter updated:**	**Chapter updated by:**
---	---	---
Project Geo:		
Ho Koon Hong (phone : +60 3 2730 8881, email : ho@kuala-lumpur.westerngeco.slb.com)		

Delivery Addresses

Copied

Santos Ltd.
c/- Toll Priority
Basement, 191 Pultney Street
Adelaide, South Australia, 5000

Attention: Nick Papanicolaou, Operations Geophysics

Orignal

WesternGeco (A) Pty Ltd
Level 5, The Capital Centre
256 St Georges Terrace
Perth, Western Australia, 6000

Attention: Mr Paul Tredgett

Proc

xxx

QC

WesternGeco (A) Pty Ltd
Level 5, The Capital Centre
256 St Georges Terrace
Perth, Western Australia, 6000

Attention: Mr Paul Tredgett

WG KL

Attn: Edward Loh / R. Grattan
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

5. Vessel Description

VESSEL SPECIFICATIONS
M/V WESTERN TRIDENT

The Survey Vessel - M/V Western Trident

WesternGeco reserves the right to alter specifications without prior notice.

Vessel Specifications

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-11
Safe Manning Certificate (Minimum)	No.M3026 (10 crew)

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)	92.50m
Length Between Perpendiculars	80.10m
Breadth (Moulded)	23.00m
Breadth (Extreme)	25.00m
Depth (Moulded)	9.00m
Draft (Max)	7.30m (Summer)
Draft (Mean)	6.40m (Design)
Air Draft (To Higest Antenna)	32.70m (Summer draft)
Helicopter Deck Rating	Sikorsky S-92 / 11.0t Max
Helicopter Deck Diameter (D-Value)	22.80m
Helicopter Deck Markings Standard	CAA / CAP437 / BHAB

Capacities And Endurance's

Cable / Towpoints / Subarrays	TMS Solid / 16 Tow Points / 10 Sub arrays
Bollard Pull	142t x 100% power
Fresh Water Capacity	446 M^3
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	3526 M^3
Fuel, Useful For 100 % Consumption	3286 M^3
Fuel Type	Gas oil
Fuel Tank Heating	N/A
Lub. Oil, Engine Oil (M^3)	30 M^3
CYLINDER OIL, HP COMPRESSORS (M^3)	7 M^3 cylinder oil, 7 M^3 screw compressor oil.
CABLE OIL, KEROSENE (Clean/Dirty)	11 M^3 clean / 7 M^3 dirty
BALLAST, SEA WATER (M^3)	3150 M^3
Speed, Transit, Max. In Calm Sea	15 Knots
Speed, Transit Economy, Ditto	12 Knots
Consumption Of Fuel , Full Speed	36 M^3 / 24 Hrs
Consumption Of Fuel, Economy Speed	26 M^3 / 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 M^3 / 24 Hrs
Safety Equipment Certificate	70 Persons

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	Maris 9000
Gyro Compass	SIMRAD RGC 11
Auto Pilot	SIMRAD AP9 Mk3 / SJS500 Joystick/Autotrack System
Gps Receiver	2 x FURUNO GP 150
Speed Log	BEN ANTHEA Electro. Mag. Furuno DS-80 Doppler Log with bridge wing repeaters
Echo Sounder	SKIPPER GDS 101
Radio's, Vhf, Gmdss*, Type 1	3 x SAILOR RT 5022 VHF / DSC
Radio's, Vhf, Gmdss*, Type 2	3 x NAVICO AXIS 250 (portable)
Radio's, Vhf	8 x MOTOROLA GP340 (portable)
Radio's, Uhf	1 x Motorola GM 300 BASE STATION 12 x Motorola GM 328 (Portable)
Radio Direction Finder	N/A
Weather Facsimile	FURUNO DFAX-208 Mk2
Navtex Receiver	McMURDO NAV 7
Ups, Power Supply To All Gmdss Radio's	FN Electro Converter/Charger with lead acid battery back up.
Helideck Monitoring System	SEATEX HMS 100.

Communication Equipment, Gmdss Compliant

Radio Station Licence No.	06-11-2003/1 Panama
Class / Corr. Category	A1, A2, A3. GMDSS
Ship / Air Craft Radio	JOTRON TR-6101 (fixed) + 2 x Dittel FSG 5
Helicopter Beacon	SAC DS410 (410 KHz. I.D. 'T R I D')
Automatic Identification System (AIS)	SAAB 24 AIS CLASS A TRANSPONDER
Transmitter / Receiver, Main (Mf)	SKANTI TRP 9000
Transmitter / Receiver, Reserve (Mf)	N/A
Transmitter / Receiver, Main (Vhf)	3 x SAILOR RT 5022 VHF, DSC
Transmitter / Receiver, Main (Dsc)	SKANTI DSC9000 MF/HF DSC CONTROLLER/RECEIVER
Ais. Automatic Idemtification System	SAAB R4 AIS TRANSPONDER SYSTEM
Radio, Portable, VHF	8 x MOTOROLA GP340 4 x MOTOROLA GP300
Booster Unit For Portable Radio (Uhf)	N/A
Emergency Radio Beacon (Epirb)	JOTRON TRON 40S 406/121.5 MHz SERIAL 130AD14503 JOTRON TRON 40S 406/121.5 MHz SERIAL 01406247
Radar Transponder	2 x JOTRON TRON SART 9 GHz
Radio, Lifeboat, Vhf	3 x NAVICO AXIS 250 (portable)

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	USE IMARSAT B LINE
Internal E-Mail & Pc-Network	Eudora, Ethernet
E-Mail Address To Vessel	captain@trident.vessel.int.slb.com

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	70 (Koppernaes)
Working Suits, Thermo Insulated	30 x 'Mustang' + 10 'Aqua' Dry suits.
Man Overboard Boat (Mob) Type	Norsafe Magnum, 7.5 mtr.
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	2 x 25 FOOT NORPOWER WORKBOATS
Engine Work Boat And Speed Of Boat	NOGVA/CUMMINS type 6BT5.9M 210HP Speed 15Kn

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

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 M^3 Tk.No.37 Roll Reduction Aft 312 M^3
Heeling Tanks, Volume And Fuel/Fw/Sw	SWB Tanks No. 6 & 7 – Total capacity: 382m3 + 392m3
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
Buisness Conference And Training Rm	A -deck
Sauna And Fitness Room	A-deck

International Oil Pollution Prevention (IOPP) Equipment

Incinerator, Sludge And Waste Oil	Teamtec-Golar, OGS400C, 65 ltr IMO sludge/h. Max 400 ltrs solid waste / charge.
Bilge / Oily Water Separator	World Water Systems, 2500 OCD, 2.5 M^3/h, through 15 ppm unit.
Oily Water / Sludge Holding Tanks Cap.	Bilge W.tank:14 M^3. Sludge/waste tk's.: 22 M^3
Sewage Disposal Plant	Hamworthy Super Trident, ST6A. Macerate, biological plant w. chem. Dosage facility. Max. flow 15 M^3/24 Hrs. BOD5 6 Kg's/ 24 Hrs.
Oil Spill Absorbent / Damage Control	2 x Set Oil Spill Kit inc. sorbent booms/pads, granules & dispersant.

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 mtr, 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

Seismic Specifications

Streamers	Thompson Marconi, Sentry & Guardian Solid streamer
Tow Points	16
Sub Arrays	6

Energy Systems

Gun Controller (Type & Manufacturer)	Source Synchronizer System (SSS), Input/Output Trisor 1.5.1 Westerngeco
Guns (Manufacturer, Type & Capacities)	Bolt 1500LL and 1900 LL (30cu in to 660 cu in)
Nominal Source Pressure	2000 psi
Pressure Release	Electro-magnetic solenoid.
Sensor Return	Bolt pressure drop sensor
Timing Resolution	0.1ms
Source	1 x 8 guns, various volumes. Max 4 arrays per side
Total Compressor Capacity	6600 SCFM
Compressors (Manufacturer & Capacity)	3 x LMF Compressors
Near Field Phone (Manufacturer & Type)	WesternGeco 6 per array
Far Field Phone (Manufacturer & Type)	NA
Depth Indicators	WesternGeco 6 per array

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	72,000m
Streamers vs. Length (Max)	
Sentry Solid Streamer	10 x 6,000m
Streamer Spread (Max spread Configuration)	1050m 8 x 150m x 6000m using 6 x Monowing
Streamer Control Device (Manufacturer & Type)	DigiCourse, 5011
Recording System (Manufacturer & Type)	Input/Output MSX 24A Input/Output MSX with WesternGeco TRIACQ 5 front end

Navigation Systems

Instrument Room Gyrocompass (Manufacturer & Type)	Sperry, MK227.
Source Positioning System (Manufacturer & Type)	Seatex, Seatrack 330
Global Positioning System (GPS) Receivers (Manufacturer & Type)	2 x Veripos Ultra Systems 1 x C & C Technologies C-Nav. 1 x C-Nav Receiver. Dual frequency. 1 x Novatel OGM3 Receiver. Dual frequency. 1 x Posnet – SARGAS Dual Frequency. 1 x Posnet – Stand Alone. 1 x TriNav GPS 1 x Trimble MS750 Receiver. Dual frequency. 3 x Trimble 4000SSE Receiver. Dual frequency.
DGPS QC System (Manufacturer & Type)	WesternGeco TRINAV 3.0.

Integrated Navigation System (Manufacturer & Type)	WesternGeco TRINAV 3.0.
3-D Quality Control System (Manufacturer & Type)	WesternGeco TRINAV 3.0.
3-D Binning System	TRINAV 3.0 2 x Sun Blade 150 Workstation 2 x Sun Blade 1500 Workstation 2 x Sun Fire 440 Workstation
Tail Buoy (TB)	
Buoy (Manufacturer & Type)	WesternGeco T98
TB Navigation (Manufacturer & Type)	WesternGeco, Seatrack 220 GPS Unit
Onboard TB Positioning (Manufacturer & Type)	Seatrack
Ultra-short Baseline (USBL) Acoustic Positioning System (Manufacturer & Type)	NA
Acoustic Positioning System (Manufacturer & Type)	Sonardyne SIPS 2
Current Profiler (Manufacturer, Type & Frequency)	RDI, ADCP, 1.5MHz
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 8100m 1 x 200 kHz to 740m
Transducer Draft	-7.42m

Recording System

Format	3-byte SEG-D, 8036 rev 2
Media	IBM 3590E tape (20GIG)
Device	6 x 3590e IBM tape drives

Other Systems

Other Systems	MSX version 2.0111 with WesternGeco TRIACQ 5.3304 front end
Single & Multi-trace Plotter (Manufacturer & Type)	OYO, GS624

Onboard Seismic Qc / Processing

System	Triacq QC 3.0 WesternGeco
Software	Triacq QC
Hardware	Sun V880
System	Multi Node PC Cluster Processing System
Software	Linux Redhat 9 Omega 2401p
Hardware	3 x Dell Precision workstation 650. 2 x INTEL SR2300 2U tape servers. 10 x IBM 3590e tape drives. 4 x Jaguar 3592e tape drives. 3 x INTEL SR2300 2U Oracle servers. 16 x IBM x330 IU processing nodes. 4.5 Tbytes total hard disk space. OYO GS-636 Thermal Plotter. OYO GS-624 Thermal Plotter. HP DesignJet 650C.

Operations Summary

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6. List of Key Personnel

6.1. Onboard Personnel

POSITION	CREW 1	CREW 2
Party Manager	Ian Halfpenny	Eckachat Insakeaw / John Pope
Captain	Paul Reid	Terry Iles
Chief Engineer	Kevin Joseph	Alan Morgan
Chief Officer	Brett McPhee	Camilla Eie
Acq. Supervisor	Victor Lopes	Mark Pye /Stewart Klincke
Acq. Shiftleader	J.Q. Chandler	Kevin Jones Michael Hutchinson
Pos. Supervisor	Chris Rollings	Mark Higgins
Pos. Shiftleader	Dave Brader Michael Gors	Andrew Peters Rickin Shah
Handling Supervisor	Atle Boerresen	Graeme Prime
Shiftleader Mechanic	Colin Robson	Aldrin Flores Romeo Doctolero
Trilogy QC Leader	N/A	N/A
Field Geophysicist	Jon De Haai	Petr Gorbatchev / Rolando Jaberina

6.2. Office Support Personnel

POSITION	NAME	OFFICE
Vessel Manager	Vinh Quoc Ly	Perth
Maritime Superint.	John Hattendorf	Kuala Lumpur
Instrument Support	InTouch	Global Operations Support
Navigation Support	InTouch	Global Operations Support
Mechanical Support	InTouch	Global Operations Support
Trilogy QC Support	InTouch	Global Operations Support
OBP Supervisor	N/A	N/A

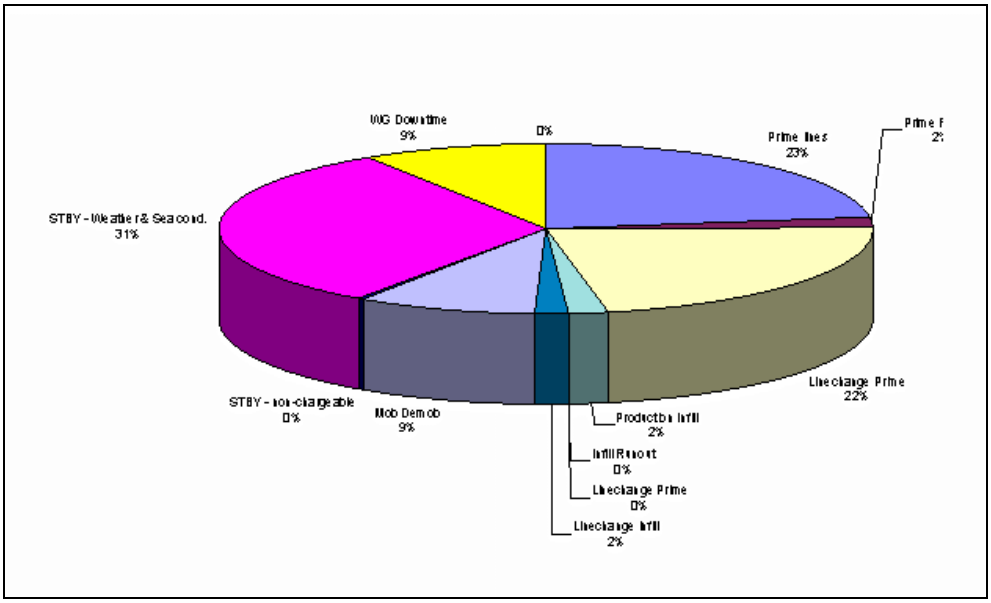
7. Field Information and Observations

7.1. Production Statistics

Job timings per category as a percentage of total time

JOB TOTAL TIMING STATISTICS		
841.44	**Total Time**	**100.0%**
190.80	Prime lines	22.7%
17.38	Prime Run out	2.1%
186.60	Line change Prime	22.2%
16.03	Production Infill	1.9%
1.63	Infill Run out	0.2%
0.00	Line change Prime	0.0%
12.83	Line change infill	1.5%
74.58	Mob Demobilization	8.9%
3.75	STBY - non-chargeable	0.4%
260.73	STBY - Weather & Sea conditions	31.0%
77.08	WG Downtime	9.2%

Job timings per category as a percentage of total time by pie chart



7.2. Daily Summary

Daily log Times are in Australian Eastern standard time = GMT +10 hours.

28th April 2007
Western Trident and OMS Pioneer arrived Wilson's Promontory and standing by for the Helicopter in the morning 0630 Local time (UTC 20:30 27th April).
It was an Easterly wind about 30Kt, with the rain shower caused poor visibility around the area.
The sea condition was around 1.5 m from the South East, which was not a problem for the helicopter to land on deck.
The helicopter landed on deck at 07:21 (2121 UTC) with the onboard client rep, Drew Murray, then it took off with 5 off signer crew members.
Trident maintained slow speed and heading North more closer to the shore seeking for calmer sea for supply boat operation. OMS Pioneer was taken along side for provision supply before noon.
Western Trident then transited form Wilson's Promontory to Otway cable deploying area after supply boat operation completed in the afternoon, with bottom speed of 12Kt.
The cable deployment area was around 50nm South West of the prospect area.
King Fisher was scouting and waiting for Trident at deployment zone.
OMS Pioneer en route to deployment area.
Trident arrived deploy area at 0345, and commenced deploy streamer at 04:30 after made contact with the scouting boat in the area, King Fisher.
King Fisher standing by behind the tail buoy during deployment.
Weather was South Easterly moderate wind with the moderate sea swell also from the South East did not caused problem with cable deployment.

29th April 2007
Moderate wind South Easterly wind ~15Kt, also slight to moderate sea form SE ~1.5m

The first 2 streamer deployment continued quite smoothly.
Streamer 8 was deployed out wide with out any problem, even thought slight leakage seen on the meter but not affect the bird communication.
Streamer 1 with the Mono-wing 1 also went out in the afternoon, while streamer 7 and 2 were deploying.
However, Streamer 7 was noticed having problem with the bird line leakage, when it was deployed up to the front end.
It required retrieving back onboard since the suspect area was around bird 5 and 6.
Active 4B was changed out which fixed the problem.
Streamer 7 had got another problem after connecting the front float. The power was tripped with the front float on the cable. The problem was fixed by adjusting the setting on the onboard power supply.
Unfortunately Mono-wing on streamer 7 had to be picked up back onboard; due to the power was tripped again. This time was caused by missing O-ring on the cable head module.
STBD engine maintenance carried out during the day.
The work boat was launched for TSDIP in the deployment area, since the weather could pick up from tomorrow as weather forecast.
TSDIP location was 38 53.07 S, 141 06.6 E
King Fisher standing by behind the tail buoy during deployment.
OMS Pioneer arrived at the location in the afternoon then company trident while deploy the cable.

30th April 2007
Streamer 2's problem with coil line leakage was noticed after testing the acoustic on the front float. Cable has to be retrieved back until active 3B, and then the leakage started to be intermittent. Problem eventually fixed after three sections, 3A 2B and Dummy section, were changed out.

The TSDIP was performed in the deployment area, at lat 38 53.07 S, Lon 141 06.6 E, since the weather could picking up from tomorrow. It will be no chance for the workboat operation until next week as weather forecast.
The work boat was launched again for checking all three Mono-wing, 1,3,4.
OMS Pioneer accompanied Trident while doing cable work on the race track.
King Fisher was scouting the Prospect area.

1st May 2007
Cable deployment continues. The weather picked up in the afternoon with Northerly wind force 6-7 gusting up to 45Kt, very rough and choppy sea with 5m swell.
Streamer3 completely deploy out early morning, and then follow single streamer deployment for streamer 5, and the last streamer 4 in the afternoon.
Section 13A on streamer 5 changed out due to bird line problem.
Streamer 4 also got the bird line leakage problem. Section 23A and 23B and CSX 19B were changed out.
Cable deployment was delay again due to problem with the optic line on Streamer 4 around Module 18. A lot of time was spent to locate the fault, by breaking the connector and cleaned the fibre optic line.
Eventually all streamer were ready to put out wide at midnight.
Trident altered the course out from deployment area in the morning, heading on to the scouting line that leading to the prospect area. OMS Pioneer was stay at 5 nm ahead of Trident during moving toward the prospect.
King Fisher was in port due to rough sea condition.

2nd May 2007
Last streamer deployed out just after midnight.
Vessel altered the course to extend run-in to allowed more time to get all gun array deploy
All gear completely deployed and ready for run-in for the first line at 05:50
The first sequence of the survey was started at 07:05, with a marginal sea condition which affecting the cable depth control and cause a noisy acoustic range data.
A set of semi Monthly test was done while extended the line change at the end of line.
The weather was North-westerly winds about 15-25 knots with 1-2 metres sea in the morning then getting rough sea in the afternoon with the Westerly swell up to 5m. This caused more noisy data on both on the Seismic and Navigation data for Sequence 2.
OMS Pioneer on standby all day in location.
King Fisher was in port due to rough sea.

3rd May 2007
Weather condition deteriorated rapidly changed during the day, very rough sea swell conditions combined due to very strong West to northwest wind 25/35 knots with Westerly Sea swell 4-5 metres.
Sequence 4 was shot early the morning, cable depth decided to be dropped down to 9m after the start of line. However all data was scratched due to the swell noise still can be see on the Seismic data after apply the SWATT, swell attenuation.
Sequence 5 was shot at 9m on the opposite direction heading South East 114 º, had a very marginal seismic data quality. At the end of line Sea swell condition seemed to be improving.
Sequence 6 was decided to be shot as a re-shoot line of sequence 4.
The weather condition deteriorated quickly and developed a very rough sea condition.
The Next production line was cancelled. Trident then went in to the weather standby.
All guns were picked up onboard.
Vessel then turned around to heading South East to follow the passage way to a shelter for the crew change on the 5th.

OMS Pioneer stood by 5nm ahead of Trident while travelling on the passage way.

4th May 2007
Trident was on the passage way heading to Central Coast of Victoria along the East side of Cape Otway. Streamers were brought down to 18m to gain more depth control.
Streamer 2 and 7 were having problem to stay at depth, when heading SE during the night, due to stern sea and swell. The ESE currently was up to 1Kt noticed on the current meter, caused very high vessel speed up to 6Kt, with 5 Kt water speed.
Cable control improving after vessel altered the course to the North East in the afternoon, having the weather from abeam, WNW 25Kt wind with sea swell of 4m form NW.
Trident arrived the East coast of Cape Otway in the evening, and then circled around waiting for crew change tomorrow morning.
Weather report on the prospect area showed west to North-westerly winds 20/30 knots increased to 30/40 knots in the afternoon. Seas 2 to 3 metres increased to 4 to 5 metres with Westerly swell 3 to 5 metres.
OMS pioneer streamed along with Trident on the passage way.

5th May 2007
Weather stand by, In Transit for crew change.
Crew change successfully completed using 6 helicopter flights out of Tooridin airport, 45 people on 46 people off.
The Trident is circling in the lee of Port Philip Bay waiting for an improvement in the weather conditions in the prospect area, the earliest this if forecasted to happen is Wednesday 9th May.

6th May 2007
The Trident spent the night and morning steaming in holding pattern in the lee of Port Philip Bay with all streamers deployed.
The afternoon forecast was still predicting strong winds and a large swell until Wednesday evening when a high pressure system is due to move into Bass Strait bring some better weather.
The Trident started heading back towards the survey in the afternoon to be on station when the weather does improve.

7th May 2007
The wind and sea moderated in the afternoon ahead of the next front which is due to pass through the area overnight Monday.
The Trident headed further to the NW before making a ninety degree turn towards the survey area. This was to avoid Cray pots which had been reported to be on our original route into the survey area.
The forecast is still not too good for the next couple of days but the wind will swing round from the North which may enable us to get some production in on the lines closer to the coast which should provide a lee from the Northerly winds.

8th May 2007
The Trident restarted production in marginal sea conditions just after midnight.
Noise levels are higher when heading into the swell on the 294 degree heading. Streamer depth control during sequence 9 was erratic resulting in depth edits on the worse affected streamers, 2, 7, & 8.
The forecast for tomorrow is for more of the same type of weather but gradually easing off in the evening as a high pressure system moves across the bight.

9th May 2007
The wind eased off in the late afternoon but the swell increased throughout the day having an adverse affect on production.
All the sequences shot today had to be scratched as the compass data was too noisy to process. The cause of the noise was the very large swell.
The Trident will continue to circle in the survey area monitoring the swell noise on the compasses once it reaches acceptable levels we will restart production. The swell had dropped enough by late evening to restart production.

10th May 2007

Wind and sea conditions continued to improve today, the affects of the swell on the streamers reduced and good production was achieved.
An extra front navigation float was deployed on the starboard side to improve the on line coverage. The float was deployed on a "mini streamer" from one on the lower streamer reels.
The forecast is reasonable up until Monday when the next low pressure system is due to pass through the area.

11th May 2007

The wind eased further overnight but the large swell remained.
However sea conditions had reduced enough for us to launch the work boat to change section 17B on streamer #2 which had faulty channels. Plans to change out a faulty bird on streamer #7 were aborted when a fog bank approached the survey area; this resulted in the workboat being recalled early to the Trident.
The workboat also transferred a survival suit across to the OMS Pioneer; this suit will be for the MMO who will be joining the Pioneer during next weeks scheduled port call.

12th May 2007

Moderate winds but still a very large long period swell passing through the survey area.
Choppy sea conditions in the morning prevented any workboat operations. In the afternoon the wind eased off which allowed the work boat to be launched for ballasting on streamers #2 & #7. Faulty birds were also changed on these two streamers.
The handling department have started to systematically recover the gun arrays for routine maintenance checks.
The starboard main engine had to be shut down at 00:35 hrs due to the failure of a fuel pipe. The faulty pipe was quickly replaced and the Trident was back onto two engines at 01:10 hrs.

13th May 2007

Choppy sea conditions in the morning but calming down in the afternoon. Still a large SW swell running through the survey area.
Continuous race track production all day. The handling department are continuing to systematically recover gun arrays for routine maintenance. The starboard side has been completed they are now working through the port arrays.
A general muster was followed by survival suit training for the whole crew in the afternoon.

14th May 2007

Choppy conditions in the morning but calming down in the afternoon. Still a large SW'ly long period swell moving through the survey area.
The work boat was launched twice first thing in the morning to transfer the client rep across to the Kingfisher. He was going home on compassionate leave. The second launch was in the afternoon to remove a large clump of weed from beneath tailbuoy #4. The weed had tipped the tailbuoy in its side causing it to steer closer to tailbuoy #3. A tsdip was also performed. On the way back to the Trident the workboat picked up the relief client rep from the Kingfisher.
Production was halted in the afternoon when a single Minke Whale was sighted just off the Trident's bow.

15th May 2007

A cold front passed through the survey area today bringing unsettled squally weather.
The first swath was considered complete after seq 35. The plan was for Trident to shoot two prime lines in the new swath so the transit to Beach Oil can be performed in daylight.
Unfortunately due to an air leak in the linechange following sequence 35 only one of these lines will be acquired. The air leak was the result of sea weed fouling the air hoses causing them to chaff through.
Tail-buoys 4 and 5 crossed and tangled in the linechange following sequence 33. This was probably due to weed getting caught under the tailbuoys causing them to steer. Hopefully they will come apart themselves during a turn. If not we will try to untangle them tomorrow using the workboat during the transit to the Beach Oil survey.

The fisheries liaison vessel Kingfisher has been scouting the transit route today looking for Cray pots and any other obstructions. The other fisheries liaison vessel Perfect Lady has started to clear the Beach Oil survey area ahead of our expect arrival in the late evening of the 16th May.

16th May 2007

The Trident completed the first phase of the Santos Champion South survey today.
The vessel will now transit approximately 50 miles West to the next survey area which is for Beach Oil.
The last sequence was acquired in the new southern swath to ensure the transit to the Beach Oil survey area is performed in daylight.

07th June 2007

Returning to the Champion South survey after completing the Beach Petroleum Bernoulli survey.
The wind swung around to the south east overnight and increased to near gale force building up the swell.
The Trident was in transit back east to repair insea equipment and perform a crew change in the lee of Cape Otway.
The OMS Pioneer is scouting the transit route approximately 6 miles ahead of the Trident. ETA Cape Otway is 24:00 hrs Friday 08th June.

08th June 2007

The strong south easterly winds continued all day the swell started to ease of a bit as we rounded Cape Otway in the early evening.
Recovery of streamer 4 was completed and streamer 3 was stacked across to the port side to allow recovery of streamer #2 to repair the power fault and replace the missing tailbuoy. Streamer #2 was fully recovered the tailbuoy STIC cable had parted just in front of the tail connector.
Streamer #2 was deployed wide again on wing 2 by transferring the old streamer #3 into position 2.

09th June 2007.

At the start of the day the vessel was moving east whilst carrying out streamer work and to position for the days crew change.
Crew change was carried out today using 6 Helicopters from Jayrow's Tooradin Base.
On completion of crew change the vessel turned back to the SW and headed back towards the Santos prospect area.
Streamer repairs continued throughout the day, Steamers 3 and 4 were onboard, streamer 6 was recovered completely to the tail, two xsrs units were lost from the mid net of this streamer as they had come off their collars and the safety ropes had chaffed and parted.
Tail-buoy 6 was recovered onboard, the STIC cable for this buoy had parted and although it was repaired and redeployed
there will be no acoustic data from the buoy. Acoustic unit S6T8 was also missing from the tail of cable 6.
At the end of the day streamer 7 and its mono-wing were being recovered.
Weather conditions for the day remained good, although the forecast is showing another low building up to the east which is expected to hit us on Monday.

10th June 2007.

At the start of the day streamer 7 was being recovered to change out compasses 2, 3, 4 and 5.
Once this was completed streamer 7 was deployed along with the mini wing and the mono wing.
Streamer 6 was deployed fully and at the end of the day streamer 3 was being deployed.
The workboat was launched this morning to take advantage of the rare relatively calm weather conditions. S1C5, S8C10, and S8C8 were all changed out. The workboat was also
able to get alongside the OMS Pioneer and transfer two crayfish pots to her that had been taken off the front end of streamer 2 by the previous crew.
Several small shipments were also able to be transferred from the Pioneer to the workboat.
A hydraulics failure on the Starboard davit delayed the recovery of the workboat until temporary repairs could be carried out.
Once the workboat was raised the Starboard Workboat and davit were taken out of service.

A ships lifeboat muster was held in the afternoon with all crew mustered correctly, after reviewing the lifeboat assignments the crew practiced donning survival suits.
A general ships safety meeting was held in the mess on completion of the drill.
A safety induction tour was carried out in the morning for seven new crew members.
The latest weather forecast indicates that a weak high pressure currently over Bass Strait will move out into the Tasman Sea ahead of a cold front which will cross Bass Strait tonight and early Monday. Another cold front will approach Bass Strait on Tuesday bringing a few more showers and freshening the local winds.
Meanwhile a high pressure system centred to the south of the Bight on Monday will strengthen then move slowly eastwards to be over the strait during Thursday and Friday. Hence a return to fine and light wind conditions.

11th June 2007
The wind increased during the night and backed around to the South.
Streamer three was being deployed at the start of the day. After a turn the streamer got caught on the front paravane float on streamer 5 and a loop developed around the float. Approx 600-800m was deployed into the loop before it was noticed that there was something wrong. 6 sections were badly tangled during accident. Birds 19922 & 8606 lost at sea. SRD 6722 lost at sea.
Streamer three was then fully deployed along with streamer 4, at the end of the day all streamers were on their marks, although the separation between streamers 2 and 3 looks low (85m)
Weather conditions increased during the day as forecast and the further forecast is for similar conditions for tomorrow with similar with winds shifting SW/WSW and easing to moderate by afternoon.
The Kingfisher was on prospect all day scouting lines for debris and fishing equipment.

12th June 2007
Production commenced on the continuation of the Santos Survey early this morning.
The separation between streamers 3 and 4 was low (<85m) and it was suspected that the cross tag line may have been tangled.
After completion of the first sequence the arrays were recovered and the front end of the Starb side brought in. During this process the tag line untangled. The streamers were put back out to their marks and the guns redeployed.
Production continued through the end of the day.
Weather conditions throughout the day were poor, and the streamer depth was set at 8.5m
Winds are expected to moderate late on Wednesday.

13th June 2007
A good day's uninterrupted production today, the weather moderated during the day allowing us to bring the streamer up to 8m for all the sequences acquired.
Weather conditions are expected to moderate further tomorrow and Friday which may allow us the opportunity to get the workboat out to do some bird battery changes.
The OMS Pioneer will head into Portland early tomorrow morning for crew change. They will be back on prospect later in the day.

14th June 2007
Weather conditions remained good on prospect today, although a large rolling swell prohibited the launch of the small boats for cable maintenance.
OMS Pioneer was alongside in Portland today carrying out crew change and loading provisions. Hopefully we will be able to uplift the provisions and one joining crew member tomorrow if the weather holds.
The Kingfisher acted as chase boat throughout the period that the Pioneer was off prospect.

15th June 2007
Weather conditions were good again for today, in the morning the FRC was launched to pick up one joining crew member and some provisions from the OMS Pioneer.
In the afternoon the Port workboat was launched and several birds and acoustic units were changed out on various streamers.
A crayfish pot was removed from one of the birds and a large amount of sea weed was removed from the tail buoy floats.

Weather conditions are forecast to be good again tomorrow.

16th June 2007

The weather deteriorated as forecast, the winds and the swell picked up causing problems with the online acoustic network and the robtrack had difficulty in keeping the required DC.
An infill line was acquired along the bottom of the prospect boundary completing the southern edge of the prospect,
there is one prime line left to complete the Champion South Block before we move down onto the Hercules Block
The projected forecast is that a high pressure system will strengthen south of the Bight during Monday and Tuesday as a low pressure system develops near the New South Wales coast.
The combination of the high to the west and the NSW low is likely to produce Fresh to strong S/SE'ly winds on Monday, tending Strong SE'ly on Tuesday.

17th June 2007

The weather deteriorated as forecast, the winds and the swell picked up causing problems with the online acoustic network and the robtrack had difficulty in keeping the required DC.
An infill line was acquired along the bottom of the prospect boundary completing the southern edge of the prospect, there is one prime line left to complete the Champion South Block before we move down onto the Hercules Block
The projected forecast is that a high pressure system will strengthen south of the Bight during Monday and Tuesday as a low pressure system develops near the New South Wales coast.
The combination of the high to the west and the NSW low is likely to produce Fresh to strong S/SE'ly winds on Monday, tending Strong SE'ly on Tuesday.

18th June 2007

The last line for the Champion block was completed early this morning and the vessel then headed towards the Hercules Prospect.
During the morning it was necessary to arrange to get one crew member off the vessel due to an urgent compassionate reason.
The vessel broke off heading towards the first line of the Hercules block and headed north to get more favourable conditions for a Helicopter landing.
Good co-operation between the Trident Vessel Manager, the Captain and the local Helicopter company saw the crewman off the vessel 4 hours after he had received the bad news from his home.
Once the helicopter had departed the vessel headed back towards Hercules block.
The weather picked up in the afternoon with winds gusting storm force (>35kts) with seas > 3.0m. A strong wind warning was current.
The first sequence of the Hercules block was commenced however the increasing weather conditions made it difficult to maintain steerage way.
Compass depths on streamers 7 and 8 were also erratic. The line was aborted part way through and the vessel kept heading in a SE direction into the weather.
Array 4 and the Port head buoy were brought on, however due to too much movement of the arrays and the vessels crab this was aborted. The upcoming forecast is as follows.
A large and intense high pressure system is centred in the Southern Ocean, well to the south of Australia. This system is moving only very slowly.
A low pressure system off the NSW coast has weakened, but should strengthen again on Tuesday. The low should move away to the south east from Wednesday onwards.
This should result in fresh to strong SE'ly winds Monday evening and on Tuesday. Expect showers, and the risk of thunderstorms with hail, as an upper level low moves across.

19th June 2007.

At the start of the day the vessel was heading SE into the wind and the sea. At daylight the vessel turned around and headed back towards the prospect area.
Weather conditions moderated slightly during the day however they started to deteriorate again towards late afternoon.
Based on a rising forecast for the next 24 - 36 hours the vessel turned back towards the SE and

headed towards King Island to take shelter in the Lee of the Island.
The weather conditions are expected to remain the same for the next 24 hours with a gradual improvement on Thursday.

An operations / safety meeting was held with the heads of all departments (Marine and Seismic) today.

20th June 2007
Standing by for weather the entire day.
The vessel headed into the weather in a SE direction and by mid afternoon was in the lee of King Island.
Conditions deteriorated as forecast however we did not get the full impact of the storm.
Early evening whilst in the lee of King Island the vessel turned around and headed back to the NW aiming to hit the weather window as we reach the prospect area.
Weather forecast shows an improvement late tomorrow with a fine spell forecast for the next several days.

21st June 2007.

Down for weather all day. The vessel moved out of the lee of King Island and headed back towards the prospect today aiming for a weather window commencing early Friday morning.
Short range weather forecast is currently good for Friday onwards.
Kingfisher is in Port.
OMS Pioneer is transiting back to the prospect ahead of Trident

22nd June 2007.
The vessel re-commenced production on the Hercules block this morning.
Production continued through out the day. Weather conditions were reasonable although a long rolling swell on the beam prohibited any small boat work.
Weather conditions look to be favourable over the next few days.
OMS Pioneer - On prospect
Kingfisher - On prospect

23rd June 2007.
In production on the Hercules block.
Weather conditions were good today, the Port Workboat was launched to change some acoustic and bird batteries.
A crayfish pot was removed from streamer 4. A check of the tail buoys was also carried out, all were ok, no weed was present.
A Fire Drill and then a ships safety meeting was carried out today. During the meeting the Chief officer gave a presentation on the MQSMS_ISM system.
The Pioneer was released early this morning to proceed into the Pilot boarding area in Portland. There she transferred two joining crew on-board from the Portland Pilot launch. Pioneer was back on prospect just after dinner time in the evening.
Kingfisher is on prospect.

24th June 2007.
Continued in production on the Hercules block.
Whilst turning to line on sequence 070, array 4 became tangled with array 5. The cause of this is unclear as the weather conditions
were fine and the turn rate was exactly the same as it had been for several previous line changes.
It was necessary to bring both arrays onboard to untangle them and replace several pigtails that had snapped.
The vessel circled on the run-in to the line whilst the gunners replaced the damaged equipment and re-deployed the two arrays.
The FRC was launched this morning to pick up two new joining crew members. A Navigator and a Shift leader Observer.
Weather conditions were good through out the day.

OMS Pioneer on prospect

Kingfisher on prospect.

25th June 2007
Continued in production on the Hercules block.

On the run-in to seq 76 the Trisor system crashed. The operators were unable to reboot the system and also the back up boot disk failed.
An urgent phone call was then initiated to the Oslo Intouch engineer.
It was necessary to move the production disk to a spare machine and boot from the spare disk to get the system up and running again.
Production then re-commenced with Seq 076 started part way down the line.
The weather increased in the afternoon. The forecast is for a build up again on Thursday with a low pressure system moving into the area.
OMS Pioneer on location.
Kingfisher on location (Scouting 2D lines)

Production switched to the BHP Labella 2D survey.

26th June 2007
The Hercules block was completed today and the vessel moved down and commenced production on the 2D lines for BHP.
The weather conditions freshened during the day ahead of an expected low pressure system due to pass through the area tomorrow.
A short safety meeting was carried out at shift handover today to run through the demobilisation plan for the recovery of the source, mono-wings and streamers on completion of the 2D lines tomorrow afternoon.

OMS Pioneer on Location
Kingfisher on Location.

27th June 2007
Weather conditions deteriorated rapidly today, on the line change before starting the last 2D line for BHP Labella streamer control was lost in the turn.
The vessel steadied up and increased speed in order to regain control. Once streamer control was re-established and stable the vessel turned back onto line heading.

The last 2D line for BHP Labella was acquired at a 10m depth and it was difficult to maintain the vessel heading on line as well as keeping the streamer under control in the conditions.
The weather was a steady force 8 at the end of the last line.

At the end of the line, the lead-ins were deployed out approx 50m, the mono wing angles decreased and the streamer set to 18m.
Trident then turned into the wind and sea and headed towards Cape Otway.

Once we have some lee from the conditions when we round the Cape tomorrow morning we will start the in-sea equipment recovery. Conditions on the gun and cables decks were deemed unsafe for recovery of the arrays / towed equipment.

A helicopter is scheduled tomorrow afternoon, and conditions permitting will uplift the Client, the MMO and the departing Medic.

OMS Pioneer is on prospect
Kingfisher is in Port.

28th June
Demobilization for Santos & BHP.

Heavy weather conditions delayed the start of the de-mob for Santos, however once the vessel was in the lee of Cape Otway the guns were recovered onboard, and streamer recovery commenced.
The client, MMO and medic departed the vessel late in the afternoon by helicopter; a new medic joined the vessel.
Late afternoon the vessel turned south and headed for the lee of King Island to continue recovery.
Weather conditions deteriorated again early evening. There is a large stationary low over Victoria causing severe weather conditions on land, heavy flooding and property damage. We are getting the edge effects of this however the lee King Island gives us allows us to continue to recover the in-sea equipment safely.
Both the OMS Pioneer and the Kingfisher are in company with us.

29th June
Continued recovery of all in sea equipment.

Weather conditions were fine during the day however deteriorated during the evening.

The vessel maintained a race track pattern sheltering in the lee of king Island to give better conditions for back deck operations.

The FRC was launched today to transfer preplot and chart information for the next survey to the OMS Pioneer.

The Kingfisher was released mid afternoon and headed back to Portland due to the rising weather conditions.

30th June

Continued demobilization from Santos & BHP.

Weather conditions deteriorated during the day although by remaining in the lee of King Island the recovery of the equipment was able to be carried out safely.

A hydraulic hose burst on the Starboard mono wing gripper which caused a delay, as well as fault finding for leakage on the bird line on streamer 2.

All streamers will be onboard tomorrow and the transit across to Fremantle will commence.

OMS Pioneer will be released tomorrow; she will then head to Portland to take on ballast water for extra stability before she heads across to Fremantle.

01st July

Finished recovery operations and headed for Fremantle.

7.3. Field Information and Encountered Problems

7.3.1. Obstructions / Installations on the Field

There were no obstructions or installations present in the survey area. The northern most line of the survey was approximately 14km from the coast.

7.3.2. Traffic / Shipping Lanes

Very little shipping traffic was observed during survey as the area was outside major shipping lanes. 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

Fishing activity in the survey area was low. There were however a number of commercial fisheries operating in the region. These were cray and lobster fishermen, shark fisherman and towards the middle of May some squid boats moved into the area. A shore based fisheries liaison officer Andrew Levings was coordinating interaction between the fishing fleet and the Western Trident during the survey. Prior to the survey starting meetings were held between the liaison officer and the local fishermen to provide details of the survey and raise the awareness of all parties so that simultaneous operations would be possible. The Kingfisher also provided local knowledge and acted as fisheries liaison in the field. In addition to the above periodic aerial surveys were performed to map the position of cray pots and any other fishing activity which may have negatively impacted the seismic survey.

7.3.4. Seismic Interference and Time Share

There was no seismic interference during the survey.

7.3.5. Environmental Obstacles

The survey area was 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. Once the fronts have passed they then swing abruptly south west behind the front at similar speeds and abate until they freshen again 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.

The currents within the survey area 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 currents in the survey area were not strong and followed a regular pattern this resulted an a low infill rate for the survey.

The East Australian current brings warmer waters into the Bass Strait and influences water temperatures. Sea surface temperatures for Bass Strait range from 16 to 18 °C in February and 12 to 14 °C in August. In line with the WesternGeco PPE (personal protective equipment) standard, full dry suits had to be worn by the small boat crews when performing in sea maintenance on the towed equipment

The survey area was situated on the coastal shelf with water depths ranged from 50 to 70m.

7.3.6. Operational Observations

The area is known for marginal sea conditions, the effect of the rough conditions is to limit the opportunities for streamer maintenance via the small boats and also the opportunities to take a supply vessel alongside for re-supply. Over a longer period of time the failure to re-supply the vessel and to maintain equipment in sea could have a detrimental effect on the efficiency of a survey.

The only area available which provides some shelter from the prevailing winds and swell is the in shore section of coastline between the entrance to Port Phillip Bay in the north and Cape Otway in the south. The Trident used this area to crew change during bad weather periods.

In order not to loose production time during periods of marginal weather Santos gave permission to lower the streamer recording depth from 8m to 9m. The following sequences were acquired in marginal sea conditions with 9m streamer depths. Seq 01 to Seq 36 which was the whole of the northern priority area of Champion South.

Large clumps of seaweed are common in the survey area; this weed can become caught in the towed equipment increasing the tension on the streamers and also reducing the overall width of the towed hydrophone arrays. On several occasion weed caught underneath the tailbouys caused them to steer and cross other tailbuoys. When conditions allowed the weed was removed from the towed equipment using the workboat.

Whales are attracted to the area by the up wellings of nutrients from the shelf. One Minke whale was sighted close to the vessel on the 14th of May and production was stopped until the whale was away from the operation. A total of 4.3hrs of standby time was logged as a result of cetacean sightings.

8. HSE Summary

Drills were held every weekend (on average).
General Safety meetings were held at the start and end of every trip.
Reporting levels were high. Small boat usage was kept to a minimum.
All significant Incident Reports were included in the Schlumberger QUEST database.

Totals for the survey.

ITEM	Western Trident
HSE General Meetings	7
LPT Meetings	2
RIRs (incl STOP etc.)	153
Audits	56
Drills	1 per week.
LTIs	0

The survey was conducted in a safe and efficient manor with no lost time injuries taking place. However there were a few first aid case reported, which were reviewed on board in line with the WesternGeco Loss Prevention Team LPT guidelines.

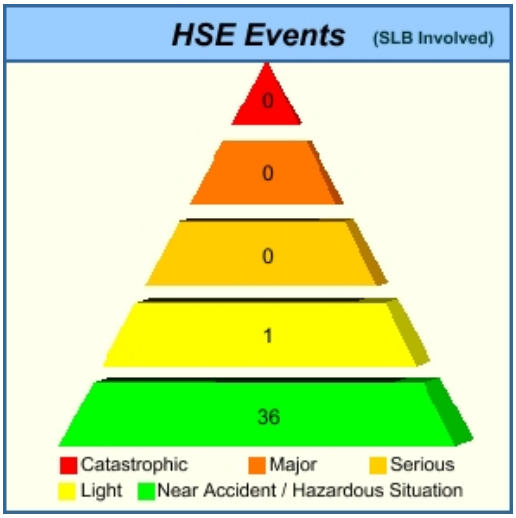
The crew was encouraged to report all incidents, near incidents and hazardous situations. Risk Identification Reports, were reported in QUEST the WesternGeco QHSE database tool. An action item (or items) was submitted for each report and completed before the report could be closed.

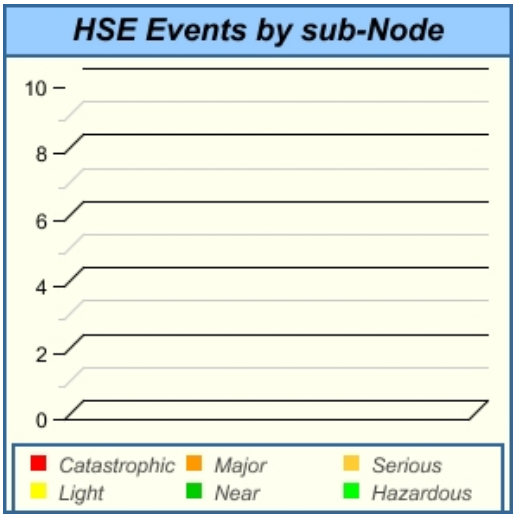
The survey was split over two periods. Tables below indicate the HSE activities between those dates.

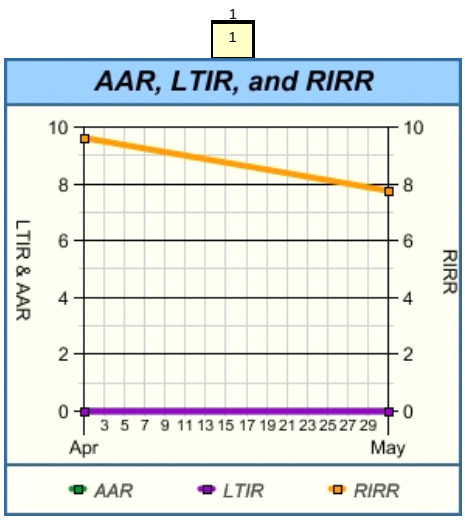
HSE Consolidation Report

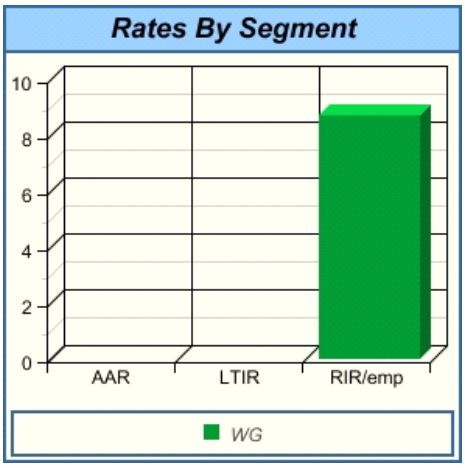
WG Trident (ASA)

Period:	***Apr 28, 2007 - May 16, 2007***
HSE:	***Yes***
Severities*:	***Catastrophic, Major, Serious, Light, Near, Hazard***



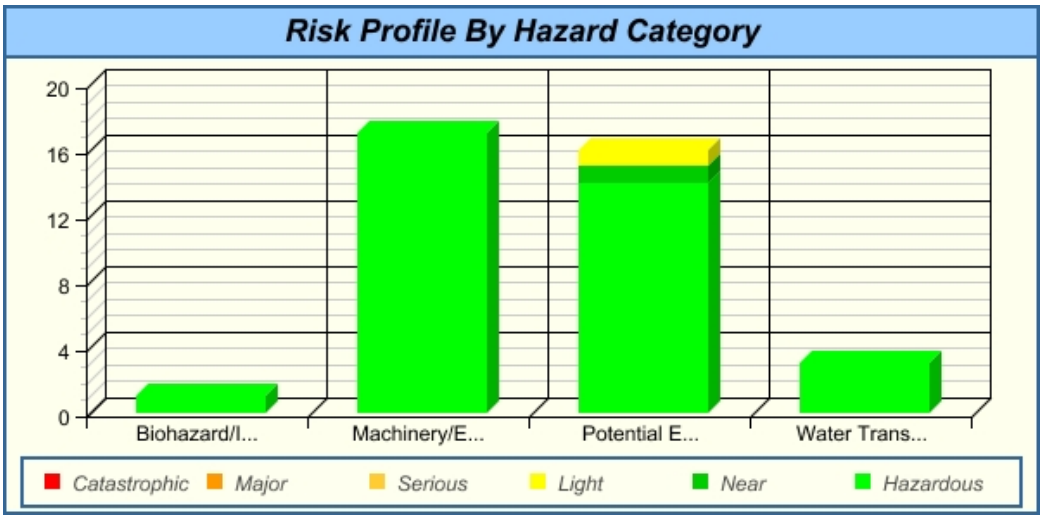



1
1
AAR, LTIR, and RIRR
LTIR & AAR
RIRR
10
8
6
4
2
0
3 5 7 9 11 13 15 17 19 21 23 25 27 29
Apr
May
AAR
LTIR
RIRR


Rates By Segment
10
8
6
4
2
0
AAR
LTIR
RIR/emp
WG


Injury Events by Hazard
100%
Potential Energy-Gravitational

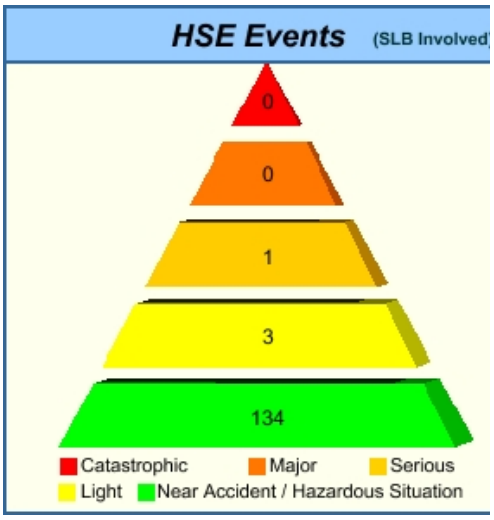

Events by Injury
100%
Arm/Hand/Finger

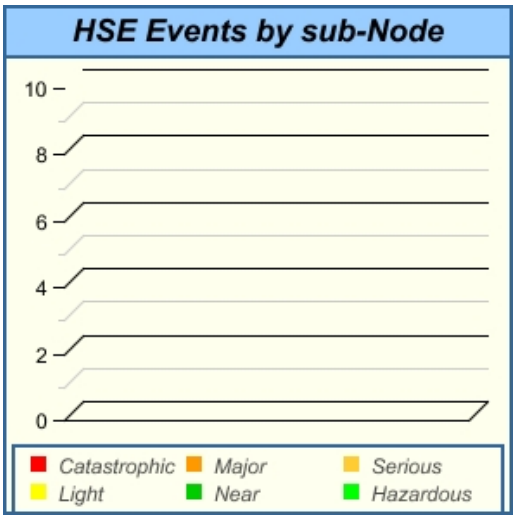

Risk Profile By Hazard Category
20
16
12
8
4
0
Biohazard/I...
Machinery/E...
Potential E...
Water Trans...
Catastrophic
Major
Serious
Light
Near
Hazardous

HSE Consolidation Report

WG Trident (ASA)

Period:	***Jun 07, 2007 - Jul 01, 2007***
HSE:	***Yes***
Severities*:	***Catastrophic, Major, Serious, Light, Near, Hazard***

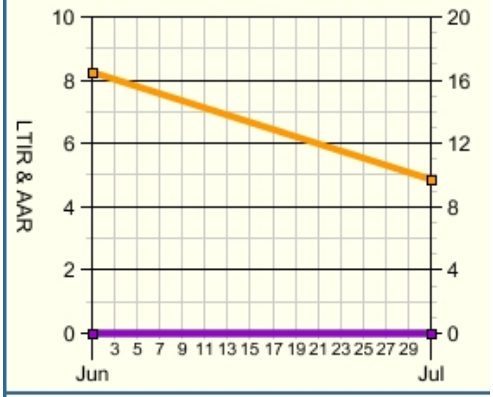




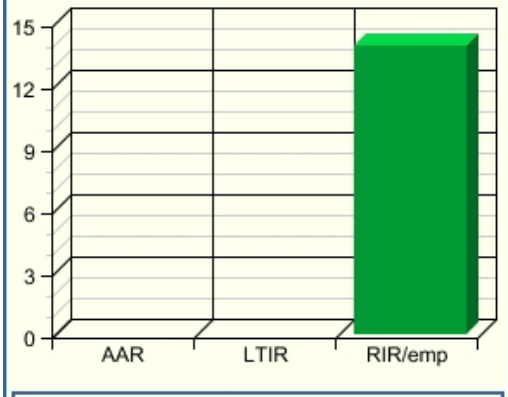
Hazardous - 62

Hazardous - 62

AAR, LTIR, and RIRR



Rates By Segment

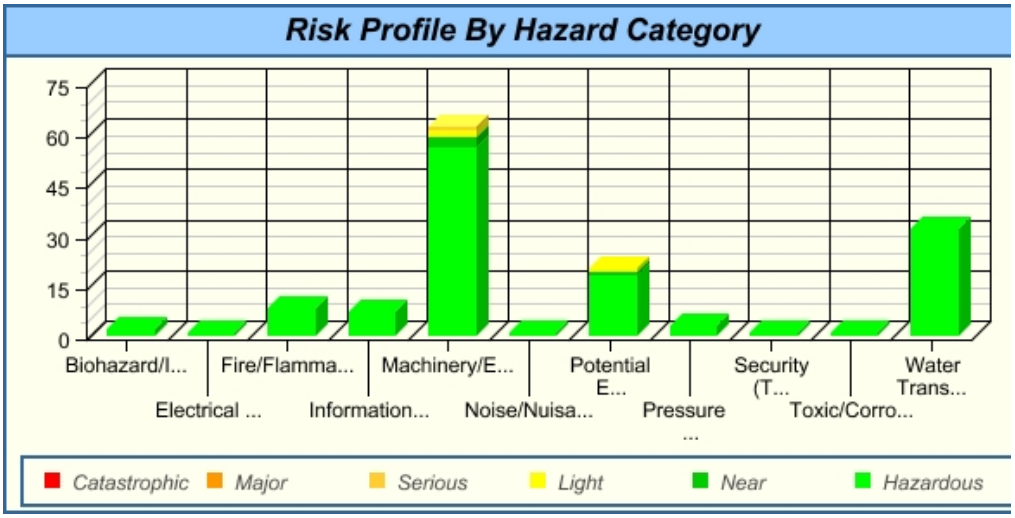


Injury Events by Hazard

No Applicable Accidents

Events by Injury

No Applicable Accidents



Report #	HSE Catastrophic Events	Status	Action Items (Open/Closed)
No records.			

AAR - Automotive Accidents / 1000 drivers / year
LTIR - Lost Time Injuries / 1000 employees / year
RIRR - Risk Identification Reports / employee / year
This report is based on Schlumberger Involved events only.

***** CMSL criteria will not affect the "HSE Events Accident Triangle", "AAR, LTIR, and RIRR", and "Rates by Segment" reports.

9. Shipment List

Shipment Number	Destination	Description
TDT-070112-AD-EXT	WesternGeco Perth	SEGD original data tapes,Job 9614 seq 001-006
TDT-070114-AD-EXT	Santos LTD. Perth	SEGD original data tapes,Job 9614 seq 007-035
TDT-070115-AD-EXT	Santos LTD. Perth	SEGD copy data tapes Job 9614 seq 001 - 057
TDT-070119-PD-EXT	Santos LTD. Perth	Nav data original tapes for Job 9614 seq 001 - 035
TDT-070124-PD-EXT	Santos LTD. Perth	Nav data original tapes Job 9614 seq 036 - 085
TDT-070125-PD-EXT	Santos LTD. Perth	Nav data copy tapes Job 9614 seq 001 - 085
TDT-070128-AD-EXT	WesternGeco Perth	Original SEGD data Job 9614 seq 036 - 057
TDT-070131-AD-EXT	Santos LTD. Perth	SEGD original data tapes, Job 9614 seq 058 - 080
TDT-070132-AD-EXT	Santos LTD. Perth	SEGD copy data tapes Job 9614 seq 058 - 080
TDT-070135-AD-EXT	Santos LTD. Perth	SEGY copy data tapes Job 9614 seq 001 - 085
TDT-070137-AD-EXT	WesternGeco KL	SEGY copy data tapes Job 9614 seq 001 - 085
TDT-070138-AD-EXT	WesternGeco Perth	SEGY copy data tapes Job 9614 seq 001 - 085
TDT-070140-PD-KUL	WesternGeco KL	Office copy nav data seq 001 - 085

BHP Labella data shipments

Shipment Number	Destination	Description
TDT-070133-AD-EXT	BHP LTD. Perth	SEGD original data tapes,Job 9614 seq 081-085
TDT-070134-AD-EXT	BHP LTD. Perth	SEGD copy data tapes Job 9614 seq 081 - 085
TDT-070139-PD-EXT	BHP LTD. Perth	Nav data original tapes Job 9614 seq 081 - 085

10. Logs

Vessel	M/V Western Trident
Area	3D Marine Seismic. (Elver)
Job no.	9614
Client	Santos Ltd
MMM-YY	27-May-07

TIMING & PRODUCTION SUMMARY

WesternGeco

	Accountable Time - Hours															Production - kms				
DATE	Mobilisation Demobilisation	Transit	WesternGeco non chargeable standby	WesternGeco Downtime	Chargeable Standby for crew change & resupply	Chargeable Standby	Production Prime	Prime runout	Linechange Prime	Production Infill	Infill runout	Linechange Infill	Total Dayrate Time	Total Standby Time	Total Time	Prime Traverse km	Infill Traverse km	Prime FF CMP Km	Infill FF CMP Km	Total FF CMP Kms
29-Apr	19.500														19.50					
30-Apr	24.000														24.00					
01-May	24.000														24.00					
02-May	7.083						7.083	0.817	9.017				16.917		24.00	70.688		1011.300		1011.300
03-May						13.517	5.750	0.317	4.417				10.484	13.517	24.00	50.719		769.800		769.800
04-May						24.000								24.000	24.00					
05-May						24.000								24.000	24.00					
06-May						24.000								24.000	24.00					
07-May						24.000								24.000	24.00					
08-May						0.667	13.133	1.183	9.017				23.333	0.667	24.00	124.125		1826.400		1826.400
09-May						21.200			2.800				2.800	21.200	24.00					
10-May						4.683	9.467	0.833	9.017				19.317	4.683	24.00	91.350		1341.900		1341.900
11-May							12.550	1.100	10.350				24.000		24.00	120.469		1767.900		1767.900
12-May				0.333			9.383	0.833	13.450				23.666		24.00	92.231		1356.000		1356.000
13-May							11.883	1.117	11.000				24.000		24.00	116.419		1703.100		1703.100
14-May						4.300	9.133	0.833	9.733				19.699	4.300	24.00	89.944		1313.400		1313.400
15-May						1.850	3.017	0.300	6.117	6.017	0.533	6.167	22.151	1.850	24.00	29.063	59.231	425.100	867.900	1293.000
16-May						2.683	3.550	0.267					3.817	2.683	6.50	35.156		522.600		522.600
17-May																				
18-May																				
19-May																				
20-May																				
21-May																				
22-May																				
23-May																				
24-May																				
25-May																				
Job Total	**74.583**			**0.33**		**144.90**	**84.95**	**7.60**	**84.92**	**6.02**	**0.53**	**6.17**	**190.18**	**144.90**	**410.00**	**820.16**	**59.23**	**12037.50**	**867.90**	**12905.40**

Total Linechange Hrs 91.09

Total Production Hrs 99.10

Total Traverse 879.39

Bill Lloyd
Client representative

Ian Halfpenny
Party Manager, Western Trident

Vessel M/V Western Trident
Area 3D Marine Seismic.
Job no. 9614
Client Santos Ltd
MMM-YY 27-Jun-07

TIMING & PRODUCTION SUMMARY

WesternGeco

	Accountable Time - Hours															Production - kms				
DATE	Mobilisation Demobilisation	Transit	WesternGeco non chargeable standby	WesternGeco Downtime	Chargeable standby for crew change & resupply	Chargeable Standby	Production Prime	Prime runout	Linechange Prime	Production Infill	Infill runout	Linechange Infill	Total Dayrate Time	Total Standby Time	Total Time	Prime Traverse km	Infill Traverse km	Prime FF CMP km	Infill FF CMP Km	Total FF CMP Kms
07-Jun														9.950	9.950					
08-Jun						9.950								14.050	24.000					
09-Jun				9.950		14.050									24.000					
10-Jun				24.000											24.000					
11-Jun				24.000											24.000					
12-Jun				9.250			6.933	0.567	7.250				14.750		24.000	64.069		945.300		945.300
13-Jun							14.150	0.567	9.283				24.000		24.000	129.956		1999.500		1999.500
14-Jun							12.467	0.833	10.700				24.000		24.000	118.088		1769.700		1769.700
15-Jun							12.850	0.800	10.350				24.000		24.000	124.875		1878.300		1878.300
16-Jun							8.950	0.850	7.800	3.567	0.267	2.567	24.001		24.001	89.550	35.531	1313.100	528.600	1841.700
17-Jun							10.267	0.833	7.867	3.783	0.283	0.967	24.000		24.000	101.250	34.350	1500.300	509.700	2010.000
18-Jun			3.750			14.550	3.633	0.283				1.783	5.699	14.550	23.999	35.269		524.400		524.400
19-Jun						24.000								24.000	24.000					
20-Jun						24.000								24.000	24.000					
21-Jun						24.000								24.000	24.000					
22-Jun						5.283	8.000	1.117	9.600				18.717	5.283	24.000	82.594		1161.900		1161.900
23-Jun							10.050	1.117	12.833				24.000		24.000	98.925		1423.200		1423.200
24-Jun				4.983			7.383	1.117	10.517				19.017		24.000	75.750		1049.400		1049.400
25-Jun				3.050			7.917	1.417	11.617				20.951		24.001	83.156		1131.000		1131.000
26-Jun				1.517			3.250	0.283	3.867	2.667	0.550	1.350	11.967		13.484	32.381	29.644	475.200	394.500	869.700
27-Jun																				
28-Jun																				
29-Jun																				
30-Jun																				
01-Jul																				
02-Jul																				
03-Jul																				
Period			3.75	76.75		115.83	105.85	9.78	101.68	10.02	1.10	6.67	235.10	115.83	431.44	1035.86	99.53	15171.30	1432.80	16604.10
Job Total	**74.583**		**3.75**	77.08		260.73	**190.80**	**17.38**	**186.60**	**16.03**	**1.63**	**12.83**	**425.29**	**260.73**	**841.44**	**1856.03**	**158.76**	**27208.80**	**2300.70**	**29509.50**

Total Linechange Hrs 199.44 **Total Traverse** 2014.78

Total Production Hrs 225.85

Drew Murray
Client representative

John Pope
Party Manager, Western Trident

Vessel M/V Western Trident
Area 3D Marine Seismic.
Job no. 9614
Client BHP Lobella
MMM-YY 27-Jun-07

TIMING & PRODUCTION SUMMARY

WesternGeco

	Accountable Time - Hours															Production - kms				
DATE	Mobilisation Demobilisation	Transit	WesternGeco non chargeable standby	WesternGeco Downtime	Chargeable standby for crew change & resupply	Chargeable Standby	Production Prime	Prime runout	Linechange Prime	Production Infill	Infill runout	Linechange Infill	Total Dayrate Time	Total Standby Time	Total Time	Prime Traverse km	Infill Traverse km	Prime FF CMP km	Infill FF CMP Km	Total FF CMP Kms
13-Jun																				
14-Jun																				
15-Jun																				
16-Jun																				
17-Jun																				
18-Jun																				
19-Jun																				
20-Jun																				
21-Jun																				
22-Jun																				
23-Jun																				
24-Jun																				
25-Jun																				
26-Jun							1.650	0.583	8.283						10.516	19.450				
27-Jun				0.800			2.783	0.867	8.733						13.183	32.525				
28-Jun																				
29-Jun																				
30-Jun																				
Period				0.80			4.43	1.45	17.02						23.70	51.98				
Job Total				0.80			4.43	1.45	17.02						23.70	51.98				

Total Linechange Hrs 17.02 **Total Traverse** 51.98

Total Production Hrs 5.88

Drew Murray
Client representative

John Pope
Party Manager, Western Trident

Equipment Configuration

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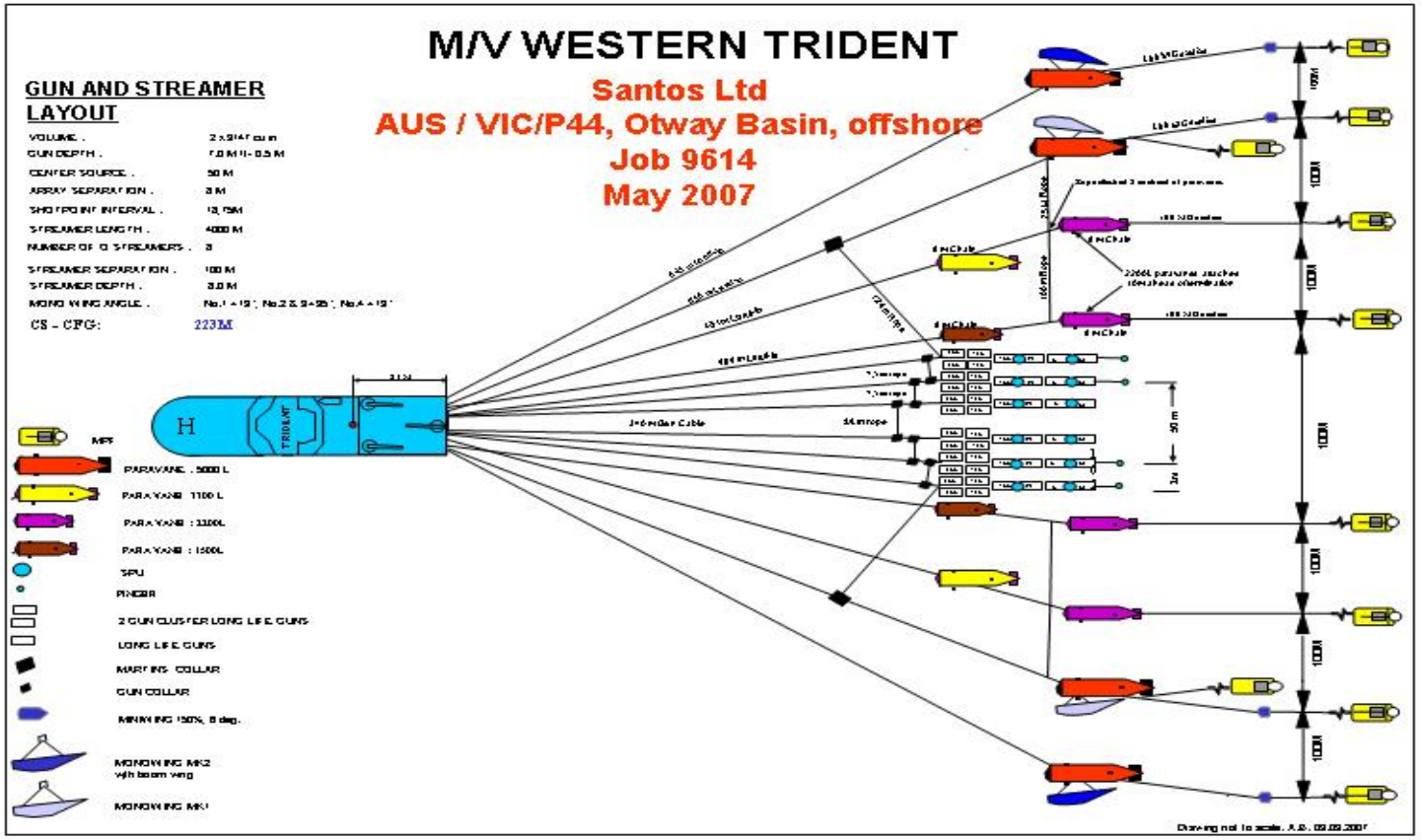
11. Towing Configuration

11.1. Towing System Layout



12. Streamer Configuration

12.1. Streamer System Description

Streamer System Parameters Sentry	
Number of Streamers	8
Type of streamer	Thompson Marconi Sonar Sentry Solid Streamer
Streamer length	5000m
Groups per streamer	400
Group intervals	12.5 m
Centre Source to Centre 1st Grp	240 m
Outside diameter	64mm
Jacket (type-thickness)	PU/PVC alloy with Aramid fibre
Breaking strength	60kN typical (13,488lbf)
Ballast fluid (Solid)	Polyurethane matrix
Connectors (diameter-length)	Max. Dia 68 mm, length 214/251 mm (NIII/NIV)
Channels per module	16
Data transmission link	Optic Fiber
Power	300-400 V AC
Leakage	> 1 Mohm
Active group lengths	17.75 m
Streamer depth	8 m
Streamer separation	100 m
Number of stretch sections / Dummy sections	Dummy sections
At the front of each streamer	1
At the end of each streamer	1
No of compasses per streamer	21
No of depth transducers per streamer	21

Streamer System Parameters Guardian	
Number of Streamers	8
Type of streamer	Thales underwater systems Guardian Solid Streamer
Streamer length	4000m (first 1000m)
Groups per streamer	400
Group intervals	12.5 m
Centre Source to Centre 1st Grp	240 m
Outside diameter	57.5 mm
Jacket (type-thickness)	PU/PVC alloy with Aramid fibre
Breaking strength	> 100kN (22,480 bf) typical
Ballast fluid (Solid)	Polyurethane matrix
Connectors (diameter-length)	Max. Dia 68 mm, length 214/251 mm (NIII/NIV)
Channels per module	16
Data transmission link	Optic Fiber
Power	300-400 V AC
Leakage	> 1 Mohm
Active group lengths	17.75 m
Streamer depth	8 m
Streamer separation	100 m
Number of stretch sections / Dummy sections	Dummy sections
in front of each streamer	1
end of each streamer	1
No of compasses per streamer	21 active
No of depth transducers per streamer	21 active

Trace allocation (example for 8 streamers)	**Location**	**Near**	**Far**
Streamer 1	Starboard Outer	1	400
Streamer 2	Starboard Outer Middle	401	800
Streamer 3	Starboard Inner Middle	801	1200
Streamer 4	Starboard Inner	1201	1600
Streamer 5	Port Inner	1601	2000
Streamer 6	Port Inner Middle	2001	2400
Streamer 7	Port Outer Middle	2401	2800
Streamer 8	Port Outer	2801	3200

Hydrophone Parameters Sentry	
Detector type	TMS seismic hydrophone (TS014)
Group interval	12.5m
Group length	17.75 m
No of groups per section	8
Hydrophones spacing	See diagram
Operating temperature range	-10 – +55 °C (14 – 131 °F)
Maximum operating depth	85m
Group sensitivity (at 7m depth)	14 V/bar

Hydrophone Parameters Guardian	
Detector type	TUS (TS014)
Group interval	12.5m
Group length	17.75 m
No of groups per section	8
Hydrophones spacing	See diagram
Operating temperature range	-10 – +55 °C (14 – 131 °F)
Maximum operating depth	150m max recommended
Group sensitivity (at 7m depth)	14 V/bar

12.2. Streamer Layout

Client: Santos Ltd.				**Area: Champion South/Hercules**
Description	Front Coil	Aft Coil	Channel Numbers	Section Length
Light Weight Lead-in (LOL)				900m Streamers: 1, 2, 7, 8
MSX Lead-in				850-1200m Streamers: 3, 4, 5, 6
Monowing adapter (MWA)				25m
Cable Head Module				0.3m
Tension cell (TOW)				1.2m
Head Dummy	Bird 1	SRD		100m Including module
CSX Module				
Active 1A	Bird 2	Acoustic 2	1-8	100m Including module
MSX Module				
Active 1B	Bird 3	Acoustic 3	9-16	100m Including module
CSX Module				
Active 2A		SRD	17-24	100m Including module
MSX Module				
Active 2B	Bird 4		25-32	100m Including module
CSX Module				
Active 3A		SRD	33-40	100m Including module
MSX Module				
Active 3B	Bird 5		41-48	100m Including module
CSX Module				
Active 4A		SRD	49-56	100m Including module
MSX Module				
Active 4B	Bird 6		57-64	100m Including module
CSX Module				
Active 5A		SRD	65-72	100m Including module
MSX Module				
Active 5B			73-80	100m Including module
CSX Module				
Active 6A	Bird 7		81-88	100m Including module
MSX Module				
Active 6B		SRD	89-96	100m Including module
CSX Module				
Active 7A			97-104	100m Including module
MSX Module				
Active 7B	Bird 8		105-112	100m Including module
CSX Module				
Active 8A		SRD	113-120	100m Including module
MSX Module				
Active 8B			121-128	100m Including module
CSX Module				
Active 9A	Bird 9		129-136	100m Including module
MSX Module				
Active 9B		SRD	137-144	100m Including module
CSX Module				
Active 10A			145-152	100m Including module
MSX Module				
Active 10B	Bird 10		153-160	100m Including module

CSX Module				
Active 11A		SRD	161-168	100m Including module
MSX Module				
Active 11B			169-176	100m Including module
CSX Module				
Active 12A	Bird 11		177-184	100m Including module
MSX Module				
Active 12B		SRD	185-192	100m Including module
CSX Module				
Active 13A	Acoustic 4		193-200	100m Including module
MSX Module				
Active 13B	Bird 12		201-208	100m Including module
CSX Module				
Active 14A	Acoustic 5	SRD	209-216	100m Including module
MSX Module				
Active 14B			217-224	100m Including module
CSX Module				
Active 15A	Bird 13		225-232	100m Including module
MSX Module				
Active 15B		SRD	233-240	100m Including module
CSX Module				
Active 16A			241-248	100m Including module
MSX Module				
Active 16B	Bird 14		249-256	100m Including module
CSX Module				
Active 17A		SRD	257-264	100m Including module
MSX Module				
Active 17B			265-272	100m Including module
CSX Module				
Active 18A	Bird 15		273-280	100m Including module
MSX Module				
Active 18B		SRD	281-288	100m Including module
CSX Module				
Active 19A			289-296	100m Including module
MSX Module				
Active 19B	Bird 16		297-304	100m Including module
CSX Module				
Active 20A		SRD	305-312	100m Including module
MSX Module				
Active 20B			313-320	100m Including module
CSX Module				
Active 21A	Bird 17		321-328	100m Including module
MSX Module				
Active 21B		SRD	329-336	100m Including module
CSX Module				
Active 22A			337-344	100m Including module
MSX Module				
Active 22B	Bird 18		345-352	100m Including module
CSX Module				
Active 23A		SRD	353-360	100m Including module
MSX Module				
Active 23B			361-368	100m Including module

CSX Module				
Active 24A	Bird 19		369-376	100m Including module
MSX Module				
Active 24B		SRD	377-384	100m Including module
CSX Module				
Active 25A	Acoustic 6		385-392	100m Including module
MSX Module				
Active 25B	Bird 20		393-400	100m Including module
CSX Module				
Tail Dummy	Bird 21 / Acoustic 7	SRD		100m Including module. Bird and Acoustic share coil
TSX Module				0.3m
Tail Swivel				1m
STIC	TB Acoustic			75m
TailBouy				

13. Source Configuration

13.1. Source System Description

Source Parameters	
Number of source arrays	2
Array separation	50 m
Array length	15m
Array width	16m
Number of sub arrays per source	3
Separation from center track	25 m
Source volume	3147 cubic inches
Number of hydrophones per sub array	6
Number of depth transducers per sub array	6
Number of guns per sub array	8
Number of clusters per subarray	2
Airgun type	Tuned Bolt Gun
Operating pressure	2000 psi
Depth of guns	7 m
Source Recording system	Trisor

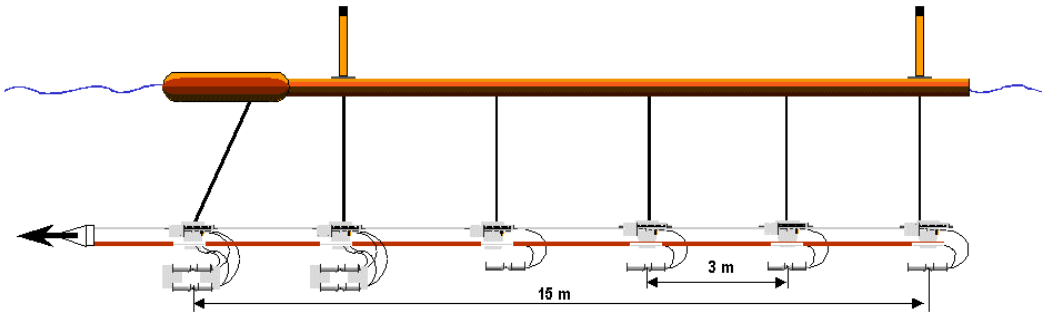
13.2. Source Layout

WesternGeco's 3147 in^3 Bolt Gun Array for 3D Operations

WesternGeco's source arrays are composed of identically tuned Bolt gun sub-arrays operating at 2000 psi, air pressure. In general, the signature produced by an array composed of multiple sub-arrays has the same shape as that produced by a single sub-array while the overall acoustic output of the array is determined by the number of sub-arrays employed. In this manner WesternGeco can offer a consistent source signature across our fleet of survey vessels.

The gun arrangement for the 1049 in^3 sub-array is detailed below.

Standard 1049 in^3 sub-array



As indicated in the diagram, the sub-array is composed of six tuning elements; two 2-gun clusters and four single guns. The clusters have their component guns arranged in a fixed side-by-side fashion with the distance between the gun ports set to maximise the bubble suppression effects of clustered guns. A near-field hydrophone is mounted about 1 m above each gun station (one phone is used per cluster), one depth transducer per position is mounted on the gun's ultrabox, and a high pressure transducer is mounted at the aft end of the subarray to monitor high pressure air supply. All the data from these sensors are transmitted to the vessel for input into the onboard systems and recording to tape.

The standard configuration of a source array for 3D surveys consists of one or more 1049 in^3 sub-arrays. When more than one sub-array is used the strings are lined up parallel to each other with either 8 m or 10 m cross-line separation between them. This separation had been chosen so as to minimise the areal dimensions of the array in order to approximate point source radiation characteristics for frequencies in the nominal seismic processing band. For the 3147 in^3 array the overall dimensions of the array are 15 m long by 16 m wide.

The following pages information was extracted from GUNDALF report, a third party signature modelling software. These physical parameters were used in modelling.

Sea temperature (C)	Velocity of sound in water (m./s.)	Expected dominant frequency in signature (Hz)	Observed wave height (m)
27	1539	20.0	0.0

The Gundalf airgun modelling engine is the end-product of 15 years of state of the art research. It takes full account of all air-gun interactions including interactions between sub-arrays. No assumptions of linear superposition are made. This means that if you move sub-arrays closer together, the far-field signature will change. The effect is noticeable even when sub-arrays are separated by as much as 10m.

The engine is capable of modelling airgun clusters right down to the 'super-foam' region where the bubbles themselves collide and distort. It has been calibrated against both single and clustered guns for a number of different gun types under laboratory conditions and accurately predicts peak to peak and primary to bubble parameters across a very wide range of operating conditions.

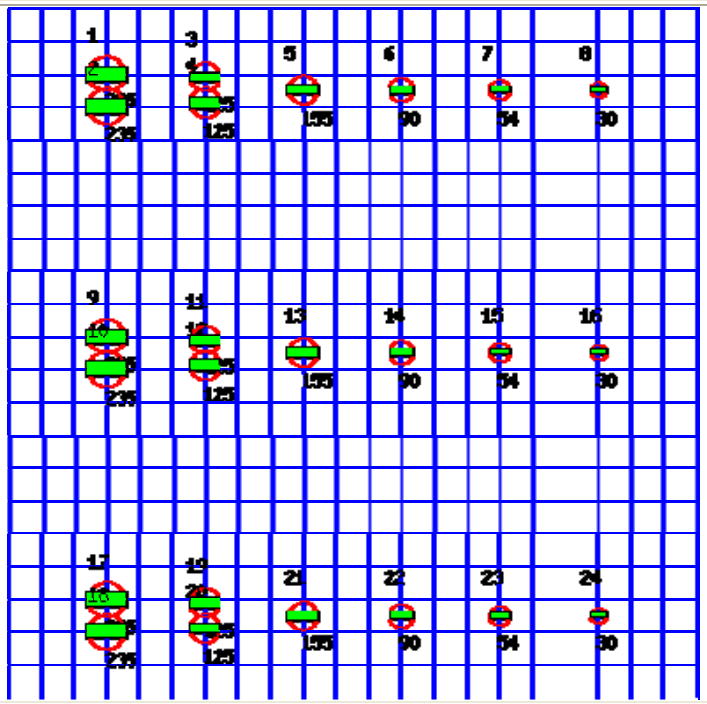
Gundalf calibration details All modelling software requires calibration against convincing experimental data. Gundalf provides accurate modelling of airguns across a wide range of gun types, gun parameters and operating environments, however, we do not expect you to take this simply on trust. It is therefore our policy to keep users of Gundalf aware of its latest calibration status and update information, including technical references; these can be found on the Gundalf Web site

www.gundalf.com

3147 in^3 Array Geometry

The following diagram shows the array geometry. There are two positioning sensors generally located at the front and aft of each string and include purpose build rGPS pods and acoustic pods.

<----- Direction of travel ----- --, (1m. grid, plan view)



The red circles denote the maximum radius reached by the bubble. Please note that pressure-field interactions take place over a much larger distance than this, (typically 10 times larger). However when bubbles touch or overlap, super-foam interaction can be expected. In this zone, significant peak AND bubble suppression will normally be observed.

Note also that a green rectangle represents a single gun and an orange rectangle indicates that the gun is currently dropped out. Where present, a yellow rectangle represents a vertical cluster (V.C.) of guns. Please see the geometry table above for more details. The small number to the above left of each gun is its reference number in this table. For clusters of guns, these reference numbers mirror the symmetry of the cluster.

3147 cu.in. Array Gun Position Table

The following table lists all the guns modelled in the array along with their characteristics. The last column is completed only if the array has actually been modelled during the interactive session and contains the contribution of that gun as a percentage of the peak to peak amplitude of the whole array. Please note that the relationship with volume is only as the cube root of the volume for the same gun type so that even small guns contribute significantly. This is particularly relevant to drop-out analysis.

Gun	Pressure (psi)	Volume (cuin)	Type	x (m.)	y (m.)	z (m.)	delay (s.)	sub-array	p-p contrib (pct.)
1	2000.0	235.0	1500LL	0.000	-8.500	7.000	0.000	1	5.3
2	2000.0	235.0	1500LL	0.000	-7.500	7.000	0.000	1	5.2
3	2000.0	125.0	1900LLX	3.000	-8.400	7.000	0.000	1	4.1
4	2000.0	125.0	1900LLX	3.000	-7.600	7.000	0.000	1	4.1
5	2000.0	155.0	1500LL	6.000	-8.000	7.000	0.000	1	4.7
6	2000.0	90.0	1900LLX	9.000	-8.000	7.000	0.000	1	4.0
7	2000.0	54.0	1900LLX	12.000	-8.000	7.000	0.000	1	3.2
8	2000.0	30.0	1900LLX	15.000	-8.000	7.000	0.000	1	2.6
9	2000.0	235.0	1500LL	0.000	-0.500	7.000	0.000	2	5.3
10	2000.0	235.0	1500LL	0.000	0.500	7.000	0.000	2	5.3
11	2000.0	125.0	1900LLX	3.000	-0.400	7.000	0.000	2	4.1
12	2000.0	125.0	1900LLX	3.000	0.400	7.000	0.000	2	4.1
13	2000.0	155.0	1500LL	6.000	0.000	7.000	0.000	2	4.8
14	2000.0	90.0	1900LLX	9.000	0.000	7.000	0.000	2	4.0
15	2000.0	54.0	1900LLX	12.000	0.000	7.000	0.000	2	3.3
16	2000.0	30.0	1900LLX	15.000	0.000	7.000	0.000	2	2.6
17	2000.0	235.0	1500LL	0.000	7.500	7.000	0.000	3	5.2
18	2000.0	235.0	1500LL	0.000	8.500	7.000	0.000	3	5.3
19	2000.0	125.0	1900LLX	3.000	7.600	7.000	0.000	3	4.1
20	2000.0	125.0	1900LLX	3.000	8.400	7.000	0.000	3	4.1
21	2000.0	155.0	1500LL	6.000	8.000	7.000	0.000	3	4.7

22	2000.0	90.0	1900LLX	9.000	8.000	7.000	0.000	3	4.0
23	2000.0	54.0	1900LLX	12.000	8.000	7.000	0.000	3	3.2
24	2000.0	30.0	1900LLX	15.000	8.000	7.000	0.000	3	2.6

13.3. Source Signature

No. of Sample: 1000
Sample Time Rate (ms): 2.0
Recording Filter (Hz-dB/Oct): 2-12 to 206-264

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
1	2.0	-0.0000003461	31	62.0	-0.3590680000
2	4.0	0.0000506906	32	64.0	14.4396000000
3	6.0	0.0002026500	33	66.0	52.0861000000
4	8.0	0.0002063460	34	68.0	35.9074000000
5	10.0	0.0001721680	35	70.0	5.4412500000
6	12.0	0.0004032320	36	72.0	7.4210400000
7	14.0	0.0001817300	37	74.0	-36.9298000000
8	16.0	-0.0037151500	38	76.0	-57.5034000000
9	18.0	-0.0118980000	39	78.0	-21.5919000000
10	20.0	-0.0085108400	40	80.0	-13.4854000000
11	22.0	0.0007450370	41	82.0	-6.2614400000
12	24.0	-0.0084466400	42	84.0	2.0309100000
13	26.0	0.0149260000	43	86.0	-0.8488830000
14	28.0	0.0119611000	44	88.0	0.7626880000
15	30.0	-0.0103397000	45	90.0	-5.5460800000
16	32.0	0.0355194000	46	92.0	-6.4011200000
17	34.0	-0.0401238000	47	94.0	-4.4557400000
18	36.0	0.0312241000	48	96.0	-4.3062900000
19	38.0	0.0012425300	49	98.0	0.7750950000
20	40.0	-0.0563513000	50	100.0	1.4100500000
21	42.0	0.1183410000	51	102.0	1.1574500000
22	44.0	-0.1582670000	52	104.0	0.7825610000
23	46.0	0.1602020000	53	106.0	-0.4362750000
24	48.0	-0.0893649000	54	108.0	-0.0938457000
25	50.0	-0.0456814000	55	110.0	0.1998570000
26	52.0	0.2300910000	56	112.0	1.2105700000
27	54.0	-0.4249700000	57	114.0	1.5774500000
28	56.0	0.5751070000	58	116.0	1.6554600000
29	58.0	-0.6345460000	59	118.0	2.0317700000
30	60.0	0.5781280000	60	120.0	1.6645100000

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
61	122.0	1.5153600000	96	192.0	1.3156200000
62	124.0	1.5986800000	97	194.0	0.6883040000
63	126.0	1.3599000000	98	196.0	0.3250690000
64	128.0	1.2982400000	99	198.0	0.0254013000
65	130.0	1.2723600000	100	200.0	-0.7410170000
66	132.0	1.2643000000	101	202.0	-0.7675520000
67	134.0	1.1674300000	102	204.0	-0.6203950000
68	136.0	1.1979400000	103	206.0	-0.8780110000
69	138.0	1.5034400000	104	208.0	-1.0098700000
70	140.0	1.5115700000	105	210.0	-1.3385100000
71	142.0	1.6755600000	106	212.0	-1.7048600000
72	144.0	1.7508700000	107	214.0	-2.1113500000
73	146.0	1.5358100000	108	216.0	-2.6088400000
74	148.0	1.4041200000	109	218.0	-2.9694100000
75	150.0	1.2095800000	110	220.0	-3.3204100000
76	152.0	1.1540800000	111	222.0	-3.3935700000
77	154.0	1.2558200000	112	224.0	-3.1692200000
78	156.0	1.4680300000	113	226.0	-2.8004300000
79	158.0	1.7036200000	114	228.0	-2.3081600000
80	160.0	1.7823700000	115	230.0	-1.8929900000
81	162.0	1.8308300000	116	232.0	-1.5700100000
82	164.0	1.7434200000	117	234.0	-1.3565100000
83	166.0	1.7098800000	118	236.0	-1.2188800000
84	168.0	1.8765400000	119	238.0	-1.0916300000
85	170.0	1.7536100000	120	240.0	-0.9893830000
86	172.0	1.7434800000	121	242.0	-0.8672870000
87	174.0	1.9671900000	122	244.0	-0.7505100000
88	176.0	1.8240100000	123	246.0	-0.6546930000
89	178.0	1.8001100000	124	248.0	-0.5594720000
90	180.0	1.9803700000	125	250.0	-0.4716730000
91	182.0	1.8405800000	126	252.0	-0.3803470000
92	184.0	1.6256000000	127	254.0	-0.2840640000
93	186.0	1.4942000000	128	256.0	-0.1833420000
94	188.0	1.2634900000	129	258.0	-0.0817487000
95	190.0	1.2912800000	130	260.0	0.0084711100

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
131	262.0	0.0952726000	166	332.0	0.3469080000
132	264.0	0.1725890000	167	334.0	0.2952800000
133	266.0	0.2363590000	168	336.0	0.2446280000
134	268.0	0.2977220000	169	338.0	0.1940450000
135	270.0	0.3501370000	170	340.0	0.1464280000
136	272.0	0.3960680000	171	342.0	0.1016860000
137	274.0	0.4366720000	172	344.0	0.0595255000
138	276.0	0.4685540000	173	346.0	0.0200059000
139	278.0	0.4946210000	174	348.0	-0.0146834000
140	280.0	0.5137130000	175	350.0	-0.0481141000
141	282.0	0.5291380000	176	352.0	-0.0840911000
142	284.0	0.5422750000	177	354.0	-0.1198950000
143	286.0	0.5553700000	178	356.0	-0.1577460000
144	288.0	0.5716470000	179	358.0	-0.2049660000
145	290.0	0.5882830000	180	360.0	-0.2640490000
146	292.0	0.6065210000	181	362.0	-0.3284960000
147	294.0	0.6252290000	182	364.0	-0.3979250000
148	296.0	0.6402170000	183	366.0	-0.4720270000
149	298.0	0.6547830000	184	368.0	-0.5320610000
150	300.0	0.6685660000	185	370.0	-0.5721270000
151	302.0	0.6789520000	186	372.0	-0.5986160000
152	304.0	0.6873380000	187	374.0	-0.6045340000
153	306.0	0.6899340000	188	376.0	-0.5936580000
154	308.0	0.6844510000	189	378.0	-0.5763570000
155	310.0	0.6731220000	190	380.0	-0.5538970000
156	312.0	0.6562240000	191	382.0	-0.5291180000
157	314.0	0.6364820000	192	384.0	-0.5025500000
158	316.0	0.6211440000	193	386.0	-0.4735170000
159	318.0	0.6098490000	194	388.0	-0.4413480000
160	320.0	0.5937460000	195	390.0	-0.4061400000
161	322.0	0.5736010000	196	392.0	-0.3709360000
162	324.0	0.5456050000	197	394.0	-0.3352330000
163	326.0	0.5016340000	198	396.0	-0.3006320000
164	328.0	0.4521920000	199	398.0	-0.2690540000
165	330.0	0.4012990000	200	400.0	-0.2381290000

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
201	402.0	-0.2087830000	236	472.0	0.2243770000
202	404.0	-0.1814740000	237	474.0	0.2145910000
203	406.0	-0.1542190000	238	476.0	0.2031030000
204	408.0	-0.1277520000	239	478.0	0.1919520000
205	410.0	-0.1028100000	240	480.0	0.1794530000
206	412.0	-0.0786886000	241	482.0	0.1650750000
207	414.0	-0.0562368000	242	484.0	0.1503320000
208	416.0	-0.0357287000	243	486.0	0.1348230000
209	418.0	-0.0161691000	244	488.0	0.1176520000
210	420.0	0.0025159200	245	490.0	0.1002170000
211	422.0	0.0207137000	246	492.0	0.0828322000
212	424.0	0.0380943000	247	494.0	0.0643346000
213	426.0	0.0545767000	248	496.0	0.0459097000
214	428.0	0.0704313000	249	498.0	0.0277258000
215	430.0	0.0846050000	250	500.0	0.0090068000
216	432.0	0.0988063000	251	502.0	-0.0092833600
217	434.0	0.1142710000	252	504.0	-0.0270299000
218	436.0	0.1293020000	253	506.0	-0.0445754000
219	438.0	0.1443740000	254	508.0	-0.0616719000
220	440.0	0.1594260000	255	510.0	-0.0778503000
221	442.0	0.1731950000	256	512.0	-0.0934623000
222	444.0	0.1860190000	257	514.0	-0.1093160000
223	446.0	0.1986180000	258	516.0	-0.1242530000
224	448.0	0.2115140000	259	518.0	-0.1380390000
225	450.0	0.2235260000	260	520.0	-0.1517050000
226	452.0	0.2332060000	261	522.0	-0.1634760000
227	454.0	0.2413310000	262	524.0	-0.1725150000
228	456.0	0.2473610000	263	526.0	-0.1801350000
229	458.0	0.2500820000	264	528.0	-0.1851950000
230	460.0	0.2513980000	265	530.0	-0.1864750000
231	462.0	0.2514640000	266	532.0	-0.1849150000
232	464.0	0.2489780000	267	534.0	-0.1816710000
233	466.0	0.2454710000	268	536.0	-0.1767280000
234	468.0	0.2400340000	269	538.0	-0.1698500000
235	470.0	0.2322940000	270	540.0	-0.1627980000

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
271	542.0	-0.1553830000	306	612.0	0.0863343000
272	544.0	-0.1455290000	307	614.0	0.0823474000
273	546.0	-0.1349690000	308	616.0	0.0794388000
274	548.0	-0.1243240000	309	618.0	0.0750175000
275	550.0	-0.1123110000	310	620.0	0.0694363000
276	552.0	-0.1006080000	311	622.0	0.0652805000
277	554.0	-0.0892010000	312	624.0	0.0603673000
278	556.0	-0.0773042000	313	626.0	0.0547299000
279	558.0	-0.0660114000	314	628.0	0.0498209000
280	560.0	-0.0547318000	315	630.0	0.0444328000
281	562.0	-0.0432714000	316	632.0	0.0378953000
282	564.0	-0.0324454000	317	634.0	0.0317400000
283	566.0	-0.0220469000	318	636.0	0.0256787000
284	568.0	-0.0118582000	319	638.0	0.0186102000
285	570.0	-0.0021151500	320	640.0	0.0126283000
286	572.0	0.0070026700	321	642.0	0.0071994300
287	574.0	0.0161774000	322	644.0	0.0013096300
288	576.0	0.0250016000	323	646.0	-0.0033487500
289	578.0	0.0328396000	324	648.0	-0.0081242600
290	580.0	0.0403622000	325	650.0	-0.0131384000
291	582.0	0.0470817000	326	652.0	-0.0174912000
292	584.0	0.0531491000	327	654.0	-0.0220931000
293	586.0	0.0589359000	328	656.0	-0.0267016000
294	588.0	0.0644259000	329	658.0	-0.0315023000
295	590.0	0.0699415000	330	660.0	-0.0354063000
296	592.0	0.0747561000	331	662.0	-0.0382184000
297	594.0	0.0798083000	332	664.0	-0.0414077000
298	596.0	0.0845766000	333	666.0	-0.0433774000
299	598.0	0.0876726000	334	668.0	-0.0446927000
300	600.0	0.0902623000	335	670.0	-0.0474494000
301	602.0	0.0914202000	336	672.0	-0.0495141000
302	604.0	0.0916956000	337	674.0	-0.0501742000
303	606.0	0.0915017000	338	676.0	-0.0510394000
304	608.0	0.0897760000	339	678.0	-0.0513810000
305	610.0	0.0886094000	340	680.0	-0.0506107000

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
341	682.0	-0.0491707000	376	752.0	0.0305005000
342	684.0	-0.0479815000	377	754.0	0.0293741000
343	686.0	-0.0470680000	378	756.0	0.0289404000
344	688.0	-0.0447297000	379	758.0	0.0277913000
345	690.0	-0.0424562000	380	760.0	0.0268684000
346	692.0	-0.0410340000	381	762.0	0.0268131000
347	694.0	-0.0379851000	382	764.0	0.0255727000
348	696.0	-0.0345254000	383	766.0	0.0244834000
349	698.0	-0.0317364000	384	768.0	0.0229842000
350	700.0	-0.0283577000	385	770.0	0.0207052000
351	702.0	-0.0254055000	386	772.0	0.0190096000
352	704.0	-0.0227197000	387	774.0	0.0168240000
353	706.0	-0.0195706000	388	776.0	0.0146700000
354	708.0	-0.0168661000	389	778.0	0.0124821000
355	710.0	-0.0133526000	390	780.0	0.0100408000
356	712.0	-0.0091478500	391	782.0	0.0081455100
357	714.0	-0.0059869800	392	784.0	0.0055065700
358	716.0	-0.0029834600	393	786.0	0.0036457600
359	718.0	-0.0000967318	394	788.0	0.0026735800
360	720.0	0.0026348400	395	790.0	0.0002466600
361	722.0	0.0054416500	396	792.0	-0.0015196800
362	724.0	0.0080018900	397	794.0	-0.0030551200
363	726.0	0.0112742000	398	796.0	-0.0058460400
364	728.0	0.0142184000	399	798.0	-0.0076784500
365	730.0	0.0160348000	400	800.0	-0.0089374200
366	732.0	0.0182633000	401	802.0	-0.0105799000
367	734.0	0.0206101000	402	804.0	-0.0118920000
368	736.0	0.0219878000	403	806.0	-0.0128598000
369	738.0	0.0237726000	404	808.0	-0.0140008000
370	740.0	0.0264294000	405	810.0	-0.0155814000
371	742.0	0.0275710000	406	812.0	-0.0164079000
372	744.0	0.0285354000	407	814.0	-0.0167777000
373	746.0	0.0301541000	408	816.0	-0.0175233000
374	748.0	0.0302074000	409	818.0	-0.0175519000
375	750.0	0.0304637000	410	820.0	-0.0176633000

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
411	822.0	-0.0180433000	446	892.0	0.0114137000
412	824.0	-0.0179064000	447	894.0	0.0115460000
413	826.0	-0.0179019000	448	896.0	0.0107669000
414	828.0	-0.0173155000	449	898.0	0.0104094000
415	830.0	-0.0166675000	450	900.0	0.0102647000
416	832.0	-0.0164968000	451	902.0	0.0097694800
417	834.0	-0.0156608000	452	904.0	0.0100458000
418	836.0	-0.0149490000	453	906.0	0.0102764000
419	838.0	-0.0140796000	454	908.0	0.0095111000
420	840.0	-0.0126324000	455	910.0	0.0092597900
421	842.0	-0.0116910000	456	912.0	0.0083310600
422	844.0	-0.0108107000	457	914.0	0.0066668600
423	846.0	-0.0096828400	458	916.0	0.0064022800
424	848.0	-0.0083129100	459	918.0	0.0060593400
425	850.0	-0.0071297600	460	920.0	0.0053179200
426	852.0	-0.0061463700	461	922.0	0.0050749500
427	854.0	-0.0044169500	462	924.0	0.0045717900
428	856.0	-0.0029833400	463	926.0	0.0037051700
429	858.0	-0.0019963300	464	928.0	0.0021405600
430	860.0	-0.0008042050	465	930.0	0.0007180400
431	862.0	-0.0000371254	466	932.0	0.0002204370
432	864.0	0.0006164050	467	934.0	-0.0006575310
433	866.0	0.0012956100	468	936.0	-0.0013114400
434	868.0	0.0025765500	469	938.0	-0.0010839500
435	870.0	0.0042894300	470	940.0	-0.0016726300
436	872.0	0.0051943300	471	942.0	-0.0030779300
437	874.0	0.0063074400	472	944.0	-0.0036897200
438	876.0	0.0073643400	473	946.0	-0.0041137300
439	878.0	0.0078434400	474	948.0	-0.0053432900
440	880.0	0.0088511300	475	950.0	-0.0060969300
441	882.0	0.0093399500	476	952.0	-0.0061249300
442	884.0	0.0095378100	477	954.0	-0.0064268200
443	886.0	0.0105133000	478	956.0	-0.0067479900
444	888.0	0.0107893000	479	958.0	-0.0066542700
445	890.0	0.0107142000	480	960.0	-0.0063514500

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
481	962.0	-0.0066364800	516	1032.0	0.0039803600
482	964.0	-0.0069825500	517	1034.0	0.0038806300
483	966.0	-0.0065653100	518	1036.0	0.0038401100
484	968.0	-0.0065604800	519	1038.0	0.0042578200
485	970.0	-0.0066244700	520	1040.0	0.0044263300
486	972.0	-0.0060512600	521	1042.0	0.0044540700
487	974.0	-0.0059007300	522	1044.0	0.0043709400
488	976.0	-0.0058208400	523	1046.0	0.0041184700
489	978.0	-0.0053887700	524	1048.0	0.0039104100
490	980.0	-0.0053592900	525	1050.0	0.0036471700
491	982.0	-0.0053100600	526	1052.0	0.0034477700
492	984.0	-0.0048997700	527	1054.0	0.0032575000
493	986.0	-0.0049622000	528	1056.0	0.0030139200
494	988.0	-0.0050185400	529	1058.0	0.0027538700
495	990.0	-0.0042586800	530	1060.0	0.0024286600
496	992.0	-0.0033413600	531	1062.0	0.0020941900
497	994.0	-0.0028098100	532	1064.0	0.0017517900
498	996.0	-0.0023678900	533	1066.0	0.0014148300
499	998.0	-0.0016848000	534	1068.0	0.0010813000
500	1000.0	-0.0013224900	535	1070.0	0.0007583340
501	1002.0	-0.0012178700	536	1072.0	0.0004292270
502	1004.0	-0.0003705830	537	1074.0	0.0000953637
503	1006.0	0.0007009100	538	1076.0	-0.0002317480
504	1008.0	0.0011987900	539	1078.0	-0.0005387650
505	1010.0	0.0016066400	540	1080.0	-0.0008318620
506	1012.0	0.0019770800	541	1082.0	-0.0011089200
507	1014.0	0.0017349800	542	1084.0	-0.0013561800
508	1016.0	0.0016189400	543	1086.0	-0.0015967400
509	1018.0	0.0022095700	544	1088.0	-0.0018271300
510	1020.0	0.0030368400	545	1090.0	-0.0020378100
511	1022.0	0.0041005100	546	1092.0	-0.0022126800
512	1024.0	0.0048988100	547	1094.0	-0.0023692700
513	1026.0	0.0051610000	548	1096.0	-0.0024907400
514	1028.0	0.0047804000	549	1098.0	-0.0025794200
515	1030.0	0.0040783600	550	1100.0	-0.0026514500

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
551	1102.0	-0.0027024400	586	1172.0	0.0017135600
552	1104.0	-0.0027416100	587	1174.0	0.0017317500
553	1106.0	-0.0027601200	588	1176.0	0.0017302700
554	1108.0	-0.0027516100	589	1178.0	0.0017208700
555	1110.0	-0.0027262300	590	1180.0	0.0017007100
556	1112.0	-0.0026789900	591	1182.0	0.0016692700
557	1114.0	-0.0026041700	592	1184.0	0.0016300300
558	1116.0	-0.0025164500	593	1186.0	0.0015787800
559	1118.0	-0.0024123100	594	1188.0	0.0015130700
560	1120.0	-0.0022920500	595	1190.0	0.0014375600
561	1122.0	-0.0021628200	596	1192.0	0.0013526300
562	1124.0	-0.0020166200	597	1194.0	0.0012547600
563	1126.0	-0.0018606200	598	1196.0	0.0011491300
564	1128.0	-0.0016961200	599	1198.0	0.0010378300
565	1130.0	-0.0015126300	600	1200.0	0.0009184840
566	1132.0	-0.0013168400	601	1202.0	0.0007959100
567	1134.0	-0.0011158400	602	1204.0	0.0006729500
568	1136.0	-0.0009085700	603	1206.0	0.0005456380
569	1138.0	-0.0006975050	604	1208.0	0.0004167200
570	1140.0	-0.0004920550	605	1210.0	0.0002895850
571	1142.0	-0.0002863100	606	1212.0	0.0001622890
572	1144.0	-0.0000777702	607	1214.0	0.0000374023
573	1146.0	0.0001247490	608	1216.0	-0.0000822004
574	1148.0	0.0003200330	609	1218.0	-0.0001986110
575	1150.0	0.0005029010	610	1220.0	-0.0003111140
576	1152.0	0.0006708810	611	1222.0	-0.0004174040
577	1154.0	0.0008214620	612	1224.0	-0.0005176080
578	1156.0	0.0009629020	613	1226.0	-0.0006106440
579	1158.0	0.0010992700	614	1228.0	-0.0006953850
580	1160.0	0.0012214900	615	1230.0	-0.0007714880
581	1162.0	0.0013369000	616	1232.0	-0.0008380740
582	1164.0	0.0014432400	617	1234.0	-0.0008957190
583	1166.0	0.0015362100	618	1236.0	-0.0009440110
584	1168.0	0.0016159800	619	1238.0	-0.0009828640
585	1170.0	0.0016740200	620	1240.0	-0.0010142000

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
621	1242.0	-0.0010375200	656	1312.0	0.0006365630
622	1244.0	-0.0010507900	657	1314.0	0.0006484110
623	1246.0	-0.0010551600	658	1316.0	0.0006558600
624	1248.0	-0.0010510000	659	1318.0	0.0006570910
625	1250.0	-0.0010370400	660	1320.0	0.0006515670
626	1252.0	-0.0010157100	661	1322.0	0.0006414130
627	1254.0	-0.0009891970	662	1324.0	0.0006255190
628	1256.0	-0.0009542270	663	1326.0	0.0006039400
629	1258.0	-0.0009117430	664	1328.0	0.0005797790
630	1260.0	-0.0008648460	665	1330.0	0.0005518050
631	1262.0	-0.0008111030	666	1332.0	0.0005190080
632	1264.0	-0.0007523090	667	1334.0	0.0004835650
633	1266.0	-0.0006926750	668	1336.0	0.0004451220
634	1268.0	-0.0006287960	669	1338.0	0.0004031510
635	1270.0	-0.0005605830	670	1340.0	0.0003601220
636	1272.0	-0.0004914660	671	1342.0	0.0003159500
637	1274.0	-0.0004194760	672	1344.0	0.0002695680
638	1276.0	-0.0003450790	673	1346.0	0.0002223480
639	1278.0	-0.0002719960	674	1348.0	0.0001749480
640	1280.0	-0.0001986560	675	1350.0	0.0001267520
641	1282.0	-0.0001243720	676	1352.0	0.0000792627
642	1284.0	-0.0000515928	677	1354.0	0.0000331406
643	1286.0	0.0000198853	678	1356.0	-0.0000124219
644	1288.0	0.0000903027	679	1358.0	-0.0000568064
645	1290.0	0.0001575800	680	1360.0	-0.0000992083
646	1292.0	0.0002216650	681	1362.0	-0.0001400140
647	1294.0	0.0002828940	682	1364.0	-0.0001785230
648	1296.0	0.0003403950	683	1366.0	-0.0002143660
649	1298.0	0.0003938130	684	1368.0	-0.0002474680
650	1300.0	0.0004431960	685	1370.0	-0.0002773680
651	1302.0	0.0004882230	686	1372.0	-0.0003039530
652	1304.0	0.0005289640	687	1374.0	-0.0003270380
653	1306.0	0.0005644210	688	1376.0	-0.0003463450
654	1308.0	0.0005941370	689	1378.0	-0.0003627810
655	1310.0	0.0006185240	690	1380.0	-0.0003760560

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
691	1382.0	-0.0003857180	726	1452.0	0.0002388570
692	1384.0	-0.0003924410	727	1454.0	0.0002453450
693	1386.0	-0.0003960150	728	1456.0	0.0002494010
694	1388.0	-0.0003959030	729	1458.0	0.0002510310
695	1390.0	-0.0003932330	730	1460.0	0.0002508830
696	1392.0	-0.0003879230	731	1462.0	0.0002483530
697	1394.0	-0.0003791870	732	1464.0	0.0002437630
698	1396.0	-0.0003676970	733	1466.0	0.0002379220
699	1398.0	-0.0003539450	734	1468.0	0.0002301030
700	1400.0	-0.0003372410	735	1470.0	0.0002200840
701	1402.0	-0.0003186500	736	1472.0	0.0002089130
702	1404.0	-0.0002988460	737	1474.0	0.0001960180
703	1406.0	-0.0002767330	738	1476.0	0.0001815570
704	1408.0	-0.0002526650	739	1478.0	0.0001665500
705	1410.0	-0.0002277760	740	1480.0	0.0001506140
706	1412.0	-0.0002012300	741	1482.0	0.0001333640
707	1414.0	-0.0001737650	742	1484.0	0.0001157330
708	1416.0	-0.0001465390	743	1486.0	0.0000975549
709	1418.0	-0.0001186760	744	1488.0	0.0000788329
710	1420.0	-0.0000901596	745	1490.0	0.0000602845
711	1422.0	-0.0000621191	746	1492.0	0.0000419765
712	1424.0	-0.0000340585	747	1494.0	0.0000235185
713	1426.0	-0.0000062920	748	1496.0	0.0000054514
714	1428.0	0.0000203453	749	1498.0	-0.0000121585
715	1430.0	0.0000460942	750	1500.0	-0.0000293123
716	1432.0	0.0000710955	751	1502.0	-0.0000456994
717	1434.0	0.0000947549	752	1504.0	-0.0000611209
718	1436.0	0.0001171720	753	1506.0	-0.0000757410
719	1438.0	0.0001382700	754	1508.0	-0.0000892399
720	1440.0	0.0001579510	755	1510.0	-0.0001016050
721	1442.0	0.0001760690	756	1512.0	-0.0001126940
722	1444.0	0.0001925400	757	1514.0	-0.0001224890
723	1446.0	0.0002072000	758	1516.0	-0.0001310190
724	1448.0	0.0002199640	759	1518.0	-0.0001382420
725	1450.0	0.0002304310	760	1520.0	-0.0001439950

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
761	1522.0	-0.0001486220	796	1592.0	0.0000927675
762	1524.0	-0.0001518750	797	1594.0	0.0000955197
763	1526.0	-0.0001538180	798	1596.0	0.0000974113
764	1528.0	-0.0001547920	799	1598.0	0.0000984217
765	1530.0	-0.0001546090	800	1600.0	0.0000985240
766	1532.0	-0.0001529130	801	1602.0	0.0000978045
767	1534.0	-0.0001502110	802	1604.0	0.0000965455
768	1536.0	-0.0001463380	803	1606.0	0.0000943558
769	1538.0	-0.0001412670	804	1608.0	0.0000913871
770	1540.0	-0.0001354530	805	1610.0	0.0000878141
771	1542.0	-0.0001289620	806	1612.0	0.0000835110
772	1544.0	-0.0001213440	807	1614.0	0.0000785325
773	1546.0	-0.0001130150	808	1616.0	0.0000733503
774	1548.0	-0.0001040400	809	1618.0	0.0000675706
775	1550.0	-0.0000942961	810	1620.0	0.0000612749
776	1552.0	-0.0000841176	811	1622.0	0.0000547164
777	1554.0	-0.0000738646	812	1624.0	0.0000478419
778	1556.0	-0.0000630641	813	1626.0	0.0000406077
779	1558.0	-0.0000519984	814	1628.0	0.0000334849
780	1560.0	-0.0000409103	815	1630.0	0.0000262395
781	1562.0	-0.0000296648	816	1632.0	0.0000189007
782	1564.0	-0.0000184124	817	1634.0	0.0000116205
783	1566.0	-0.0000075785	818	1636.0	0.0000044805
784	1568.0	0.0000031570	819	1638.0	-0.0000026247
785	1570.0	0.0000136291	820	1640.0	-0.0000093833
786	1572.0	0.0000236914	821	1642.0	-0.0000158967
787	1574.0	0.0000333151	822	1644.0	-0.0000220962
788	1576.0	0.0000425104	823	1646.0	-0.0000279723
789	1578.0	0.0000510778	824	1648.0	-0.0000333795
790	1580.0	0.0000591317	825	1650.0	-0.0000384014
791	1582.0	0.0000665063	826	1652.0	-0.0000428837
792	1584.0	0.0000732648	827	1654.0	-0.0000469369
793	1586.0	0.0000792740	828	1656.0	-0.0000503898
794	1588.0	0.0000845335	829	1658.0	-0.0000533387
795	1590.0	0.0000890100	830	1660.0	-0.0000557433

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
831	1662.0	-0.0000576365	866	1732.0	0.0000354540
832	1664.0	-0.0000589605	867	1734.0	0.0000365584
833	1666.0	-0.0000599781	868	1736.0	0.0000373831
834	1668.0	-0.0000604249	869	1738.0	0.0000377661
835	1670.0	-0.0000603585	870	1740.0	0.0000379317
836	1672.0	-0.0000598397	871	1742.0	0.0000377524
837	1674.0	-0.0000588663	872	1744.0	0.0000372841
838	1676.0	-0.0000573256	873	1746.0	0.0000364510
839	1678.0	-0.0000555833	874	1748.0	0.0000354261
840	1680.0	-0.0000534144	875	1750.0	0.0000340123
841	1682.0	-0.0000508294	876	1752.0	0.0000324434
842	1684.0	-0.0000479163	877	1754.0	0.0000306575
843	1686.0	-0.0000447548	878	1756.0	0.0000286847
844	1688.0	-0.0000411845	879	1758.0	0.0000264243
845	1690.0	-0.0000375397	880	1760.0	0.0000241249
846	1692.0	-0.0000337017	881	1762.0	0.0000215657
847	1694.0	-0.0000296687	882	1764.0	0.0000189572
848	1696.0	-0.0000254539	883	1766.0	0.0000162791
849	1698.0	-0.0000212340	884	1768.0	0.0000135845
850	1700.0	-0.0000168306	885	1770.0	0.0000107369
851	1702.0	-0.0000125029	886	1772.0	0.0000079920
852	1704.0	-0.0000082077	887	1774.0	0.0000051589
853	1706.0	-0.0000039701	888	1776.0	0.0000024161
854	1708.0	0.0000002658	889	1778.0	-0.0000002954
855	1710.0	0.0000042963	890	1780.0	-0.0000028531
856	1712.0	0.0000082834	891	1782.0	-0.0000054162
857	1714.0	0.0000120380	892	1784.0	-0.0000077724
858	1716.0	0.0000156310	893	1786.0	-0.0000100787
859	1718.0	0.0000189727	894	1788.0	-0.0000121635
860	1720.0	0.0000221532	895	1790.0	-0.0000141489
861	1722.0	0.0000250217	896	1792.0	-0.0000158781
862	1724.0	0.0000277031	897	1794.0	-0.0000174958
863	1726.0	0.0000300398	898	1796.0	-0.0000188201
864	1728.0	0.0000321765	899	1798.0	-0.0000200321
865	1730.0	0.0000339576	900	1800.0	-0.0000209489

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
901	1802.0	-0.0000217500	936	1872.0	0.0000132040
902	1804.0	-0.0000223103	937	1874.0	0.0000136187
903	1806.0	-0.0000227546	938	1876.0	0.0000140162
904	1808.0	-0.0000229086	939	1878.0	0.0000141856
905	1810.0	-0.0000229948	940	1880.0	0.0000143610
906	1812.0	-0.0000227861	941	1882.0	0.0000142626
907	1814.0	-0.0000224789	942	1884.0	0.0000141918
908	1816.0	-0.0000219750	943	1886.0	0.0000138737
909	1818.0	-0.0000213853	944	1888.0	0.0000135658
910	1820.0	-0.0000205180	945	1890.0	0.0000130400
911	1822.0	-0.0000196402	946	1892.0	0.0000125750
912	1824.0	-0.0000185231	947	1894.0	0.0000118541
913	1826.0	-0.0000173576	948	1896.0	0.0000111975
914	1828.0	-0.0000160528	949	1898.0	0.0000103293
915	1830.0	-0.0000147558	950	1900.0	0.0000095281
916	1832.0	-0.0000132434	951	1902.0	0.0000085297
917	1834.0	-0.0000117839	952	1904.0	0.0000076682
918	1836.0	-0.0000101710	953	1906.0	0.0000065941
919	1838.0	-0.0000085940	954	1908.0	0.0000056438
920	1840.0	-0.0000069241	955	1910.0	0.0000045251
921	1842.0	-0.0000053617	956	1912.0	0.0000035498
922	1844.0	-0.0000036725	957	1914.0	0.0000024024
923	1846.0	-0.0000021040	958	1916.0	0.0000014621
924	1848.0	-0.0000004622	959	1918.0	0.0000003541
925	1850.0	0.0000010517	960	1920.0	-0.0000005562
926	1852.0	0.0000026134	961	1922.0	-0.0000016105
927	1854.0	0.0000039929	962	1924.0	-0.0000024421
928	1856.0	0.0000054227	963	1926.0	-0.0000034237
929	1858.0	0.0000066642	964	1928.0	-0.0000041480
930	1860.0	0.0000079369	965	1930.0	-0.0000050165
931	1862.0	0.0000090091	966	1932.0	-0.0000056120
932	1864.0	0.0000100985	967	1934.0	-0.0000063495
933	1866.0	0.0000109842	968	1936.0	-0.0000067940
934	1868.0	0.0000118816	969	1938.0	-0.0000073820
935	1870.0	0.0000125342	970	1940.0	-0.0000076692

Sample No.	Time (ms)	Amplitude	Sample No.	Time (ms)	Amplitude
971	1942.0	-0.0000081225	986	1972.0	-0.0000052279
972	1944.0	-0.0000082540	987	1974.0	-0.0000048884
973	1946.0	-0.0000085650	988	1976.0	-0.0000040659
974	1948.0	-0.0000085536	989	1978.0	-0.0000037243
975	1950.0	-0.0000087308	990	1980.0	-0.0000028638
976	1952.0	-0.0000085688	991	1982.0	-0.0000025251
977	1954.0	-0.0000086395	992	1984.0	-0.0000016106
978	1956.0	-0.0000083417	993	1986.0	-0.0000013203
979	1958.0	-0.0000082773	994	1988.0	-0.0000003546
980	1960.0	-0.0000078521	995	1990.0	-0.0000001445
981	1962.0	-0.0000076892	996	1992.0	0.0000008544
982	1964.0	-0.0000071322	997	1994.0	0.0000009417
983	1966.0	-0.0000069098	998	1996.0	0.0000020121
984	1968.0	-0.0000062670	999	1998.0	0.0000019027
985	1970.0	-0.0000059615	1000	2000.0	0.0000031097

13.4. Pulse Response

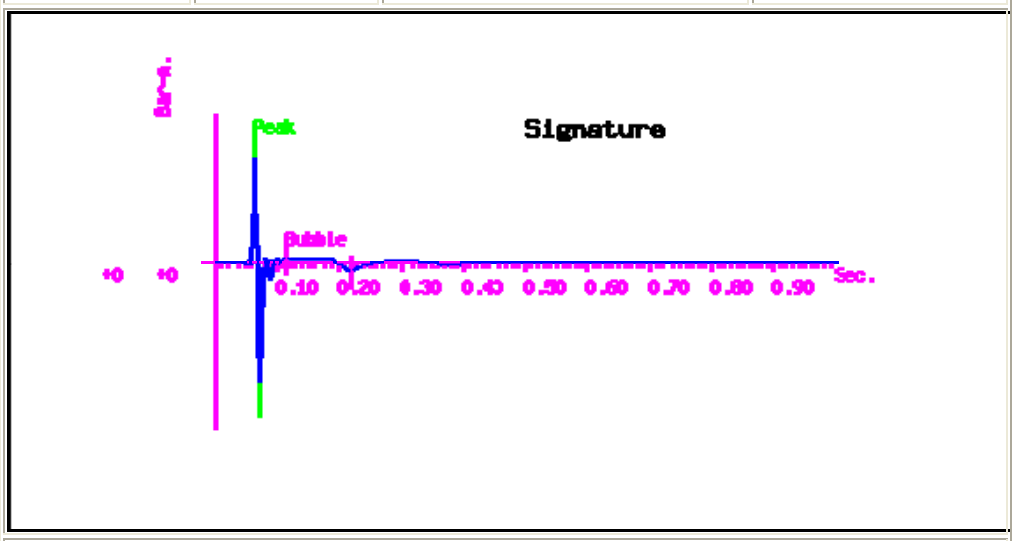
3147 in^3 Array Signature and Acoustic Radiation Patterns

The following pages show the time series and amplitude spectrum for the far-field signature and the computed acoustic emission pattern for the vertical inline and crossline planes for the 3147 in^3 array with guns at the specific depth, with a **MSX 2-206Hz zero phase recording filter**.

The following table lists the statistics for the array quoted in various commonly used units for convenience. Note that the rms value is computed over the entire modelled signature.

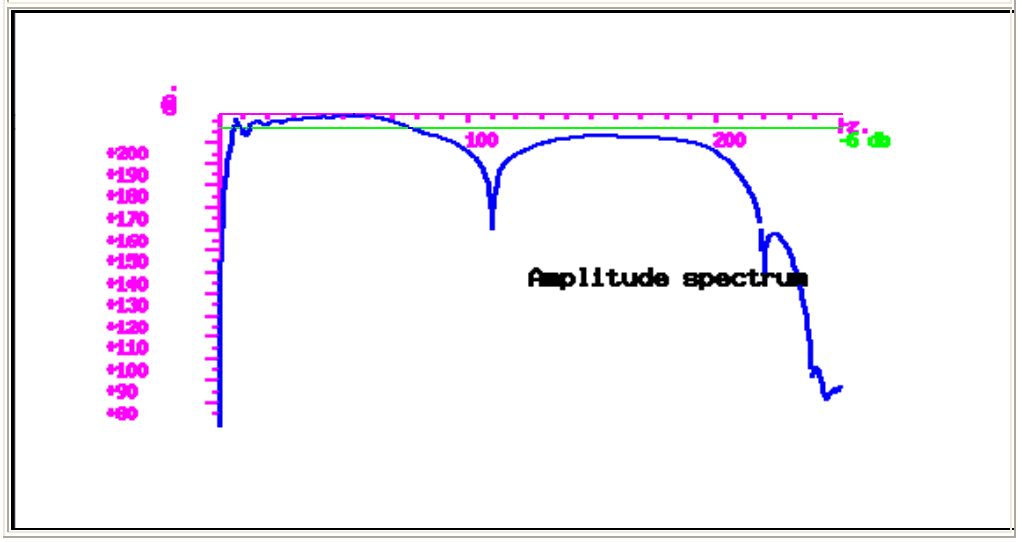
Array parameter	Array value
Number of guns	24
Total volume (cu.in).	3147.0 (51.6 litres)
Peak to peak in bar-m.	110 (11 MPa, 261 db re 1 microPascal. at 1m.)
Zero to peak in bar-m.	52.1 (5.21 MPa, 254 db re 1 microPascal. at 1m.)
RMS pressure in bar-m.	3.16 (0.316 MPa, 230 db re 1 microPascal. at 1m.)
Primary to bubble (calculated peak to peak)	20.2
Bubble period to first peak (s.)	0.052
Maximum spectral ripple (db): 10.0 - 70.0 Hz.	9.29
Maximum spectral value (db): 10.0 - 70.0 Hz.	213
Average spectral value (db): 10.0 - 70.0 Hz.	211
Total acoustic energy (Joules)	314233.5
Total acoustic efficiency (%)	44.1

Peak to peak in bar-m.	Zero to peak in bar-m.	Primary to bubble (calculated peak to peak)	Bubble period to first peak (s.)
110	52.1	20.2	0.052



Band-pass filter: MSX_2ms_2_12-206_264.flt

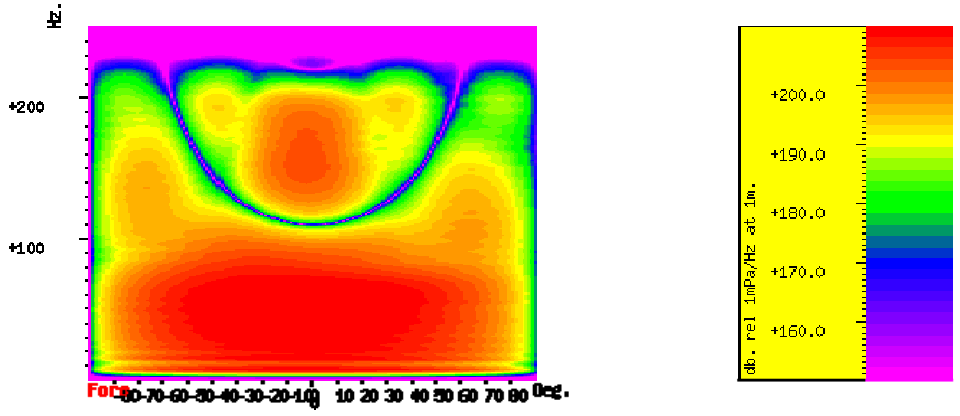
Amplitude spectrum. Units are db. relative to 1 microPascal / Hz. at 1m.



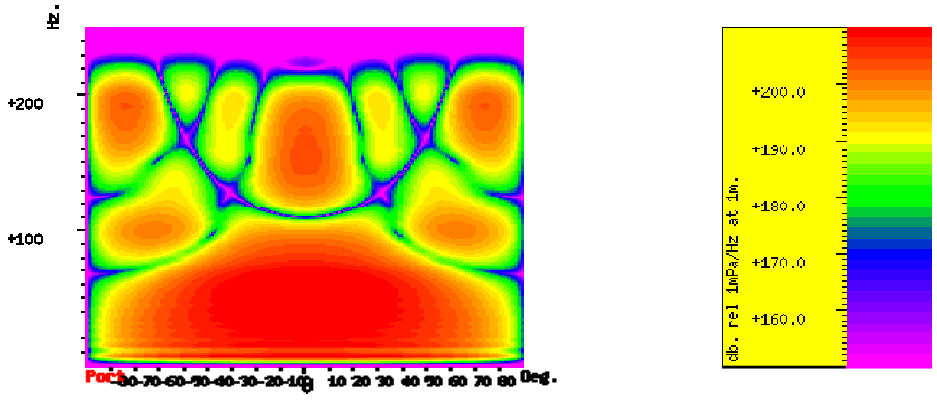
The acoustic emission pattern plots show that the energy emitted by the array is uniformly distributed. This is a desirable feature for an array used to acquire 3D seismic data.

The following tables show the inline and crossline directivity of the array in (dip angle-frequency) form. Both plots are scaled as db. relative to 1 microPa. per Hz. at 1m.

Inline directivity, bearing = 0 degrees

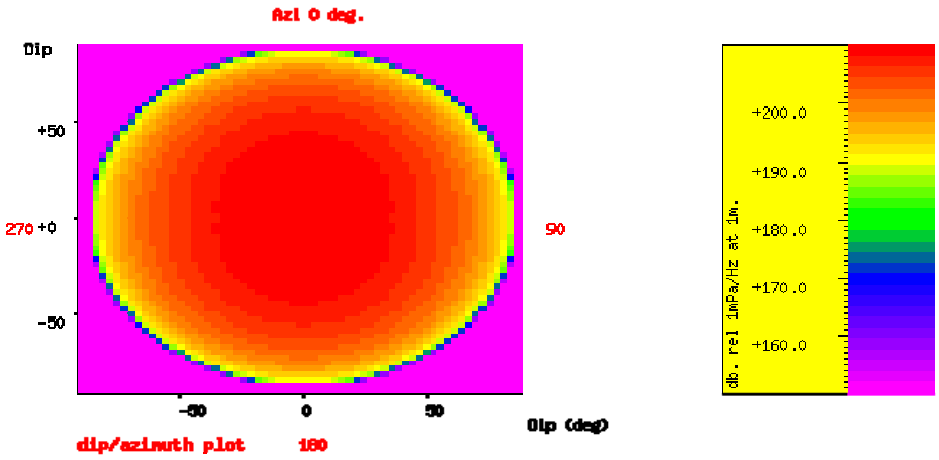


Crossline directivity, bearing = 90 degrees

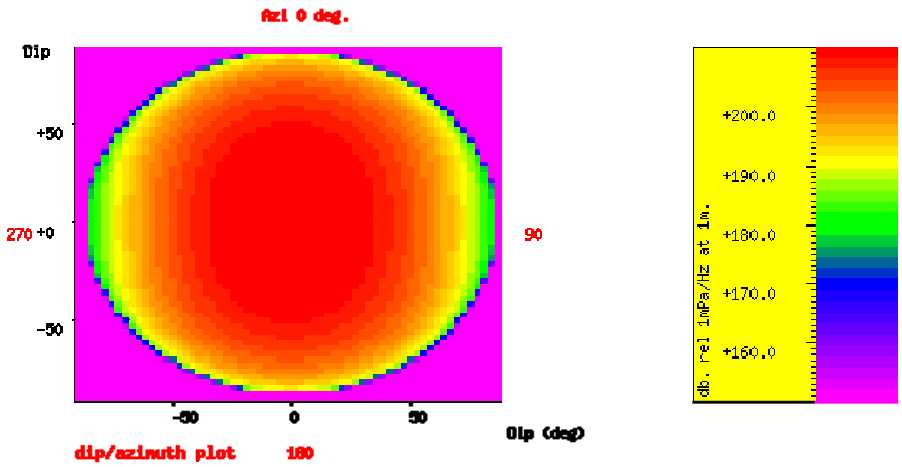


The following tables show the azimuthal directivity (i.e. plan view) theta-phi plots, at four user-specified frequencies. The dip, theta is the angle to the vertical so a value of zero corresponds to vertically down, (the centre of the plot). The azimuthal angle phi is measured relative to the positive x axis so the boat direction corresponds to a value of phi of 180 degrees. The plots are scaled as db. relative to 1 microPa. per Hz. at 1m.

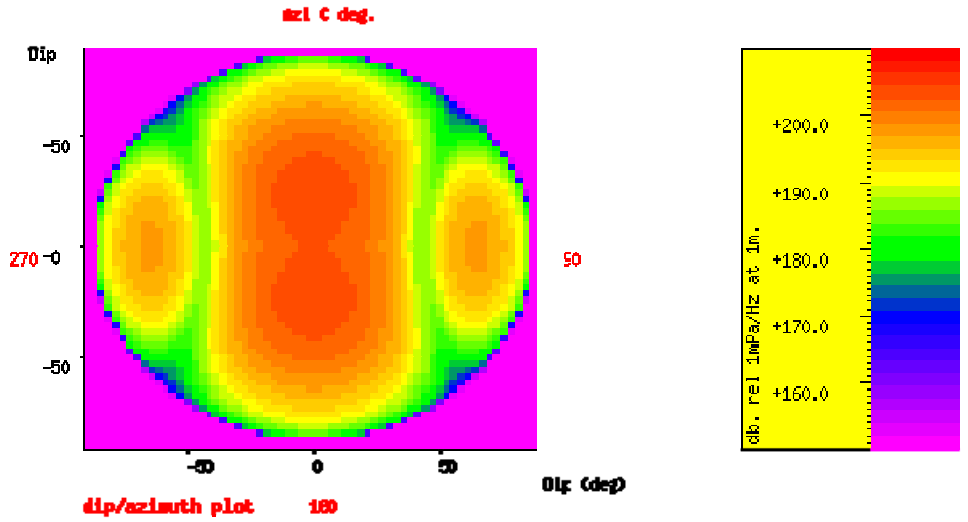
Azimuthal response at: 30 Hz.



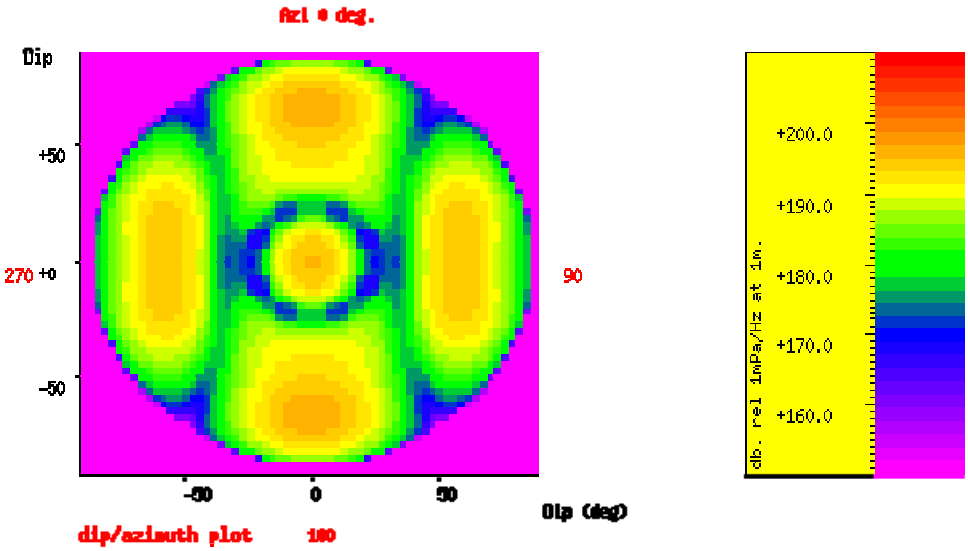
Azimuthal response at: 60 Hz.



Azimuthal response at: 90 Hz.



Azimuthal response at: 120 Hz.



WesternGeco Gun Dropout Analysis and Specifications

Far-field source signature specifications are in accordance with the SEG recommendations as published in the Special Report of the SEG Technical Standards Committee "SEG standards for specifying marine seismic energy sources" Geophysics, Vol. 53, No. 4 (April 1988), pp. 556-575. Specifications and dropout criteria are referenced to the response of a DFS-V recording system with an out-128 Hz, 72 dB/octave bandwidth.

Dropout specifications are based on signatures modelled with GUNDALF, a third party signature modelling software, whereby the criteria used are:

- The average deviation in the 10 to 70 Hz band-width from the spectrum of the full array shall not exceed ± 1.5 dB;
- The maximum deviation from the spectrum of the full array shall not exceed ± 3 dB anywhere in the 10 to 70 Hz bandwidth.

3147 cu.in. Array Dropout Table

The following statistics are checked against the requested values:-

- The primary to bubble ratio.
- The normalised cross-correlation between the array with drop-outs and the full array.
- The average drop in db. computed as the average amplitude of the full array within a defined frequency passband minus the average amplitude of the dropped out array within the same passband. (AVDROP)
- The maximum absolute difference in db. between the full array and the dropped-out array at some frequency within the passband. (MXDROP).

The passband was set to: 10.0-70.0 Hz.

Drop-outs that breach the defined limits for any of the computed statistics are highlighted in red.

The trigger limits are shown in the column headers.

Note that the maximum db difference between the full array and the array with drop-out has been calculated after correcting for the overall average difference between the two spectra.

13.5. Double gun drop-out amplitude spectral effects

Gun	Vol. (cuin)	x (m.)	y (m.)	z (m.)	Gun	Vol. (cuin)	x (m.)	y (m.)	z (m.)	Peak - Peak in Bar-m.	Max. abs. amp. in Bar-m.	P/B percent drop (10.0)	Norm. cross - corr. (0.998)	AVDROP (db.) (1.5)	MXDROP (db.) (3.0)	MXDROP freq.(Hz.)
1	235.0	0	-8.5	7	2	235.0	0	-8	7	98.204	51.410	-7.686	0.9991	1.0081	1.7044	13.7
1	235.0	0	-8.5	7	3	125.0	3	-8	7	100.379	52.596	-4.156	0.9988	0.8099	1.7672	13.7
1	235.0	0	-8.5	7	4	125.0	3	-8	7	100.427	52.635	-5.103	0.9988	0.8087	1.7937	13.7
1	235.0	0	-8.5	7	5	155.0	6	-8	7	99.288	51.992	-8.774	0.9992	0.8843	1.5055	21.0
1	235.0	0	-8.5	7	6	90.0	9	-8	7	100.112	52.458	6.242	0.9993	0.8214	1.6987	11.7
1	235.0	0	-8.5	7	7	54.0	12	-8	7	100.898	52.913	-0.692	0.9991	0.7477	1.8800	12.7
1	235.0	0	-8.5	7	8	30.0	15	-8	7	101.581	53.317	-2.172	0.9994	0.6659	1.2971	13.2
1	235.0	0	-8.5	7	9	235.0	0	-1	7	99.177	51.884	10.485	0.9967	0.9628	2.9791	13.2
1	235.0	0	-8.5	7	10	235.0	0	1	7	99.189	51.895	11.662	0.9966	0.9618	3.0048	13.2
1	235.0	0	-8.5	7	11	125.0	3	0	7	100.449	52.621	1.999	0.9988	0.8034	1.9904	13.2
1	235.0	0	-8.5	7	12	125.0	3	0	7	100.455	52.625	2.022	0.9988	0.8029	1.9907	13.2
1	235.0	0	-8.5	7	13	155.0	6	0	7	99.223	51.898	-5.261	0.9991	0.8908	1.6564	13.2
1	235.0	0	-8.5	7	14	90.0	9	0	7	100.024	52.355	5.340	0.9992	0.8303	1.4756	11.2
1	235.0	0	-8.5	7	15	54.0	12	0	7	100.850	52.856	0.980	0.9991	0.7612	1.8646	12.7
1	235.0	0	-8.5	7	16	30.0	15	0	7	101.561	53.293	-2.662	0.9994	0.6757	1.3388	13.2
1	235.0	0	-8.5	7	17	235.0	0	8	7	99.248	51.969	9.881	0.9965	0.9543	2.9038	13.2
1	235.0	0	-8.5	7	18	235.0	0	9	7	99.207	51.935	7.989	0.9968	0.9524	2.8082	13.2
1	235.0	0	-8.5	7	19	125.0	3	8	7	100.506	52.687	-4.575	0.9989	0.7993	1.9812	13.2
1	235.0	0	-8.5	7	20	125.0	3	8	7	100.468	52.653	-4.279	0.9989	0.7998	1.9577	13.2
1	235.0	0	-8.5	7	21	155.0	6	8	7	99.304	51.998	-8.395	0.9993	0.8828	1.5869	20.5
1	235.0	0	-8.5	7	22	90.0	9	8	7	100.099	52.442	6.362	0.9993	0.8240	1.7102	11.7
1	235.0	0	-8.5	7	23	54.0	12	8	7	100.891	52.905	-0.187	0.9991	0.7510	1.8948	12.7
1	235.0	0	-8.5	7	24	30.0	15	8	7	101.603	53.318	-1.841	0.9968	0.6694	1.5407	13.2
2	235.0	0	-7.5	7	3	125.0	3	-8	7	100.431	52.636	-3.175	0.9986	0.8109	1.8541	13.7
2	235.0	0	-7.5	7	4	125.0	3	-8	7	100.459	52.664	-3.855	0.9986	0.8121	1.8580	13.7
2	235.0	0	-7.5	7	5	155.0	6	-8	7	99.331	52.027	-8.012	0.9992	0.8868	1.5341	21.0
2	235.0	0	-7.5	7	6	90.0	9	-8	7	100.155	52.493	6.731	0.9992	0.8238	1.7135	11.7
2	235.0	0	-7.5	7	7	54.0	12	-8	7	100.941	52.949	0.130	0.9990	0.7500	1.9597	12.7
2	235.0	0	-7.5	7	8	30.0	15	-8	7	101.624	53.352	-1.359	0.9993	0.6683	1.3775	13.2
2	235.0	0	-7.5	7	9	235.0	0	-1	7	99.206	51.908	10.757	0.9965	0.9666	3.0648	13.2
2	235.0	0	-7.5	7	10	235.0	0	1	7	99.220	51.919	11.935	0.9964	0.9651	3.1013	13.2
2	235.0	0	-7.5	7	11	125.0	3	0	7	100.481	52.646	2.773	0.9986	0.8068	2.0778	13.2
2	235.0	0	-7.5	7	12	125.0	3	0	7	100.490	52.654	2.801	0.9986	0.8059	2.0809	13.2
2	235.0	0	-7.5	7	13	155.0	6	0	7	99.266	51.934	-6.213	0.9990	0.8937	1.7350	13.2
2	235.0	0	-7.5	7	14	90.0	9	0	7	100.072	52.395	5.828	0.9991	0.8325	1.4845	21.0
2	235.0	0	-7.5	7	15	54.0	12	0	7	100.893	52.892	1.741	0.9990	0.7633	1.9456	12.7
2	235.0	0	-7.5	7	16	30.0	15	0	7	101.603	53.328	-1.822	0.9993	0.6780	1.4187	13.2
2	235.0	0	-7.5	7	17	235.0	0	8	7	99.290	52.003	12.102	0.9963	0.9561	2.9999	13.2
2	235.0	0	-7.5	7	18	235.0	0	9	7	99.248	51.969	9.886	0.9965	0.9543	2.9038	13.2
2	235.0	0	-7.5	7	19	125.0	3	8	7	100.548	52.722	-4.186	0.9988	0.8014	2.0677	13.2
2	235.0	0	-7.5	7	20	125.0	3	8	7	100.510	52.688	-3.891	0.9988	0.8020	2.0443	13.2
2	235.0	0	-7.5	7	21	155.0	6	8	7	99.346	52.033	-8.631	0.9992	0.8844	1.6160	20.5
2	235.0	0	-7.5	7	22	90.0	9	8	7	100.142	52.477	6.740	0.9992	0.8257	1.7311	11.7
2	235.0	0	-7.5	7	23	54.0	12	8	7	100.933	52.939	0.600	0.9990	0.7534	1.9768	12.7
2	235.0	0	-7.5	7	24	30.0	15	8	7	101.645	53.353	-1.304	0.9967	0.6727	1.6173	13.2
3	125.0	3	-8.4	7	4	125.0	3	-8	7	100.870	52.906	-2.930	0.9998	0.7080	0.8990	60.5

3	125.0	3	-8.4	7	5	155.0	6	-8	7	100.487	52.667	-5.527	0.9998	0.7363	0.9577	61.0
3	125.0	3	-8.4	7	6	90.0	9	-8	7	101.348	53.155	7.239	0.9998	0.6720	1.3016	11.7
3	125.0	3	-8.4	7	7	54.0	12	-8	7	102.158	53.631	2.170	0.9998	0.5981	1.2203	12.7
3	125.0	3	-8.4	7	8	30.0	15	-8	7	102.848	54.042	-0.751	0.9998	0.5161	0.6875	40.0
3	125.0	3	-8.4	7	9	235.0	0	-1	7	100.440	52.603	0.243	0.9988	0.8107	2.1779	12.7
3	125.0	3	-8.4	7	10	235.0	0	1	7	100.447	52.610	0.753	0.9988	0.8101	2.1857	12.7
3	125.0	3	-8.4	7	11	125.0	3	0	7	101.701	53.330	4.452	0.9996	0.6537	1.3055	12.7
3	125.0	3	-8.4	7	12	125.0	3	0	7	101.709	53.338	4.557	0.9996	0.6530	1.3064	12.7
3	125.0	3	-8.4	7	13	155.0	6	0	7	100.476	52.609	-0.036	0.9995	0.7395	1.2156	66.9
3	125.0	3	-8.4	7	14	90.0	9	0	7	101.293	53.082	7.172	0.9996	0.6787	1.1383	11.2
3	125.0	3	-8.4	7	15	54.0	12	0	7	102.115	53.581	3.147	0.9997	0.6099	1.2036	12.7
3	125.0	3	-8.4	7	16	30.0	15	0	7	102.820	54.011	-0.327	0.9998	0.5253	0.6706	48.3
3	125.0	3	-8.4	7	17	235.0	0	8	7	100.509	52.688	-3.882	0.9988	0.8020	2.0442	13.2
3	125.0	3	-8.4	7	18	235.0	0	9	7	100.467	52.653	-4.270	0.9989	0.7998	1.9577	13.2
3	125.0	3	-8.4	7	19	125.0	3	8	7	101.766	53.406	-0.153	0.9996	0.6488	1.2460	13.2
3	125.0	3	-8.4	7	20	125.0	3	8	7	101.728	53.372	0.177	0.9996	0.6491	1.2281	12.7
3	125.0	3	-8.4	7	21	155.0	6	8	7	100.564	52.717	-2.073	0.9998	0.7293	0.9242	60.1
3	125.0	3	-8.4	7	22	90.0	9	8	7	101.360	53.161	8.323	0.9998	0.6707	1.3217	11.7
3	125.0	3	-8.4	7	23	54.0	12	8	7	102.150	53.622	2.823	0.9998	0.5999	1.2329	12.7
3	125.0	3	-8.4	7	24	30.0	15	8	7	102.860	54.034	2.090	0.9972	0.5201	1.4994	67.4
4	125.0	3	-7.6	7	5	155.0	6	-8	7	100.525	52.701	-6.175	0.9998	0.7360	0.9889	61.0
4	125.0	3	-7.6	7	6	90.0	9	-8	7	101.386	53.189	6.879	0.9998	0.6718	1.2645	11.7
4	125.0	3	-7.6	7	7	54.0	12	-8	7	102.196	53.665	1.904	0.9998	0.5979	1.2329	12.7
4	125.0	3	-7.6	7	8	30.0	15	-8	7	102.886	54.077	-1.018	0.9998	0.5159	0.6781	40.0
4	125.0	3	-7.6	7	9	235.0	0	-1	7	100.470	52.629	-0.039	0.9988	0.8115	2.1905	12.7
4	125.0	3	-7.6	7	10	235.0	0	1	7	100.480	52.639	0.448	0.9988	0.8105	2.2007	12.7
4	125.0	3	-7.6	7	11	125.0	3	0	7	101.733	53.358	4.120	0.9995	0.6546	1.3190	12.7
4	125.0	3	-7.6	7	12	125.0	3	0	7	101.740	53.364	4.206	0.9995	0.6536	1.3208	12.7
4	125.0	3	-7.6	7	13	155.0	6	0	7	100.506	52.635	-0.546	0.9994	0.7401	1.2563	66.9
4	125.0	3	-7.6	7	14	90.0	9	0	7	101.330	53.115	6.914	0.9995	0.6789	1.0926	11.2
4	125.0	3	-7.6	7	15	54.0	12	0	7	102.157	53.619	2.899	0.9997	0.6096	1.2180	12.7
4	125.0	3	-7.6	7	16	30.0	15	0	7	102.858	54.045	-0.583	0.9998	0.5250	0.6839	13.2
4	125.0	3	-7.6	7	17	235.0	0	8	7	100.547	52.722	-4.177	0.9988	0.8014	2.0677	13.2
4	125.0	3	-7.6	7	18	235.0	0	9	7	100.505	52.687	-4.566	0.9989	0.7993	1.9813	13.2
4	125.0	3	-7.6	7	19	125.0	3	8	7	101.804	53.439	-0.514	0.9996	0.6484	1.2673	13.2
4	125.0	3	-7.6	7	20	125.0	3	8	7	101.766	53.406	-0.153	0.9996	0.6488	1.2460	13.2
4	125.0	3	-7.6	7	21	155.0	6	8	7	100.602	52.751	-2.448	0.9998	0.7287	0.9397	60.1
4	125.0	3	-7.6	7	22	90.0	9	8	7	101.398	53.195	8.013	0.9998	0.6698	1.2933	11.7
4	125.0	3	-7.6	7	23	54.0	12	8	7	102.189	53.657	2.591	0.9998	0.5992	1.2476	12.7
4	125.0	3	-7.6	7	24	30.0	15	8	7	102.898	54.068	1.832	0.9971	0.5206	1.5364	67.4
5	155.0	6	-8	7	6	90.0	9	-8	7	100.124	52.462	4.812	0.9997	0.7744	1.7289	10.7
5	155.0	6	-8	7	7	54.0	12	-8	7	100.977	52.962	-1.178	0.9998	0.6823	0.9159	10.3
5	155.0	6	-8	7	8	30.0	15	-8	7	101.688	53.391	-3.252	0.9997	0.5960	0.9367	18.1
5	155.0	6	-8	7	9	235.0	0	-1	7	99.289	51.960	-2.485	0.9991	0.8920	1.7975	20.0
5	155.0	6	-8	7	10	235.0	0	1	7	99.289	51.960	-2.101	0.9991	0.8914	1.7959	20.0
5	155.0	6	-8	7	11	125.0	3	0	7	100.541	52.679	3.275	0.9998	0.7335	1.0191	65.9
5	155.0	6	-8	7	12	125.0	3	0	7	100.549	52.687	3.356	0.9998	0.7326	1.0173	65.9
5	155.0	6	-8	7	13	155.0	6	0	7	99.306	51.948	-0.860	0.9992	0.8182	1.3036	65.9
5	155.0	6	-8	7	14	90.0	9	0	7	100.124	52.422	3.385	0.9994	0.7592	1.5822	10.3
5	155.0	6	-8	7	15	54.0	12	0	7	100.962	52.936	-1.022	0.9997	0.6903	1.0525	61.0

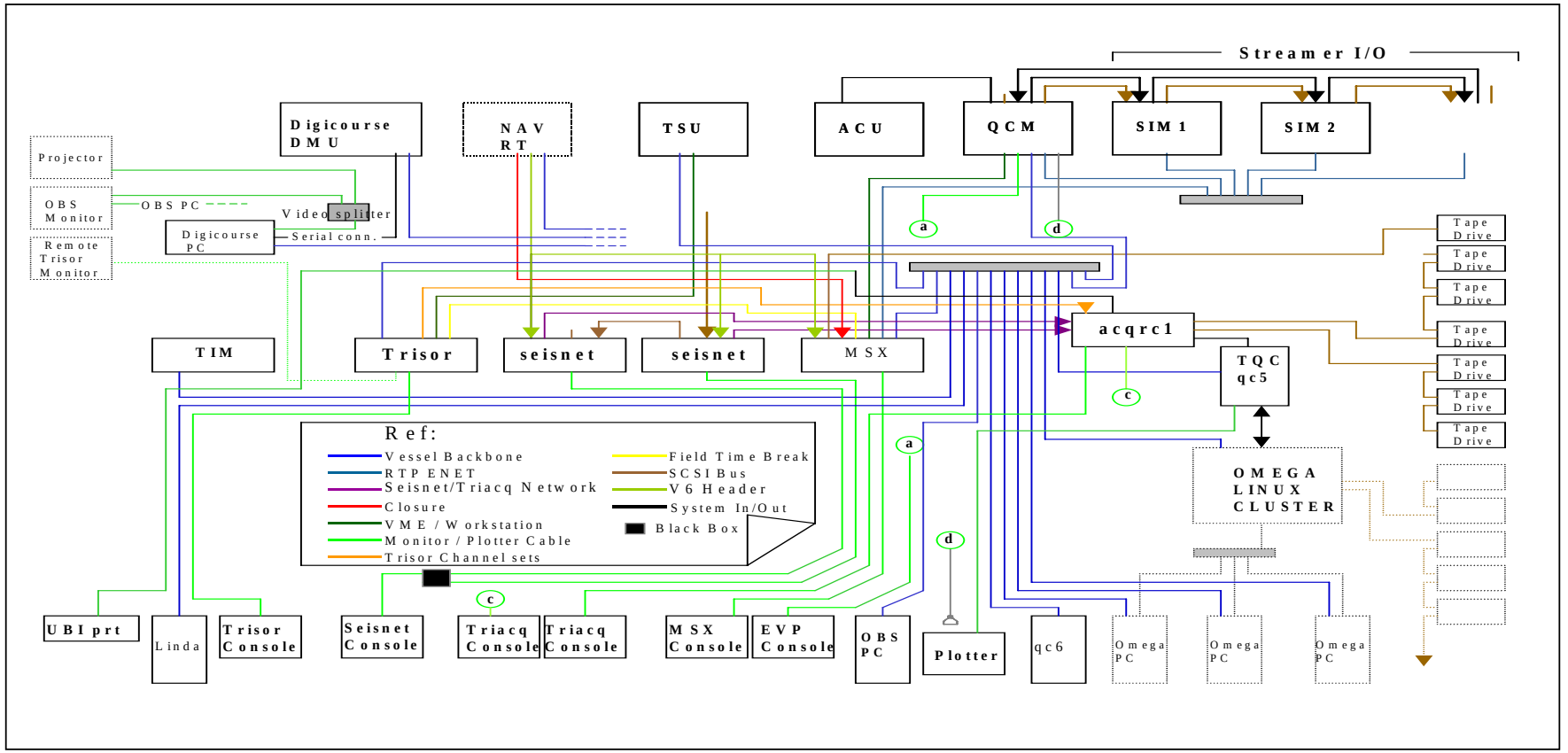
5	155.0	6	-8	7	16	30.0	15	0	7	101.665	53.364	-3.333	0.9997	0.6041	0.8902	17.6
5	155.0	6	-8	7	17	235.0	0	8	7	99.346	52.032	-8.634	0.9992	0.8845	1.6157	20.5
5	155.0	6	-8	7	18	235.0	0	9	7	99.304	51.997	-8.396	0.9993	0.8829	1.5866	20.5
5	155.0	6	-8	7	19	125.0	3	8	7	100.602	52.750	-2.453	0.9998	0.7288	0.9400	60.1
5	155.0	6	-8	7	20	125.0	3	8	7	100.564	52.716	-2.078	0.9998	0.7294	0.9245	60.1
5	155.0	6	-8	7	21	155.0	6	8	7	99.401	52.061	-2.847	0.9994	0.8074	1.1801	19.0
5	155.0	6	-8	7	22	90.0	9	8	7	100.196	52.505	4.017	0.9997	0.7501	1.3966	10.3
5	155.0	6	-8	7	23	54.0	12	8	7	100.988	52.967	-0.924	0.9998	0.6793	0.8748	61.0
5	155.0	6	-8	7	24	30.0	15	8	7	101.695	53.377	1.147	0.9971	0.5985	1.5425	66.9
6	90.0	9	-8	7	7	54.0	12	-8	7	101.733	53.380	10.976	0.9997	0.6316	1.6723	11.7
6	90.0	9	-8	7	8	30.0	15	-8	7	102.467	53.820	10.467	0.9997	0.5395	1.2159	11.2
6	90.0	9	-8	7	9	235.0	0	-1	7	100.077	52.396	9.969	0.9991	0.8312	1.9781	11.7
6	90.0	9	-8	7	10	235.0	0	1	7	100.072	52.390	10.031	0.9991	0.8311	1.9757	11.7
6	90.0	9	-8	7	11	125.0	3	0	7	101.347	53.132	12.421	0.9997	0.6734	1.5105	11.7
6	90.0	9	-8	7	12	125.0	3	0	7	101.348	53.133	12.419	0.9997	0.6728	1.5058	11.7
6	90.0	9	-8	7	13	155.0	6	0	7	100.106	52.396	5.964	0.9994	0.7600	1.2361	65.4
6	90.0	9	-8	7	14	90.0	9	0	7	100.912	52.859	17.000	0.9991	0.7026	2.5469	11.2
6	90.0	9	-8	7	15	54.0	12	0	7	101.747	53.370	13.074	0.9995	0.6328	1.8493	11.2
6	90.0	9	-8	7	16	30.0	15	0	7	102.463	53.811	10.270	0.9996	0.5461	1.2644	11.2
6	90.0	9	-8	7	17	235.0	0	8	7	100.141	52.477	6.745	0.9992	0.8257	1.7305	11.7
6	90.0	9	-8	7	18	235.0	0	9	7	100.099	52.441	6.366	0.9993	0.8240	1.7097	11.7
6	90.0	9	-8	7	19	125.0	3	8	7	101.398	53.194	8.011	0.9998	0.6699	1.2928	11.7
6	90.0	9	-8	7	20	125.0	3	8	7	101.359	53.160	8.320	0.9998	0.6708	1.3211	11.7
6	90.0	9	-8	7	21	155.0	6	8	7	100.196	52.505	4.020	0.9997	0.7501	1.3973	10.3
6	90.0	9	-8	7	22	90.0	9	8	7	100.991	52.949	17.600	0.9994	0.6926	2.6604	11.2
6	90.0	9	-8	7	23	54.0	12	8	7	101.782	53.410	12.482	0.9997	0.6209	1.7169	11.2
6	90.0	9	-8	7	24	30.0	15	8	7	102.489	53.820	10.296	0.9971	0.5379	1.4241	66.9
7	54.0	12	-8	7	8	30.0	15	-8	7	103.233	54.263	3.276	0.9997	0.4701	0.6637	51.8
7	54.0	12	-8	7	9	235.0	0	-1	7	100.858	52.846	4.710	0.9990	0.7587	2.1905	12.7
7	54.0	12	-8	7	10	235.0	0	1	7	100.857	52.846	4.782	0.9990	0.7590	2.1923	12.7
7	54.0	12	-8	7	11	125.0	3	0	7	102.134	53.590	7.283	0.9997	0.6006	1.3106	12.7
7	54.0	12	-8	7	12	125.0	3	0	7	102.131	53.586	7.281	0.9997	0.6006	1.3109	12.7
7	54.0	12	-8	7	13	155.0	6	0	7	100.904	52.864	2.191	0.9995	0.6870	1.1105	65.4
7	54.0	12	-8	7	14	90.0	9	0	7	101.707	53.323	11.797	0.9995	0.6293	1.5580	11.2
7	54.0	12	-8	7	15	54.0	12	0	7	102.532	53.825	6.631	0.9994	0.5609	1.3525	12.2
7	54.0	12	-8	7	16	30.0	15	0	7	103.244	54.264	4.091	0.9996	0.4750	0.7108	51.8
7	54.0	12	-8	7	17	235.0	0	8	7	100.932	52.939	0.605	0.9990	0.7534	1.9768	12.7
7	54.0	12	-8	7	18	235.0	0	9	7	100.890	52.904	-0.183	0.9991	0.7511	1.8948	12.7
7	54.0	12	-8	7	19	125.0	3	8	7	102.189	53.656	2.585	0.9998	0.5992	1.2476	12.7
7	54.0	12	-8	7	20	125.0	3	8	7	102.150	53.622	2.817	0.9998	0.5999	1.2329	12.7
7	54.0	12	-8	7	21	155.0	6	8	7	100.987	52.968	-0.922	0.9998	0.6793	0.8749	61.0
7	54.0	12	-8	7	22	90.0	9	8	7	101.781	53.411	12.480	0.9997	0.6208	1.7170	11.2
7	54.0	12	-8	7	23	54.0	12	8	7	102.572	53.872	6.433	0.9995	0.5490	1.3158	12.2
7	54.0	12	-8	7	24	30.0	15	8	7	103.281	54.284	5.444	0.9973	0.4649	1.3221	66.9
8	30.0	15	-8	7	9	235.0	0	-1	7	101.550	53.259	2.495	0.9993	0.6767	1.5356	12.7
8	30.0	15	-8	7	10	235.0	0	1	7	101.550	53.259	2.520	0.9993	0.6770	1.5370	12.7
8	30.0	15	-8	7	11	125.0	3	0	7	102.817	53.993	5.018	0.9998	0.5193	0.7173	12.7
8	30.0	15	-8	7	12	125.0	3	0	7	102.817	53.993	5.015	0.9998	0.5194	0.7179	12.7
8	30.0	15	-8	7	13	155.0	6	0	7	101.588	53.269	0.547	0.9996	0.6042	0.9775	65.9
8	30.0	15	-8	7	14	90.0	9	0	7	102.405	53.742	9.172	0.9995	0.5462	1.0765	11.2

8	30.0	15	-8	7	15	54.0	12	0	7	103.226	54.241	4.608	0.9996	0.4786	0.7150	12.2
8	30.0	15	-8	7	16	30.0	15	0	7	103.932	54.672	1.515	0.9995	0.3942	0.7251	17.6
8	30.0	15	-8	7	17	235.0	0	8	7	101.625	53.352	-1.335	0.9993	0.6698	1.3776	13.2
8	30.0	15	-8	7	18	235.0	0	9	7	101.582	53.317	-2.160	0.9993	0.6671	1.2968	13.2
8	30.0	15	-8	7	19	125.0	3	8	7	102.879	54.068	-0.741	0.9998	0.5179	0.6723	40.0
8	30.0	15	-8	7	20	125.0	3	8	7	102.841	54.035	-0.487	0.9998	0.5181	0.6821	40.0
8	30.0	15	-8	7	21	155.0	6	8	7	101.678	53.380	-3.264	0.9997	0.5976	0.9279	18.1
8	30.0	15	-8	7	22	90.0	9	8	7	102.473	53.824	10.157	0.9997	0.5386	1.2381	11.2
8	30.0	15	-8	7	23	54.0	12	8	7	103.263	54.285	3.971	0.9997	0.4671	0.6809	12.2
8	30.0	15	-8	7	24	30.0	15	8	7	103.974	54.697	2.473	0.9972	0.3857	1.2377	67.4
9	235.0	0	-0.5	7	10	235.0	0	1	7	98.075	51.233	-0.671	0.9986	1.0394	2.1171	13.2
9	235.0	0	-0.5	7	11	125.0	3	0	7	100.316	52.488	5.477	0.9985	0.8307	2.1415	12.7
9	235.0	0	-0.5	7	12	125.0	3	0	7	100.326	52.494	5.477	0.9984	0.8296	2.1535	12.7
9	235.0	0	-0.5	7	13	155.0	6	0	7	99.156	51.811	0.776	0.9985	0.9061	1.7580	13.2
9	235.0	0	-0.5	7	14	90.0	9	0	7	99.999	52.305	9.142	0.9987	0.8404	1.6167	11.7
9	235.0	0	-0.5	7	15	54.0	12	0	7	100.826	52.807	5.993	0.9988	0.7700	2.1610	12.7
9	235.0	0	-0.5	7	16	30.0	15	0	7	101.527	53.234	2.226	0.9992	0.6851	1.5675	12.7
9	235.0	0	-0.5	7	17	235.0	0	8	7	99.219	51.918	11.927	0.9964	0.9652	3.1014	13.2
9	235.0	0	-0.5	7	18	235.0	0	9	7	99.188	51.894	11.653	0.9966	0.9619	3.0049	13.2
9	235.0	0	-0.5	7	19	125.0	3	8	7	100.480	52.638	0.443	0.9988	0.8105	2.2007	12.7
9	235.0	0	-0.5	7	20	125.0	3	8	7	100.447	52.609	0.747	0.9988	0.8102	2.1857	12.7
9	235.0	0	-0.5	7	21	155.0	6	8	7	99.288	51.960	-2.101	0.9991	0.8914	1.7960	20.0
9	235.0	0	-0.5	7	22	90.0	9	8	7	100.072	52.391	10.030	0.9991	0.8311	1.9761	11.7
9	235.0	0	-0.5	7	23	54.0	12	8	7	100.857	52.845	4.779	0.9990	0.7591	2.1923	12.7
9	235.0	0	-0.5	7	24	30.0	15	8	7	101.564	53.257	2.739	0.9964	0.6825	1.6598	12.7
10	235.0	0	0.5	7	11	125.0	3	0	7	100.326	52.494	5.478	0.9984	0.8296	2.1535	12.7
10	235.0	0	0.5	7	12	125.0	3	0	7	100.316	52.488	5.476	0.9985	0.8307	2.1415	12.7
10	235.0	0	0.5	7	13	155.0	6	0	7	99.156	51.811	0.775	0.9985	0.9061	1.7580	13.2
10	235.0	0	0.5	7	14	90.0	9	0	7	99.999	52.305	9.142	0.9987	0.8404	1.6167	11.7
10	235.0	0	0.5	7	15	54.0	12	0	7	100.826	52.807	5.993	0.9988	0.7700	2.1610	12.7
10	235.0	0	0.5	7	16	30.0	15	0	7	101.527	53.234	2.226	0.9992	0.6851	1.5675	12.7
10	235.0	0	0.5	7	17	235.0	0	8	7	99.205	51.907	10.749	0.9965	0.9666	3.0650	13.2
10	235.0	0	0.5	7	18	235.0	0	9	7	99.176	51.883	10.475	0.9967	0.9628	2.9793	13.2
10	235.0	0	0.5	7	19	125.0	3	8	7	100.469	52.629	-0.043	0.9988	0.8115	2.1905	12.7
10	235.0	0	0.5	7	20	125.0	3	8	7	100.439	52.602	0.236	0.9988	0.8108	2.1780	12.7
10	235.0	0	0.5	7	21	155.0	6	8	7	99.289	51.961	-2.487	0.9991	0.8920	1.7976	20.0
10	235.0	0	0.5	7	22	90.0	9	8	7	100.077	52.396	9.967	0.9991	0.8312	1.9785	11.7
10	235.0	0	0.5	7	23	54.0	12	8	7	100.858	52.846	4.707	0.9990	0.7587	2.1904	12.7
10	235.0	0	0.5	7	24	30.0	15	8	7	101.564	53.256	2.730	0.9964	0.6822	1.6586	12.7
11	125.0	3	-0.4	7	12	125.0	3	0	7	100.762	52.763	9.171	0.9992	0.7169	1.3470	66.4
11	125.0	3	-0.4	7	13	155.0	6	0	7	100.358	52.498	5.282	0.9989	0.7550	1.4998	66.9
11	125.0	3	-0.4	7	14	90.0	9	0	7	101.243	53.017	11.904	0.9992	0.6851	1.3040	11.2
11	125.0	3	-0.4	7	15	54.0	12	0	7	102.093	53.541	8.118	0.9995	0.6129	1.3477	12.2
11	125.0	3	-0.4	7	16	30.0	15	0	7	102.802	53.975	4.661	0.9998	0.5272	0.7487	12.7
11	125.0	3	-0.4	7	17	235.0	0	8	7	100.489	52.653	2.800	0.9986	0.8059	2.0810	13.2
11	125.0	3	-0.4	7	18	235.0	0	9	7	100.454	52.625	2.021	0.9988	0.8029	1.9908	13.2
11	125.0	3	-0.4	7	19	125.0	3	8	7	101.740	53.364	4.198	0.9995	0.6536	1.3208	12.7
11	125.0	3	-0.4	7	20	125.0	3	8	7	101.709	53.337	4.549	0.9996	0.6531	1.3064	12.7
11	125.0	3	-0.4	7	21	155.0	6	8	7	100.549	52.687	3.356	0.9998	0.7326	1.0173	65.9
11	125.0	3	-0.4	7	22	90.0	9	8	7	101.348	53.133	12.417	0.9997	0.6728	1.5062	11.7

11	125.0	3	-0.4	7	23	54.0	12	8	7	102.131	53.586	7.281	0.9997	0.6006	1.3108	12.7
11	125.0	3	-0.4	7	24	30.0	15	8	7	102.828	53.986	6.422	0.9968	0.5261	1.6223	66.9
12	125.0	3	0.4	7	13	155.0	6	0	7	100.358	52.498	5.282	0.9989	0.7550	1.4998	66.9
12	125.0	3	0.4	7	14	90.0	9	0	7	101.243	53.017	11.904	0.9992	0.6851	1.3040	11.2
12	125.0	3	0.4	7	15	54.0	12	0	7	102.093	53.541	8.118	0.9995	0.6129	1.3477	12.2
12	125.0	3	0.4	7	16	30.0	15	0	7	102.801	53.975	4.660	0.9998	0.5272	0.7487	12.7
12	125.0	3	0.4	7	17	235.0	0	8	7	100.480	52.645	2.772	0.9986	0.8069	2.0779	13.2
12	125.0	3	0.4	7	18	235.0	0	9	7	100.449	52.620	1.997	0.9988	0.8035	1.9905	13.2
12	125.0	3	0.4	7	19	125.0	3	8	7	101.732	53.357	4.112	0.9995	0.6547	1.3191	12.7
12	125.0	3	0.4	7	20	125.0	3	8	7	101.701	53.329	4.443	0.9996	0.6538	1.3055	12.7
12	125.0	3	0.4	7	21	155.0	6	8	7	100.541	52.679	3.274	0.9998	0.7335	1.0191	65.9
12	125.0	3	0.4	7	22	90.0	9	8	7	101.347	53.132	12.419	0.9997	0.6734	1.5108	11.7
12	125.0	3	0.4	7	23	54.0	12	8	7	102.134	53.590	7.282	0.9997	0.6007	1.3106	12.7
12	125.0	3	0.4	7	24	30.0	15	8	7	102.828	53.986	6.420	0.9968	0.5261	1.6223	66.9
13	155.0	6	0	7	14	90.0	9	0	7	99.940	52.242	5.394	0.9985	0.7919	1.5285	65.4
13	155.0	6	0	7	15	54.0	12	0	7	100.838	52.794	1.971	0.9991	0.7018	1.2746	64.9
13	155.0	6	0	7	16	30.0	15	0	7	101.568	53.246	-0.437	0.9995	0.6126	1.0320	65.9
13	155.0	6	0	7	17	235.0	0	8	7	99.265	51.933	-6.211	0.9990	0.8937	1.7350	13.2
13	155.0	6	0	7	18	235.0	0	9	7	99.222	51.897	-5.259	0.9991	0.8909	1.6565	13.2
13	155.0	6	0	7	19	125.0	3	8	7	100.506	52.634	-0.552	0.9994	0.7401	1.2562	66.9
13	155.0	6	0	7	20	125.0	3	8	7	100.476	52.608	-0.042	0.9995	0.7396	1.2155	66.9
13	155.0	6	0	7	21	155.0	6	8	7	99.305	51.948	-0.861	0.9992	0.8182	1.3036	65.9
13	155.0	6	0	7	22	90.0	9	8	7	100.106	52.396	5.965	0.9994	0.7599	1.2361	65.4
13	155.0	6	0	7	23	54.0	12	8	7	100.904	52.864	2.189	0.9995	0.6870	1.1105	65.4
13	155.0	6	0	7	24	30.0	15	8	7	101.596	53.260	2.623	0.9966	0.6116	1.7327	66.9
14	90.0	9	0	7	15	54.0	12	0	7	101.610	53.235	12.392	0.9990	0.6557	1.6267	11.2
14	90.0	9	0	7	16	30.0	15	0	7	102.364	53.701	9.644	0.9994	0.5562	1.1202	11.2
14	90.0	9	0	7	17	235.0	0	8	7	100.071	52.394	5.831	0.9991	0.8325	1.4844	21.0
14	90.0	9	0	7	18	235.0	0	9	7	100.024	52.354	5.343	0.9992	0.8303	1.4755	11.2
14	90.0	9	0	7	19	125.0	3	8	7	101.330	53.114	6.910	0.9995	0.6790	1.0924	11.2
14	90.0	9	0	7	20	125.0	3	8	7	101.293	53.081	7.167	0.9996	0.6788	1.1381	11.2
14	90.0	9	0	7	21	155.0	6	8	7	100.124	52.422	3.386	0.9994	0.7592	1.5829	10.3
14	90.0	9	0	7	22	90.0	9	8	7	100.912	52.859	16.998	0.9991	0.7026	2.5470	11.2
14	90.0	9	0	7	23	54.0	12	8	7	101.707	53.323	11.796	0.9995	0.6293	1.5579	11.2
14	90.0	9	0	7	24	30.0	15	8	7	102.416	53.737	9.591	0.9967	0.5473	1.5334	66.9
15	54.0	12	0	7	16	30.0	15	0	7	103.169	54.189	4.101	0.9995	0.4913	0.7537	60.5
15	54.0	12	0	7	17	235.0	0	8	7	100.892	52.891	1.743	0.9990	0.7634	1.9456	12.7
15	54.0	12	0	7	18	235.0	0	9	7	100.849	52.855	0.981	0.9991	0.7613	1.8646	12.7
15	54.0	12	0	7	19	125.0	3	8	7	102.157	53.618	2.892	0.9997	0.6096	1.2180	12.7
15	54.0	12	0	7	20	125.0	3	8	7	102.115	53.580	3.140	0.9997	0.6099	1.2036	12.7
15	54.0	12	0	7	21	155.0	6	8	7	100.962	52.936	-1.021	0.9997	0.6903	1.0524	61.0
15	54.0	12	0	7	22	90.0	9	8	7	101.747	53.370	13.071	0.9995	0.6328	1.8492	11.2
15	54.0	12	0	7	23	54.0	12	8	7	102.532	53.825	6.631	0.9994	0.5609	1.3524	12.2
15	54.0	12	0	7	24	30.0	15	8	7	103.245	54.243	5.898	0.9970	0.4747	1.3809	66.4
16	30.0	15	0	7	17	235.0	0	8	7	101.602	53.327	-1.820	0.9993	0.6780	1.4188	13.2
16	30.0	15	0	7	18	235.0	0	9	7	101.560	53.292	-2.661	0.9994	0.6758	1.3389	13.2
16	30.0	15	0	7	19	125.0	3	8	7	102.858	54.044	-0.591	0.9998	0.5251	0.6840	13.2
16	30.0	15	0	7	20	125.0	3	8	7	102.819	54.010	-0.335	0.9998	0.5254	0.6707	48.3
16	30.0	15	0	7	21	155.0	6	8	7	101.665	53.364	-3.336	0.9997	0.6041	0.8901	17.6
16	30.0	15	0	7	22	90.0	9	8	7	102.463	53.811	10.268	0.9996	0.5462	1.2644	11.2

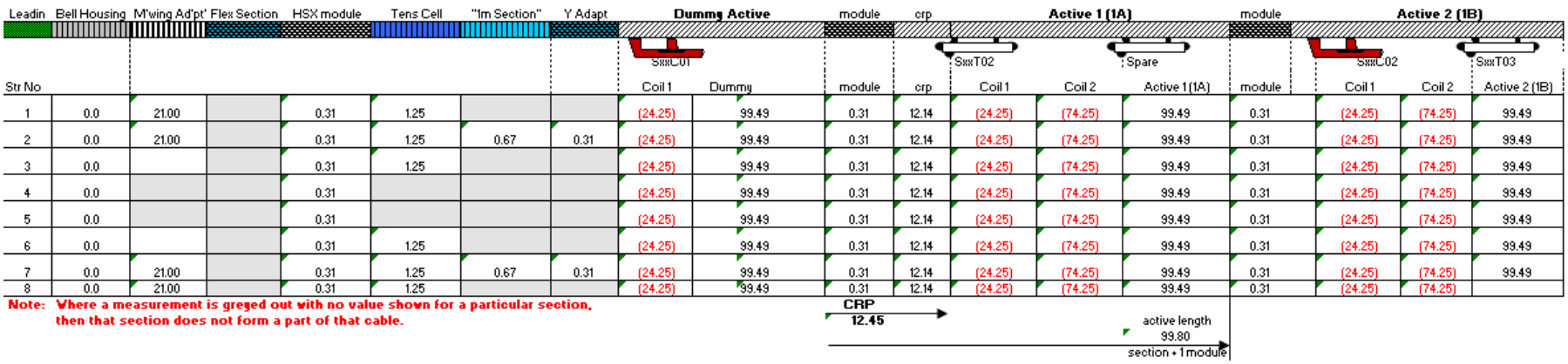
16	30.0	15	0	7	23	54.0	12	8	7	103.245	54.263	4.091	0.9996	0.4751	0.7108	51.8
16	30.0	15	0	7	24	30.0	15	8	7	103.954	54.675	2.510	0.9972	0.3930	1.2482	66.9
17	235.0	0	7.5	7	18	235.0	0	9	7	98.203	51.409	-7.682	0.9991	1.0081	1.7043	13.7
17	235.0	0	7.5	7	19	125.0	3	8	7	100.458	52.662	-3.855	0.9986	0.8122	1.8581	13.7
17	235.0	0	7.5	7	20	125.0	3	8	7	100.430	52.634	-3.176	0.9986	0.8110	1.8542	13.7
17	235.0	0	7.5	7	21	155.0	6	8	7	99.330	52.026	-8.006	0.9992	0.8869	1.5343	21.0
17	235.0	0	7.5	7	22	90.0	9	8	7	100.154	52.492	6.730	0.9992	0.8238	1.7137	11.7
17	235.0	0	7.5	7	23	54.0	12	8	7	100.940	52.947	0.129	0.9990	0.7501	1.9595	12.7
17	235.0	0	7.5	7	24	30.0	15	8	7	101.642	53.350	-1.367	0.9966	0.6709	1.6100	13.2
18	235.0	0	8.5	7	19	125.0	3	8	7	100.426	52.634	-5.104	0.9988	0.8089	1.7938	13.7
18	235.0	0	8.5	7	20	125.0	3	8	7	100.378	52.594	-4.158	0.9988	0.8101	1.7673	13.7
18	235.0	0	8.5	7	21	155.0	6	8	7	99.288	51.991	-8.773	0.9992	0.8844	1.5057	21.0
18	235.0	0	8.5	7	22	90.0	9	8	7	100.112	52.457	6.240	0.9993	0.8215	1.6989	11.7
18	235.0	0	8.5	7	23	54.0	12	8	7	100.898	52.912	-0.693	0.9991	0.7478	1.8800	12.7
18	235.0	0	8.5	7	24	30.0	15	8	7	101.600	53.315	-1.885	0.9968	0.6680	1.5349	13.2
19	125.0	3	7.6	7	20	125.0	3	8	7	100.870	52.906	-2.939	0.9998	0.7080	0.8989	60.5
19	125.0	3	7.6	7	21	155.0	6	8	7	100.524	52.700	-6.181	0.9998	0.7361	0.9888	61.0
19	125.0	3	7.6	7	22	90.0	9	8	7	101.386	53.188	6.868	0.9998	0.6719	1.2646	11.7
19	125.0	3	7.6	7	23	54.0	12	8	7	102.196	53.664	1.895	0.9998	0.5980	1.2328	12.7
19	125.0	3	7.6	7	24	30.0	15	8	7	102.903	54.073	1.759	0.9971	0.5193	1.5307	67.4
20	125.0	3	8.4	7	21	155.0	6	8	7	100.486	52.667	-5.534	0.9998	0.7364	0.9576	61.0
20	125.0	3	8.4	7	22	90.0	9	8	7	101.348	53.154	7.226	0.9998	0.6721	1.3017	11.7
20	125.0	3	8.4	7	23	54.0	12	8	7	102.158	53.630	2.160	0.9998	0.5982	1.2203	12.7
20	125.0	3	8.4	7	24	30.0	15	8	7	102.865	54.039	2.050	0.9972	0.5185	1.4945	67.9
21	155.0	6	8	7	22	90.0	9	8	7	100.124	52.462	4.816	0.9997	0.7744	1.7290	10.7
21	155.0	6	8	7	23	54.0	12	8	7	100.977	52.962	-1.181	0.9998	0.6823	0.9162	10.3
21	155.0	6	8	7	24	30.0	15	8	7	101.705	53.388	1.215	0.9972	0.5973	1.5342	66.9
22	90.0	9	8	7	23	54.0	12	8	7	101.734	53.380	10.970	0.9997	0.6316	1.6721	11.7
22	90.0	9	8	7	24	30.0	15	8	7	102.483	53.817	10.761	0.9972	0.5391	1.4199	66.9
23	54.0	12	8	7	24	30.0	15	8	7	103.294	54.324	5.361	0.9927	0.5601	2.0182	61.0

14. Instrumentation Room System Diagram



15. Equipment Offset Diagrams

Front sensor diagram



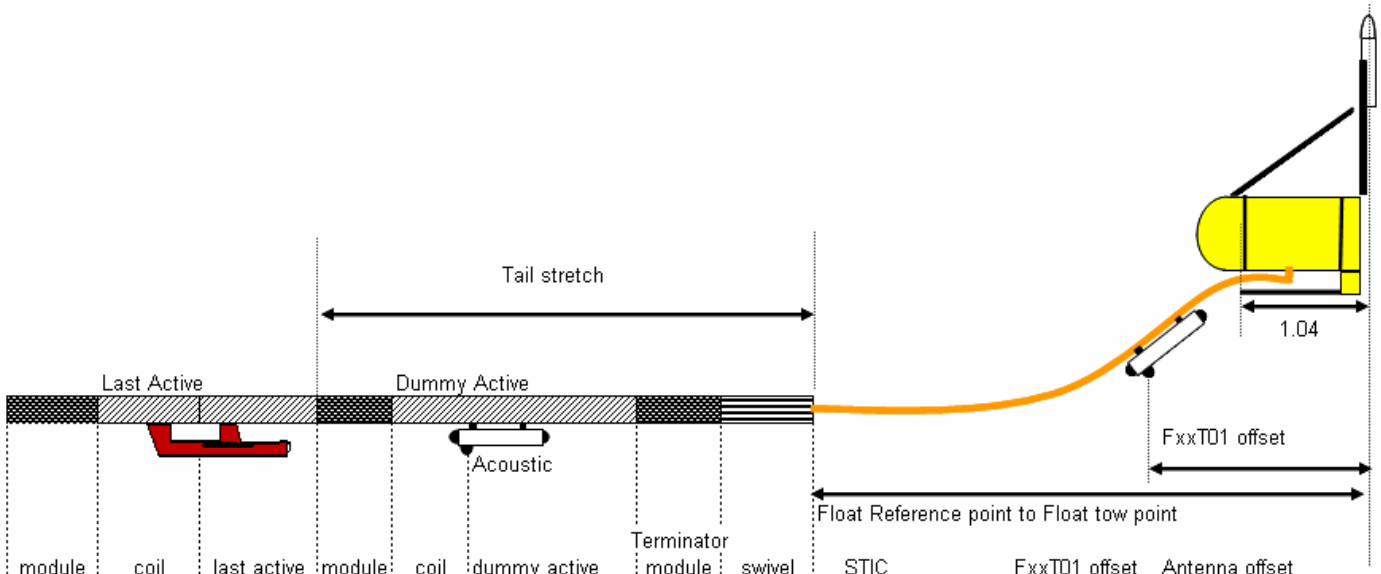
Str No								Coil 1	Dummy	module	crp	Coil 1	Coil 2	Active 1 (1A)	module	Coil 1	Coil 2	Active 2 (1B)
1	0.0	21.00		0.31	1.25			(24.25)	99.49	0.31	12.14	(24.25)	(74.25)	99.49	0.31	(24.25)	(74.25)	99.49
2	0.0	21.00		0.31	1.25	0.67	0.31	(24.25)	99.49	0.31	12.14	(24.25)	(74.25)	99.49	0.31	(24.25)	(74.25)	99.49
3	0.0			0.31	1.25			(24.25)	99.49	0.31	12.14	(24.25)	(74.25)	99.49	0.31	(24.25)	(74.25)	99.49
4	0.0			0.31				(24.25)	99.49	0.31	12.14	(24.25)	(74.25)	99.49	0.31	(24.25)	(74.25)	99.49
5	0.0			0.31				(24.25)	99.49	0.31	12.14	(24.25)	(74.25)	99.49	0.31	(24.25)	(74.25)	99.49
6	0.0			0.31	1.25			(24.25)	99.49	0.31	12.14	(24.25)	(74.25)	99.49	0.31	(24.25)	(74.25)	99.49
7	0.0	21.00		0.31	1.25	0.67	0.31	(24.25)	99.49	0.31	12.14	(24.25)	(74.25)	99.49	0.31	(24.25)	(74.25)	99.49
8	0.0	21.00		0.31	1.25			(24.25)	99.49	0.31	12.14	(24.25)	(74.25)	99.49	0.31	(24.25)	(74.25)	

Note: Where a measurement is greged out with no value shown for a particular section, then that section does not form a part of that cable.

CRP
12.45

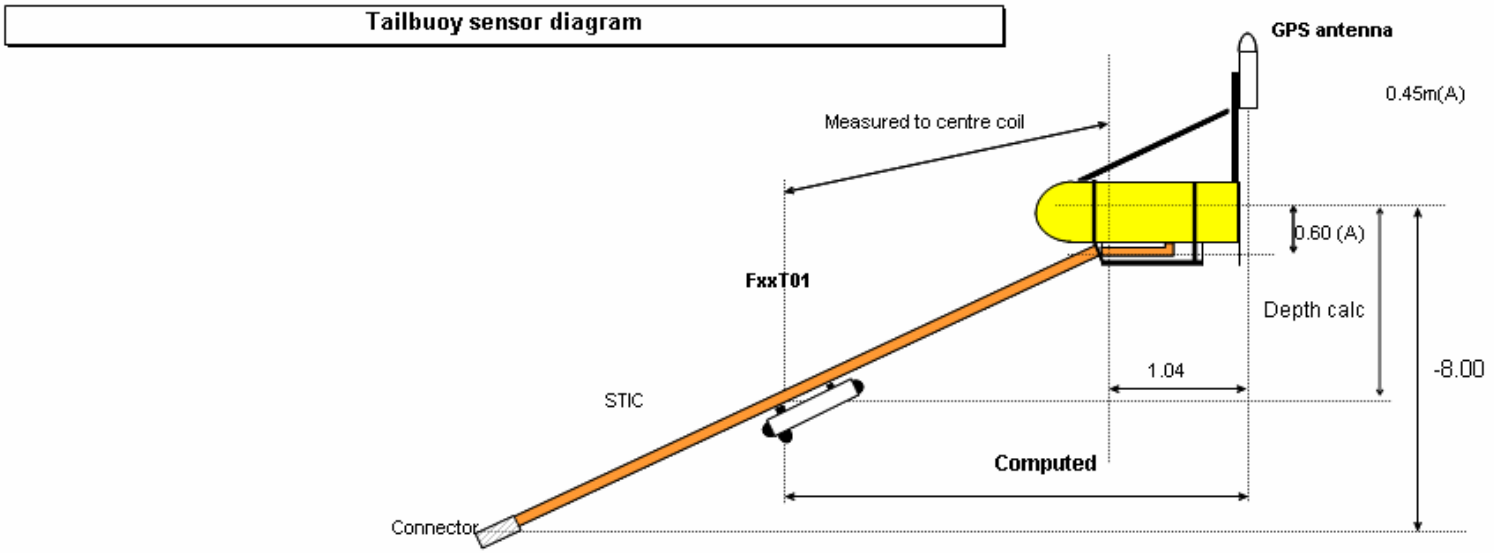
active length
99.80
section + 1 module

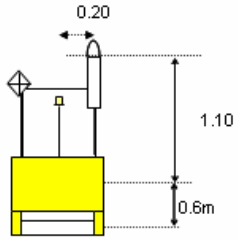
Tail sensor diagram



	module	coil	last active	module	coil	dummy active	Terminator module	swivel	STIC		FxxT01 offset	Antenna offset
1	0.31	(24.25)	99.49	0.31	(24.25)	99.49	0.31	1.00	71.00		8.6	1.04
2	0.31	(24.25)	99.49	0.31	(24.25)	99.49	0.31	1.00	76.00		8.6	1.04
3	0.31	(24.25)	99.49	0.31	(24.25)	99.49	0.31	1.00	73.00		8.6	1.04
4	0.31	(24.25)	99.49	0.31	(24.25)	99.49	0.31	1.00	77.00		8.6	1.04
5	0.31	(24.25)	99.49	0.31	(24.25)	99.49	0.31	1.00	75.00		8.6	1.04
6	0.31	(24.25)	99.49	0.31	(24.25)	99.49	0.31	1.00	66.00		8.6	1.04
7	0.31	(24.25)	99.49	0.31	(24.25)	99.49	0.31	1.00	76.00		8.6	1.04
8	0.31	(24.25)	99.49	0.31	(24.25)	99.49	0.31	1.00	76.00		8.6	1.04

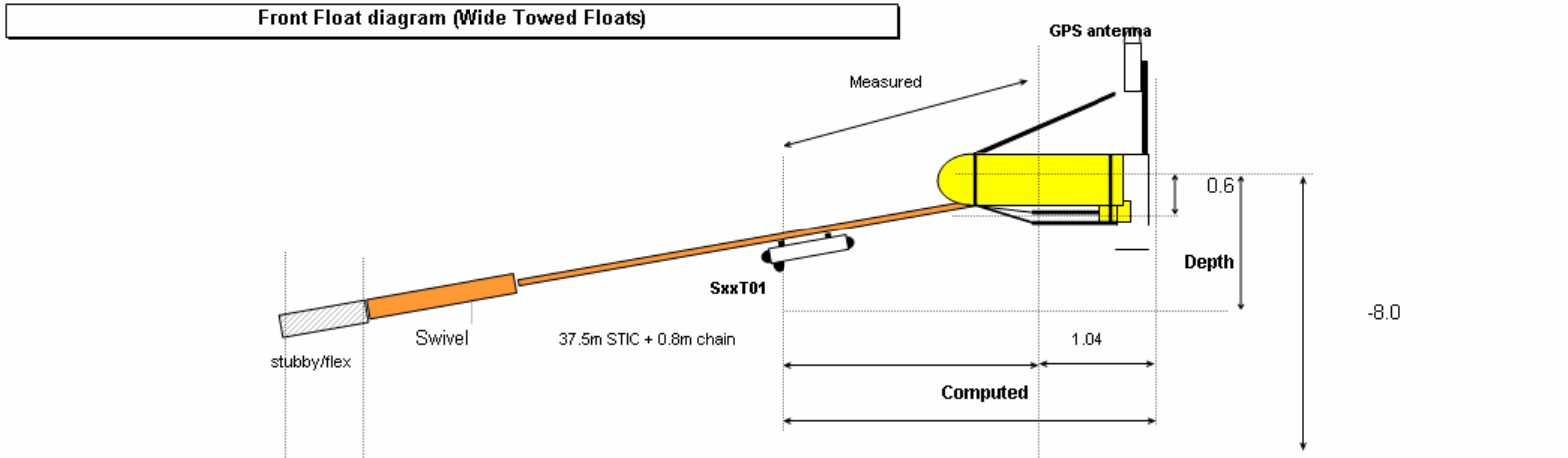
Tail Stretch = 101.11



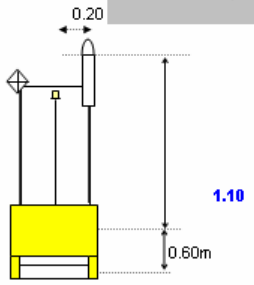


Unit	STIC	Measured	Chain Length	Slope Angle	Computed (pinger head)	Depth calc	pinger offset from head of STIC
F01T01	71	6.9	0.8	10	8.6	-1.9	64.1
F02T01	76	6.9	0.8	10	8.6	-1.9	69.1
F03T01	73	6.9	0.8	10	8.6	-1.9	66.1
F04T01	77	6.9	0.8	10	8.6	-1.9	70.1
F05T01	75	6.9	0.8	10	8.6	-1.9	68.1
F06T01	66	6.9	0.8	10	8.6	-1.9	59.1
F07T01	76	6.9	0.8	10	8.6	-1.9	69.1
F08T01	76	6.9	0.8	10	8.6	-1.9	69.1

Front Float diagram (Wide Towed Floats)

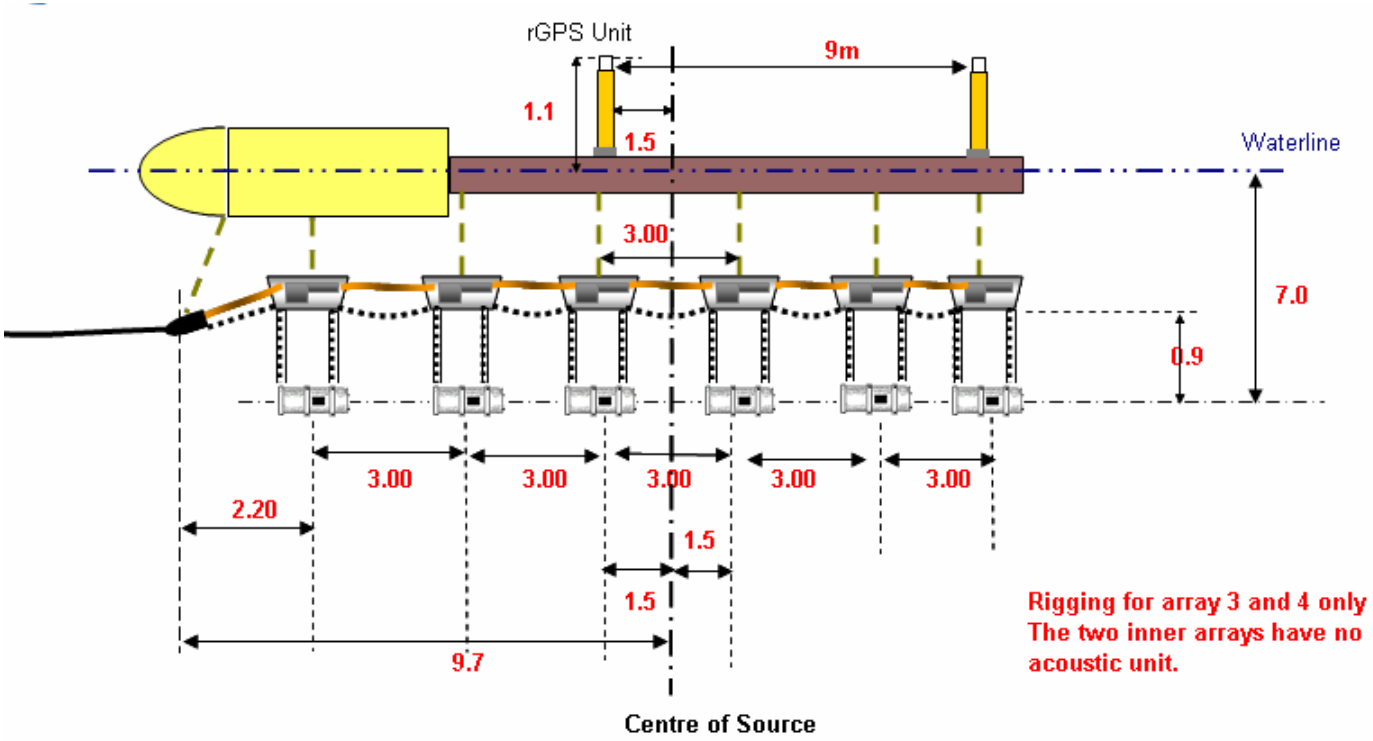


					Strm Depth	Horiz Dist (to Y adapt)	Ant to CFG
FF02	2.10	1.00	37.0		-8.0	39.29	72.65
FF07	2.10	1.00	37.0		-8.0	39.29	72.65



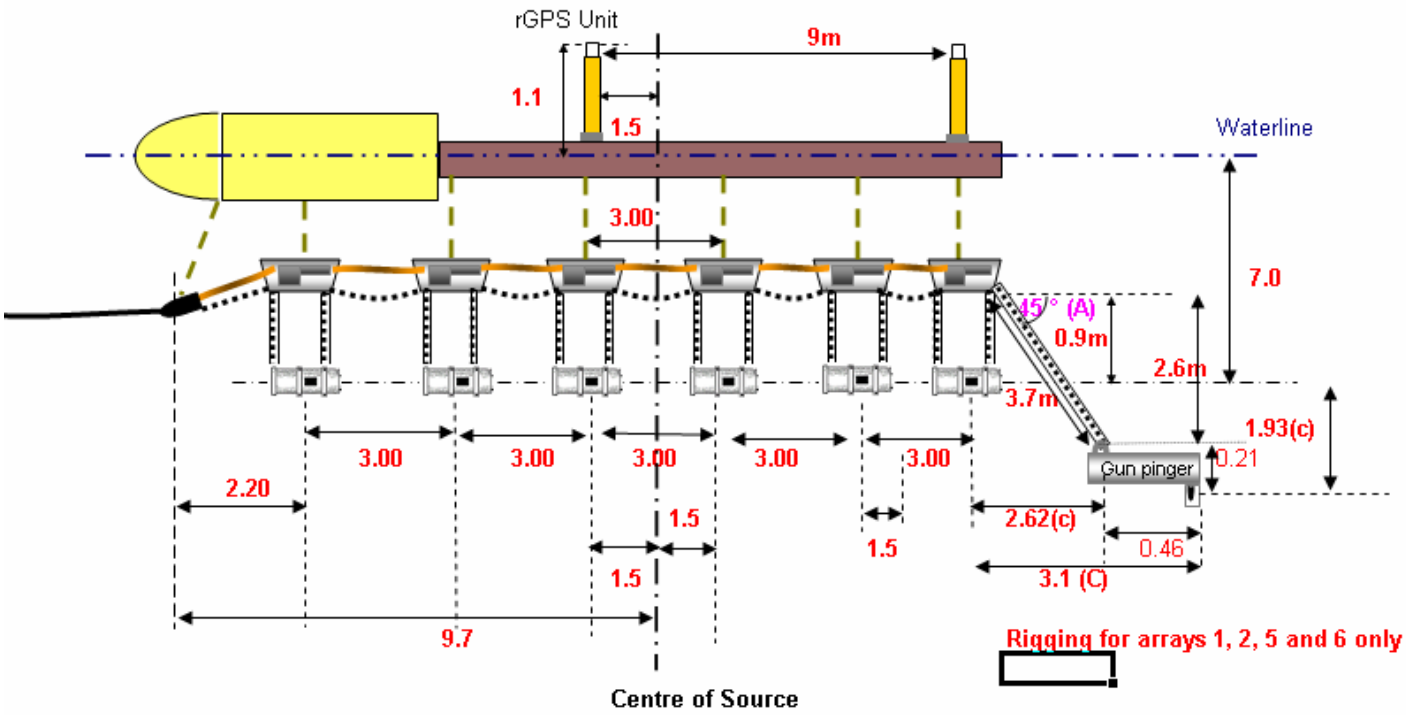
	Unit	Measured	Chain Len	Slope Angle (assumed)	Computed	Depth calc
FF02	S02T01	6.0	0.8	10	7.7	-1.8
FF07	S07T01	6.0	0.8	10	7.7	-1.8

Gun Array Sensor diagram



Gun Depth	Bulkhead to 1st gun	Length of array guns	Center Source to Bulkhead	SPU1 to center Source @ MSL along	SPU1 to center Source @ MSL up	SPU2 to center Source @ MSL along	SPU2 to center Source @ MSL up	The length between each gun
7.00	2.20	15.00	9.70	1.50	1.10	-7.50	1.10	3.00

rGPS Unit Diagram



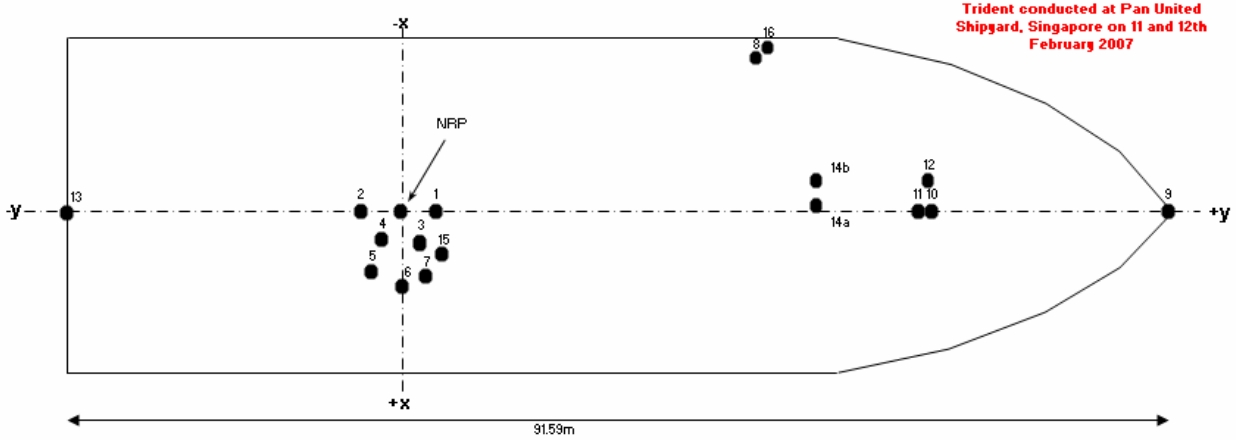
Gun Depth	Bulkhead to 1st gun	Length of array guns	Center Source to Bulkhead	SPU1 to center Source @ MSL		SPU2 to center Source @ MSL		GxTx offset to centre source		The length between each gun
				along	up	along	up	along	up	
7.00	2.20	15.00	9.70	1.50	1.10	-7.50	1.10	-10.58	-1.93	3.00

Antenna Offsets

Loc	AntennaFunction	Y(m)	X(m)	Z(m)	Rx Type	Antenna	SYSTEM
		Along	Across	Above			
NRP	Reference Point	0.00	0.00	24.39			
1	TRINAV GPS	0.48	0.00	24.50	Novatel dual frequency		TRINAV GPS 2.6
2	POSNET-1	-0.53	0.00	24.51	Trimble 4000 DS		WesternGeco Posnet Version 1.81, RTCM via CNAV RTG
3	Veripos FWD	0.20	0.31	24.58	Topcon		Veripos Spotbeam
4	Veripos AFT	-0.20	0.34	24.51	Topcon		Veripos Imarsat
5	CNAV-1	-0.36	0.69	24.49	CNAV		C & C Technologies CNAV
6	CNAV-2	0.00	1.10	24.54	CNAV		C & C Technologies CNAV
7	Veripos Spotbeam	0.39	0.98	25.00	Spot, L-Band Decoder		Spotbeam RTCM Corrections
8	rtCalib Antenna	17.67	-11.31	22.27	Leica MX9400		TRINAV GPS 2.6
9	Bow Helideck	63.68	0.00	10.28	For X,Y Only		Bow Helideck
10	ECHO. 18 kHz	46.88	0.23	-7.93	Echosounder		Simrad EA500.
11	ECHO. 200 kHz	46.28	0.25	-7.93	Echosounder		Simrad EA500.
12	ECHO, 38 kHz	46.89	-0.85	-7.94	Echosounder		Simrad EA500.
13	STERN Stmr deck	-27.91	0.00	13.32	For X,Y Only		Stern Helideck
14a	ADCP Stbd	28.71	-0.26	-7.91	RDI		Current Meter
14b	ADCP Port	28.71	-0.58	-7.91	RDI		Current Meter
15	Water Speed Log	0.39	0.45	-7.64	S80		Speed Log
16	Mid ship TF load line	17.98	-11.48	0.00	Datum Value for Z=0 only		Z=0 vertical ref point at Tropical Fresh Water Load Line

Positive heights are above the Tropical Fresh Water load line.

Data from Vessel Offset Measurement results for MV Trident conducted at Pan United Shipyard, Singapore on 11 and 12th February 2007



Navigation

Table of Contents

16. Navigation and Positioning System Description

16.1. System Configuration

16.1.1. Navigation Hardware and Software

Note: Navigation offset diagrams are included in **Section 3: Configuration** of the FFOR.

System	Hardware (Type and Serial No.)	Software Version
TRINAV	WesternGeco TRINAV	TRINAV 3.0.1 Patch 34, Mar 07
Acoustic System	Sonardyne SIPS-2	2.20.1
Compasses	I/O Digicourse	System 3 version 5.3
TS-meter	Valeport 604 CTD / SIPS2 ASV	
Echo Sounder	Simrad EA 500	SP 5.1
Current Meter	Nortek AWAC at 1000kHz.	SeisADCP Version 1.33

16.1.2. System Timing

TRINAV issued a network shot message containing the absolute time at which the guns were to reach peak pressure. The shot message was distributed to the source system (TRISOR) via the instrument room Ethernet. This message was sent sufficiently in advance of the shot time to account for any network delay and to allow the source to reach ready state and trigger at the correct time.

In addition, TRINAV issued closures to the recording system (MSX), 328 milliseconds before the predicted time of source peak pressure. All TRINAV system positions are at the time of predicted peak pressure.

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 WesternGeco's TRINAVGPS, Subsea 7's Veripos Ultra system and C&C Technologies C-Nav system.

The centre near group of each streamer and the sources were positioned relative to the vessel using a network consisting of 6 rGPS system units mounted on each source, 2 rGPS system units towed wide from the front of the streamers, 201 SIPS 2 acoustic ranges and 24 compass azimuths.

The centre last group of each streamer was positioned using a network consisting of 8 rGPS system units, 8 compass azimuths and 24 SIPS 2 acoustic units.

The mid streamer network consisted of 116 range between 16 acoustic transceivers mounted 2407.3 and 2606.9 meters from the center first group of each streamer.

The streamer shape was modeled by 168 Digicourse series 5011 combined streamer depth control and magnetic compass units.

Least squares 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 C-Nav Version 14.3
RTG corrections via integrated receiver.

System 2: Subsea 7 Veripos Verify version v1.06
Veripos Ultra corrections via InMarsat POR

System 3: WesternGeco TRINAV-GPS
Veripos Standard+ dual frequency RTCM corrections via InMarsat POR and a composite RTCM correction calculated and output by C-Nav.

Vessel positioning was calculated by TRINAV using a combined solution of C&C Technologies C-Nav., Subsea 7's Veripos Ultra and WesternGeco TRINAV-GPS.

- **C-Nav**

The C-Nav GPS Receiver combines a dual-frequency, geodetic grade, GPS Receiver with an integrated L-BAND communication RF detector and decoder all linked by an internal microprocessor. The entire assembly is combined into a single integrated package.

C-Nav is based upon the Real Time Gypsy (RTG) technology developed by NASA's Jet Propulsion Laboratory (JPL) to provide centimeter-level accuracy for space applications. C&C Technologies 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

- **Veripos Ultra**

The Veripos Verify Ultra service is based around a positioning technique known as PPP (Precise Point Positioning) where all errors in the GPS system are either independently corrected or modelled to a high degree of accuracy.

The system consists of one set of corrections for the satellites, which are valid globally. These are used at any location with no dependence on distance to reference stations.

Veripos Ultra delivers a high accuracy position using a proprietary PPP algorithm developed by Veripos that minimises or removes all of the main GPS errors sources such as satellite orbit, satellite clock, troposphere, ionosphere and multi-path.

To carry out this absolute positioning technique orbit and clock correction information is broadcast for each and every GPS satellite to allow removal of satellite based error components. Use of dual-frequency GPS hardware at the user-end permits the calculation and removal of local ionosphere errors, whilst troposphere delays are estimated within the calculation.

Other sources of error are also modelled and include ocean loading, earth tides and phase windup. To obtain the high-accuracy solution, multi-path and GPS receiver noise errors are minimised through use of carrier phase observables, which are precise to the millimetre level.

Further Veripos system information can be found at http://www.veripos.com/s_ultra.php

- **TRINAV-GPS**

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 recommended DGPS quality indicators - the precision and reliability of the fix are displayed as an Error Ellipse and Marginally Detectable Errors (MDE).

The different 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.

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.

Summary

The two independent sources of corrections (Veripos Standard+ and C-Nav) were transmitted to and received onboard the vessel by independent means thereby providing a high degree of redundancy to ensure continuous vessel positioning.

Three different, independent 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 Subsea 7's Standard+ System.

16.3.2. Float Navigation

Float (tailbuoy, source and front of streamer) surface navigation was provided by TRINAV GPS. Tailbuoy and wide-tow front floats used Seatex Seatrack 220 integrated GPS/Radio units, whilst the source surface navigation used a Seatex Seatrack 330 GPS Units.
The in-sea units incorporated a GPS receiver and interfacing for direct data transmission of the raw satellite pseudo-range data via Ethernet, through the source umbilical for the source mounted units, and by conventional UHF telemetry radio for tail and front buoy units.

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 Sonardyne's **S**eismic **I**ntegrated **P**ositioning **S**ystem (SIPS 2). This system comprises a rack mounted Controller, Processor and Graphical Display Unit which are located in the instrument room. HGPS (Hull and Gun Positioning System) transceivers mounted on sub arrays 1, 2, 5 and 6, together with XSRS (Cross Streamer Ranging System) transceivers mounted on the front of each streamer and each headbuoy provide a front network from which vessel relative source and streamer positioning is computed.

XSRS transceivers mounted around the middle of the streamers provide a mid network.

XSRS transceivers mounted on the tail of the streamers and the tailbuoys provide vessel and tailbuoy relative streamer positioning.

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16.4.2. Streamer Compasses

Twenty one series 5011 Digibird combined magnetic compass and streamer depth controllers were attached to each streamer. They were controlled via the I/O Digicourse System 3 DMU rack controller.

Compass Sampling Rate	=	1 second
Averaging constant	=	7 seconds

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

16.4.3. Gyro Compass

The gyrocompasses used during the survey were:

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

The gyro correction values were computed whilst alongside in Pan United Shipyard, Singapore on 12th February, were as follows:

Instrument Room Gyro 1 0.22°
Instrument Room Gyro 2 -1.22°

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 Series 604 CTDI**

Valeport Series 604 CTD is a direct Reading Meter temperature / salinity probe which outputs measurements of pressure, salinity, conductivity, density and temperature to internal memory. On recovery to the vessel the files are extracted and a spreadsheet computes the speed of sound from the readings taken.

- **Type: Sonardyne ASV Sensor**

One or more (depending on availability and environment) Combined Acoustic XSRS and Velocimeter units were mounted on the streamers to monitor real time speed of sound measurements in the water. The data was not logged to the TRINAV Database. The data was monitored to check for significant deviation from the velocity value used in processing.

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 on the prospect area using the Valeport 604 CTD. The computed speed of sound, draught value, draught measurements taken during the survey and tide corrections 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 AWAC operating at 1000 kHz.

17. Navigation Systems Verification and Monitoring

17.1. Echo Sounder Verification

An echo sounder gross error check was performed in port at Singapore on 17th February 2007. The draught was determined by reading of the vessel's draught marks and correcting for the vertical position of the transducer with reference to the draught marks.

- **The draught measurements 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.

- **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**

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 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, and then archived on 3590 tapes.

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 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 center 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.

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 from TRISOR via TIM.

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

18.1.3. Recompute

The vessel system position was computed and the positions saved at one second intervals to disk 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 was 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.

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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 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.

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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. A tracking node is chosen for each shot from the front and tail networks as a reference for head and tail of each streamer. If more than one node from each network passes the PAC for that streamer, the node with the smallest SMA is chosen.
3. Compute the rotation bias using the solved front and tail reference node positions.
4. A mid-network tracking node is chosen, based upon PAC testing of the mid net nodes from the previous shot. If both mid-network nodes pass, the node closest to the compass ahead is chosen. If there is no solution from the previous shot, the mid-network node closest to the vessel is used.
5. The positions of the mid-network reference nodes for each streamer are computed using the selected front network reference node, compasses and scaled offsets (point scale factor and tension model). Compasses have been corrected for rotation bias only.
6. Least squares solution of the mid network and testing of the computed positions against PAC.
7. The solved network positions for front, mid and tail networks which pass the raw PAC tests are smoothed using a Kalman Forward/Backward filter. The smoothed tracking node positions are tested against a second set of more stringent PAC tests (smoothed PAC tests).
8. Selection of reference nodes is repeated picking smoothed front and tail networks nodes on each streamer which pass the smoothed PAC tests and have the smallest SMA.
9. The mid-network node reference node is again chosen as the node which passes the smoothed PAC tests and is closest to the compass ahead.

10. Condition equations are solved for front, mid, tail misclosure resulting in adjusted values for rotation bias, scale factor and individual compass corrections.
11. Compute the compass and receiver positions going from front to tail.
12. Compute the adjusted covariance matrix of the compass positions and generate error ellipses.

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

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18.2. Quality Control

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

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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. Additional external QC

As there was no navigation representative onboard the vessel a selection of lines were sent to Fast Geophysical Positioning Solutions for additional QC.

200 shots of raw data (P2 file) and processed data (P1 file) for the selected lines were sent, along with all documentation defining the navigation configuration. Data files were transmitted from the vessel by FTP to a dedicated password protected site on the FGPS server. The P2 header was checked for conformity with the documented configuration. The P2 data underwent detailed appraisal and was processed to produce a P1/90 dataset. This dataset was compared with the vessel P1/90 and the differences logged. A comprehensive report was produced and published on their password protected website.

18.2.3. 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 position and recomputed 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.

18.2.4. 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 analyzed every 20 lines 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 raw water depth data was filtered to de-spike and interpolate missing data and then:

- corrected for measured sound velocity in water
- corrected for draught
- corrected for tide and reduced to Mean Sea Level

The tidal corrections were supplied for the survey area by Metocean.

- **The C-O values used are contained in the Job Book located in Section 1 of the Final Field Operations Report.**

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

19. Observations

19.1. Navigation Summary

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

19.1.1. TRINAV GPS Integrity Monitor

Sale integrity monitor had some periods where the IOLAN in Oslo wasn't transmitting data to the vessel. A request was sent to the office for the unit to be reset. When data was being received again TRINAV position was checked to confirm integrity.

19.1.2. rGPS (Tailbuoys)

There were short instances when a single float rGPS was not operational. These instances were uncommon and did not affect the data quality due to the high redundancy in the network. Further mention is made here of occasions when more than the normal dropout was observed.

- Deployed an additional wide-tow float on sequence 017. Not in position at SOL.
- Working from 031.
- The tailbuoys were towing strangely on sequence 029 and 030. A large amount of seaweed was removed from F004 and F006.
- F004 and F005 tangled from Seq 034 until 036.
- S4C19 and S5C19 caught together on seq 035.
- Survey re-started at Seq 037.
- Wide tow float FF03 deployed from seq 037. FF02 and FF07 were lost on Beach survey.
- Wide tow float FF06 could not be deployed until seq 038 due to weather and crab angle.
- Tailbuoy GPS units F003 and F004 were not operational from sequence 037.

19.1.3. rGPS (Source)

The source rGPS units performed well throughout the survey.

19.1.4. Acoustics

S7T1 was not operational from sequence 007 until sequence 010, active again from sequence 011 but died again during sequence 012 to the end of job.
S2T1 was not operational from sequence 011 until the end of job
S1T8 was not operational from sequence 007 to sequence 048
S6T8 was not operational from sequence 037 to end of job
S2T8 was not operational from sequence 060 to end of job
S5T3 was not operational from sequence 049 to end of job
S3T1 was in use on wide tow float from sequence 031
S6T1 was in use on wide tow float from sequence 038

Poor acoustic performance was caused by various factors including bad weather, debris, fishing pots and seaweed kelp.

19.1.5. Compasses

Generally the compasses performed well considering the adverse sea conditions. As a result of the poor weather, the streamer depth was lowered to 9m. Details of the major issues experienced are listed below;

- Noisy compass sequences 008 and 009.
- Sequences 010 – 013 had to be scratched due to compass noise caused by large swell.
- Various compasses throughout the survey had poor communications, bad depth indicator, compass bias or bad compass, these were made passive in reprocessing but did not affect streamer shape.
- The compasses were most affected by bad weather where heavy filtering was required. Comparisons were carried out with the onshore positioning QC companies and acceptable results were obtained.
- During the BHP Labella 2D phase the weather deteriorated considerably with compass data deteriorating accordingly.

19.1.6. Gyro

Gyro 1 was used throughout the survey. Gyro 2 had some spiking but was not used in the solution.

19.1.7. Echo Sounder

Only the 38 KHz and 200 KHz transducers were used throughout the survey in depths between 40 to 70 metres.

19.1.8. Current Meter

Every two weeks current meter data was sent to FugroGeos for checking. Data was assessed for accuracy, consistency and agreement with available models.

19.2. Processing and QC Summary

The Santos survey was started on 29 April and all three areas were completed on 27 June 2007.

Between 16 May and 7 June 2007 Trident carried out a survey for Beach Petroleum.

Santos Champion South area was started on 29 April and completed on 18 June, sequences 001 to 057.

Santos Hercules area was started on 18 June and completed on 26 June, sequences 058- 079.

BHP Billiton Labella 2D area was started on 26 June and completed on 27June, sequences 081 to 085.

Sequences 001-006 were shot in marginal weather with streamers down to 9m. Sequence 004 was NTBP due to weather. Whilst weather was poor Trident steamed to shelter and carried out a crew change.

On 08 May survey resumed at sequence 007.

Sequences 015-017 were reshoots of sequences 011-013 due to noisy compass data.

On completion of the Beach survey vessel transited to shelter for crew change and resumed the Champion South prospect on 12 June at Seq 037.

Sequence 058 on 18 June, the first line of the Hercules survey, was scratched due to weather and vessel steering. The weather remained bad until 22 June when the Hercules prospect was restarted.

Sequences 059 and 080 were not recorded due to problems starting these sequences in the navigation and recording software.

Due to some equipment being lost in bad weather during the Beach survey 2 extra wide tow floats, FF03 and FF06 were deployed to replace front floats FF02 and FF07, these were towed from streamer winches and separated by running the tow rope along the leadins. In the survey editor these were defined as being attached at the front ends of streamer 3 and 6, however their actual position was slightly forward and outboard of the gun arrays. These floats provided extra bracing of the front end where gun ranges were weak.

On sequence 037 the shot points recorded were displaced by 3 from the preplot shot. This was noted on the logs and no full fold coverage lost.

Poor weather at the start of the survey and at the start and end of the second period meant that acoustic ranges and compass data was marginal, however following QC checks with ECL and FGPS data comparisons were reasonable considering the conditions.

Due to the large swell and rough weather compass data was particularly noisy. The compass data was filtered with longer median and mean filters than normally required by procedures. Plotted data from adjacent compasses were overlaid on each other to check for any bias or shifts as well as examining the results from the compass calibration program for each sequence. Any units showing these problems were set passive for the affected shot points.

19.3. Conclusions

The predominant factor during these surveys was the weather, compass directions and acoustic ranges suffered the most from the large swells. Vessel steering and cable depth control then became difficult as swell and wind increased. These tended to shut the operation down before seismic streamer noise became too bad. As swell increased, streamers were lowered from 8 to 9 metres and then to 10 metres.

Currents were generally weak and consistent so infill percentage was very low. Overall coverage was very good.

A few fishing pots that hadn’t been spotted by our support fishing vessel were caught on the streamer and affected streamer depth and acoustic ranges in that area but no real damage was sustained.

Some seaweed buildup on the tailbuoys caused some acoustic range problems in the tail net and may have accounted for a few lost units.

20. Navigation Exhibits

Exhibit 1**: Navigation System**

- **DGPS Coverage Maps for RTCM Sources**

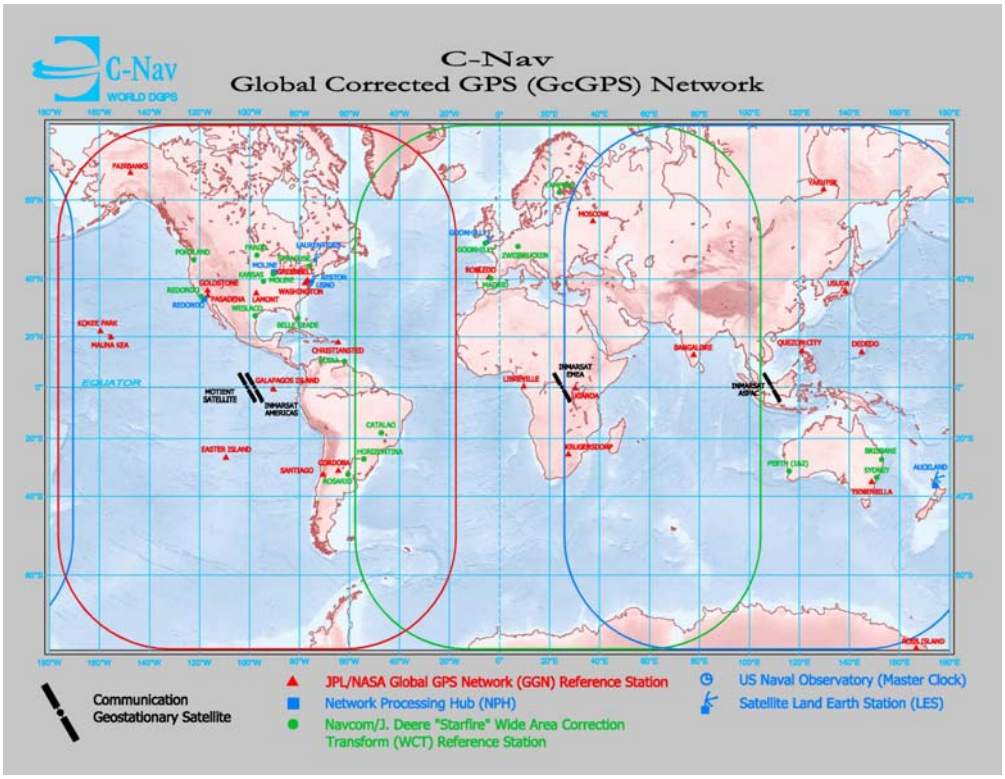
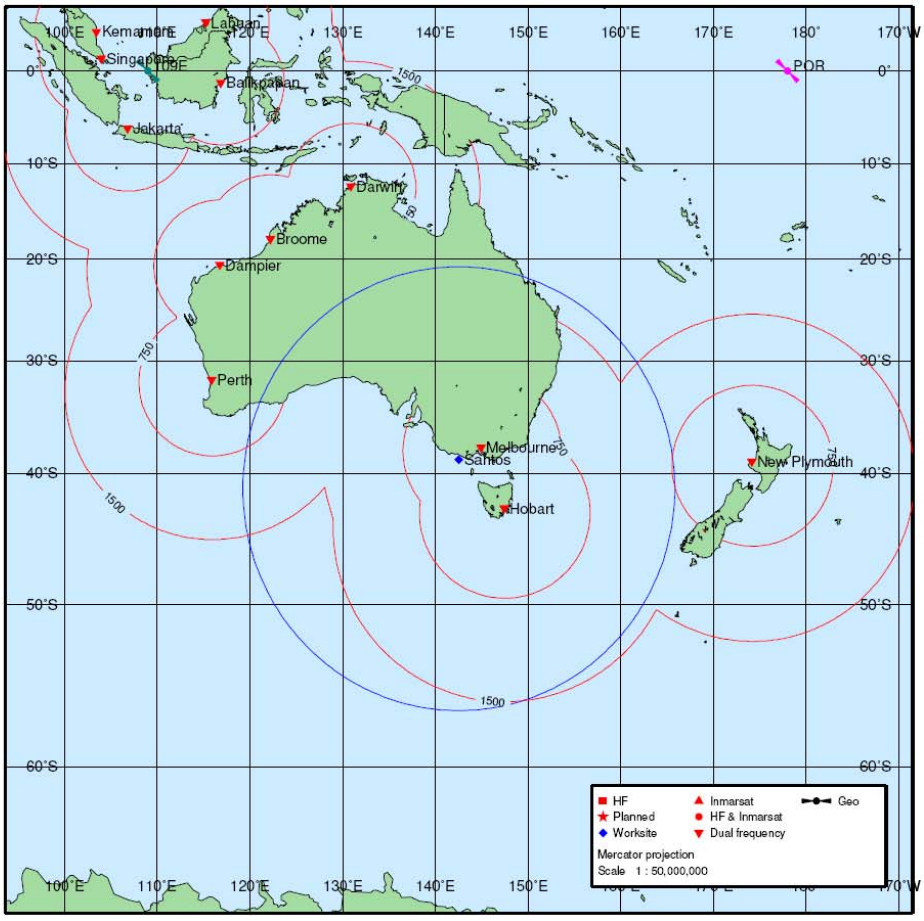


Figure 1 - C-Nav Coverage Map

Santos



Location	*ID*	*Longitude*	*Latitude*	*Range*
Balikpapan	304	116° 52′ E	1° 16′ S	4914
Broome	402	122° 13′ E	17° 57′ S	3039
Dampier	403	116° 45′ E	20° 37′ S	3189
Darwin	401	130° 55′ E	12° 26′ S	3143
Hobart	408	147° 25′ E	42° 49′ S	603
Jakarta	303	106° 49′ E	6° 13′ S	5092
Kemamam	311	103° 27′ E	4° 15′ N	6237
Labuan	302	115° 14′ E	5° 15′ N	5635
Melbourne	406	144° 58′ E	37° 49′ S	240
New Plymouth	409	174° 8′ E	39° 2′ S	2725
Perth	404	115° 53′ E	31° 48′ S	2536
Singapore	301	103° 58′ E	1° 22′ N	5949

Worksite

Santos 142° 33′ E 38° 51′ S

Operating range 2000km

Inmarsat downlinks

POR	49° Azimuth	32° Elevation
98W		Below horizon
AOR-W		Below horizon
AOR-E		Below horizon
25E		Below horizon
IOR	277° Azimuth	0° Elevation
109E	313° Azimuth	33° Elevation

Notes

Ranges are as indicated in kilometres.

HF coverage shown is nominal.

*These HF stations are available to Veripos users through special agreement between Veripos and the station operators. Veripos does not guarantee the performance of these stations.

Reference date 1 April 2007
Station file VeriposStations_14November06.txt [5D460ADF]

Untitled.vcc

Figure 2 - Veripos RTCM Stations

- **TRINAV GPS Integrity Monitor Station Description**

GPS Integrity Monitor

WesternGeco

Latitude	38° 06' 06.2498" S
Longitude	147° 05' 21.2046" E
Ellipsoid	WGS-84
Semi Major Axis	6378137.0 m
Inverse flattening	1/298.257 223 563
Datum:	WGS-84
Ellipsoid Height	21.3283 m

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

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 coordinates of the station were obtained through logging of greater then 48hours of Rinex Data from the ARP to the phase center at 0.060m. With the world leading software Navstar Consortium (UNAVCO) TEQC together with GIPSY-OASIS II with published finalized Orbital information. Full report of the survey is enclosed on a separate document.
Date of Survey:	16th August 2006
Comments:	None.

Figure 3 - Sale Integrity Monitor Information

Exhibit 2**: Echo Sounder Calibration**

Echo Sounder Check (In Port)

Vessel:	Western Trident	**Date :**	2/17/2007
Client:	Apache Energy Limited	**Check started (GMT):**	11:33
Job no.	9605	**Check ended (GMT):**	11:37
Location:	Loyang, Singapore	**E/S draught:**	6.76 m
E/S type:	Simrad EA500	**Vertical offset keel to E/S:**	0.00 m
Serial no:	4139	**Bridge E/S reading**	N/A

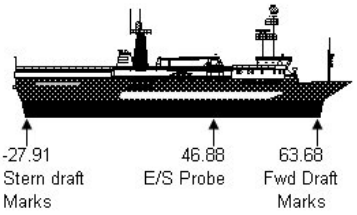
Observed				
Draught (m)			Lead Line Depth (m)	
Bow	Mid-ships	Stern	Stbd (1)	Port (2)
6.60	7.20	7.80	10.10	10.30
Draught at E/S		**6.82**	LL Depth at E/S	**10.20**

Echo Sounder Readings	
Freq 2 (m)	Freq 3 (m)
38	200kHz
2.04	2.17
2.04	2.17
2.05	2.16
2.06	2.18
2.06	2.18
Average =	**2.05**	**2.17**
+ vertical offset keel to E/S transducer	-0.50	-0.50
+ draught (keel to sea surface)	6.82	6.82
Total water depth (m)	**9.37**	**9.49**

Observed - Echo Sounder = **0.83 m** Freq 2
Observed - Echo Sounder = **0.71 m** Freq 3

*Too Shallow for 18KHz transducer

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	25.01 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.

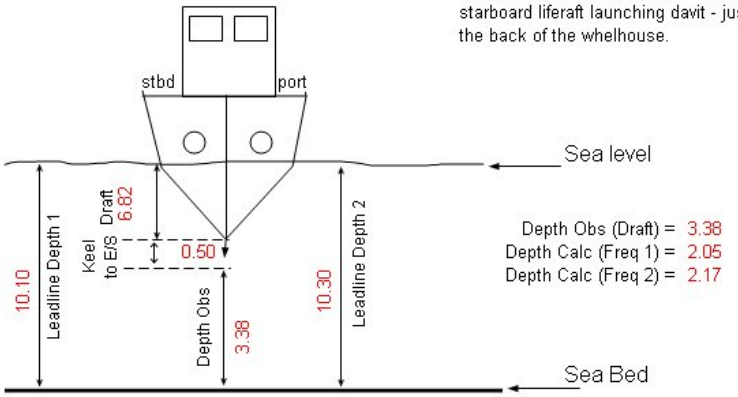


Figure 4 - Echo Sounder Calibration Sheet

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 Santos Limited from 29 April to 27 June on the Champion South and Hercules prospects (WesternGeco job number 9614), 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 rtCalib 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)		-0.6949	0.48299
Gyro 2 (mean)		2.04977	0.61632
GPS Integrity Monitor Results	Delta Easting	0.40577	0.41154
	Delta Northing	0.11564	0.59744
CNAV vs. TRINAV GPS	Radial	0.59	0.16
Veripos vs. TRINAV GPS	Radial	0.63	0.14
rGPS System	Easting	-0.05	0.08
	Northing	0.00	0.10

II. Differential GPS Verification

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

C&C Technologies' CNav with RTG corrections via an integrated receiver.

Veripos Ultra with corrections delivered by InMarsat-B.

A Novatel OEM-4 Dual Frequency GPS receiver providing raw pseudo range data to WesternGeco's TRINAV GPS 3.0. TRINAVGPS, with Veripos Standard+ dual frequency RTCM corrections delivered by InMarsat B and RTCM corrections generated by CNAV from a virtual reference station.

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 of 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 5 shows the average misclosure of the integrity monitor station in graphical form (separated into northing and easting misclosures) for all the sequences acquired. For ease of interpretation, separate displays are also included to allow any line heading dependency of the GPS positioning to be ascertained.

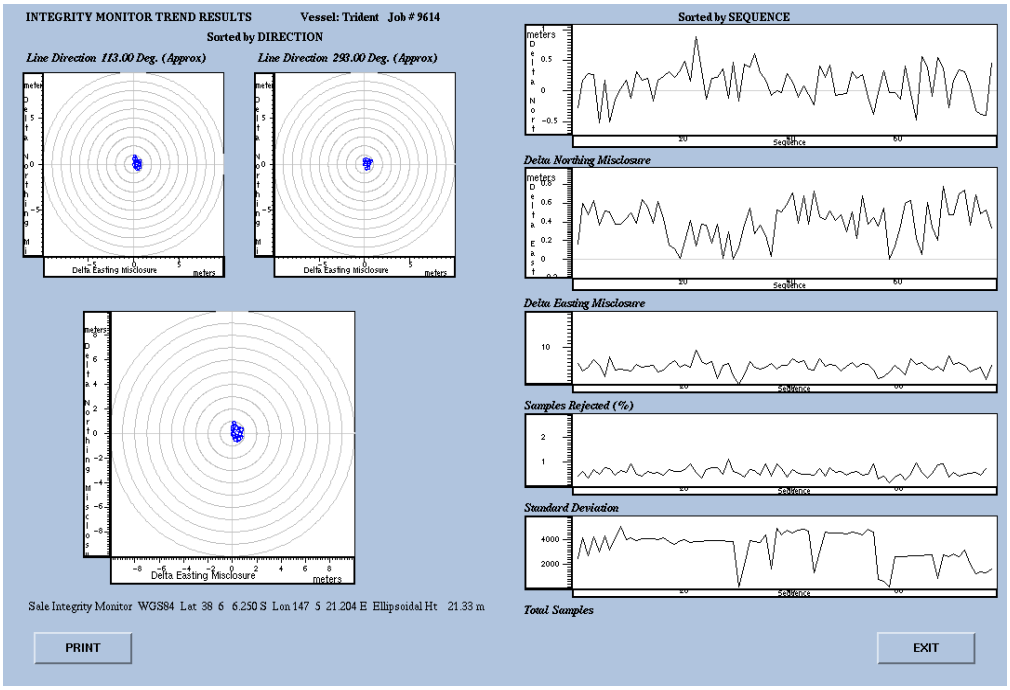


Figure 5: Integrity Monitor Plot Trends to demonstrate GPS quality during the calibrations

III. rGPS Verification

M/V Western Trident utilised WesternGeco's TRINAV GPS 3.0 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 end of the survey.

rGPS Verification Test Data

Position:	Unit ID:	Date:	Samples:		Delta:		STD:	
			Number	Rejected	Easting	Northing	Easting	Northing
F01_1548	1548	1-Jul-07	812	0	-0.04	-0.12	0.06	0.12
F02_1720	1720	30-Jun-07	341	0	0.22	0.63	0.04	0.10
F03_1722	1722	1-Jul-07	340	0	0.00	-0.13	0.10	0.09
F04_1586	1586	28-Jun-07	288	0	-0.53	-0.32	0.08	0.13
F05_1507	1507	28-Jun-07	318	0	0.04	0.13	0.02	0.05
F06_1729	1729	29-Jun-07	326	0	0.18	-0.16	0.13	0.08
F07_1587	1587	29-Jun-07	310	0	0.02	-0.06	0.05	0.12
F08_1601	1601	30-Jun-07	270	0	0.14	-0.18	0.05	0.07
FF02_1505	1505	N/A	N/A	N/A	N/A	N/A	N/A	N/A
FF07_1509	1509	N/A	N/A	N/A	N/A	N/A	N/A	N/A
FF03_1719	1719	27-Jun-07	210	0	-0.29	-0.28	0.12	0.25
FF06_1721	1721	27-Jun-07	210	0	-0.16	-0.19	0.04	0.21
SE11_355	355	28-Jun-07	226	0	-0.19	-0.33	0.10	0.19
SE12_447	447	28-Jun-07	197	0	-0.03	0.01	0.05	0.02
SE21_433	433	28-Jun-07	209	0	-0.25	0.46	0.13	0.16
SE22_356	356	28-Jun-07	463	0	0.11	-0.12	0.05	0.02
SE31_362	362	28-Jun-07	280	0	0.08	0.18	0.08	0.03
SE32_441	441	28-Jun-07	257	0	0.13	-0.01	0.01	0.07
SE41_444	444	28-Jun-07	231	0	0.08	0.00	0.09	0.03
SE42_443	443	28-Jun-07	287	0	-0.08	0.12	0.03	0.11
SE51_448	448	28-Jun-07	321	0	0.00	0.06	0.04	0.03
SE52_326	326	28-Jun-07	425	0	0.18	-0.08	0.14	0.12
SE61_442	442	28-Jun-07	359	0	-0.13	0.18	0.09	0.06
SE62_445	445	27-Jun-07	367	0	-0.09	0.02	0.10	0.16

Table 3: rGPS verification test data from re-radiation tests

IV. Gyro Calibration

M/V Western Trident is fitted with two gyro compasses, a main survey gyro of type C Plath SR180 Mk1 Serial No 5029 and a secondary gyro of type C Plath SR180 Mk1 Serial No 5033 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 17.67m ahead and 11.31 to the port 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 Subsea7 (Singapore) Pte Ltd., whilst the Vessel was in Pan United Shipyard, Singapore on 11th and 12th February 2007.

Method used

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

Results

Results from rtCalib are available in several formats, both graphical and tabular. **Figure 6** shows the average C-O for each of the gyros in graphical form for all the sequences acquired. For ease of interpretation, separate displays are also included to allow any line heading dependency of the gyro performance to be ascertained. The earlier TRINAV GPS Integrity Monitor trend plot (**Figure 5**) is useful to confirm the GPS positioning when the gyro quality shows interesting trends.

Numerical results for rtCalib are shown in chapter VII.

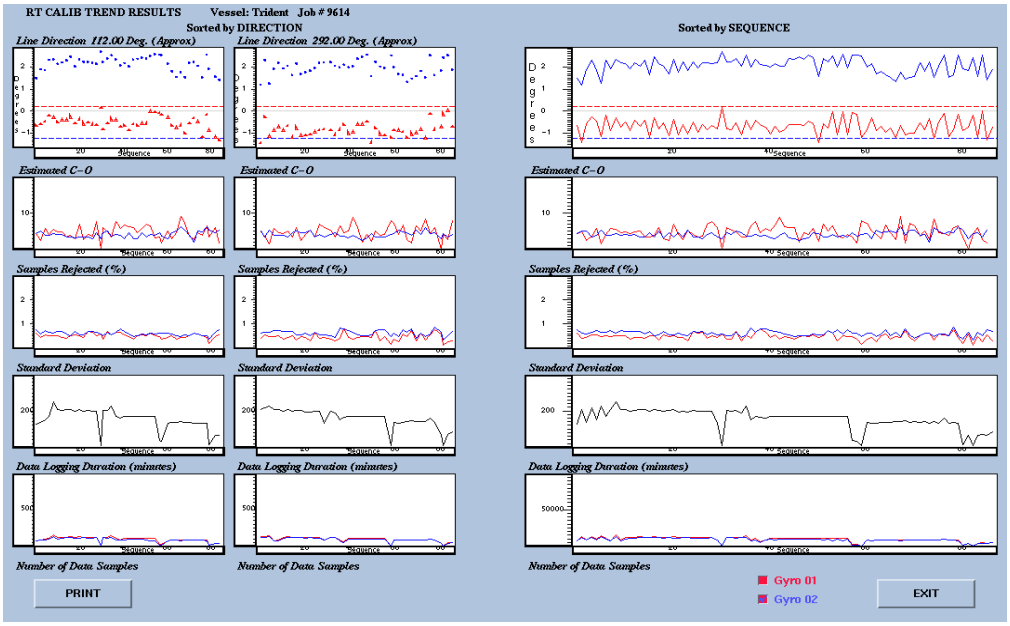


Figure 6: Gyro Calib Trends

V. Conclusions and Comments on Data Quality

The re-radiation tests conducted before the start and at the end of the survey showed no significant deviations thus confirming performance of individual rGPS units. Only results collected on recovery of the equipment at the end of the job are included.

The GPS positions throughout the survey were reliable and generally in good agreement with one another. The main problem was loss of floats due to weather and loss of power to Seatrack units due to failure of the Streamer Tailbuoy Interface Cable (STIC).

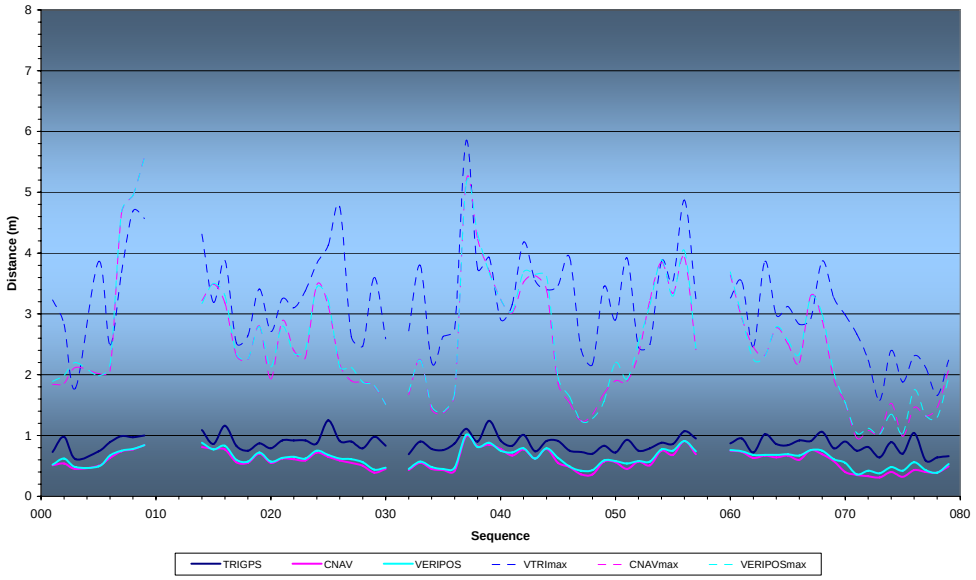
The gyro data for gyro 1 was good throughout the survey and rtCalib results tied in with dockside calibration within 1 degree. Gyro 2 data was spiky and was not used in the solution.

VI. Secondary (CNav) & Tertiary (Veripos) 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.

Seq#	CNAV system (Delta) [m] radial	VERIPOS system (Delta) [m] radial	Seq#	CNAV system (Delta) [m] radial	VERIPOS system (Delta) [m] radial	Seq#	CNAV system (Delta) [m] radial	VERIPOS system (Delta) [m] radial
001	0.51	0.52	032	0.43	0.45	057	0.69	0.74
002	0.54	0.62	033	0.55	0.57	060	0.75	0.76
003	0.45	0.48	034	0.45	0.48	061	0.73	0.74
005	0.5	0.49	035	0.43	0.45	062	0.63	0.68
006	0.63	0.67	036	0.42	0.47	063	0.67	0.68
007	0.74	0.75	037	0.99	1.01	064	0.64	0.68
008	0.77	0.78	038	0.82	0.81	065	0.67	0.69
009	0.84	0.84	039	0.85	0.88	066	0.6	0.67
014	0.81	0.88	040	0.78	0.75	067	0.76	0.76
015	0.78	0.77	041	0.67	0.72	068	0.69	0.75
016	0.77	0.83	042	0.77	0.79	069	0.58	0.61
017	0.56	0.6	043	0.62	0.62	070	0.4	0.55
018	0.55	0.57	044	0.78	0.79	071	0.35	0.36
019	0.7	0.72	045	0.55	0.63	072	0.33	0.42
020	0.55	0.57	046	0.48	0.49	073	0.31	0.38
021	0.62	0.63	047	0.36	0.42	074	0.4	0.48
022	0.61	0.65	048	0.36	0.43	075	0.32	0.42
023	0.59	0.62	049	0.57	0.59	076	0.43	0.56
024	0.72	0.75	050	0.56	0.58	077	0.4	0.43
025	0.65	0.68	051	0.45	0.54	078	0.39	0.39
026	0.59	0.62	052	0.57	0.58	079	0.49	0.53
027	0.55	0.61	053	0.51	0.57			
028	0.5	0.56	054	0.75	0.77			
029	0.39	0.44	055	0.68	0.75			
030	0.45	0.47	056	0.91	0.91			
Mean:	**0.59**	**0.63**						
SD:	**0.16**	**0.14**						

DGSP System - Difference Estimators (versus Primary = VTGPS, CNAV & MFIX) and Max radial distance from Primary Estimator.



VII. Line by Line Results from rtCalib for Gyros and Integrity Monitor

First rtCalib data logged: May-01-2007-21:06

Available Gyros: GY01 Surveydef Corr: 0.220 deg

GY02 Surveydef Corr: -1.220 deg

Gyro Calibration Results:

Line	Calib start time	Mins used	Start hdg.	End hdg.	Name	C-O [deg]	Std [deg]	No. samp.	%Rej	Name	C-O [deg]	Std [deg]	No. samp.	%Rej
1008P001	May--1-2007-21:06	125	112	113	GY01	-0.66	0.64	7459	4.4	GY02	1.48	0.77	7282	4.4
1232P002	May--2-2007-02:48	209	295	295	GY01	-1.44	0.42	12569	4.9	GY02	1.19	0.61	12270	5.1
1024P003	May--2-2007-09:14	136	114	111	GY01	-0.58	0.46	8163	2.5	GY02	1.89	0.6	7832	5
1248P004	May--2-2007-14:13	218	301	302	GY01	-0.27	0.55	13061	3.7	GY02	2.3	0.65	11864	3.5
1040P005	May--2-2007-20:34	151	111	112	GY01	-0.47	0.54	9050	5.7	GY02	1.85	0.73	8414	3.8
1248A006	May--3-2007-03:19	229	296	285	GY01	-1.14	0.48	13740	1.4	GY02	1.24	0.66	13337	5.2
1056P007	May--7-2007-14:41	172	116	118	GY01	-0.19	0.52	10302	4	GY02	2.32	0.66	8969	3.8
1264P008	May--7-2007-20:45	209	291	291	GY01	-0.87	0.48	7563	5.8	GY02	1.91	0.74	6910	3.8
1072P009	May--8-2007-03:00	252	118	117	GY01	-0.29	0.5	15115	5.6	GY02	2.34	0.63	12776	4.4
1280P010	May--8-2007-10:24	210	285	285	GY01	-0.73	0.5	8573	4.6	GY02	2.19	0.72	7244	3.9
1088P011	May--8-2007-16:49	207	122	117	GY01	-0.5	0.51	11536	4.8	GY02	2.13	0.71	9880	4.2
1296P012	May--8-2007-23:27	197	288	288	GY01	-0.88	0.36	11846	4.4	GY02	1.93	0.69	11066	3.9
1104P013	May--9-2007-05:51	204	118	120	GY01	-0.41	0.46	12249	4.8	GY02	2.2	0.68	10850	4
1280A014	May--9-2007-12:13	208	289	287	GY01	-0.67	0.46	12452	5	GY02	2.05	0.69	11388	3.3
1088A015	May--9-2007-18:42	206	116	117	GY01	-0.42	0.42	12368	3.3	GY02	2.29	0.59	11417	3.4
1296A016	May-10-2007-01:34	200	290	290	GY01	-1.18	0.53	12011	3.5	GY02	1.63	0.69	11587	4.5
1104A017	May-10-2007-08:02	209	117	116	GY01	-0.3	0.52	12531	3.8	GY02	2.45	0.52	11384	3.4
1312P018	May-10-2007-14:49	202	288	290	GY01	-0.8	0.35	12102	6	GY02	2.15	0.54	11634	5.1
1120P019	May-10-2007-21:21	198	116	116	GY01	-0.54	0.56	11222	2.9	GY02	2.02	0.7	10865	3.1
1328P020	May-11-2007-04:02	203	293	291	GY01	-1.1	0.47	12166	2.5	GY02	1.68	0.57	11840	4.7
1136P021	May-11-2007-10:26	210	113	115	GY01	-0.37	0.5	12592	6.9	GY02	2.35	0.54	10616	3.5
1344P022	May-11-2007-17:15	193	293	294	GY01	-1.09	0.44	11599	4	GY02	1.77	0.61	11162	4.7
1152P023	May-12-2007-00:22	200	113	114	GY01	-0.6	0.44	12001	2.8	GY02	2.23	0.55	11293	3.5
1360P024	May-12-2007-07:00	195	291	293	GY01	-1.05	0.31	11702	5.4	GY02	1.82	0.52	11342	5.2
1168P025	May-12-2007-13:40	205	114	113	GY01	-0.51	0.71	12278	4.2	GY02	2.23	0.71	10814	3.5

1376P026	May-12-2007-19:57	197	295	296	GY01	-0.95	0.63	11791	3.5	GY02	1.95	0.66	10958	3.3
1184P027	May-13-2007-02:28	196	113	114	GY01	-0.61	0.67	11779	3.7	GY02	2.18	0.7	10475	3
1392P028	May-13-2007-09:12	199	293	294	GY01	-0.85	0.41	11930	7	GY02	2.18	0.54	11122	4.1
1200P029	May-13-2007-15:51	196	110	110	GY01	-0.63	0.5	11730	7.7	GY02	2.13	0.67	11401	4.6
1408P030	May-13-2007-23:25	134	297	296	GY01	-0.82	0.44	8044	5.9	GY02	2.2	0.54	7710	3.5
1216P031	May-14-2007-04:53	7	108	115	GY01	0.15	0.58	426	0	GY02	2.69	0.6	306	2.9
1216A032	May-14-2007-09:11	205	111	105	GY01	-0.82	0.37	12315	6.1	GY02	2.23	0.5	11381	4.7
1424P033	May-14-2007-16:00	198	298	297	GY01	-0.85	0.36	11884	5.2	GY02	2.21	0.52	11450	4.1
1216J034	May-14-2007-23:27	202	113	112	GY01	-0.54	0.68	12091	4.8	GY02	2.38	0.65	10436	5.1
1424J035	May-15-2007-05:53	190	293	297	GY01	-1.07	0.3	11397	3.4	GY02	2.05	0.45	11214	4.7
1600P036	May-15-2007-16:42	228	113	112	GY01	-0.42	0.55	13650	3.5	GY02	2.52	0.55	11672	3.6
1440P037	Jun-11-2007-18:47	153	281	282	GY01	-0.83	0.42	8300	6.4	GY02	1.98	0.83	7545	3.7
1616P038	Jun-12-2007-06:52	168	123	122	GY01	-0.4	0.67	10077	7.6	GY02	2.34	0.66	7816	4.1
1456P039	Jun-12-2007-14:06	163	278	281	GY01	-0.62	0.79	5714	4.7	GY02	2.09	0.82	4473	3.6
1632P040	Jun-12-2007-21:15	162	125	122	GY01	-0.71	0.66	8794	5.8	GY02	2.06	0.8	7714	3.9
1472P041	Jun-13-2007-04:14	168	288	286	GY01	-1.03	0.43	10078	5.1	GY02	1.98	0.74	9421	3.2
1648P042	Jun-13-2007-11:22	168	117	119	GY01	-0.67	0.56	10080	6.7	GY02	2.16	0.71	8484	3
1488P043	Jun-13-2007-18:32	168	290	293	GY01	-0.96	0.37	10080	8.8	GY02	2.03	0.66	9580	3.9
1664P044	Jun-14-2007-01:27	168	114	113	GY01	-0.86	0.47	10077	6.3	GY02	2.02	0.59	9231	4.5
1504P045	Jun-14-2007-08:38	168	293	294	GY01	-0.61	0.46	10080	6.1	GY02	2.37	0.57	9191	3.2
1680P046	Jun-14-2007-15:33	168	112	112	GY01	-0.59	0.39	10027	6	GY02	2.33	0.48	9601	3
1520P047	Jun-14-2007-22:10	168	292	294	GY01	-0.6	0.49	10079	1.9	GY02	2.45	0.52	9658	2.4
1696P048	Jun-15-2007-05:16	168	115	111	GY01	-0.66	0.5	10075	4.5	GY02	2.36	0.5	9603	3
1536P049	Jun-15-2007-11:52	168	292	295	GY01	-0.47	0.49	10081	4.1	GY02	2.55	0.51	9325	3.2
1712P050	Jun-15-2007-18:16	168	114	118	GY01	-0.56	0.55	10071	5.8	GY02	2.43	0.6	9395	4.6
1536J051	Jun-16-2007-00:34	168	291	291	GY01	-1.43	0.46	10080	2.2	GY02	1.58	0.56	9995	4.3
1728P052	Jun-16-2007-06:58	168	115	121	GY01	-0.57	0.5	10078	6.9	GY02	2.39	0.55	8818	3.5
1552P053	Jun-16-2007-13:31	168	290	292	GY01	-0.78	0.72	10081	5.1	GY02	2.23	0.73	8855	3.4
1744P054	Jun-16-2007-19:57	168	126	124	GY01	-0.02	0.63	10077	6.5	GY02	2.5	0.62	7059	4
1568P055	Jun-17-2007-02:30	168	280	290	GY01	-1.07	0.32	10077	3.9	GY02	2.01	0.75	9324	3.5
1744J056	Jun-17-2007-08:59	168	122	131	GY01	-0.04	0.53	10079	3.1	GY02	2.57	0.59	7016	3.9
1584P057	Jun-17-2007-15:48	168	288	285	GY01	-1.09	0.48	10074	4.2	GY02	1.96	0.78	9519	3.3
2064P058	Jun-18-2007-05:41	37	129	124	GY01	-0.08	0.47	2214	3.5	GY02	2.55	0.64	1503	4.7
2064P058	Jun-18-2007-06:19	30	128	129	GY01	-0.15	0.38	1789	1.7	GY02	2.53	0.64	1209	3.7
2208P059	Jun-19-2007-07:24	7	6	14	GY01	-1.2	0.16	395	7.8	GY02	2.51	0.47	368	4.1
2208P060	Jun-21-2007-19:19	137	287	290	GY01	-0.85	0.38	8238	7.3	GY02	1.99	0.62	7736	4.4

2064A061	Jun-22-2007-00:35	133	117	117	GY01	-0.3	0.45	7502	5	GY02	2.14	0.64	7029	3
2224P062	Jun-22-2007-05:32	134	288	291	GY01	-0.88	0.28	8064	4.2	GY02	1.68	0.48	7840	5.4
2080P063	Jun-22-2007-10:41	138	118	113	GY01	-0.67	0.53	8267	2.9	GY02	1.8	0.59	7842	4.7
2240P064	Jun-22-2007-15:50	137	289	292	GY01	-0.94	0.6	8174	6.7	GY02	1.65	0.78	7945	4.8
2096P065	Jun-22-2007-20:59	135	114	111	GY01	-0.75	0.38	8100	4.6	GY02	1.54	0.5	7908	5
2256P066	Jun-23-2007-01:56	139	291	289	GY01	-1.21	0.47	8343	2.7	GY02	1.32	0.66	8120	4.6
2112P067	Jun-23-2007-07:05	141	114	111	GY01	-0.65	0.44	8432	9	GY02	1.75	0.49	7538	6.2
2272P068	Jun-23-2007-12:09	145	299	295	GY01	-1.06	0.73	8720	1.8	GY02	1.46	0.8	8355	3.8
2128P069	Jun-23-2007-17:26	136	114	112	GY01	-1.01	0.43	8178	7.1	GY02	1.53	0.54	7994	5.4
2288P070	Jun-24-2007-02:48	141	296	293	GY01	-0.99	0.32	8478	6.4	GY02	1.58	0.42	8265	5.2
2144P071	Jun-24-2007-07:58	135	109	104	GY01	-0.55	0.53	8105	3.6	GY02	2.18	0.5	7829	3.9
2304P072	Jun-24-2007-13:00	143	304	299	GY01	-0.84	0.63	8581	5.1	GY02	1.81	0.64	8233	4
2160P073	Jun-24-2007-18:08	132	106	105	GY01	-0.32	0.62	7938	2.6	GY02	2.23	0.64	7709	1.9
2320P074	Jun-24-2007-23:05	143	304	300	GY01	-1.23	0.34	8602	8.4	GY02	1.53	0.47	8390	5.9
2176P075	Jun-25-2007-04:16	133	111	110	GY01	-0.49	0.6	8001	4.6	GY02	2.05	0.59	7760	5.1
2336P076	Jun-25-2007-09:28	159	303	299	GY01	-0.12	0.57	9568	4.4	GY02	2.52	0.6	8939	4.3
2192P077	Jun-25-2007-14:56	133	108	116	GY01	-1.16	0.5	7997	3.9	GY02	1.53	0.52	7691	4.8
2336A078	Jun-25-2007-20:07	136	284	284	GY01	-0.84	0.76	8070	6.1	GY02	1.63	0.86	7944	4.5
2192J079	Jun-26-2007-01:16	133	114	121	GY01	-0.15	0.45	8004	6.6	GY02	2.55	0.5	7353	6.3
04P080	Jun-26-2007-03:57	15	131	125	GY01	-0.88	0.19	875	3.5	GY02	1.91	0.39	866	5.2
04P081	Jun-26-2007-06:14	65	271	271	GY01	-0.72	0.58	3900	0	GY02	1.84	0.65	3862	2.9
02P082	Jun-26-2007-07:23	7	270	255	GY01	-0.18	0.11	427	4.2	GY02	2.41	0.33	414	4.3
02P082	Jun-26-2007-10:18	67	36	36	GY01	-1.19	0.48	4024	6.1	GY02	1.55	0.66	3966	4.6
03P083	Jun-26-2007-14:45	69	207	212	GY01	0.02	0.26	4163	2.6	GY02	2.52	0.5	3852	3.5
01P084	Jun-26-2007-20:03	65	41	42	GY01	-1.32	0.55	3899	1.8	GY02	1.42	0.76	3716	5.2
05P085	Jun-27-2007-01:49	82	250	253	GY01	-0.71	0.32	4917	7.9	GY02	1.87	0.71	4616	4.2

Summary of results – Gyro compasses difference

Gyro	C-O	SD	MIN	MAX
GY01	-0.6949	0.48299	-1.44	0.15
GY02	2.04977	0.61632	1.19	2.69

GPS Integrity Monitor Results:

Line	Calib start time	Mins used	Start hdg.	End hdg.	Name	C-O [deg]	Std [deg]	No. samp.	%Rej	Name	C-O [deg]	Std [deg]	No. samp.	%Rej
1008P001	May--1-2007-21:05	126	114	113	IM_dn	-0.28	0.42	2470	5.6	IM_de	0.16	0.25	2470	3.6

1232P002	May--2-2007-02:47	210	296	295	IM_dn	0.18	0.62	4183	3.6	IM_de	0.6	0.42	4183	3.8
1024P003	May--2-2007-09:13	137	112	111	IM_dn	0.29	0.35	2730	4.6	IM_de	0.48	0.3	2730	5.2
1248P004	May--2-2007-14:12	219	303	302	IM_dn	0.27	0.69	4239	6.8	IM_de	0.63	0.53	4239	4.1
1040P005	May--2-2007-20:33	152	109	112	IM_dn	-0.52	0.51	3034	5.3	IM_de	0.37	0.25	3034	5.1
1248A006	May--3-2007-03:18	230	295	285	IM_dn	0.18	0.78	4343	2.2	IM_de	0.52	0.42	4343	5.9
1056P007	May--7-2007-14:40	173	116	118	IM_dn	-0.51	0.73	3170	7.4	IM_de	0.51	0.49	3170	4.7
1264P008	May--7-2007-20:44	209	290	290	IM_dn	-0.15	0.47	4147	3.9	IM_de	0.38	0.26	4147	6.5
1072P009	May--8-2007-02:59	263	119	117	IM_dn	0.03	0.65	5150	4.3	IM_de	0.38	0.48	5150	5
1280P010	May--8-2007-10:24	211	286	286	IM_dn	0.18	0.59	4020	3.8	IM_de	0.44	0.42	4020	5.9
1088P011	May--8-2007-16:48	208	121	117	IM_dn	-0.12	0.93	4159	3.7	IM_de	0.5	0.38	4159	3.9
1296P012	May--8-2007-23:26	198	286	288	IM_dn	0.31	0.52	3962	5.5	IM_de	0.39	0.39	3962	4
1104P013	May--9-2007-05:50	205	118	120	IM_dn	0.18	0.43	4079	4.6	IM_de	0.64	0.4	4079	5.9
1280A014	May--9-2007-12:12	208	288	287	IM_dn	0.2	0.61	4132	4.9	IM_de	0.56	0.4	4132	2.8
1088A015	May--9-2007-18:41	207	117	116	IM_dn	-0.16	0.55	4134	5.1	IM_de	0.39	0.4	4134	3.8
1296A016	May-10-2007-01:33	201	289	290	IM_dn	0.18	0.59	4007	3.3	IM_de	0.62	0.42	4007	3.3
1104A017	May-10-2007-08:01	210	116	116	IM_dn	0.24	0.49	4190	4	IM_de	0.44	0.33	4190	6.6
1312P018	May-10-2007-14:48	203	288	290	IM_dn	0.32	0.71	3909	5.4	IM_de	0.15	0.46	3909	6.2
1120P019	May-10-2007-21:20	201	116	116	IM_dn	0.23	0.63	3648	6.4	IM_de	0.11	0.37	3648	5.2
1328P020	May-11-2007-04:02	204	294	291	IM_dn	0.33	0.64	3937	4.8	IM_de	0.01	0.46	3937	8.5
1136P021	May-11-2007-10:25	211	114	115	IM_dn	0.48	0.7	4027	5.5	IM_de	0.19	0.41	4027	6.3
1344P022	May-11-2007-17:14	194	293	294	IM_dn	0.16	0.92	3825	4.7	IM_de	0.42	0.48	3825	7.3
1152P023	May-12-2007-00:21	201	113	114	IM_dn	0.89	0.58	3893	9.4	IM_de	0.14	0.57	3893	3.8
1360P024	May-12-2007-06:59	196	291	293	IM_dn	0.34	0.34	3898	6.3	IM_de	0.38	0.43	3898	5.2
1168P025	May-12-2007-13:39	206	114	113	IM_dn	-0.13	0.71	3968	5.5	IM_de	0.37	0.53	3968	2.8
1376P026	May-12-2007-19:56	198	296	296	IM_dn	0.2	0.79	3943	6.2	IM_de	0.17	0.31	3943	4.4
1184P027	May-13-2007-02:27	197	113	114	IM_dn	0.22	0.77	3928	1.7	IM_de	0.38	0.48	3928	4.4
1392P028	May-13-2007-09:11	200	293	294	IM_dn	0.36	0.52	3942	5.3	IM_de	0.01	0.42	3942	7.3
1200P029	May-13-2007-15:50	196	110	110	IM_dn	-0.12	1.13	3844	5.6	IM_de	0.3	0.39	3844	4.1
1408P030	May-13-2007-22:23	195	297	296	IM_dn	0.47	0.64	3901	2.3	IM_de	0	0.4	3901	4.2
1216P031	May-14-2007-04:53	8	109	115	IM_dn	-0.17	0.56	160	0	IM_de	0.13	0.44	160	0
1216A032	May-14-2007-09:10	100	108	112	IM_dn	0.44	0.39	1958	2.6	IM_de	0.37	0.47	1958	6.1
1424P033	May-14-2007-16:00	198	297	297	IM_dn	0.39	0.69	3939	6.3	IM_de	0.55	0.37	3939	4.8
1216J034	May-14-2007-23:26	202	114	112	IM_dn	0.61	0.68	3882	4.8	IM_de	0.27	0.55	3882	4.6
1424J035	May-15-2007-05:52	191	294	297	IM_dn	0.3	0.46	3799	4.1	IM_de	0.37	0.47	3799	4.6
1600P036	May-15-2007-16:41	229	113	112	IM_dn	0.18	0.95	4448	4.7	IM_de	0.25	0.33	4448	4.7
1616P038	Jun-12-2007-09:22	83	125	122	IM_dn	-0.07	0.43	1661	5.8	IM_de	0.03	0.37	1661	7.2

1456P039	Jun-12-2007-13:59	252	275	281	IM_dn	0.01	0.95	4988	4.3	IM_de	0.53	0.45	4988	4.7
1632P040	Jun-12-2007-21:07	230	126	122	IM_dn	-0.03	0.75	4406	5.2	IM_de	0.51	0.46	4406	4.4
1472P041	Jun-13-2007-04:13	242	287	286	IM_dn	0.29	0.41	4841	5.2	IM_de	0.59	0.5	4841	9.2
1648P042	Jun-13-2007-11:21	238	117	119	IM_dn	0.14	0.7	4610	7	IM_de	0.71	0.37	4610	5.9
1488P043	Jun-13-2007-18:31	239	290	293	IM_dn	-0.11	0.56	4771	6	IM_de	0.39	0.3	4771	6.3
1664P044	Jun-14-2007-01:27	244	113	113	IM_dn	0.08	0.53	4848	6.5	IM_de	0.68	0.49	4848	4.5
1504P045	Jun-14-2007-08:37	237	293	294	IM_dn	-0.06	0.51	4726	4.2	IM_de	0.38	0.44	4726	5.3
1680P046	Jun-14-2007-15:32	66	113	111	IM_dn	-0.23	0.48	1311	4	IM_de	0.73	0.27	1311	4.4
1520P047	Jun-14-2007-22:09	153	292	293	IM_dn	0.41	0.73	3056	7	IM_de	0.46	0.39	3056	5.6
1696P048	Jun-15-2007-05:15	232	113	111	IM_dn	0.23	0.45	4636	5	IM_de	0.43	0.35	4636	5.9
1536P049	Jun-15-2007-11:52	229	293	295	IM_dn	0.43	0.77	4557	5.4	IM_de	0.52	0.38	4557	3.2
1712P050	Jun-15-2007-18:15	229	115	118	IM_dn	-0.07	0.59	4576	5.2	IM_de	0.42	0.32	4576	5.8
1536J051	Jun-16-2007-00:33	231	292	291	IM_dn	-0.05	0.64	4602	3.7	IM_de	0.48	0.47	4602	4.3
1728P052	Jun-16-2007-06:57	226	115	121	IM_dn	-0.04	0.47	4518	4.9	IM_de	0.3	0.39	4518	6.3
1552P053	Jun-16-2007-13:30	232	293	292	IM_dn	0.32	0.6	4638	6	IM_de	0.51	0.45	4638	5.1
1744P054	Jun-16-2007-19:56	229	126	124	IM_dn	0.2	0.61	4583	4.8	IM_de	0.22	0.31	4583	5.4
1568P055	Jun-17-2007-02:29	230	281	290	IM_dn	0.27	0.49	4447	5.7	IM_de	0.68	0.53	4447	4
1744J056	Jun-17-2007-08:58	245	123	131	IM_dn	-0.11	0.53	4890	5.4	IM_de	0.38	0.46	4890	5.1
1584P057	Jun-17-2007-15:47	234	287	285	IM_dn	-0.39	0.94	4688	4	IM_de	0.45	0.48	4688	5.3
2064P058	Jun-18-2007-05:40	38	126	124	IM_dn	-0.03	0.32	757	1.6	IM_de	0.36	0.39	757	2.6
2064P058	Jun-18-2007-06:18	31	126	129	IM_dn	0.33	0.42	611	2.1	IM_de	0.55	0.3	611	2.6
2208P059	Jun-19-2007-07:23	8	5	14	IM_dn	-0.02	0.18	151	3.3	IM_de	0	0.23	151	0.7
2208P060	Jun-21-2007-19:18	138	286	290	IM_dn	-0.02	0.41	2650	5.2	IM_de	0.14	0.38	2650	4.7
2064A061	Jun-22-2007-00:34	133	119	117	IM_dn	-0.13	0.51	2667	3.9	IM_de	0.36	0.54	2667	5.1
2224P062	Jun-22-2007-05:32	135	290	291	IM_dn	0.41	0.29	2668	2.6	IM_de	0.6	0.39	2668	2.2
2080P063	Jun-22-2007-10:40	139	118	113	IM_dn	-0.04	0.51	2706	7	IM_de	0.63	0.42	2706	3.9
2240P064	Jun-22-2007-15:49	138	291	292	IM_dn	-0.47	0.96	2747	5.4	IM_de	0.22	0.52	2747	2.7
2096P065	Jun-22-2007-20:58	136	112	111	IM_dn	0.57	0.6	2710	5.9	IM_de	0.05	0.38	2710	3.3
2256P066	Jun-23-2007-01:55	140	291	289	IM_dn	0.38	0.37	2791	4.6	IM_de	0.61	0.31	2791	4.4
2112P067	Jun-23-2007-07:04	141	114	111	IM_dn	-0.09	0.55	2784	3.8	IM_de	0.35	0.29	2784	6.5
2272P068	Jun-23-2007-12:13	44	298	298	IM_dn	0.55	0.9	889	4.9	IM_de	0.2	0.47	889	4.7
2304P072	Jun-24-2007-12:59	144	304	299	IM_dn	0.37	0.95	2785	3.6	IM_de	0.78	0.41	2785	5
2160P073	Jun-24-2007-18:07	133	106	105	IM_dn	-0.28	0.4	2665	7.7	IM_de	0.48	0.31	2665	6.1
2320P074	Jun-24-2007-23:04	144	305	300	IM_dn	0.18	0.6	2884	5.5	IM_de	0.48	0.44	2884	6.5
2176P075	Jun-25-2007-04:15	134	110	110	IM_dn	0.35	0.42	2679	5.9	IM_de	0.7	0.58	2679	4.9
2336P076	Jun-25-2007-09:27	160	303	299	IM_dn	0.32	0.53	3204	5.1	IM_de	0.74	0.4	3204	5.9

2192P077	Jun-25-2007-14:55	102	108	114	IM_dn	0.07	0.54	2029	3.3	IM_de	0.37	0.37	2029	4.4
02P082	Jun-26-2007-10:17	68	36	37	IM_dn	-0.32	0.58	1272	4.3	IM_de	0.69	0.53	1272	5.7
03P083	Jun-26-2007-14:44	70	205	211	IM_dn	-0.39	0.48	1403	4.7	IM_de	0.49	0.36	1403	2.6
01P084	Jun-26-2007-20:02	66	41	42	IM_dn	-0.4	0.76	1314	1.4	IM_de	0.53	0.59	1314	1.9
05P085	Jun-27-2007-01:48	83	254	253	IM_dn	0.46	0.44	1645	5.2	IM_de	0.34	0.43	1645	3.2

Summary of results – Integrity Monitor difference

Northing				Easting			
Mean				Mean			
C-O	SD	Min	Max	C-O	SD	Min	Max
0.11564	0.59744	-0.52	0.89	0.40577	0.41154	0	0.78

Exhibit 4 : Coverage Maps

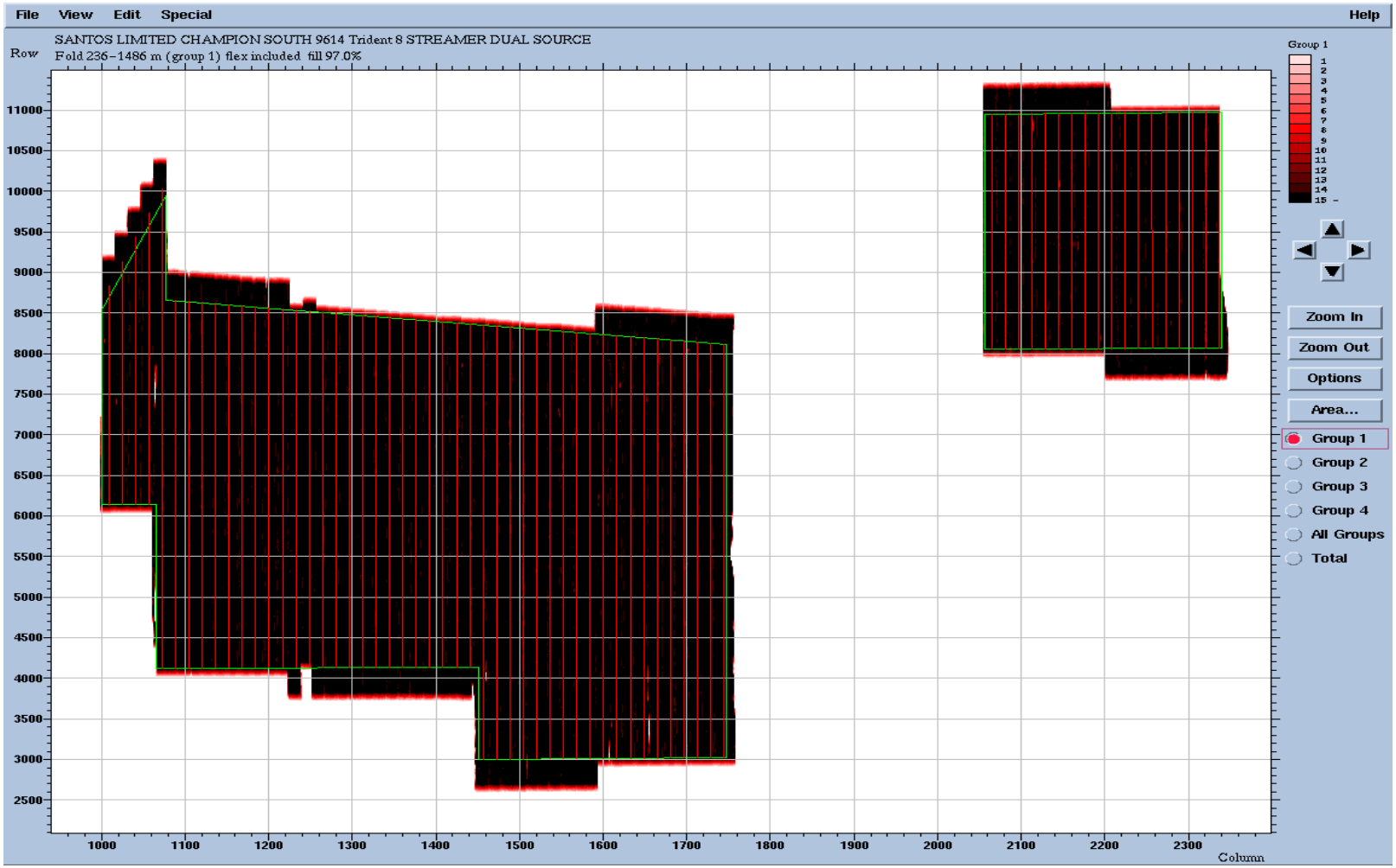


Figure 1 - Group 1 Flex Included

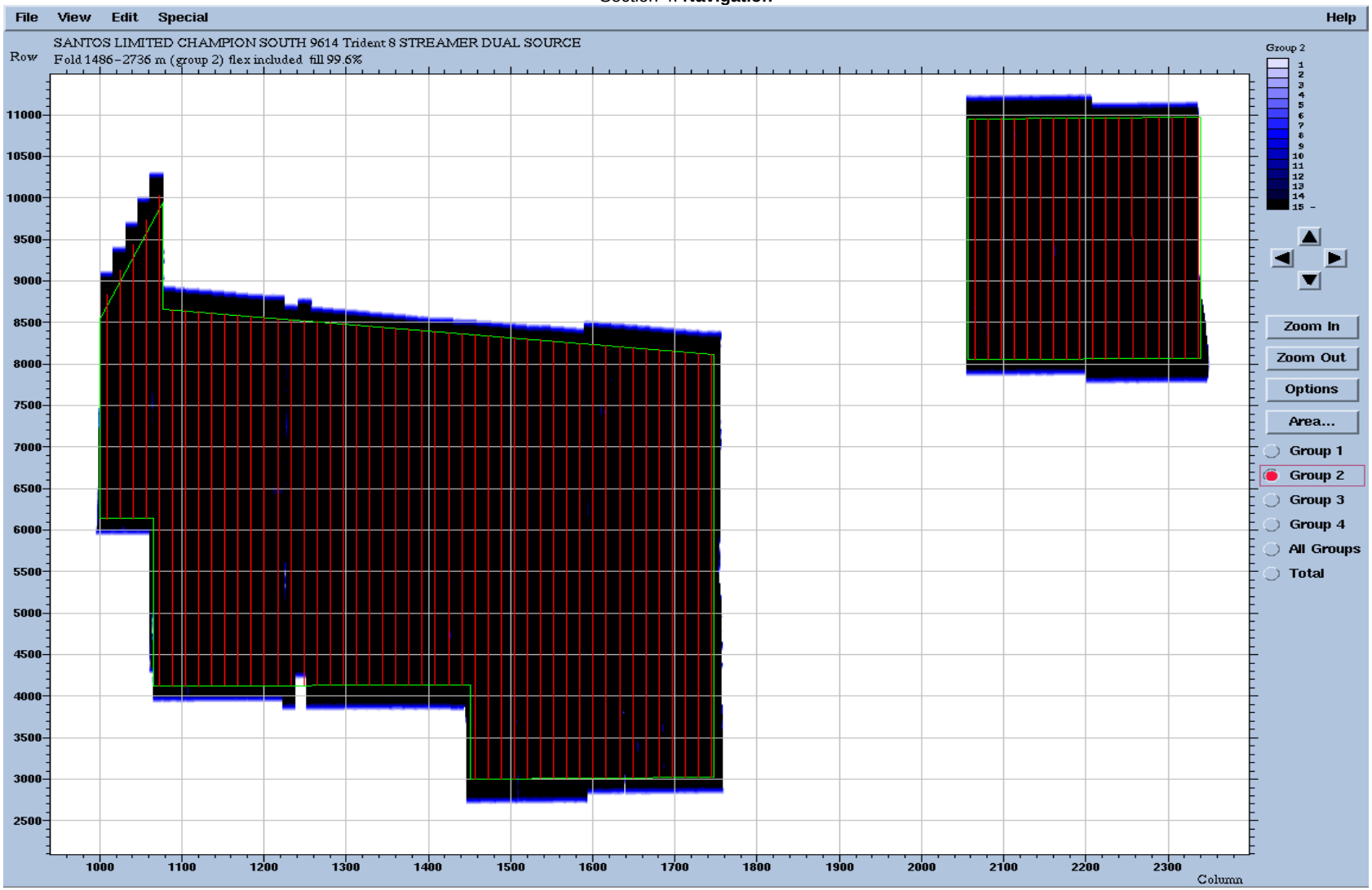


Figure 2 - Group 2 Flex Included

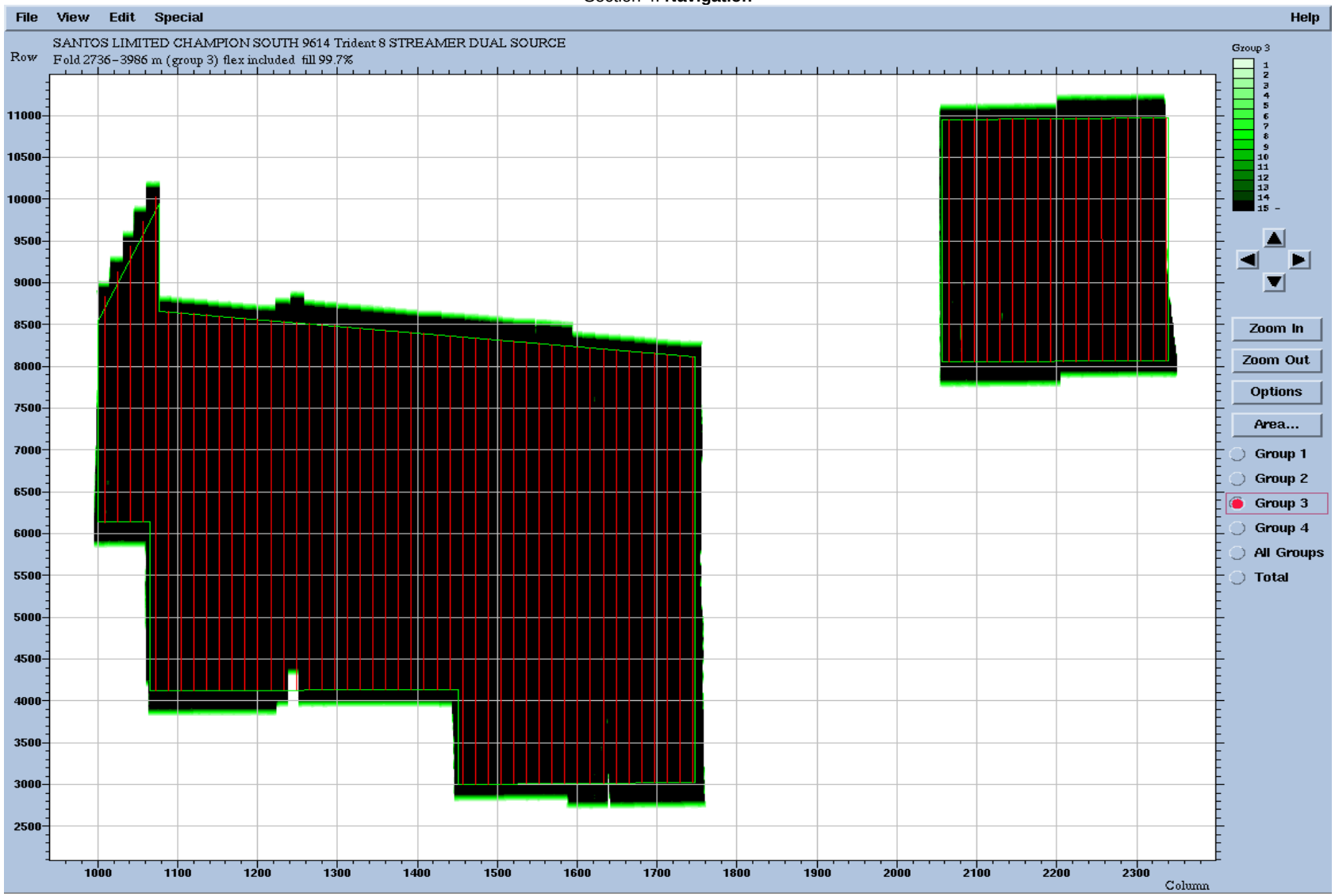


Figure 3 - Group 3 Flex Included

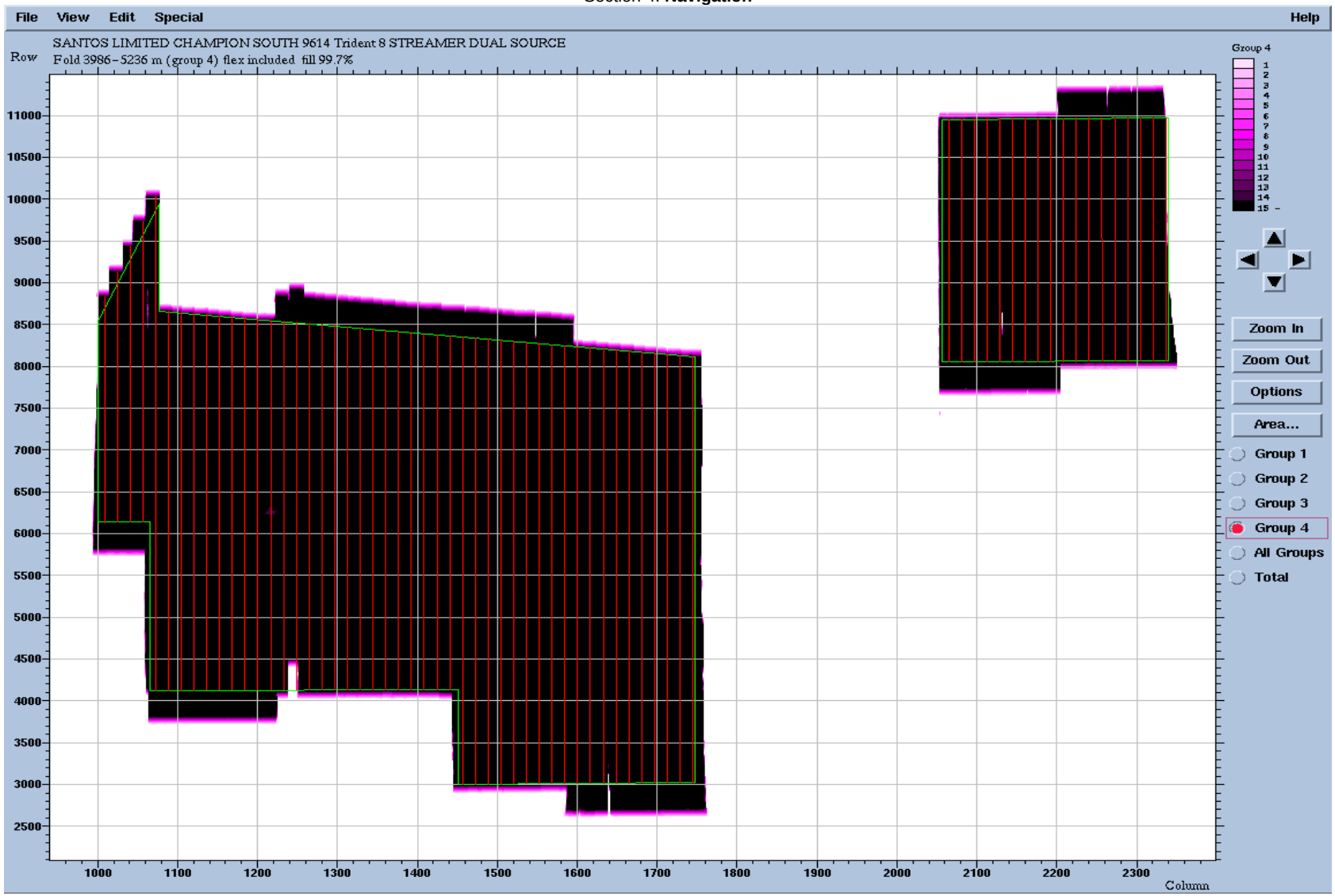


Figure 4 - Group 4 Flex Included

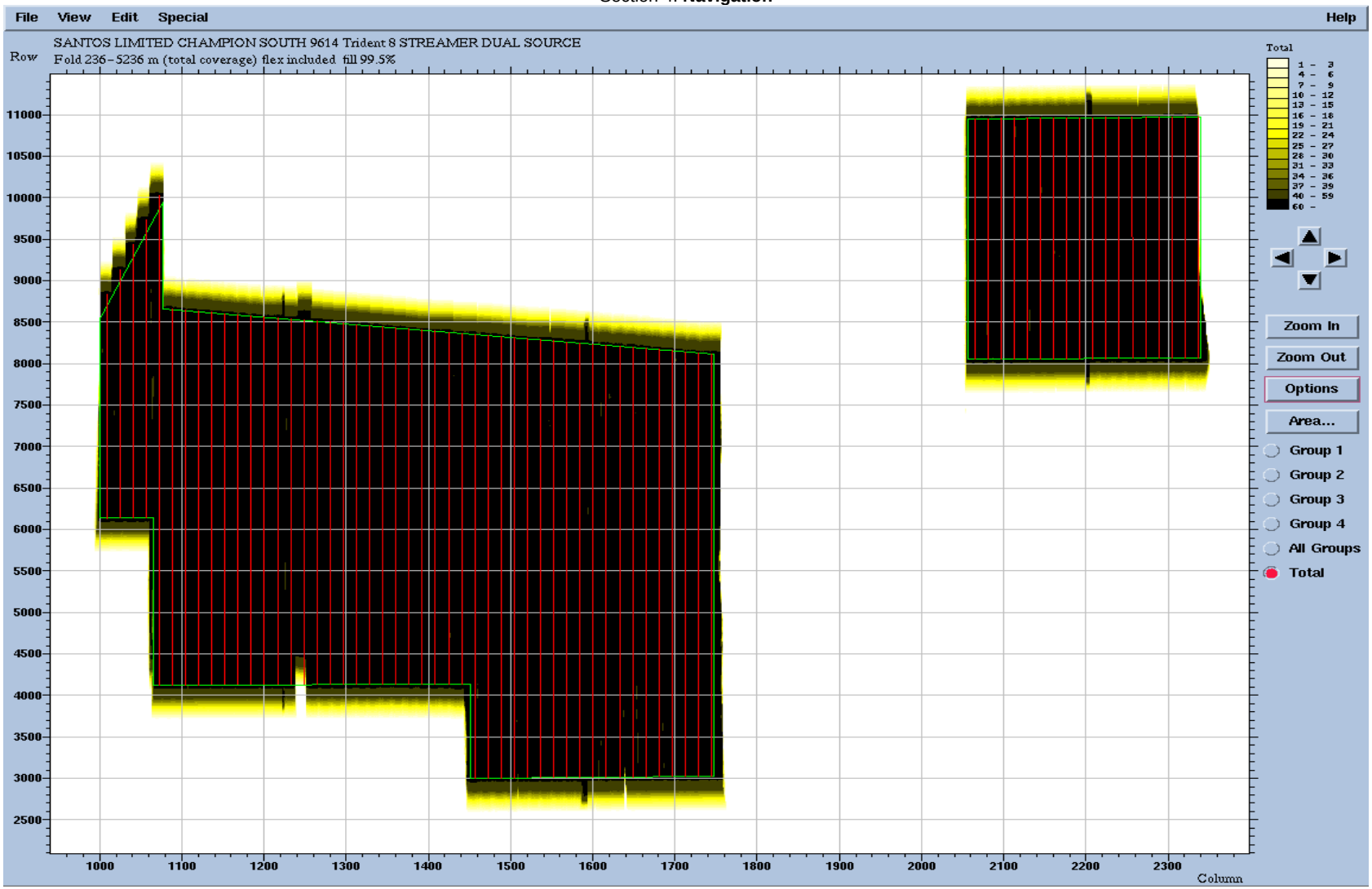


Figure 5 - Total Group Flex included

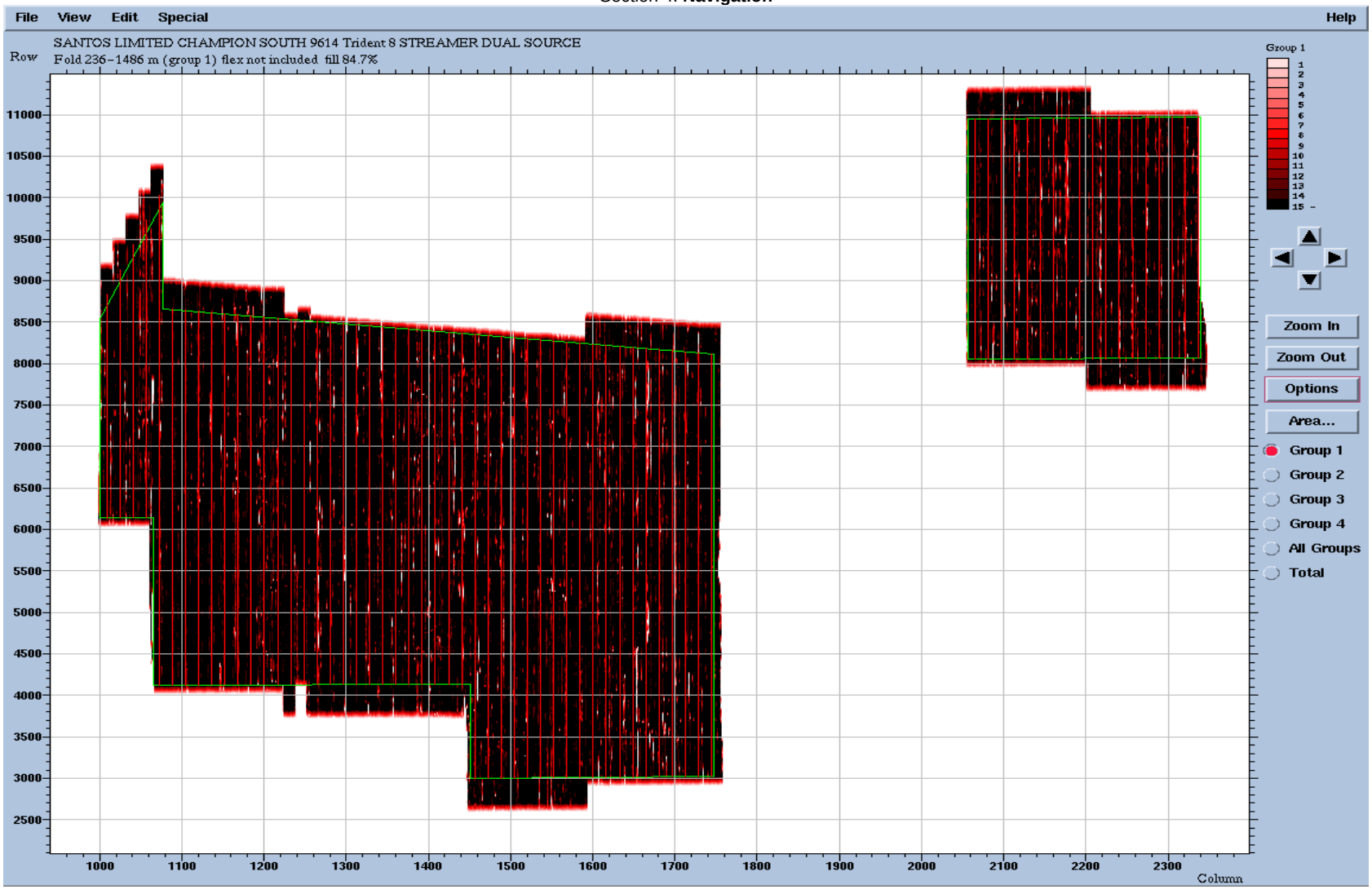


Figure 6 - Group 1 Flex not included

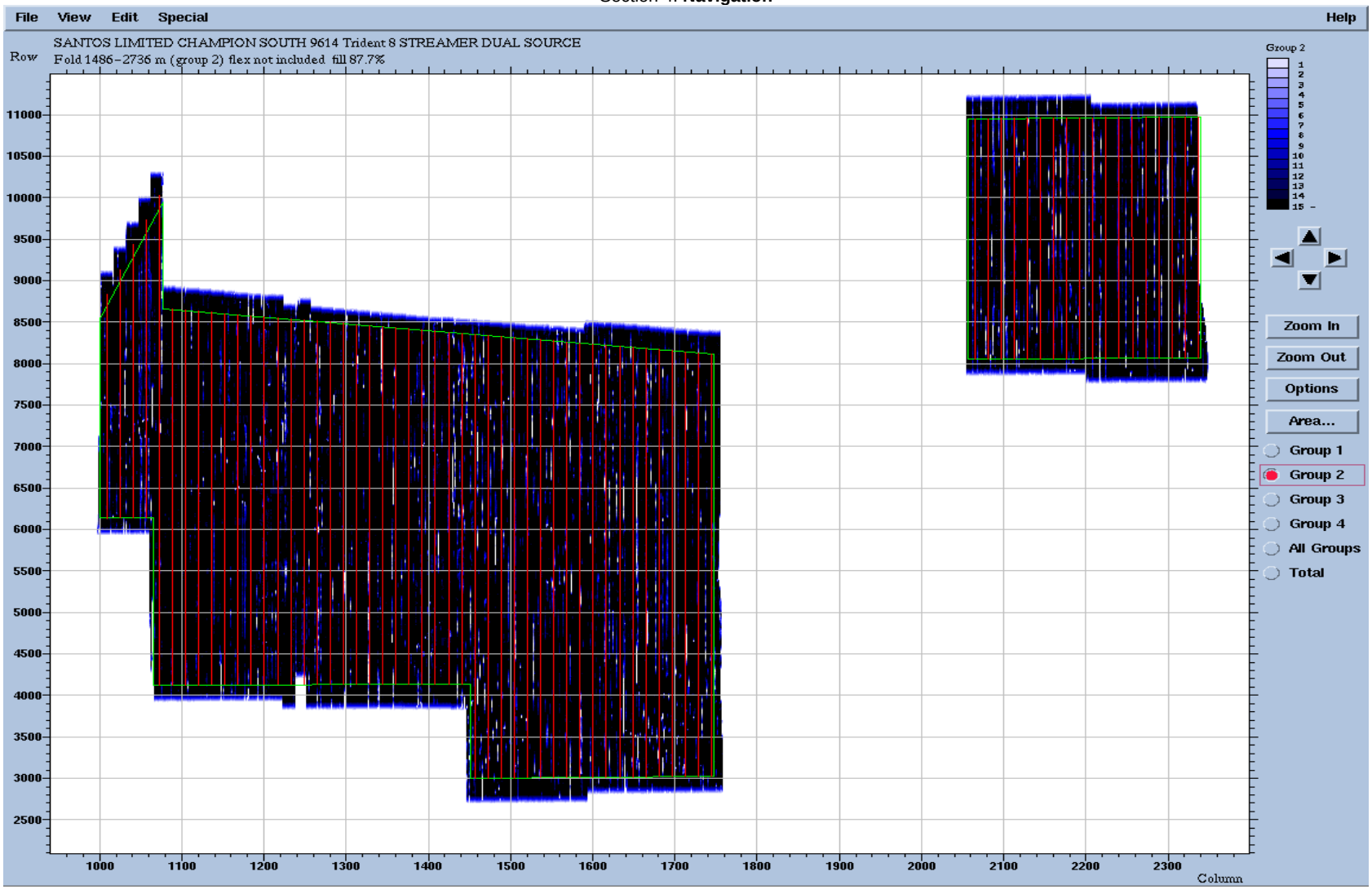


Figure 7 - Group 2 Flex not included

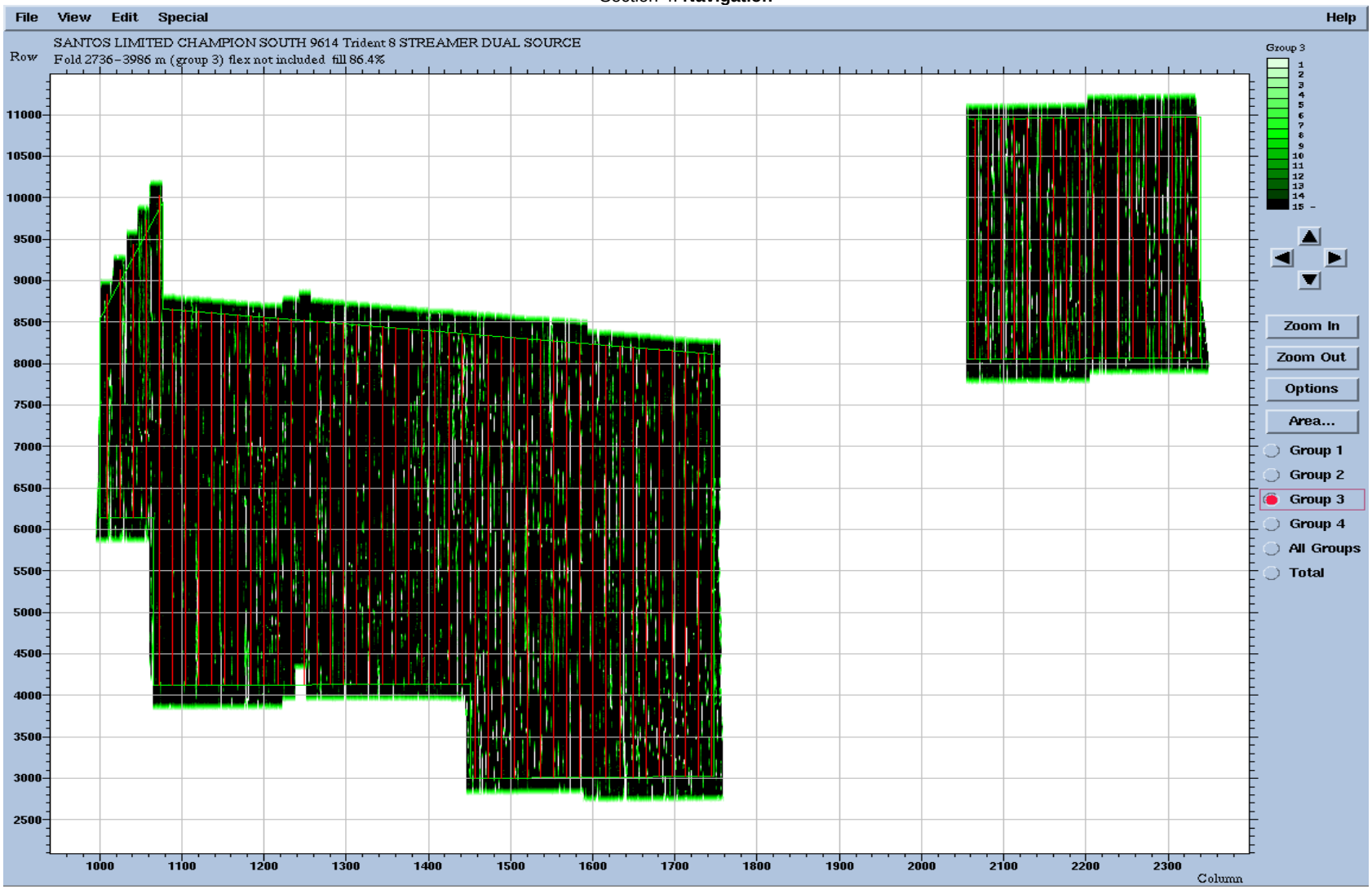


Figure 8 - Group 3 Flex not included

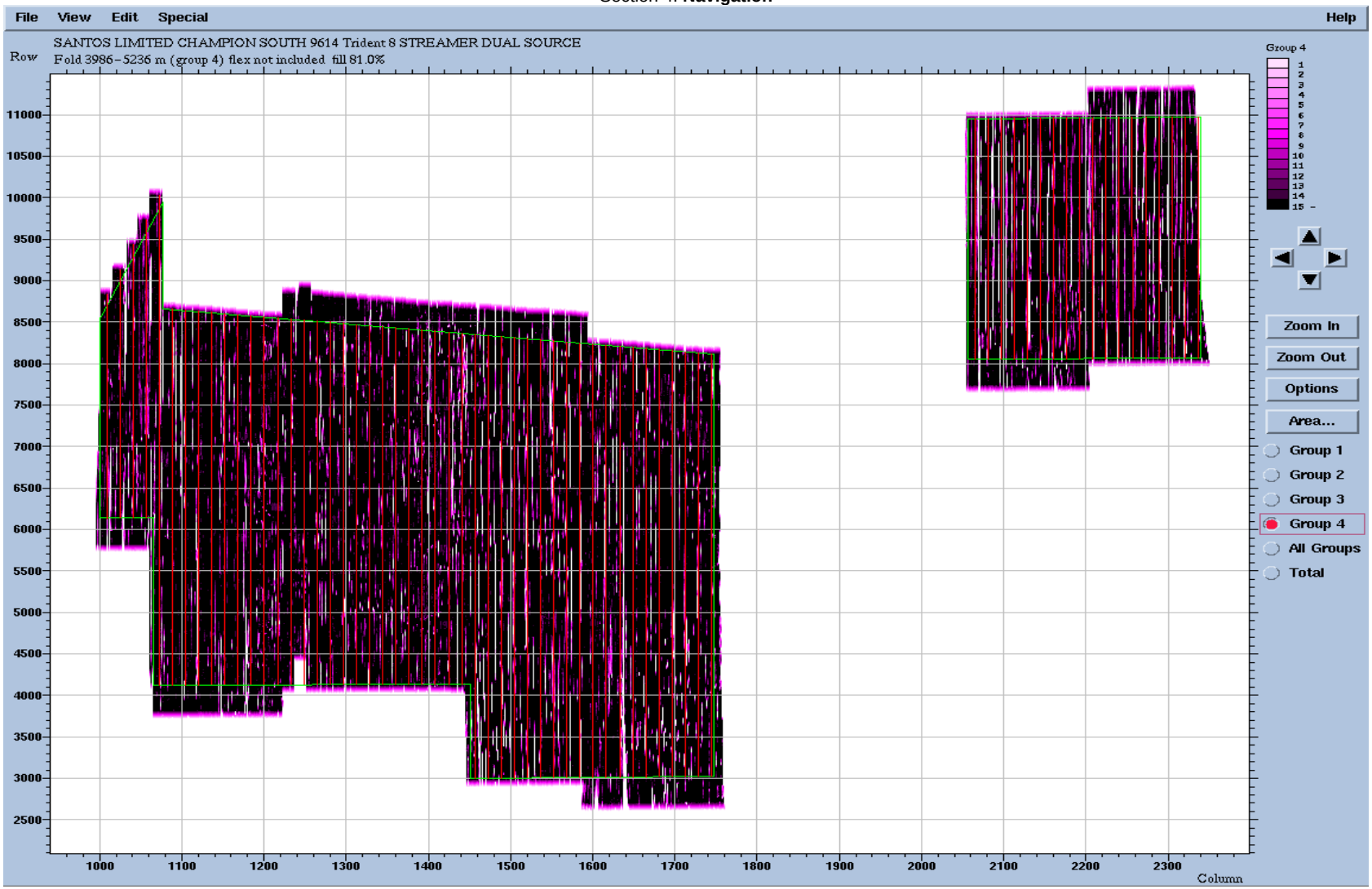


Figure 9 - Group 4 Flex not included

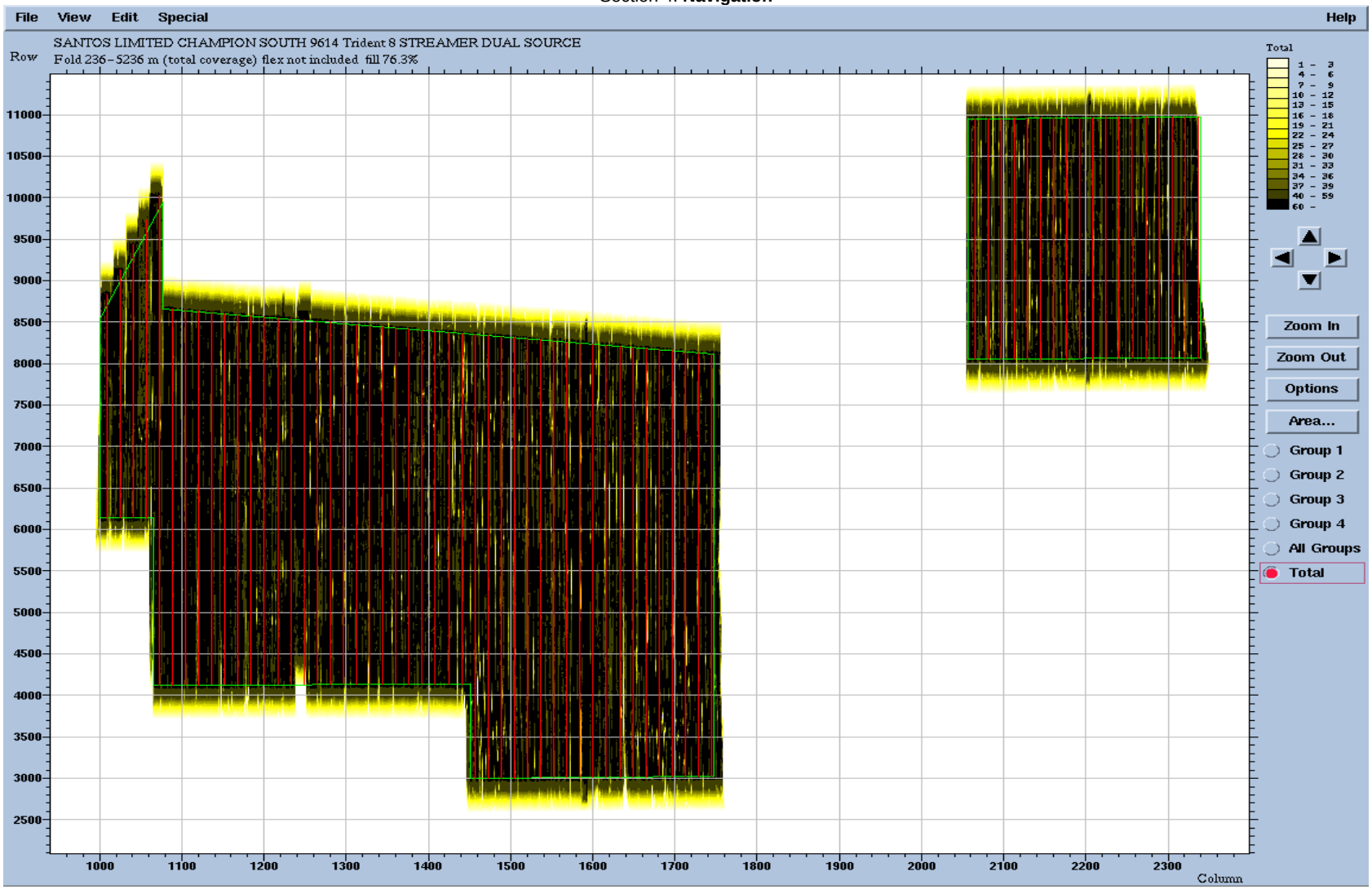


Figure 10 – Total Group Flex not included

Exhibit 5 **: Acoustic Range System**

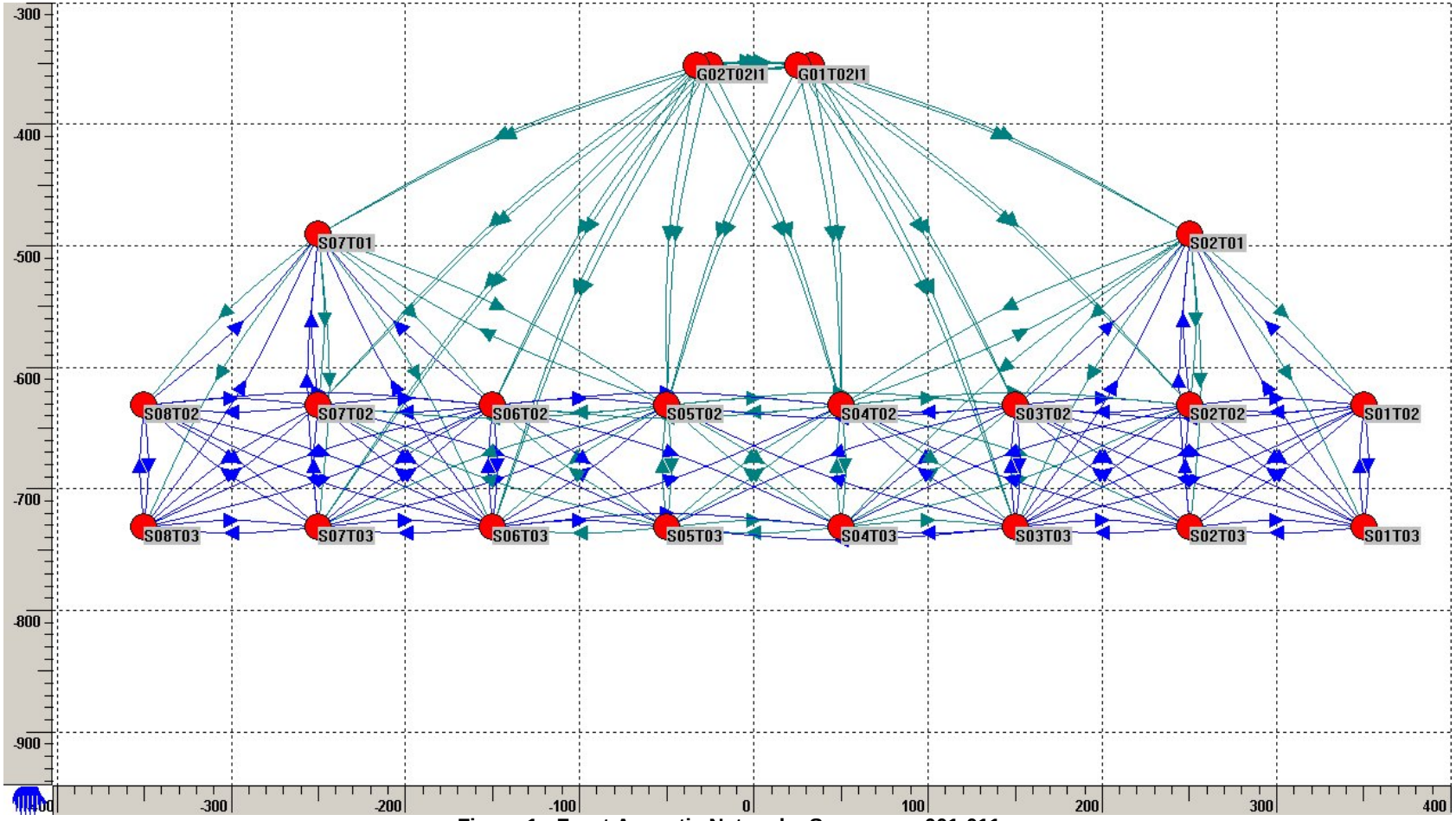


Figure 1 - Front Acoustic Network - Sequences 001-011

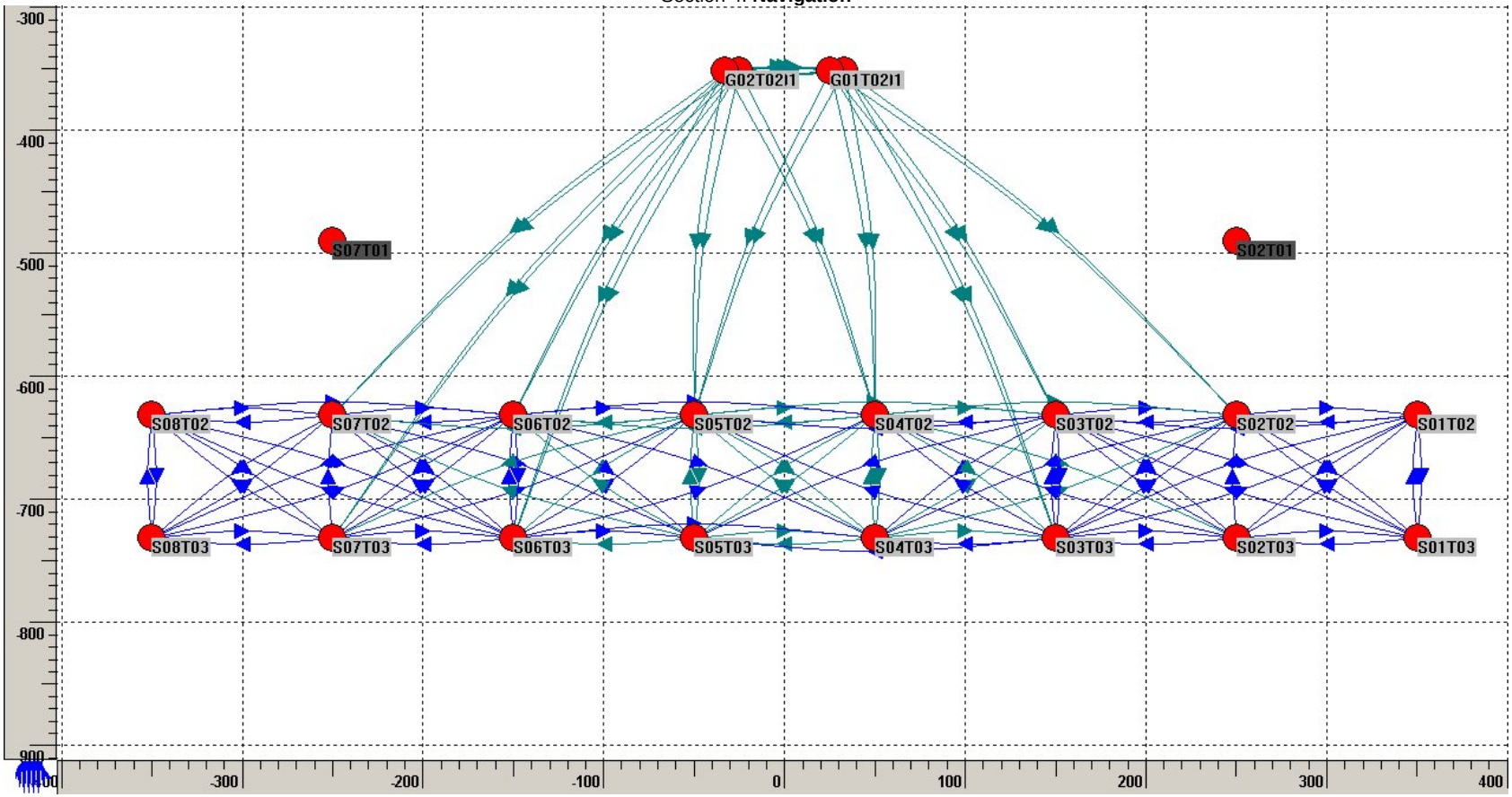


Figure 2 - Front Acoustic Network - Sequences 012-020

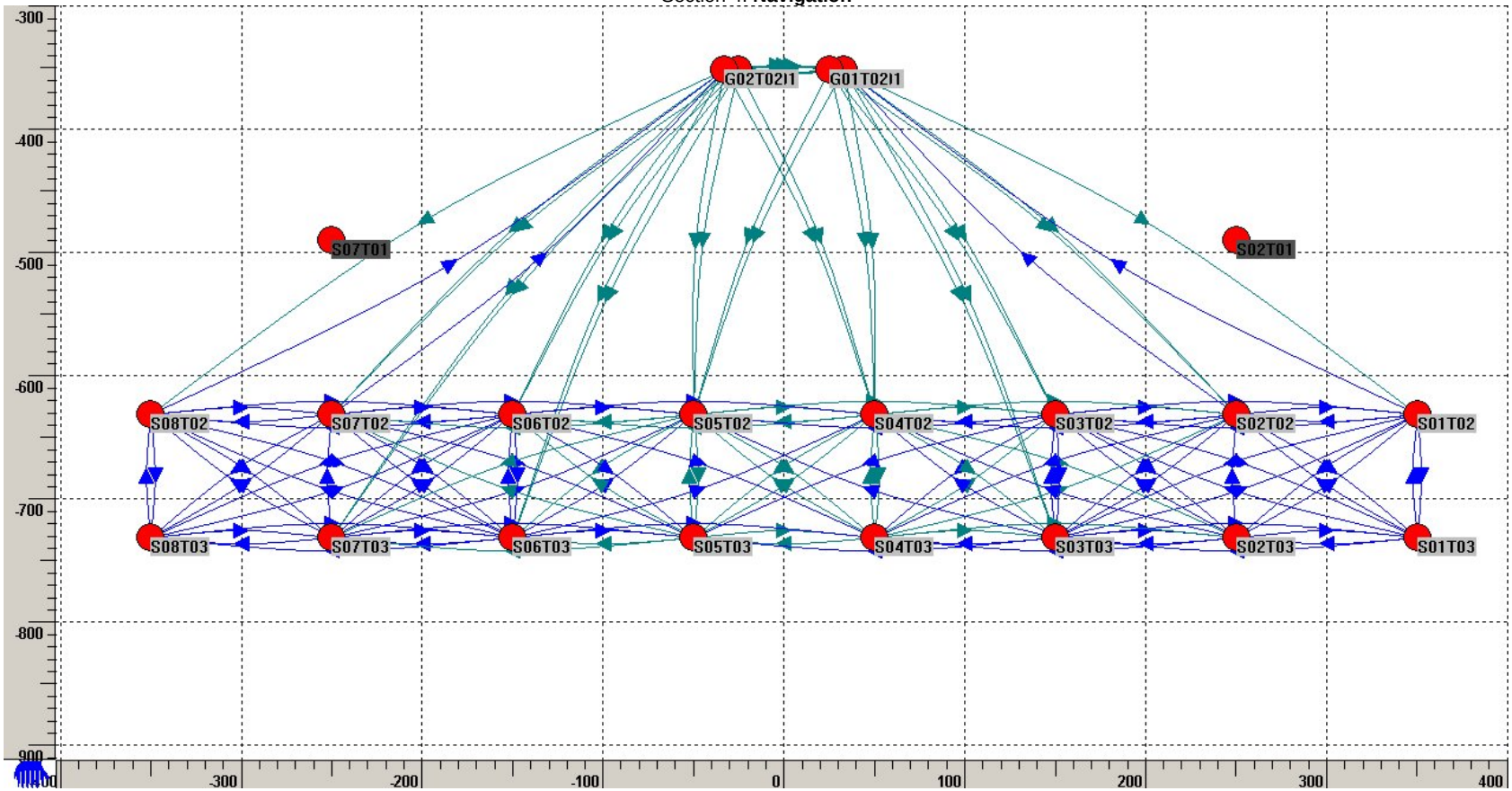


Figure 3 - Front Acoustic Network - Sequences 021-030

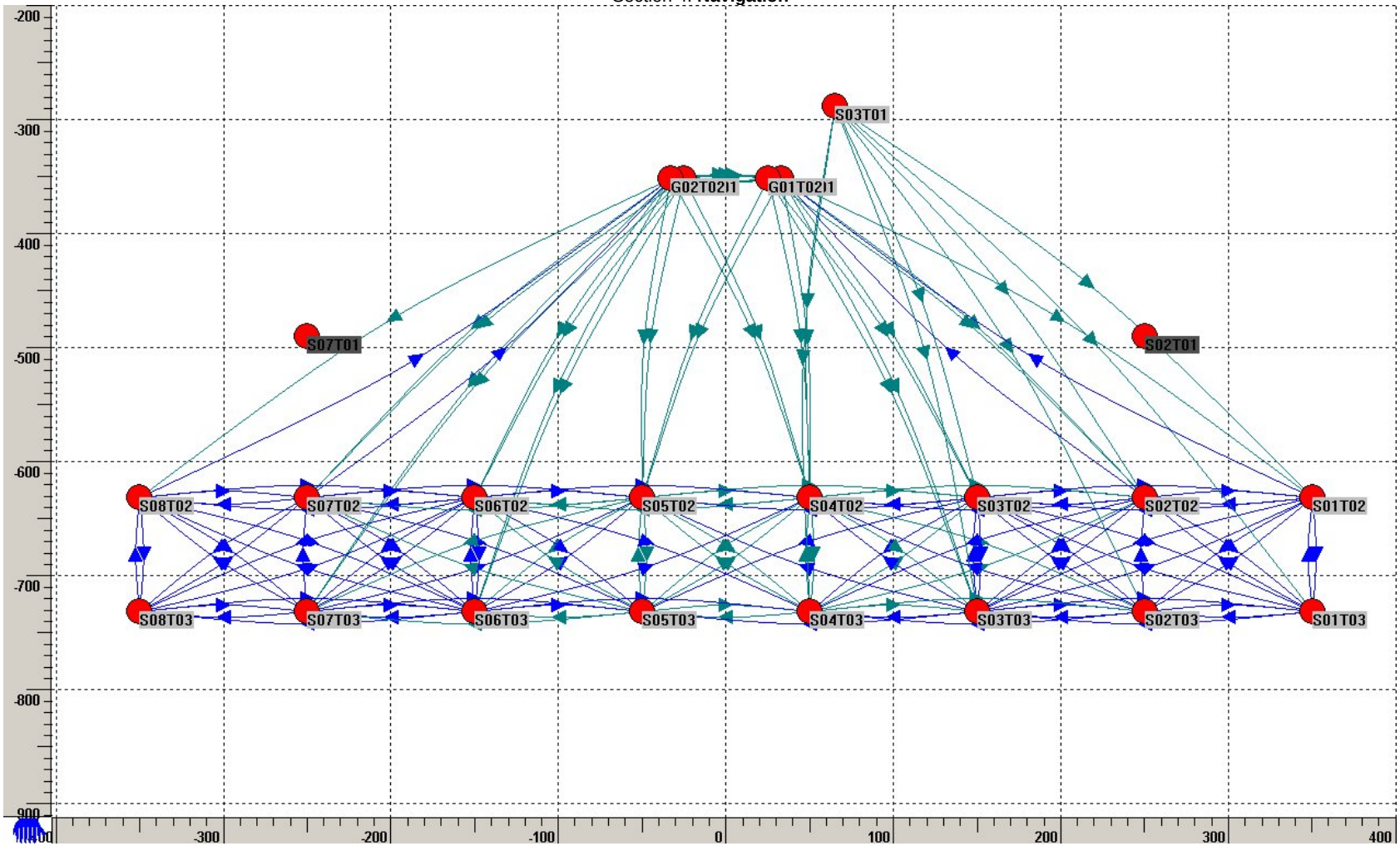


Figure 4 - Front Acoustic Network - Sequences 031-037

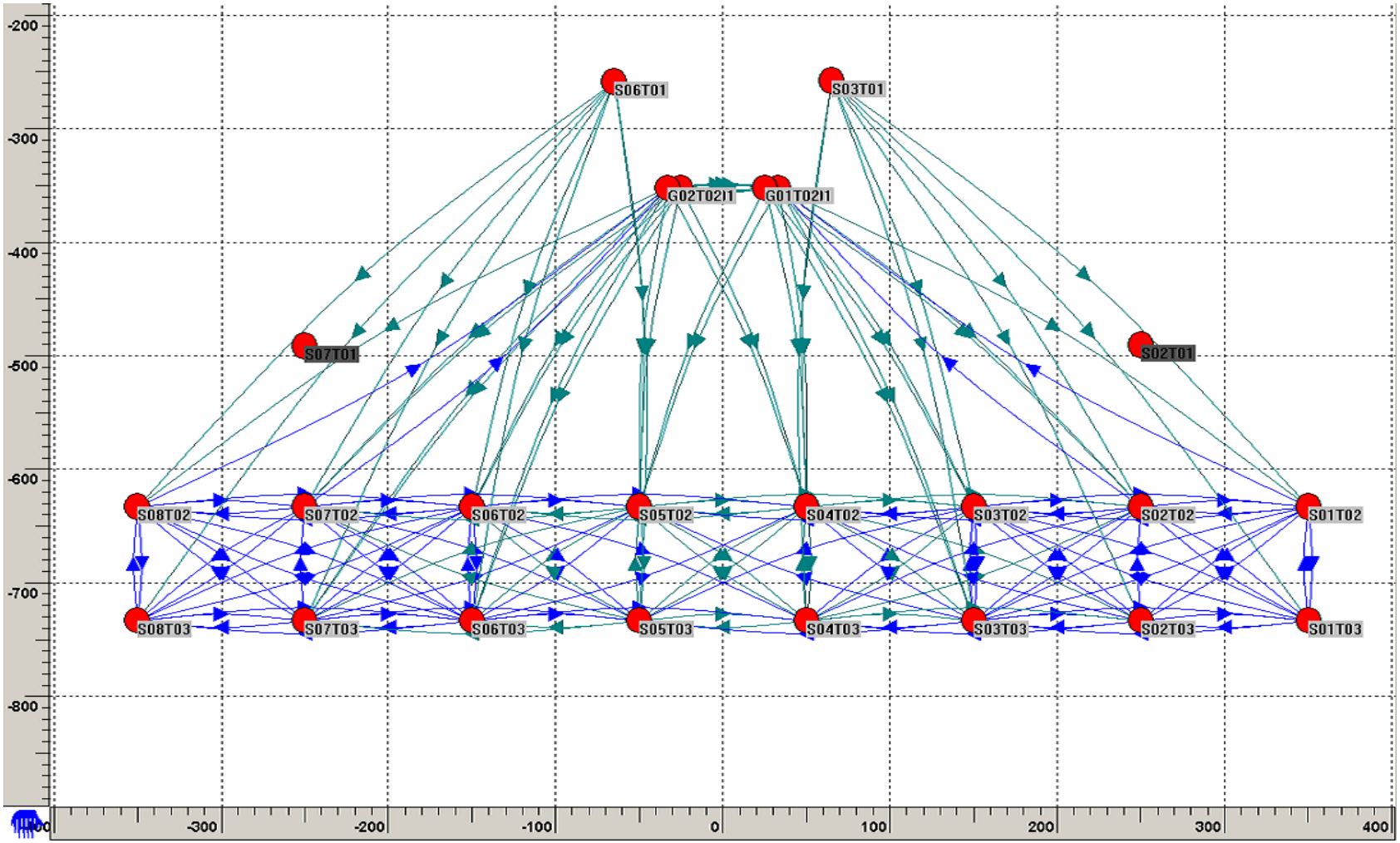


Figure 5 - Front Acoustic Network - Sequences 038-085

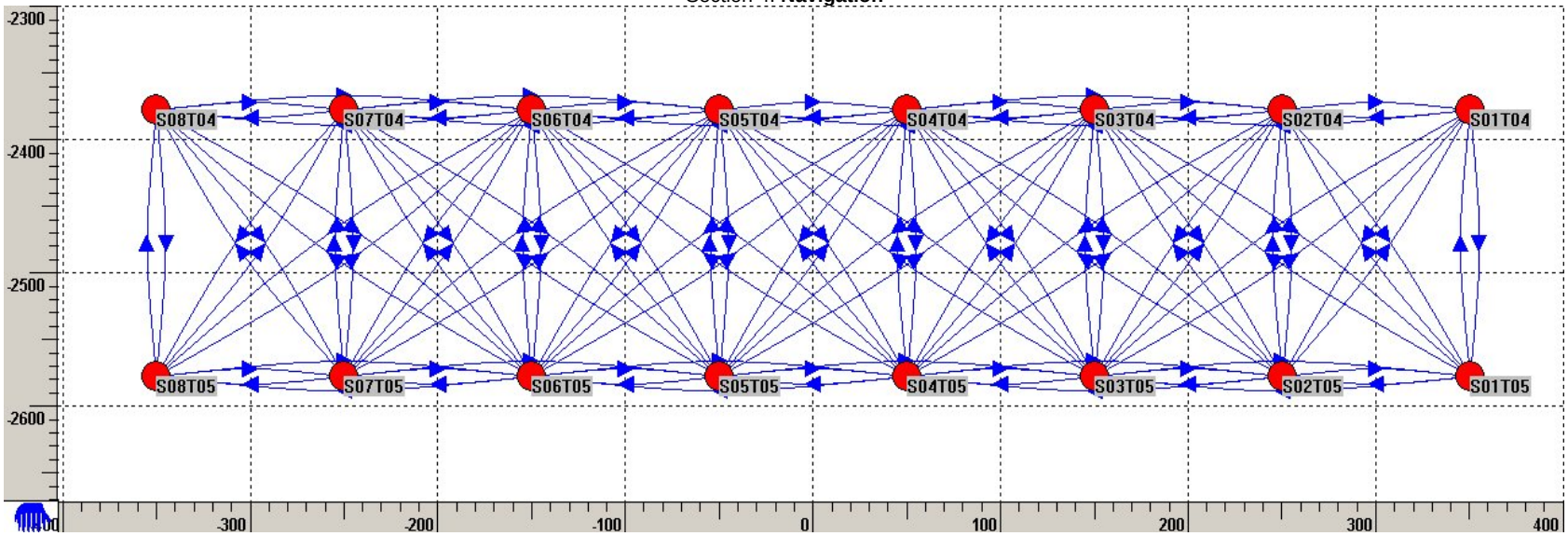


Figure 6 - Mid Acoustic Network

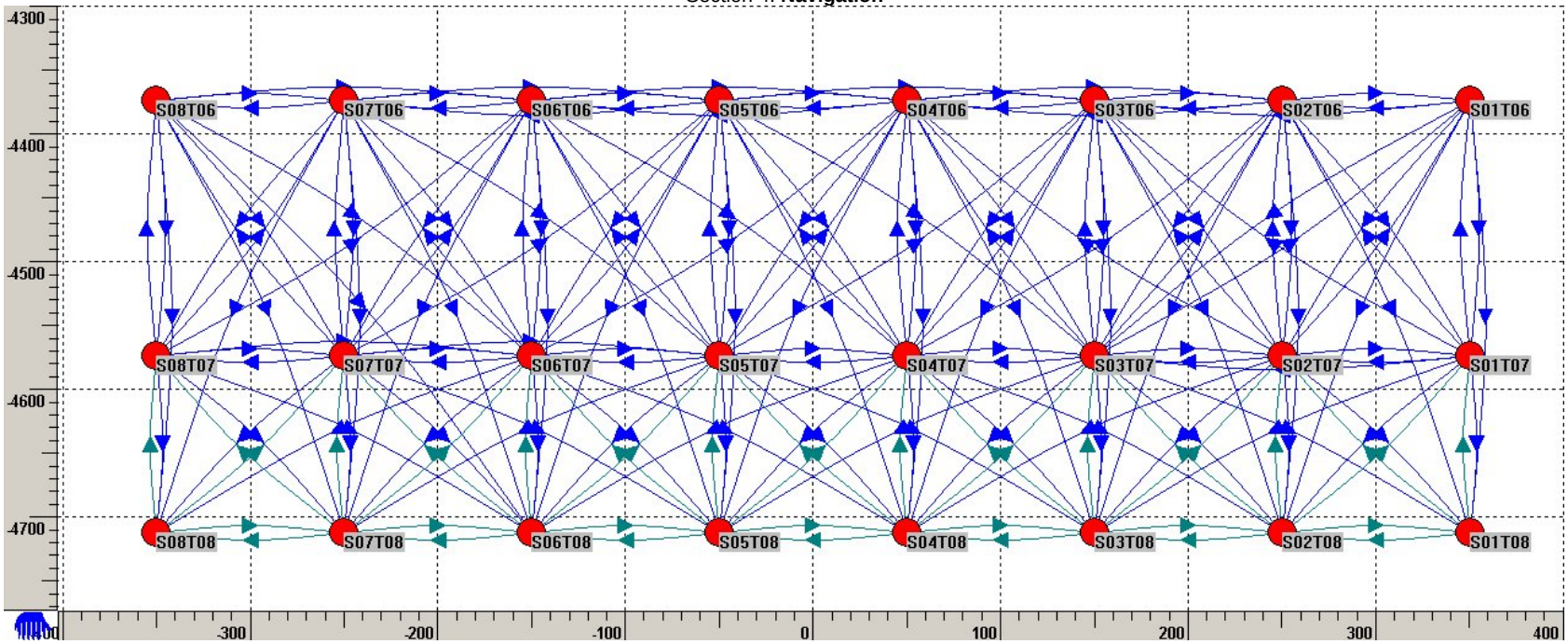


Figure 7 - Tail Acoustic Network

Exhibit 6 **: Survey Definition Changes Summary**

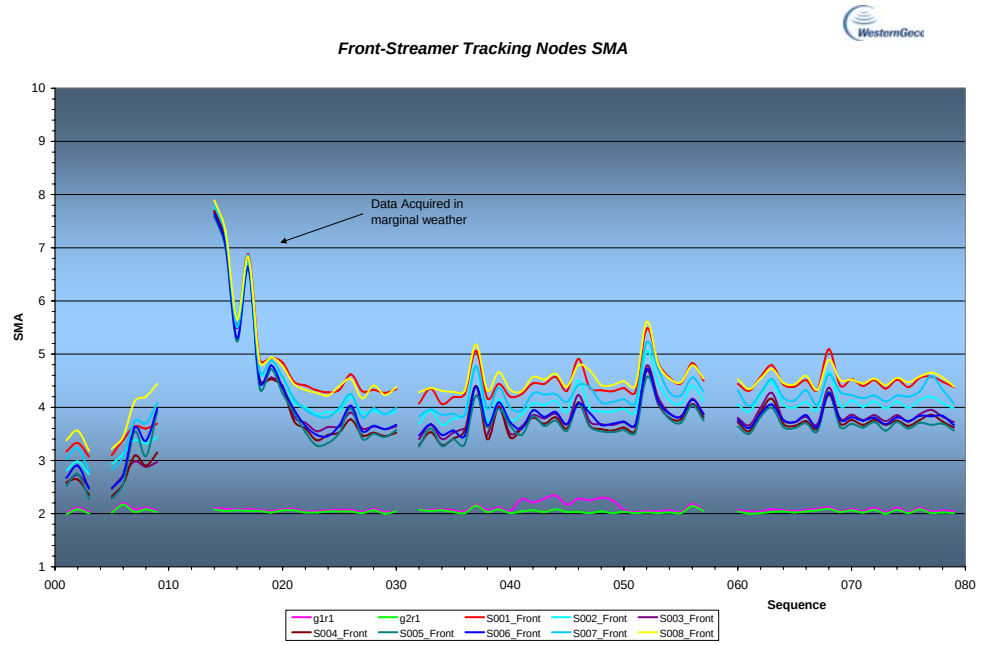
Client:	**Santos Ltd.**	***Vessel:***	**Western Trident**
Area:	**Champion South 3D Hercules 3D Labella 2D**	***Start Date:***	**29/04/07**
Job No:	**9614**	***End Date:***	**27/06/07**

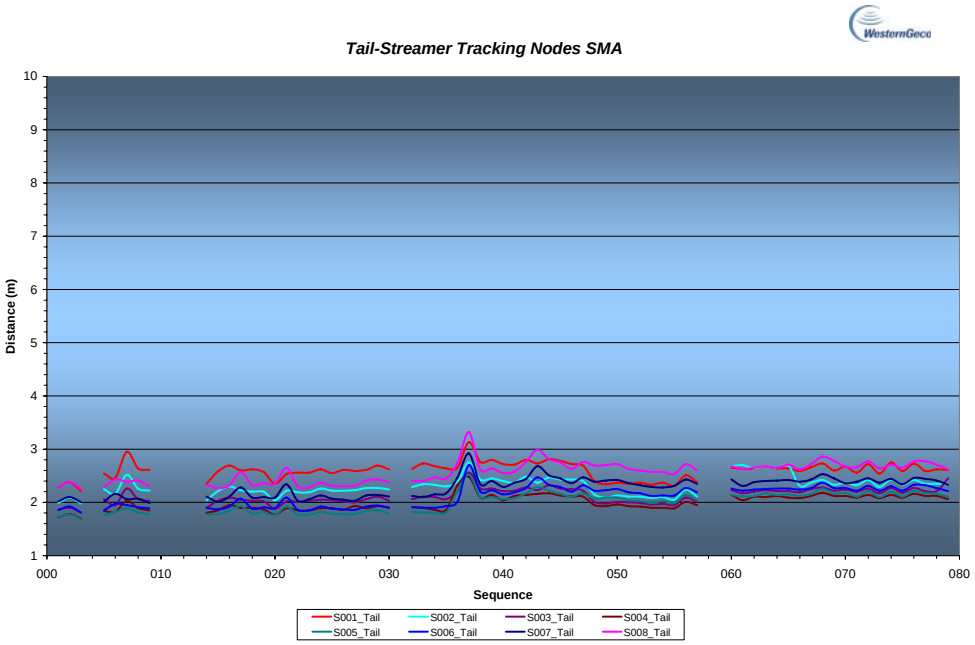
Date	Surdef in use mas9614_	From Seq	To Seq	Offset Database	Description
29-Apr-07	01	000	000	01	New F008 GPS Unit ID Removed all acx from TBs and put them on STIC cables with proper offsets Changed names from FxxT01 -> SxxT08
29-Apr-07	02	001	002	01	Remade F08 and F04 entered slot no's for WB's and remade compass net TS-DIP_01 Added, compass SNs updated. GS3 rt estimator inputs created. Dummy Line included in preplots going across the survey Shot fix point changed from COS -> CMP (no more source DC steering)
02-May-07	03	003	006	01	Remade SIPS job file to same naming convention as TRINAV Survey Editor for port gun-strings and imported into TRINAV Changed offsets of SxT5s by 50m, which was wrong in earlier surdef **All changes updated in previous survey definitions and sequences.**
07-May-07	04	007	016	01	Feedback from FLQC: 1) Area name changed to 'CHAMPION SOUTH' instead of 'CHAMPION SOUTH, OTWAY BASIN' 2) Changed Far Receiver Group on each streamer from 320 to 400 3) Changed S.D's for Baselines S0xT02 -> T03 from 2.5 to 2.0 4) Corrected along offset for all S0xT08 and recalculated streamer slope. 5) Corrected S/N for S3C17 from 15978 to 15798 6) Inserted new correct TSDip data – was using wrong formula previously. 7) Corrections made in LineLog. **Changes 1, 2, 5, 6 and 7 updated in previous survey definitions and sequences.**
10-May-07	05	017	018	02	Added FB01 (Additional Wide Towed Float – Stbd Side) Added FB01T01 and used additional ranges (new adf file #5).
11-May-07	06	019	020	02	Renamed FB01 and FB01T01 to FL… Changed offset of FL01 to correct position insea. Also changed offset of FL01T01 in the ADF file #6
11-May-07	07	021	023	02	Renamed FB01 and fb01t01 to H01 and h01t01… Redundant ranges removed and new ranges added in ADF #7 to strengthen the front net.
12-May-07	08	024	030	02	New compass S07C13 old s/n 30368 new s/n 14210 New compass S02C14 old s/n 21269 new s/n 8519
13-May-07	09	031	036	02	Changed setup of additional front towed float – simulated as attached to streamer 3. Renamed H01 and h01t01 to FF03 and s03t01 Using Sonardyne ADF file #8 containing above name changes only. Added results and data for TSDip02: New Computed Propagation Velocity = 1510.920 New Speed of Sound in water = 1510.880
11-June-07	10				Corrupted
11-June-07	11	037	051	03	Changed Delta Draft after inspection from -0.2m to -0.9m Added FF06 (Additional Wide Towed Float – Port Side) Added S06T01 and used additional ranges (new adf file #9). Changed streamer offset- New: 610m Old: 570m Changed source offset- New: 370m Old: 330m Changed Gyro s.d. to 2.0 (due to only 1 Gyro in the estimator). Changed S6C10 old s/n 12671 new s/n 19330 Changed the geoid height from 3 to -5m. Note that this value is only used in Manual mode when the GeoidServer is turned off. This does not affect any previous or current sequences; it is a cosmetic change only and was corrected

					for purposes of consistency. Changed Seatrack F006 new 1729, old 1528 New compass S07C5 old s/n 18122 new s/n 18111 New compass S07C4 old s/n 6594 new s/n 8524 New compass S07C3 old s/n 7941 new s/n 14145 New compass S07C2 old s/n 13576 new s/n 18101 New compass S01C5 old s/n 20189 new s/n 20002 New compass S08C10 old s/n 14014 new s/n 17173 New compass S08C8 old s/n 7697 new s/n 20323 New compass S06C10 old s/n 19330 new s/n 19038 Changed S3C17. new s/n is 9373 (old 17305) Changed S3C16. new s/n is 14595 (old 20368) Changed S3C13. new s/n is 7205 (old 20089) Geoid sepration -2, only applied if in manual Changed S5C9 new s/n 8192 (old 17256) Changed S6C10 new s/n 16931 (old 19038) Changed S2C14 new s/n 20186 (old 14293)
16-Jun-07	12	052	057		TSDip-03 Included New Computed Propagation Velocity = 1509.49 New Speed of Sound in water = 1509.35
18-Jun-07	13	058	079		Old preplots removed. New preplots loaded Survey Area Name changed to HERCULES
26-Jun-07	14	080	085		Old preplots removed. New 5 lines added. Changed line name Prefix (HOT07A-) Changed Client Name to (SANTOS LIMITED / BHP BILLITON PETROLEUM) Survey type changed to 1STREAMER SINGLE SOURCE Survey Area: Name → Labella 2D, Australia Shot distance → from 18.75m to 25m Shot time increment → 10 sec (approx) Cell size inline → from 6.25m to 12.5m G02 → firing sequence set from 2 to '0'

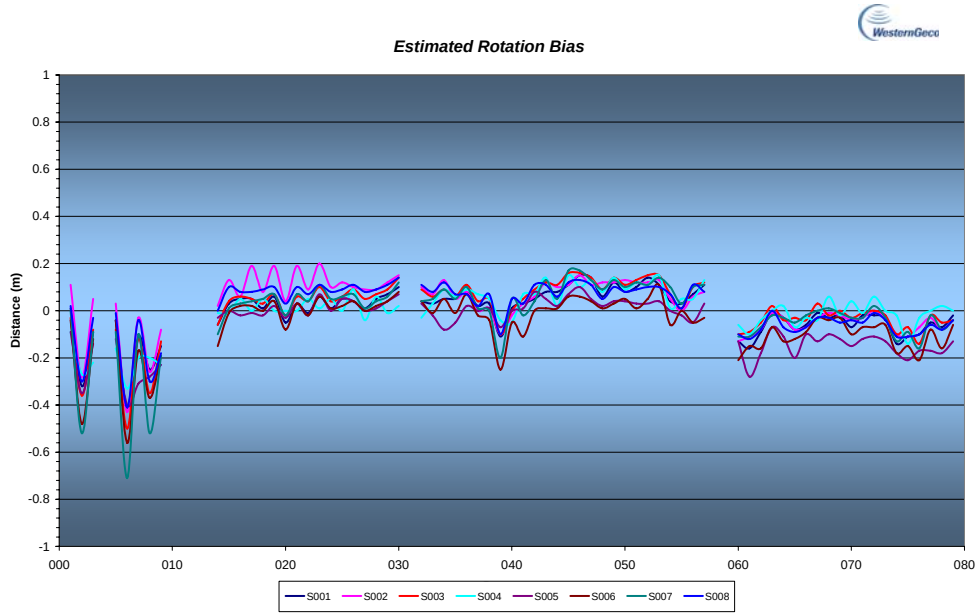
Exhibit 7 **: Trend Analysis**

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

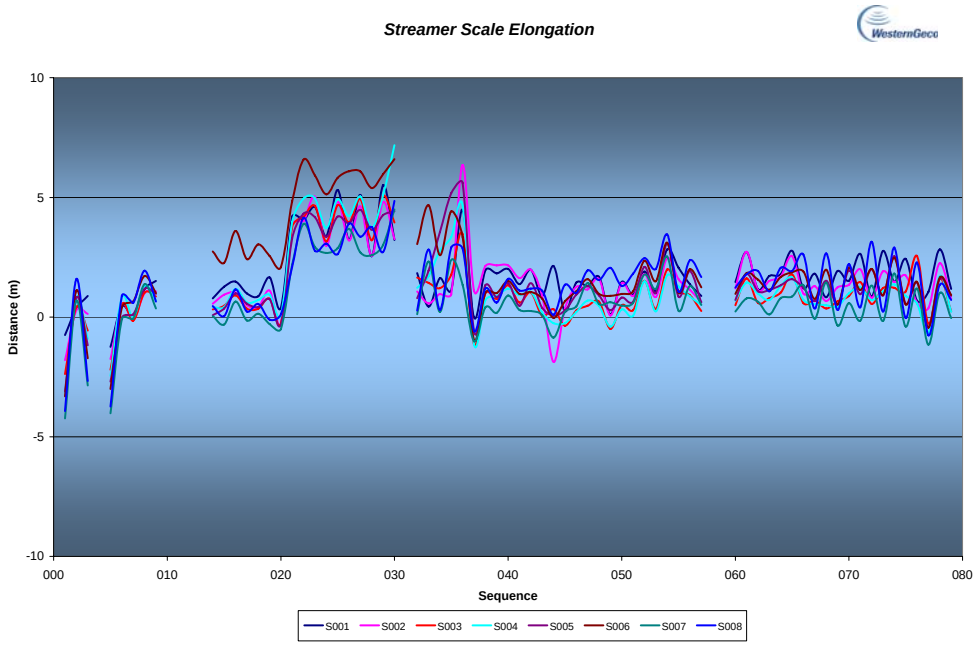




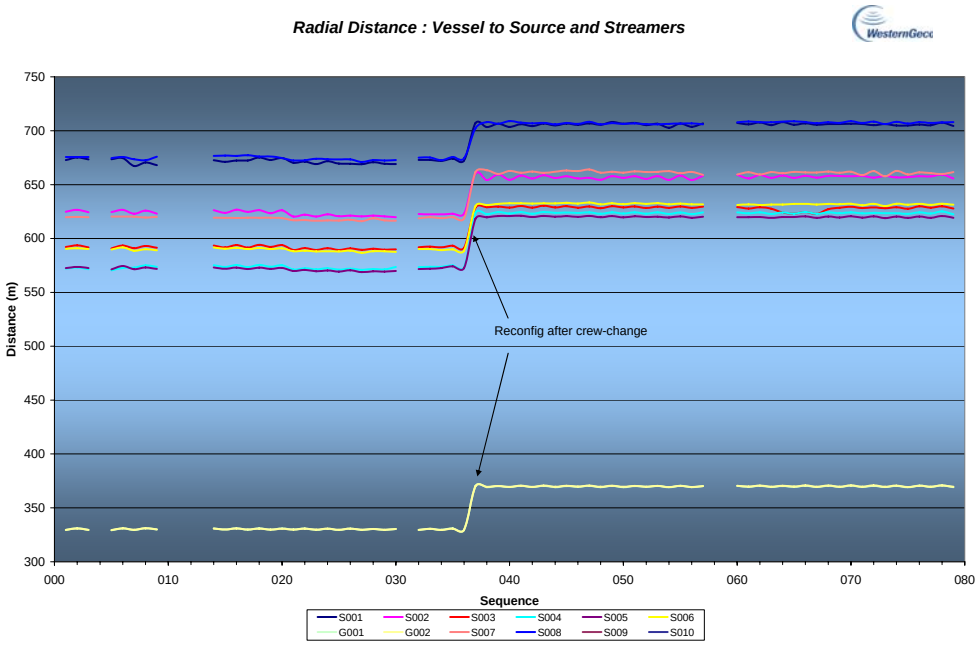
❑ Estimated Rotation Bias



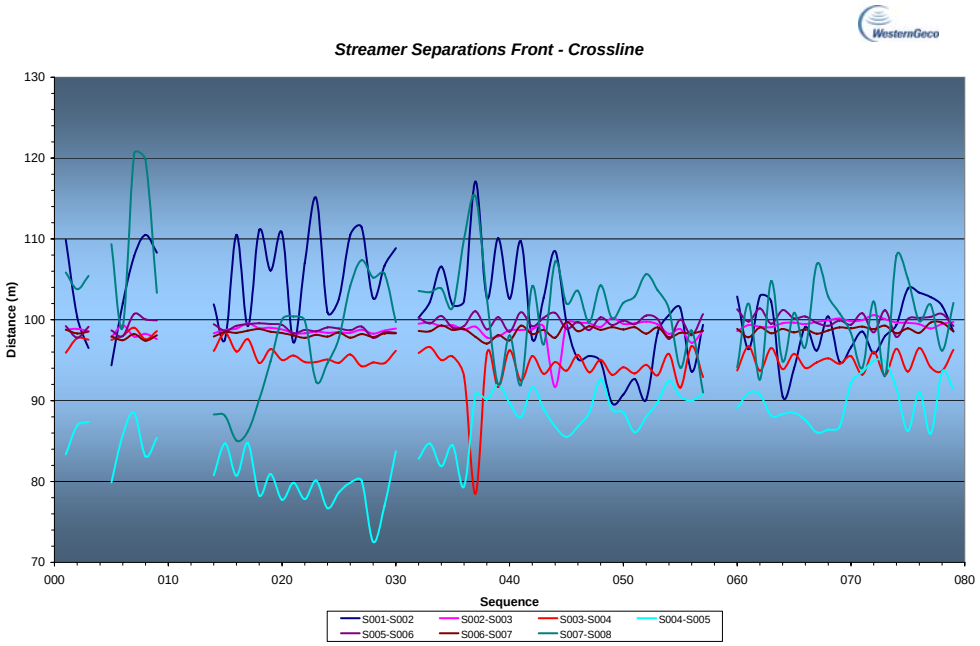
❑ Streamer Scale Elongation

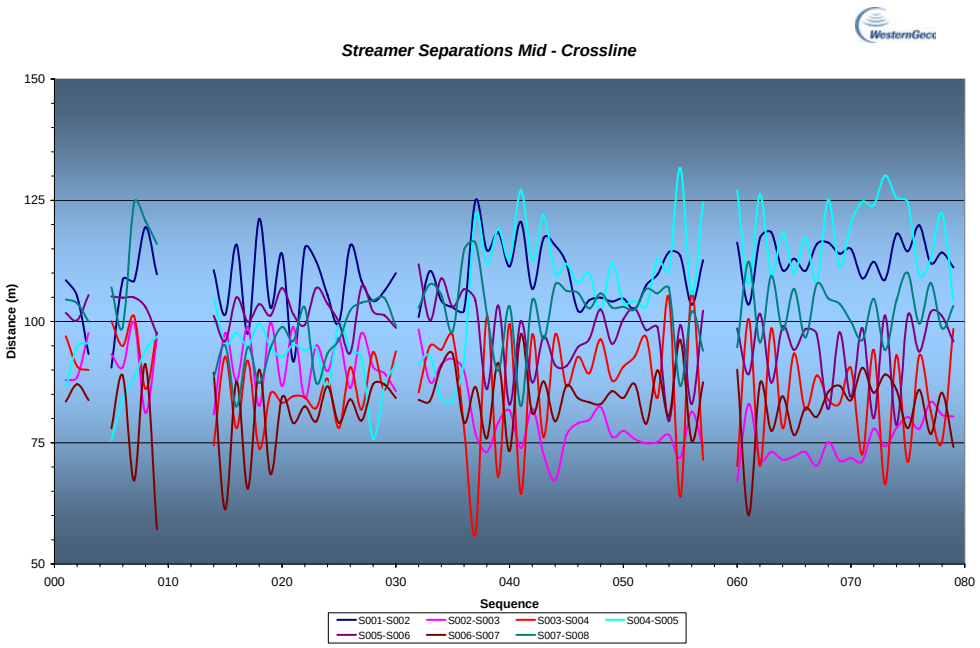


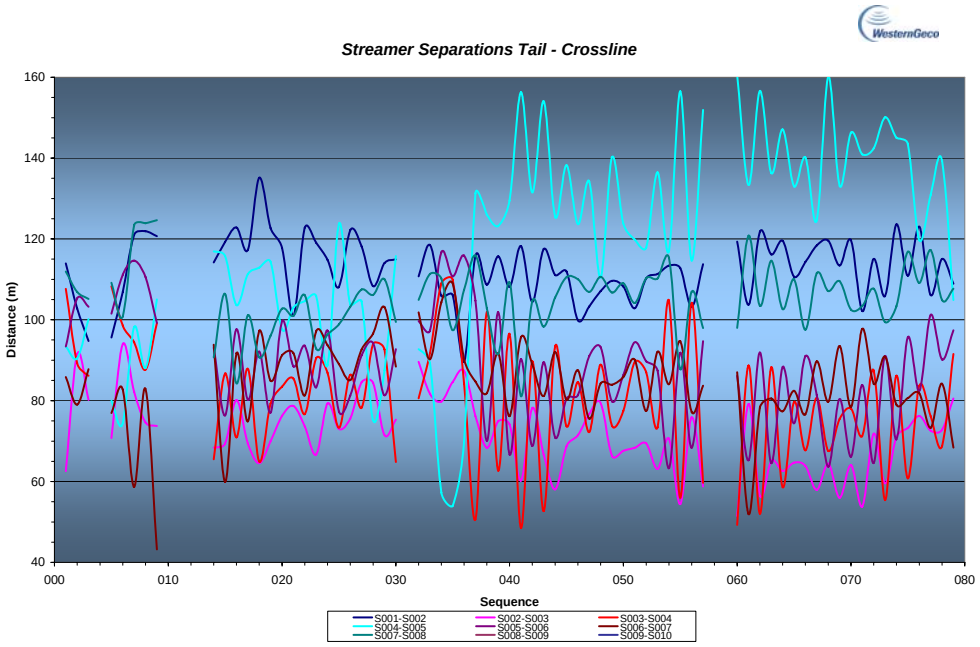
❑ Radial Separation (Vessel to all streamers and sources)



❑ Cross Separation (All streamers to front, middle and tail)




Streamer Separations Mid - Crossline
Distance (m)
150
125
100
75
50
000
010
020
030
040
050
060
070
080
Sequence
S001-S002
S002-S003
S003-S004
S004-S005
S005-S006
S006-S007
S007-S008


Streamer Separations Tail - Crossline
Distance (m)
160
140
120
100
80
60
40
000
010
020
030
040
050
060
070
080
Sequence
S001-S002
S002-S003
S003-S004
S004-S005
S005-S006
S006-S007
S007-S008
S008-S009
S009-S010

❑ Cross Separation (Sources)

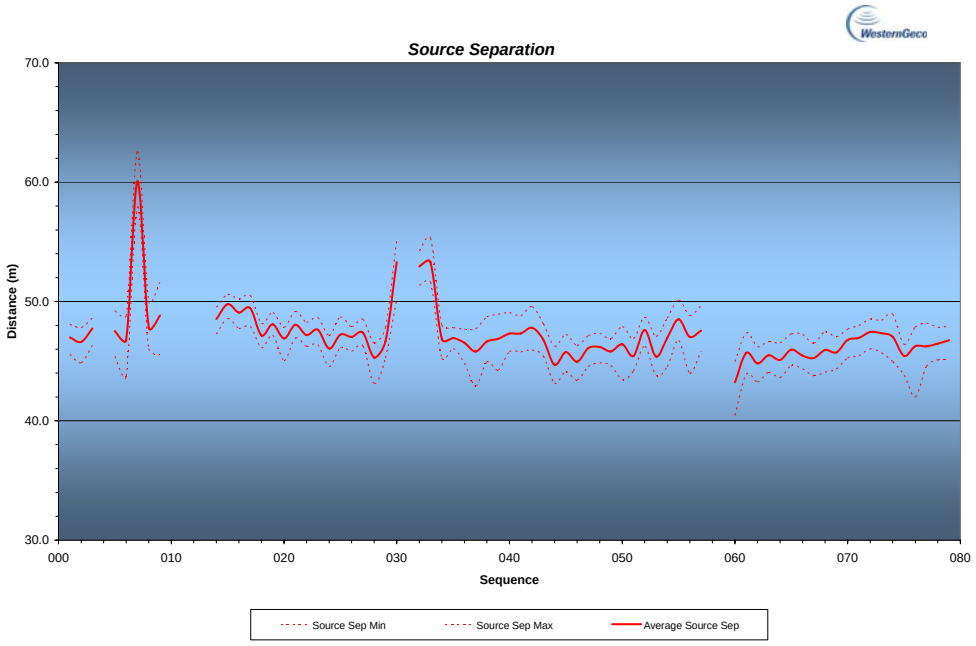
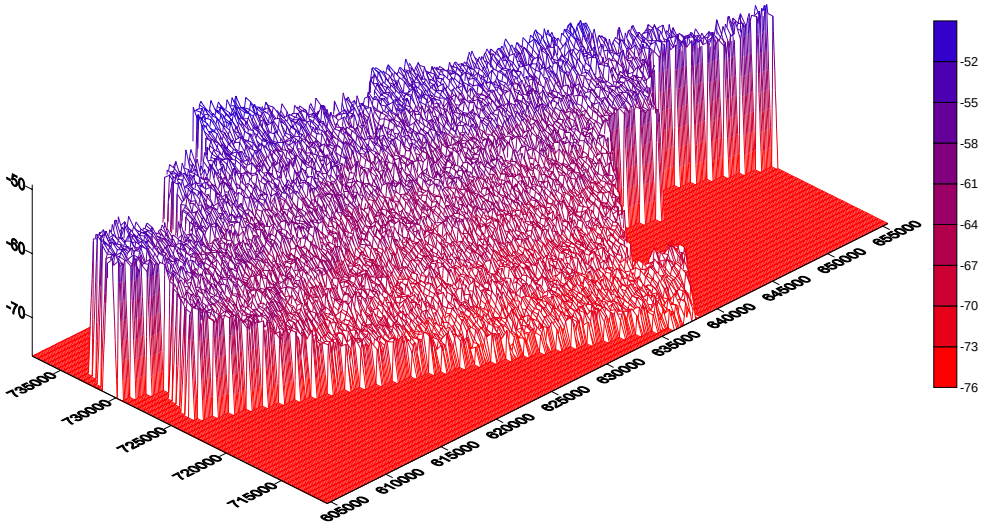
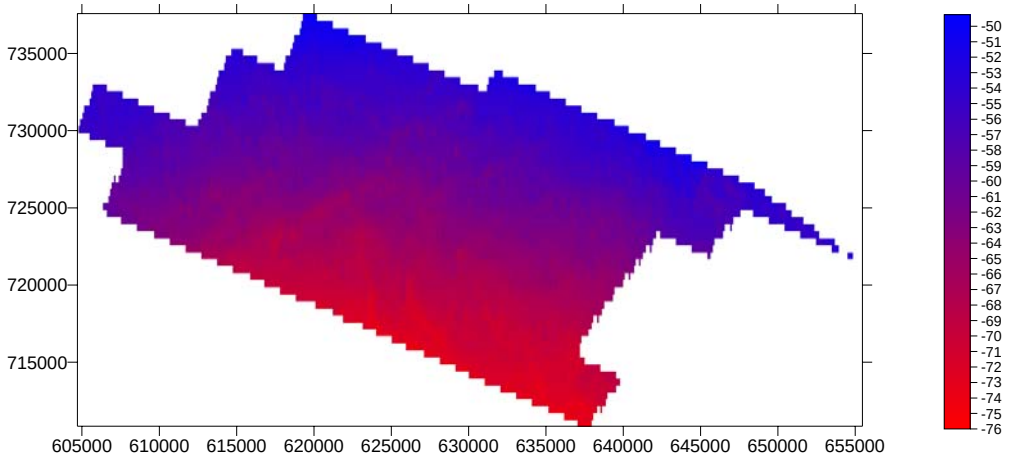


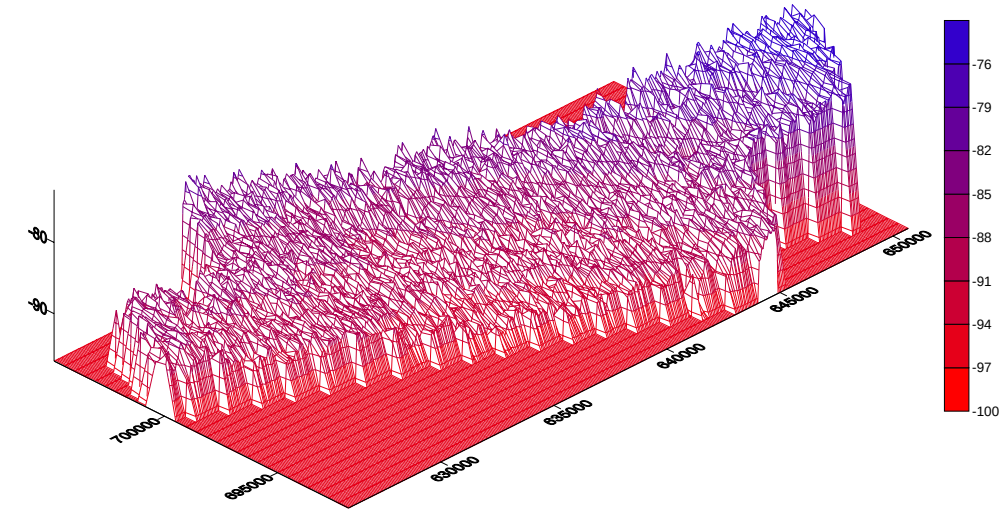
Exhibit 8 **:** SURFER Plots

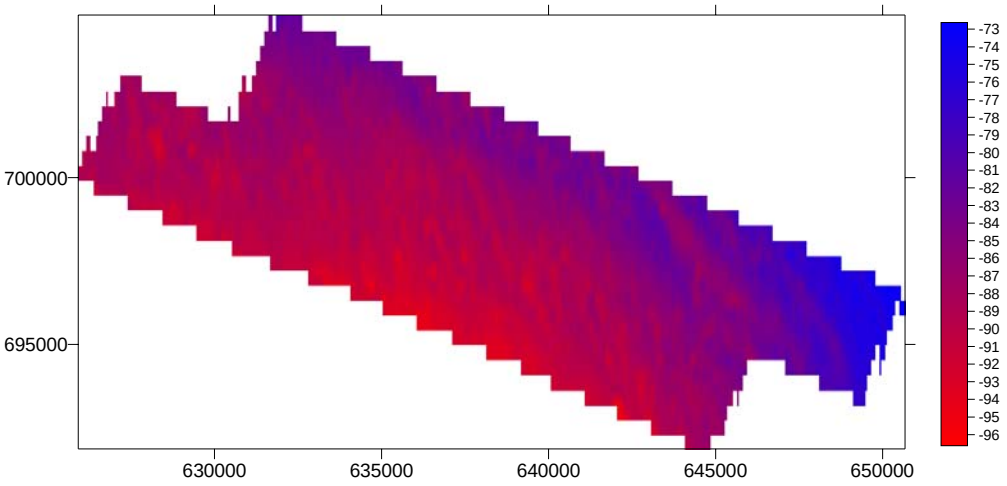
Champion South:





Hercules


-76
-79
-82
-85
-88
-91
-94
-97
-100
700000
695000
690000
650000
645000
640000
635000
630000


-73
-74
-75
-76
-77
-78
-79
-80
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-86
-87
-88
-89
-90
-91
-92
-93
-94
-95
-96
700000
695000
630000
635000
640000
645000
650000

Instrumentation, Source and QC

Table of Contents

21. Instrumentation and QC System Description

21.1. Recording and On-line QC system Description

System	Hardware	Software
Recording	Input/Output MSX system VME Chassis Sun Ultra 10	Version 2.01
Recording	TriAcq 5 – SunFire V440 SeisNet – Dell Power Edge 2600	Version 5.3305
Tape drives	6 IBM 3590E tape drives	
Plotter	OYO Geospace: 24 inch	
On-line QC	TriAcq Q5 – SunFireV890 TriAcq Q6 - Dell Precision 690 Omega – Dell Precision 490	Version 3.0 Omega 2.401p
Source Controller	TriSor – SunFireV240	Version 1.5.2
Auxiliary Systems	MSX	Version 2.01
Navigation System	TriNav SunFire V440	Version 3.0.1
External Header	(TIM) SunFire V120	Version 2.4.2
Tension Monitor	WesternGeco STM	Version 4.7
Bird Controller	Digicourse System 3	Version 5.01

The onboard data quality control functions are performed both online and offline. TriAcq QC and Omega2 Processing System were used for online QC displays such as RMS noise analysis, Sources Comparison, Guns pressures/depths/timing displays, shot gather display and aerial RMS display. The On-line QC system allowed monitoring of data quality in real time and gave the ability to make immediate decisions if necessary.

The recording and processing systems were connected to the other onboard departments through the vessel network, which also provided an easy access to/from onshore processing centres for all required data transfers, as well as for onshore support and/or hardware maintenance. The following pages contain a description of the onboard quality control and processing system instruments.

21.2. Off-Line QC System

System	Hardware	Software
OMEGA SPS Onboard Processing (RedHat Linux OS)	1 x Dell Precision 650 Workstation 2 x Intel SR2300 System Servers 2 x Intel SR2300 Tape Servers 3 x IBM x346 Filesystem Servers 4 x 2TB IBM EXP400 SCSI Disk Enclosures (14 x 146GB disks) 16 x IBM x336 Nodes 3 x Cisco 3750 Switches 1 x Dell 2161DS KVM Switch 10 × 3590E Tape Drives 1 × 36" OYO plotter	OMEGA version 2.401p

22. Instrumentation and QC Tests

22.1. Start-up tests

A set of semi-monthly instrument tests were run showing no major problems in the spread.
Results shown below on sections 22.4.

22.2. Additional Client Tests

22.2.1. Gain Correction Tests

The set of gain correction tests was run to derive a gain correction function to be applied in Brute Stack, Near Trace Gather and Water Bottom Cube jobs flow.
The parameters were tested using data from line 1008P1001 and verified using data of the line 1232P002.

The table below represents the parameters of tests.
Velocity function for Geospread compensation was supplied by Santos.

- **Gain Correction Tests**

Test #	Gain Correction Function
1	Geospread compensation, application time 0 – 6144 ms;
2	Time function gain: T**2.0; Application time: Two way water bottom travel time – 6144 ms.
3	Time function gain: T**1.8 Application time: Two way water bottom travel time – 6144 ms.
4	Geosp 0-4000 + Gain 4 db start 750ms, end 2750 ms
5	Geosp 0-4000 + Gain 5 db start 750ms, end 2750 ms
6	Geosp 0-5000 + Gain 2 db start 750ms, end 3250 ms
7	Time function gain: T**1.9 Application time: Two way water bottom travel time – 4500 ms.
8	Time function gain: T**2.0 Application time: Two way water bottom travel time – 4000 ms.
9	Time function gain: T**2.1 Application time: Two way water bottom travel time – 4000 ms.

- **Conclusion**

The parameters of the last test were accepted for production.

22.2.2. Velocities Test

A water bottom dependent function was provided by Santos. The final velocity function, used in production, is presented below in a form of pair Time / Velocities with WB TWT as a control point.

Control Point	Pairs of Time (ms) / Velocities (m/s)
50	0 1520 50 1520 199 1736 299 1928 391 2096
	459 2204 571 2352 656 2420 743 2480 843 2532
	940 2568 1044 2612 1238 2640 1394 2700 1573 2776
	1797 2920 2042 3148 2161 3324 2319 3508 2576 3756
	2814 4008 3160 4322 3506 4580 3790 4760 4111 4936
	4470 5076 4912 5236 5500 5401 6500 5700
100	0 1520 100 1520 250 1736 350 1928 400 2096
	500 2204 620 2352 696 2420 743 2480 843 2532
	940 2568 1044 2612 1238 2640 1394 2700 1573 2776
	1797 2920 2042 3148 2161 3324 2319 3508 2576 3756
	2814 4008 3160 4322 3506 4580 3790 4760 4111 4936
	4470 5076 4912 5236 5500 5401 6500 5700
200	0 1520 200 1520 350 1736 450 1928 500 2096
	600 2204 720 2352 796 2420 843 2480 943 2532
	1000 2568 1044 2612 1238 2640 1394 2700 1573 2776
	1797 2920 2042 3148 2161 3324 2319 3508 2576 3756
	2814 4008 3160 4322 3506 4580 3790 4760 4111 4936
	4470 5076 4912 5236 5500 5401 6500 5700

22.2.3. Front Mute Parameters

The front mute, used for Brute Stack, was derived from NMO corrected CMP gathers as a two way water bottom travel time (WB TWT) dependent function.

WB TWT (ms)	Offset (m)	Mute Time (ms)
	0 500 630 2200 4500	0 10 780 2900 5000

22.2.4. Swell Noise Attenuation Parameters Test

Swell noise attenuation (SWATT) parameters were tested using the data of noisy lines 1024P003 and 1248P004.

The table below represents the parameters of tests. The 0 ms time in a second column corresponds to two way water bottom travel time plus 100 ms delay.

- **SWATT Tests**

Test #	Time (ms)	Threshold
1	0 1000 2000 4000 6000	200 40 15 9 6
2	0 1000 2000 4000 6000	200 20 5 3 3
3	0 1000 2000 4000 6000	200 40 10 3 2.5
4	0 1000 2000 4000 6000	200 40 7 5 3

- **Conclusion**

The parameters of the test 4 were accepted for production.

22.3. Daily and Semi-Monthly Tests

- **Daily Test**

A set of Daily tests consists of 6 files recorded to Tape. The Tests can be run either manually or from the default scripts on the MSX System.
The Sets of Daily test will be performed on a daily basis, every 24 hours, during the survey if the operational time allowed.

File 1: T13, 0dB, 15.625Hz Sine Wave
File 2: T2, 0dB, 15.625Hz Sine Wave, No Hydrophones. Spec: DRD +/- 4%, THD < 0.0005%
File 3: T2, -60dB, 15.625Hz Sine Wave, No Hydrophones. Spec: DRD +/- 4%, THD < 0.5%
File 4: T5, Pre-Amp Input Shorted, No Hydrophones. Spec: Noise < 2.9uV (-114dB FS)
File 5: T6, Impulse, No Hydrophones. Spec: Spectral Response +/- 10%, Amplitude Difference.

- **Cable Test**

File 1: T11, Cross-feed Isolation, Odd Pair Driven, +4dB, 15.623 Hz Sine Wave, Phones connected.
File 2: T12, Cross-feed Isolation, Even Pair Driven, +4dB, 15.623 Hz Sine Wave, Phones connected.
File 3: T7, Impulse, with Hydrophones. Spec: Spectral Response =/- 10% Amplitude Difference.
File 4: T7, Step 0-1, with Hydrophones. Spec: Spectral Response =/- 10% Amplitude Difference.
File 5: T4, 0dB, 15.625Hz Sine Wave, With Hydrophones. Spec: DRD +/- 10%
File 6-7: T0 (Normal Production) cable noise files, with Production Low cut filter, usually 8Hz/18dB and 6Hz/18dB respectively.

The tests check the validity of the hydrophone input (T4, T7, T11, and T12), These tests do not strictly determine the validity of the in-sea spread. These test results are for use by the operator to aid in pro-active cable trouble-shooting, determination of cable maintenance plans, and the creation of trace edits. The relative trace sensitivity will be validated on signal data using the line-averaged trace RMS QC, which will be performed on every sequence acquired.

- **Semi-Monthly Test**

A Semi-Monthly Test consists of 26 files recorded to Tape. The Tests can be run either manually or from the default scripts on the MSX System.
The Sets of Semi-monthly test were performed at the start of the survey, before the end of the survey, and on monthly basis during the survey.

File 1000: T13, Dummy File
File 1001: T13, Special Bit Pattern, All Ones
File 1002: T13, Special Bit Pattern, 50/50
File 1003: T13, Special Bit Pattern, All Zeros
File 1004: T13, 0dB, 15.625Hz Sine Wave

File 1005 – 1015: T2, 15.625Hz Sine Wave, stepped from 0dB through to –100dB, No Phone connected.

File 1016: T5, Pre-Amp Input Shorted, No Hydrophones. Spec: Noise <2.6uV (-114dB FS), No Phone connected.

File 1017: T10, Common Mode, +4dB, 15.625 Hz Sine Wave, Phones connected.

File 1018: T6, Impulse, No Hydrophones. Spec: Spectral Response =/- 7% Amplitude difference.

File No.	Test Mode	Data Type	Low Cut	DC Offset Removal	Analysis -- Spec	
1000	T13	Dummy File	OUT	NO		
1001	T13	All One	OUT	NO	**PATTERN**	
1002	T13	50/50	OUT	NO	DOWN TRACE	
1003	T13	All Zeros	OUT	NO	0 errors	
1004	T13	15.625 Hz @ 0 dB	OUT	NO	Sample – 0 errors	
					THD	**DRD Amp**
1005	T2	15.625 Hz @ 0DB	IN	YES	< 0.0005%	+/- 4%
1006	T2	15.625 Hz @ -10 dB	IN	YES	< 0.002%	+/- 4%
1007	T2	15.625 Hz @ -20 dB	IN	YES	< 0.005%	+/- 4%
1008	T2	15.625 Hz @ -30 dB	IN	YES	< 0.016%	+/- 4%
1009	T2	15.625 Hz @ -40 dB	IN	YES	< 0.05%	+/- 4%
1010	T2	15.625 Hz @ -50 dB	IN	YES	< 0.16%	+/- 4%
1011	T2	15.625 Hz @ -60 dB	IN	YES	< 0.50%	+/- 4%
1012	T2	15.625 Hz @ -70 dB	IN	YES	< 0.6%	+/- 4%
1013	T2	15.625 Hz @ -80 dB	IN	YES	< 5.0%	+/- 4%
1014	T2	15.625 Hz @ -90 dB	IN	YES	No Spec	+/- 4%
1015	T2	15.625 Hz @-100 dB	IN	YES	No Spec	+/- 4%
1016	T5	Pre-Amp Noise - Input Shorted - SBP 50/50	IN	YES	Noise level < 2.9uv (-114 dB FS)	
1017	T10	Common Mode **** 15.625 Hz @ 0 dB	IN	YES	**DRD** -- < 66 dB FS	
1018	T6	Impulse Response * Bit Pattern :Impulse	2Hz	YES	**SPECTRAL**-- +/- 10% amplitude difference	

22.4. Start of Job Instrument Test

Performed 6th June 2007

SemiMonthly Test Results

Cable	Location	SG	Trace	Channel	File 1	File 2	File 3	File 4	File 5	File 6	File 7	File 8	File 9	File 10	File 11	File 12	File 13	File 14	File 15	File 16	File 17	File 18
					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	T 6 Impulse response 2Hz
					All Ones	50/50	All Zeros	Sine 15.625	< 0.0005%	< 0.002%	< 0.005%	< 0.016%	< 0.05%	< 0.05%	< 0.16%	< 1.6%	< 5%	+/- 4.0%	+/- 4.0%	< .210 uB	<66dB FS	+/- 7.0%
1																						
2																						
	1A		407	7																		1.55
	7A		500	100																		0.77
	20B		716	316																0.2		
	21A		721	321											0.162165							
	21A		722	322										0.05507	0.209486							
	21A		723	323											0.172254							
	21A		724	324											0.17171							
	21A		726	326											0.181865							
	21A		727	327											0.175							
	21A		728	328											0.186198							
3																						
4																						
5																						
	13A		1793	193																0.238		
6																						
7																						
	11A		2566	166											0.16609							
8																						
	21A	SG	3128	328																0.226		

22.5. End of Job Instrument Test

Performed 27th June 2007

SemiMonthly Test Results

Cable	Location	SG	Trace	Channel	File 1	File 2	File 3	File 4	File 5	File 6	File 7	File 8	File 9	File 10	File 11	File 12	File 13	File 14	File 15	File 16	File 17	File 18
					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	T 6 Impulse response 2Hz
					All Ones	50/50	All Zeros	Sine 15.625	< 0.0005%	< 0.002%	< 0.005%	< 0.016%	< 0.05%	< 0.05%	< 0.16%	< 1.6%	< 5%	+/- 4.0%	+/- 4.0%	< .210 uB	<66dB FS	+/- 7.0%
1																						
	7b		110	110					0.000552													
2																						
	1a		407	7																		1.55
	7a		500	100																		0.77
	21a		721	321											0.171264							
	21a		722	322										0.059218	0.215783							
	21a		723	323										0.050781	0.184102							
	21a		724	324											0.182744							
	21a		726	326										0.052199	0.193328							
	21a		727	327										0.050439	0.186171							
	21a		728	328										0.052497	0.192179							
3																						
4																						
5																						
	13a		1793	193																0.237		
6																						
7																						
	11a		2565	165											0.162922							
	11a		2566	166											0.18255							
	11a		2568	168											0.160046							
	23a		2754	354					0.026209	0.137604	0.898782	4.828258	60.90997	75.71314	2.105312	90.84419	29.90157	64.4847	71.1893	13.662		15.06
8																						
	24b		3182	382																0.227		

23. QC Products and Processing Sequence

23.1. Shots and FK Spectral Analysis

The Raw Shot record & FK spectra were displayed online for the every 9-th shot with rotation of selected source / streamer combination. This helped to identify noise sources, and to QC data outside the windows used for attribute analysis.
The FK analysis was performed over the ambient window (0 – 500 ms. of last 80 traces) of the raw shot record and the result was displayed online using SeisView (Interactive Display) software. FK analysis was also performed over the seismic data (from Water Bottom + 2000 ms. to maximum reflection time). Every 63-rd shot was output to disk for visual inspection in DIO format (Internal Omega2 format) at the end of line.
For every line Shot and FK displays of the one shot / cable were saved in PNG format and posted in SuperVision.

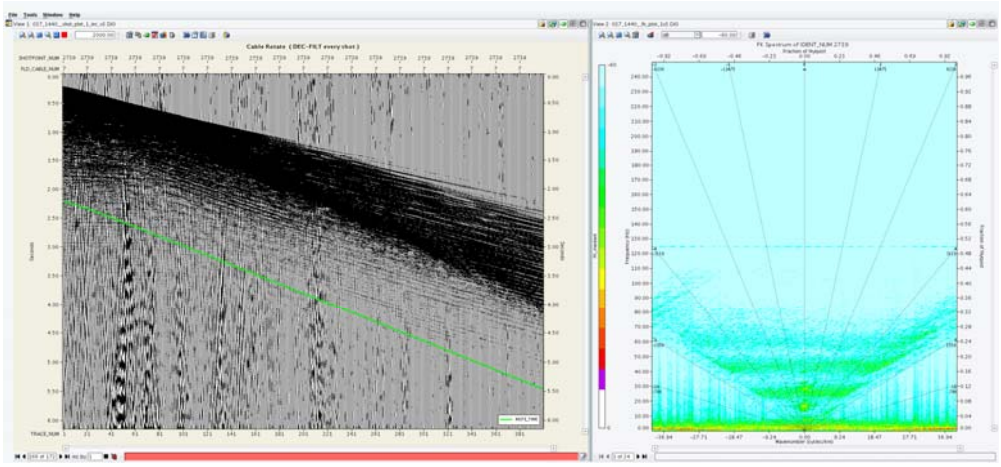

Figure 1. Raw Shot and FK Display. Sequence 037.

23.2. Online RMS Analysis

RMS values were calculated for every trace and each shot. These were calculated in the entire frequency range, and also were split into three bands of frequencies, 0 to 6 Hz, 6 to 60 Hz and above 60Hz.
All calculated RMS values were stored in the Aqua Database and displayed using PRO and ATV.

23.2.1. Deep and Ambient RMS Windows

Deep window RMS values were calculated in a time window from 5600-6144 ms of the records. RMS values were calculated for every trace, each shot.

Ambient RMS values were calculated in a time window from 0 – 500 ms. The calculation was performed for the last 80 field channels of each streamer to evaluate average ambient RMS level.

- **Processing Sequence**

1.	Data Input:	Deep RMS: All shots, all channels, window 5600 - 6144 ms. Ambient RMS: All shots, last 80 field channels of each streamer (on-line), all channels (off-line), window 0 - 500 ms.
2.	Scaling:	By 71.428571 to convert amplitudes to microbars.
3.	Raw RMS Analysis:	One trace is output for each shot containing the RMS amplitude over the window for each selected channel: Deep RMS analysis: field channels 1 - 400 Ambient RMS analysis: field channels 321 – 400; Low cut 6 Hz. High cut 206 Hz.
4.	Low Frequency RMS Analysis:	One trace is output for each shot containing the Deep RMS amplitude over the window (see row 1) for each channel. Low cut 2 Hz. High cut 6 Hz.
5.	Mid Frequency RMS Analysis:	One trace is output for each shot containing the Deep RMS amplitude over the window for each channel. Minimum phase band pass filter was applied: Low cut 6 Hz; High cut 60 Hz.
6.	High Frequency RMS Analysis:	One trace is output for each shot containing the Deep RMS amplitude over the window for each channel. Low cut 60 Hz; High cut 206 Hz.
7.	Output:	To disk file (Aqua Database).
8.	Online display:	Using PRO and ATV.

23.2.2. RMS Displays

The outputs, described in 23.2.1, generated various displays, allowing analysis of the level of noise in different frequency bands, to identify noise source (sometimes in combination with information from Shot display, FK display and/or BSTK), to detect bad channels and detect or confirm shots, affected by external or electrical noise.

The first two displays, described below, are based on the same Raw Deep RMS data. Each of them highlights some of the events that may be difficult to identify or measure on other plots.

RMS SVT display

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

The display was generated for Raw Deep RMS data.

RMS values of each cable versus Shotpoint

This Display was generated in order

- to identify noisy areas throughout the sail line;
- to detect shots, affected by electrical noise (for example: telemetry errors),
- to detect direction of any interfering external noise.

The display was produced for Raw (total background) Deep and Ambient RMS, as well as for bandpass filtered Deep RMS

Average values for all streamers of Deep and Ambient RMS versus Shotpoint

For each shot, RMS values were averaged and plotted versus Shotpoint. Corresponding to 23.2.1, five graphs were presented on display: Deep Raw, Low, Mid, High frequency RMS and Ambient Raw RMS.

The ability to observe and analyse together the RMS, registered in different time and frequency windows, helped 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).

These values were used also to produce RMS maps over the entire survey area. The main purpose of this tool is an estimation of RMS level for each line as well as for different parts of survey area. These values would work as extra information during the following data processing.

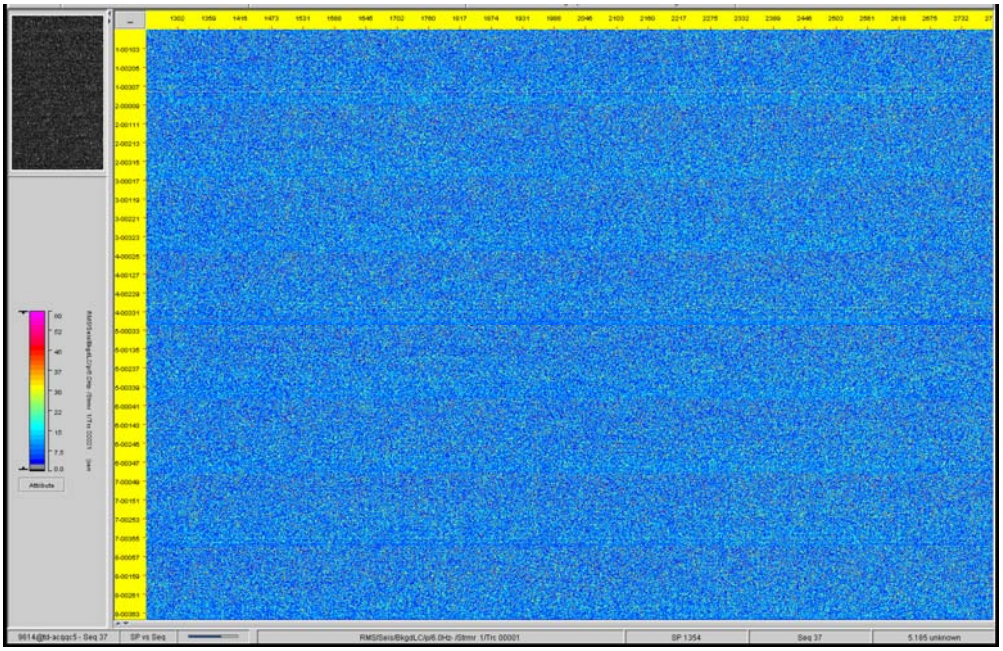

Figure 2. RMS SVT display. Sequence 037.

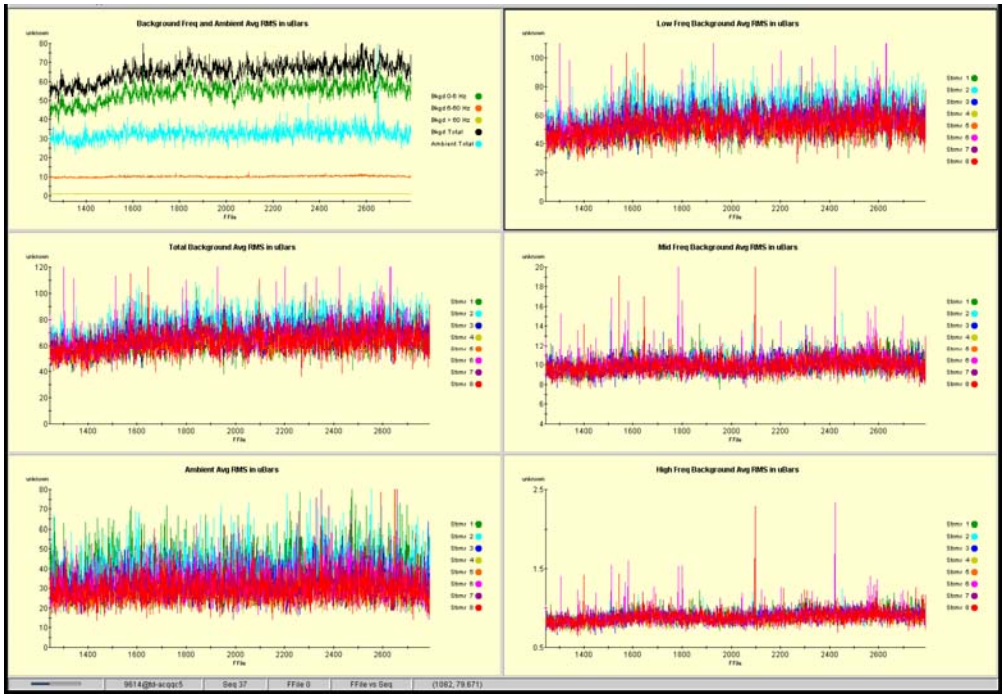

Figure 3. Average RMS values display. Sequence 037.

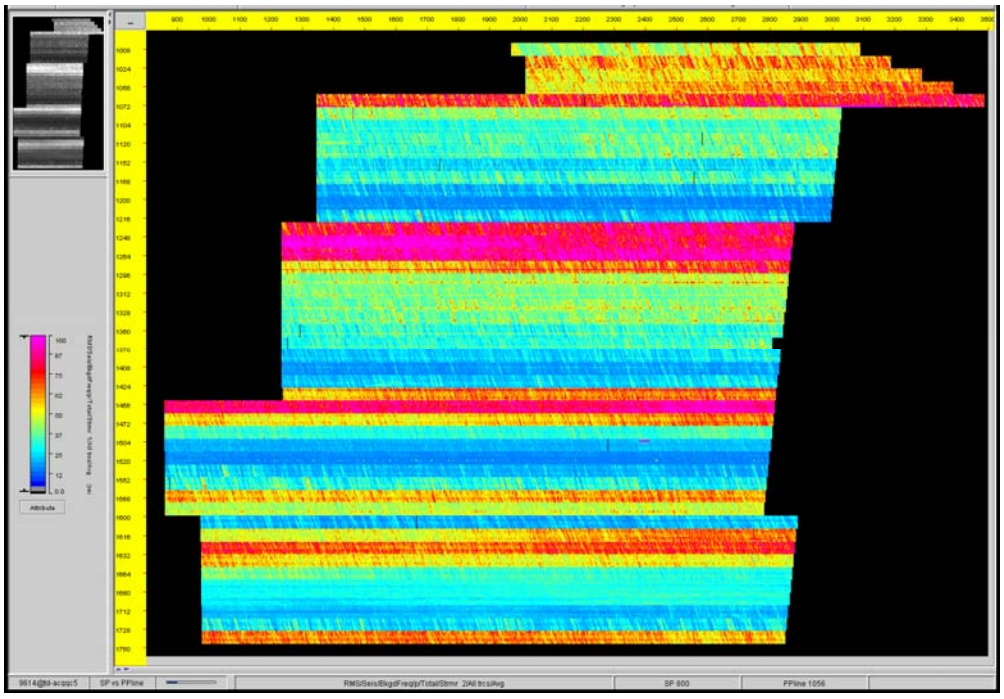

Figure 4. Raw Deep RMS Map. (Champion South)

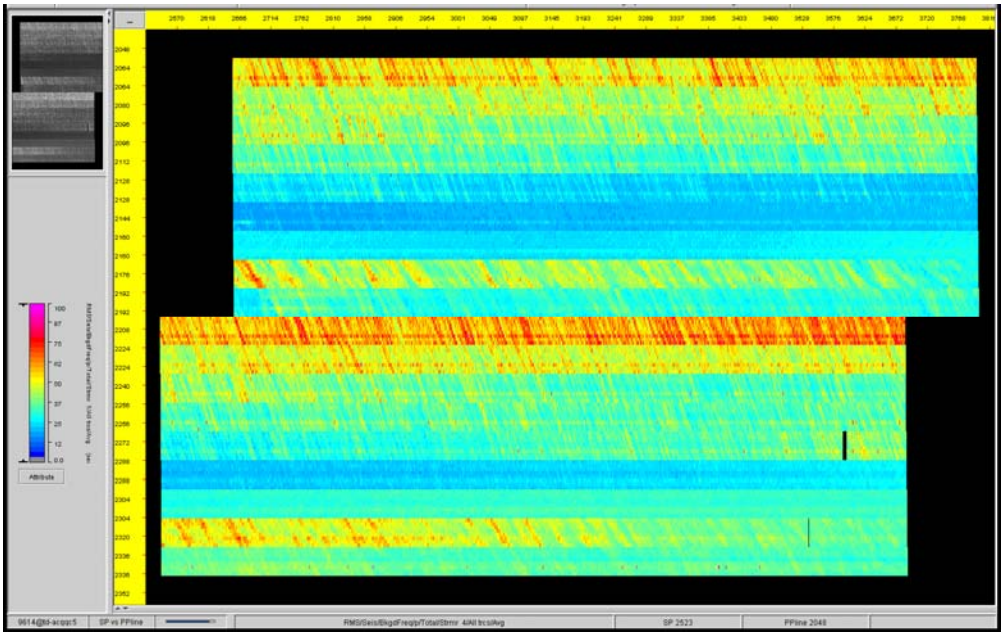

Figure 5. Raw Deep RMS Map. (Hercules)

23.3. 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 source depth and gun firing times. Header information was read from a single trace to detect the required information. Correspondingly, the following displays were produced on-line and off-line:

Source Attributes display

- Subarray pressure vs shotpoint for each string;
- Minimum and Maximum firing time error vs shotpoint for each string;
- Minimum Gun depth vs shotpoint for each string;
- Maximum Gun depth vs shotpoint for each string.

Sources Comparison display

For source performance comparison the RMS was calculated for the 50 near traces of the two inner streamers (streamers 4 and 5 for 8 streamers configuration) in the time window starting 100 ms above water bottom two way travel time. Window length for RMS calculation was set to 1000 ms. Calculation was performed for every shot fired. The averaged values for Port and Starboard sources and their difference vs shot point were plotted.

Near Field Hydrophone display

The peak amplitude of the near field record (auxiliary traces) is plotted for every gun / cluster over a line. For each source guns of equal volume are plotted in one box. Ideally, a gun of the same volume fired with the same pressure at the same depth should give the same amplitude within a reasonable tolerance. If one gun shows much higher or lower amplitude than its colleagues of the same volume, something is probably wrong, such as air leakage, variation in pressure, etc.

Examples below (Figure 5 – 7) demonstrates examples of these displays.

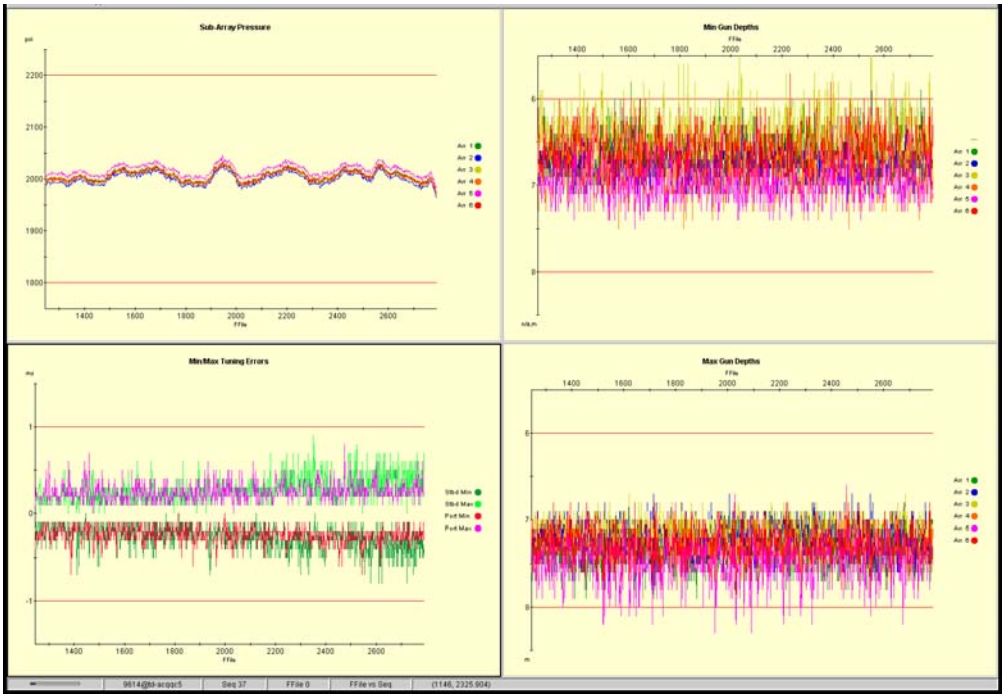

Figure 6. Sources Attribute. Sequence 037.

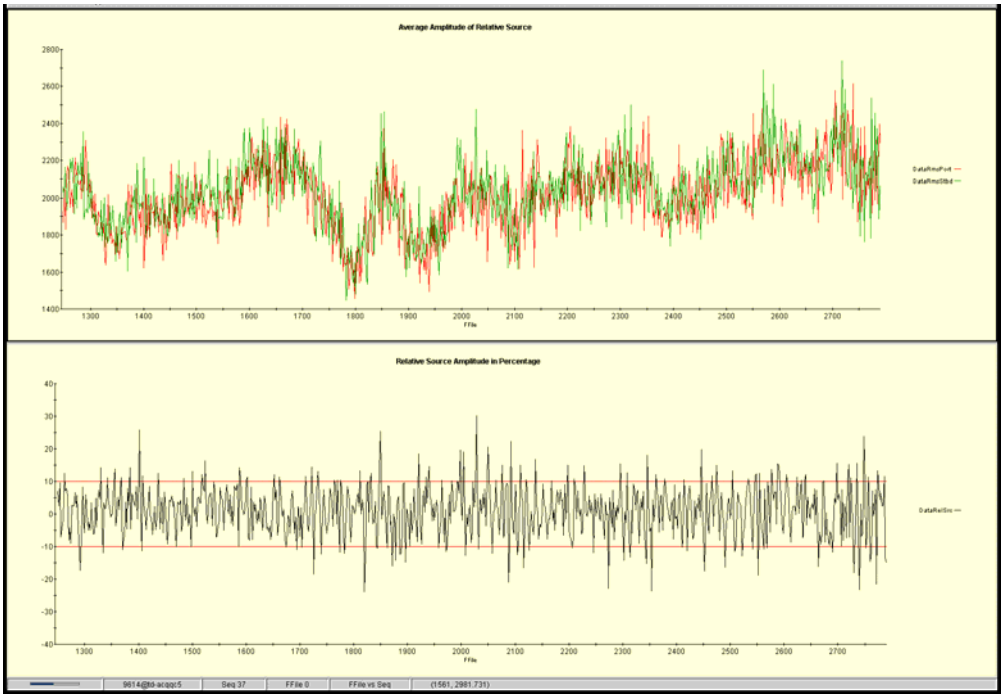

Figure 7. Sources Comparison. Sequence 037.

- ***Top graph represents average amplitude for both sources;***
- ***Bottom graph represents the average amplitude deviation.***

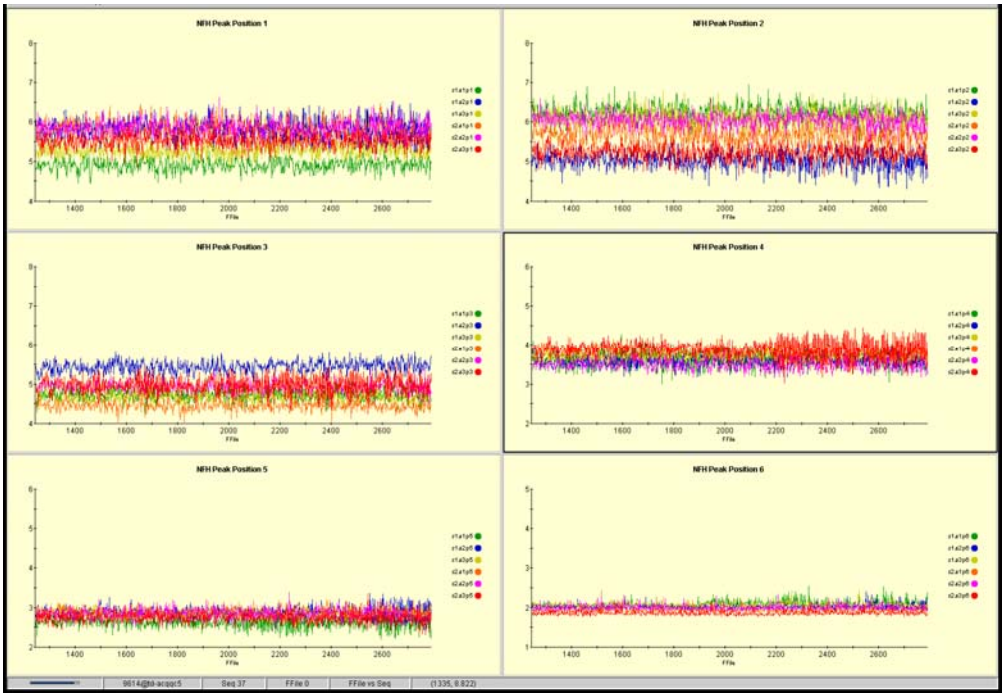

Figure 8. Near field Hydrophones Display. Sequence 037.

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. Two displays – for Starboard and Port sources - were displayed using SeisView and allowed a monitoring of sources sequence and detection of auto fires.

Processing sequence

1. Collect near traces	Field channel 4 of selected streamer.
2. Bandpass frequency filter	Low cut filter 2 Hz. 12dB/oct
3. Gain recovery	T**1.3 time function gain
4. Output	DIO format on disk, SeisView for Visualisation

23.5. Brute Stack

For each sail line a different source / streamer combination was used to generate a brute stack for one subsurface CMP line.
The purpose of this product is to determine the overall quality of data, detect the level of any external noise if present, check for bad traces / shots detected during the previous analysis steps and to provide a first imagination of geological structures.

Two brute stack plots were produced for each line: raw brute stack and brute stack with swell noise attenuation.

- **Raw brute stack processing sequence**

Input one CMP line per sail line	400 channels
Low Cut Minimum Phase Frequency Filter	3 Hz 12 dB/Oct
Nominal Marine Geometry	2D geometry using nominal offsets Group Interval 12.5 m
CMP Sorting	Sorting into CMP domain using nominal geometry
Gain Recovery	T**2 time function gain correction
Normal Move Out Correction	Single velocity function (For velocity function see 22.2.2)
Pre-stack Outside Mute	Mute (For mute see 22.2.3)
Stack Root N scaling	Nominal Fold 66.7
Output	To disk file in DIO format
Output	To disk file in SEGY format
Screen Output	SeisView for QC

For Swatt Brute Stack Anomalous Amplitude Attenuation SFM was applied in CMP domain only. Parameters for SWATT are described in 22.2.4.
An example below demonstrates sections of Brute Stack sections before and after SWATT application.

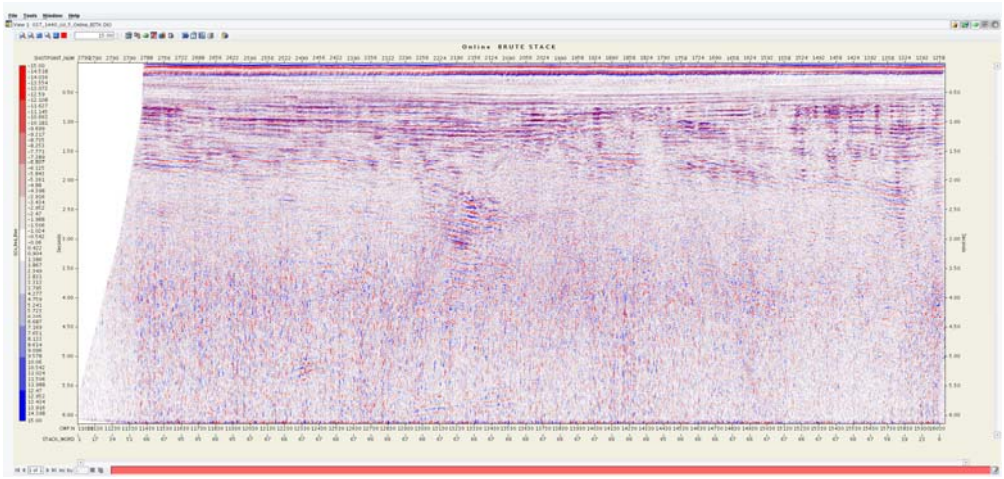

Figure 9. Raw Brute Stack. Sequence 037.

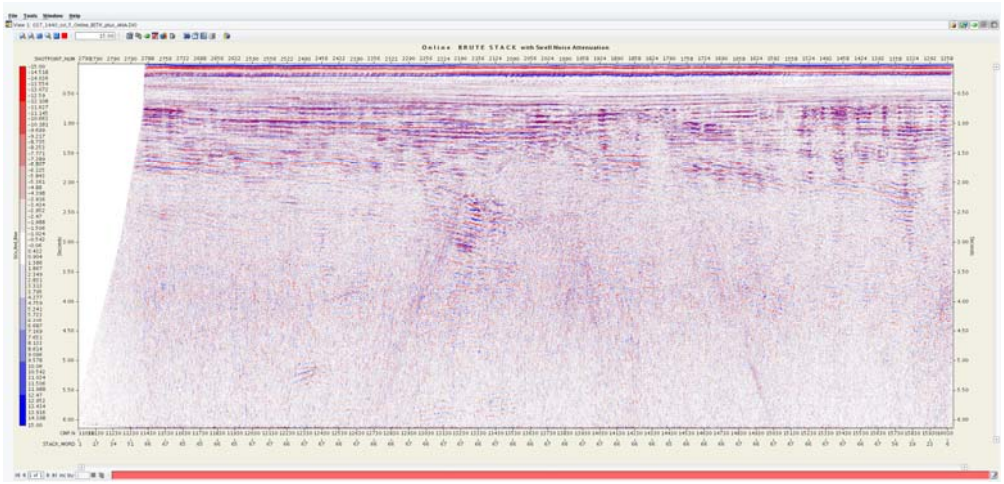

Figure 10. Brute Stack after swell noise attenuation. Sequence 037.

23.6. First Break QC (P1/90 QC) Displays

The main purpose of these QC displays was to make a preliminary confirmation of UKOOA P1/90 file correctness by analysis of the positioning, detected from the UKOOA P1/90, of the source and one of near traces of each cable.

This was done by calculating the distance between the source and the near trace of each cable using the x-y coordinates from the UKOOA P1/90. Using this distance and a water velocity of 1500 m/s, a calculated time was derived from the equation **distance = velocity** x **time**. The calculated time (navigation time) as a spike was superimposed onto the seismic trace and shifted 50 ms earlier so that it could be compared from SP to SP.

An incorrect source position in the UKOOA P1/90 would be represented by a shift of roughly 10-30ms depending on which streamer was being viewed. If this occurred, it was obvious by the way the traces were displayed on the QC plot. That SP was either edited (added to the Final Edits File) or the P1/90 file was recreated.

The other purpose of this QC tool was to check the consistency of the navigation network from shot to shot. Any slight movements in the navigation spike could represent a weak network solution, if proportional movements are not seen with the first break of the seismic traces.

Field channel number 1 from each streamer was selected. Once the final navigation data (UKOOA P1/90) was produced, 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.

The QC display allowed to monitor the merged data after LMO correction with superimposed navigation time . This display was produced separately for starboard source and port source.

Processing sequence

1. Select near traces:	Select first life field channel among 2 - 5 from each cable
2. Geometry update	Merge selected traces with final P1/90 file. A shift of 70 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 DIO format, and also viewed via SeisView interactive display.
5. LMO Correction	Correction of data using constant water velocities 1500 m/s
6. Gain Correction	Programmed gain correction and trace balancing
7. Output	Output on disk in CGM format; Output on disk in DIO format, and also viewed via SeisView interactive display.

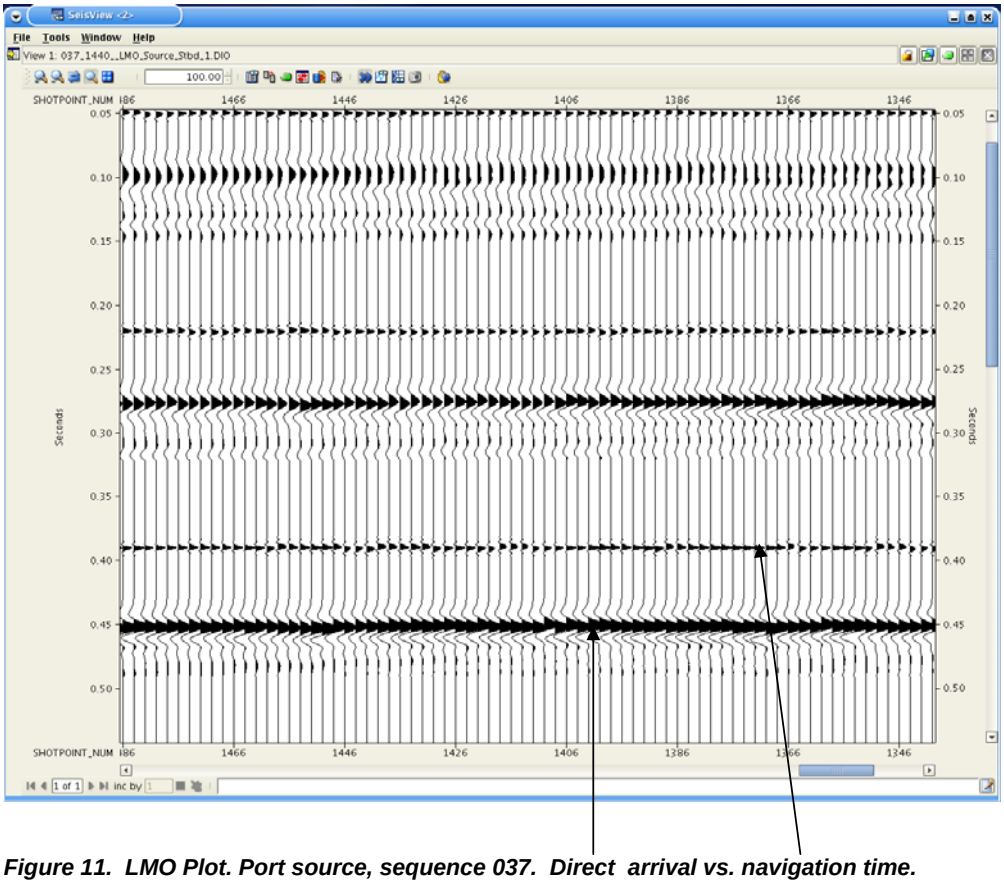

Figure 11. LMO Plot. Port source, sequence 037. Direct arrival vs. navigation time.

23.7. Near Traces Cube

The main purpose of this QC tool is to make a final on-board check for erroneous positioning during the acquisition by analysis of in-line, cross-line, and time-slices plots.

The near traces of the seismic data were merged with navigation data after a final navigation P1/90 data was available and first break QC (see 23.6) was performed. 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 a source to receiver offset of 490m +/- 32m, and then grid these selected traces.

The processing flow included:

- Input selected traces (1 – 25 from each streamer);
- Low cut frequency filter 3 Hz, 12 dB/Oct;
- Merge Seismic Data with final P190 file;
- Gridding the merged seismic data;
- Bad traces/shot edited;
- Sorting traces;
- Gain Correction:
  T**2;
- NMO (normal moveout correction) using water bottom dependent velocity function (see 22.2.2);
- Writing into OmegaVu cube for visual inspection on screen.

❑ **Cube Parameters**

For Champion South:

In lines	: 988 - 1764	Increment:	1
Cross lines	: 801 - 3546	Increment:	1
Cell Size	: 18.75 m crossline x 25 m inline		
Rotation	: 114.0 degrees		
Corners Coordinates			
988 / 801	MG1 : X = 610029.79 Y = 5744076.23		
988 / 3546	MG2 : X = 657048.83 Y = 5723142.00		
1764 / 801	MG3 : X = 602139.10 Y = 5726353.45		
1764 / 3546	MG4 : X = 649158.14 Y = 5705419.22		
Data Time Range	: 0 - 500 ms.		
Sample Rate	: 2 ms.		

For Hercules:

In lines	: 2023 - 2368	Increment:	1
Cross lines	: 2523 – 3823	Increment:	1
Cell Size	: 18.75 m crossline x 25 m inline		
Rotation	: 114.0 degrees		
Corners Coordinates			
2023 / 2523	MG1 : X = 606367.96 Y = 5772730.40		
2023 / 3823	MG2 : X = 686308.89 Y = 5737138.39		
2368 / 2523	MG3 : X = 575862.70 Y = 5704214.49		
2368 / 3823	MG4 : X = 655803.64 Y = 5668622.49		
Data Time Range	: 0 - 500 ms.		
Sample Rate	: 2 ms.		

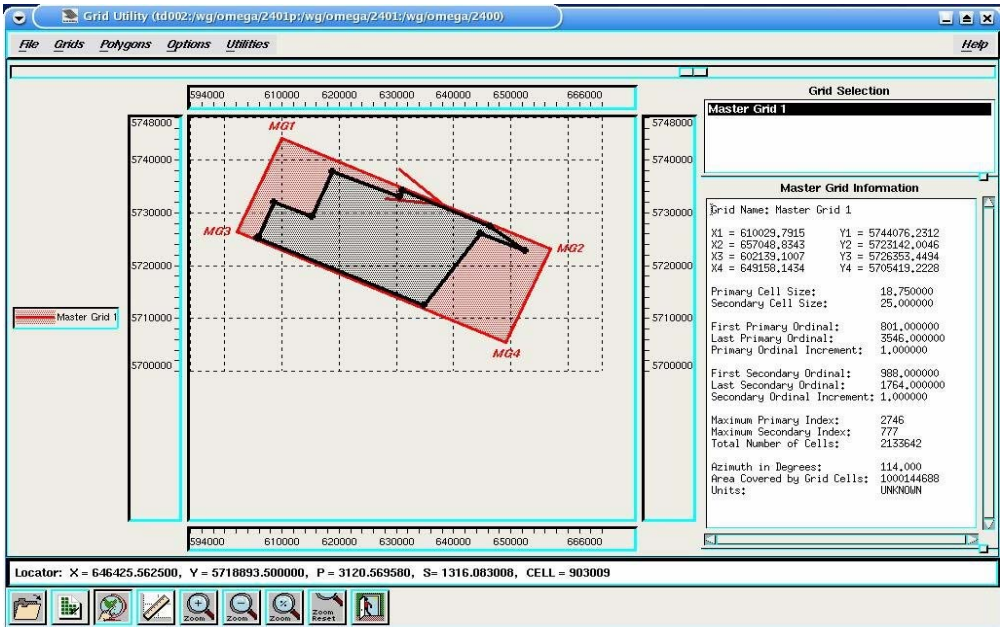

Figure 12. The survey area and the Grid used for Near Traces Cube. (Champion South)

The cube was displayed as having:

- In lines increase from top to bottom.
- Crosslines increase from left to right.

In-lines of the cube correspond to the sail line numbering, while cross-lines correspond to shotpoint numbers.

Note: The grid for Hercules looks big as it uses the original bin grid points which include the area where Champion South was located.

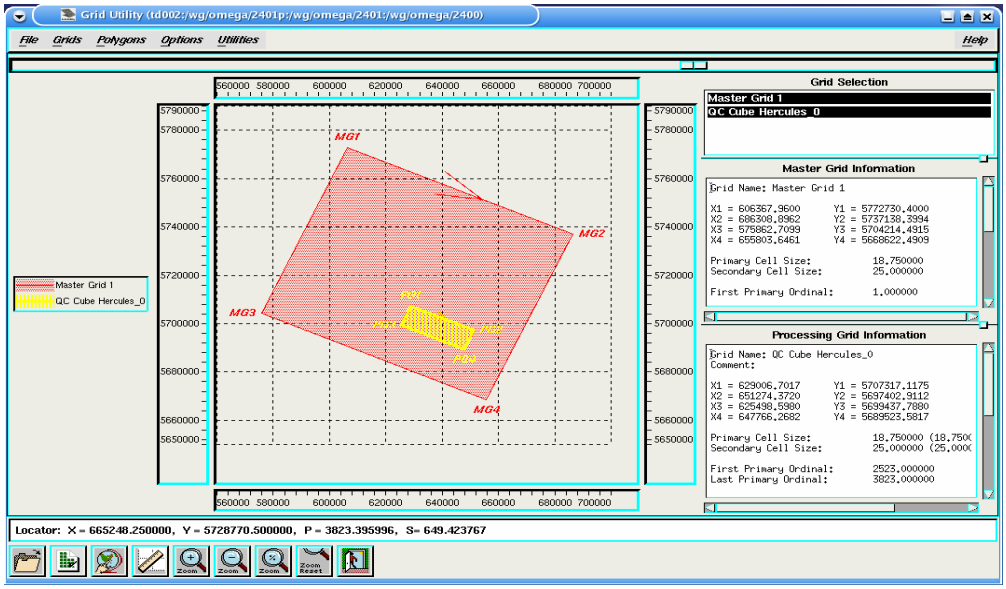

Figure 13. The survey area and the Grid used for Near Traces Cube. (Hercules)

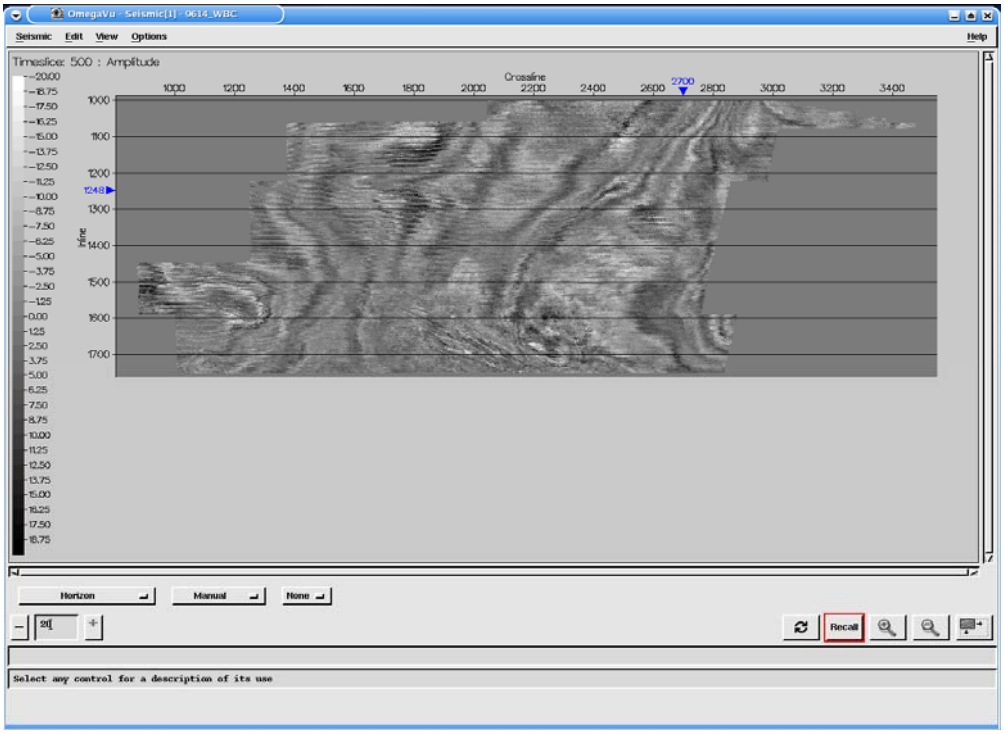

Figure 14. Near Traces Cube. Timeslice 500 ms. (Champion South)

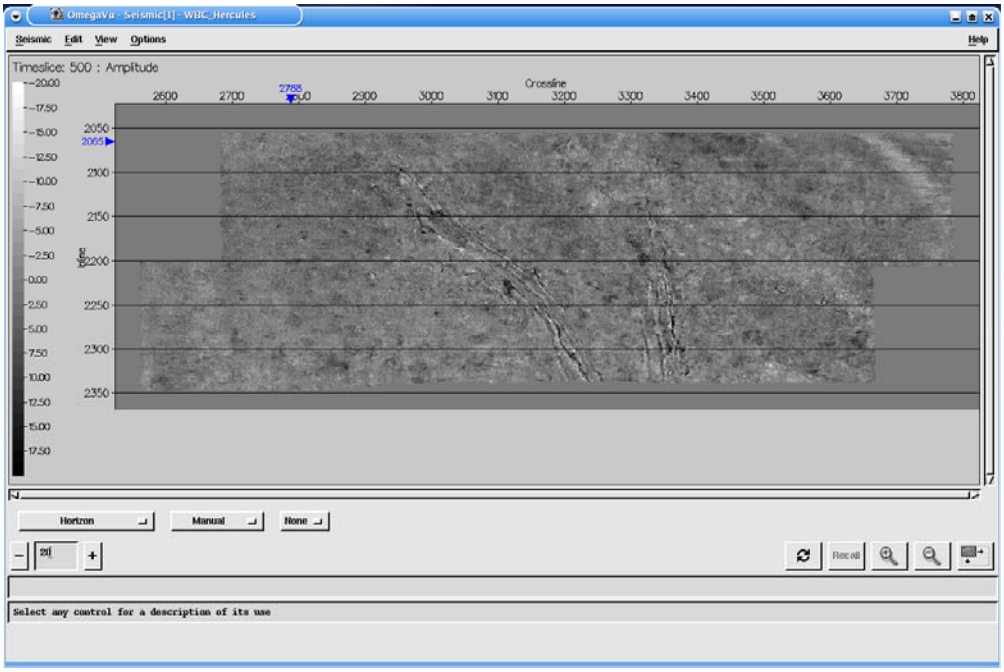

Figure 15. Near Traces Cube. Timeslice 500 ms. (Hercules)

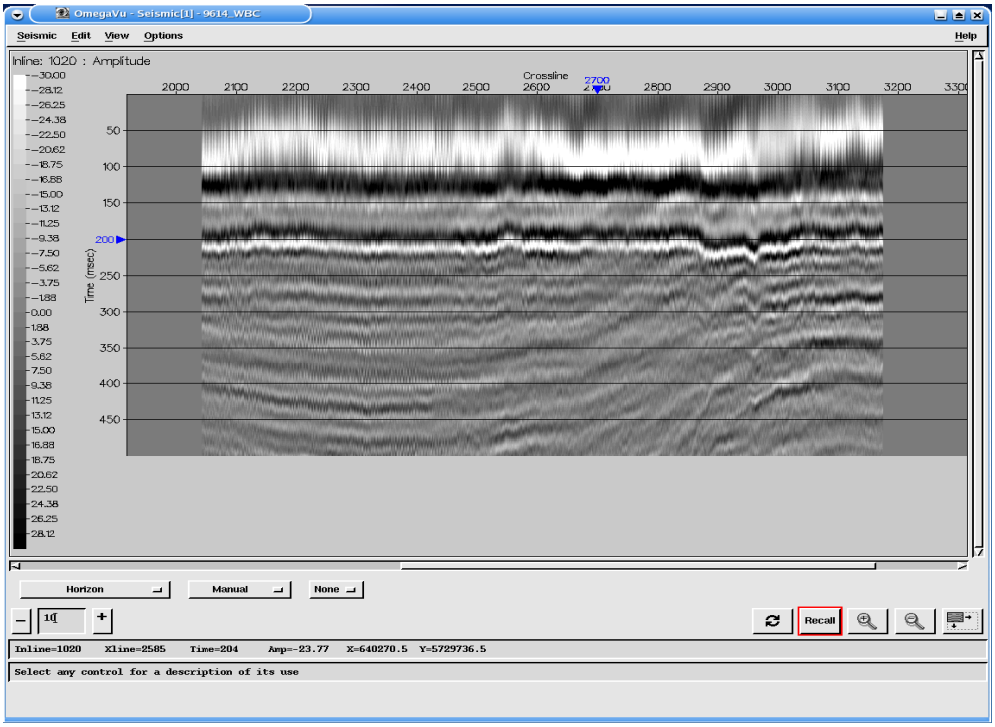

Figure 16. Near Traces Cube. Inline 1020. (Champion South)

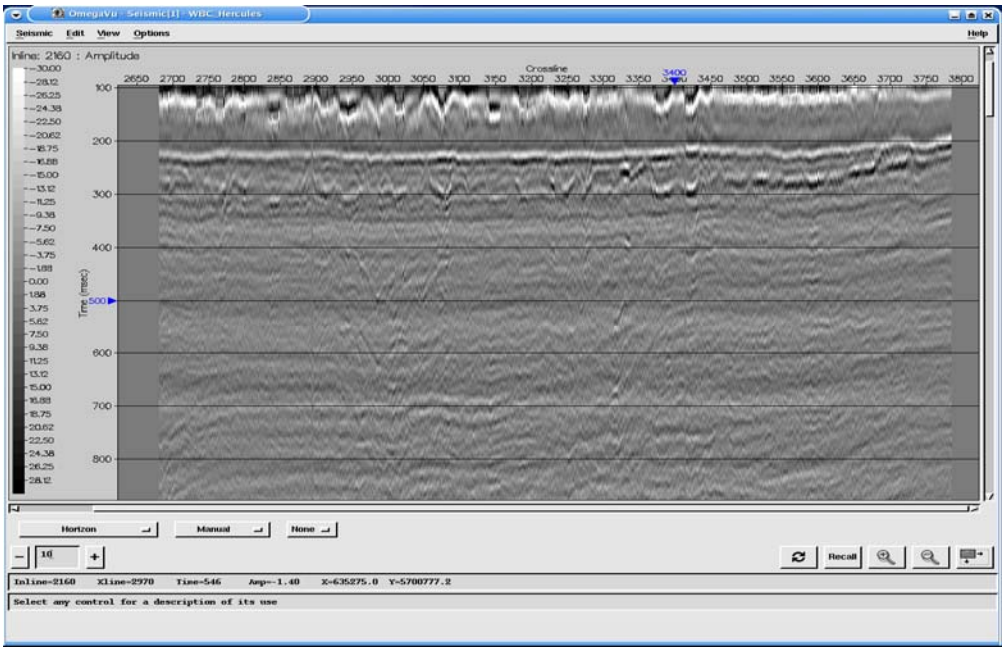

Figure 17. Near Traces Cube. Inline 2160. (Hercules)

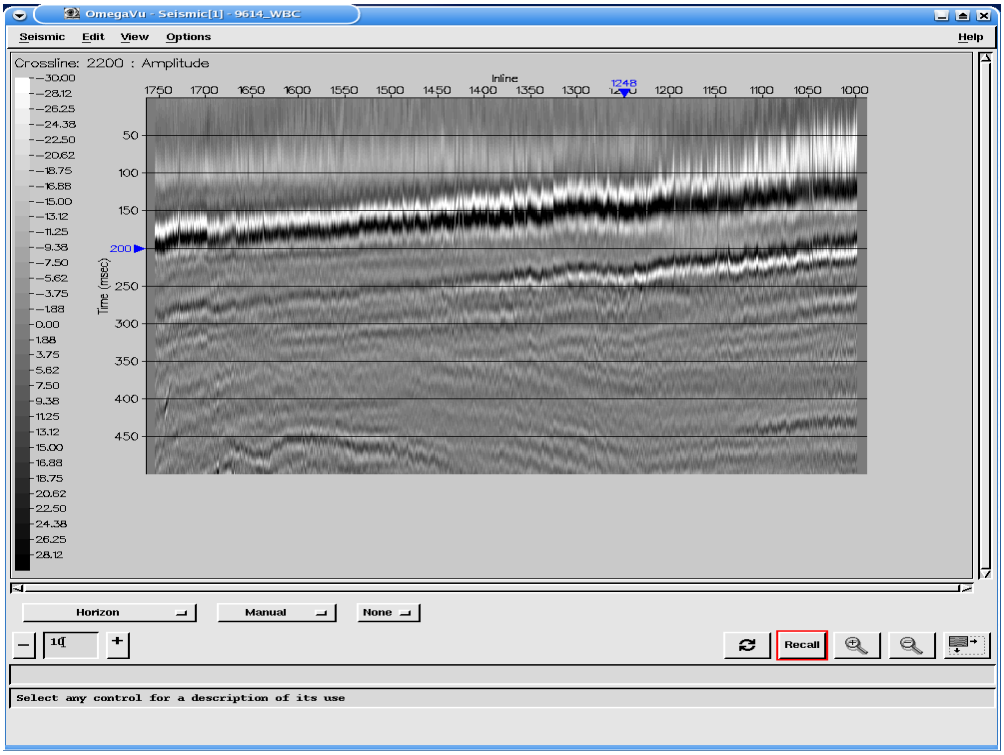

Figure 18. Near Traces Cube. Cross-line 2200. (Champion South)

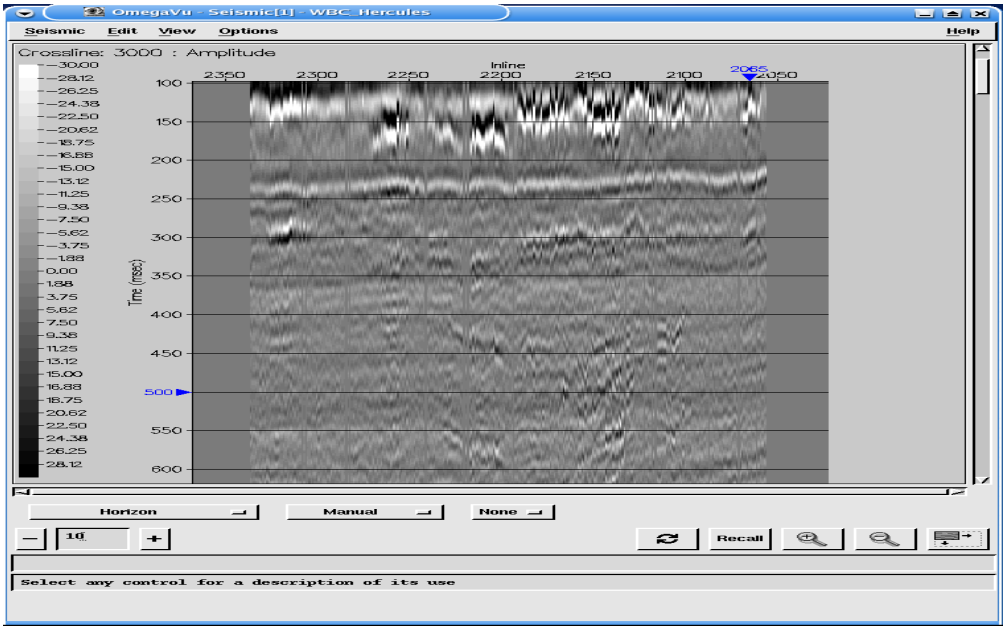

Figure 19. Near Traces Cube. Cross-line 3000. (Hercules)

24. Data Quality / Observations

24.1. Quality Control Summary

24.1.1. Water Depth Variation

The survey area was a shallow water bottom area, around 40 – 60 mtrs for Champion South and 50 – 90 mtrs for Hercules. Variation was minimal.
Figure 15 below represents the survey's area water bottom map for Champion South and Hercules.

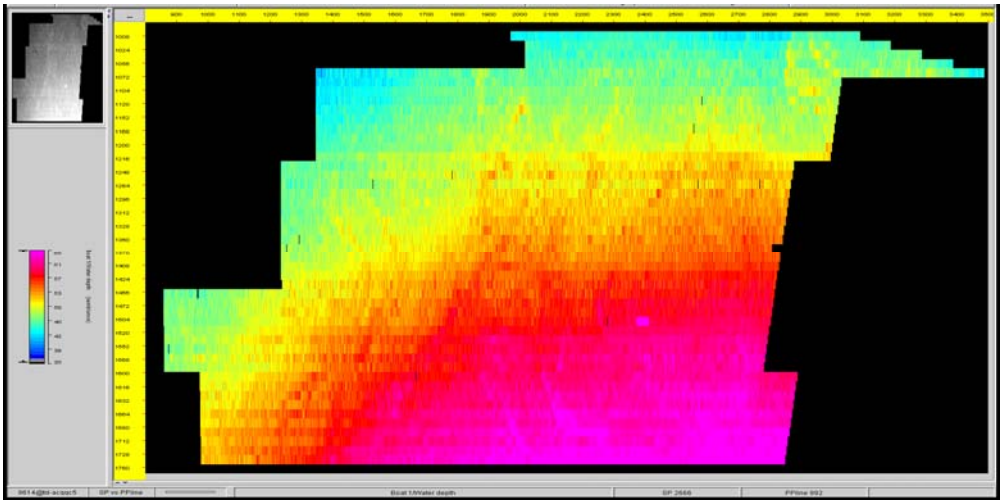

Figure 20. The map of the water bottom depth.
Colour scheme: blue – shallow, pink – deep. (Champion South)

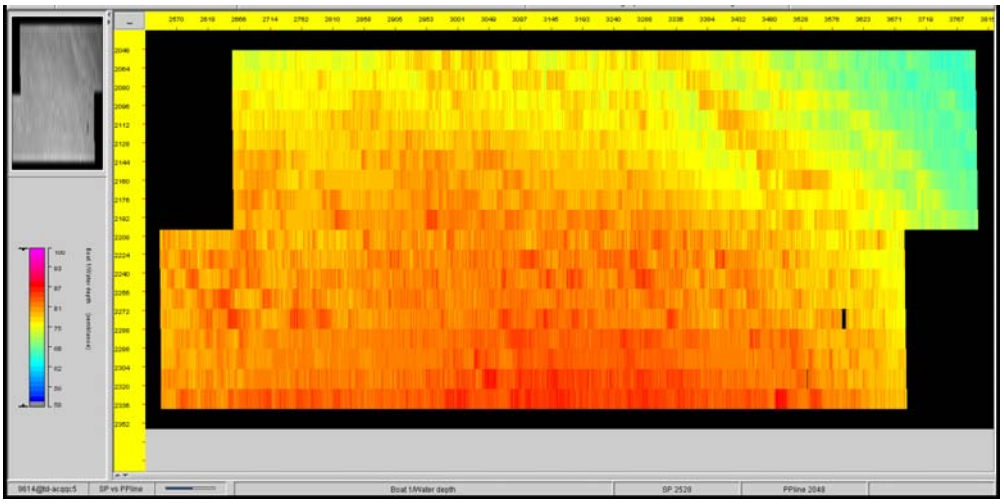

Figure 21. The map of the water bottom depth.
Colour scheme: blue – shallow, red – deep. (Hercules)

24.1.2. Noise Types Encountered

- **Swell Noise**

Affected significant number of acquisition sequences, however sequence 04, 10, 11, 12, 13, 58 was rejected due to excessive swell noise and a loss of streamers depth control.
The swell noise affected sequences 01-35
Sequence 05-35, 56, 57 was acquired with 9.0 m streamers depth, sequence 37, 38 with 8.5 m streamer depth.

- **Rip Current Noise**

Rip current noise was not a factor in the acquisition or the quality of the data.
Light bend noise could be observed occasionally at start of lines.

- **Seismic Interference**

No seismic interference was seen through the survey.
Sequence 31 was aborted and scratched due to whale sited in the area.

- **Rig noise**

Only seq 21 was affected with a high frequency Rig noise.

- **Bad traces**

Zeroed, distorted, noisy traces were identified as bad and included in the acquisition log as edits.
Weak traces were marked in observers 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.

- **Source problems and auto-fires**

All shots that were affected by misfires, low or high pressure, synchronisation errors exceeding 1.25 ms for any gun, were added to the Edits File.
Major source related errors are:
Seq 06: shotpoints 1370 - 1244 NTBP d/t gun Block Trigun errors.
Seq 76: shotpoints 3660 – 3046 NTBP d/t Trisor system errors.

24.2. Instrumentation Summary

- Changes to configuration – none.
- Changes to recording parameters – none.
- Acquisition System - none
- Recording system

There were a few media errors that resulted in the lack of an EOT mark on some tapes. The problems were cause by bad batch of tape in some boxes.

- Streamer problems

No major streamer problems, numbers of bad traces per streamer is in spec.

- Cable control

Cable control was one of the concern for line acquired during rough weather.
In general streamer balance was reasonable throughout the survey. Occasional monowing wash caused instability to the front birds of streamers 1, 2, 8 and was more often affected streamer 7.

- Major Operational Errors - none