Apache Energy Ltd

Gippsland Basin 3D Seismic Project

Offshore Victoria / Australia

SUE 3D Survey GAP04B
Block Vic/P58

15th January – 16th February 2005

M/V *Western Trident*

Seismic Acquisition Quality Control

Provided By

Ian Milne

GEOCON

Jon Evan-Cook

Enquest

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APPENDICES

1.0 INTRODUCTION

Apache Energy Limited contracted WesternGeco Australia Pty Ltd to conduct a marine 3D seismic survey in the Gippsland Basin area of the Tasman Sea, offshore Victoria, Australia. WesternGeco Australia Pty Ltd mobilised the survey vessel M/V *Western Trident* to carry out the survey. Enquest Pty Ltd were contracted to provide project supervision, geophysical and navigation quality control assurance in addition to HSE monitoring and reporting.

This report contains complete details of the acquisition, positioning and HSE aspects of the surveys. Enquest Pty Ltd provided Jonathan Evan Cook and Geocon provided Ian Milne as geophysical quality control personnel and Stephen Burt and Patrick Bonnevier from RPS Energy were the navigation and positioning quality control representatives.

1.1 Vessel Mobilisation

M/V *Western Trident* arrived at the GAP04B Sue 3D seismic survey area on January 16 following a transit from a previous survey and commenced survey operations at 04:57 local time. The vessel was soon standing by for weather however as sea and swell conditions
forced a suspension of operations at 20:00 hours.

1.2 Survey Geological and HSE Objectives

The project geological and HSE goals and objectives were the development of the Gippsland Basin as an oil and gas producing zone. The HSE goals and objectives of the survey were ensuring prevention of injury and to promote safe working practices. The prevention of accidents through identification and elimination of core defects and deficiencies was considered everyone's responsibility.

Environmental considerations were very important. A constant day watch for cetaceans and other marine life was maintained. Soft-start of the energy source was maintained throughout the survey. Care was taken when operating in close proximity to the Ninety Mile Marine National Park nature reserve to ensure that neither the *Western Trident* nor any component of the trailing seismic survey equipment, encroached onto the park acreage at any time.

1.3 General Survey Description

Survey Name	GAP04B SUE 3D Seismic Survey
Survey Area	Vic / P58 - Offshore Victoria, Australia
Survey Type	3D Marine Seismic
Survey Mode	Single Vessel / 8 Streamers / Dual Sources
Client	Apache Energy Ltd
Seismic Contractor	WesternGeco (A) Pty. Ltd
Survey Vessel	M/V Western Trident
Chase Vessels	Lady Roula, OMS Pioneer
Undershoot Vessel	MV Pacific Titan
Client Representative Onboard Client Representative	Rob Kneale – Apache Energy Ian Milne / Patric Bonnevier Jon Evan-Cook / Stephen Burt
WG Party Chief	Ian Halfpenny / Mike Martin

1.4 Survey Configuration

Streamers

The Sue 3D GAP04B survey was carried out using 8 x 4800 metre digital solid streamers, spaced at 100 metre intervals. The streamers were towed at a depth of 8.0 metres. Each streamer consisted of 384 seismic data channels. The farthest channel from the vessel being the lowest number. The survey was acquired using an 18.75 metre alternating shotpoint interval achieving nominal 64 fold.

Energy Source

The energy source used for both surveys was the dual sleeve gun array energy source using dual 3000 cubic inch arrays operated at a depth of 7.0 metres. The source nominal operating pressure was 2000 psi using a shot point interval of 18.75 metres. Source centre to centre was 50.0 metres. Array dimensions were 16.1 metres x 18 metres. The array used four sub-arrays using 8 active guns and 2 spare guns per array.

1.5 Survey Dimensions & Acquisition Technique

GAP04B SUE 3D Survey

The survey area of 1073.3175 full fold square kilometres was divided into 6 swaths of roughly equal dimensions. Average line length was 34.829 sail kilometres. Sail line spacing was 400 metres and cell spacing was 25.00 metres crossline. Survey line orientation was North East to South West

The vessel steered the near mid and mid offset segments to acquire required coverage. The coverage was acquired using the pressing up technique where new coverage was abutted against the adjacent data previously acquired. Progressive infill was employed to fill coverage to an adjacent prime line that had already been binned. The positioning specialist would elect to conduct a progressive infill pass and seamlessly fill gaps in prime coverage.

1.6 Undershoot Programme

Dual Vessel Undershoot Mobilisation

Following completion of the prime and infill acquisition an undershoot programme involving dual boat survey operations around the Perch and Dolphin monopod platforms was begun.

The survey vessel MV *Pacific Titan* which had been conducting a small 2D streamer survey adjacent to the SUE 3D survey, was utilised as the energy source vessel. The undershoot mobilisation started at approx 21:00 hours on February 12th when the two vessels arrived at the Dolphin platform location. The task of setting up the dual-vessel timing link got underway and straight away the mobilisation became bogged down in technical problems relating to the dual vessel link. The link was the WesternGeco True Time unit used for two-boat operations such as undershoots.

Dual Vessel Timing Link

After approximately 36 hours of troubleshooting and acquiring a test line, the problems with the dual vessel equipment were rectified and the undershoot commenced. MV *Pacific Titan* used a 3000 cubic inch single source that was configured using three sub-arrays.

The undershoot was acquired in a single source and 8 streamer mode which required two passes for each sail line. This required that the 8 cmp columns acquired be interleaved with the previous sail line pass in order to complete the 3D coverage build up.

As with the delineation of the undershoot zone involving close passes to the Perch and Dolphin platforms, strict procedures were followed involving communication with the controllers on neighbouring installations. The escort vessel *OMS Pioneer* was always on station ahead of *Western Trident* during the close passes during the undershoot.

Data Time Shift Problem

A data time-shift problem was observed during the first sequence acquired where singe channel data from one streamer was observed to be shifting from shot to shot by anywhere from zero to 14 milliseconds. The fault was related to the field source time break issued by the WesternGeco TriNav system. GPS clock times on Western Trident and Pacific Titan did not match from shot to shot.

The problem was reported to WesternGeco technical support and data processing. The problem was reported to Apache, along with GIF files of the single trace plots included in the daily report for February 15th.

1.7 Survey General

GAP04B SUE 3D Survey

Commercial shipping was prohibited from entering the area and commercial fishing activity limited. Other oilfield activity, mainly sub-sea engineering operations were commonplace including diving operations at the Barracouta platform, and undersea cable repair and dredging operations to the South of the survey area.

Current and tide were often moderate to strong and almost constantly setting to the South, resulting in predictable feathering angles providing good feather matching for most of the survey. The acquisition technique of pressing up against adjacent coverage was applied, thus keeping infill to a minimum.

Moderate to strong wind and sea from the South West and North East during the middle part of the survey generated sea and swell conditions of up to 5.0 metres. Ambient swell noise was closely monitored. Weather forecasts received were usually accurate and consistent with observed wind and sea conditions.

Crew Changes

A regular scheduled helicopter crew change was carried out during the survey. The helicopter crew change was operated from Melbourne. Off going and oncoming crewmembers were briefed on the aviation company policies for all personnel. A safety briefing video concerning the type of aircraft to be used for the crew change was required viewing by all off going crew members.

Weather

Towards the end of January, South Westerly winds of up to 35 and occasionally 45 knots with sea and swell building to 3.5 metres on occasion. During Early February, the weather and sea conditions deteriorated further and the *Western Trident* had to suspend survey operations due to severe weather.

Production & Infill

By the end of January over 65 percent of the survey had been acquired with infill coverage amounting to only 3.0 percent of total survey prime full fold area. Average daily production of 1946 sail cmp kilometres and had been achieved for the survey to date.

Time Sharing

MV *Pacific Titan* arrived in the area on February 9th to perform a small 2D regional survey close inshore to the North of the SUE 3D survey. Communication between MV *Western Trident* and MV *Pacific Titan* was established by e-mail and telephone. The distance between the two vessels prohibited direct marine VHF communication. Upon first arrival, the Pacific Titan observed Western Trident energy source interference at 16.0 ubars rms and suspended their operation until a time sharing schedule could be established. *Western Trident* moved back offshore after completing the closest inshore sail lines and increased the distance between the two vessels. Once this shooting pattern was established, both vessels were able to remain in production without observing each other's energy source

Downtime

Technical downtime was incurred during the survey due to a combination of source, streamer, recording system, armoured tow leader damage and tag line problems, each causing a suspension or interruption of operations. Other technical downtime included problems with source and streamers that may have been related to having the trailing equipment deployed in very rough seas. Compass line leakage, damaged tailbuoys and acoustics were replaced as necessary following the period of bad weather. Technical downtime relating to the dual vessel undershoot mobilisation is covered in a separate paragraph of this section of the report.

Survey Completion

The GAP04B SUE 3D survey was completed on February 12th with a total of 45326.663 prime cmp kilometres and 3084.90 cmp kilometres of infill acquired bringing the infill to a total of 6.72 % of prime kilometres surveyed in the single vessel mode.

1.8 Production Statistics

During the GAP04B SUE 3D programme a total of 45326.663 cmp sail kilometres of prime data and 3084.90 cmp kilometres of infill data were acquired. Production rate averaged 1618.80 cmp kilometres per day, commencing on January 15th 2005 and terminating on February 16th 2005.

GAP04B SUE 3D Survey	**Single Vessel**
Survey Prime Full Fold Square Km	**1066.516**
Survey Prime Sail CMP Km	**45326.663**
Survey Infill Sail CMP Km	**3084.90**
Survey Total Sail CMP Km (Prime + Infill)	**48411.563**
Survey Total Infill Percentage	**6.72 %**
Survey Timing Statistics	**Single Vessel**
Operational	**506.64 hours**
Standby	**131.00 hours**
Downtime	**34.36 hours**
Costing USD	
Operational	**3,546,480**
Standby	**917,000**
Total	**4,463,480**

GAP04B SUE 3D Survey	**Dual Vessel**
Survey Prime Full Fold Square Km	**67.709**
Survey Prime Sail CMP Km	**1507.800**
Survey Infill Sail CMP Km	**00.000**

Survey Total Sail CMP Km	**1507.800**
Survey Total Infill Percentage	**0.00 %**
Survey Timing Statistics	**Dual Vessel**
Operational	**36.55 hours**
Standby	**15.34 hours**
Downtime	**35.13 hours**
Local Travel at Survey Completion	**9.00 hours**
Costing USD	
Operational	**255,850**
Standby	**107,380**
Local Travel at Survey Completion (9.0 hours)	**63,000**
Total	**426,230**
Survey Grand Total	**4,889,710.00**

1.9 Weather Reports

Daily weather reports were obtained from the Australian Government Bureau of Meteorology website and from the NOAA provided weather information website, buoyweather.com.

Reports included a text report and bar graph displays of wind strength and direction and sea and swell heights.

A daily surface prognosis was provided with a 5 day forecast showing wind strength and direction as well as significant and maximum combined sea and swell height. Daily weather fax reports were also received. Weather information was also received through Navtex broadcasts received via InMarsat C for Navarea 10 and the SafetyNET Auscoast warnings which included Victoria and Tasmania.

Additional seven day weather forecasts, surface conditions and wave height information was obtained from the following websites.

www.bom.gov.au

www.buoyweather.com.

During the GAP04B SUE 3D survey, virtual wave rider buoy conditions were modeled for the following positions.

39º:05 South
147º.50 East

Seven day and short-term forecasts were received twice daily. The time zone for the model was set at GMT + 11.00 hours. The data provided was courtesy of the US National Oceanic and Atmospheric Administration (NOAA) Ocean Modeling Branch. Surface wind strength and direction was shown in tabular and graphical format as well as significant wave and swell height, along with a brief synopsis.

1.10 Communications

Communications during the survey was through e-mail. Daily reports and status updates were sent to Enquest and Apache. Daily reports, status updates and weekly reports were sent to the following addresses:

Frank Renton f.renton@enquest.com

Rob Kneale Rob.Kneale@aus.apachecorp.com

The writer had access to the web-based SuperVISION system which enabled the client representative onboard the vessel, and the client onshore to view a wide array of quality control plots and displays, daily reports and survey parameters as well as processed seismic data sections. These plots and displays were available soon after completion of each survey line. Questions arising from the information show on SuperVISION could then be quickly addressed by both parties on and off the vessel.

1.11 Data Shipments

Data shipments were carried out during the crew change on January 27th by helicopter to Melbourne. A total of 3 boxes of recorded seismic data tapes were shipped to the following address in both shipments.

Seismic Data Shipping Address

Original Data Set

Access Information Management
80 Pilbara Street
Welshpool WA 6106

Attn: Alyce Jackson

Copy Tapes

Kestrel Information Management
39 McDowell Street
Welshpool WA 6106

Attn: Barry Lloyd

2.0 SURVEY PARAMETERS

2.1 Survey Definition

The GAP04B 3D survey area comprised an area of 1066.711 square kilometres, forming an irregular rectangle 40.00 kilometres in length by 20 kilometres in breadth. The survey consisted of 77 prime sail lines oriented North East - South West with a line an average length of 34.829 sail kilometres. The geographical location of the prospect centre was as follows:

Latitude	38° 26' 22.872 South
Longitude	147° 23' 48.329 East

Number of Sail Lines	77
CMP Spacing	6.25 m x 25.00 m
CMP per sail-line	16
Number of CMP lines	1232
Line Heading	44.566° / 224.566°
Total Area Defined	1066.711 km^2

2.2 Acquisition Parameters

Number of Streamers	8
Streamer Length	4800 m
Streamer Depth	8.0 m
Streamer Spacing	100.0 m
No of Source Arrays	2
No of Sub-Arrays	4 per array
Sub Array Volume	750 cu in
Source Volume	3000 cu in
Source Depth	7.0 m
Source Pressure	2000 psi
Source Firing Interval	18.75 m

2.3 Line Naming Convention

The following format represents the naming of the lines during the survey.

GAP04B – LLLL-P-R-J- SSS

Line Number	GAP04B	=	Line Prefix ID

LLLL	=	Line Number
P	=	Prime Lines
A	=	Reshoot Lines
J	=	Infill Lines

2.4 Shotpoint Numbering Convention

Primary Line Heading	045.0°	Incrementing SP numbers
Secondary Line Heading	225.0°	Decrementing SP numbers
Incrementing \ Decrementing Factor		1.0
Line Prefix		GAPO4B
Array 1 Starboard Source		Odd Shotpoints
Array 2 Port Source		Even Shotpoints

2.5 Binning Parameters

Flex cell expansion parameters were to be used only when assessing infill requirements and infill allocation. Application of cell expansion was used as a linear function.

Primary Acquisition

Offset Segment	Min	Max	Required %	Flex Binning
1 Nears	0	1200	90.0 %	50 % - 112.50
2 Near Mid	1201	2400	90.0%	112.5% - 175.00
3 Near Far	2401	3600	90.0 %	175.00 % - 237.50
4 Fars	3601	4800	90.0 %	237.5 % - 300.00

Infill Acquisition

Offset Segment	Min	Max	Required %	Flex Binning
1 Nears	0	1200	90.0 %	100.00 % - 150.00
2 Near Mid	1201	2400	90.0%	150.00 % - 200.00
3 Near Far	2401	3600	90.0 %	200.00 % - 250.50
4 Fars	3601	4800	90.0 %	250.00 % - 400.00

3.0 RECORDING SYSTEM

3.1 Recording System & Parameters

Recording System	Input \ Output MSX 24 bit Digital
	CRS + PDL Sub Systems
	EMASS Robotic Tape Library
Software Version	2.1
Number of Data Channels	3072 (384 per streamer)
Sample Rate	2 milliseconds
Filter Settings Low Cut	2.0 hz / 12 db per octave
Anti-Alias High Cut	206 hz / 264 db per octave
Shot Display Filter	8.0 hz low cut
Record Length	5.0 seconds
Digital Filter Delay	0 ms
Tape Format	SEG-D 8036
Pre-amp Gain	12 db
Auxiliary Channels	48
Nominal Fold	64 fold
Recording Polarity	SEG Convention
Recording Medium	IBM 3590 Cartridge
Acquisition QC System	SeisView + Omega

3.2 System Description

The MSX marine 24-bit digital recording system features rack mounted assemblies and a VME basic utility system that consists of Streamer Interface Modules (SIM) quality control Module (QCM) as well as an auxiliary channel unit, cable power monitor and control as well as power distribution unit.

The MSX recording system is controlled from the Operator Console Module that uses graphical user interface that provides centralised presentation of system status and configuration options. The Embedded Visualization Processor (EVP) display provides quality control facilities for the MSX recording system and is used to display seismic channels from the EVP section of the Streamer Interface Module and to view the instrument quality control tests.

The operator display showed system parameter entries, real time streamer data and depth information as well as system status information. The quality control display and operator display monitors were each driven by a separate high-speed graphics processor interface

The MSX recording system is interfaced to the Continuous Recording System and PDL (Project Data Logger) sub-systems, the TriNav Integrated navigation system, and the I/O SSS source synchronisation system, DigiCourse streamer depth control and compass heading recording system via the dedicated instrument room ethernet.

The MSX was a very reliable recording system and most problems encountered are related to tape drive subsystems. The system generated extensive logs on the internal disk of the workstation to archive detected errors and exceptions.

3.3 System Tests

A comprehensive set of system monthly tests was carried out prior to the start of production, at a convenient interval, or following any streamer repairs a set of daily instrument tests was conducted. All tests were carried out with production filters and sample rate.

Monthly	Calibration of Recording Instruments System Voltage Check Test Oscillator Calibration System Timing Test Timebreak Accuracy Test Header Verification By Playback Streamer RMS Noise Channel Gain Accuracy Harmonic Distortion Impulse Response Dynamic Resolution Hydrophone Leakage MSX Integrity and Memory Tests Tape Drive Self Tests
Daily	Amplifier RMS Noise and DC Offset Dynamic Range Harmonic Distortion Impulse Response Hydrophone Leakage Channel Gain Accuracy Streamer Noise

3.4 System QC Displays

A number of the quality control functions generated displays on-line and in real-time, with a selection composed of a mixture of seismic trace data displays and statistics. Ambient and cultural noise showed up on a variety of displays.

Streamer data was viewed in colour-coded bar graph displays on a graphics display for each for streamers 1 to 8 and raw seismic shot data was displayed one streamers at a time at a sample rate of 8.0 ms with DC offset removed and operator selected fixed gain display.

Seismic shot energy for all 8 cables was viewed real time sequentially, one through eight then back to one, on the streamer monitor display while streamer depth profile as well as depth controller fin angle information was viewed on the DigiCourse depth controller display. The energy source QC display including autofire detect was displayed on the rack-mounted colour graphics monitors. Seismic data as well as start of line and end of line ambient noise plots were produced on the thermal plotters.

Sequences occurred where source autofires had been detected and flagged by the source QC system as bad shots. The source control system subsequently identified these autofires as false. The sequence was then pronounced acceptable and added to the coverage dataset.

3.5 Quality Control Plots

Amplitudes of all channels and all shots from one of the shallow, ambient noise, windows was displayed to monitor noise build up and distribution. For ambient and cultural noise estimates two analysis gates outside the range of reflected energy was required and this was selected as ambient and deep.

The advantage of this type of analysis comes in a real-time monitoring environment when the build up of noise can be readily observed across all streamers and cut-off points determined on those occasions when any particular noise component has become excessive.

The observers produced a line summary record of recording parameters and events and exceptions that occurred during the line. The MSX recording system generated a system log showing shotpoint and file numbers along with a time stamp.

3.6 System Performance

The MSX recording system performed well during the survey. Downtime was incurred and attributed to the system hang-ups. Several records were missed due to data collector errors which were duly noted on the observer line summary sheets. Technical downtime relating to the recording system and sub-systems amounted to 7.47 hours during the GAP04B survey.

4.0 STREAMER CABLE

4.1 Streamer Specifications

Type	Thales Guardian & Thomson Marconi Sonar Sentry Solid Streamer Sections
Length	4800 metres
Group Interval	12.5 metres
Group Length	17.55 metres
Number of Groups	384
Groups per section	12
Hydrophones per Group	14
Hydrophone Sensitivity	13.8 uvolts \ ubar
Streamer Nominal Dia	60mm
Active Section Length	150m
Tail Isolation Section	Syntron 75m Conventional Elastic
Streamer Operating Depth	8.0 metres + \ - 1.0m
Streamer Separation	100 metres + \ - 10 %
Depth Controllers	DigiCourse 5011 x 19
Streamer Recovery Units	Concord Technologies SRD 500
Headbuoy &Tailbuoy	WesternGeco Posnet

4.2 Streamer Description

The eight digital streamers deployed from the MV W*estern Trident* were solid streamer sections each 4800 metres in length. The streamer cables sections are connected by active and passive 24 bit electronics modules every two active sections or 150 metre intervals. The modules are pressurised to 25 psi with nitrogen to prevent seawater ingress at depth.

The streamers consisted of two types of section. One was the older Sentry type section and the newer Guardian sections. The Guardian sections comprised the majority of the sections at the front of the streamers, but accounted for less than 30 % of the overall deployed array.

Each streamer consisted of 384 hydrophone groups centered at 12.5 metre intervals. Each hydrophone group consisted of 14 individual hydrophones linearly spaced at 1.25 metres to produce an overall group length of 17.55 metres.

The streamer data channels were numbered 1- 384 with the lowest channel farthest from the vessel and the highest channel number nearest the vessel. The head of the active streamer is decoupled from the lead in through the use of a 5 metre isolation section know as an RVIM, or Radial Vibration Isolation Module. The last active streamer section was fitted with a terminator module, a 4 metre section, and a 50 metre elastic section which is in turn connected to an AG 77 STIC umbilical cable which provides power to the tailbuoy.

The streamer tailbuoy was a moulded foam-filled plastic dingy-shaped device that was equipped with mountings for a strobe , RGPS receivers as well as a passive radar reflector.

Spaced along the length of the streamer at specified intervals, were Concord Technologies SRD 500 Streamer Recovery Devices. The SRD 500 consisted of an inflatable airbag with a pressure activated release mechanism that is preset to 70 psi, or a depth of 53 metres.

4.3 Streamer Operation

Streamer neutral buoyancy was achieved using external bronze ballast weights. Depth control along the streamer length was achieved using 19 DigiCourse 5011 series compass \ depth controllers spaced evenly along the streamer at 300 metre intervals.

Each depth controller contained an accurate depth transducer that required no on-site calibration. Depth keeping and control functions were variable and a comprehensive set of adjustable control gain settings were available for a wide range of operating conditions.

The control gain settings were usually set to medium sea conditions that provided an optimum balance between good depth keeping and unit battery life. In addition, the streamer depth controllers were fitted with long-life battery cells for extended duration.

Streamer ballast was maintained by adjustment to individual cable section ballast condition through adding or removing external ballast weights to sections. Depth controller fin angles and depth sensor readings were used to ascertain overall streamer trim and balance.

4.4 Streamer Performance

Spare streamer sections aboard MV *Western Trident* following the survey start-up amounted to approximately 27.0 % of the total deployed array. The normal accepted inventory of spare streamer sections the writer would expect to see carried onboard would amount to between 20 and 30 percent of the total deployed cable. Streamer and streamer-related downtime amounted to only 0.53 hours during the GAP04B 3D survey.

See Appendix A
MS Powerpoint Presentation
MV Western Trident Streamer & Wide Tow System

5.0 ENERGY SOURCE

5.1 Source Specifications

Source Type	Tuned Sleeve Airgun Array
Operating Pressure	2000 psi
Single Array Volume	3000 cubic inch – dual array
Undershoot Source Array	3040 cubic inch – single array
Number of Arrays	2
Array Centre Separation	50.0 m
Sub Array Separation	6.0 m
Operating Depth	7.0 m + / - 0.5 m
Array Length Dimensions	15.10 m
Array Width Dimensions	18.0 m
Float System	Flexible Pressurised Float System
Guns Per Sub –Array	8
Spare Guns Per Array	2
Source Controller	Syntron SSS Ver 4.85
Source Synchronization	+ \ - 1.25 ms
Gun Type	I/O Sleeve guns SGII & SG I (40 cu in)
Array Peak Output	43.2 bar/m (DFSV Out -12hz)
Peak Output	86.3 bar/m (DFSV Out – 128 hz)
Primary to Bubble Ratio	9.6
Nearfield Hydrophones	I/O 2933008 / AAG 800-05
Depth Transducers	3 per sub array
Compressors	3 x LMF 57/138 -207- E60
Combined SCFM	6000 SCFM (All Units)
Final Stage Output Pressure	2000 psi

5.2 Source System Description

The energy source consisted of four sub-arrays, each with a total volume of 750 cubic inches combining to form the 3000 cubic inch array. The array made use of cluster guns as well as single gun elements to produce the desired signature, and to provide good primary to bubble ratio. Each sub-array was towed by a 300 metre umbilical bundle cable that contained all air supply and electrical lines.

Each sub-array was deployed and recovered on a chute at the stern. Each individual gun string was positioned by means of an offset towing arrangement where the outer sub-array was tagged to a sliding towpoint on armoured lead in cables No 3 and No 6. Each gun umbilical was tagged together with a short synthetic rope to improve stability of the sub-array positioning and geometry.

This arrangement provided adequate stability for the source sub-array spacing and overall source array geometry. The source elements were suspended by chains from a reservoir that routes airlines and electrical cabling to individual guns.

Each sub-array was fitted with three depth transducers along it's length. Near field hydrophones were assigned toe each element. Source output air pressure sensors were located in the head of each sub-array and on the shipboard source air supply regulating manifold.

Shut-off valves were fitted to the individual airgun elements. Both the source depth and output pressure was recorded by the SSS source synchroniser system and written on the seismic data header record.

5.3 Source Operation

Each survey line was started with a soft start ramp up of individual guns to full array strength for the first shotpoint which was an automatic software feature of the Syntron SSS source controller. Individual gun timing errors were common. Misfires and autofires were infrequent as were air pressure leaks.

Source in-water positioning was achieved by RGPS pods located above the aft airgun on each sub-array and DigiCourse acoustic units attached to the manifold adjacent to the aft gun element on each sub-array.

The SSS sleeve airgun was usually a very stable airgun with respect to individual gun firing times and usually has a high level of outgoing signature repeatability. The airgun design itself was one of very good mechanical design and reliability and has been rated to operate at air pressure of 2000 psi.

5.4 Source QC

A source statistics report was produced by the Syntron SSS controller for each line showing individual gun firing times, delay and errors. A comprehensive set of statistics in graphical and numerical format with time series histograms in PDF format was produced at the end of each line. Minimum, maximum and mean operating air pressure for each sub-array, as well as sub-array separation and gun depth was reported.

5.5 Source Performance

Most survey lines were acquired with the full array volume of 3000 cubic inches but a considerable number of delta errors, misfires and autofires were observed. When a single element failed during a line, the spare gun was either enabled or the single element simply switched off and the line recorded with a slightly lower volume on one array.

The allowable drop-out specifications substitution rules listed below were not violated however, and single or cluster gun timing errors, misfires or autofires were detected straight away. If the gun element timing error persisted, the gun would be disabled and a spare enabled. The gun would then be repaired or replaced at the most convenient opportunity during a line change.

A total of 16.76 hours of downtime was attributed to source problems, including compressors during the single vessel GAP04B 3D Survey

5.6 Array Substitution and Dropout Specifications

- □ If one gun in a cluster goes down, the other gun must be turned off.
- □ Any single array element, cluster or single gun may be dropped.
- □ Any two array elements, clusters or single guns may be dropped.
- □ Any three array elements, clusters or single guns may be dropped as long as combined volume is less than 760 in^3 and not all three guns are the same volume.
- □ Any four array elements, clusters or single guns may be dropped as long as the combined volume does not exceed 320 in^3.
- □ All three dropped elements are not of the same volume.

5.7 Undershoot Vessel Energy Source

The seismic vessel MV *Pacific Titan* provided the energy source for the Perch and Dolphin undershoot programme during the SUE 3D Seismic Survey. The source was a 3040 cubic inch array utilising 3 separate sub-arrays to form the array.

The array was operated at a depth of 7.0 metres and port output pressure of not less than 2000 psi. A source array plan diagram was provided but no far-field signature or array drop-out specifications were provided. The *Pacific Titan* energy source array was fitted with three depth transducers along the length of each sub-array and a single pressure transducer located in the centre of each sub-array.

See Appendix A
MS Powerpoint Presentation
MV Western Trident Energy Source

6.0 PROSPECT

6.1 General Description

The GAP04B SUE 3D seismic survey area was located in the Gippsland Basin off the coast of Victoria in the Tasman Sea, Southern Australia. The survey was situated in a large marine exploitation area in an oil and gas producing zone. This zone was located between Wilson's Promontory in the South and Gabo Island farther North along the East Australia coast.

The approximate geographical centre of the survey was located at Latitude 38° 26' 22.872 South and Longitude 147° 23' 48.329 East. The survey consisted of 77 prime sail lines that were oriented to the North East and South West with an average line length of 34.80.00 kilometres. Average water depth in the survey area was 40.0 metres.

The SUE 3D marine seismic survey ran parallel along the Victoria coast along Ninety Mile Beach and abutted the Eastern boundary of the Ninety Mile Beach Marine National Park. Very strict regulations prohibited the vessel or any component of the trailing seismic equipment to enter the marine park boundaries under any circumstances except in an emergency.

6.2 Weather

The SUE 3D survey area was subject to maritime climate variation and precipitation. The wind and sea conditions during January and February were unsettled. Prevailing wind was predominantly South Westerly with only three percent calms during January and February. Average sea surface temperatures during January and February were between 18 and 19 degrees Celsius.

Severe weather during early February caused a suspension of operations as a low pressure system generated 45 knot winds and 5 to 6 metre seas in the survey area. The vessel remained on station to the North of the survey area with the trailing equipment deployed.

6.3 Tide & Current

Current circulation in the Gippsland Basin is influenced by the East Australian Current which sets to the South with high constancy of > 50 % and the Southern Ocean current that sets to the East with much lower constancy of < 30 % from December through February. Tidal flow through the survey area was Northeast and Southwest and set at a rate of up to 1.0 knots. Tidal level measured at the Perch and Dolphin monopod structures was 0.5 metres maximum.

6.4 Oilfield Activity

Sub sea engineering operations in the form of diving operations, dredging and undersea cable repair were ongoing activity during the course of the survey. Diving operations at the Barracouta platform at the Northern end of the survey were in progress. The cable laying and repair vessel *Gioulle Verne* was carrying out undersea cable repair operations to the immediate South West of the survey area.

6.5 Fishing & Shipping

The survey area was located close to a restricted zone where unauthorized vessels over 200 GRT were not permitted to enter. Consequently, shipping was not observed or presented a hazard and while commercial fishing vessels were present in the survey area from time to time, their numbers were very limited and activity seemed confined to close inshore operations. Fishing activity did not present a hazard to operations.

6.6 Shallow Water

The inshore section of the Sue 3D survey was located in shallow water strewn with rocks and reef and a certain percentage of the survey could not be accessed by MV *Western Trident* in this area due mainly to the depth of lead in catenaries, and the safety of the vessel. An airborne bathymetry survey

had been carried out using the highly accurate Laser Airborne Depth Survey technique that employs surface penetrating laser to determine water depth and seabed contours.

This survey produced a highly accurate bathymetry map of the seabed and water depths at the Western survey boundary close inshore, bordering the Ninety Mile Beach Marine Park and surrounding area. The survey results, which were produced in a graphical colour areal map of the seabed and water depths, enabled the *Western Trident* Captain, Party Chief and the Apache representative to determine definitively, which survey lines could be achieved and which could not using the existing 8 cable configuration.

6.7 Survey Boundary Coordinates

1	38 22 45.888 S	147 15 38.335 E	1001.00	6223.00
2	38 23 12.284 S	147 16 11.840 E	1047.00	6221.00
3	38 30 58.400 S	147 06 30.403 E	1047.00	3001.00
4	38 36 56.628 S	147 16 11.733 E	1758.00	3316.00
5	38 36 54.333 S	147 27 32.478 E	2227.00	5165.00
6	38 34 52.074 S	147 30 04.330 E	2227.00	6007.00
7	38 31 51.252 S	147 30 05.165 E	2072.00	6648.00
8	38 21 47.644 S	147 42 38.473 E	2077.00	10819.00
9	38 18 38.585 S	147 25 59.303 E	1219.00	8781.00
10	38 16 17.751 S	147 26 45.679 E	1130.00	9404.00
11	38 15 52.268 S	147 24 11.774 E	1001.00	9076.00

Mid-point	38 26 22.834 S	147 23 48.283 E
Centroid	38 27 25.020 S	147 23 42.256 E

6.8 Platforms & Obstructions

Three fixed structures were located in the survey area and a fourth, the Barracouta platform situated outside the North Easter survey boundary. The three monopod installations were the Perch, Dolphine and Tarwhinne structures. The coordinates for these structures was as follows:

	Dolphin	**Perch**	**Tarwhinne**	**Barracouta**
X	532921.7000	528109.9000	546221.5000	559108.2000
Y	5740050.1000	5730979.6000	5749307.0000	5761069.5000

Close passes to the three structures located on the survey grid were carried out prior to an undershoot programme being carried out. Extended line changes around the Barracouta platform were conducted during the course of the survey.

6.9 Nature Reserve

The Ninety Mile Beach Marine National Park was a 2750 hectare nature reserve situated along the Victoria Coast between Merriman Creek and Lake Denison. The GAP04B Sue 3D marine seismic survey boundary abutted the boundary of the Marine National Park.

Special precautions were required to ensure that neither the *Western Trident* nor any component of the vessel's trailing seismic equipment entered the park boundary under any circumstances, except an emergency.

The Marine Park boundary coordinates were given as follows:

1. 32º 23' 06" S
   147º 10' 49" E

2. 38º 25' 12" S
   147º 13' 22" E

3. 38º 25' 02" S
   147º 08' 24" E

4. 38º 27' 08" S
   147º 11' 01" E

During the closest pass to the park boundary during February 7th, M/V *Western Trident* monitored the vessel position and the position of the ship's outermost components of trailing equipment and ensured that neither the vessel nor any of the trailing equipment encroached onto the Marine Park reserve acreage.

The positioning information was derived from the DGPS tracking devices installed on the vessel, as well as on the trailing equipment components such as the POSNET RGPS tailbuoy tracking system.

7.0 VESSEL

7.1 Vessel Particulars

Name	M/V Western Trident
Owners	First Security Bank N.A.
Operator	WesternGeco
Flag	Panama
Port of Registry	Panama
Year Built	1999 Ulsteinvik, Norway
Call Sign	LMIE3
IMO Number	9817502
Length O.A.	92.50 m
Beam	23.0m
Draught	7.0 m
Classification	DNV + 1A1, EO, HELDK, ICE-C
Tonnage	8369 GRT
Helideck Classification	Sikorsky S-61
Cruising Speed	14.0 knots
Endurance	85 days Operational Mode
Berths	68 Including Hospital
Fuel Capacity	3550 m^3
Lube Oil Capacity	30 m^3
Potable Water Capacity	440 m^3
Watermaker	2 x 12 tonne per day evaporator unit
Deck Cranes	3 x Norlift GPFO 40 0208 8 Ton SWL

7.1.1 Propulsion System & Machinery

Main Engines	2 x Bergen Diesel BRM9 5400 BHP
Generators	2 x AVK DSG 114K1-6W shaft generators
Auxiliary Engine	2 x Caterpillar 3516 STD 1.4 Mw
Emergency Generator	1 x Caterpillar 3406 DITA 345 Kw
HP Air Compressors	3 x LMF 57/138-207-E60 – 2000 CFM

Air Output Capacity	6000 SCFM
	1 x LMF V17/5518-E60 – 75 CFM
Bowthruster	1 x Ulstein Liaaen TV 1.1 Mw
Bollard Pull	142.0 tons at full power

7.1.2 Vessel Safety & Lifesaving Equipment

Lifeboats	2 x Norsafe 70 person
Liferafts	4 x Viking 25 person
	2 x 20 person
Lifejackets	142 x Seamaster 1983 Cabins & Muster Stations
Survival Suits	68 x Koppernaes
Fast Rescue Craft	1 x Norsafe AS 7.5m Magnum GRP 13862
Workboat	1 x ABC CMV + Zodiac Mk VI

7.1.3 Vessel Fire fighting Equipment

Engine Room	Inergen Zenith Electro
Compressor Room	CO2 \ Foam \ Portable Dry Powder
Instrument Room	Inergen
Tape Store	Inergen
Galley	CO2
Incinerator Room	Inergen
Fire Detection System	Scana Servoteknikk MBS 802 16R
System Capacity	Foam Tank – 4.0 m3
Deluge System	Foam \ Water
Portable Fire Extinguishers	CO2 x 5kg x 10 CO2 x 22 kg x 1
	Dry Powder x 12 kg x 15 Dry Powder x 45 kg x 2 Dry Powder x 25 kg x 2
	Water Extinguishers x 9 litre x 10 Portable Foam Applicators 2
Main Foam Pump	AFFF Grundfoss CR8 -100/9
Main Fire Pump	1 x Allweiler NB 40-200/01/194
Emergency Fire Pump	1 x Allweiler NB 40-200/01/189

7.1.4 Vessel Communications Equipment

GMDSS	A1, A2 & A3
HF-MF Radio Station	Skanti GMDSS Station – Licence No 28134-B
Watch keeping Receivers	2182 Khz Skanti WR 6000 2187.5 Khz
Main MF Transceiver	Skanti TRP 8251D
VHF Transceivers	3 x Skanti VHF 1000 DSC
Frequencies	154.400 – 159.150 Mhz Simplex 159.000 – 163.750 Mhz Duplex
Aircraft Radio	Jotron TR-6101 + ICOM IC-A3E
Helicopter Beacon	SAC DS410 (410 khz – ID TRID)
Inmarsat B	NERA Saturn B 335 726 910
Inmarsat C	Skanti CAPSAT 435 726 912
Telex	871 335 726 911
Telex Inmarsat C	435 726 910
International Telephone	47 38 33 00 46
GSM	47 98 05 75 71
Weather Facsimile	Furuno DFAX 208 Weatherfax Receiver
Navtex Receiver	ICS Electronic Nav 5
Emergency Communications	3 x Navico Axis 250 GMDSS VHF
	3 x Skanti VHF 1000 DSC
	Jotron Tron 40S MK2 EPIRB 406/121.5 mhz
	Jotron Tron SART 9 Ghz Radar Transponder
Portable Radios	6 x Motorola GP340 + 2 x Motorola GP300
Lifeboat Radios	3 x Navico Axis 250

7.1.5 Vessel Aids to Navigation

Radar	Furuno
Make \ Model	FAR-2835S (S-Band) ARPA 3cm FAR-2835X (X-band) ARPA 10cm
Autopilot	Kongsberg Simrad AP9 Mk3 SJS 500
Echosounder	Simrad Skipper GDS-101
Gyrocompass	Simrad RGC-11

DGPS Satellite Receiver	Trimble NT 300D GPS
	Furuno GPS Navigator GP-80
Speed Log	Ben Anthea Electromagnetic
Wind Direction Finder	DEIF 879 Wind Sensor
Electronic Chart	Simrad SPS COS-100

7.1.6 Vessel Management Systems

Planning Station	Simrad SPS Planning Station Simrad STS 500 Tracking System (Robtrac)
Vessel Management	UME 5543 Integrated Alarm & Control System

7.2 Vessel Description

The M\V *Western Trident* was, built in 1999. The vessel was the first of two of this class of vessels built for seismic survey operations. The accommodation was spacious with comfortable single and two man berths on five deck levels. A comfortable, pleasant mess hall and a well-equipped galley were complemented by two large lounges for viewing television, and a small library. A separate conference room for meetings, and a large theatre.

A well-equipped gymnasium was available as well as a sauna. Full laundry facilities were available on each accommodation deck. Catering onboard was excellent with a wide variety of meals of high quality. The vessel was in very good condition. Engineering spaces were clean, tidy and well ventilated.

The seismic operations areas were very well laid out. The streamer deck was superbly laid out, spacious and well ventilated, as was the gun deck. All operations areas were monitored by cameras. The instrument room was well laid out with observer, navigator, navigation processing and seismic QC processing stations laid out in a central console

7.3 Vessel Operation

While in continuous operation, M\V *Western Trident* fuel consumption was approximately 29 cubic metres daily with 2 main engines running at 160 propeller shaft RPM. Between 55 % and 60 % propeller pitch was a normal setting. Main engine revolutions were kept constant while propeller pitch was adjusted according to desired shooting speed and prevailing wind & sea conditions. Water making capacity was 20 m^3 daily through the evaporator plant. Waste was handled and disposed of according to Marpol requirements.

7.4 Workboat & FRC

The *MV Western Tident* was equipped with two dedicated workboats. The workboats were used for streamer section, module, depth controller and acoustic unit replacement operations as well as tailbuoy maintenance. The Norsafe Magnum Fast Rescue Craft was also used on occasional inspection trips or used to transfer personnel and equipment to and from the escort vessels.

The workboats were fitted with RGPS receivers. The boat was tracked during operations to allow constant monitoring of the location of the boat during in-water streamer maintenance. The RGPS position was relayed to the *Western Trident* and is displayed on the Spectra multi-streamer monitors located at the observer, navigator and helmsman consoles.

In addition to being tracked by ship's radar, this permitted the shipboard controller to vector the workboat by radio to any given remote streamer unit quickly and with a high degree of accuracy, thus saving time.

7.5 Vessel Performance

No downtime due to vessel systems and operation was incurred during the GAP04B SUE 3D marine seismic survey.

See Appendix A
MS Powerpoint Presentation
MV Western Trident
Fuel Efficiency & CO2 Emission

7.6 Chaseboats

See Appendix A
Word Documents OMS Pioneer & Lady Roula

8.0 SEISMIC EQUIPMENT

8.1 Monowing Paravane System

M/V *Western Trident* wide tow system consisted of two MK I and two MK II monowing paravanes that provided the spreading force necessary to tow up to 8 streamers at 100 metre spacing. The monowings were augmented by four smaller spreading devices attached to the streamers, known as miniwings.

The two MK I monowings tow the outer two streamers. Each is assisted by a single miniwing that is attached to the head of the streamer via an adapter section. The two more powerful MK II monowings, tow the inner three streamers and each was assisted by a miniwing attached to the front of streamers 2 and 6. This arrangement provided the spreading force required to stabilize the streamers and source arrays at the specified separation.

System Specifications

Mark I Monowing 35º angle of attack	Lift	6630 kg	Drag	1250 kg	L/D Ratio 5.3:1
Mark II Monowing 35º angle of attack	Lift	9680 kg	Drag	1470 kg	L/D Ratio 6.58:1
Miniwing 10º angle of attack	Lift	350 kg	Drag	45.87 kg	L/D Ratio 7.63:1

Flotation

MK I & MK II Monowing	Streamers 1,2,6,7	5100 litre floats
	Streamers 3,4,5,6	3200 litre primary floats 2200 litre secondary floats 16 x 65 lb clamp-on floats

Total System Pressure Drag at 5.0 knots = 36.7 tons

(8 x 4800 metre streamers \ dual 3000 cubic inch gun arrays \ Monowing wide tow system)

System Description

The Monowings were towed from the main streamer reel winch system via the armoured tow leader. Control of the monowing angle of attack was via an electro-hydraulic control system that was controlled from a standalone dedicated workstation situated in the instrument room that provided power, monitoring and control of the monowing electro-hydraulics and electronic monitoring and control system.

Battery units provided the power to the electro-hydraulic mechanism contained inside the monowing foil. This controlled the monowing angle of attack via an hydraulic actuator cylinder and arm arrangement. Accelerometers mounted on the monowing body provide feedback data relating to wing angle of attack, pitch and roll. This permitted the operator in the instrument room to adjust wing angle of attack and increase or reduce spreading force as desired. This feature was especially useful in maintaining constant streamer and source separation across a wide variety of operating conditions.

The proposed source and streamer towing configuration for the survey were first modeled using WesternGeco in-house modeling programme called TowSim. This simulation system computed

source and streamer offset and layback as well as maximum lead in catenary depth. The model also computed overall hydrodynamic pressure drag for the complete towing arrangement at a fixed velocity, as well as producing an analysis of drag contribution from individual components.

8.2 Streamer & Source Handling Systems

The streamer & source handling system was comprised of 16 independent streamer reels and 8 gun umbilical reels. The reels can be operated independently or in a synchronised mode and were operated by remote radio control units linked to a Siemens Coros OP 15 PLC and an ODIM 300 Master Synchro System control and display unit. The two outer streamer reels had a capacity for storing up to 7,600 metres of 57 mm dia streamer while the remainder of the streamer reels had a capacity of 10,000 metres. The airgun reels can store up to 400 metres of 70 mm dia airgun umbilical.

The armoured lead in cables were supported and towed from the stern by Odim Spectrum 700 / 50 series fairleaders that were suspended from the deck head on individual hydraulically operated towing arms. Theses can be lowered and raised, extended and retracted as required, and were locked in position during normal operations.

8.3 Cable Repair Facility

MV *Western Tident* was equipped with a fully functional cable repair and testing facility situated forward of the streamer deck aft of the accommodation on C deck. Faulty or damaged sections could be easily transferred off the active streamer reel and into the cable workshop.

The workshop was fitted with two controllable cable reels and a worktop for carrying out repairs to cable sections. Full testing facilities and instruments were available. One crew member was aboard employed full time as a cable repair technician.

8.4 Storage and Handling

MV *Western Trident* had ample storage facility for spare streamer sections. Four additional streamer reels were situated below the main streamer deck and had the same capacity as the main towing and handling system. In addition, multiple individual storage reels were located at the forward end of the streamer deck.

The vessel made wide use of synthetic rope on all utility winches located about the working areas. The synthetic rope in use was constructed from Dyneema® SK75 synthetic fibre which was recognised as the strongest rope, with the highest strength to weight ratio of any rope available. All utility winches were clearly marked with rated SWL.

8.5 Wide Tow System Performance

The outer streamers were occasionally affected by the trailing vortex disturbance generated by the monowings. This usually resulted a brief depth fluctuation between depth controllers No 3 to No 6. This phenomenon relates to an industry-wide problem that has yet to be adequately dealt with. Downtime attributed to the wide tow system and associated equipment during the GAP04B SUE 3D marine seismic survey accounted for only 0.92 hours of the total survey time.

See Appendix A
MS Powerpoint Presentation
MV Western Trident - Streamers & Wide Tow Sytem

9.0 QC PROCESSING

9.1 Processing System Description

Shipboard data processing and quality control used the SeisView system using Omega software which was used to produce RMS plots, brute stacks, time slices and a near trace and 3-fold cube. The system was used as a QC tool. Brute stacks were inspected for seismic interference, swell noise and tow noise on the streamers. Shot records were inspected to locate or verify autofiring guns, spiking traces, and corrupted data caused by transmission errors.

For QC purposes, the contractor processed data from one streamer per sail line. For each line an alternate streamer was selected, ensuring all streamers were sequentially checked. The system was used to produce a common near trace offset cube and shallow time slices were made to evaluate data quality and to monitor the effects of external noise such as swell induced noise and seismic interference. The streamer noise was also recorded into a shallow gate. Production processing was not carried out during the survey. QC processing was operated on a 24 hour continuous basis.

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

The main system hardware used was an IBM P series 640 Model B80 N4000 with 4 processor with 8gb memory. Grahics were displayed in dual 21 inch colour graphics monitors and an HP Visualize 360 workstation. Plots were produced on an OYO GS-636 36 inch thermal plotter, an HP Design jet plotter and an HP LaserJet printer.

9.2 QC Quality Control

A number of the quality control procedures created displays on-line and in real-time. This selection comprised a mixture of seismic trace data displays including shot records and gathers as well as statistics such as RMS amplitude plots. All data was resampled from 2ms to 4ms and re-formatted from SEG-D to Omega internal format.

Source Comparison Plots

RMS data were collected for both separate gun arrays and later plotted graphically over each other. This allowed for a simple method of directly comparing the output of one array against the other. Generally, these graphs were produced only on-screen.

Noise Plots

These plots displayed all of the major sources of noise that impacted upon the survey. Swell noise was apparent on occasions and tended to increase in amplitude over several hours before decaying again. The level of this swell noise did occasionally exceed the 10 % of all traces cut-off level of affected traces per shot.

9.3 Brute Stack Processing Sequence

- Reformat data from SEGD to OMEGA internal format.
- Resample from 2 ms to 4 ms applying minimum phase anti alias filter
- Apply 3 hz / 18 db\ octave low-cut filter
- Edits based on observer log
- Geospread compensation – Single Velocity Function
- Select one streamer source combination.
- VT Spherical divergence correction
- Predictive deconvolution
- Operator length 300 ms – lag 36 ms
- Application of 2D geometry
- Outer trace suppression mute
- CMP Stack square root normalisation
- Alternate trace drop after spatial anti-alias

9.4 Navigation Merge QC

A crosscheck was made of the navigation and seismic data. This was performed by merging the post-processed P1/90 positioning data with the near offset trace data from each streamer for each shot. A hard copy showing the navigation derived time picks overlaid on the seismic direct arrivals was produced for each line for all streamers.

This display was designed to detect source flips where the expected active source changes to the opposite one. If navigation data processing does not take account of this change a corresponding flip was noticed on the display.

9.5 Initial Brute Stack

Raw and filtered and scaled brute stacks, created using a regional velocity function, were produced for each line. This stack was generally available one hour after the last shot, depending on the line length.

A common near offset trace cube was created on each cable for every shot, for every line. These offsets, in preference to the near trace, were used so that cable head noise could be avoided. From this cube of data, time slices and cross lines were extracted at intervals to check on geometry integrity, acquisition lineation, noise, etc. The final deliverable products included field tape copies, brute stacks and an on board processing report.

9.6 Near Trace Cube

The cube was constructed as a navigation QC tool, using one near channel of each streamer, representing approximately equal offset radius positions from the source. The near trace cube was produced on a regular basis throughout the survey.

9.7 Swell Attenuation

During periods of heavy sea and swell conditions during the survey, reliance was placed on the SWAT (Swell Attenuation) function to attenuate swell noise. The SWAT routine is designed to enhance the signal to noise ratio of data using a complex prediction or projection deconvolution filter in the F-X domain. This process can enhance lateral linear continuity without significant mixing of various dipping events. In order to apply the filter to the real dataset, the user may separate the data flow group into a number of trace panels and time windows, such that the wanted events are roughly linearly dipped towards the same direction within each panel and each window.

A SWAT stack was produced if deemed necessary. Where swell noise was observed on the brute stack, a further stack was produced using the SWAT swell attenuation program. If the swell noise was thought to be severe, a difference plot would also be generated.

10.0 PERSONNEL

10.1 Seismic Personnel

The compliment of seismic personnel aboard the vessel for seismic operations was considered more than sufficient for day to day running and management of acquisition and routine daily maintenance operations.

The seismic and marine crew rotate every five weeks with the full crew changed out at each rotation. This practice is usual in the industry. Each department compiles a comprehensive set of handover notes. The department chiefs have sufficient verbal handover discussion during crew change.

The attitude of the crew towards QHSE was generally very good. The level of safety awareness in general was high. Each individual crewmember in general paid particular attention to the use of correct PPE for any given task.

The seismic crew was considered competent, well trained and carried out their duties in a very professional manner. The writer was given excellent cooperation and assistance with all aspects of the operation. The party manager and department chiefs were especially helpful with input into the operation and valuable assistance with information regarding enquiries into the particulars of equipment and operations.

10.2 Crewlists

10.2.1 Crew List – December 2004 – January 2005

(Name of shipping line, agent, etc.) **Monson Agencies**			**CREW LIST** ☐ Arrival ☒ Departure			Page No **1**
1. Name of ship **Western Trident**			2. Port of arrival/departure **CRT off**	3. Date of arrival/departure **17-Jan-05**		
4. Nationality of ship **Panamanian**			5. Port arrived from **Fremantle**		6. Nature and NO of identity document (passport)	
7. No.	8. Family name, given	9. Rank or rating	10. Nationality	11. Date and place of birth		12. Expiry date
1	Reid, Paul	Captain	Irish	18-Aug-60, Cork	W102231	24-Oct-12
2	Defossez, Luc Georges Armand	Chief Officer	Belgian	30-Jan-46, Wervik	EC248805	05-May-07
3	Fernandes, Augustine	2nd Officer	Australian	02-Oct-49, Bombay	E7538858	05-Aug-09
4	Kjelstad, John	Maritime Advisor	Norwegian	30-May-68, Norway	20587665	02-Jul-14
5	Sanders, Gordon J	Chief Engineer	Australian	04-Sep-61, Perth	E7035309	09-Jan-07
6	Morgan, Alan	2nd Engineer	New Zealand	11-May-58, Wellington	N984996	19-Apr-10
7	Lucas-Calcraft, Malcolm	3rd Engineer	Australian	13-Apr-58, Newborough	L6610841	13-Jul-08
8	Lacki, Marek	Electrician	Polish	18-Nov-49, Poznan	AB5769943	16-Oct-11
9	Chapman, Robert, Charles	Electrician	Australian	10-Aug-45, Melbourne	L8599881	30-Jun-10
10	Seaman, Mark Leslie	Bosun	Australian	27-Sep-57, Amersham	L0411317	28-Sep-05
11	Harris, Luke, Damon	AB	Australian	19-Apr-72, Sydney	AA787759	12-Aug-13
12	Softly, Christopher, Anthony	AB	Australian	06-Jul-67, Adelade	L8404104	09-May-10
13	Guy, Andrew, Richard	OS	Australian	23-Sep-66, Merthyr Tydfil	L9239500	14-Sep-10
14	Hill, David	Fitter	New Zealand	16-Sep-58, N. Zealand	M085834	12-Jul-05
15	Anderson, Frank	MTM	Australian	19-Aug-46, Halden	L6678597	31-Aug-08
16	Skvor, Sonia	CTO	Australian	21-Jun-69, Mornington	L9957059	05-Oct-11
17	Smith, Steven, Gerard	Cook	Australian	28-Feb-63, Sydney	L6544427	29-Jun-08
18	Leslie, Sam, Nayan	2nd Cook	Australian	06-Apr-75, Rose Park	L9726948	09-Aug-11
19	Gore, Terence R.	Messman	Australian	17-Jan-52, Perth	L 1268863	30-Jan-08
20	Baker, Richard J. J.	Paramedic	Australian	19-Aug-57, Godstone	L 0661565	13-Jun-06
21	Halfpenny, Ian	Party Manager	British	11-Aug-57, UK	740198128	18-May-11
22	Melody, Paul M.	Chief Pos	British	13-Jun-67, Church Village	093081090	06-Dec-13
23	Gors, Michael	SL Pos	Australian	17-Apr-68, Australia	L1409600	23-Feb-10
24	Farrell, Paul	SL Pos	British	29-Sep-68, Hyde	740137957	16-Jun-09
25	Brader, David	Pos Operator	New Zealand	02-Aug-65, Wanganui	M050842	21-Jan-07
26	Ryan, Steven	Pos Operator	Australian	10-Aug-81, Melbourne	L3099345	04-Jan-12
27	Lopes, Victor	Chief Acq	Portuguese	28-Jul-57, Portugal	F591638	11-Dec-10
28	Chandler, John	SL Acq	American	04-Nov-59, U.S.A.	067349598	30-Dec-13
29	Morgan, Richard	SL Acq	British	10-Dec-67, Liverpool	740201329	28-May-13
30	Nicholson, Bruce	Acq Operator	Australian	17-Jan-58, Brisbane	L4792095	31-Oct-13
31	Turnbull, Stanley, W.	Acq Operator	Australian	09-May-67, Hobart	E7048208	21-Apr-08
32	Rawlings, Kendall, John	SL Han	Australian	31-Mar-67, Wellington	L3777941	29-Aug-12
33	Robson, Colin	SL Han	British	24-Nov-57, U.K.	26600128	07-Apr-07
34	Deamer, William	Han Operator	Australian	29-Mar-58, Bellata	E7049903	09-Mar-08
35	Woodworth, Richard	Han Operator	Canadian	29-May-72, Bridgewater	BC204319	17-Jul-07
36	Darnell, Neil, J.C.	QAS	British	07-Jul-67, Durban	500339320	15-Mar-11
37	DeHaai, Jon	Field Geo	American	26-Sep-67, U.S.A.	133102105	11-Oct-09
38	Burt, Stephen, J.	Client Rep	British	12-Mar-55, Manchester	740209240	20-Jul-11
39	Evan-Cook, Jonathan	Client Rep	British	23-Dec-50, Erith	740146339	09-Jan-12

8 Date and signature by master, authorized agent or officer

10.2.3 Crew List – January- March 2005

(Name of shipping line, agent, etc.)

CREW LIST

☐ Arrival ☐ Departure

Page No **1**

1. Name of ship	2. Port of arrival/departure	3. Date of arrival/departure
Western Trident		

4. Nationality of ship	5. Port arrived from
Panamanian	

7. No.	8. Family name, given	9. Rank or rating	10. Nationality	11. Date and place of birth	6. Nature and NO of identity document (passport)	12. Expiry date
1	Bless, Rudolf	Captain	German	03-Apr-50, Hattendorf	1885051534	26-Sep-12
2	Mcphee, Brett	Chief Officer	Australian	05-Aug-64, Brisbane	L0821017	29-Nov-06
3	Mc Clain, Jo	2nd Officer	American	18-Apr-64, Alabama	Z7632087	14-Mar-06
4	Tybring, Jens	Maritime Advisor	Norwegian	03-Sep-62, Horton	20324241	20-Mar-14
5	Joseph, Kevin	Chief Engineer	Australian	15-Jun-49, Shoreham	E7531711	08-Apr-08
6	Glavina, Paul	2nd Engineer	Australian	20-Apr-54, Trieste	L7064291	11-Jan-09
7	Foster, William C.	3rd Engineer	Australian	18-Nov-49, Warwick	E7032513	18-Oct-06
8	James, Geir Allan	Electrician	Norwegian	15-Feb-56, Borgund	20609163	25-Oct-14
9	Brealey, Jason L.	Electrician	Australian	27-Jun-74, Semaphore	E1022243	25-Jan-15
10	Spreadborough, Peter L.	Fitter	Australian	07-Dec-54, Toowoomba	L8772805	24-Jul-10
11	Smith, Wayne M.	Bosun	Australian	05-Aug-56, Sydney	L8504214	10-May-10
12	Gardner, Douglas	AB	Australian	12-Aug-47, Whitburn	702206706	21-Jul-08
13	Hoogerwaard, Simon	AB	Australian	20-Jun-74, Singapore	E 7592411	14-Mar-12
14	Meheux, Robert W.	AB	Australian	01-Aug-55, Perth	L1216585	09-Sep-07
15	Cartwright, Craig A.	MTM	Australian	26-Apr-68, Melbourne	L3922831	24-Oct-12
16	Willis, Troy A.	MTM	Australian	17-Dec-72, Port Kembala	L5024644	28-Apr-05
17	Shanahan, Peter G.	CTO	Australian	21-Feb-55, Melbourne	L7565474	30-Jun-09
18	Bishop, William A.	Cook	Australian	22-Jul-65, Subiaco	L3402444	03-Apr-12
19	Aucote, Terrence B.	2nd Cook	Austrian	12-May-51, Pambula	L7513246	19-Jun-09
20	O'Byrne, Mark P.	Steward	Australian	10-Aug-52, Bunbury	L9894200	10-Oct-11
21	Annetts, Peter James	Paramedic	Australian	06-May-56, Sydney	L4588306	20-Feb-13
22	Martin, Michael	Party Manager	British	21-Jan-59, Wallasey	200546129	17-Jul-09
23	Kilmurray, Stephen John	Chief Pos	British	23-Oct-66, Wigan	093099322	14-Jan-14
24	Pederick, Joel	SL Pos	Australian	15-Jan-75, Adelaide	E7577789	27-Jun-11
25	Perkins, Adrian T.	Pos Operator	Australian	11-Jun-81, Ulverstone	L7556930	05-Jul-09
26	Shah, Rickin J.	Pos Operator	Indian	10-Feb-85, Mumbai	F1549460	04-Aug-09
27	IsdarYanto, Donny	Chief Acq	Indonesian	22-Jul-64, Semarang	M930619	01-Sep-08
28	Leija, Esau Harim	SL Acq	American	03-Sep-67, Mexico	132820745	19-Jan-09
29	Klincke, Stewart	SL Acq	British	30-Jan-69, Stockton	024932155	18-Nov-06
30	Aurelio, John R.	Acq Operator	Philippine	29-May-63, Iloilo	ZZ129588	23-Jul-09
31	Mra, Aung Kyaw Swa	Acq Operator	Burmese	07-Feb-66, Yangon	605204	03-Nov-08
32	Roehl, Armin	Chief Han	German	21-Aug-63, Kiel	1210021933	30-Oct-07
33	Flores, Aldrin	SL Han	Philippine	02-Aug-69, Pampanga	ZZ096958	06-Jan-08
34	Doctolero, Romeo	Han Operator	Philippine	19-Feb-55, La Union	ZZ130493	19-Aug-09
35	O'Neill, Kevin M.	Han Operator	Australian	23-Aug-61, Wellington	L4358702	30-Jul-13
36	Al Krishnan, Sri M.	Han Operator	Malaysian	15-Jun-75, Pulau Pinang	A 14049746	05-May-10
37	Chan, Danny K. W.	Trainee Han	Australian	03-Feb-80, Kuching	L3173350	28-Nov-11
38	Bin Malit, Khairuz Zharfan	Trainee Han	Malaysian	07-Oct-80, Selangor	A 12296803	10-Aug-07
39	Maheshwari, Kishore Kumar	QAS	Indian	24-Apr-70, Lucknow	Z 117034	23-Jan-07
40	Gorbatchev, Petr	Field Geo	New Zealand	20-Mar-62, Moscow	N988750	17-Apr-10
41	Busby, Gregory	Cable Rep	American	27-Jun-72, Mississippi	133986160	07-May-12
42	Bonnevier, Johan Patric	Client Rep	Swedish	30-Jun-56, Vaexjoe	34792395	17-Feb-09
43	Milne, Ian C.	Client Rep	British	04-Oct-55, Edinburgh	702405329	08-Feb-09

11.0 HEALTH SAFETY and ENVIRONMENT

11.1 General

Consultants Ian Milne and Patrick Bonnevier joined the vessel via helicopter from Melbourne on January 29th to take over responsibility from Jon Evan-Cook and Stephen Burt. The Chief Officer gave the consultants a full formal safety orientation tour of the vessel shortly after arrival aboard the vessel.

Emergency muster drills and fire drills were conducted at regular intervals. A Tee-card system of ensuring all personnel are accounted for during drills and actual emergencies was in use. A monthly safety committee meeting was held in the ship's conference room with the full safety committee in attendance. General crew safety meetings were usually held a week before crew change.

A check of the safety equipment in each cabin was routinely carried out. The level hazard and Risk Identification Reporting (RIR) was good. Waste management and segregation was strictly adhered to. A lock-out \ tag-out system was in effect in critical areas.

A comprehensive special permit to work system was in place along with a crane operations checklist. Workboat and FRC pre-launch toolbox meetings precede any activity or planned in-water maintenance and are well documented and recorded. A marine mammal observation procedure was in place whereby the marine mammal observation record is maintained by the officer on watch. The soft-start of the energy source on approach to each line was carefully
logged and documented

11.2 Emergency Response

An Emergency Response Plan was in place in which emergency procedures and contact numbers were clearly defined. Copies of the emergency plan and response numbers were kept by the bridge crew, Party Chief, client representatives, and in the copies of the project plans issued prior to the start of the survey.

11.3 Medical Response

The vessel was equipped with a treatment room & hospital complete with 2 beds. A paramedic was assigned to the crew. The vessel medical supplies were complete and complied with SOLAS requirements for unrestricted service. First aid kits were provided in the gun control room, instrument room, processing room, helicopter prep room, engine control room, bridge, galley, and the life boat. Eyewash stations were located adjacent to all areas in which there were potential hazards to the face and eyes from flying debris or chemicals.

11.4 Small Boat Operations

The vessel was equipped with a two purpose-built work boats mounted Port and Starboard and a modern Fast Rescue Craft. Before launching any small boats, a toolbox meeting was held. At this meeting, all crew members participating in the forthcoming mission were present. The purpose and proposed conduct of the mission were discussed. Only when prevailing conditions were within the contractor and client safety guidelines was the boat launched. The workboat was fitted with an rGPS beacon in order that it could be tracked during deployment.

11.5 Helicopter Operations

During the survey, crewmembers were changed out by helicopter. The helicopters flew from Melbourne. The flight time from Melbourne was about 50 minutes. Several of the crewmembers were trained as Helicopter Landing Officers. The H.L.O. communicated directly with the pilot during helicopter landing and takeoff. During helicopter operations the chase boat was brought close to the W*estern Trident*. Additionally the FRC crew was on standby for any emergencies.

11.6 Safety Tours, Drills and Meetings

All new arrivals to the vessel were familiarised with the safety features onboard by means of an HSE induction tour conducted by the Chief Officer. The induction lasted about 30 minutes and was normally carried out within 24 hours following the person's arrival on the vessel. Regular drills were conducted and attended by all crewmembers not essential to survey operations.

11.7 Safety Awareness, Training and PPE

The safety culture aboard *Western Trident* was well-developed and in keeping with other vessels in the contractor fleet. The level of readiness maintained onboard the vessel during the course of the survey was also good. Personal protective equipment was used when required. The PPE on board was of a high standard and usually replaced as soon as a defect was noticed.

All personnel onboard were required to attend a basic offshore survival course and HUET training, allowing crew changes to take place by helicopter. The contractor also required a valid offshore medical certificate for every person sailing on the vessel.

A general safety meeting involving the entire crew was convened each trip. This meeting discussed recent issues and also topics arising from incidents on other contractor vessels through the experience transfer process. In addition, a meeting of the safety committee for heads of departments were held. The meetings were normally chaired by the Party Manager and the Captain.

11.8 Safety Equipment

Lifesaving Equipment

M/V *Western Trident* was equipped with two totally enclosed Norsafe lifeboat with a 70 man capacity. Four twenty five-man life rafts and two twenty-man liferafts were available. Three situated on the Starboard side and two on the Port side of the vessel adjacent to the lifeboats. .

Personal life jackets and survival suits were available for all personnel. Inflatable life jackets, coveralls and safety harnesses were available for use during the deployment and recovery of source arrays and streamer cables. The use of the inflatable work vests and harnesses was mandatory during work on deployed equipment near the stern of the vessel and within the gun slipways.

For a man overboard situation, two six-man life rafts were available near to the stern of the vessel and a fast rescue craft was provided. MOB drills were held about once every six-week tour of duty, during daylight hours and during periods of good weather and sea conditions.

The vessel carried greater than 200% life jackets. One jacket per berth was kept in the cabins and 60 jackets were stowed in lockers at the muster point. All jackets were fitted with lights and reflective tape. Sixty survival suits were also available at the muster point. The vessel carried 14 life buoys, for use in a man overboard emergency. Six of these buoys were equipped with light and smoke markers, two with light and rope, two with light, and four with rope. Two man overboard life rafts were installed in cradles on the stern. Man overboard alarms buttons were placed strategically at various locations about the working areas.

Vessel Fire Fighting System

M/V *Western Trident* was equipped with a fire detection system that covered all major internal spaces in the ship. Fire control plans were posted on the bridge and in the accommodation areas. A copy of the plan was also kept in a watertight enclosure in two open deck locations.

The vessel was protected by a water main that supplied all hydrants. Each hydrant was equipped with a fire hose and combined jet / fog nozzle. The fire mains were pressurised by an engine room fire pump. An Inergen fire suppression system was installed in the engine room, engine control room, and compressor room. An Inergen system covered paint locker, incinerator room, and emergency generator room as well as the instrument room. A foam deluge system was in place and covered the cable reels, mezzanine deck and helideck.

The vessel carried portable extinguishers of various types. Water, Dry Powder and CO2. Class “D” extinguishers were to be used in the case of a fire involving the lithium batteries. Four fire blankets were provided in various locations on the vessel.

Fireman's outfits were part of the ship’s equipment and consisted of fire suits, gloves, and helmets. Four SCBA units were also part of the emergency equipment. Spare air bottles and an air compressor were available to enable the bottles to be re-charged after use. This recharging capability allowed personnel to be trained with the equipment.

Emergency Communications Equipment

The vessel was equipped with an 'EPIRB' (Emergency Position Indicating Radio Beacon) installed in a float-free fastening on top of the bridge, and two 'SART' (Search and Rescue Radar Transponder) on the bridge to meet the requirements of the 'GMDSS' (Global Maritime Distress & Safety System).

11.9 Reporting

Safety reporting utilised the WesternGeco Quest system linked to company servers. All reportable incidents were entered into this system. The Risk Identification Reporting system (RIR) followed that all reportable hazards were sent to head office via e-mail for distribution the company fleet. This allowed each vessel to view hazard reports and incidents of other WesternGeco vessels. Crewmembers were encouraged to report safety related observations and topics through the safety awareness improvement system.

11.10 Waste Management

A comprehensive waste management and segregation system was in place. Waste was separated into biodegradable, incinerated and solid waste. Lithium batteries were stored aboard for transportation and disposal ashore. Waste management responsibility resided with the Chief Officer and Chief Engineer.

Waste produced onboard was also sub-divided into categories. Domestic waster including glass, tins and hazardous waste. Biodegradable food waste was discharged overboard after maceration. Flammable waste was incinerated. Non-flammable and non-biodegradable waste was stored and disposed of ashore. Additional procedures for the handling and disposal of hazardous wastes were in place.

11.11 Permit to Work

A comprehensive permit to work system was in place, which enabled control and monitoring of the following activities

- The use of hot work equipment
- Confined space entry and use of equipment in confined spaces
- Working aloft or at height
- Work on high-pressure systems
- Work on electrical systems.
- Use of deck cranes.
- All non-routine activities

The permit to work system was controlled and monitored from the bridge, which ensured a central control point for all the necessary activity.

11.12 Chronology of Significant Events

16th January 2005

04:57 Start of GAP04B SUE 3D Marine Seismic Survey

17th January 2005

Lost Time Incident. One member of the seismic crew and a member of the marine crew sent ashore for medical examination following an incident on the previous survey.

27th January 2005

Helicopter crew change

28th January 2005

MOB alarm activated twice (false alarm) and shut down the energy source.

29th January 2005

Client representative handover & helicopter crew change

31st January 2005

Suspended operations to remove fishing gear entangled in the trailing equipment. Damage incurred to lead in cable No 3.

2nd February 2005

Acquisition operations suspended due to severe weather – Wind & sea force 7-8 / 5 metre seas

3rd February 2005

A meeting of the safety committee was held in the ship's conference room from 12:45 to 14:00

6th February 2005

A Fire Drill was carried out at 12:45 with a simulated fire in the ship's rope locker in the foc's'le

7th February 2005

A general crew safety meeting was convened in the mess from 13:00 to 14:00 with all available crew in attendance. First Aid and CPR training was carried out for the ship's crew by the medic

8th February 2005

First Aid and burn treatment training was carried out for the ship's crew by the medic.

10th February 2005

A Lost Time and Productivity (LPT) meeting was held (WesternGeco Internal)

12th February 2005

An unannounced emergency medevac drill was conducted by the ship's crew between 10:00 and 10:30 am. The purpose of the unscheduled drill was to evaluate the response time from the emergency medevac helicopter evacuation team.

First aid and CPR training was carried out for the ship's crew by the medic.

14th & 15th February

First aid & CPR training continued

12.0 ACTIVITY AND PRODUCTION

12.1 Activity Summary

Mobilisation for the GAP04B Sue 3D survey involved a short transit from an adjacent survey with no reconfiguring the streamers required. The survey commenced on January 16th. A crew change was carried out on January 27th and a client representative handover took place on January 29th by helicopter.

12.1.1 Survey Operations – January

Production commenced on January 16th in unsettled weather and steady production continued until January 27. During the crew change, the vessel was required maintain a constant heading for the landing and take off, thus missing the start of a survey line.

Steady prime production continued until October 28th when operations were interrupted by a fault with the man overboard shutdown system that suddenly shut down the guns for no apparent reason at 00:19 local time. The same thing happened again a short while later at 06:57. All MOB alarms systems were checked and reset.

A series of close passes by the Perch monopod structure in the centre of the survey were carried out. During this time the client representative was in attendance on the bridge for observation of procedures and communications during the exercise.

During sequence 049 on January 31st strong low frequency strumming and tugging was observed at noise levels up to 30 ubars. Operations were suspended to investigate the Problem and considerable damage was observed to the flag fairing and Cumberland Grips on lead in No 3. The lead in had evidently snagged a submerged object, most likely fishing gear. Production resumed early February 1st.

The month of January ended with the vessel in continuous production and a good monthly production total to report. Forty nine sequences had been acquired and a total of 1946.53 prime sail kilometres and 87.39 infill sail kilometres acquired, amounting to 68.5 % of the survey total with only 3.05 % infill.

12.1.2 Survey Operations - February

Production continued into February with prime acquisition and elective infill in progress. This continued until February 2nd when the vessel was shut down due to severe weather.

Following the weather downtime period acquisition resumed and the GAP04B SUE 3D seismic survey single vessel operation was completed early on February 12th with a total of 90 sequences being acquired and 6.72 % infill recorded.

Acquisition Time Accounting – GAP04B Sue 3D Seismic Survey

a) A nominal line change time was established shortly after the start of the survey which involved a standard 1.833 hours line change at the Southern end of the survey and a 2.25 hour standard line change at the Northern end, where the vessel had to go around the Barracouta platform.

b) Line change times in excess of 1.883 hours and 2.25 hours was classified as either current and tide \ survey geometry, and obstructions or shallow water respectively.

12.1.3 Dual Vessel Undershoot

Following completion of the prime and infill acquisition an undershoot programme involving dual boat survey operations around the Perch and Dolphin monopod platforms was begun.

The survey vessel MV *Pacific Titan* which had been conducting a small 2D streamer survey adjacent to the SUE 3D survey, was utilised as the energy source vessel. The mobilisation for the undershoot was commenced at approx 21:00 hours on February 12th when the two vessels arrived at the Dolphin

platform location. The task of setting up the dual-vessel timing link got underway and straight away the mobilisation became bogged down in technical problems relating to the dual vessel link. The link was the WesternGeco True Time unit used for two-boat operations such as undershoots.

Problems relating to the drifting field timebreak issued by TriNav continued through the undershoot and processing QC of single trace plots revealed that each trace had a different first arrival time from one shot to the next. Individual trace first arrival times were drifting from zero to 15 milliseconds from shot to shot compared to navigation P190 output data. This anomoly was duly reported to WesternGeco field technical support and data processing departments.

Onboard QC processing staff attempted to correct this time-shift by writing a script file to adjust each trace in the time domain to no avail. The undershoot was completed and a further attempt to rectify this problem by installing a spare Truetime unit and by-passing TriNav in the instrument room yielded no result.

WesternGeco technical support and data processing staff eventually demonstrated that the time error could be corrected and displays showing before and after condition of the single trace plots verified that the data could be corrected in processing.

12.2 Survey Production Chronology

Daily Activity (Timezone = GMT + 11.0Hrs.) Daily Report 16-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	04:57	LT		Transit from MOBY 3D GAP04A survey				
04:57	05:33	LT		First SUE 3D line 1536P - Soft start of source				
05:33	11:04	PR	001	Line complete	1536P1	3185	944	672.6000
11:04	12:10	LC		Heading for line 1808P				
12:10	12:50	LC		Soft start of source				
12:50	18:08	PR	002	Line complete - heavy swell noise at EOL	1808P1	1161	3528	710.4000
18:08	19:10	LC		Heading for line 1552P				
19:10	19:40	LC		TBs 5/6 & 7/8 crossed during turn Str6 & Str8 surfaced				
19:40	19:58	LC		End of nominal line change				
19:58	24:00	WX		WoW. Swell noise in excess of 40µB - line attempt abandoned				

Daily Activity (Timezone = GMT + 11.0Hrs.) Daily Report 17-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	03:35	WX		Waiting for weather improvement.				
03:35	04:11	WX		Soft start of source				
04:11	09:06	PR	003	Line complete.	1824P1	1182	3541	708.0000
09:06	10:25	LC		Heading for line 1552P				
10:25	11:08	LC		Soft start of source				
11:08	15:58	PR	004	Line complete.	1552P1	3198	947	675.6000
15:58	17:48	LC		Heading for line 1840P				
17:48	18:06	ED		Line change extended due to work on source				
18:06	18:51	ED		Soft start of source				
18:51	23:36	PR	005	Line complete.	1840P1	1203	3554	705.6000
23:36	24:00	LC		Heading for line 1568P over midnight				

Daily Activity (Timezone = GMT + 11.0Hrs.) Daily Report 18-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	01:26	LC		End of nominal line change over midnight.				
01:26	02:40	FO		Extended line change due to turn around Barracouta platform				
02:40	03:08	FO		Soft start of source				
03:08	07:44	PR	006	Line complete	1568P1	3210	949	678.6000
07:44	09:03	LC		Heading for line 1856P				
09:03	09:33	LC		Soft start of source				
09:33	14:25	PR	007	Line complete - Speed reduced Sp 2905 for divers	1856P1	1224	3566	702.9000
14:25	14:28	LC		Heading for line 1584P				
14:28	14:35	LC		Launched work boats for maintenance and TS-Dip				
14:35	14:35			TS-DIP Taken @ Posn 38 20.7 S 147 37.4 E				
14:35	16:15	LC		End of nominal line change.				
16:15	16:36	FO		Extended line change due to turn around Barracouta platform				
16:36	17:03	FO		Soft start of source				
17:03	21:41	PR	008	Line complete. Close pass to Dolphin CPA TB08-468m.	1584P1	3223	951	681.9000
21:41	23:01	LC		Heading for line 1872P				
23:01	23:36	LC		Soft start of source				
23:36	24:00	PR	009	Midnight Sp	1872P1	1245.00	1445	60.3000

Daily Activity (Timezone = GMT + 11.0Hrs.) — Daily Report 19-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	04:30	PR	009	Continued line over midnight	1872P1	1446	3579	640.2000
04:30	06:20	LC		Heading for line 1600P				
06:20	07:08	FO		Extended line change around Barracouta platform				
07:08	07:35	FO		Soft start of source				
07:35	12:44	PR	010	Line complete - Close pass Dolphin - CPA TB8 - 391m	1600P1	3236	954	684.9000
12:44	14:30	LC		Heading for line 1888P				
14:30	14:34	LC		Soft start of source				
14:34	15:04	TC		Slow line change due to strong Sw'ly current				
15:04	20:44	PR	011	Line complete.	1888P1	1266	3591	697.8000
20:44	22:34	LC		Heading for line 1616P				
22:34	23:06	FO		Extended line change around Barracouta platform				
23:06	23:52	FO		Soft start of source				
23:52	24:00	PR	012	Midnight Sp	1616P1	3248	3189	18.0000

Daily Activity (Timezone = GMT + 11.0Hrs.) — Daily Report 20-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	04:55	PR	012	Completed over midnight - Dolphin close pass CPA TB8 3	1616P1	3188	956	669.9000
04:55	06:45	LC		Heading for line 1904P				
06:45	06:50	TC		Slow line change due to wind and current from ahead.				
06:50	07:15	TC		Soft start of source				
07:15	12:06	PR	013	Line complete	1904P1	1287	3604	695.4000
12:06	13:56	LC		Heading for line 1632P				
13:56	14:01	FO		Extended line change around Barracouta				
14:01	14:45	FO		Soft start of source				
14:45	19:22	PR	014	Line complete - Dolphin close pass TB-1 CPA 130m	1632P1	3261	959	690.9000
19:22	20:52	LC		Heading for line 1920P				
20:52	21:12	LC		Soft start of source				
21:12	21:35	TC		Slow line change due to wind and current from ahead.				
21:35	24:00	PR	015	Line continued over midnight	1920P1	1308	2466	347.7000

Daily Activity (Timezone = GMT + 11.0Hrs.) — Daily Report 21-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	02:17	PR	015	Completed line over midnight	1920P1	2467	3617	345.3000
02:17	04:07	LC		Heading for line 1648P				
04:07	04:28	FO		Extended line change around Barracouta				
04:28	05:05	FO		Soft start of source				
05:05	10:01	PR	016	Line complete - Dolphin close pass TB-1 CPA 381m	1648P1	3266	961	691.8000
10:01	11:31	LC		Heading for line 1936P				
11:31	11:51	LC		Soft start of source				
11:51	12:08	TC		Slow line change due to current from ahead.				
12:08	16:57	PR	017	Line complete	1936P1	1329	3629	690.3000
16:57	18:25	LC		Heading for line 1664P				
18:25	18:47	LC		Soft start of source				
18:47	19:15	FO		Extended line change around Barracouta				
19:15	24:00	PR	018	Line continued over midnight	1664P1	3286	1049	671.4000

Daily Activity (Timezone = GMT + 11.0Hrs.) — Daily Report 22-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	00:12	PR	018	Line completed over midnight	1664P1	1048	963	25.8000
00:12	01:52	LC		Change of racetrack -heading for adjacent line 1680P				
01:52	02:52	FO		Extended teardrop line change to acquire lines towards Barracouta				
02:52	03:24	FO		Soft start of source				
03:24	04:02	RD	019	Recording system hang up - Scratch	1680P1	1094	1399	
04:02	05:06	ED	019	Separation rope failed between sub-arrays 3 & 4	1680P1	1400	1865	
05:06	08:25	PR	019	Incomplete line d/t technical problems	1680P1	1866	3427	468.6000
08:25	10:15	LC		Heading for line 1952P				
10:15	10:28	FO		Long line change around Barracouta				
10:28	11:01	FO		Soft start of source				
11:01	16:04	PR	020	Line complete.	1952P1	3514	1222	687.9000
16:04	17:48	LC		Heading for line 1696P				
17:48	17:54	LC		Soft start of source				
17:54	18:19	LC		Longer line change d/t survey shape & maintaining line heading towards Barracouta				
18:19	18:29	TC		Delay due to opposing current				
18:29	24:00	PR	021	Continued over midnight	1696P1	1096	3408	693.9000

Daily Activity (Timezone = GMT + 11.0Hrs.) — Daily Report 23-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	00:04	PR	021	Completed over midnight.	1696P1	3409	3440	9.6000
00:04	01:54	LC		Heading for line 1968P1				
01:54	02:20	FO		Long turn around Barracouta				
02:20	02:53	FO		Soft start of source				
02:53	07:51	PR	022	Line complete.	1968P1	3527	1243	685.5000
07:51	09:35	LC		Heading for line 1712P1. Workboat launched for streamer maintenance.				
09:35	09:41	LC		Soft start of source				
09:41	10:06	LC		Longer line change d/t survey shape & maintaining line heading towards Barracouta				
10:06	10:12	TC		Delay due to currents				
10:12	15:07	PR	023	Missed Sps 2704-2736, charged as complete. Reshoot re	1712P1	1098	3452	706.5000
15:07	16:57	LC		Heading for line 1984P1				
16:57	17:48	FO		Predicted SOL 1984P1 - aborted due to s/array 8 failure				
17:48	19:45	ED		New target line, heading for line 2080P1				
19:45	20:22	ED		Soft start of source				
20:22	21:59	PR	024	Line complete.	2080P1	2215	1390	247.8000
21:59	23:49	LC		Heading for line 1792P1				
23:49	24:00	LC		Long line change over midnight d/t survey shape & maintaining line heading towards Barracouta				

Daily Activity (Timezone = GMT + 11.0Hrs.) Daily Report 24-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	00:14	LC		Long line change over midnight d/t survey shape & maintaining line heading towards Barracouta				
00:14	00:48	TC		Soft start of source - line change against currents.				
00:48	05:32	PR	025	Line complete.	1792P1	1140	3516	713.1000
05:32	07:22	LC		Heading for line 1984P				
07:22	07:37	FO		Line turn around Barracouta				
07:37	08:11	FO		Soft start of source.				
08:11	12:39	PR	026	Line complete.	1984P1	3539	1264	682.8000
12:39	14:20	LC		Heading for line 1776P				
14:20	14:29	LC		Soft start of source				
14:29	14:54	LC		Long line d/t survey shape & maintaining line heading towards Barracouta				
14:54	14:58	TC		Line change against the currents				
14:58	20:05	PR	027	Line complete.	1776P1	1119	3503	715.5000
20:05	21:55	LC		Heading for line 2000P				
21:55	22:12	FO		Line turn around Barracouta				
22:12	22:50	FO		Soft start of source.				
22:50	24:00	PR	028	Line continued over midnight.	2000P1	3552	2967	175.8000

Daily Activity (Timezone = GMT + 11.0Hrs.) Daily Report 25-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	03:31	PR	028	Line completed over midnight	2000P1	2966	1285	504.6000
03:31	05:21	LC		Heading for line 1520P				
05:21	05:46	LC		Long line d/t survey shape and not being able to pass monopods				
05:46	06:27	FO		Soft start of source				
06:27	11:09	PR	029	Line complete.	1520P1	1070	3300	669.3000
11:09	12:18	LC		Heading for line 1280P				
12:18	12:59	LC		Soft start of source				
12:59	17:21	PR	030	Line complete	1280P1	2982	907	622.8000
17:21	18:44	LC		Heading for line 1504P				
18:44	19:11	LC		Soft start of source				
19:11	19:22	TC		Line change against currents				
19:22	24:00	PR	031	Acquisition continues over midnight	1504P1	1068	2969	570.6000

Daily Activity (Timezone = GMT + 11.0Hrs.) Daily Report 26-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	00:45	PR	031	Line completed over nmidnight	1504P1	2970	3288	95.7000
00:45	02:12	LC		Heading for line 1264P				
02:12	02:37	LC		Soft start of source				
02:37	07:27	PR	032	Line complete.	1264P1	2970	904	620.1000
07:27	08:33	LC		Heading for line 1488P				
08:33	09:00	LC		Soft start of source				
09:00	09:14	RD	033	Recording system lock up - NTBP	1488P1	1065	1172	
09:14	13:48	PR	033	Line incomplete missed Sp 1761-1788 d/t MSX lock-up	1488P1	1173	3275	630.9000
13:48	14:56	LC		Heading for line 1248P				
14:56	15:39	LC		Soft start of source				
15:39	20:08	PR	034	Line complete.	1248P1	2957	902	616.8000
20:08	21:08	LC		Heading for line 1472P				
21:08	21:48	LC		Soft start of source				
21:48	24:00	PR	035	Line continued over midnight.	1472P1	1063	1920	257.4000

Daily Activity (Timezone = GMT + 11.0Hrs.) Daily Report 27-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	03:03	PR	035	Line completed over midnight	1472P1	1921	3262	402.6000
03:03	04:15	LC		Heading for line 1232P				
04:15	04:58	LC		Soft start of source				
04:58	09:53	PR	036	Line complete. Telemetry strmr 8 and poor tail seps.	1232P1	2944	899	613.8000
09:53	10:32	LC		Heading for line 1456P				
10:32	11:43	LC		Nominal line change - aborted run-in due to helicopter movements				
11:43	16:22	CC		Unable to manoeuvre due to helicopter operations for crew-change				
16:22	16:55	CC		Soft start of source				
16:55	21:21	PR	037	Line complete	1456P1	1061	3250	657.0000
21:21	23:11	LC		Heading for line 1296P				
23:11	23:40	FO		Teardrop line change to balance swaths d/t inaccessible shallow lines				
23:40	24:00	FO		Soft start of source over midnight.				

Daily Activity (Timezone = GMT + 11.0Hrs.) Daily Report 28-Jan-05

From Hr:m	To Hr:m	Activity Code	Seq	Remarks	Line	FGSP	LGSP	FF CMP Km
00:00	00:17	FO		Soft start of source continued over midnight				
00:17	00:19	PR	038	Source sequence error on run-inMSX reboot @ SOL	1296P1	2995	2981	4.5000
00:19	02:13	PR	038	Source shut down by false MOB alarm	1296P1	2980	2019	288.6000
02:13	02:33	PR	038	Check all personnel & reset MOB alarm	1296P1	2018	1867	45.6000
02:33	04:36	PR	038	Complete remaining segment to EOL	1296P1	1866	909	287.4000
04:36	06:26	LC		Heading for line 1440P				
06:26	06:27	FO		Teardrop line change due to balancing swaths				
06:27	06:57	FO		Soft start of source.				
06:57	09:52	PR	039	Source shut down by false MOB alarm	1440P1	1058	2526	440.7000
09:52	09:58	PR	039	Ensure alarm false & reset MOB alarm	1440P1	2527	2576	15.0000
09:58	11:18	PR	039	Complete remaining segment to EOL	1440P1	2577	3237	198.3000
11:18	11:18			Muster & abandon ship drill held at 11:15				
11:18	12:44	LC		Heading for line 1216P				
12:44	13:08	LC		Soft start of source				
13:08	13:16	TC		Line change against current.				
13:16	17:44	PR	040	Line complete - Supply boat alongside 15:00	1216P1	2953	897	617.1000
17:44	17:47	LC		Supply boat away				
17:47	19:34	LC		Heading for line 1728P - recommence close passes - extended line change				
19:34	20:07	LC		Soft start of source.				
20:07	24:00	PR	041	Close pass to Perch -continued over midnight	1728p1	1101.00	2960	558.0000

29 January 2005

00:00:00	01:09:00	1.150	P1	Start day on Line 1728P1\ Line Complete * Seq 041 *
01:09:00	02:59:00	1.833	P2	Nominal line change
02:59:00	03:19:00	0.333	S6	Extended line change going around Barracouta
03:19:00	03:53:00	0.567	S6	Commence source soft start
03:53:00	09:19:00	5.433	F1	Start Infill Line 2000J \ Line Complete * Seq 042 *
09:19:00	11:34:00	2.250	F2	Nominal infill line change
11:34:00	12:16:00	0.700	S2	Extended line change due to strong current
12:16:00	12:53:00	0.617	S2	Commence source soft start
12:53:00	17:24:00	4.517	P1	Start line 1744P1 \ Line incomplete * Seq 043 *
17:24:00	19:14:00	1.833	P2	Nominal line change
19:14:00	19:20:00	0.100	S6	Extended line change to go around Barracouta
19:20:00	19:59:00	0.650	S6	Commence source soft start
19:59:00	24:00:00	4.017	P1	Start Prime line 2016P1 \ End day on line * Sequence 044 *

30th January 2005

00:00:00	00:34:00	0.567	P1	Start day on line \ End of line
00:34:00	02:49:00	2.250	P2	Nominal line change - survey geometry
02:49:00	03:10:00	0.350	S2	Extended line change due to current - Commence Source soft start at 02:35
03:10:00	07:58:00	4.800	P1	Start Prime Line 1760P1 \ Line complete * Sequence 045 *
07:58:00	09:48:00	1.833	P2	Nominal line change
09:48:00	11:08:00	1.333	S6	Extened line change around Barracouta - Commence Source soft start at 10:27
11:08:00	15:44:00	4.600	P1	Start Prime Line 2032P1 \ Line complete * Sequence 046 *
15:44:00	17:59:00	2.250	P2	Nominal line change - survey geometry- Commence source soft-start at 17:40
17:59:00	18:13:00	0.233	S2	Extended Line change due to current
18:13:00	23:04:00	4.850	F1	Start Infill Line 1760J \ Line complete * Seq 047 *
23:04:00	24:00:00	0.933	F2	End day on line change

31st January 2005

00:00:00	00:54:00	0.900	F2	Start day on line change
00:54:00	01:32:00	0.633	S6	Extended line change to go around Barracouta - Commence soft start at 00:58
01:32:00	06:10:00	4.633	P1	Start Prime Line 2048P1 \ Line complete * Sequence 048 *
06:10:00	08:25:00	2.250	P2	Nominal line change
08:25:00	09:38:00	1.217	S6	Extended line change to centre swath - Commence source soft start at 09:10
09:38:00	14:07:00	4.483	P1	Start Prime Line 1424P1 \ Line complete * Sequence 049 *
14:07:00	15:57:00	1.833	P2	Nominal line change
15:57:00	17:40:00	1.717	S4	Commence recovering trailing gear to investigate strumming on cable # 3
17:40:00	18:00:00	0.333	S4	Suspend recovery to deploy FRC to remove separation rope collar
18:00:00	18:40:00	0.667	S4	Suspend recovery to remove cable # 3 module
18:40:00	24:00:00	5.333	S4	Replacing damaged towpoint and flag fairing torn off lead in No 3

01 February 2005

00:00:00	07:12:00	7.200	S4	Reconfiguring trailing equipment for shallow water while repairs underway
07:12:00	07:24:00	0.200	D2	Start of line delayed - faulty shutoff valve on source - air pressure below minimum
07:24:00	12:27:00	5.050	P1	Start Prime Line 2046P1 \ Line ended * Sequence 050 * Line Incomplete *
12:27:00	14:42:00	2.250	P2	Nominal line change
14:42:00	15:43:00	1.017	S6	Extended line change due to surface obstructions * Soft start at 15:00 *
15:43:00	17:32:00	1.817	P1	Start Prime Line 1680A Reshoot seq 019 - MSX hangup \ Eol * Sequence 051
17:32:00	18:17:00	0.750	D5	Downtime following reshoot for MSX hangup

18:17:00	19:12:00	0.917	D8	Downtime due to source tagline failure * Soft start at 18:44 *
19:12:00	19:18:00	0.100	D5	Start Prime Line 1712A Reshoot seq 023 – MSX Hangup \ Eol * Seq 052 *
19:18:00	20:40:00	1.367	D5	Downtime following reshoot for MSX hangup - transit to next line
20:40:00	24:00:00	3.333	S1	Standby for weather - wind SW 45 knots \ sea & swell 3m

02 February 2005

00:00:00	12:10:00	12.167	S1	Standing by for an improvement in weather. Wind & Sea SSW 7
12:10:00	12:43:00	0.550	S1	Commence source soft start
12:43:00	17:49:00	5.100	P1	Start Prime Line 1408P1 \ Eol * Sequence 053 *
17:49:00	19:39:00	1.833	P2	Nominal line change
19:39:00	24:00:00	4.350	S1	Standing by for an improvement in weather. Wind & Sea SE 7-8 & 4-5 metre seas

03 February 2005

00:00:00	19:25:00	19.417	S1	Standing by awaiting an improvement in weather - heading to prospect
19:25:00	19:56:00	0.517	S1	Commence source soft start
19:56:00	24:00:00	4.067	P1	Start Prime Line 1200P1 \ End day on line * Sequence 054 *

04-February 2005

00:00:00	00:29:00	0.483	P1	Start day on line 1200P1 \ Eol * Sequence 054 *
00:29:00	02:19:00	1.833	P2	Nominal line change
02:19:00	02:32:00	0.217	S6	Extened line change due to survey configuration & shallow water
02:32:00	02:57:00	0.417	S6	Commence source soft start
02:57:00	08:08:00	5.183	P1	Start Prime Line 1392P1 \ Eol * Sequence 055 *
08:08:00	09:58:00	1.833	P2	Nominal line change
09:58:00	10:32:00	0.567	S6	Extended line change - shallow water - commence soft start at 09:58
10:32:00	14:59:00	4.450	P1	Start Prime Line 1184P1 \ Eol * Sequence 056 *
14:59:00	16:49:00	1.833	P2	Nominal line change
16:49:00	17:07:00	0.300	S6	Extended line change due to survey configuration & shallow water
17:07:00	17:52:00	0.750	S6	Commence source soft start
17:52:00	22:44:00	4.867	P1	Start Prime Line 1367P1 \ Eol * Sequence 057 *
22:44:00	24:00:00	1.267	P2	End day on line change

05 February 2005

00:00:00	00:34:00	0.567	P2	Continue line change
00:34:00	00:59:00	0.417	S6	Extended line change due to shallow water - commence soft start at 00:34
00:59:00	05:37:00	4.633	P1	Start Prime Line 1168P1 \ Eol * Sequence 058 *
05:37:00	07:27:00	1.833	P2	Nominal line change
07:27:00	08:18:00	0.850	S6	Extended line change due to shallow water - commence soft start at 07:50
08:18:00	12:32:00	4.233	P1	Start Prime Line 1360P1 \ Eol * Sequence 059 *
12:32:00	14:22:00	1.833	P2	Nominal line change
14:22:00	14:47:00	0.417	S6	Extended line change due to shallow water - commence soft start at 14:05
14:47:00	19:15:00	4.467	P1	Start Prime Line 1152P1 \ Eol * Sequence 060 *
19:15:00	21:05:00	1.833	P2	Nominal line change
21:05:00	21:48:00	0.717	S6	Extended line change due to shallow water - commence soft start at 21:20
21:48:00	24:00:00	2.200	P1	Start Prime Line 1344P1 \ End day on line

06 February 2005

00:00:00	02:00:00	2.000	P1	Start day on Line 1344P1 \ Eol * Sequence 061 *
02:00:00	03:50:00	1.833	P2	Nominal line change - commence source soft-start at 03:34
03:50:00	04:08:00	0.300	S6	Extended line change due to shallow water
04:08:00	08:54:00	4.767	P1	Start Prime Line 1136P1 \ Eol * Sequence 062 *

08:54:00	10:44:00	1.833	P2	Nominal line change
10:44:00	11:13:00	0.483	S6	Extended line change due to shallow water
11:13:00	15:26:00	4.217	P1	Start Prime Line 1328P1 \ Eol * Sequence 063 *
15:26:00	17:16:00	1.833	P2	Nominal line change - commence source soft-start at 17:00
17:16:00	17:28:00	0.200	S6	Extended line change due to shallow water
17:28:00	22:04:00	4.600	P1	Start Prime Line 1120P1 \ Eol * Sequence 064 *
22:04:00	23:54:00	1.833	P2	Nominal line change
23:54:00	24:00:00	0.100	S6	Extended line change due to shallow water

07 February 2005

00:00:00	00:36:00	0.600	S6	Extended line change due to shallow water - commence source soft start at 00:08
00:36:00	04:46:00	4.167	P1	Start Prime Line 1312P1 \ Eol * Sequence 065 *
04:46:00	06:36:00	1.833	P2	Nominal line change
06:36:00	06:46:00	0.167	S6	Extended line change due to shallow water
06:46:00	08:06:00	1.333	D2	Downtime due to source failure - RACU unit in string No 8 fault at SOL 1104
08:06:00	10:13:00	2.117	P1	Start Prime Line 1104P1 * Recording streamers 1 - 6 * 12 CMP only *
10:13:00	11:24:00	1.183	P1	Prime Line 1104P1 * Recording streamers 1 - 7 * 14 CMP Only * Seq 066 *
11:24:00	11:56:00	0.533	D1	Downtime due to faulty coil in streamer section causing compass line leakage
11:56:00	12:05:00	0.150	S1	Standby time due to tailbuoy No 8 acoustic replacement lost during bad weather
12:05:00	13:14:00	1.150	P2	Nominal line change minus downtime adjustment to account for streamer 7 outage
13:14:00	14:39:00	1.417	S6	Extended line change due to shallow water - Commence source soft-start at 14:07
14:39:00	19:05:00	4.433	P1	Start Prime Line 1056P1 \ Eol * Sequence 067 *
19:05:00	20:55:00	1.833	P2	Nominal line change
20:55:00	22:07:00	1.200	S6	Extended line change due to shallow water - Commence source soft-start at 21:35
22:07:00	24:00:00	1.883	P1	Start Prime Line 1088P1 \ End day on line * Sequence 068 *

08 February 2005

00:00:00	03:09:00	3.150	P1	Start day on Line 1088P1 \ Eol * Sequence 068 *
03:09:00	04:59:00	1.833	P2	Nominal line change
04:59:00	06:35:00	1.600	S6	Extended line change due to shallow water - Commence source soft-start at 05:52
06:35:00	10:52:00	4.283	P1	Start Prime Line 1072P1 \ Eol * Seq 069 * Line ended early due to shallow water ahead
10:52:00	12:42:00	1.833	P1	Nominal line change
12:42:00	13:38:00	0.933	S6	Extended line change due to shallow water - Commence source soft-start at 13:05
13:38:00	15:04:00	1.433	P1	Start Prime Line 1104A1 \ Eol * Seq 070 * Reshoot of seq 066 * Previously not charged *
15:04:00	16:16:00	1.200	F1	Start Infill Line 1104A1 \ Eol * Sequence 070 *
16:16:00	18:06:00	1.833	P2	Nominal infill line change
18:06:00	19:44:00	1.633	S6	Extended line change due to shallow water - Commence source soft-start at 19:06
19:44:00	22:00:00	2.267	P1	Start Prime Line 1040P1 \ Eol * Seq 071 * Line ended early due to shallow water ahead
22:00:00	23:50:00	1.833	P2	Nominal line change
23:50:00	24:00:00	0.167	S6	Extended line change due to shallow water

09 February 2005

00:00:00	00:37:00	0.617	S6	Extended line change due to shallow water - Commence source soft-start at 00:02
00:37:00	00:58:00	0.350	D2	Start Prime Line 1296A1 \ Eol * Seq 072 * Reshoot of Seq 038 * Prev charged as complete *
00:58:00	03:24:00	2.433	D2	Transit to next line following re-shoot - Commence source soft-start at 02:54
03:24:00	05:07:00	1.717	P1	Start Prime Line 1024P1 \ Eol * Seq 073 *
05:07:00	06:57:00	1.833	P1	Nominal line change
06:57:00	09:44:00	2.783	S6	Long line change to acquire shallow water line - commence source soft start at 09:05
09:44:00	11:32:00	1.800	P1	Start Prime Line 1008P1\ Eol * Seq 074 Line ended early due to shallow water ahead
11:32:00	13:22:00	1.833	P2	Nominal line change
13:22:00	16:32:00	3.167	S6	Extendeded line change to go around Barracouta platform * commence soft start 15:50
16:32:00	16:42:00	0.167	P1	Start Prime Line 2064J1 * Reshoot of seq 050 * Late start due to air leaks * Not prev charged *
16:42:00	21:08:00	4.433	F1	Start Infill Line 2064J1 \ Eol * Sequence 075 *

21:08:00	22:03:00	0.917	F2	Nominal infill line change
22:03:00	22:58:00	0.917	D2	Downtime due to source reshoot at start of sequence 075
22:58:00	23:29:00	0.517	D2	Downtime due to source reshoot at start of sequence 075
23:29:00	24:00:00	0.517	S3	Extended line change - survey geometry & commence time-sharing with Pacific Titan

10 February 2005

00:00:00	00:27:00	0.450	D2	Downtime due to source reshoot at start of sequence 075 - commence soft start at 00:17
00:27:00	00:54:00	0.450	S3	Extended line change - time-sharing with Pacific Titan
00:54:00	01:51:00	0.950	P1	Start Prime Line 2224P1 \ Eol * Sequence 076 *
01:51:00	04:06:00	2.250	P2	Nominal line change
04:06:00	04:55:00	0.817	S3	Extended line change - time-sharing with Pacific Titan - commence source soft-start at 04:20
04:55:00	06:52:00	1.950	P1	Start Prime Line 2096P1 \ Eol * Sequence 077 *
06:52:00	09:07:00	2.250	P2	Nominal line change
09:07:00	09:56:00	0.817	S3	Extended line change - time sharing with Pacific Titan - commence source soft-start at 09:21
09:56:00	10:59:00	1.050	P1	Start Prime Line 2208P1 \ Eol * Sequence 078 *
10:59:00	13:14:00	2.250	P1	Nominal line change
13:14:00	13:51:00	0.617	S3	Extended line change - time sharing with Pacific Titan - commence source soft-start at 13:25
13:51:00	15:25:00	1.567	P1	Start Prime Line 2112P1 \ Eol * Sequence 079 *
15:25:00	17:40:00	2.250	P2	Nominal line change
17:40:00	18:27:00	0.783	S3	Extended line change - time-sharing with Pacific Titan - commence source soft-start at 18:00
18:27:00	19:30:00	1.050	P1	Start Prime Line 2192P1 \ Eol * Sequence 080 *
19:30:00	21:45:00	2.250	P2	Nominal line change
21:45:00	22:23:00	0.633	S3	Extended line change - time-sharing with Pacific Titan - commence source soft-start at 21:47
22:23:00	23:45:00	1.367	P1	Start Prime Line 2128P1 \ Eol * Sequence 081 *
23:45:00	24:00:00	0.250	P2	Nominal line change

11 February 2005

00:00:00	02:00:00	2.000	P2	Start day on nominal line change
02:00:00	03:00:00	1.000	S3	Extended line change - time sharing with P.Titan - commence source soft-start at 02:32
03:00:00	03:13:00	0.217	P1	Start Prime Reshoot Line 1488A - Re-shoot of seq 033 - MSX hangup * Prev not charged *
03:13:00	04:22:00	1.150	D5	Overlap following reshoot segment - * Seq 082 *
04:22:00	04:27:00	0.083	D5	Second reshoot segment due to second MSX hangup * Eol \ Previously charged *
04:27:00	07:36:00	3.150	D5	Downtime to travel to next reshoot - commence source soft-start at 07:00
07:36:00	08:14:00	0.633	D3	Start Reshoot Line 2064A - Seq 075 - Trinav system hangup * Eol * Previously charged
08:14:00	10:44:00	2.500	D3	Downtime to travel to next reshoot - commence source soft-start at 10:10
10:44:00	12:01:00	1.283	P1	Start Prime Line 2176P1 - Seq 084 \ Eol
12:01:00	14:16:00	2.250	P2	Nominal Line Change
14:16:00	14:56:00	0.667	S3	Extended line change - time sharing with Pacific Titan - commence source soft-start at 14:22
14:56:00	16:20:00	1.400	P1	Start Prime Line 2144P1 - Seq 085 \ Eol
16:20:00	18:35:00	2.250	P2	Nominal line change
18:35:00	19:41:00	1.100	S3	Extended line change - time sharing with Pacific Titan - commence source soft-start at 19:40
19:41:00	20:13:00	0.533	D2	Start Reshoot Line 1408A - Seq 086 - Compressor failure seq 053 \ Eol * Prev charged *
20:13:00	21:23:00	1.167	D2	Downtime to travel to next reshoot - commence source soft-start at 21:00
21:23:00	21:56:00	0.550	D2	Start Reshoot Line 1440A - Seq 087 - Compressor failure seq 039 \ Eol * Prev charged *
21:56:00	24:00:00	2.067	D2	Downtime following reshoot for compressor failure

12 February 2005

00:00:00	00:11:00	0.183	D2	Downtime following reshoot for compressor failure
00:11:00	02:41:00	2.500	S6	Extended line change to go around Barracouta platform Commence source soft start at 02:19
02:41:00	08:12:00	5.517	F1	Start Infill Line 1984J1 * Seq 088* \ Eol
08:12:00	10:27:00	2.250	P2	Nominal infill line change - commence source soft-start at 10:14
10:27:00	10:47:00	0.333	S1	Extended turn radius due to sea conditions
10:47:00	12:09:00	1.367	P1	Start Prime Line 2160P1 * Seq 089 * \ Eol

12:09:00	14:24:00	2.250	P2	Nominal line change
14:24:00	16:34:00	2.167	S1	Extended turn radius due to sea conditions - commence source soft-start at 15:57
16:34:00	18:08:00	1.567	F1	Start Infill line 2144J1 * Seq 090 * \ Eol
18:08:00	20:23:00	2.250	P2	Nominal line change following completion of single-vessel acquisition
20:23:00	24:00:00	3.617	S7	Proceeding to rendezvous with Pacific Titan & establish dual vessel link

13 February 2005

00:00:00	06:00:00	6.000	S6	Reconfiguring navigation systems for dual vessel operations
06:00:00	12:00:00	6.000	D3	Technical downtime - dual vessel link equipment configuration problems
12:00:00	13:56:00	1.933	D3	Technical downtime - dual vessel link equipment configuration problems
13:56:00	15:35:00	1.650	D3	Conduct test line - close pass to Dolphin with Pacific Titan – Hdg 225 degrees
15:35:00	18:00:00	2.417	D3	Technical downtime - dual vessel link & equipment configuration problems
18:00:00	24:00:00	6.000	D3	Technical downtime - continue troubleshooting navigation equipment configuration

14 February 2005

00:00:00	09:35:00	9.583	D3	Technical downtime - troubleshooting dual boat link
09:35:00	11:02:00	1.450	D3	Commence source soft start at 09:35
11:02:00	14:25:00	3.383	P1	SOL Line 1632U1 \ Eol * Seq 091 * Start of Undershoot * Recording 8 CMP Single Source
14:25:00	16:40:00	2.250	P2	Nominal line change
16:40:00	18:18:00	1.633	S6	Extended line change - teardrop turn * commence source soft-start at 18:00
18:18:00	20:37:00	2.317	P1	Sol Line 1744U1 \ Eol * Seq 92 * Undershoot of Perch *
20:37:00	22:52:00	2.250	P2	Nominal line change
22:52:00	24:00:00	1.133	S6	Extended line change to next Dolphin undershoot

15 February 2005

00:00:00	00:22:00	0.367	S6	Extended line change to Dolphin undershoot - source firing continuously
00:22:00	03:12:00	2.833	P1	Sol Line 1632U2 \ Eol Seq 093
03:12:00	05:27:00	2.250	P2	Nominal line change
05:27:00	06:20:00	0.883	S6	Extended line change - teardrop turn * commence source soft-start at 06:00
06:20:00	08:31:00	2.183	P1	Sol Line 1744U2 \ Eol Seq 094
08:31:00	10:46:00	2.250	P2	Nominal line change
10:46:00	12:23:00	1.617	S6	Extended line change - teardrop turn * commence source soft-start at 12:00
12:23:00	15:19:00	2.933	P1	Sol Line 1632U3 \ Eol Seq 095
15:19:00	17:34:00	2.250	P2	Nominal line change
17:34:00	18:46:00	1.200	S6	Extended line change - teardrop turn * commence source soft-start at 18:00
18:46:00	21:06:00	2.333	P1	Sol Line 1744U3 \ Eol Seq 096
21:06:00	23:21:00	2.250	P2	Nominal line change
23:21:00	24:00:00	0.650	S6	Extended line change - teardrop turn

16th Feburary 2005

00:00:00	01:01:00	1.017	S6	Extended line change - commence source soft-start at 00:30
01:01:00	04:02:00	3.017	P1	Sol Line 1632U4 \ Eol Seq 097
04:02:00	06:17:00	2.250	P2	Nominal line change
06:17:00	07:07:00	0.833	S6	Extended line change -teardrop turn - source continuously firing
07:07:00	08:54:00	1.783	P1	Sol Line 1744U4 \ Eol Seq 098
08:54:00	15:00:00	6.100	D3	Technical downtime - vessel heading to attempt re-shoot of seq 093
15:00:00	24:00:00	9.000	S7	Local transit to OSCAR 3D survey

APACHE SUE 3D GAP04B Marine Seismic Survey Complete

13.0 CONCLUSIONS AND RECOMMENDATIONS

13.1 Conclusions

13.1.1 Data Quality Assurance

The quality of the data was generally good and the data was acquired within specifications in all cases. The overall performance and attitude of the crew towards quality assurance was good. The contractor's personnel were very diligent and strived to maintain high standards.

The level of ambient and cultural noise levels was usually within specified limits, except when operating in marginal conditions such as were experienced during the severe weather in early February.

The contractor's personnel were diligent in performing their duties and provided excellent input and assistance with acquisition coverage, infill and reshoot planning as well as all other data quality assurance issues.

Client representative access to real time data observation was limited however. The MSX system raw seismic data displayed only one streamer at a time for each successive shot shown on a standard 15 inch monitor. Seismic shot records were plotted on the OYO Geospace thermal plotter behind the main instrument console in a very poorly illuminated area that impaired observation of plotted seismic records.

The QC processing staff were prompt in producing brute stacks and providing information as an when it was requested. The processing staff made every possible effort to correct the time-shift error associated with the undershoot data and are to be commended for their efforts.

13.1.2 Seismic Equipment

Streamer Cable

The Thales Guardian solid streamers performed very well and were slowly phasing out the older TMS Sentry solid streamer sections. Noisy groups were listed on the observer's line summary sheets. Streamer faults were readily attended to by the workboat as often as sea conditions would allow. The solid streamer demonstrated the usual capability to withstand flexing in swell conditions that helped to keep ambient sea and swell noise to a minimum.

Streamer Head Tension Monitoring

Only one streamer tension sensor was operational on the graphics display situated above the observer console. The display provided constant monitoring of cable head tensions which were very important especially when operating long streamers in heavy sea and swell conditions, or in regions known for barnacle build-up where the streamers have been in the water without cleaning, often for months at a time.

Workboat

MV *Western Trident* was equipped with two dedicated workboats for streamer maintenance and other in-water repair work. The crew of MV *Western Trident* is to be commended on the safe and efficient practices used involving in-water streamer maintenance and small boat operations procedures in general.

Energy Source

Nearfield Hydrophones

The source arrays were fitted with near-field hydrophone sensors that can be used to assist in detecting autofires. The nearfield phones are essential in corroborating correct source controller to

airgun element fire detect timing. A technical audit by any major client would undoubtedly include individual source element testing involving near field hydrophones.

General

Some survey lines were acquired with reduced source array volume and individual gun delta errors, misfires and autofires were infrequent. Single gun timing errors were reported as they occurred and these errors were frequent but rarely exceeded specified limits. Autofires were occasionally flagged by the SSS source synchroniser. The performance of the energy source during the GAP04B 3D seismic survey was considered good.

13.1.3 Safety Equipment

The writer was surprised to find that there were no emergency escape smoke hoods or flashlights located in individual cabins. The matter was raised with the contractor's senior personnel at the safety committee meeting held aboard on February 3rd 2005.

The writer was informed that Flag State regulations do not require these additional safety features and that the escape routes and layout aboard *Western Trident* make such accessories more or less redundant. The writer was also advised that this matter has been taken up with WesternGeco management several times and that this particular issue has been ongoing for the last five years.

13.1.4 HSE Management and Reporting

The systems and practices in place aboard MV *Western Trident* were generally of a high standard. The crew was well trained in safety. A comprehensive permit to work system was actively used and a record of all permits issued was maintained. Detailed checklists were filled out prior to any crane operations. A waste management programme was in place with detailed records of waste segregation and disposition maintained.

Procedures and work instructions for given tasks were clearly understood by the crew and this was reflected by the way, in which routine operations were carried out in a professional manner. Toolbox meetings held before any in-water streamer maintenance was to be carried out were thorough and comprehensive.

The deck department managed all records of the extensive permit-to-work system and crane operations check list as well as logs of all FRC activity.

The deck department and the officer on watch maintained a marine mammal observation watch and a detailed record of any observations was carefully maintained.

13.1.5 Vessel Facilities

The vessel facilities were well laid out and all emergency escape routes, stairways and exits are clearly signposted, unobstructed, and fitted with emergency lighting. Hazardous material and chemicals such as lithium batteries were segregated and stored in separate suitable storage areas. Exposed rotating machinery such as the main tow winches were cordoned off with proper hand rails. Engineering, storage spaces and workshops were generally clean although housekeeping could be improved upon in these areas.

The writer was particularly impressed with the cable and gun deck layout. Both areas were very spacious, clean, tidy and well ventilated. All seismic operations areas were monitored by closed circuit cameras from the bridge and the instrument room.

13.1.6 Communications

A dedicated client office facility was available aboard *Western Trident.* The writer was content to work in the client cabin. Communications facilities consisted of e-mail via Eudora Pro Ver 5.0 and VSAT as well as a dedicated mobile phone line. Four dedicated Internet workstations were available located in the helicopter reception office which proved an ideal location for this facility.

13.1.7 Dual Vessel Operations

The contractor was ill-prepared for the undershoot to be carried out with MV *Pacific Titan* and was evidently in a race against the clock to get the undershoot started and completed as quickly as possible. The dual vessel link and timing synchronising equipment failed, including the spare unit.

The result of this lack of preparation was a dataset whose value and use was initially highly questionable. If the two vessels involved in a undershoot cannot be brought together, the contractor must take additional measures to ensure the verification of the systems timing and synchronisation before the undershoot commences.

13.2 Recommendations

13.2.1 Data Quality Assurance

- The contractor should consider having at least one workstation installed in the client office for the client representative to access and view to seismic data, in addition to the SuperVision system.

- The contractor should consider relocating the raw seismic data plotter and table to a more accessible location that is properly illuminated elsewhere in the instrument room as a matter of some urgency.

- The overhead projector system for showing online displays for remote viewers should be reactivated as this provides a means of observing quality control displays without the client representative having to constantly look over the operator's shoulders to observe QC displays and functions.

13.2.2 Seismic Equipment

Streamer Cables

- The contractor should continue the programme of replacing the Sentry sections with the Thales Guardian solid cable sections.

- The contractor should make an effort to have all streamer tension sensors operational.

13.2.3 HSE Management & Reporting

- Very little in the way of recommendations for improvement are required to the *Western Trident* HSE management and reporting structure.

- The practice of conducting unannounced emergency drills should be discontinued, or at the very least, the client representative be advised of the drill in advance and kept informed.

13.2.4 Safety Equipment

Emergency escape smoke hoods and flashlights should be assigned to each cabin.

13.2.5 Dual Vessel Operations

The contractor should ensure that future dual vessel operations are better prepared for and that their equipment to be installed aboard a third-party vessel has been thoroughly tested before being shipped to the field and also that the contractor's field equipment to be used is compatible with the third Party's vessel and equipment.

Both vessels involved in undershoot operations should be have their time break and positioning system closure synchronisation systems hard-wired for a consistency check. If this is not possible then at the very least, the principal contractor directing the undershoot

should conduct a short test line and process the data to verify system timing integrity and synchronisation before commencing production on the undershoot.

13.2.6 Summary

The GAP04B SUE 3D Marine Seismic Survey for Apache Energy Limited was conducted efficiently, and in a safe and professional manner by a well trained crew who were most cooperative and helpful. The vessel and facilities are of a high standard. Accommodation, communication and recreational facilities aboard MV Western Trident are first rate. The safety features of the vessel are of the highest standard. Catering onboard was excellent with a wide variety of quality meals available.

The seismic data was acquired well within specifications in almost all cases and the acquisition and processing personnel sought to maintain a high standard. The Party Chief and department heads were most helpful at all times with regard to enquiries and assistance concerning any aspect of the survey.

The writer would have no hesitation in recommending MV *Western Trident* and her crew for any future projects for Apache Energy Limited.