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# 1. Survey Information and Objectives

The Western Trident was contracted to undertake a 3D Marine Seismic Survey for ***Apache Energy Limited*** in the blocks VIC/P-47 & VIC/P-58, Gippsland Basin, Australia. The SUE survey was located in block VIC/P-58, Client reference GAP04B

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

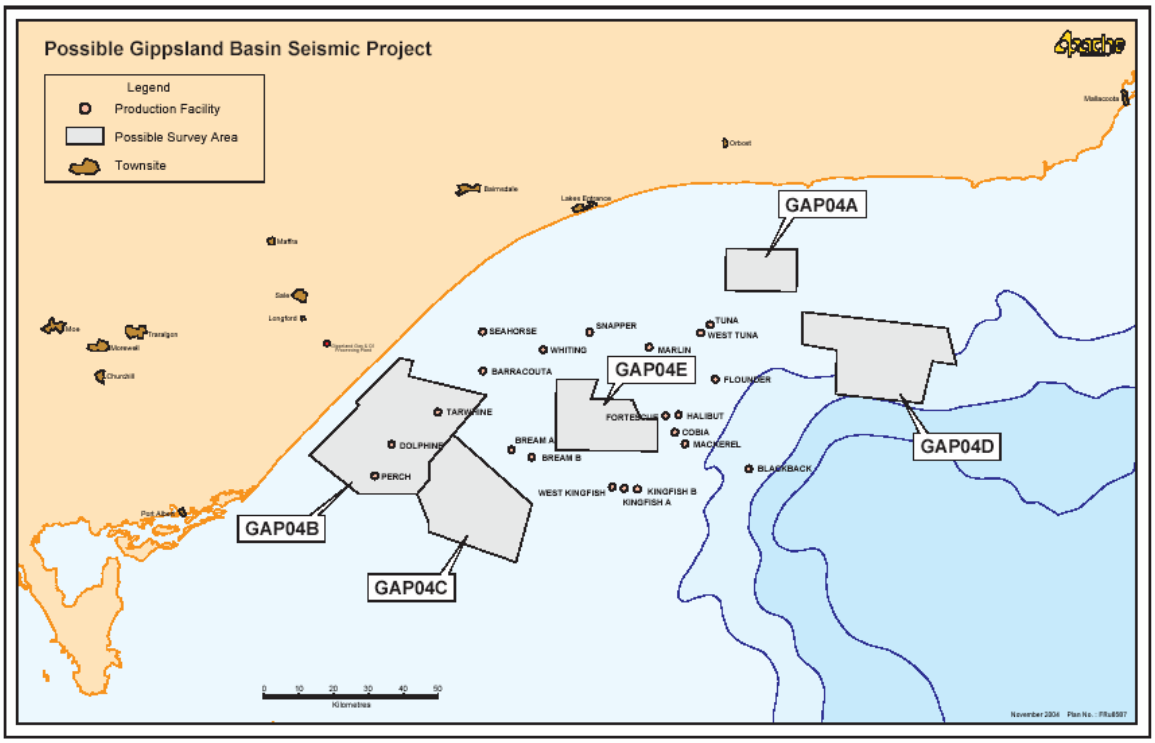
The *M/V Western Trident* is a purpose built vessel for seismic operations and is one of the largest vessels in WesternGeco's fleet. She was delivered in November 1999. The vessel has carried out many complex 3D surveys in various locations worldwide. She is capable of towing 12 x 6,000m TMS Sentry Solid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

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

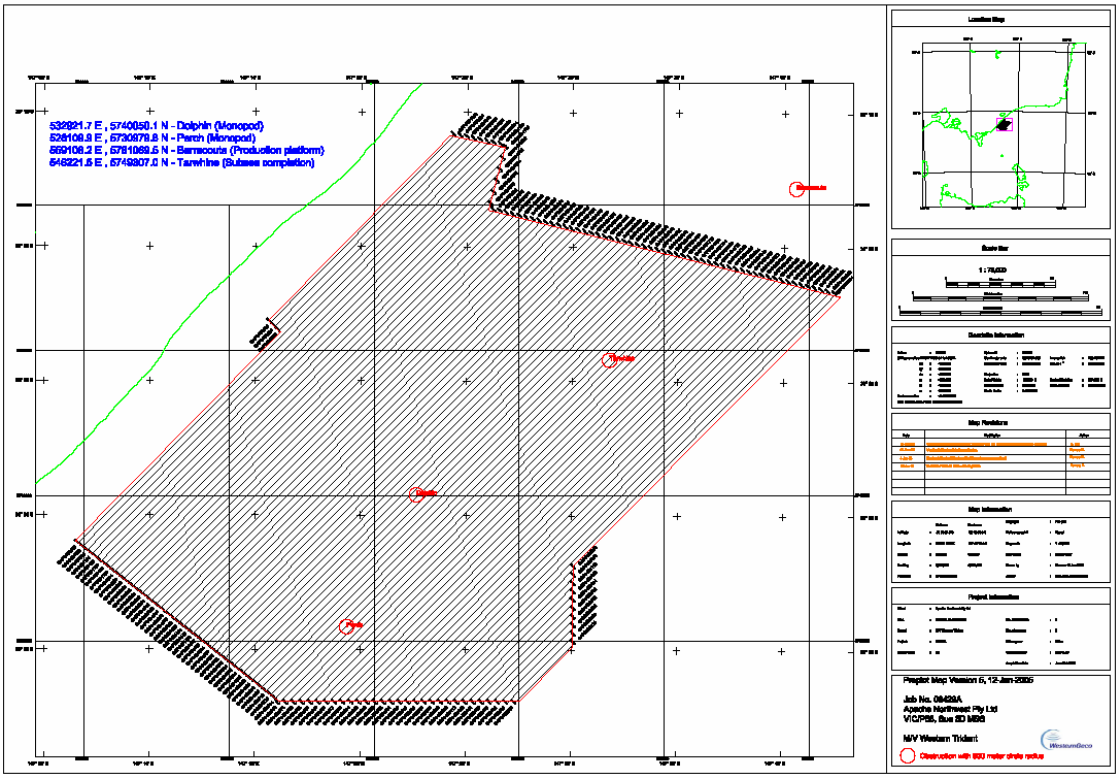
There were 2 obstructions within the VIC/P-58 survey area that required undershoot operations and further details concerning these operations can be found in section 2 of this report.

Apache Energy Pty Ltd chartered the vessel Multiwave seismic survey vessel MV Pacific Titan as the "undershoot source vessel". WesternGeco installed a two boat link communications system on board the Pacific Titan to enable to two vessels to work in tandem.

# 2. Area Map


Possible Gippsland Basin Seismic Project
Legend
Production Facility
Possible Survey Area
Townsite
GAP04A
GAP04B
GAP04C
GAP04D
GAP04E
SEAHORSE
SNAPPER
TUNA
WEST TUNA
WHITING
MARLIN
BARRACOUTA
FLOUNDER
TARWHINE
FORTESCUE
HALIBUT
COBIA
MACKEREL
BREAM A
BREAM B
DOLPHIN
PERCH
BLACKBACK
WEST KINGFISH
KINGFISH B
KINGFISH A

# 3. Program Map



# 4. Job Book

WesternGeco

**Seismic Job Book**
**Version : 12**

| Job number: | Client: | Location: |
|---|---|---|
| 9429 | Apache Northwest Pty. Ltd. | AUS / VIC/P58, Sue 3D MSS |
| **Chapter status:** | **Chapter updated:** | **Chapter updated by:** |
| Reviewed by vessel | 17-Jan-05 | cctee |
| **Project Geo:** | | |
| Tee Chee Cherng (phone : +60 3 2730 8844, email : cctee@slb.com) | | |

## Seismic Acquisition Parameters

### General

| | |
|---|---|
| **Client:** | Apache Northwest Pty. Ltd. |
| **Vessel(s):** | Western Trident |
| **Bid reference:** | |
| **Job number:** | 9429 |
| **Contract number:** | |
| **Location:** | VIC/P58, Sue 3D MSS |
| **Country:** | Australia |
| **Corporation code:** | Apache_Energy |
| **Client reference:** | |
| **Type of survey:** | 3D marine streamer |
| **Estimated start date:** | 11-Jan-05 |
| **Estimated duration (days):** | 43 |
| **SuperVision required:** | No |

| | |
|---|---|
| **Project geo:** | |
| **name:** | Tee Chee Cherng |
| **email:** | cctee@slb.com |
| **telephone:** | +60 3 2730 8844 |
| **Nav supervisor:** | |
| **name:** | Kumara Krishnasamy |
| **email:** | kkrishnasamy@slb.com |
| **telephone:** | +60 3 2730 8851 |
| **Sales contact:** | |
| **name:** | Sean Murray |
| **email:** | smurray2@perth.westerngeco.slb.com |
| **telephone:** | +61 (0)8 9420 4798 |
| **Vessel manager:** | |
| **name:** | Kiran Tuite |
| **email:** | tuite1@kuala-lumpur.westerngeco.slb.com |
| **telephone:** | +60 3 2730 8861 |

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| Reviewed by vessel | 17-Jan-05 | cctee |
| **Project Geo:** | | |
| Tee Chee Cherng (phone : +60 3 2730 8844, email : cctee@slb.com) | | |

# Seismic Acquisition Parameters

## Survey Area

| | |
|---|---|
| **Area (km2):** | 1066.711 |
| **Average line length (km):** | 34.829 |
| **Number of saillines:** | 77 |
| **Heading (deg):** | 44.566 |
| **Reciprocal heading (deg):** | 224.566 |

## Streamer Parameters

| | |
|---|---|
| **Cable type:** | MSX solid streamer |
| **Module type:** | MSX |
| **Number of streamers:** | 8 |
| **Group length (m):** | 17.75 |
| **Number of phones per group:** | 14 |
| **Group interval (m):** | 12.5 |
| **Lo-cut analogue response (Hz-dB/Oct):** | 2.5-6 |
| **Hydrophone sensitivity (V/B):** | 13.8 |
| **Pre-amplifier gains (dB or mB full scale):** | 6 |
| **Streamer length (m):** | 4800.0 |
| **Streamer depth (m):** | 8.0 |
| **Streamer separation (m):** | 100.0 |
| **Number of groups per streamer:** | 384 |
| **Requested source to receiver offset (m):** | As Near As Possible/150 |

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| Reviewed by vessel | 17-Jan-05 | cctee |
| **Project Geo:** | | |
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# Seismic Acquisition Parameters

## Recording Parameters:

| | |
|---|---|
| **Recording system:** | MSX |
| **Recording format:** | SegD 8058, Rev 1 |
| **Record length (binary sec.):** | 5.0 |
| **Sample rate (ms):** | 2 |
| **Lo-cut recording filter (Hz-dB/Oct):** | 2-12 |
| **Hi-cut recording filter (Hz-dB/Oct):** | 206-264 |
| **Recording system delay (ms):** | 0 |
| **Filter type:** | Zero phase |
| **Adjacent trace summation 12.5m to 25m:** | No |
| **Record auxiliary channels:** | Yes |
| **Offline tape copy required:** | No |
| **Dual recording/tape copies (Group formed tapes):** | Yes |

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|---|---|---|
| 9429 | Apache Northwest Pty. Ltd. | AUS / VIC/P58, Sue 3D MSS |
| **Chapter status:** | **Chapter updated:** | **Chapter updated by:** |
| Ready for review | 14-Jan-05 | kkrishnasamy |
| **Nav Supervisor:** | | |
| Kumara Krishnasamy (phone : +60 3 2730 8851, email : kkrishnasamy@slb.com) | | |

# Positioning Acquisition Parameters

## Acquisition Geodetic Parameters

**Work datum:**

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

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

| | |
|---|---|
| **dX (m):** | 0.0 |
| **dY (m):** | 0.0 |
| **dZ (m):** | 0.0 |
| **rX (arc secs):** | 0.0 |
| **rY (arc secs):** | 0.0 |
| **rZ (arc secs):** | 0.0 |
| **Scale (ppm):** | 0.0 |

| | |
|---|---|
| **Projection type:** | UTM |
| **Zone:** | 55S |
| **Central meridian:** | 147° 0' 0.0" E |
| **Scale factor:** | 0.9996 |
| **False easting (m):** | 500000 |
| **False northing (m):** | 10000000 |
| **Latitude of origin:** | 0° 0' 0.0" N |

## Test Point

| | |
|---|---|
| **Latitude in WGS 84:** | 38° 26' 22.872" S |
| **Longitude in WGS 84:** | 147° 23' 48.329" E |
| **Northing in WGS 84:** | 5745324.46 |
| **Easting in WGS84:** | 534625.36 |
| **Latitude in local datum:** | 38° 26' 22.872" S |
| **Longitude in local datum:** | 147° 23' 48.329" E |
| **Northing in local projection (m):** | 5745324.46 |
| **Easting in local projection (m):** | 534625.36 |

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| Ready for review | 14-Jan-05 | kkrishnasamy |
| **Nav Supervisor:** | | |
| Kumara Krishnasamy (phone : +60 3 2730 8851, email : kkrishnasamy@slb.com) | | |

# Positioning Acquisition Parameters

## Magnetic Variation and Geoidal Height

**Location of prospect centre, latitude:** 38° 26' 22.872" S
**Location of prospect centre, longitude:** 147° 23' 48.329" E
**Magnetic variation:**
**Annual magnetic variation change:**
**Source of variation data:** IGRF2000
**Geoidal height data (m):**
**Source of geoidal height data:** EGM96
**Date for which values calculated:**

## Vessel Positioning

**Integrated navigation system:** TriNav 2.6
**Number of independently positioned vessels:** 1

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| Ready for review | 14-Jan-05 | kkrishnasamy |
| **Nav Supervisor:** | | |
| Kumara Krishnasamy (phone : +60 3 2730 8851, email : kkrishnasamy@slb.com) | | |

# Positioning Acquisition Parameters

## Vessel Positioning

**Vessel name : Western Trident**

**Primary navigation system**

| | |
|---|---|
| Vessel position computation system: | Cnav |
| RTCM delivery system: | Global Monitoring |
| Delivery method: | Inmarsat |
| Survey and differential company: | C&C Technologies |
| Contact person: | Terry Tay , terry.tay@cctechnol.com |

DGPS reference stations:

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

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

**Secondary navigation system**

| | |
|---|---|
| Vessel position computation system: | Fugro Multifix 4 |
| RTCM delivery system: | Global Monitoring XP |
| Delivery method: | Inmarsat / Spotbeam |
| Survey and differential company: | Furgo Survey |
| Contact person: | Avezac, D Rene, rdavezac@FUGRO.com.sg |

DGPS reference stations:

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

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

**Tertiary navigation system**

| | |
|---|---|
| Vessel position computation system: | Trinav GPS 2.6 |

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|---|---|---|
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| **Chapter status:** | **Chapter updated:** | **Chapter updated by:** |
| Ready for review | 14-Jan-05 | kkrishnasamy |
| **Nav Supervisor:** | | |
| Kumara Krishnasamy (phone : +60 3 2730 8851, email : kkrishnasamy@slb.com) | | |

# Positioning Acquisition Parameters

| | |
|---|---|
| RTCM delivery system: | Fugro Skyfix |
| Delivery method: | Inmarsat |
| Survey and differential company: | Fugro Survey |
| Contact person: | Singapore Network Control Centre (24hrs) +65 6863 0604 |

DGPS reference stations:

Please use all available Referance stations.

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

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

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| **Chapter status:** | **Chapter updated:** | **Chapter updated by:** |
| Ready for review | 14-Jan-05 | kkrishnasamy |
| **Nav Supervisor:** | | |
| Kumara Krishnasamy (phone : +60 3 2730 8851, email : kkrishnasamy@slb.com) | | |

# Positioning Acquisition Parameters

## Streamer Parameters

**Positioning:**

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

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| Reviewed by vessel | 17-Jan-05 | cctee |
| **Project Geo:** | | |
| Tee Chee Cherng (phone : +60 3 2730 8844, email : cctee@slb.com) | | |

# Source Acquisition Parameters

| | |
|---|---|
| **Source type:** | Tuned sleevegun array |
| **Number of source arrays:** | 2 |
| **Alternatively fired sources (flip-flop):** | Yes |
| **Source array separation (m):** | 50.0 |
| **Inline stagger required:** | No |
| **Shotpoint interval (m):** | 18.75 |
| **Shotpoint interval per source (m):** | 37.5 |
| **Array volume per source (In3):** | 3000.0 |
| **Operating pressure (psi):** | 2000 |
| **Source depth (m):** | 7.0 |
| **Number of subarrays per source:** | 4 |
| **Subarray separation (m)** | 6 |
| **Number of airguns per subarray:** | 8 |
| **Subarray length (m):** | 15.1 |
| **Gun timing specification (ms):** | 1.25 |
| **Source control system:** | SSS |
| **Record nearfields:** | Yes |
| **CMS required:** | No |
| **Total SCFM required at 4.8 knots:** | 1420 |
| **Timebreak control:** | Volume |

**Specification:**

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

# 5. Vessel Description

## Maritime Specifications / Particulars

### Main Particulars

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

### Principal Particulars

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

**Capacities And Endurance's**

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

**Bridge Navigation Equipment**

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

**Communication Equipment, Compliant With Gmdss Requirements**

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

**Satellite Communications**

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

## Safety Equipment Crew

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

**Fixed Fire Extinguisher System**

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

**Hull Outfitting**

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

**International Oil Pollution Prevention (IOPP) Equipment**

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

## Machinery Equipment

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

# Seismic Specifications

## Main Particulars

| | |
|---|---|
| Streamers | 12 |
| Tow Points | 16 |
| Sub Arrays | 8 |

## Energy Systems

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

### Streamer Systems

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

## Navigation Systems

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

## Recording System

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

## Other Systems

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

## Onboard Seismic Qc

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

## Onboard Seismic Processing

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

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

# Table of Contents

# 6. List of Key Personnel

## 6.1. Onboard Personnel

| POSITION | CREW 1 | CREW 2 |
|---|---|---|
| **Party Manager** | Michael Martin | Ian Halfpenny |
| **Captain** | Rudy Bless | Rudy Bless |
| **Chief Engineer** | Kevin Joseph | Gordon Saunders |
| **Chief Officer** | Brett Mcphee | Luc Defossez |
| **Acq. Supervisor** | Donny Isdaryanto | Victor Lopes |
| **Acq. Shiftleader** | Stewart Klincke<br>Essau Leija | J.Q. Chandler<br>Richard Morgan |
| **Pos. Supervisor** | Stephen Kilmurray | Paul Melody |
| **Pos. Shiftleader** | Joel Pederick | Paul Farrell<br>Mike Gors |
| **Handling Supervisor** | Armin Roehl | Paul May |
| **Shiftleader Mechanic** | Aldrin Flores<br>Munisvaran Krishan | Colin Robson<br>Paul Hollingsworth |
| **Trilogy QC Leader** | | |
| **Field Geophysicist** | Petr Gorbatchev | Jon De Haai |

## 6.2. Office Support Personnel

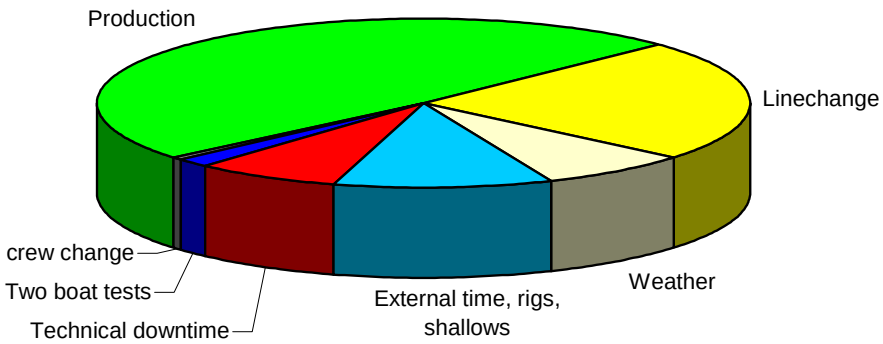
| POSITION | NAME | OFFICE |
|---|---|---|
| **Vessel Manager** | Kiran Tuite | Kuala Lumpur |
| **Maritime Superint.** | John Hattendorf | Kuala Lumpur |
| **Instrument Support** | InTouch Global Operations Support. | Oslo |
| **Navigation Support** | InTouch Global Operations Support, Kumara Krishnasamy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

# 7. Field Information and Observations

## 7.1. Production Statistics

| PRODUCTION (Km) | | |
|---|---|---|
| **Prime Traverse Production** | 3027.56275 Km | |
| **Infill Traverse Production** | 192.80625 Km | ( 6.4 % ) |
| **Total Traverse** | 3220.36900 Km | |
| **Prime CMP Production** | 44055.26250 Km | |
| **Infill Production** | 2892.90000 Km | |
| **Total CMP Production** | 46948.16250 Km | |

| TIME DISTRIBUTION (Hours) | | |
|---|---|---|
| **Production** | 368.6700 Hours | ( 48.9 % ) |
| **Linechange** | 176.3200 Hours | ( 23.4 % ) |
| **Weather** | 55.9830 Hours | ( 7.4 % ) |
| **External time, rigs, shallows** | 80.5830 Hours | ( 10.7 % ) |
| **Technical downtime** | 54.6000 Hours | ( 7.2 % ) |
| **Two boat tests** | 12.1000 Hours | ( 1.6 % ) |
| **crew change** | 5.2000 Hours | ( 0.7 % ) |
| **Total Survey time** | 753.4560 Hours | ( 100 % ) |



## 7.2 Daily Summary

Party Managers log in local time UTC + 11

# SUE Survey

**16th January 2005**
Extra floatation was added to the inner streamer lead-ins #4 & #5 in preparation for shallow water operations. The source was deployed and production started on the SUE survey at 05:33 hrs. At the request of Apache the MSX was changed to 5sec records and the run-in to lines has been reduced to 4.8 km. Strong winds and currents have been slowing down the vessel's shooting speed. The wind and sea picked up from the SW during the second sequence and by the end of the line the streamer RMS was >40 m/bar, compass data was also noisy. During the turn to the next line depth control of streamers #6 & #8 was lost and they surfaced. This resulted in tailbuoys crossing, but once the turn was completed we regained control of the streamers and the tailbuoys returned to the correct positions. A noise test taken on the run-in showed the ambient noise to be too high for production to continue. The Trident is continuing the shooting racetrack monitoring the feather and waiting for the weather to improve. The diving operations at Barracouta have not interfered with production and the bridge are following the EAPL procedures contacting the platform and LPCR on entering and leaving restricted zones. V-Sat communications were finally restored today at 11:00 hrs, the Indian Ocean satellite has failed and we have been re routed to the Pacific Ocean satellite.

**17th January 2005**
The wind and sea conditions improved overnight allowing production to restart at 04:11 hrs. Production was continuous for the rest of the day apart for an extended line change to perform gun maintenance and repair the starboard head float. The planned helicopter operation was delayed for 2 hours to allow the Trident time to clear the Barracouta platform. The helicopter landed at 11:15 hrs and picked up 4 off signers who were taken into Essendon.

**18th January 2005**
The Trident continued with racetrack production gradually closing in on the Dolphine and Perch platforms. Line changes at the eastern end of the prospect had to be extended to safely transit around the Barracouta platform. The first close pass to the Dolphine platform was successfully completed at 20:00 hrs CPA was tailbuoy #8 at 470m. There were diving operations at Barracouta today but no lines were aborted, good communications with the platform ensured that we did not enter the 8km zone when divers were in the water. Sea conditions were suitable for small boat work and both boats were launched to change the last section on streamer #7 and change acoustic pods on tailbuoys #7, #5, & #2. The CMV ferried the new section out to the workboat then performed a TS-dip and bird changes. The work boat checked the depths of the front end lead-ins, the deepest reading was 16m.

**19th January 2005**
Good weather conditions continued today. Production was uninterrupted, strong currents of up to 1.4 knots slowed the vessel bottom speed in the afternoon causing an extended line change between sequence 9 & 10. The Barracouta will continue with diving operations for the next two to three weeks, no time delays were incurred today as a result of the diving. A close pass to the Dolphine platform was successfully completed in the morning the closest point of approach was tailbuoy #8 at 391m.

**20th January 2005**
The wind and sea picked up in the morning then dropped off again in the evening. Production continued all day without interruption, two close passes were performed on the Dolphine platform. The platform is now boxed in with coverage on both sides. The Trident will continue in its present swath racetrack moving the coverage in towards the Perch platform. Diving operations were again in progress on the Barracouta but were timed such that they didn't interfere with our program.

**21st January 2005**
The sea conditions deteriorated in the morning as the wind strengthened and swung around to the SW. The forecast is for an improvement overnight, the planned supply boat operation was cancel due to unsuitable sea conditions. The final close pass to the Dolphine platform was completed, the next close pass to this platform will be during the undershoot operation. Diving operations on Barracouta are still in progress; good communications with the dive supervisor ensure that both operations can proceed simultaneously.

**22nd January 2005**
The weather improved enough to launch the CMV in the morning to change two birds on streamer #7 and add some ballast weights to the front of streamer #6. The CMV also transferred passengers from the Lady Roula to the Trident and from the Trident to the Omnes Pioneer. The first 14 km of sequence 19 were scratched due to problems with the MSX recording system and the source separations. During this period the port main engine was also shut down following a spurious alarm from a faulty jacket water temperature sensor. The 225 degree direction swath was swapped to the eastern side of the block so all the central swath lines can be shot in the 45 degree direction into the Barracouta platform. Nominal line change time now increased to 2:15 hours due to survey shape.

**23rd January 2005**
The Omnes Pioneer left the survey area at 06:00 hrs bound for Melbourne to crew change and pick up supplies and bunkers for the Trident. Whilst she is away we will not be able to perform any close passes to the Perch platform. The CMV was deployed in the morning to change birds on streamers #7 & 8. Adjustments to the ballast of streamer #8 at the front and tail were also performed. A RACU failure in the line change after sequence 23 meant the planned line GAP04B1984 was aborted and the Trident continued heading west to pick up line GAP04B2080.

**24th January 2005**
Wind and sea conditions picked up slightly but not enough to interfere with production. Completed the last run to the south of the Perch platform 500m zone, to move any close we'll need the Omnes Pioneer to be in attendance. After acquiring line GAP042000 production will switch to the northern block away from the platforms until the Omnes Pioneer returns from Melbourne.

**25th January 2005**
Continuous production throughout the day. The Trident changed over to the northern swath in the morning to avoid close passes to the Perch platform. The cable-laying vessel Julio Verne is approximately 3.8nm off the end of line GAP04B1136 moving slowly away from the prospect on a heading of 225 degrees. She is not interfering with our turns and is expected to complete her work in the area within the next week. The Omnes Pioneer has been delayed in Melbourne pending an inspection by the Victoria work safe authority and the AIMPE.

**26th January 2005**
Problems with the MSX during sequence 33 caused two reshoot holes. The MSX locks up for no apparent reason. The MSX memory boards were reseated in the line change after seq 33 in an attempt to isolated the fault. The Julio Verne will remain in the area or another 6 days, line changes today were not effected by the cable laying operation. The Omnes Pioneer is expected to sail from Melbourne Thursday evening and be back on prospect Saturday morning.

**27th January 2005**

Crew change was completed today by three helicopter flights out of West Sale. Due to the helicopters operators limits on roll and pitch and the prevailing swell conditions Trident was unable to complete the turn onto line after sequence 36 with the first helicopter on deck. After monitoring vessel movement on line direction Trident had to turn to head with seas on the quarter to ensure safe operations. 5.2hrs was therefore logged as crew change time.

The Omnes Pioneer is expected to be back on prospect tomorrow morning. The Julio Verne undertaking cable laying operation is still in position the west of the prospect.

**28th January 2005**
Production continued in the northern swath C before switching back to swathe A in the evening to continue boxing in the Perch platform. A close pass was completed on sequence 41 with Tailbuoy 1 passing 228m off.

False man over board alarms left two holes in production today, one on sequence 38 and one on sequence 39 when the guns automatically shut down on line. The first alarm occurred at 02:13. All crew were contacted and accounted for. On the line change after sequence 39 the fault was traced to a loose connection in the MOB controller patch panel in the gun shack. Total lost time and will depend on re-shoot time. Lines charged full but incomplete.

The Omnes Pioneer arrived back on prospect at 14:00 and was taken alongside at 14:36 whilst the vessel was on line 1440P1039. The fresh provisions were loaded and three reels of cables for repair discharged. She was let go EOL at 17:35. Although alongside for over 3hrs only 179m3 of bunkers was received. Whilst maneuvering alongside ship to ship contact was made between the fenders bending the gun deck door frame.

A planned small boat operation to ballast the head of streamer 2 had to be cancelled at the end of the day due to increased swell and heavy rain and lightning.

The Julio Verne undertaking cable laying operation is still in position the west of the prospect.

**29th January 2005**
Production continued in swathe A, a close pass's of Perch platform on lines heading east.

No new coverage was achieved at the start of line 1744P1043 west of Perch. This was due to a combination of an engine problem on Omnes Pioneer and a northerly feather. After Omnes Pioneer reported problems with the starboard engine on the line change Trident steered north on the run-in to line to clear the platform outside 500m. Omnes Pioneer managed to complete repairs for the close pass to take place but no new coverage was achieved for the first 5km of the line, a northerly feather preventing any new coverage as Trident moved back on to line. Good coverage was archived north of Perch as Trident maneuvered around the platform with the outer stbd paravane passing 160m off.

Linechanges in the east had to be extended for the vessel to turn outside of Barracouta platform. They were longer in the west due to the stagger of the prospect. Shooting speed was reduced due to strong head 1.0kt head currents.

The work boat was deployed in the morning to attempt ballast work at the front of streamer 2. Due to increasing wind the operation was aborted and work boat returned onboard. The job was completed with a second launch late afternoon with streamer 2 bird 3 being replaced and a loose SRD being re-attached on streamer 7.

The Client crew change was completed by helicopter in the morning. Ian Milne and Patric Bonnevier joined.

Support vessel Lady Roula departed at 0530 to call into Lakes Entrance for crew change, supplies and was back on prospect at 23:00.

**30th January 2005**
Production continued in swathe A. Two good close passes of Perch platform on lines heading east successfully acquired, no further coverage is possible without deadhead runs or undershooting.

Linechanges in the east had to be extended for the vessel to turn outside of Barracouta platform. Linchanges were longer in the west due to the stagger of the prospect.

The work boat was deployed in the morning to change bird 11 on streamer 7 which was running light. Sea conditions were two rough for section changing.

The Julio Verne was contacted and Trident was informed that they still have 5 days work outstanding. This will have an impact on completing the run out of line in the NW corner of the prospect.

**31st January 2005**
After completion of line 2048P1048 production switch back to the centre swathe C. The long linechange (change of swathes and prospect shape) was utilized to deploy the workboats to change section 23A streamer 7.

Strumming noise on streamer 3 increased to level, over 30uB, that action was demeaned necessary. After completion of line sequence 49, guns were recovered and streamer 4 stacked to allow recovery of lead-in 3 to investigate. Fairing had been stripped form end of the lead-in and Cumberland grip damaged, probably by catching floating debris or fishing gear.

Whilst undertaking the work to repair the fairing the support paravanes will be adjusted to buoy up the front-ends in preparation for the shallow part of the survey. The support paravanes on lead-in's 3 and 6 will be changed to larger 5000ltr and the support chains shortened. The work boat was deployed prior to the work to check the depth of the lead-ins aft of the support paravanes, 10m was recorded.

The FRC was launched at the end of the day to assist in recovering a gun separation rope and collar which had been lost down lead-in 2 during mobilization. Also the front float T-piece inserted in streamer 3 for the failed front float was removed. The time taken for these tasks was logged as WesternGeco downtime.

In the evening OMS Pioneer spotted and recovered a drifting front buoy which was lost by Trident during mobilization.

OMS Pioneer departed the prospect to head for Port Welshpool to change out an engineer for compassionate leave and a change of Captains.

**1st February 2005**
Reconfiguration work in preparation for the shallows was completed with streamer 6 support paravane adjusted and all gear redeployed for production to resume at 07:12. (The last long prime line in the east). The first 1.3km of the line was lost due to an air leak. Two re-shoot lines were acquired in the centre swathe. Sea conditions deteriorated in the evening with a southwesterly wind gusting to 45kts. Streamer control was lost with streamers surfacing, streamer 6 remaining on the surface and crossing behind streamer 4. With a poor forecast the decision was taken to head Sw'ly down the coast and recover the guns for safety.

The forecast for the next three days is not too promising; a low-pressure system will develop to the northeast of Bass Strait early Wednesday before deepening and moving over eastern Bass Strait.

The plan to sound the lead-ins in the afternoon had to be canceled as a front crossed the Bass Strait and with wind increasing to 30kts.

OMS Pioneer departed for Port Welshpool 00:00, to change out an engineer for compassionate leave and to change out of Captains, and was back on location at 12:00

**2nd February 2005**
The weather eased in the morning allowing the vessel to turn back to the prospect, deploy guns and resume production at 12:43. Weather conditions deteriorated on line, wind SE force 7-8 rough seas. The line was completed but further production halted with the vessel continuing east along the coast to wait on weather.

An ENE wind increased to 45kts in the evening and seas 4-5m. Streamer control was lost with streamer 6 crossing streamers 7 and 8 and 2 and 3 surfacing and crossing streamer 1. With the waves forcast to be larger offshore Trident contined down the coast, rolling in a beam sea.

A gale warning is current, Southerly winds 30/40 knots tending northwest to northerly and moderating to 15/25 knots from the east overnight. Seas 4 to 6 metres abating to 2 to 3 metres. Southeasterly swell 2 to 3 metres.

Earlier in the day a yellow egg float was dragged up lead-in 6 by the gun separation rope. During an attempt to recovery the float it was lost from the back deck.

**3rd February 2005**
As an intense low pressure over the Bass Strait headed west the gale force wind switched to the NW and round to the NE. Streamer control continued to be unstable in seas 4 to 5m and streamers surfacing and crossing. Tailbuoy 8, entangled on tailbuoy 6 late yesterday, parted from the streamer, the two tailbuoys towed from streamer 6. Conditions eased slightly in the morning and cable control was regained allowing Trident to turn back towards the prospect at 05:50. The weather damage has reduced the tail-end positioning redundancy and cable 7 suffers from intermittent coil line leakage. As soon as sea conditions permit the work boats will need to be deployed to repair the damage.

Support paravanes were deployed from the back deck to buoy up lead-ins 4 and 5. In theory all gear should be buoyed up to 12m.

Production resumed at 19:56 on line GAP04B1200P1054, Lady Roula ahead monitoring depths. Wind NE 28Kts, wave height 2.0m.

An Operations and Safety committee meeting was held in the afternoon.

**4th February 2005**
Production continued in swathe C, heading closer in to the shallows, minimum water depth on line 1184P1056 20.9m.

Weather conditions improved during the afternoon allowing the work boat to be launched on the linechange. The crew first replaced bird 5 on streamer 6 and reattached bird 8 which had come adrift from the front collar. They then successfully untangled tailbuoy 8 from tailbuoy 6 and after replacing the swivel reattached the tailbuoy to streamer 8. The crew then returned to streamer 6 to replace the acoustic unit on tailbuoy 6.

After completing a TS Dip the work boat crew attempted to sound the lead-ins. Sea conditions were not ideal but the deepest point on lead-ins 2 and 3 was found at 8.5m. A possible depth of 15m was observed on lead-in 4 in front of the guns. The support paravane chain will be shortened and lead-in re-sounded in the morning if sea conditions permit,

**5th February 2005**
Production continued in swathe C, closing in on the coast.

The work boat was deployed on the morning linechange to change bird 4 on streamer 1 and sound the lead-ins. Deepest point was found forward of the gun arrays on lead-in 4 at 10.0m. The wind picked up in the morning to westerly 20kts preventing any further small boat activities.

Lady Roula has requested to call in to Port Welshpool on Monday for crew change.

Latest information is than source vessel Pacific Titon will be on location 12$^{th}$ February for undershoot of the Perch and Dolphin platforms.

**6th February 2005**
Production continued in swathe C, closing in on the coast. Weather conditions deteriorated late afternoon, west/southwesterly wind increasing to 30 knots and a short 1.5/2m sea building in the evening.

The wind is forecast to back northerly early morning and although 20 to 30 knots may allow production to continue with the short fetch off the coast.

Intermittent coil line leakage evident since the last bad weather period is causing occasional loss of compass and acoustic data on streamer 7.

A fire drill took place in the afternoon, the scenario a fire in the rope locker.

Support vessel OMS Pioneer remains in close attendance for the shallow lines.

Lady Roula will depart the prospect after midnight to head for Port Welshpool for crew change.

**7th February 2005**
Weather conditions continued to be very variable, light winds in the morning increasing to 25kts late afternoon. With NE'ly wind off the land and wave height of less than 1.5m production was able to continue off the coast but with caution.

A General Safety Meeting was held in the afternoon.

Swathe C border was closed with the acquisition of prime line 1312P1065 leaving no infill coverage outstanding.

Acquisition of the lines along the coast continued. A 14.1m pinnacle in the east prevents the vessel lining up for full coverage on lines north of 1104P1066 inclusive. The vessel successfully passed over 16.3m soundings. At the end of line 1104P1066 the vessel performed a teardrop turn to acquire inshore line 1056P1067. Full coverage could not be achieved at the SOL line due to water depths less than 16m on the run-in. 18m was observed for the first part of the line. A slight deviation of 50m offline was required to ensure the streamers remained outside the marine park. The vessel commenced turning 6km before end of line to ensure safe clearance and sea room from the 14.1m pinnacle. A tear drop turn was then required to turn back onto line 1088P1068 sliding in past the 14.1m point.

The first 11.9km at start of line 1104P1066 was scratched due to failure of an 8/10 pin jumper on array 5. The vessel continued on line whilst the array was recovered, launching the work boat to fault find the streamer 7 intermittent coil line leakage. Section 19A was identified and with good sea condition's the section was change was undertaken on line. With the gun array redeployed production continued with streamer 7 and 8 buried in the coverage and 12CMP recorded. After streamer 7 was repaired production continued with 14 CMP whilst the acoustic unit on tailbuoy 8, damaged in last weeks weather tangle was repaired.

The time for the section change on streamer 7 was accounted as downtime by a factor of 2/16 or 2/8 of the time the vessel was in production in 12 CMP mode. The reduction was subtracted from line change time.

The CMV was deployed to assist the workboat with the section change. The GPS unit was changed but the buoy remains down. An underwater camera inspection was attempted but the water visibility was too poor.

Lady Roula arrive back on prospect at 12:00. OMS Pioneer was on close standby whilst Trident was in water depths of 20m and less.

**8th February 2005**
Production along the coast continued with completion of the long lines. Teardrop turns were required at each end of the survey. Re-shoot Line 1104A1070 was acquired which include a segment of infill although full coverage could not be obtained at the start of line 1104 because of the 14.1m pinnacle on the run-in. Acquisition continued with the first short line 1040P1071 east of the marine park.

The work boat was deployed midday for bird maintenance.

**9th February 2005**

The last shallow line was successfully completed at 11:32. Trident them made a long transit around Barracouta to continue production acquiring a re-shoot and infill line 2064J1075 down the eastern edge on route to the short lines in the south.

Multiwave vessel “Pacific Titan” called to report her arrival on a block to the NE of Trident with an intended start time of 06:40GMT, 1740 local. Trident started line 2064J1075 at 16:32. Titan reported seismic interference to be too excessive to live with and time sharing will be required form the end of line 2064J1075 at 21:09.

The long transit was utilsed for streamer maintenance, the work boat with the assistance of the CMV was deployed to change active 13A on streamer 4. The work then attempted to repair the acoustic unit on tailbuoy 7 without success.

**10th February 2005**
Production continued on the short lines in the south-east corner of the survey area. Close communication was maintained with Multiwave vessel “Pacific Titan” and vessels were able to shoot in each other’s linechange with little delay to production. After reporting observing Trident at 160uB yesterday evening, today with the vessels at maximum distance apart, Titan reported no interference from Trident and no interference was observed on Trident.

Breezy weather conditions persisted today and there was no opportunity for small boat activity.

An LPT meeting was held in the afternoon.

**11th February 2005**
Production switched through out the day between the short-line in the south-east and small re-shoot lines in the centre swathes. Communication was maintained with pacific Titan to avoid interference.

The shooting plan was changed to acquire an extra infill in the east requested by Apache and at the end of the day Trident was in transit around Barracouta to pick up the line.

The work boat was launched midday to change out 3 birds, plans to carry out maintenance on tail buoy 3 and change out tail buoy 5 had to be postponed due to the sea state.

Lady Roula departed the prospect at 01:40 to pick up two-boat engineer from Lakes Entrance. Chidi Offor was successfully transferred to Pacific Titan and Lady Roula was back on location at 15:30.

**12th February 2005**
Trident acquired full infill line GAP04B1984J1088 to head south. Weather conditions deteriorated but the two outstanding prime lines and an infill line were acquired to complete the short lines in the south-east. With the wind SW 25kts and seas 3.0m a larger turn circle radius was required and streamer control was poor on line with swell noise evident.

With completion of the short southeastern lines at 18:08 Trident turned to rendezvous with Pacific Titan whose ETA at Dolphin was 19:30. Configuration of two boat link commenced at 19:30 with Trident deploying guns.

A medivac drill was carried out in the morning with the maritime crew preparing the helideck.

A first aid training session was held by the medic in the afternoon on the subject of CPR.

**13th February 2005**
Weather, SW force 6 decreasing to light airs in the afternoon.

The two boat system configuration continued after midnight with a planned test line scheduled to start at 01:30 missed. Time was logged as technical downtime from 06:00, the start of the first scheduled undershoot pass. WesternGeco engineer Chidiebere Offor reported the problem was due to the failure of the truetime receiver installed as part of the (WesternGeco) two boat

equipment on Pacfic Titan. The suggested solution was to transfer the salve truetime unit from Trident and to make a TTL from closure as replacement on Trident.

Weather conditions slowly improved in the morning and after Trident turned to create a lee the CMV was launched to transfer the receiver. A line attempt was made past the Dolphin platform in the afternoon with Trinav and spectra systems apparently configured and the line was steered well, but with no closure being received by the MSX no data could be recorded. Chidiebere Offor was transferred across to Trident late afternoon to continue to search for a solution and workaround for the failed true time receiver.

As the swell dropped and the workboat was launched on run-in to line in the afternoon to change out 4 birds.

**14th February 2005**
Good weather persisted, NE force 3 to light airs.

Tridents two-boat setup was reconfigured to adjust for transfer of the salve Truetime receiver to source vessel Pacific Titan. Initial tests and an attempt to reconfigure back to single vessel mode were complicated by a bad relay in the Spectra relay box. Two-boat production commenced at 11:02 with the first undershoot pass of the Dolphin platform. Production then continued in an anti-clockwise loop around Dolphin and Perch in turn. Turns had to be extended due to strong current up to 1.3kts.

The two-boat FTB is now being issued by a Trinav relay instead of TTL signal so there is a drift between the FTB on two boats. This drift is being logged to file and will be closely checked by QC of the data and will need to be applied in processing. Technical support was contacted for feedback on improvements to the set-up.

The work boat was deployed in the morning, the crew successfully replacing the acoustic coil on taibuoy 3. The crew again launched in the afternoon line change and successfully replaced tailbuoy 5.

On the first boat launch the Chief Officer was transfer to support vessel Pioneer for an informal inspection and to explain Trident supply boat operations and check lists.

First aid training sessions held continued, today's session on the subject of hemorrhage management.

**15th February 2005**
Undershoot with Pacific Titan.

The weather deteriorated rapidly today, a strong wind warning was issued west-southwest winds increasing to 25/30 knots during the day and seas 2-3m.

Production continued in an anti-clockwise loop around Dolphin and Perch in turn. Turns had to be extended due to deteriorating weather and strong currents. Good coverage was obtained with close passage of Trident streamers.

Two vessel timing variation resulting from the use of the two Trinav relays in place of the truetime receiver continue to be monitored and recorded. Two boat data was FTP'd to Perth processing data for a review of the dtat quality.

A SIPP's refresher training session was held.

First aid training sessions continued, today's second session on the subject of hemorrhage management.

**16th February 2005**
Undershoot with Pacific Titan completed.

The weather remained poor today, a strong wind warning was issued west-southwest winds increasing to 25/35 knots during the day and seas 3-4m.

Good coverage was obtained on the final undershoot runs past Dolphin and Perch and the Client accepted the coverage as complete after sequence 98, end of line 08:55

A slight lull in weather and a good lee in the turn allowed the CMV to be launched to collect the failed true time receiver from PacificTitan. A extra undershoot run was made whilst attempts to utilise the truetime receiver as master on Trident were undertaken. The effort was unsuccessful and Pacific Titan was released at 15:00

The time from 08:55 to 15:00 was logged as WesternGeco Time.

Western Trident commenced the Transit to Oscar prospect at 15:00 speed reduced due to the weather, wind southwest 35kts, Sea SW 3-4m.

Efforts continue both on board and ashore to ensure the timing drift in the Undershoot data can be corrected. At a meeting in Perth data processing provided Apache with a before and after display of a single trace gather with the timing shifts removed using a method based on the positioning data and picking of direct arrivals. The LMO corrected data looks promising.

First aid training session on burns was held in the afternoon.

**END of Job 9438, Vessel on Transit to next survey.**

# Field Information and Encountered Problems

## 7.2.1 Obstructions / Installations on the Field

The survey area approached within 4.2 km of the coastline and came within 0.3 km of Ninety Mile Beach Marine National Park. Seismic acquisition could not be undertaken within the Marine Park boundary, it was treated as an obstruction and the vessel and trailing gear did not traverse the Marine Park. The Marine part restricted the run-in onto the three northern most lines.

Cable ship Guilio Verne, on site to repair the Bass link submarine cable, was a restriction on the run out of lines in the north-west of the survey area at the start of the survey. However her departure was well timed prior to Trident commencing work on the shallow lines and no time was lost.

A detailed bathymetric survey using Laser Airborne Depth Survey (LADS) was completed prior to the seismic survey to fully define the 20 m depth contour. This identified pinnacles with water depths less than 18m in the survey area. To acquire the coastal lines Western Tridents 8 streamer spread was buoyed up to a minimum depth above 12m. Following a hazard analysis (HARC) by the crew the risk was deemed acceptable to take the vessel into a minimum water depth of 18m and traverse over pinnacles with a minimum depth 16m with the vessel on a straight course. This meant a small s of coverage on the north-western boundary could not be acquired due Pinnacles of 15.0m and an area in the extreme north east of the prospect could not be acquired due to the vessel having to turn to clear a pinnacle of 14.1m to the east of lines 1120 and 1104.

There were two fixed obstructions in the survey area, monopods Dolphin and Perch. The Barracouta platform was situated 8km to the east of the prospect area restricting the vessel turning manoeuvres. The survey shooting plan and swathe design was therefore designed to ensure a full run out toward Barracouta but extra line change time was required, logged as “external downtime obstructions”, to enable the vessel to turn around the outside of the platform. Diving Operations were in progress on Barracouta and the procedures for “DIVERS in the WATER”, drawn up with agreement between Apache and Esso/BHPB were closely followed. Good communication between the vessel and Diving Supervisor resulted in no lost time due to diving operations. WesternGeco and Esso Australia Close Pass Procedure’s were closely adhered to and good communication established with the Northern Fields Platforms and Longford Control Room.

At the end of the survey the monopods Dolphin and Perch were undershot with the assistance of Multiwave vessel “Pacific Titan”. The undershoot was completed with the minimum eight runs, as Titan towed a single source this consisted of four runs followed by four interleave lines.

## 7.2.2 Traffic / Shipping Lanes

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

## 7.2.3 Fishing Activity

Occasionally fishing vessels from Lakes Entrance passed through the survey area but stayed well clear of the Trident and its towed equipment. Prior to the start of the survey a lot of time had been

invested informing the local fishing fleet of the Western Trident's planned activities. This has clearly paid dividends with no lost time recorded for fishing activities during the survey.

### 7.2.4 Seismic Interference and Time Share

Multiwave vessel "Pacific Titan" arrived on the 9th February to carry out a small 2D survey on the coast to the northeast of SUE. Trident completed the coastal lines on the same day and was able to transit to continue acquisition on the short lines in the south-east corner of the survey area. Close communication was maintained with Multiwave vessel "Pacific Titan" and vessels were able to shoot in each other's line change with no delay to production. No interference was observed on Trident.

### 7.2.5 Environmental Obstacles

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

An unusual low pressure system which tracked west across Bass Straight on the 2nd and 3rd February resulted in 42hrs of weather downtime.

Regionally, Bass Strait has a unique geometry consisting of a broad shallow region, which descends abruptly to very deep water on each side. The Gippsland Basin is the broad shallow region on the eastern side of Bass Strait. The flux of water through the strait and its variations are key components of many physical and biological processes in the region. The currents within the Gippsland Basin region include components due to tides and wind stress. As a function of this in the open waters, tides generally result in an elliptical movement of the water mass. The East Australian current brings warmer waters into Bass Strait and influences water temperatures. Sea surface temperatures for Bass Strait range from 16 to 18oC in February and 12 to 14oC in August Wave energy is relatively low, particularly in the broader shelf area in the Gippsland Basin. However, stalled low-pressure systems in the Tasman Sea during the summer can generate higher wave energy at this time. Intermittent upwelling occur along parts of the east Gippsland coast.

Infill was low, 6.4% as the current was parallel to the coast and mainly in line direction resulting in low feather. The strong current often over 1.0kt did reduce the vessels average ground speed.

The water depth range for the survey varied from 18m, with pinnacles below 15m on the coast to 40m in the south.

### 7.2.6 Operational Observations

The combination of 8m streamer depths and the use of solid streamers allowed production to continue in some very marginal sea conditions. The proximity of the prospect to the coast and the short fetch allowed production to continue with near gale force winds from the NW to the NE. The limiting factor regarding production was not the streamer noise but streamer control and the ability to process the navigation data, as high swell conditions produce noisy compass and acoustic data.

At the end of the survey the monopods Dolphin and Perch were undershot with the assistance of Multiwave vessel "Pacific Titan". Operationally the undershoot was completed efficiently with the minimum eight runs, with Titan towing a single source this consisted of four runs followed by four interleave lines.

The undershoot start was delayed by the failure of WesternGeco's source vessel Truetime receiver that meant that the crew had to strip Trident of one of its units to transfer to Titan and use two TRINAV relays in its place on Trident. The relays introduced erratic timing differences that will be adjusted in processing with static correction files created to adjust the data from a recorded FTB QC file.

Chase boat Performance:
The crew of the supply support vessel "OMS Pioneer" and the fishing support vessel "Lady Roula" performed up to expectations.

Lady Roula's presence ensured good co-operation with the local fishing communities and was also used for personal transfer to Lakes Entrance (tidal dependant) and Welshpool. However due to the variable weather in this area it should be stressed that personnel transfers cannot always be guaranteed and should be restricted to a minimum on future surveys.

During the survey one supply operation with OMS Pioneer was undertaken on line. On approach the port shoulder of the supply vessel Pacific Pioneer made direct contact with Western Trident between the two rigged Yokahama fenders and the framing of the gun deck the door was slightly bent inboard. The incident was reported RIR 20050129002200. A third Yokahama fender will be rigged at the gun deck door to avoid re-occurrence of the incident. This incident is a reminder that future surveys in this area should be planned with a minimum of supply boat opertions.

# 8 HSE Summary

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

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

Tables below list the following;
RIR's, STOP-cards.
HSE-meetings
Audits & Inspections.

| RIR | Description | Date | Category |
|---|---|---|---|
| 20050217043035 | Bagle virus found on computer | Feb 14, 2005 | Near Accident |
| 20050217000759 | Found door for Odim control cabinet open. | Feb 16, 2005 | Hazardous Sit. |
| 20050216173022 | Power lead not put away | Feb 16, 2005 | Hazardous Sit. |
| 20050215062959 | Potential slip hazard in cabins. | Feb 15, 2005 | Hazardous Sit. |
| 20050214073534 | Emergency Exit Deficiency | Feb 14, 2005 | Hazardous Sit. |
| 20050214052616 | Broken tie rod on LMF compressor | Feb 14, 2005 | Hazardous Sit. |
| 20050214031914 | Fire hazard | Feb 14, 2005 | Hazardous Sit. |
| 20050214022428 | Obstructed Access to header tanks | Feb 13, 2005 | Hazardous Sit. |
| 20050214001148 | Bad solding stand | Feb 14, 2005 | Hazardous Sit. |
| 20050213235351 | Defective pressureswitch for air vent. system. | Feb 13, 2005 | Hazardous Sit. |
| 20050213092710 | Tape library door left open. | Feb 10, 2005 | Hazardous Sit. |
| 20050213060630 | person wearing wrong flotation device | Feb 13, 2005 | Hazardous Sit. |
| 20050213041042 | Air hose hazard. | Feb 12, 2005 | Hazardous Sit. |
| 20050213035842 | doorstep loose | Feb 13, 2005 | Hazardous Sit. |
| 20050213035152 | Lack of PPE in ER | Feb 12, 2005 | Hazardous Sit. |
| 20050212231931 | Defective batterycharger for stb. lifeboat. | Feb 12, 2005 | Hazardous Sit. |
| 20050212220943 | Houskeeping in Small boat Recesses | Feb 11, 2005 | Hazardous Sit. |
| 20050212220258 | Unsecured items in the Gym | Feb 03, 2005 | Hazardous Sit. |
| 20050212215821 | Power tool switch | Feb 08, 2005 | Hazardous Sit. |
| 20050212215146 | Food provision transfer | Feb 01, 2005 | Hazardous Sit. |
| 20050212002930 | Norpower Workboat: Found navigation lights broken. | Feb 12, 2005 | Hazardous Sit. |
| 20050211165517 | Swinging door. | Feb 12, 2005 | Hazardous Sit. |
| 20050211002601 | Bilge pumps in CMV did not operate. | Feb 10, 2005 | Hazardous Sit. |
| 20050210182540 | Not Using Safety Equipment While working | Feb 09, 2005 | Hazardous Sit. |
| 20050210150404 | Seized wheels on fire extinguisher's trolley | Feb 10, 2005 | Hazardous Sit. |
| 20050210051221 | Observation of tool use, spanners on array. | Feb 10, 2005 | Hazardous Sit. |
| 20050209110818 | Lost balance on the work boat. | Feb 09, 2005 | Near Accident |
| 20050209042943 | Skinned knuckles. | Feb 02, 2005 | Hazardous Sit. |
| 20050208235724 | exhaust fan in store not covered | Feb 09, 2005 | Hazardous Sit. |
| 20050208222215 | Slip Hazard - Heli-deck | Feb 09, 2005 | Hazardous Sit. |
| 20050208194610 | Wood Pallet blocking walkway | Feb 09, 2005 | Hazardous Sit. |
| 20050208145909 | Potential slip hazard | Feb 08, 2005 | Hazardous Sit. |
| 20050208000546 | Person working in Safety zone without correct PPE | Feb 07, 2005 | Hazardous Sit. |
| 20050208000026 | Scales in Heli Reception left Unsecured | Feb 07, 2005 | Hazardous Sit. |
| 20050207235446 | Small oil spill on D Deck under Scrap metal bin | Feb 05, 2005 | Hazardous Sit. |
| 20050207234823 | Short Preventer(Safety Line) FRC | Feb 04, 2005 | Hazardous Sit. |

| | | | |
|---|---|---|---|
| 20050207234244 | Fire Extinguisher not in place | Feb 01, 2005 | Hazardous Sit. |
| 20050207180126 | Person positioned himself between cable and reel | Feb 07, 2005 | Hazardous Sit. |
| 20050207104653 | Doing inappropriate exercise in the gym. | Feb 07, 2005 | Hazardous Sit. |
| 20050207053140 | Typhoon suit had damage collar neck | Feb 07, 2005 | Hazardous Sit. |
| 20050207014456 | Lost SRD on tail end of Streamer 6. | Feb 07, 2005 | Accident/Failure |
| 20050207012550 | Survival suits dripping water around ship | Feb 07, 2005 | Hazardous Sit. |
| 20050206160904 | Slip hazard | Feb 06, 2005 | Hazardous Sit. |
| 20050206140842 | Tools left over after work | Feb 05, 2005 | Hazardous Sit. |
| 20050206135903 | Railing bent near the cable reel | Feb 03, 2005 | Hazardous Sit. |
| 20050206135727 | Working aloof with no safety harness. | Feb 06, 2005 | Hazardous Sit. |
| 20050203160301 | GO. Contract worker cleaned up duty mess | Feb 03, 2005 | Hazardous Sit. |
| 20050203071050 | Moving empty wood reels on deck. | Jan 28, 2005 | Hazardous Sit. |
| 20050203065531 | No hard hat working near crane block. | Jan 28, 2005 | Hazardous Sit. |
| 20050203042858 | Helicopter parked to close to personnel baggage | Feb 03, 2005 | Hazardous Sit. |
| 20050203041451 | Lead-in 7 was rubbing against radar reflector | Feb 03, 2005 | Hazardous Sit. |
| 20050203033904 | Tail buoy 8 parted and caught on Tail buoy 6. | Feb 03, 2005 | Accident/Failure |
| 20050202140638 | Lithium Batteries not properly stored. | Jan 30, 2005 | Hazardous Sit. |
| 20050202062905 | SRD hanging on the cable7 | Jan 31, 2005 | Hazardous Sit. |
| 20050202060754 | Workboat chains do not indicate when twisted. | Feb 02, 2005 | Hazardous Sit. |
| 20050202040500 | Small hatch for cable section left open | Feb 02, 2005 | Hazardous Sit. |
| 20050201002751 | Lithium battery protection kit not in place | Feb 01, 2005 | Hazardous Sit. |
| 20050131130907 | laptop and other goods stolen | Jan 27, 2005 | Accident/Failure |
| 20050131031435 | STOP coffee spill on stairs | Jan 31, 2005 | Hazardous Sit. |
| 20050130220115 | Loudspeaker on CMV radio not functional | Jan 30, 2005 | Hazardous Sit. |
| 20050129002200 | Contact with supply vessel (steel to steel) | Jan 28, 2005 | Accident/Failure |
| 20050128063637 | Lost production due to False man over board alarms | Jan 28, 2005 | Accident/Failure |
| 20050125114958 | Hydraulic oil leak from cable deck | Jan 24, 2005 | Hazardous Sit. |
| 20050124225512 | Virus scan definition files not up to date | Jan 25, 2005 | Hazardous Sit. |
| 20050124061244 | Contents of First Aid Kit Fast Rescue boat | Jan 22, 2005 | Hazardous Sit. |
| 20050123102507 | VHF radios not put away after use | Jan 23, 2005 | Hazardous Sit. |
| 20050123060919 | Defective pressure gauge. | Jan 23, 2005 | Hazardous Sit. |
| 20050123055422 | Faulty pressure gauge. | Jan 23, 2005 | Hazardous Sit. |
| 20050123003409 | Cup & rubbish on streamer deck. | Jan 23, 2005 | Hazardous Sit. |
| 20050120223542 | Sludge pump failure. | Jan 20, 2005 | Hazardous Sit. |
| 20050119201358 | Acoustic unit lost | Jan 20, 2005 | Accident/Failure |
| 20050119053701 | Broken dipstick. | Jan 19, 2005 | Hazardous Sit. |
| 20050118100253 | Broken posnet mast | Jan 18, 2005 | Hazardous Sit. |
| 20050118054709 | Valve spindle damaged. | Jan 18, 2005 | Hazardous Sit. |
| 20050118052408 | Failed HP fuel pipe on Stbd Eng | Jan 18, 2005 | Hazardous Sit. |
| 20050118022207 | Broken regulating valve spring. | Jan 18, 2005 | Hazardous Sit. |
| 20050118021700 | High exh gas deviation | Jan 17, 2005 | Hazardous Sit. |
| 20050117003130 | Grounding of enclosures | Jan 17, 2005 | Hazardous Sit. |
| 20050116201103 | Swelling of Right Knee & Lower Leg / Ankle | Jan 16, 2005 | Accident/Failure |

## HSE Meetings

| Meeting | Description | Date |
|---|---|---|
| 20050123173744 | LPT | Jan 24, 2005 |
| 20050130030157 | Catering dept. weekly QHSE meeting w 4 | Jan 30, 2005 |
| 20050203050941 | Operations and Safety Committee Meeting | Feb 03, 2005 |
| 20050207231648 | Weekly Deck Department Meeting Week 4 | Feb 03, 2005 |
| 20050208022947 | Catering dept weekly QHSE meeting 8 Feb 05 | Feb 08, 2005 |
| 20050208075323 | Engine Dept Safety Meeting | Feb 08, 2005 |
| 20050212060720 | Safety and ISPS Basic Awareness Level 1 | Feb 11, 2005 |
| 20050212074731 | Seismic Chiefs Meeting 5th February | Feb 05, 2005 |
| 20050212074954 | Seismic Chiefs Meeting 12th February | Feb 12, 2005 |
| 20050213050217 | ISPS basic awareness Level 1 | Feb 13, 2005 |
| 20050213072059 | Acq. dept QHSE meeting | Feb 13, 2005 |

## Audits Inspections.

| Audit | Description | Date |
|---|---|---|
| 20050122024850 | Vessel feedback report Jan 05 | Jan 22, 2005 |
| 20050126073819 | Western Trident Monthly H&H Report January 2005 | Jan 25, 2005 |
| 20050126205132 | D Deck inspection | Jan 27, 2005 |
| 20050203074719 | Australasian Jet Audit for WG Trident | Jan 26, 2005 |
| 20050212065436 | Inspection of Western Tridents gym. | Feb 10, 2005 |
| 20050215061428 | Internal Cross Audit, of Gun, Mono & Cable decks. | Feb 11, 2005 |

# 9 Shipment List

| | | |
|---|---|---|
| TDT-05018-AD-EXT | SEG D Original Tapes & P190 data | Seq 001-098 |
| TDT-05017-AD-EXT | SEGD Field Tapes& client deliverables | Seq 001-098 |

# 10Logs

The final field and copy tape logs are written in PDL (Prospect Data Logger) format. The logs are copied as HTML files and copied onto CD. Copies of the PDL line logs were provided for Apache in the data shipments.

A scanned copy of the Production and Timing Summary is enclosed on the next page.

| | |
|---|---|
| **Vessel** | **M/V Western Trident** |
| **Area** | **GAP04B - SUE** |
| **Job no.** | **9429** |
| **Client** | **Apache Energy** |
| **MMM-YY** | **17-Feb-05** |

## TIMING & PRODUCTION SUMMARY

| | Accountable Time - Hours | | | | | | | | | | | | | | Production - kms | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | Transit | WesternGeco Downtime | Undershoot Prod | Undershoot Line chanege | Undershoot Standby | Other chargeable Standby | Production Prime | Prime runout | Linechange Prime | Production Infill | Infill runout | Linechange Infill | **Total Day Rate** | Total Time | Prime Traverse km | Infill Traverse km | Prime FF CMP km | Infill FF CMP Km |
| 16-Jan | | | | | | 4.033 | 10.267 | 0.550 | 3.600 | | | | **18.45** | 18.450 | 86.43750 | | 1306.20000 | |
| 17-Jan | | 1.050 | | | | 4.183 | 13.733 | 0.767 | 4.267 | | | | **22.95** | 24.000 | 130.57500 | | 1974.00000 | |
| 18-Jan | | | | | | 2.500 | 13.667 | 0.833 | 7.000 | | | | **24.00** | 24.000 | 132.73130 | | 2008.50000 | |
| 19-Jan | | | | | | 3.050 | 14.567 | 0.883 | 5.500 | | | | **24.00** | 24.000 | 127.55630 | | 1925.70000 | |
| 20-Jan | | | | | | 1.700 | 16.017 | 0.783 | 5.500 | | | | **24.00** | 24.000 | 150.24380 | | 2288.70000 | |
| 21-Jan | | | | | | 1.717 | 15.850 | 0.933 | 5.500 | | | | **24.00** | 24.000 | 149.92500 | | 2271.00000 | |
| 22-Jan | | 1.700 | | | | 2.467 | 13.150 | 0.933 | 5.750 | | | | **22.30** | 24.000 | 117.26250 | | 1744.80000 | |
| 23-Jan | | 2.567 | | | | 1.933 | 10.717 | 0.850 | 7.933 | | | | **21.43** | 24.000 | 103.08750 | | 1524.60000 | |
| 24-Jan | | | | | | 2.367 | 14.700 | 0.783 | 6.150 | | | | **24.00** | 24.000 | 142.95000 | | 2172.00000 | |
| 25-Jan | | | | | | 0.867 | 16.383 | 0.833 | 5.917 | | | | **24.00** | 24.000 | 147.95630 | | 2252.10000 | |
| 26-Jan | | 0.233 | | | | | 15.667 | 1.100 | 7.000 | | | | **23.77** | 24.000 | 138.80630 | | 2067.30000 | |
| 27-Jan | | 5.200 | | | | 0.817 | 11.567 | 0.833 | 5.583 | | | | **18.80** | 24.000 | 104.58750 | | 1558.20000 | |
| 28-Jan | | | | | | 0.933 | 16.133 | 0.883 | 6.050 | | | | **24.00** | 24.000 | 153.45000 | | 2340.00000 | |
| 29-Jan | | | | | | 2.967 | 9.117 | 0.567 | 3.667 | 5.100 | 0.333 | 2.250 | **24.00** | 24.000 | 85.72500 | 42.52500 | 1294.80000 | 642.00000 |
| 30-Jan | | | | | | 1.917 | 9.217 | 0.750 | 6.334 | 4.583 | 0.267 | 0.933 | **24.00** | 24.000 | 92.51250 | 44.86875 | 1365.00000 | 679.50000 |
| 31-Jan | | | | | | 9.900 | 8.500 | 0.617 | 4.083 | | | 0.900 | **24.00** | 24.000 | 82.72500 | | 1246.80000 | |
| 1-Feb | | 3.350 | | | | 11.550 | 6.583 | 0.267 | 2.250 | | | | **20.65** | 24.000 | 54.99375 | | 841.50000 | |
| 2-Feb | | | | | | 17.067 | 4.783 | 0.317 | 1.833 | | | | **24.00** | 24.000 | 40.50000 | | 609.60000 | |
| 3-Feb | | | | | | 19.933 | 4.067 | | | | | | **24.00** | 24.000 | 35.19375 | | 563.10000 | |
| 4-Feb | | | | | | 2.250 | 13.900 | 1.083 | 6.767 | | | | **24.00** | 24.000 | 124.55625 | | 1839.30000 | |
| 5-Feb | | | | | | 2.400 | 14.767 | 0.767 | 6.067 | | | | **24.00** | 24.000 | 142.89375 | | 2171.10000 | |
| 6-Feb | | | | | | 1.100 | 14.517 | 1.050 | 7.333 | | | | **24.00** | 24.000 | 143.11875 | | 2136.30000 | |
| 7-Feb | | 1.867 | | | | 3.633 | 13.150 | 0.533 | 4.817 | | | | **22.13** | 24.000 | 122.64375 | | 1791.56250 | |
| 8-Feb | | | | | | 4.400 | 10.750 | 0.317 | 5.500 | 1.200 | | 1.833 | **24.00** | 24.000 | 90.13125 | 9.93750 | 1403.70000 | 159.00000 |
| 9-Feb | | 2.783 | | | | 7.600 | 3.683 | | 3.667 | 4.183 | 0.250 | 1.833 | **21.22** | 24.000 | 33.41250 | 40.53750 | 534.60000 | 610.20000 |
| 10-Feb | | | | | | 4.567 | 6.283 | 1.650 | 11.500 | | | | **24.00** | 24.000 | 68.73750 | | 869.40000 | |
| 11-Feb | | 11.833 | | | | 2.767 | 2.317 | 0.583 | 6.500 | | | | **12.17** | 24.000 | 24.91875 | | 321.90000 | |
| 12-Feb | | 0.183 | | | | 8.617 | 1.067 | 0.300 | 2.250 | 6.367 | 0.717 | 4.500 | **23.82** | 24.000 | 11.45625 | 54.93750 | 144.90000 | 802.20000 |
| 13-Feb | | 18.000 | | | 6.000 | | | | | | | | **6.00** | 24.000 | | | | |
| 14-Feb | | 11.033 | 5.700 | 4.500 | 2.767 | | | | | | | | **12.97** | 24.000 | 52.12500 | | 397.80000 | |
| 15-Feb | | | 10.283 | 9.000 | 4.717 | | | | | | | | **24.00** | 24.000 | 93.61875 | | 748.95000 | |
| 16-Feb | 9.000 | 6.100 | 4.800 | 2.250 | 1.850 | | | | | | | | **17.90** | 24.000 | 42.73125 | | 341.85000 | |
| 17-Feb | 12.650 | | | | | | | | | | | | **12.65** | 12.650 | | | | |
| Month | 21.650 | 65.900 | 20.783 | 15.750 | 15.333 | 127.233 | 305.117 | 19.766 | 148.317 | 21.433 | 1.567 | 12.249 | **709.20** | 775.10 | 3027.56275 | 192.80625 | 44055.26250 | 2892.90000 |
| Prev Month | | | | | | | | | | | | | | | | | | |
| **Job Total** | 21.650 | 65.900 | 20.783 | 15.750 | 15.333 | 127.233 | 305.117 | 19.766 | 148.317 | 21.433 | 1.567 | 12.249 | **709.20** | 775.10 | 3027.56275 | 192.80625 | 44055.26250 | 2892.90000 |

| | | | |
|---|---|---|---|
| Total linechange | 176.32 | Total Traverse | 3220.36900 |
| Total Production | 368.67 | | |
| Total Standby | 142.57 | | |
| Total | 687.55 | | |

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Ian Milne
Client Representative, Apache / Bass Strait Oil

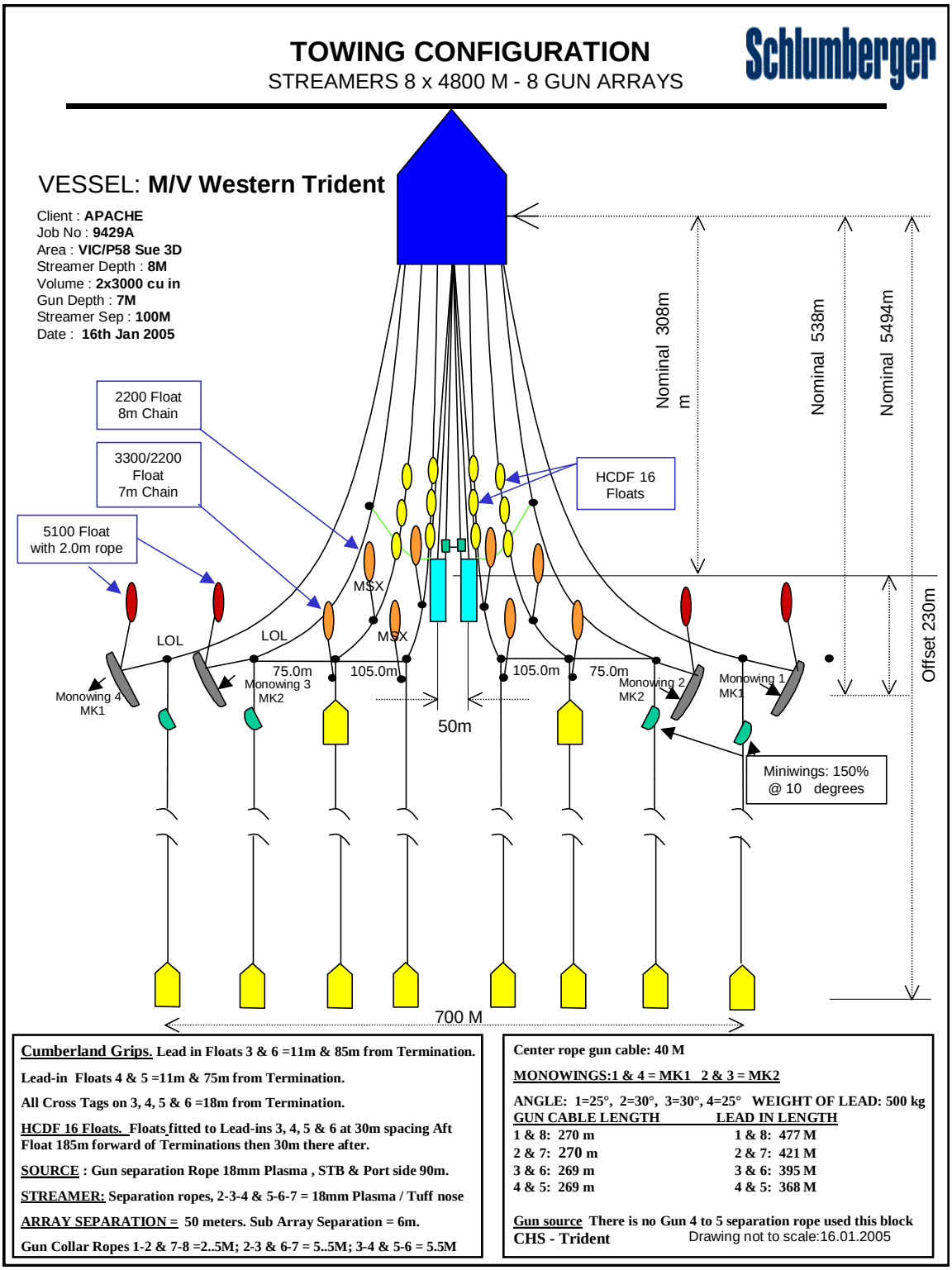
---
Mike Martin
Party Manager, Western Trident

Note: Differences in time logged on the 8th and 9th due to Apache request to split line changes after sequence 70 and 75 . A total 3.6hours day rate time in dispute

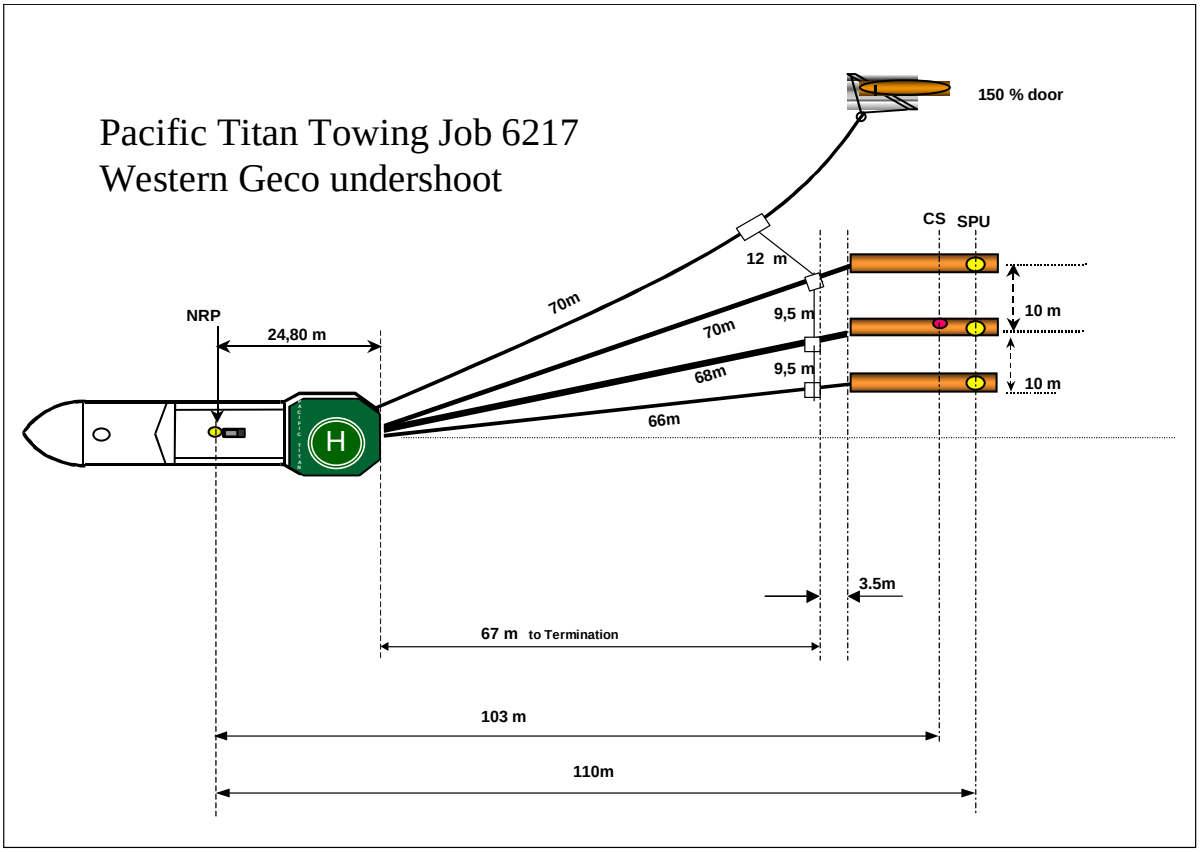
# Table of Contents

# 11. Towing Configuration

## 11.1. Towing System Layout



## 11.2. Towing Layout of Source Vessel during Undershoot



# 12. Streamer Configuration

## 12.1. Streamer System Description

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

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

| **Hydrophone Parameters** | |
|---|---|
| Detector type | TMS Bender Hydrophone |
| Group interval | 12.5m |
| Detectors per group | 14 |
| Group length | 17.75 m |
| No of groups per section | 8 |
| Hydrophones spacing | Centre Weighted |
| Maximum operating depth | 85 Metre |
| Group sensitivity | 13.8 V/bar |

## 12.2. Streamer Layout

### STREAMER 1

**CABLE 1**
**REEL 1**

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

## STREAMER 2

**CABLE 2**
**REEL 2**

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

## STREAMER 3

**CABLE 3 Reel 3**

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

STIC xxx 0598138970-4

## STREAMER 4

CABLE 4 Reel 5

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

## STREAMER 5

**Cable 5 Reel-8**

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

## STREAMER 6

**CABLE 6**
**Reel 10**

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

## STREAMER 7

**CABLE 7**
**REEL 11**

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

## STREAMER 8

**CABLE 8 Reel 12**

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

# 13. Source Configuration

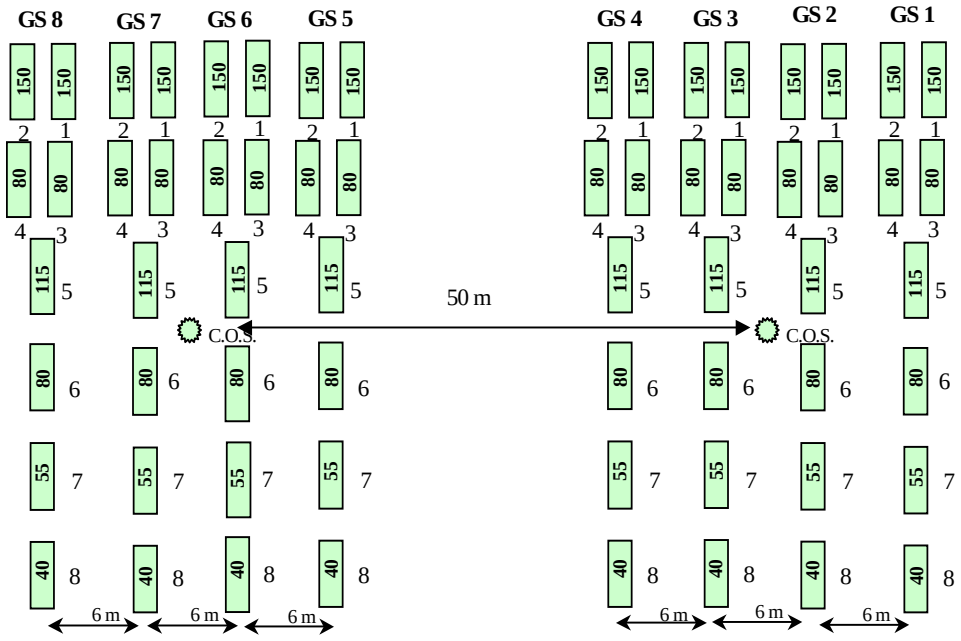
## 13.1. Source System Description

| **Source Parameters** | |
|---|---|
| Number of source arrays | 2 (Dual source) for Single boat<br>1 (single source) for Undershoot |
| Array separation | 50 m |
| Array length | 15.1 m |
| Array width | 18 m |
| Number of strings/array | 4 |
| Separation from centre track | 25 m |
| Source volume | 3000 cubic inches (Single boat)<br>3040 cu.in (Under shoot) |
| Number of hydrophones per array | 24 |
| Number of depth transducers per array | 12 |
| Number of guns per array | 32 |
| Number of clusters per array | 8 |
| Airgun type | WesternGeco Sleevegun (single boat)<br>Bolt for Source Vessel (Under shoot) |
| Operating pressure | 2000 psi |
| Depth of guns | 7 m |
| Peak to Peak amplitude | 118.3 Bar-m |
| Primary to Bubble ratio | 13.0 |

## 13.2. Source Layout

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

# MARINE SURVEY
# SOURCE LAYOUT




Dual 3000 cu.in. array

Type of guns : Sleeve Guns

| | | | | | |
|---|---|---|---|---|---|
| Vessel : **Western Trident** | **Set 1** | From date | To date | From seq. | To seq. |
| Client : APACHE | Valid | 16_Jan 05 | xxx 05 | 001 | xx |
| Area: VIC/P-58 SUE | All measurements quoted in metres<br>All separations are nominal values<br>Not drawn to scale | | Start of Job | | |
| Job no : 9429 | | | | | |

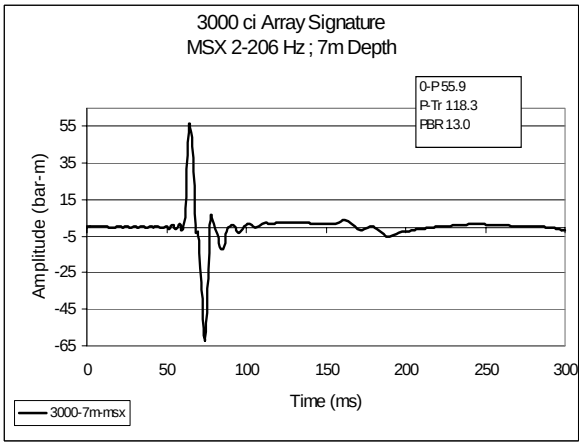
Party Chief _____ (Print) (Sign)

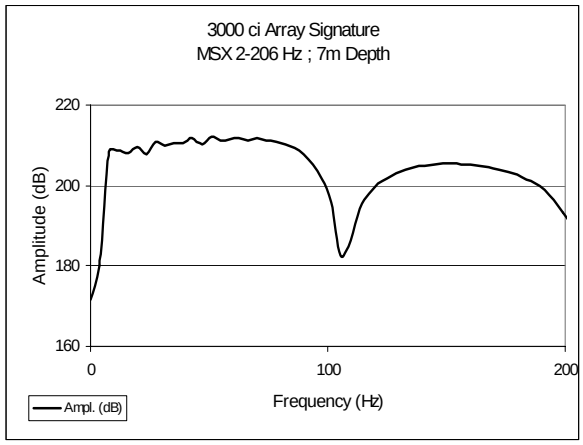
Client's Rep. _____ (Print) (Sign)

## 13.3. Pulse Response

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

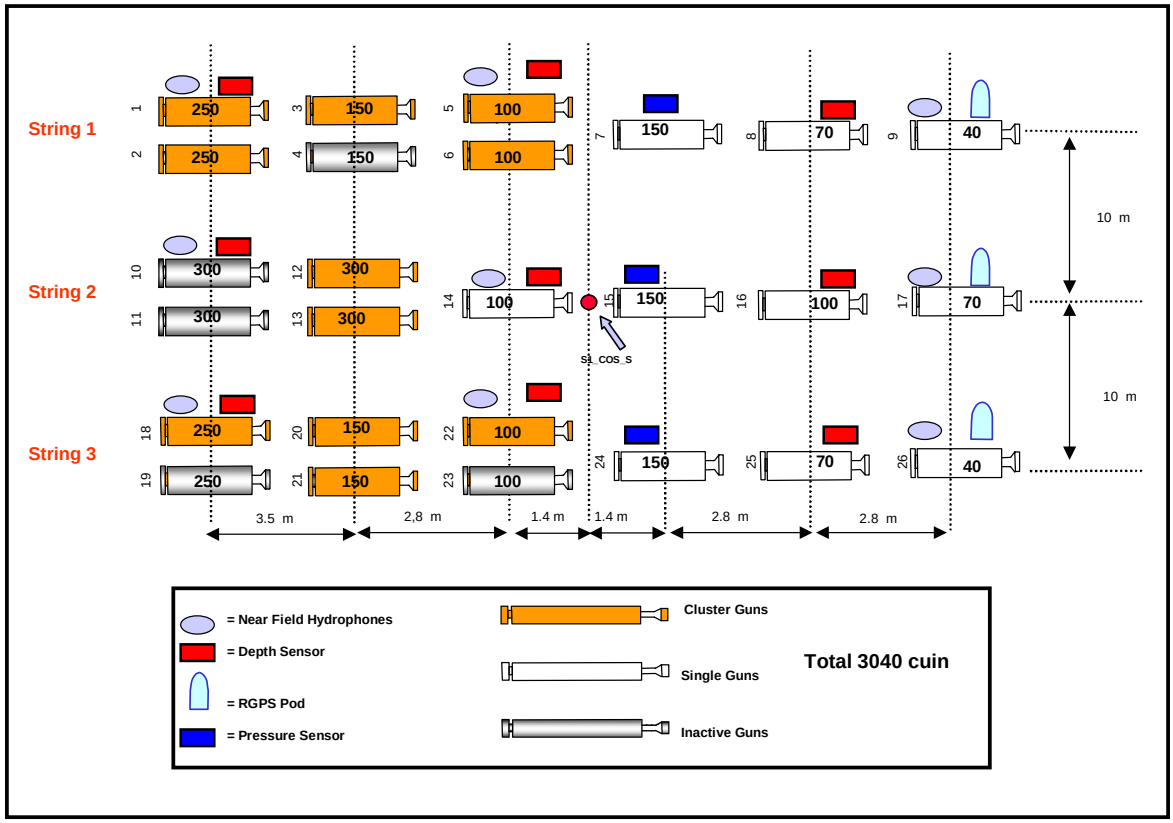
# MARINE SURVEY
# PULSE RESPONSE




| | | | | | | |
|---|---|---|---|---|---|---|
| Vessel : **Western Trident** | **Set 1** | From date | To date | From seq. | To seq. | Party Chief _____ Print Sign |
| Client : APACHE | Valid | 16_Jan 05 | xxx 05 | 001 | xx | |
| Area: VIC/P-58 SUE | All measurements quoted in metres<br>All separations are nominal values<br>Not drawn to scale | | Start of Job | | | Client's Rep. _____ Print Sign |
| Job no : 9429 | | | | | | |

# 13.4. Source Layout during Undershoot (Pacific Titan)



# 13.5. Gun Dropout specs on Source vessel (Pacific Titan)

## Gun Dropout Specs - 3040 cu.in. Source, 7 m gundepth.

**All two-guns dropouts are allowed, Except these:**

| | | | | | |
|---|---|---|---|---|---|
| 1-7 and 1-9 | 1-7 and 3-9 | 1-8 and 3-8 | 2-6 and 3-7 | 2-8 and 3-8 | |
| 1-7 and 2-6 | 1-8 and 2-7 | 1-9 and 2-6 | 2-7 and 2-8 | | |
| 1-7 and 2-8 | 1-8 and 2-8 | 2-6 and 2-8 | 2-7 and 3-8 | | |

If Gun 1-7 (150cuin) fails, switch off Gun 1-8 (70cuin) - back in spec

If Gun 2-6 (150cuin) fails, switch off Gun 2-7 (100cuin) - back in spec

If Gun 2-7 (100cuin) fails, switch off Gun 2-6 (150cuin) - back in spec

**Cluster guns:**

| | |
|---|---|
| Cluster 2-2: | If Gun 2-4 or 2-3 (300 cuin) fails, turn of the whole cluster and replace it with Cluster 2-1, Gun 2-2 and 2-1 (300 cuin) |
| Cluster 3-1: | If Gun 3-1 (250 cuin) Fails, switch on Gun 3-2 (250 cuin) |
| Cluster 1-2: | If 1-3 (150cuin) fails switch on 1-4 (150cuin) |
| Cluster 3-3: | If 3-5 (100cuin) fails switch on 3-6 (100cuin) |
| | If 3-6 (100cuin spare) is enabled and fails, disable 2-6(150cuin) - back in spec |
| Cluster 3-2: | If Gun 3-3 (150cuin) fails also switch off 1-1 (250cuin) and 1-5 (100cuin), switch on 1-4 (150cuin), 3-2 (250cuin) and 3-6 (100cuin) |
| | If Gun 3-4 (150cuin) fails also switch off 1-1 (250cuin) and 1-5 (100cuin), switch on 1-4 (150cuin), 3-2 (250cuin) and 3-6 (100cuin) |
| Cluster 1-1: | If Gun 1-1 (250cuin) fails also switch off 1-5 (100cuin) and 3-3 (150cuin), switch on 1-4 (150cuin), 3-2 (250cuin) and 3-6 (100cuin) |
| | If Gun 1-2 (250cuin) fails also switch off 1-5 (100cuin) and 3-3 (150cuin), switch on 1-4 (150cuin), 3-2 (250cuin) and 3-6 (100cuin) |
| Cluster 1-3: | If Gun 1-5 (100cuin) fails also switch off 1-1 (250cuin) and 3-3 (150cuin), switch on 1-4 (150cuin), 3-2 (250cuin) and 3-6 (100cuin) |
| | If Gun 1-6 (100cuin) fails also switch off 1-1 (250cuin) and 3-3 (150cuin), switch on 1-4 (150cuin), 3-2 (250cuin) and 3-6 (100cuin) |

If spare fails - array is still good

**Array 1**

| Spare | | | | Spare | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Gun 1-1 | Gun 1-2 | Gun 1-3 | Gun 1-4 | Gun 1-5 | Gun 1-6 | 1-7 | 1-8 | 1-9 | |
| 250 cuin | | 150 cuin | | 100 cuin | | 150 cuin | 70 cuin | 40 cuin | |

**Array 2**

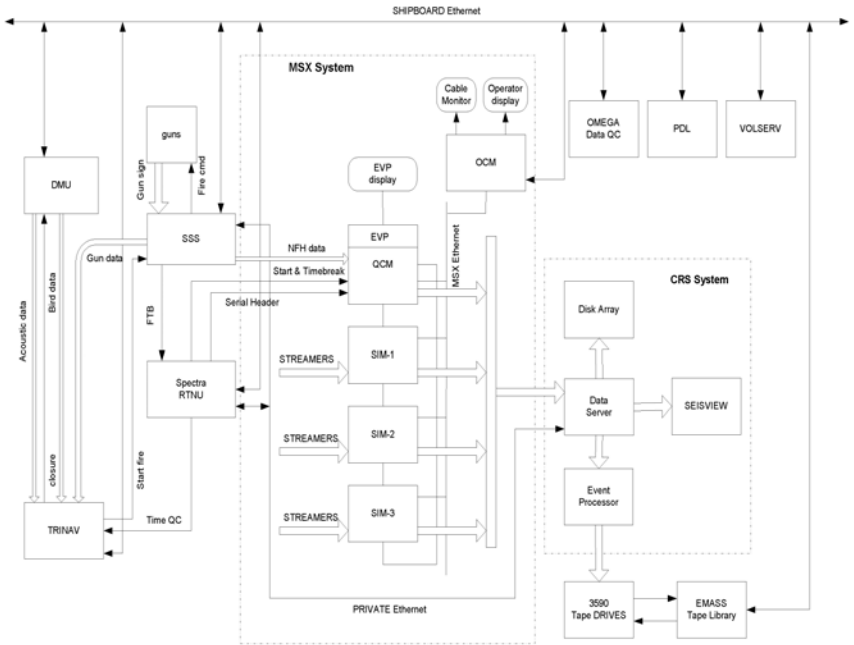
| Spare | Spare | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gun 2-1 | Gun 2-2 | Gun 2-3 | Gun 2-4 | 2-5 | 2-6 | 2-7 | 2-8 | |
| 300 cuin | | 300 cuin | | 100 cuin | 150 cuin | 100 cuin | 70 cuin | |

**Array 3**

| | | Spare | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gun 3-1 | Gun 3-2 | Gun 3-3 | Gun 3-4 | Gun 3-5 | Gun 3-6 | 3-7 | 3-8 | 3-9 |
| 250 cuin | | 150 cuin | | 100 cuin | | 150 cuin | 70 cuin | 40 cuin |

# 14. Instrumentation Room System Diagram

| Western Geco Sdn Bhd<br>11th Floor, Rohas Perkasa,<br>8, Jalan Perak,<br>50450 Kuala Lumpur<br>Malaysia | **MARINE SURVEY**<br>**INS. ROOM SYSTEM DIAGRAM** | WesternGeco |
|---|---|---|

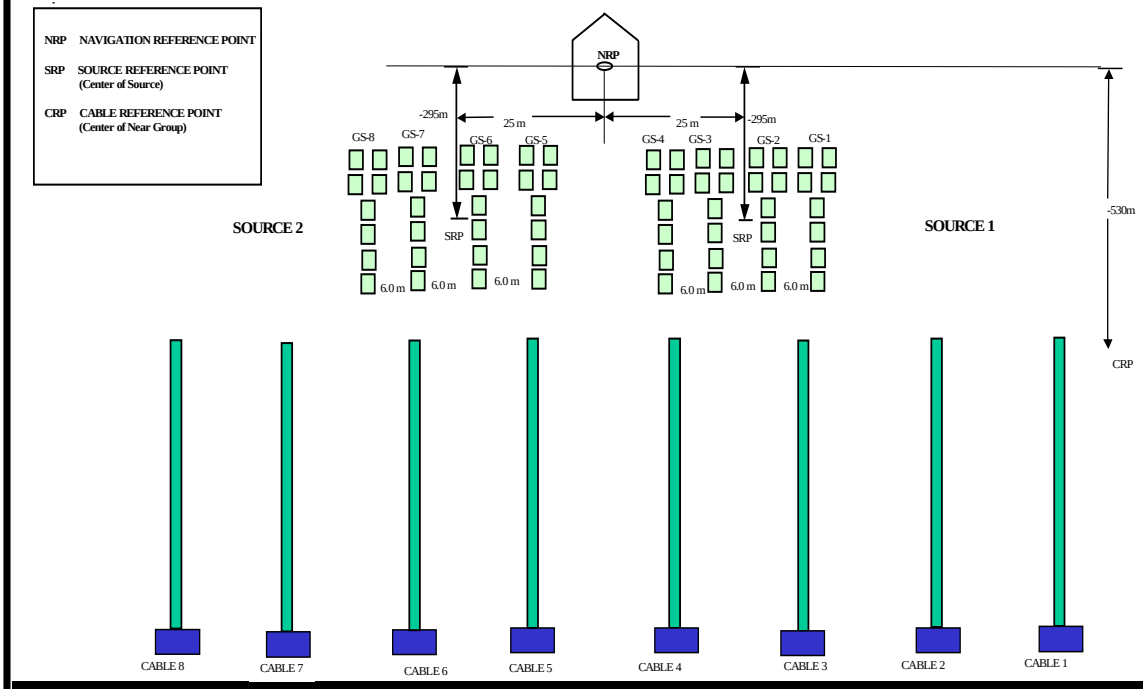



| | | | | | | |
|---|---|---|---|---|---|---|
| Vessel : **Western Trident** | **Set 1** | From date | To date | From seq. | To seq. | Party Chief _____ Print Sign |
| Client : APACHE | Valid | 16_Jan 05 | xxx 05 | 001 | xx | |
| Area: VIC/P-58 SUE | All measurements quoted in metres<br>All separations are nominal values<br>Not drawn to scale | | Start of Job | | | Client's Rep. _____ Print Sign |
| Job no : 9429 | | | | | | |

# 15. Equipment Offset Diagrams

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

## MARINE SURVEY
## TOWING CONFIGURATION




| | | | | | |
|---|---|---|---|---|---|
| Vessel : **Western Trident** | **Set 1** | From date | To date | From seq. | To seq. |
| Client : APACHE | Valid | 16_Jan 05 | xxx 05 | 001 | xx |
| Area: VIC/P-58 SUE | All measurements quoted in metres<br>All separations are nominal values<br>Not drawn to scale | | Start of Job | | |
| Job no : 9429 | | | | | |

Party Chief _____ (Print) (Sign)

Client's Rep. _____ (Print) (Sign)

# Table of Contents

# 16. Navigation and Positioning System Description

## 16.1. System Configuration

### 16.1.1. Navigation Hardware and Software

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

### 16.1.2. System Timing

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

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

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

### 16.1.3. Undershoot Timing

TRINAV issued a closure to the TrueTime master box at 1500ms before shot time. This signal was time stamped and transferred to the TrueTime slave box on the Pacific Titan. The slave TrueTime box was configured to issue a TTL signal out to the gun control system, GunLink, at a specified delay after the time stamp. The GunLink controller then utililised its own internal GPS clock to count down until the shot time at which point the guns would fire and a time break pulse was issued to the slave TrueTime box. This (remote) FTB was time stamped and a message returned to the master TrueTime box with the time of the remote FTB. Both TrueTime boxes were synchronised to GPS time via an onboard GPS clock.

TRINAV used another closure relay to send a signal at shot time to the MSX recording system. This signal was also sent, in parallel, to the master TrueTime box to act as the (local) FTB and was time stamped upon its arrival. The three times (initial closure, local FTB and remote FTB) were output as an ASCII string on each shot and recorded in a file along with any timing difference between the two FTB signals.

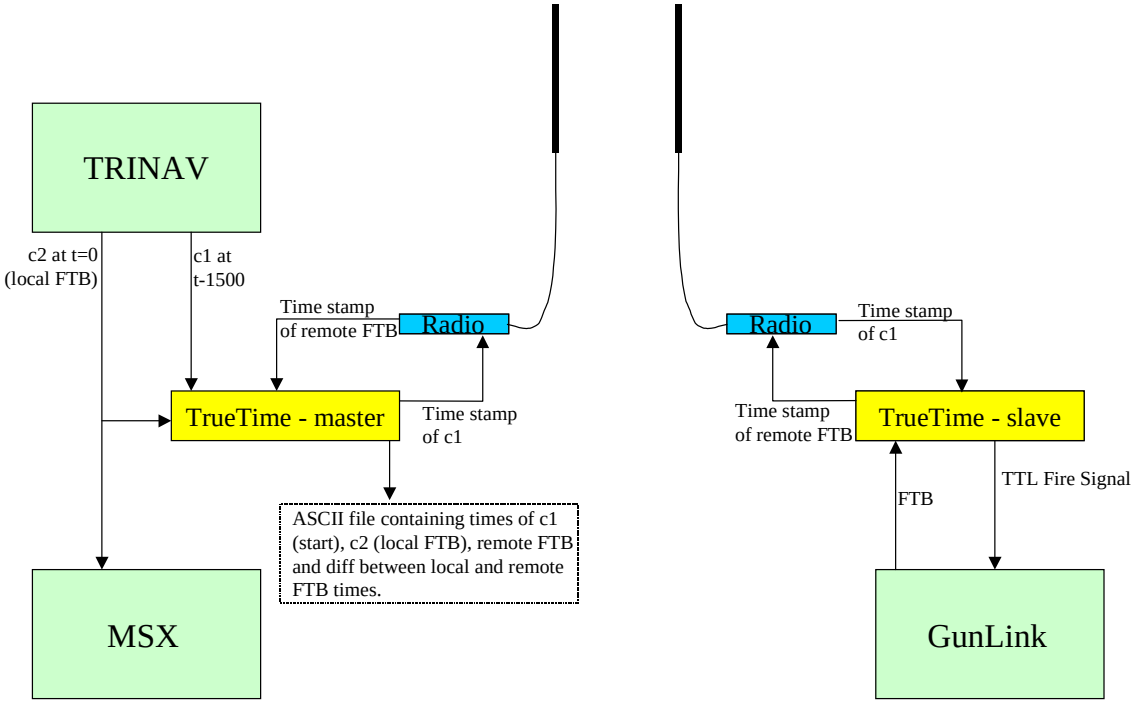



**Diagram of timing signals for the undershoot**

## 16.2. Survey Positioning Method Used

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

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

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

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

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

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

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

## 16.3. Surface Positioning

### 16.3.1. Vessel Navigation

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

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

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

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

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

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

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

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

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

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

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

TRINAV GPS is a multiple reference station DGPS system with the capability to be used in dual frequency mode when required, and tailored for the specific needs of seismic surveying. State-of-the-art algorithms combine reference station data and pseudo range measurements into the best position estimates.

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

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

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

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

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

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

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

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

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

### 16.3.2. Float Navigation

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

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

## 16.4. Streamer and Source Positioning

### 16.4.1. Acoustics

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

### 16.4.2. Streamer Compasses

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

Compass Sampling Rate = 1 second
Averaging constant = 7 seconds

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

### 16.4.3. Gyro Compass

The gyrocompasses used during the survey were:

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

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

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

### 16.4.4. Velocity of Sound in Water

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

- **Type: Valeport 604 CTD**

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

Velocity measurements were taken during the survey on a weekly basis when the weather permitted.

### 16.4.5. Echo Sounder

The echo sounder speed of sound was set to 1500 m/s. A draught correction of zero was entered in the echo sounder. The speed of sound for the total water column was derived from Temperature Salinity profile measurements taken throughout the survey. The computed speed of sound and draught value were used to produce water depth corrected P190s.

## 16.5. Auxiliary Navigation Sensors

### 16.5.1. Current Meter

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

# 17. Navigation Systems Verification and Monitoring

## 17.1. Echo Sounder Verification

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

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

## 17.2. Gyro Monitoring

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

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

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

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

## 17.3. GPS Monitoring

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

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

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

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

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

## 17.4. Current Meter Monitoring

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

# 18. Navigation Processing

## 18.1. The TRINAV System

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

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

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

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

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

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

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

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

### 18.1.1. Shot Editor

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

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

### 18.1.2. Gun Editor

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

- The Gun Editor was used on shot-points interpolated by the Shot Editor to generate the missing gun mask. The gun mask is normally relayed to TRINAV via the External Header.
- The Gun Editor was used to change the status of the sources to non-firing for any NTBP sections of the lines.

### 18.1.3. Recompute

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

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

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

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

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

### 18.1.4. Smoother

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

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

- **Kalman filter**

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

- **Forward-Backward (FB) Kalman Filter**

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

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

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

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

### 18.1.5. Filtering

- **Compass Processing**

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

- **Gyro Filtering**

No gyro filtering was carried out.

- **Acoustic Filtering**

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

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

### 18.1.6. Reprocessing

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

The processes are:

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

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

## 18.2. Quality Control

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

### 18.2.1. First Line Test Data

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

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

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

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

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

### 18.2.2. Initial QC

The post-processing procedures included the following checks:

- QC checks on all survey parameters.
- Generation of correct survey definitions.
- Completion of shot point edits.
- P2/94 production.
- Completion of gun edits.
- QC of system positions and recomputed positions if required.
- Smoothing of the vessel and buoy positions if required.

- Selective check and filtering if required, of the observations including:
  - Acoustic ranges.
  - Compass bearings.
  - Gyro heading.
- Least squares adjustment of front and tail network if required.
- Smoothing of source/streamer tracking nodes if required.
- Cable shaping to determine final source/receiver positions if required.
- Final QC of all lines
- P1/90 production.

The following documentation was produced for onboard QC:

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

### 18.2.3. Final QC

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

## 18.3. Water Depth Processing

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

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

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

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

# 19. Observations

## 19.1. Navigation Summary

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

### 19.1.1. TRINAV RT/QCPR & Spectra

No major problems were seen in either system except for one line where the TRINAV VME system software crashed whilst online. This resulted in a reshoot.

### 19.1.2. DGPS

The various DGPS systems all agreed with one another throughout the job. The Multifix XP system developed an electrical problem on its antenna and so stopped working correctly and gave large errors in position. As this was only one of several inputs to the vessel estimator, no loss of positioning accuracy was caused, and, once the antenna had been replaced, the XP system worked well again.

### 19.1.3. Integrity Monitor

This system performed as specified through the survey. However, there were some gaps in the data received because of problems with the vessel's VSAT system. These problems originated with the VSAT provider and were associated with the shore based equipment. There is no reason to believe that there was any error in the positioning of the vessel during the periods when the Integrity Monitor was not available.

### 19.1.4. rGPS (Sources, Head and Tail Buoys)

All source and tail buoy floats were operational throughout most of the survey. Marginal weather conditions affected the data quality at times; the gun string rGPS units as waves can swamp the antennas mounted 0.8m above the water line and the tailbuoy GPS shows evidence of the tailbuoy being thrown around by the sea.

There were several instances of the tailbuoy GPS units being non-operational for periods of time. These were usually caused by power problems on the tailbuoy and the units were fixed as weather permitted. The redundancy employed in the tail end network ensured that sufficient positioning accuracy was achieved at all times.

### 19.1.5. Acoustics

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

The shallow water created additional problems as reflections were seen in the data acquired. Attempts to gate these reflections out sometimes resulted in data being lost outside the window as the streamers moved relative to one another. At all times, sufficient data was acquired such that the redundancy allowed a high degree of confidence in the final solution.

Several lines were affected by an intermittent coil line leakage problem on streamer 7. The loss of data for a shot or two at a time was such that it was a simple matter to filter through the missed data using a short median/mean filter. Once the leakage on the coil line became bad enough to

affect the data from the acoustic units it was easy to trace and so was repaired. The repair was carried out before the cable positioning was adversely affected.

### 19.1.6. Compasses

Generally, this was very good data when the weather was clam. The compasses did suffer from the same coil line leakage as the acoustics, but to a lesser degree since they send a much shorter and simpler message. There were several lines that were shot into marginal weather conditions and these caused some problems in processing as the data spiked greater than 10° for large portions of the line. The filters applied smoothed the data to a degree acceptable to the client.

### 19.1.7. Undershoot

The two boat undershoot went well once the timing issues had been resolved.

A failure of the third TrueTime box meant that it was not possible to start the recording system referenced to this same closure as the initial start signal (t-1500ms). As a result, the TRINAV used another closure relay to send a signal at shot time (t=0) to the MSX recording system. The nature of relays is such that there was a different, and random, small delay on each relay between the time that the relay was signalled and the time that the relay actually closed. This resulted in a variable difference in the two FTB signals of +/-20ms. This difference between the two FTB signals was applied to the recorded seismic data in data processing and resolved this difference.

## 19.2. Processing and QC Summary

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

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

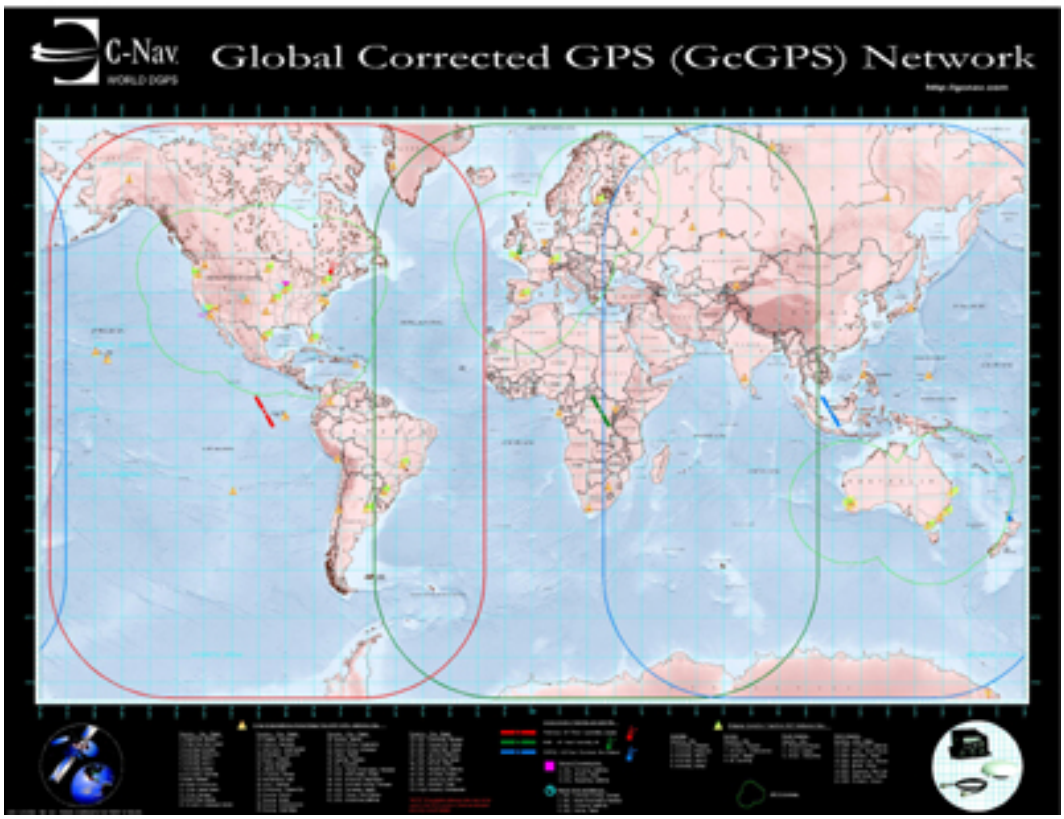
## 19.3. Conclusions

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

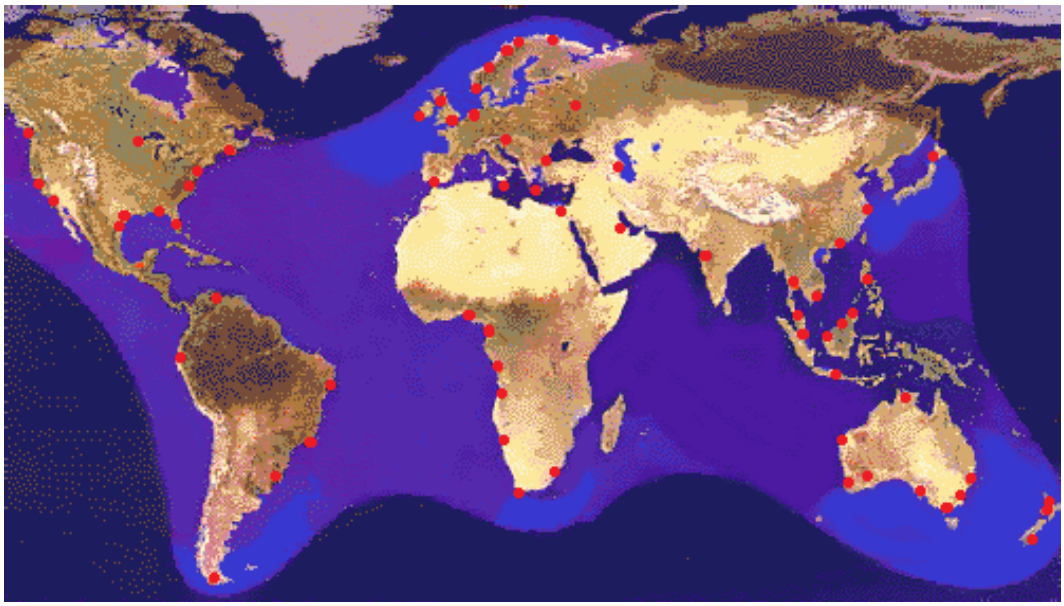
# 20. Navigation Exhibits

## Exhibit 1 **: Navigation System**

- **DGPS Coverage Maps for RTCM Sources**




- **OmniStar Reference Stations**



## ❑ GPS System Installation Notes

### WesternGeco GPS Receivers

**TRINAV GPS**

Novatel Millennium Receiver

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

**PosNet-1 Trimble**

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

**PosNet-2 Trimble**

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

**rtCalib**

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

### Third Party GPS

**Multifix Main**

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

**Skyfix Main**

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

**CNAV Main**

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

## TrueTime Receivers

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

**ITR**

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

**Timing QC**

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

## ❑ TRINAV GPS Integrity Monitor Station Description

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

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

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

**Exhibit 2** : Echo Sounder Calibration

# Echo Sounder Check (In Port)

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

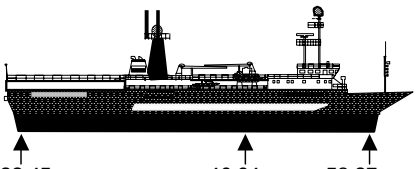
| Observed | | | | |
|---|---|---|---|---|
| Draught (m) | | | Lead Line Depth (m) | |
| Bow | Mid-ships | Stern | Stbd (1) | Port (2) |
| | | | | |
| 6.90 | | 7.60 | 10.65 | 13.50 |
| | | | | |
| Draught at E/S | | **6.99** | LL Depth at E/S | **12.08** |

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

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

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

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

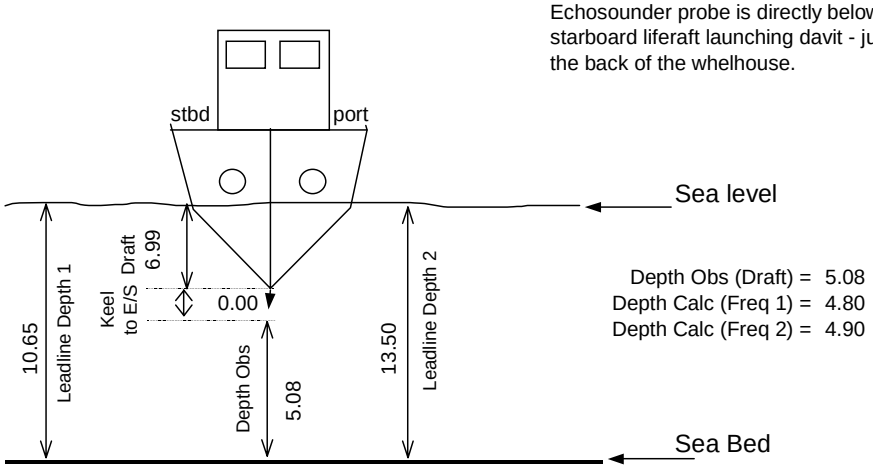


-33.45 Stern draft Marks

46.04 E/S Probe

58.37 Fwd Draft Marks

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




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

## Exhibit 3 **: GPS and Gyro Calibration**

- **Offshore Calibration Report**

# OFFSHORE CALIBRATION REPORT

## Table of Contents



## I. Introduction and Abstract of Results

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

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

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

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

# Abstract of Results

| Value | | C-O | SD |
|---|---|---|---|
| Gyro 1 (mean) | | -1.47° | 0.55° |
| Gyro 2 (mean) | | -0.20° | 0.55° |
| GPS Integrity Monitor Results | Delta Easting | 0.36m | 0.48m |
| | Delta Northing | 1.00m | 0.69m |

Navigation System Average Radial Differences

| | Diff | SD |
|---|---|---|
| TriGPS | 0.53m | 0.10m |
| C-Nav | 0.38m | 0.16m |
| Posnet 1 | 0.46m | 0.19m |
| Posnet 2 | 0.66m | 0.16m |
| Multifix | 0.42m | 0.32m |

## II. Differential GPS Verification

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

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

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

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

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

## Method used

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

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

## Results

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

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

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

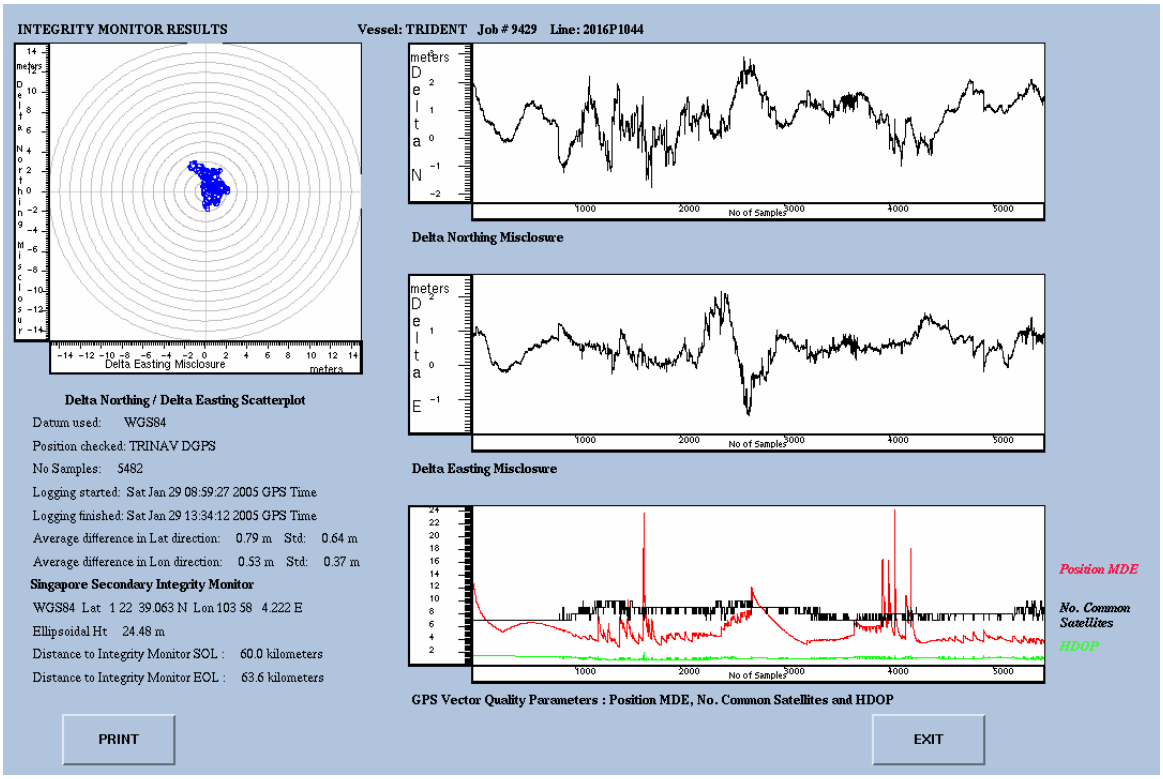



**Figure 1: Integrity Monitor Plot to demonstrate GPS quality**

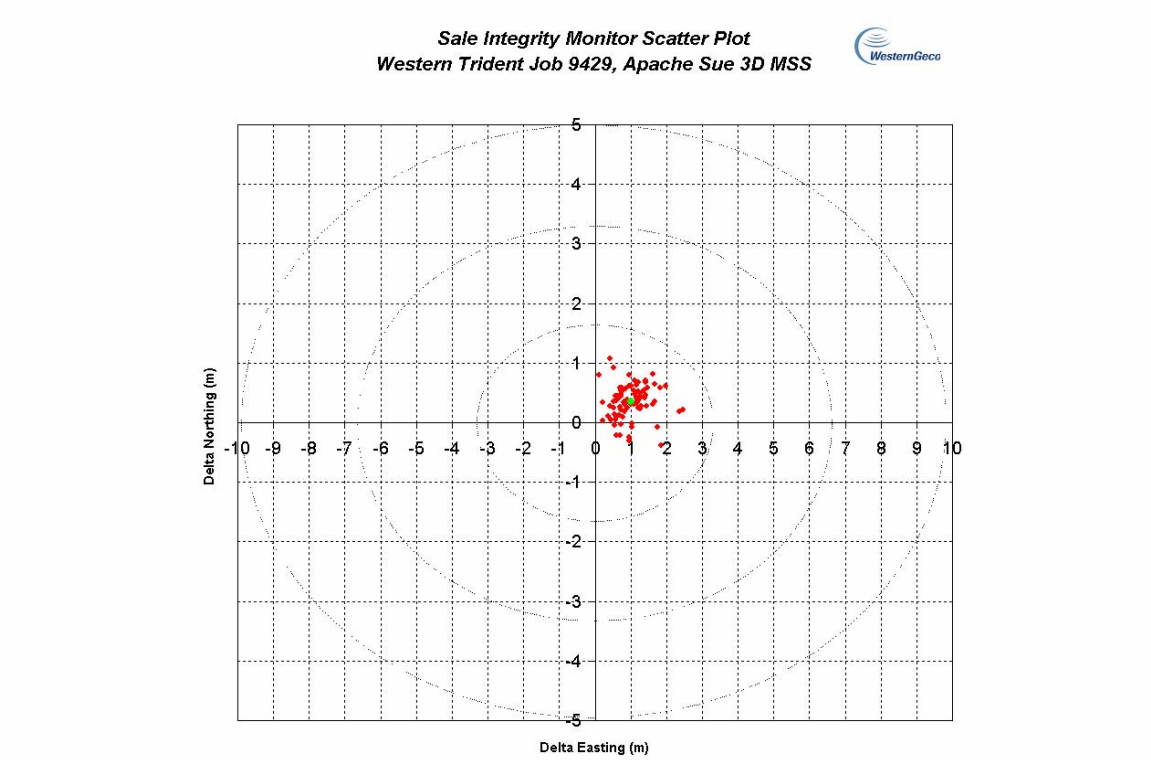



**Figure 2: Integrity Monitor Delta Easting - Delta Northing Scatter Plot**

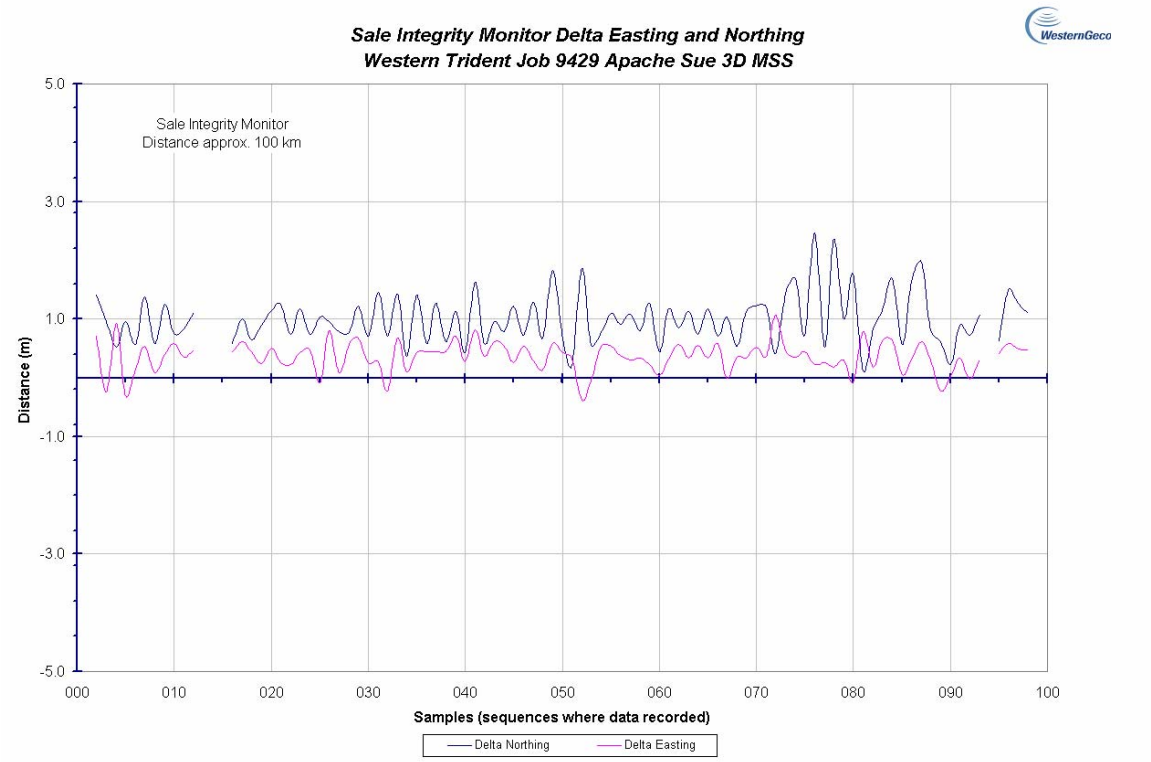



**Figure 3: Integrity Monitor Delta Easting – Delta Northing Trend**

# III. rGPS Verification

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

## Method used

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

## Results

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

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

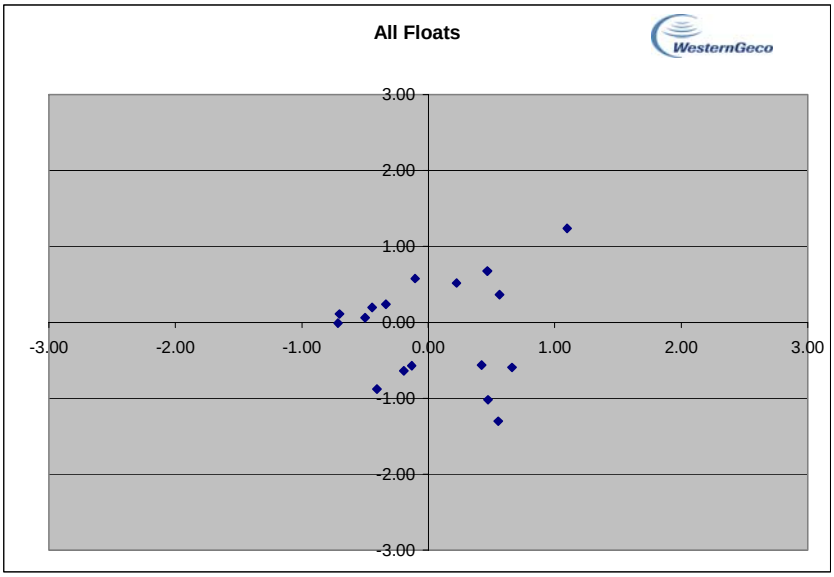



**Table 1: rGPS verification test data from re-radiation tests**

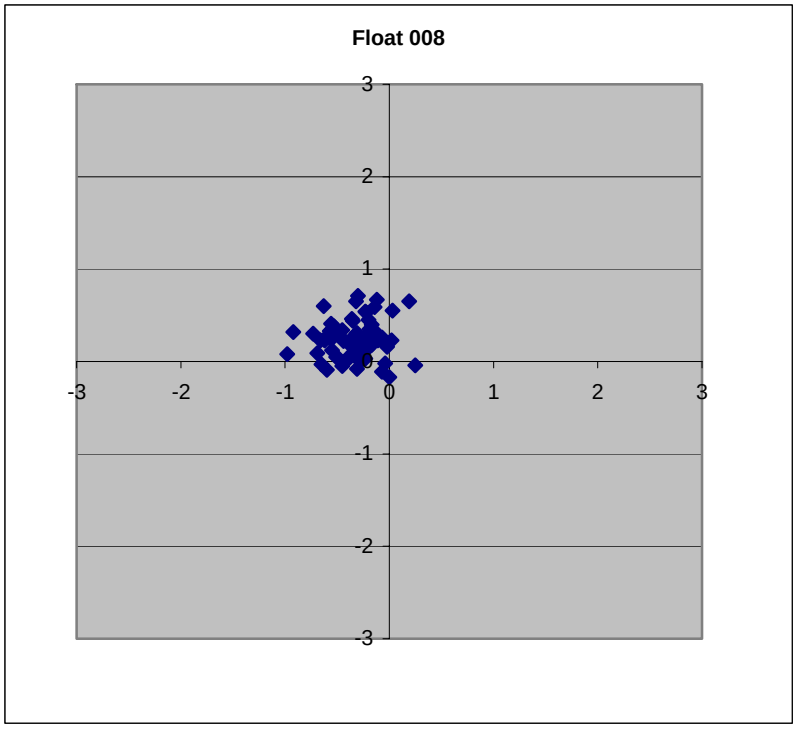



**Figure 4: A typical data sample for a unit**

## IV. Gyro Calibration

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

### Method used

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

### Results

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

Numerical results for RT Calib are shown in chapter VII.

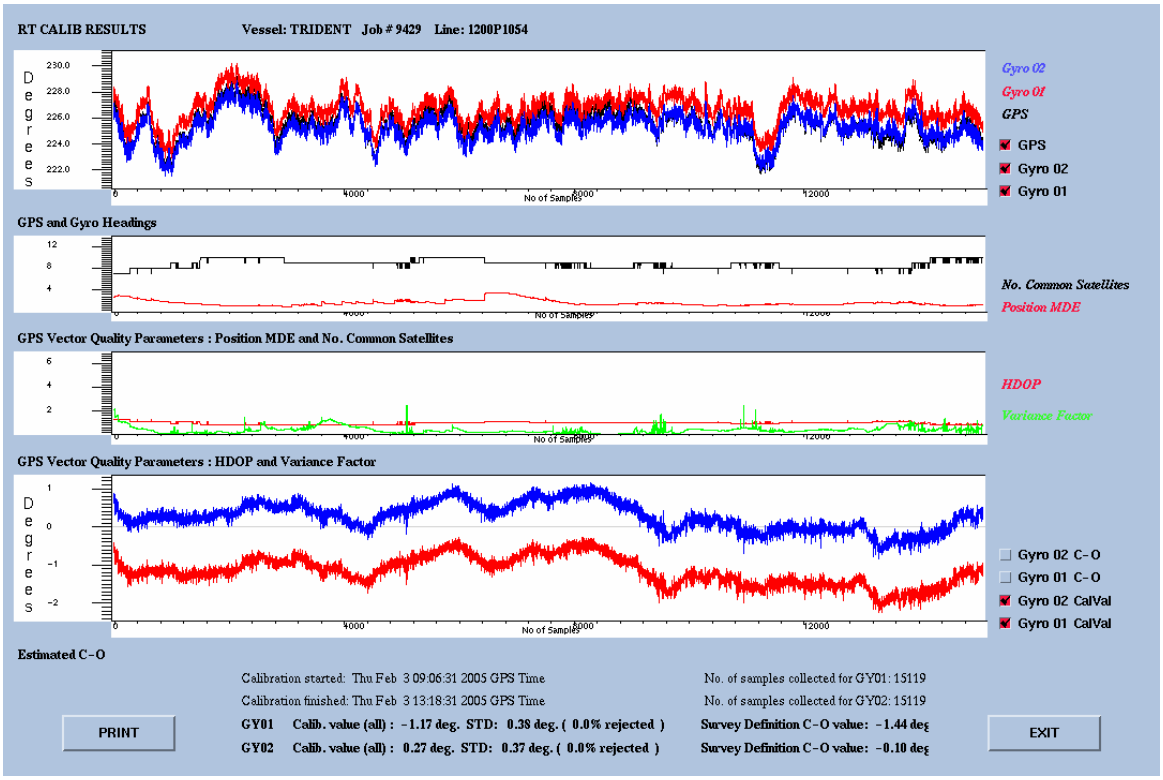



**Figure 5: Example of rtcalib plot for a singe sequence**

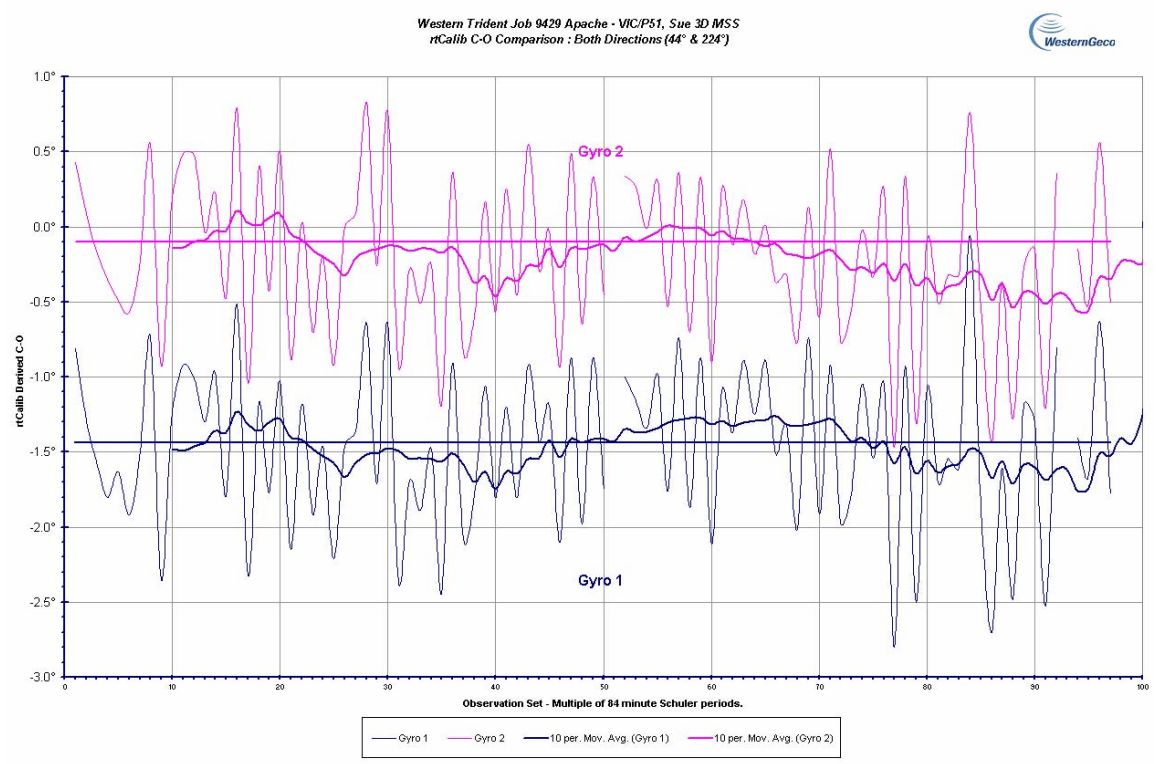



**Figure 6: Gyro Calib Trends**

## V. Conclusions and Comments on Data Quality

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

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

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

## VI. Secondary & Tertiary DGPS System Differences to TRINAV GPS

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

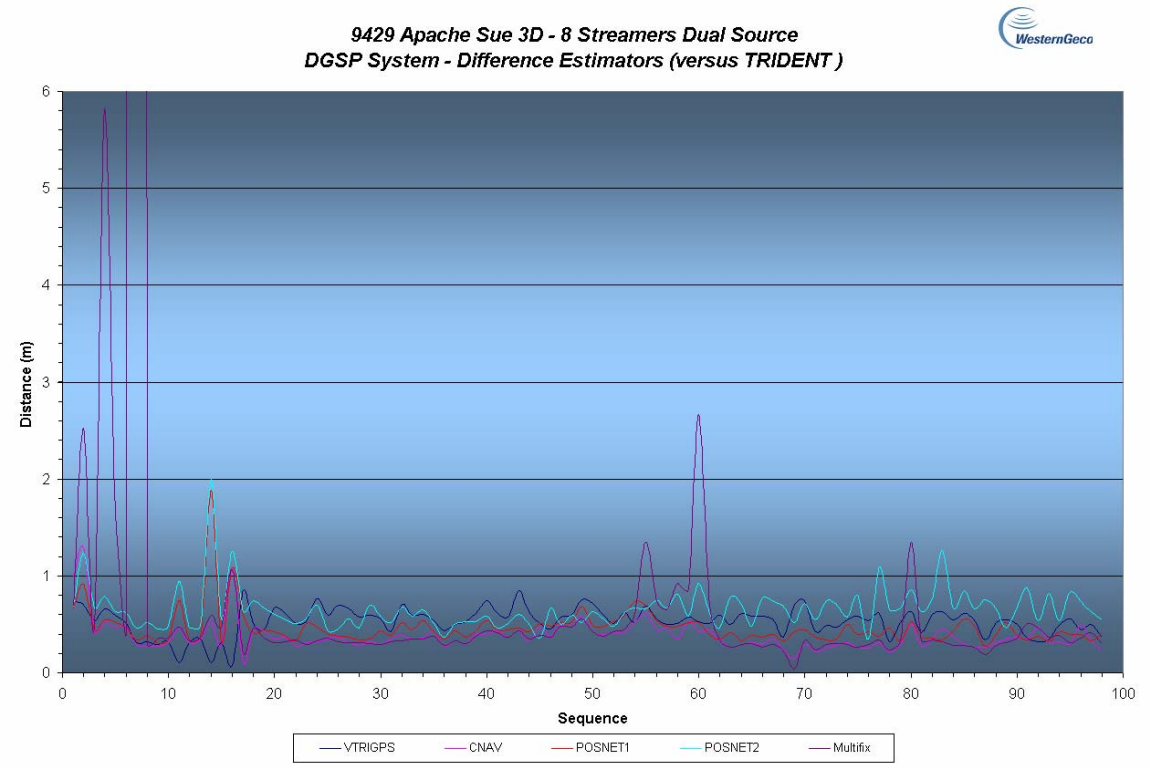



**Figure 7: Differences between GPS systems during the survey**

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

Available Gyros: GY01 Surveydef Corr: -1.44 deg

GY02 Surveydef Corr: -0.10 deg

**Gyro Calibration Results:**

**Western Trident Job 9429 Apache Sue 3D MSS**
**rtCalib C-O Comparison : Both Directions (44° & 224°)**

| Line Name | | C-O [deg] | Std [deg] | No. samp. | | C-O [deg] | Std [deg] | No. samp |
|---|---|---|---|---|---|---|---|---|
| 1536P1001 | GY01 | -0.81 | 1.45 | 4441 | GY02 | 0.43 | 1.44 | 4441 |
| 1808P1002 | GY01 | -1.29 | 0.57 | 3979 | GY02 | 0.09 | 0.7 | 4194 |
| 1824P1003 | GY01 | -1.56 | 0.51 | 5039 | GY02 | -0.16 | 0.51 | 5039 |
| 1552P1004 | GY01 | -1.8 | 0.59 | 5035 | GY02 | -0.35 | 0.6 | 5035 |
| 1840P1005 | GY01 | -1.63 | 0.36 | 4178 | GY02 | -0.49 | 0.49 | 4590 |
| 1568P1006 | GY01 | -1.92 | 0.28 | 5038 | GY02 | -0.57 | 0.26 | 5038 |
| 1856P1007 | GY01 | -1.49 | 0.13 | 5034 | GY02 | -0.21 | 0.12 | 5034 |
| 1584P1008 | GY01 | -0.73 | 0.57 | 5038 | GY02 | 0.55 | 0.61 | 5037 |
| 1872P1009 | GY01 | -2.35 | 0.27 | 5038 | GY02 | -0.93 | 0.28 | 5038 |
| 1600P1010 | GY01 | -1.24 | 0.55 | 4962 | GY02 | 0.19 | 0.58 | 4978 |
| 1888P1011 | GY01 | -0.92 | 0.49 | 5039 | GY02 | 0.49 | 0.49 | 5039 |
| 1616P1012 | GY01 | -1.01 | 0.23 | 5039 | GY02 | 0.48 | 0.23 | 5039 |
| 1904P1013 | GY01 | -1.3 | 0.27 | 5033 | GY02 | -0.04 | 0.27 | 5033 |
| 1632P1014 | GY01 | -0.97 | 0.4 | 5037 | GY02 | 0.23 | 0.39 | 5037 |
| 1920P1015 | GY01 | -1.79 | 0.33 | 5036 | GY02 | -0.47 | 0.34 | 5036 |
| 1648P1016 | GY01 | -0.52 | 0.46 | 5039 | GY02 | 0.79 | 0.46 | 5039 |
| 1936P1017 | GY01 | -2.32 | 0.4 | 5038 | GY02 | -1.04 | 0.43 | 5038 |
| 1664P1018 | GY01 | -1.17 | 0.58 | 5031 | GY02 | 0.4 | 0.59 | 5032 |
| 1680P1019 | GY01 | -1.77 | 0.98 | 5037 | GY02 | -0.43 | 1 | 5037 |
| 1952P1020 | GY01 | -1.03 | 0.42 | 5038 | GY02 | 0.5 | 0.45 | 5038 |
| 1696P1021 | GY01 | -2.15 | 0.69 | 4781 | GY02 | -0.88 | 0.71 | 5039 |
| 1968P1022 | GY01 | -1.18 | 0.3 | 5036 | GY02 | 0.03 | 0.31 | 5036 |
| 1712P1023 | GY01 | -1.92 | 0.25 | 5038 | GY02 | -0.7 | 0.24 | 5038 |
| 2080P1024 | GY01 | -1.46 | 0.46 | 5038 | GY02 | -0.19 | 0.45 | 5038 |
| 1792P1025 | GY01 | -2.21 | 0.7 | 5020 | GY02 | -0.92 | 0.72 | 5040 |
| 1984P1026 | GY01 | -1.46 | 0.3 | 5038 | GY02 | 0 | 0.31 | 5038 |
| 1776P1027 | GY01 | -1.36 | 0.53 | 5033 | GY02 | 0.09 | 0.54 | 5033 |
| 2000P1028 | GY01 | -0.64 | 0.56 | 5039 | GY02 | 0.83 | 0.56 | 5039 |
| 1520P1029 | GY01 | -1.71 | 0.54 | 5038 | GY02 | -0.26 | 0.54 | 5038 |
| 1280P1030 | GY01 | -0.64 | 0.33 | 5041 | GY02 | 0.77 | 0.32 | 5041 |
| 1504P1031 | GY01 | -2.37 | 0.42 | 5039 | GY02 | -0.93 | 0.41 | 5041 |
| 1264P1032 | GY01 | -1.69 | 0.24 | 5041 | GY02 | -0.28 | 0.24 | 5041 |
| 1488P1033 | GY01 | -1.89 | 0.42 | 5032 | GY02 | -0.51 | 0.43 | 5032 |
| 1248P1034 | GY01 | -1.48 | 1.2 | 5036 | GY02 | -0.26 | 1.18 | 5036 |
| 1472P1035 | GY01 | -2.44 | 0.35 | 5038 | GY02 | -1.19 | 0.3 | 5039 |
| 1232P1036 | GY01 | -0.91 | 0.43 | 5041 | GY02 | 0.36 | 0.41 | 5041 |
| 1456P1037 | GY01 | -2.08 | 0.68 | 5038 | GY02 | -0.84 | 0.61 | 5038 |
| 1456P1037 | GY01 | -1.78 | 0.39 | 5117 | GY02 | -0.59 | 0.41 | 5117 |
| 1296P1038 | GY01 | -1.06 | 0.51 | 4939 | GY02 | 0.17 | 0.49 | 4939 |
| 1440P1039 | GY01 | -1.8 | 0.48 | 5056 | GY02 | -0.57 | 0.49 | 5056 |
| 1216P1040 | GY01 | -1.2 | 0.62 | 3757 | GY02 | 0.25 | 0.7 | 4995 |
| 1728P1041 | GY01 | -1.8 | 0.48 | 5091 | GY02 | -0.45 | 0.48 | 5116 |
| 2000J1042 | GY01 | -0.92 | 0.5 | 5115 | GY02 | 0.55 | 0.49 | 5115 |
| 1760P1045 | GY01 | -1.43 | 0.38 | 5114 | GY02 | -0.29 | 0.38 | 5114 |
| 2032P1046 | GY01 | -1.19 | 0.27 | 5118 | GY02 | -0.03 | 0.27 | 5118 |
| 1760J1047 | GY01 | -2.1 | 0.48 | 4890 | GY02 | -0.93 | 0.51 | 5112 |
| 2048P1048 | GY01 | -0.87 | 0.44 | 5117 | GY02 | 0.49 | 0.43 | 5117 |
| 1424P1049 | GY01 | -1.98 | 0.8 | 4982 | GY02 | -0.65 | 0.79 | 5107 |
| 2064P1050 | GY01 | -0.87 | 0.78 | 3648 | GY02 | 0.33 | 0.88 | 3648 |

| Line Name | | C-O [deg] | Std [deg] | No. samp. | | C-O [deg] | Std [deg] | No. samp |
|---|---|---|---|---|---|---|---|---|
| 1680A1051 | GY01 | -1.75 | 0.67 | 5947 | GY02 | -0.46 | 0.67 | 5964 |
| | | | | | | | | |
| 1200P1053 | GY01 | -1 | 0.53 | 5117 | GY02 | 0.34 | 0.5 | 5117 |
| 1200P1054 | GY01 | -1.16 | 0.36 | 5119 | GY02 | 0.27 | 0.34 | 5119 |
| 1392P1055 | GY01 | -1.34 | 0.57 | 5113 | GY02 | -0.01 | 0.58 | 5113 |
| 1184P1056 | GY01 | -0.98 | 0.49 | 5118 | GY02 | 0.31 | 0.47 | 5118 |
| 1376P1057 | GY01 | -1.76 | 0.4 | 5108 | GY02 | -0.53 | 0.41 | 5108 |
| 1168P1058 | GY01 | -0.74 | 0.41 | 5113 | GY02 | 0.36 | 0.43 | 5113 |
| 1360P1059 | GY01 | -1.87 | 0.41 | 4654 | GY02 | -0.7 | 0.43 | 4654 |
| 1152P1060 | GY01 | -0.87 | 0.67 | 5104 | GY02 | 0.33 | 0.66 | 5070 |
| 1344P1061 | GY01 | -2.11 | 0.46 | 4433 | GY02 | -0.9 | 0.45 | 4506 |
| 1136P1062 | GY01 | -1.09 | 0.55 | 4830 | GY02 | 0.25 | 0.51 | 4830 |
| 1328P1063 | GY01 | -1.37 | 0.8 | 4544 | GY02 | -0.12 | 0.78 | 4544 |
| 1120P1064 | GY01 | -0.89 | 0.53 | 5113 | GY02 | 0.18 | 0.52 | 5113 |
| 1312P1065 | GY01 | -1.25 | 0.78 | 4327 | GY02 | -0.18 | 0.82 | 4365 |
| 1104P1066 | GY01 | -0.89 | 0.47 | 5114 | GY02 | 0.01 | 0.47 | 5114 |
| 1056P1067 | GY01 | -1.51 | 0.47 | 5112 | GY02 | -0.37 | 0.47 | 5112 |
| 1088P1068 | GY01 | -1.32 | 0.34 | 5119 | GY02 | -0.32 | 0.37 | 5119 |
| 1072P1069 | GY01 | -2.01 | 0.39 | 5109 | GY02 | -0.77 | 0.41 | 5109 |
| 1104A1070 | GY01 | -0.74 | 0.75 | 8754 | GY02 | 0.13 | 0.77 | 8771 |
| 1040P1071 | GY01 | -1.91 | 0.44 | 7373 | GY02 | -0.6 | 0.43 | 7453 |
| 1296A1072 | GY01 | -0.92 | 0.29 | 690 | GY02 | 0.52 | 0.3 | 690 |
| 1024P1073 | GY01 | -1.96 | 0.42 | 7486 | GY02 | -0.75 | 0.43 | 7486 |
| 1008P1074 | GY01 | -1.78 | 0.6 | 6407 | GY02 | -0.55 | 0.5 | 6407 |
| 2064J1075 | GY01 | -1.05 | 0.63 | 4865 | GY02 | -0.02 | 0.62 | 4866 |
| 2224P1076 | GY01 | -1.54 | 0.68 | 2879 | GY02 | -0.33 | 0.69 | 2879 |
| 2096P1077 | GY01 | -1.06 | 0.4 | 6396 | GY02 | 0.24 | 0.42 | 6396 |
| 2208P1078 | GY01 | -2.8 | 0.33 | 3191 | GY02 | -1.47 | 0.31 | 3191 |
| 2112P1079 | GY01 | -0.93 | 0.34 | 5032 | GY02 | 0.34 | 0.31 | 5032 |
| 2192P1080 | GY01 | -2.5 | 0.34 | 3209 | GY02 | -1.31 | 0.37 | 3209 |
| 2128P1081 | GY01 | -1.07 | 0.22 | 4342 | GY02 | -0.08 | 0.27 | 4342 |
| 1488A1082 | GY01 | -1.7 | 0.52 | 4613 | GY02 | -0.51 | 0.51 | 4613 |
| 2064A1083 | GY01 | -1.54 | 0.18 | 1692 | GY02 | -0.32 | 0.19 | 1692 |
| 2176P1084 | GY01 | -1.61 | 0.35 | 4016 | GY02 | -0.32 | 0.35 | 4016 |
| 2144P1085 | GY01 | -0.06 | 1.51 | 4149 | GY02 | 0.76 | 1.37 | 4006 |
| 1408A1086 | GY01 | -1.86 | 0.5 | 1305 | GY02 | -0.54 | 0.45 | 1305 |
| 1440A1087 | GY01 | -2.7 | 0.21 | 1365 | GY02 | -1.44 | 0.21 | 1365 |
| 1984J1088 | GY01 | -1.61 | 0.71 | 5039 | GY02 | -0.37 | 0.68 | 5039 |
| 2160P1089 | GY01 | -2.48 | 0.49 | 4319 | GY02 | -1.28 | 0.49 | 4319 |
| 2144J1090 | GY01 | -1.18 | 0.48 | 5027 | GY02 | -0.27 | 0.48 | 5027 |
| 1632U1091 | GY01 | -1.3 | 0.51 | 5027 | GY02 | -0.15 | 0.45 | 5037 |
| 1744U1092 | GY01 | -2.52 | 0.64 | 5039 | GY02 | -1.2 | 0.58 | 5039 |
| 1632U2093 | GY01 | -0.8 | 0.65 | 5033 | GY02 | 0.36 | 0.64 | 5033 |
| | | | | | | | | |
| 1632U3095 | GY01 | -1.41 | 0.27 | 5031 | GY02 | -0.15 | 0.28 | 5031 |
| 1744U3096 | GY01 | -1.65 | 0.22 | 5039 | GY02 | -0.51 | 0.22 | 5039 |
| 1632U4097 | GY01 | -0.63 | 0.65 | 5041 | GY02 | 0.56 | 0.64 | 5041 |
| 1744U4098 | GY01 | -1.78 | 0.31 | 5039 | GY02 | -0.51 | 0.32 | 5039 |

| | C-O | SD | Min | Max |
|---|---|---|---|---|
| **Gyro 1** | **-1.47°** | **0.55°** | **-2.80°** | **-0.06°** |
| **Gyro 2** | **-0.20°** | **0.55°** | **-1.47°** | **0.83°** |

| | C-O used in survey | Difference |
|---|---|---|
| **Gyro 1** | **-1.44°** | **0.03°** |
| **Gyro 2** | **-0.10°** | **0.10°** |

## GPS Integrity Monitor Results:

**Job 9429, APACHE Sue 3D MSS**

| Line Name | No. of Minutes | Start hdg. | End hdg. | C-O Northing | Std [deg] | No. samp. | %Rej | C-O Easting | Std [deg] | No. samp. | %Rej |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No Data | | | | | | | | | | | |
| 1808P1002 | 311 | 47 | 45 | 1.41 | 2.03 | 6003 | 3.9 | 0.71 | 1.48 | 6003 | 7.9 |
| 1824P1003 | 266 | 44 | 36 | 0.95 | 0.99 | 5290 | 5 | -0.24 | 0.95 | 5290 | 4 |
| 1552P1004 | 291 | 226 | 224 | 0.52 | 1.61 | 5774 | 4.3 | 0.92 | 1.02 | 5774 | 6.2 |
| 1840P1005 | 285 | 43 | 44 | 0.96 | 1.46 | 5634 | 2.9 | -0.30 | 1.07 | 5634 | 4.3 |
| 1568P1006 | 276 | 225 | 225 | 0.56 | 1.02 | 5509 | 6.9 | 0.14 | 1.06 | 5509 | 3.4 |
| 1856P1007 | 262 | 45 | 53 | 1.37 | 0.57 | 5189 | 4.2 | 0.54 | 0.39 | 5189 | 3.3 |
| 1584P1008 | 278 | 218 | 228 | 0.59 | 0.62 | 5491 | 4.4 | 0.09 | 0.39 | 5491 | 1.9 |
| 1872P1009 | 294 | 45 | 49 | 1.25 | 0.70 | 5868 | 2.5 | 0.40 | 0.39 | 5868 | 5.3 |
| 1600P1010 | 308 | 227 | 227 | 0.76 | 0.43 | 6121 | 4.3 | 0.59 | 0.29 | 6121 | 5.7 |
| 1888P1011 | 340 | 48 | 45 | 0.83 | 0.59 | 6723 | 4.4 | 0.35 | 0.53 | 6723 | 5.7 |
| 1616P1012 | 95 | 230 | 228 | 1.11 | 0.33 | 1834 | 3.1 | 0.47 | 0.36 | 1834 | 4.4 |
| No Data | | | | | | | | | | | |
| No Data | | | | | | | | | | | |
| No Data | | | | | | | | | | | |
| 1648P1016 | 115 | 233 | 228 | 0.59 | 0.87 | 2268 | 5.7 | 0.44 | 0.47 | 2268 | 3.5 |
| 1936P1017 | 290 | 46 | 50 | 1.00 | 0.62 | 5716 | 2.9 | 0.62 | 0.52 | 5716 | 3.3 |
| 1664P1018 | 297 | 219 | 234 | 0.64 | 0.78 | 5769 | 2.0 | 0.45 | 0.37 | 5769 | 2.1 |
| 1680P1019 | 301 | 52 | 47 | 0.90 | 0.73 | 5860 | 4.9 | 0.24 | 0.44 | 5860 | 6.8 |
| 1952P1020 | 302 | 228 | 223 | 1.14 | 1.03 | 5910 | 6.3 | 0.51 | 0.57 | 5910 | 4.3 |
| 1696P1021 | 335 | 50 | 40 | 1.25 | 0.56 | 6577 | 2.3 | 0.25 | 0.43 | 6577 | 3.2 |
| 1968P1022 | 298 | 227 | 222 | 0.74 | 0.58 | 5951 | 4.9 | 0.22 | 0.37 | 5951 | 5.7 |
| 1712P1023 | 295 | 47 | 48 | 1.17 | 0.69 | 5871 | 7.2 | 0.42 | 0.59 | 5871 | 5.0 |
| 2080P1024 | 97 | 226 | 227 | 0.74 | 0.86 | 1945 | 3.0 | 0.47 | 0.45 | 1945 | 0.1 |
| 1792P1025 | 284 | 40 | 44 | 1.04 | 0.54 | 5652 | 5.4 | -0.08 | 0.38 | 5652 | 4.5 |
| 1984P1026 | 269 | 217 | 224 | 0.95 | 0.91 | 5362 | 2.8 | 0.80 | 0.47 | 5362 | 3.2 |
| 1776P1027 | 307 | 48 | 46 | 0.79 | 0.64 | 6105 | 5.1 | 0.09 | 0.56 | 6105 | 2.2 |
| 2000P1028 | 280 | 223 | 226 | 0.77 | 0.77 | 5606 | 4.9 | 0.57 | 0.57 | 5606 | 4.8 |
| 1520P1029 | 282 | 48 | 45 | 1.22 | 0.62 | 5635 | 6.2 | 0.67 | 0.50 | 5635 | 1.4 |
| 1280P1030 | 262 | 223 | 226 | 0.71 | 0.98 | 5243 | 6.2 | 0.26 | 0.33 | 5243 | 5.7 |
| 1504P1031 | 323 | 49 | 41 | 1.45 | 0.50 | 5822 | 5.6 | 0.27 | 0.38 | 5822 | 3.8 |
| 1264P1032 | 291 | 227 | 221 | 0.71 | 0.97 | 3937 | 2.7 | -0.22 | 0.51 | 3937 | 1.9 |
| 1488P1033 | 288 | 50 | 47 | 1.43 | 0.98 | 4399 | 7.0 | 0.67 | 0.78 | 4399 | 4.5 |
| 1248P1034 | 270 | 223 | 226 | 0.37 | 0.75 | 5356 | 3.6 | 0.10 | 0.56 | 5356 | 3.9 |
| 1472P1035 | 309 | 48 | 42 | 1.40 | 0.67 | 6178 | 7.0 | 0.42 | 0.37 | 6178 | 2.9 |
| 1232P1036 | 295 | 226 | 222 | 0.58 | 0.52 | 5876 | 8.8 | 0.44 | 0.45 | 5876 | 1.2 |
| 1456P1037 | 266 | 45 | 45 | 1.27 | 0.41 | 5280 | 4.8 | 0.45 | 0.43 | 5280 | 3.5 |
| 1296P1038 | 259 | 225 | 228 | 0.61 | 0.56 | 5173 | 4.3 | 0.44 | 0.69 | 5173 | 3.5 |
| 1440P1039 | 261 | 46 | 47 | 1.12 | 0.73 | 5191 | 1.6 | 0.70 | 0.45 | 5191 | 4.7 |
| 1216P1040 | 268 | 221 | 228 | 0.43 | 0.89 | 5316 | 5.0 | 0.27 | 0.46 | 5316 | 4.8 |
| 1728P1041 | 301 | 44 | 50 | 1.62 | 0.90 | 5939 | 2.8 | 0.81 | 0.62 | 5939 | 7.5 |
| 2000J1042 | 326 | 226 | 225 | 0.59 | 0.76 | 6507 | 4.6 | 0.37 | 0.49 | 6507 | 3.1 |
| 1744P1043 | 308 | 56 | 50 | 0.95 | 1.00 | 6125 | 1.9 | 0.61 | 0.54 | 6125 | 3.5 |
| 2016P1044 | 275 | 221 | 224 | 0.79 | 0.64 | 5482 | 5.7 | 0.53 | 0.37 | 5482 | 5.1 |
| 1760P1045 | 288 | 44 | 41 | 1.22 | 0.53 | 5726 | 5.3 | 0.25 | 0.50 | 5726 | 5.6 |
| 2032P1046 | 276 | 216 | 220 | 0.72 | 0.55 | 5500 | 5.0 | 0.53 | 0.42 | 5500 | 2.4 |
| 1760J1047 | 290 | 46 | 43 | 1.29 | 0.45 | 5770 | 4.3 | 0.28 | 0.33 | 5770 | 3.7 |
| 2048P1048 | 277 | 229 | 227 | 0.67 | 0.70 | 5517 | 4.3 | 0.13 | 0.34 | 5517 | 6.4 |
| 1424P1049 | 269 | 45 | 49 | 1.82 | 0.88 | 5357 | 6.5 | 0.58 | 0.47 | 5357 | 4.3 |
| 2064P1050 | 316 | 228 | 223 | 0.67 | 0.57 | 6304 | 5.3 | 0.42 | 0.44 | 6304 | 4.2 |
| 1680A1051 | 109 | 48 | 49 | 0.21 | 1.24 | 2184 | 4.0 | 0.33 | 0.36 | 2184 | 10.3 |
| 1712A1052 | 6 | 46 | 48 | 1.86 | 0.09 | 122 | 0.8 | -0.38 | 0.08 | 122 | 4.1 |
| 1200P1053 | 270 | 216 | 212 | 0.56 | 0.53 | 5391 | 6.4 | -0.05 | 0.66 | 5391 | 4.8 |
| 1200P1054 | 273 | 228 | 226 | 0.77 | 0.41 | 5262 | 3.4 | 0.54 | 0.24 | 5262 | 3.9 |
| 1392P1055 | 311 | 44 | 45 | 1.09 | 0.65 | 5974 | 3.4 | 0.54 | 0.43 | 5974 | 3.7 |
| 1184P1056 | 267 | 229 | 224 | 0.91 | 0.52 | 5275 | 3.8 | 0.38 | 0.35 | 5275 | 4.5 |
| 1376P1057 | 292 | 45 | 42 | 1.08 | 0.51 | 5832 | 5.3 | 0.30 | 0.32 | 5832 | 5.6 |
| 1168P1058 | 278 | 228 | 227 | 0.80 | 0.43 | 5485 | 3.8 | 0.34 | 0.30 | 5485 | 7.9 |
| 1360P1059 | 254 | 44 | 43 | 1.27 | 0.51 | 5068 | 6.1 | 0.23 | 0.39 | 5068 | 2.5 |
| 1152P1060 | 269 | 225 | 231 | 0.44 | 0.69 | 5363 | 3.2 | 0.04 | 0.48 | 5363 | 4.1 |

## Job 9429, APACHE Sue 3D MSS

| Line Name | No. of Minutes | Start hdg. | End hdg. | C-O Northing | Std [deg] | No. samp. | %Rej | C-O Easting | Std [deg] | No. samp. | %Rej |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1344P1061 | 252 | 43 | 42 | 1.17 | 0.45 | 5002 | 3.2 | 0.32 | 0.32 | 5002 | 4.0 |
| 1136P1062 | 286 | 230 | 231 | 0.85 | 0.57 | 5712 | 4.0 | 0.56 | 0.32 | 5712 | 2.9 |
| 1328P1063 | 252 | 43 | 48 | 1.13 | 0.64 | 4973 | 3.9 | 0.34 | 0.51 | 4973 | 2.2 |
| 1120P1064 | 276 | 220 | 226 | 0.74 | 0.57 | 5501 | 3.1 | 0.55 | 0.52 | 5501 | 4.3 |
| 1312P1065 | 249 | 45 | 45 | 1.18 | 0.45 | 4961 | 5.2 | 0.34 | 0.53 | 4961 | 6.0 |
| 1104P1066 | 277 | 229 | 226 | 0.70 | 0.56 | 5543 | 4.3 | 0.59 | 0.53 | 5543 | 3.3 |
| 1056P1067 | 266 | 42 | 80 | 1.03 | 0.81 | 5069 | 6.3 | -0.01 | 0.57 | 5069 | 4.1 |
| 1088P1068 | 302 | 229 | 220 | 0.53 | 0.38 | 5997 | 5.9 | 0.35 | 0.30 | 5997 | 3.9 |
| 1072P1069 | 263 | 42 | 82 | 1.13 | 0.83 | 5003 | 3.2 | 0.34 | 0.47 | 5003 | 5.0 |
| 1104A1070 | 158 | 228 | 225 | 1.22 | 0.85 | 2975 | 4.7 | 0.52 | 0.51 | 2975 | 4.8 |
| 1040P1071 | 136 | 46 | 77 | 1.21 | 0.54 | 2633 | 5.4 | 0.37 | 0.51 | 2633 | 4.4 |
| 1296A1072 | 21 | 229 | 228 | 0.41 | 0.35 | 428 | 1.2 | 1.07 | 0.40 | 428 | 0.0 |
| 1024P1073 | 135 | 45 | 157 | 1.42 | 0.56 | 2597 | 3.1 | 0.46 | 0.37 | 2597 | 5.7 |
| 1008P1074 | 117 | 45 | 88 | 1.68 | 0.88 | 2303 | 5.4 | 0.35 | 0.48 | 2303 | 4.5 |
| 2064J1075 | 276 | 224 | 231 | 0.73 | 0.53 | 5462 | 4.1 | 0.45 | 0.53 | 5462 | 7.0 |
| 2224P1076 | 55 | 43 | 42 | 2.47 | 1.66 | 635 | 3.1 | 0.22 | 0.97 | 635 | 6.6 |
| 2096P1077 | 117 | 230 | 228 | 0.52 | 0.53 | 1823 | 6.6 | 0.25 | 0.90 | 1823 | 4.3 |
| 2208P1078 | 63 | 48 | 51 | 2.35 | 0.36 | 1263 | 5.9 | 0.18 | 0.39 | 1263 | 6.0 |
| 2112P1079 | 94 | 224 | 228 | 1.01 | 0.76 | 1877 | 2.8 | 0.31 | 0.28 | 1877 | 4.7 |
| 2192P1080 | 63 | 45 | 49 | 1.76 | 1.01 | 1246 | 2.6 | -0.07 | 0.45 | 1246 | 3.5 |
| 2128P1081 | 82 | 224 | 225 | 0.12 | 0.59 | 1459 | 6.0 | 0.79 | 0.35 | 1459 | 5.3 |
| 1488A1082 | 87 | 44 | 44 | 0.82 | 0.67 | 1443 | 4.1 | 0.18 | 0.56 | 1443 | 5.1 |
| 2064A1083 | 38 | 227 | 237 | 1.15 | 0.20 | 763 | 7.7 | 0.63 | 0.30 | 763 | 0.0 |
| 2176P1084 | 77 | 47 | 47 | 1.68 | 0.81 | 1537 | 4.0 | 0.64 | 0.27 | 1537 | 5.0 |
| 2144P1085 | 84 | 229 | 227 | 0.57 | 0.64 | 1663 | 7.4 | 0.05 | 0.54 | 1663 | 2.0 |
| 1408A1086 | 32 | 50 | 50 | 1.63 | 0.43 | 622 | 0.8 | 0.30 | 0.25 | 622 | 1.0 |
| 1440A1087 | 33 | 47 | 46 | 1.97 | 0.28 | 653 | 8.4 | 0.62 | 0.14 | 653 | 5.1 |
| 1984J1088 | 330 | 228 | 227 | 0.82 | 0.67 | 6546 | 4.3 | 0.30 | 0.45 | 6546 | 4.5 |
| 2160P1089 | 82 | 49 | 50 | 0.61 | 0.67 | 1620 | 8.4 | -0.22 | 0.56 | 1620 | 7.6 |
| 2144J1090 | 94 | 225 | 227 | 0.22 | 0.51 | 1871 | 3.0 | 0.03 | 0.44 | 1871 | 6.2 |
| 1632U1091 | 281 | 227 | 222 | 0.89 | 0.59 | 5269 | 5.9 | 0.33 | 0.35 | 5269 | 4.2 |
| 1744U1092 | 139 | 42 | 41 | 0.73 | 0.69 | 2771 | 2.3 | -0.03 | 0.31 | 2771 | 2.1 |
| 1632U2093 | 549 | 214 | 56 | 1.08 | 0.66 | 855 | 3.6 | 0.30 | 0.32 | 855 | 5.2 |
| | | | | | | | | | | | |
| 1632U3095 | 176 | 225 | 221 | 0.63 | 0.69 | 3524 | 5.4 | 0.41 | 0.32 | 3524 | 3.9 |
| 1744U3096 | 157 | 41 | 43 | 1.48 | 0.30 | 3135 | 6.4 | 0.58 | 0.36 | 3135 | 2.5 |
| 1632U4097 | 185 | 231 | 231 | 1.26 | 0.66 | 3678 | 1.6 | 0.49 | 0.52 | 3678 | 2.3 |
| 1744U4098 | 120 | 40 | 72 | 1.10 | 0.47 | 2391 | 2.5 | 0.47 | 0.27 | 2391 | 4.8 |
| | | | | | | | | | | | |

**Sale Integrity Monitor**

| Northing | | | | Easting | | | |
|---|---|---|---|---|---|---|---|
| Mean | | | | Mean | | | |
| C-O | SD | Min | Max | C-O | SD | Min | Max |
| **1.00** | **0.69** | **0.12** | **2.5** | **0.36** | **0.48** | **-0.38** | **1.1** |

**GPS Radial Difference Results**

| Difference Estimators | | | | | |
|---|---|---|---|---|---|
| Sequence | TRIGPS | CNAV | POSNET1 | POSNET2 | MFIX |
| 1 | 0.73 | 0.99 | 0.67 | 0.69 | |
| 2 | 0.71 | 1.29 | 0.91 | 1.23 | |
| 3 | 0.54 | 0.42 | 0.44 | 0.68 | |
| 4 | 0.66 | 0.52 | 0.55 | 0.79 | |
| 5 | 0.59 | 0.47 | 0.52 | 0.63 | |
| 6 | 0.51 | 0.48 | 0.46 | 0.62 | |
| 7 | 0.31 | 0.29 | 0.34 | 0.46 | |
| 8 | 0.32 | 0.27 | 0.39 | 0.52 | 0.29 |
| 9 | 0.29 | 0.27 | 0.3 | 0.45 | 0.36 |
| 10 | 0.32 | 0.31 | 0.34 | 0.48 | 0.36 |
| 11 | 0.1 | 0.46 | 0.74 | 0.94 | 0.47 |
| 12 | 0.31 | 0.31 | 0.33 | 0.47 | 0.33 |
| 13 | 0.35 | 0.34 | 0.37 | 0.48 | 0.37 |
| 14 | 0.1 | 0.53 | 1.88 | 2 | 0.59 |
| 15 | 0.31 | 0.28 | 0.32 | 0.56 | 0.47 |
| 16 | 0.08 | 1.05 | 1.08 | 1.25 | 1.06 |
| 17 | 0.85 | 0.1 | 0.59 | 0.64 | 0.21 |
| 18 | 0.51 | 0.45 | 0.41 | 0.74 | 0.46 |
| 19 | 0.44 | 0.42 | 0.44 | 0.67 | 0.36 |
| 20 | 0.67 | 0.35 | 0.42 | 0.6 | 0.31 |
| 21 | 0.61 | 0.37 | 0.38 | 0.55 | 0.32 |
| 22 | 0.51 | 0.27 | 0.33 | 0.51 | 0.34 |
| 23 | 0.53 | 0.31 | 0.51 | 0.56 | 0.29 |
| 24 | 0.76 | 0.32 | 0.47 | 0.7 | 0.33 |
| 25 | 0.59 | 0.35 | 0.4 | 0.43 | 0.36 |
| 26 | 0.7 | 0.37 | 0.38 | 0.45 | 0.32 |
| 27 | 0.66 | 0.31 | 0.37 | 0.56 | 0.31 |
| 28 | 0.57 | 0.28 | 0.34 | 0.46 | 0.31 |
| 29 | 0.59 | 0.32 | 0.35 | 0.7 | 0.3 |
| 30 | 0.56 | 0.29 | 0.43 | 0.57 | 0.29 |
| 31 | 0.42 | 0.35 | 0.39 | 0.52 | 0.32 |
| 32 | 0.71 | 0.39 | 0.52 | 0.68 | 0.33 |
| 33 | 0.59 | 0.35 | 0.44 | 0.58 | 0.35 |
| 34 | 0.6 | 0.36 | 0.54 | 0.65 | 0.35 |
| 35 | 0.54 | 0.42 | 0.42 | 0.51 | 0.38 |
| 36 | 0.43 | 0.27 | 0.35 | 0.37 | 0.28 |
| 37 | 0.5 | 0.33 | 0.43 | 0.5 | 0.33 |
| 38 | 0.53 | 0.3 | 0.37 | 0.53 | 0.3 |
| 39 | 0.61 | 0.4 | 0.43 | 0.53 | 0.38 |
| 40 | 0.74 | 0.4 | 0.54 | 0.58 | 0.43 |
| 41 | 0.62 | 0.43 | 0.44 | 0.46 | 0.41 |
| 42 | 0.57 | 0.37 | 0.44 | 0.51 | 0.37 |
| 43 | 0.85 | 0.43 | 0.46 | 0.6 | 0.43 |
| 44 | 0.63 | 0.33 | 0.42 | 0.51 | 0.35 |
| 45 | 0.51 | 0.46 | 0.51 | 0.36 | 0.39 |
| 46 | 0.45 | 0.38 | 0.48 | 0.67 | 0.37 |
| 47 | 0.57 | 0.49 | 0.52 | 0.5 | 0.48 |
| 48 | 0.59 | 0.47 | 0.52 | 0.59 | 0.47 |
| 49 | 0.75 | 0.58 | 0.69 | 0.52 | 0.56 |
| 50 | 0.72 | 0.42 | 0.49 | 0.63 | 0.42 |

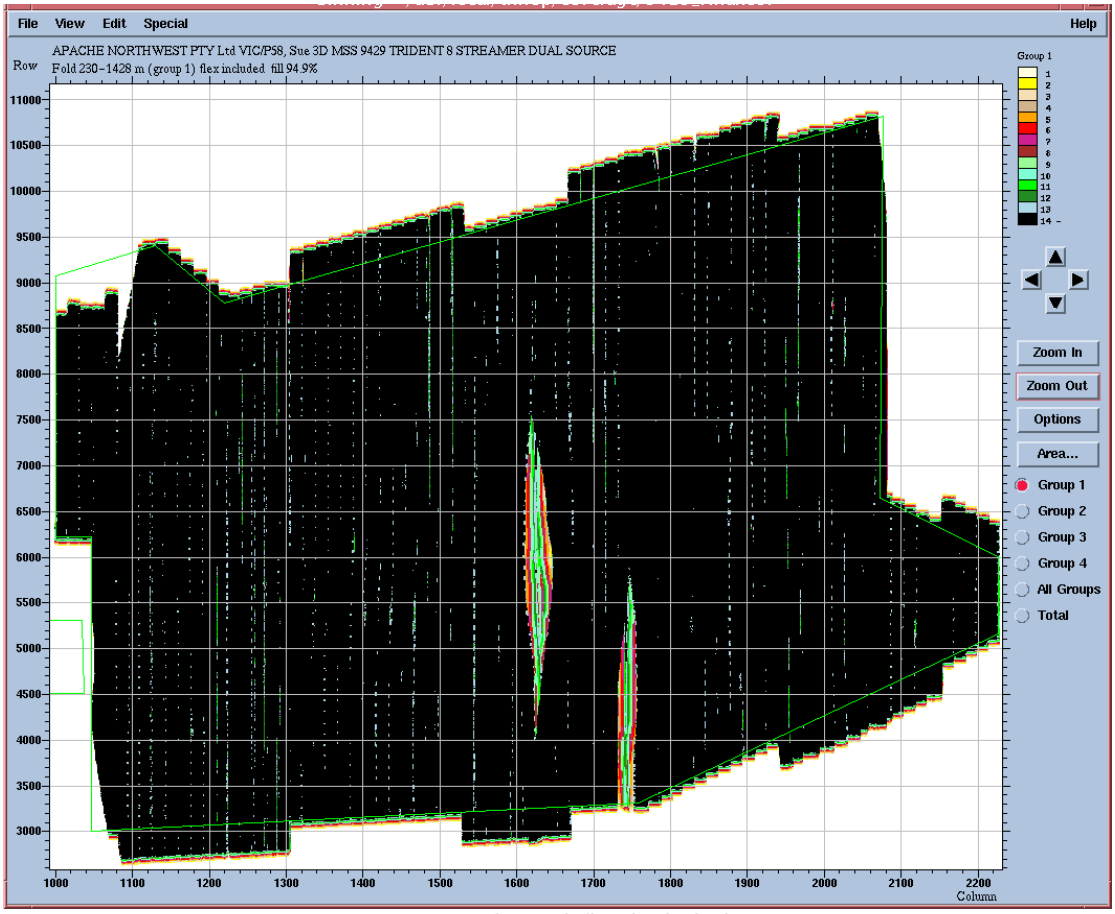
| Difference Estimators | | | | | |
|---|---|---|---|---|---|
| Sequence | TRIGPS | CNAV | POSNET1 | POSNET2 | MFIX |
| 51 | 0.59 | 0.4 | 0.48 | 0.56 | 0.38 |
| 52 | 0.51 | 0.41 | 0.53 | 0.48 | 0.42 |
| 53 | 0.62 | 0.41 | 0.59 | 0.62 | 0.45 |
| 54 | 0.52 | 0.52 | 0.73 | 0.67 | 0.61 |
| 55 | 0.69 | 0.61 | 0.7 | 0.66 | 1.35 |
| 56 | 0.56 | 0.44 | 0.54 | 0.74 | 0.74 |
| 57 | 0.5 | 0.46 | 0.48 | 0.67 | 0.65 |
| 58 | 0.51 | 0.35 | 0.48 | 0.81 | 0.92 |
| 59 | 0.57 | 0.53 | 0.52 | 0.58 | 0.86 |
| 60 | 0.53 | 0.42 | 0.52 | 0.92 | 2.67 |
| 61 | 0.51 | 0.44 | 0.4 | 0.61 | 0.7 |
| 62 | 0.59 | 0.33 | 0.35 | 0.46 | 0.34 |
| 63 | 0.5 | 0.26 | 0.41 | 0.78 | 0.26 |
| 64 | 0.61 | 0.29 | 0.33 | 0.71 | 0.29 |
| 65 | 0.58 | 0.31 | 0.39 | 0.48 | 0.3 |
| 66 | 0.58 | 0.3 | 0.37 | 0.77 | 0.26 |
| 67 | 0.55 | 0.35 | 0.4 | 0.73 | 0.29 |
| 68 | 0.37 | 0.24 | 0.33 | 0.69 | 0.23 |
| 69 | 0.71 | 0.14 | 0.42 | 0.52 | 0.04 |
| 70 | 0.74 | 0.29 | 0.44 | 0.72 | 0.33 |
| 71 | 0.42 | 0.22 | 0.37 | 0.55 | 0.24 |
| 72 | 0.49 | 0.25 | 0.34 | 0.74 | 0.29 |
| 73 | 0.47 | 0.28 | 0.35 | 0.71 | 0.3 |
| 74 | 0.55 | 0.31 | 0.5 | 0.57 | 0.29 |
| 75 | 0.58 | 0.26 | 0.4 | 0.8 | 0.26 |
| 76 | 0.54 | 0.25 | 0.42 | 0.35 | 0.29 |
| 77 | 0.61 | 0.31 | 0.38 | 1.09 | 0.34 |
| 78 | 0.32 | 0.22 | 0.46 | 0.66 | 0.23 |
| 79 | 0.52 | 0.29 | 0.33 | 0.67 | 0.33 |
| 80 | 0.63 | 0.51 | 0.53 | 0.86 | 1.35 |
| 81 | 0.41 | 0.27 | 0.37 | 0.63 | 0.34 |
| 82 | 0.6 | 0.36 | 0.36 | 0.76 | 0.34 |
| 83 | 0.63 | 0.45 | 0.34 | 1.26 | 0.32 |
| 84 | 0.55 | 0.38 | 0.43 | 0.67 | 0.28 |
| 85 | 0.61 | 0.29 | 0.56 | 0.85 | 0.28 |
| 86 | 0.55 | 0.26 | 0.49 | 0.66 | 0.26 |
| 87 | 0.34 | 0.26 | 0.27 | 0.75 | 0.19 |
| 88 | 0.52 | 0.31 | 0.4 | 0.66 | 0.28 |
| 89 | 0.55 | 0.35 | 0.52 | 0.46 | 0.31 |
| 90 | 0.5 | 0.37 | 0.39 | 0.68 | 0.36 |
| 91 | 0.36 | 0.35 | 0.34 | 0.88 | 0.51 |
| 92 | 0.32 | 0.47 | 0.38 | 0.54 | 0.46 |
| 93 | 0.35 | 0.31 | 0.32 | 0.82 | 0.37 |
| 94 | 0.49 | 0.32 | 0.42 | 0.54 | 0.39 |
| 95 | 0.56 | 0.3 | 0.4 | 0.83 | 0.31 |
| 96 | 0.44 | 0.5 | 0.4 | 0.73 | 0.36 |
| 97 | 0.5 | 0.33 | 0.33 | 0.63 | 0.41 |
| 98 | 0.37 | 0.23 | 0.41 | 0.55 | 0.3 |

| | | | | | |
|---|---|---|---|---|---|
| Average | 0.53 | 0.38 | 0.46 | 0.66 | 0.42 |
| SD | 0.14 | 0.16 | 0.19 | 0.22 | 0.32 |

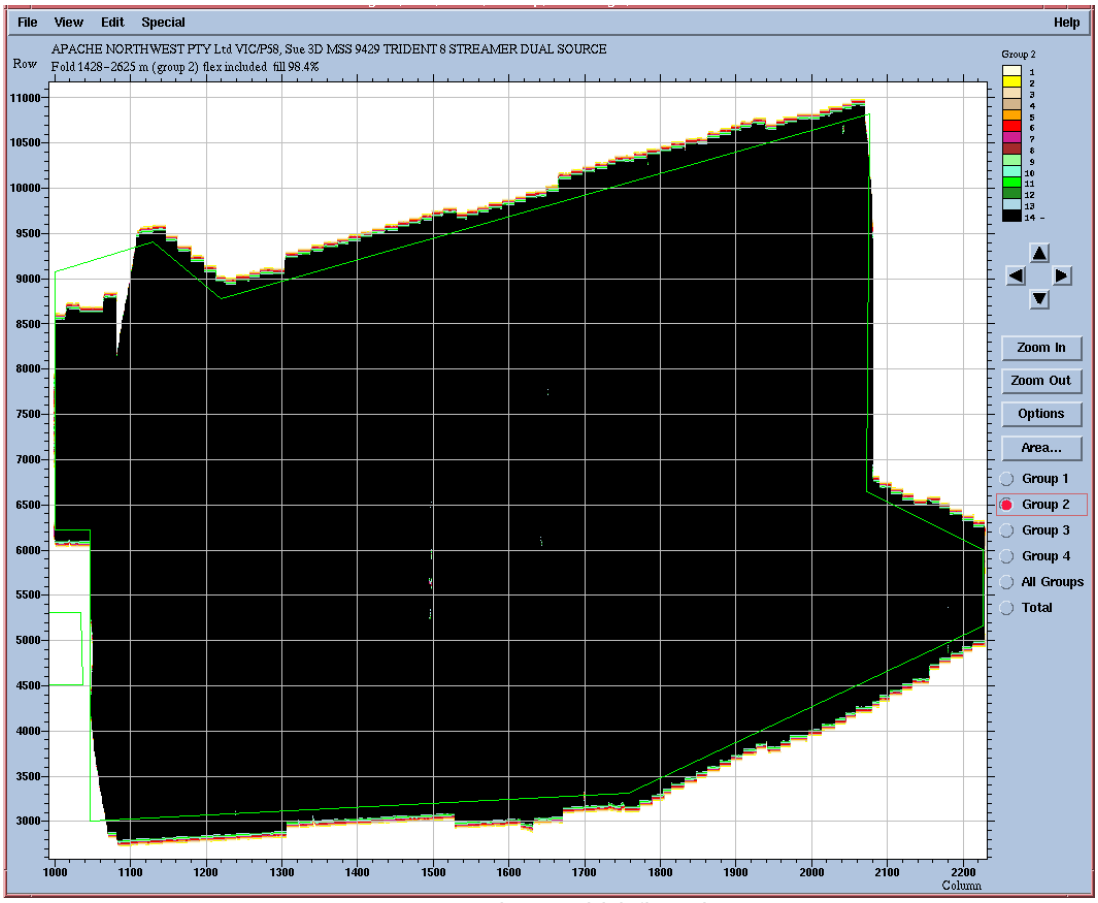
## Exhibit 4 **: Coverage Maps**

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

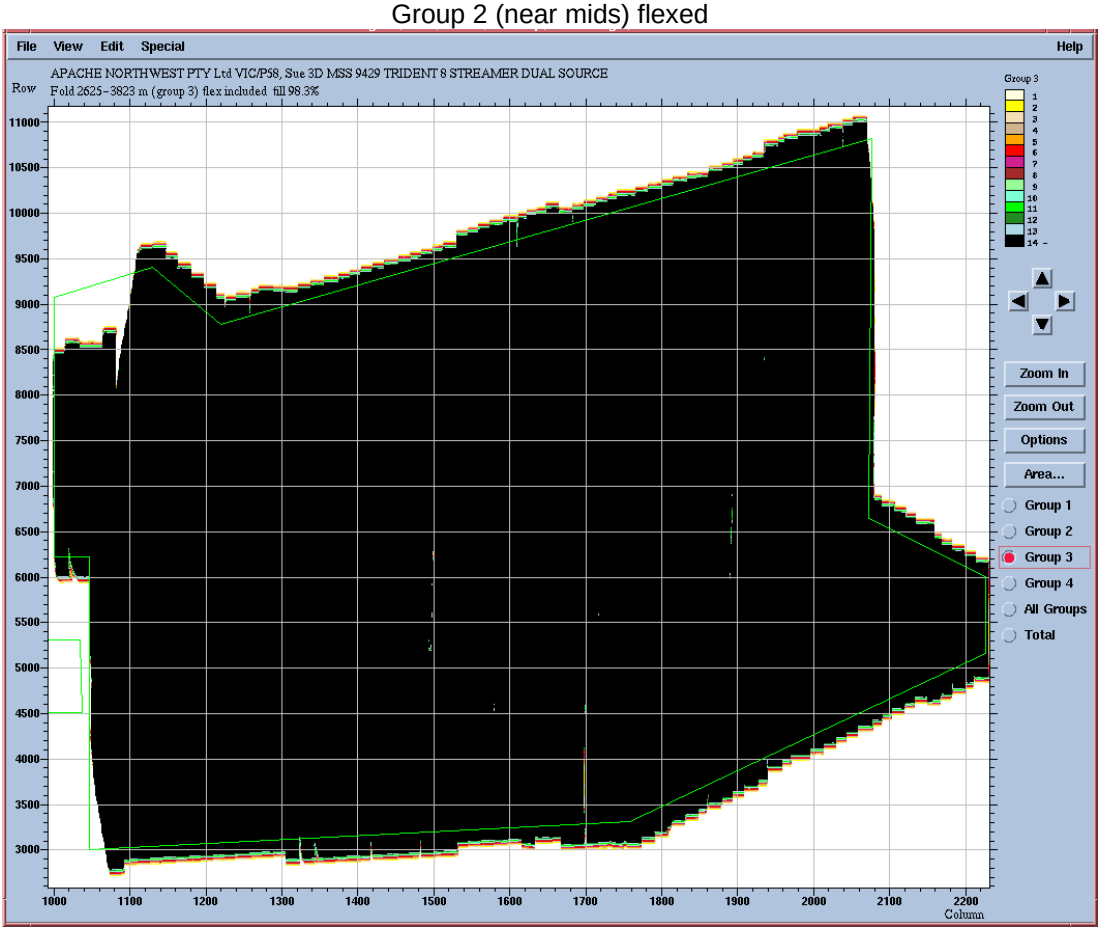
| Group | bin width at head | bin width at tail | per side expansion |
|---|---|---|---|
| 1 | 50.0 | 62.5 | 18.75 |
| 2 | 62.5 | 75.0 | 25.00 |
| 3 | 75.0 | 87.5 | 31.25 |
| 4 | 87.5 | 125.0 | 50.00 |



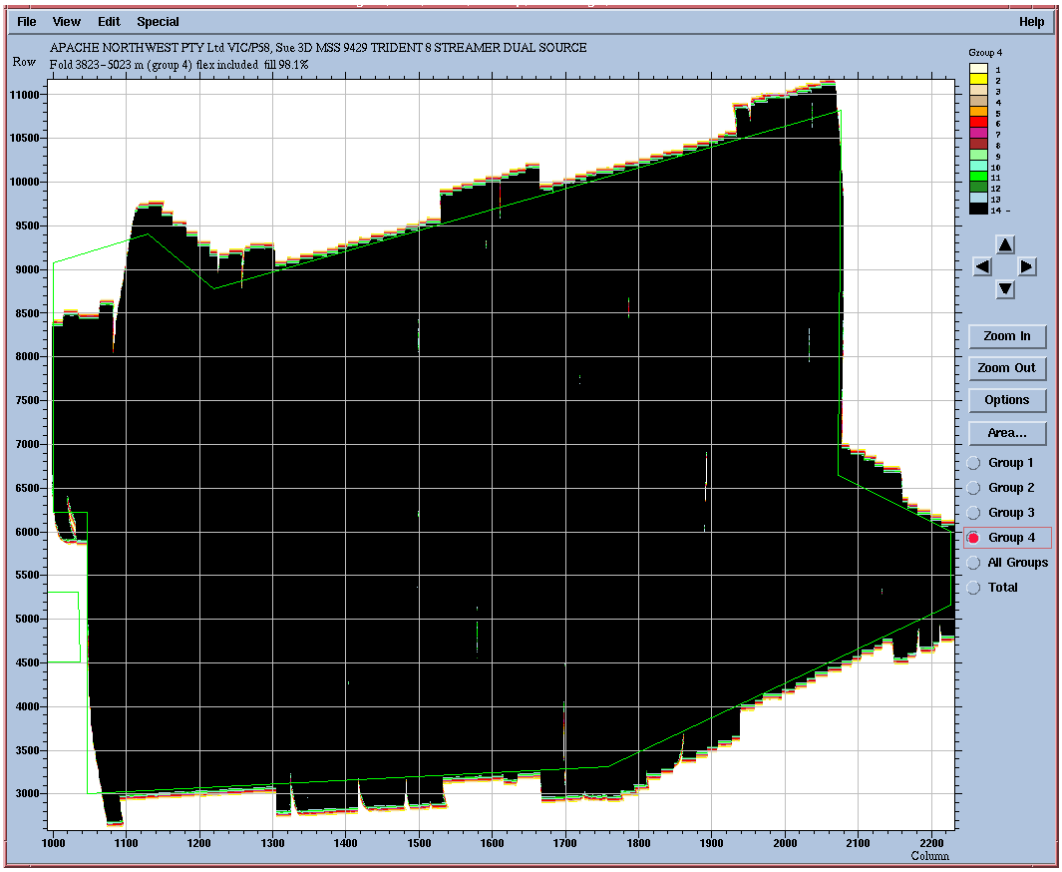

Group 1 (nears) flex included



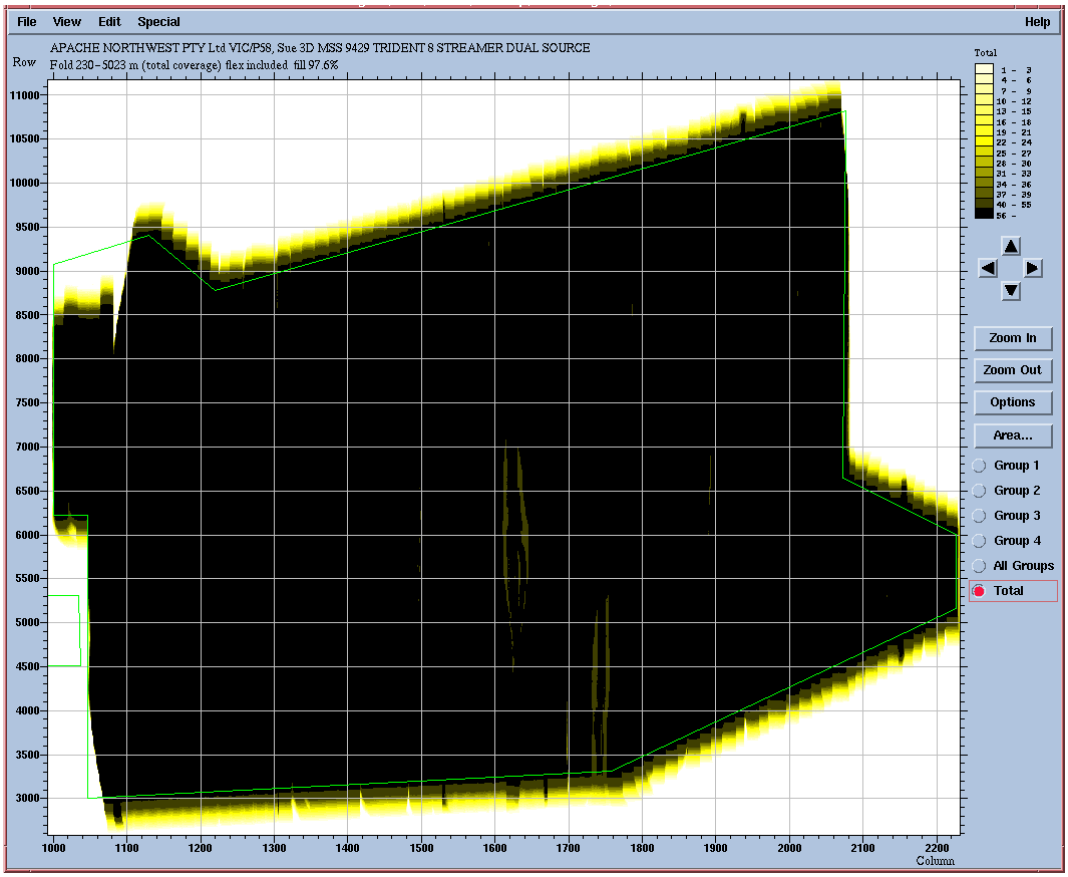

Group 2 (near mids) flexed



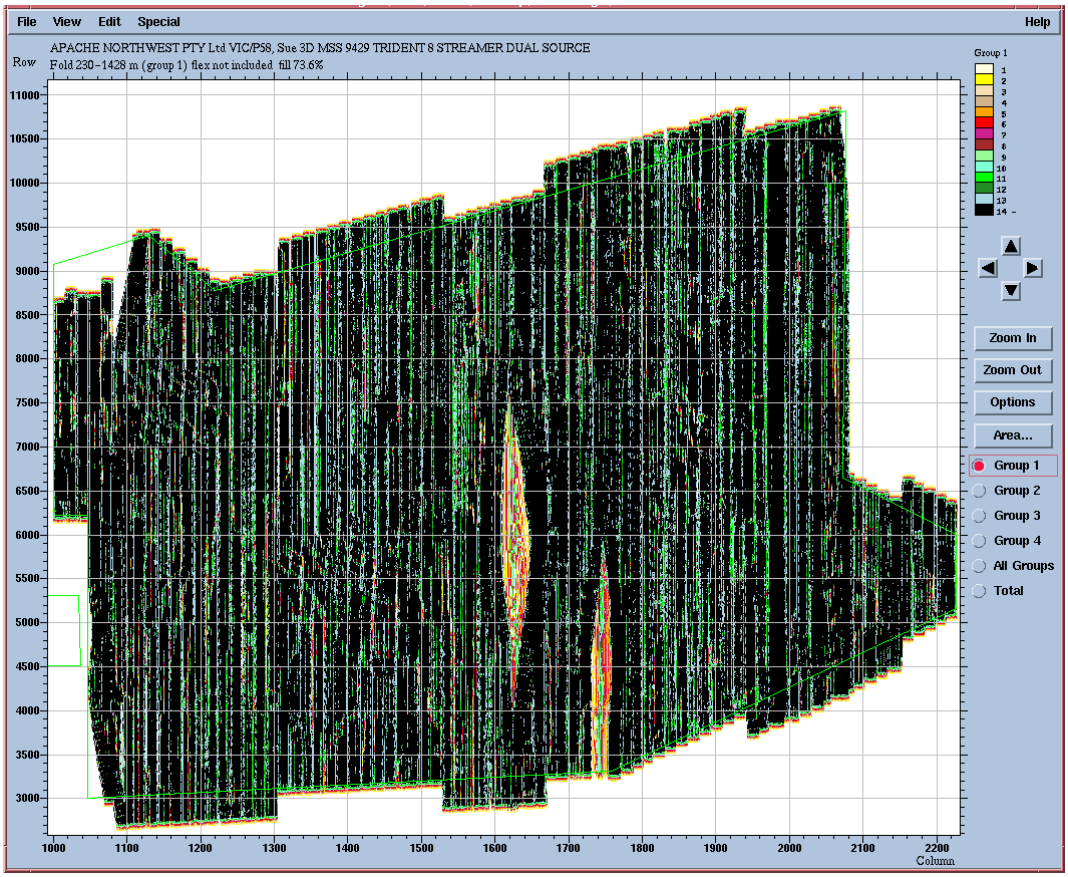

Group 3 (far mids) flexed



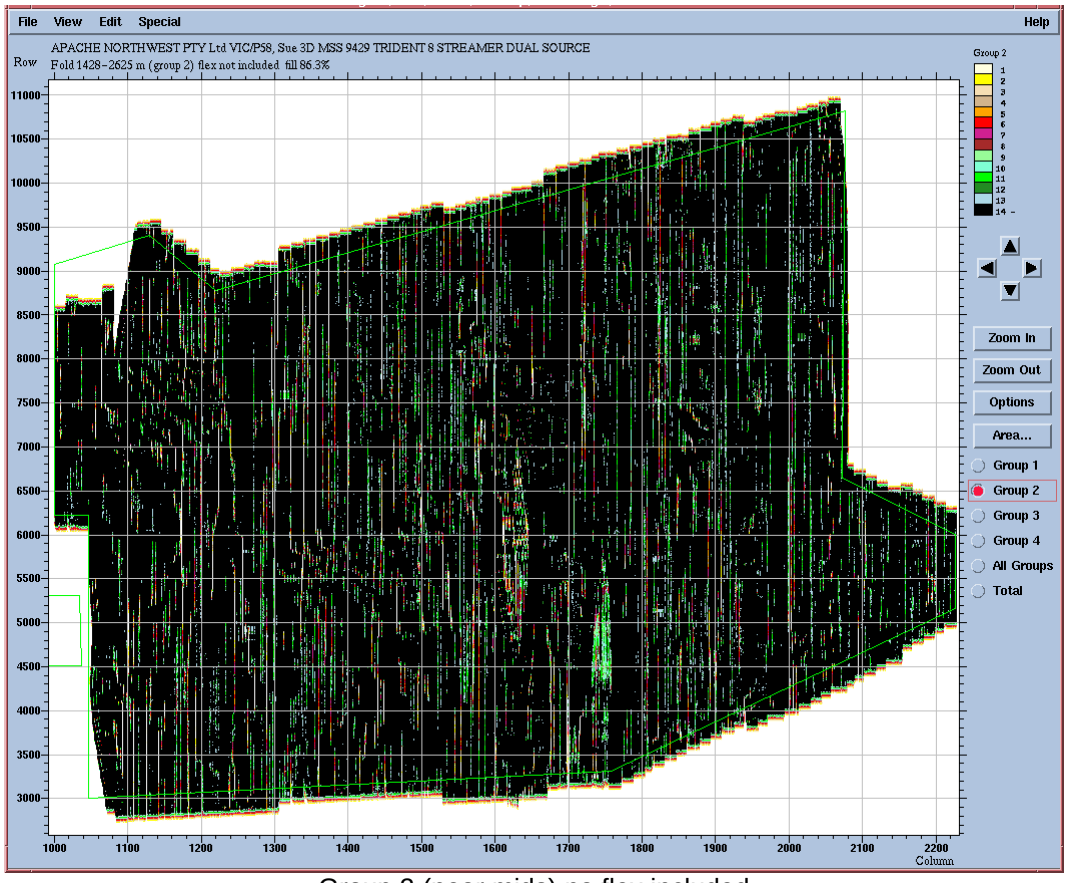

Group 4 (fars) flexed



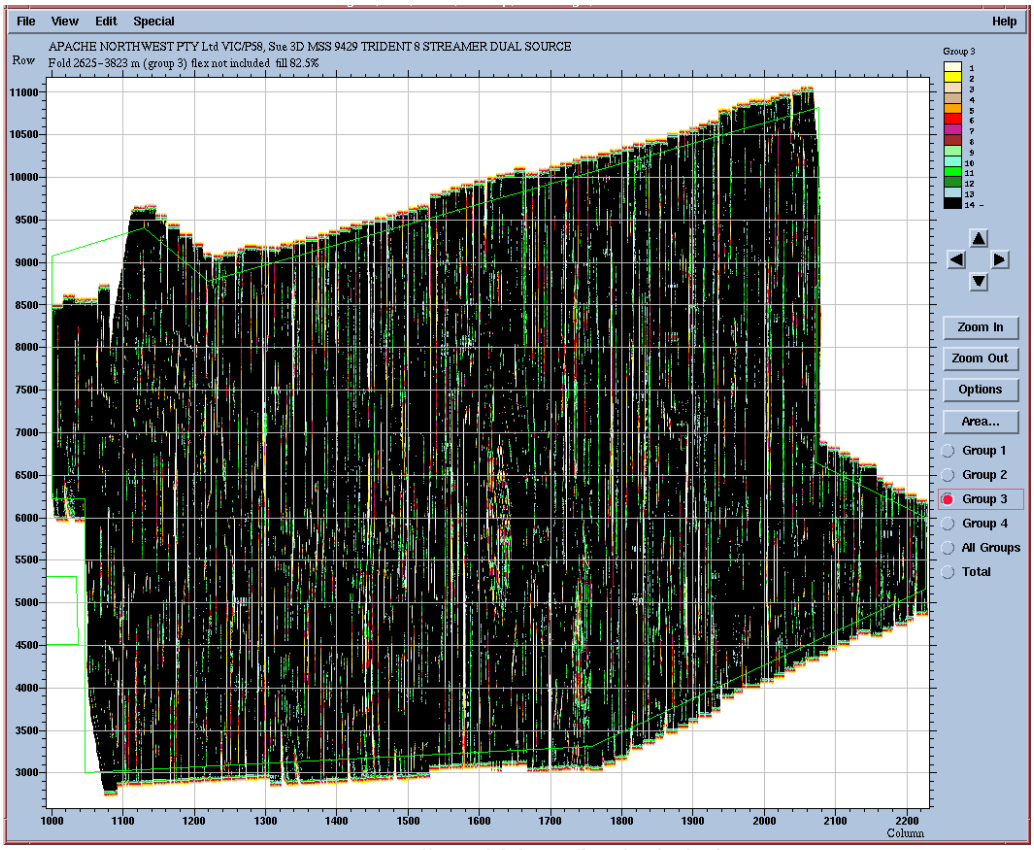

Total cable flexed



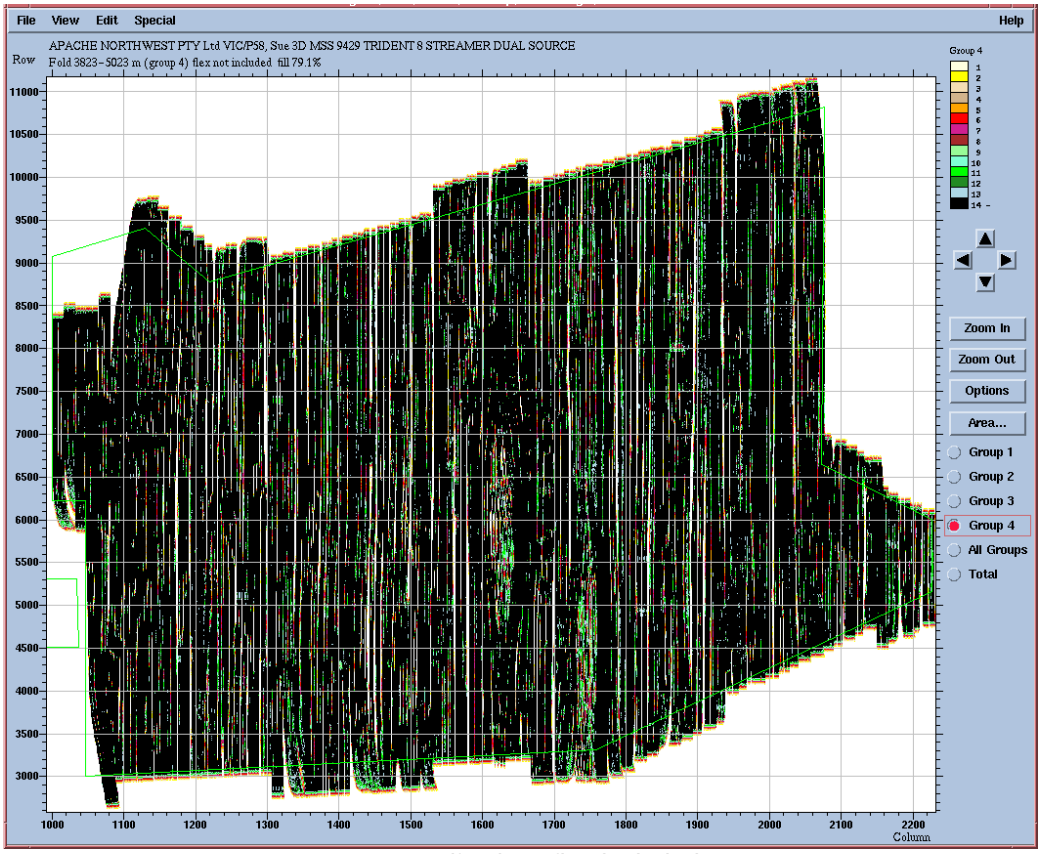

Group 1 (nears) no flex included



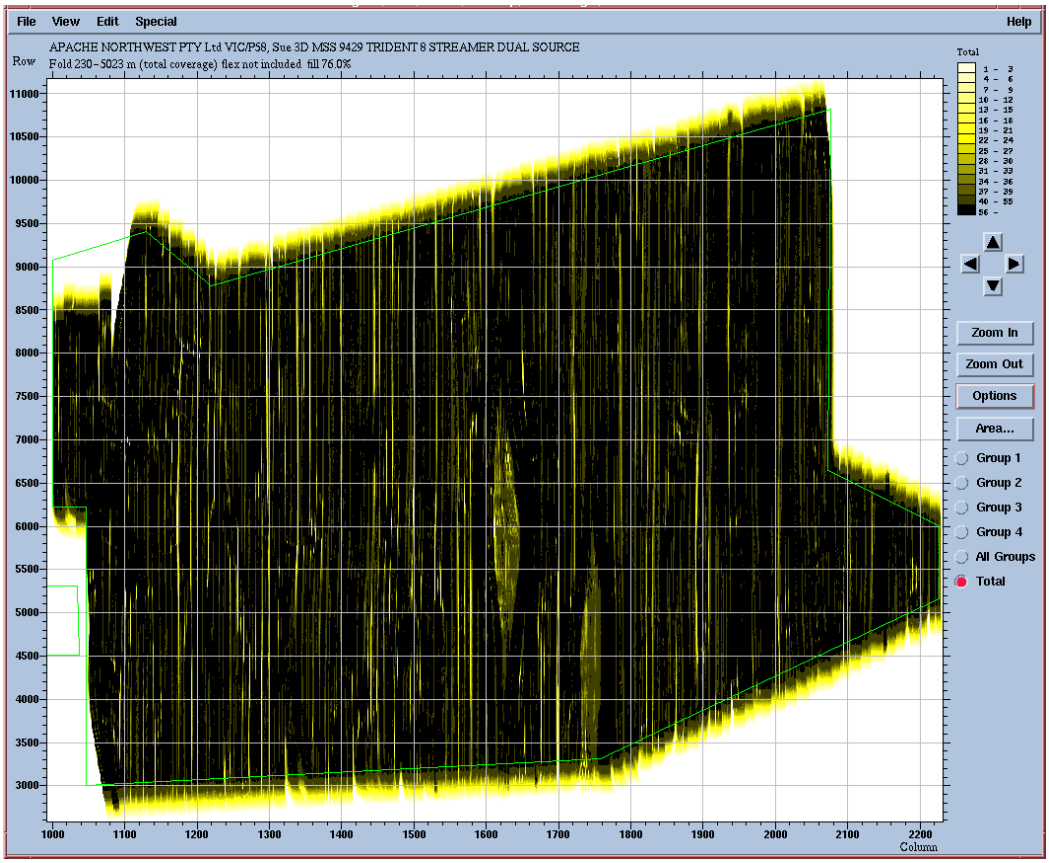

Group 2 (near mids) no flex included




Group 3 (far mids) no flex included

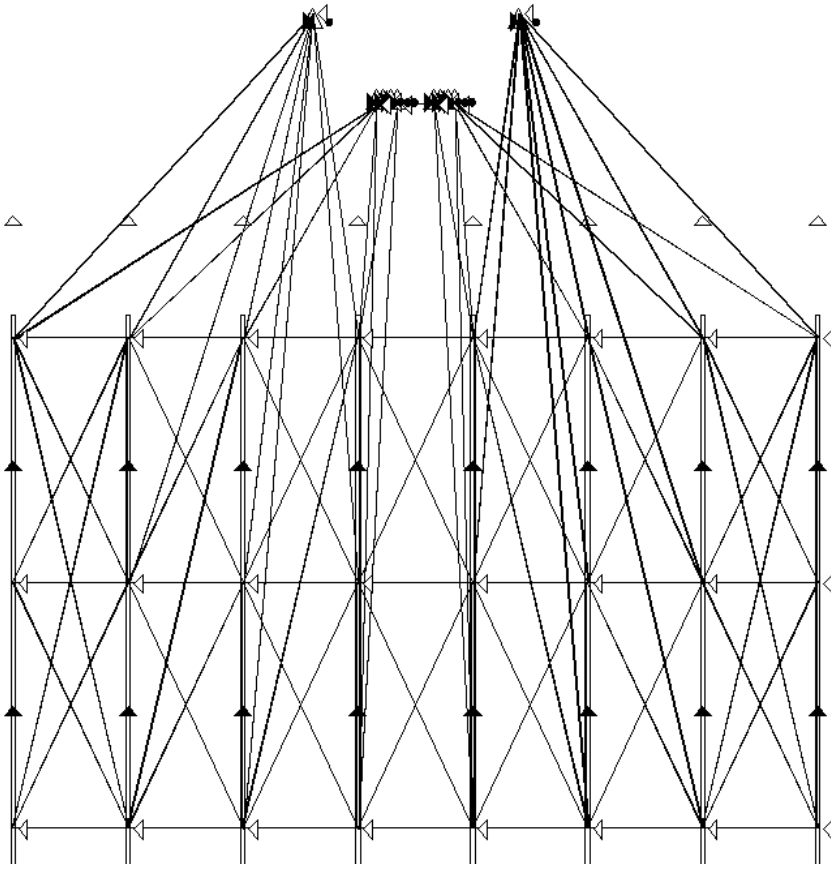



Group 4 (fars) no flex included

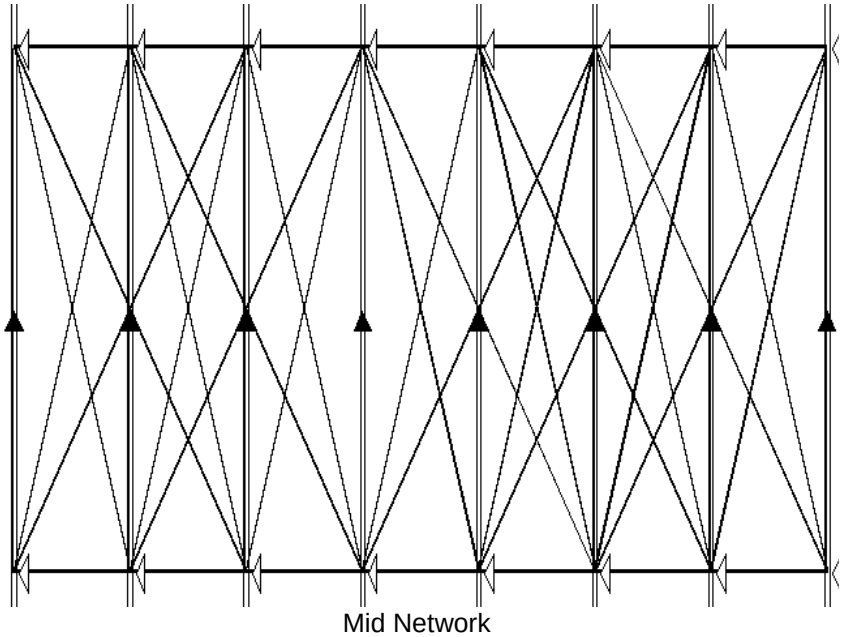



Total cable no flex included

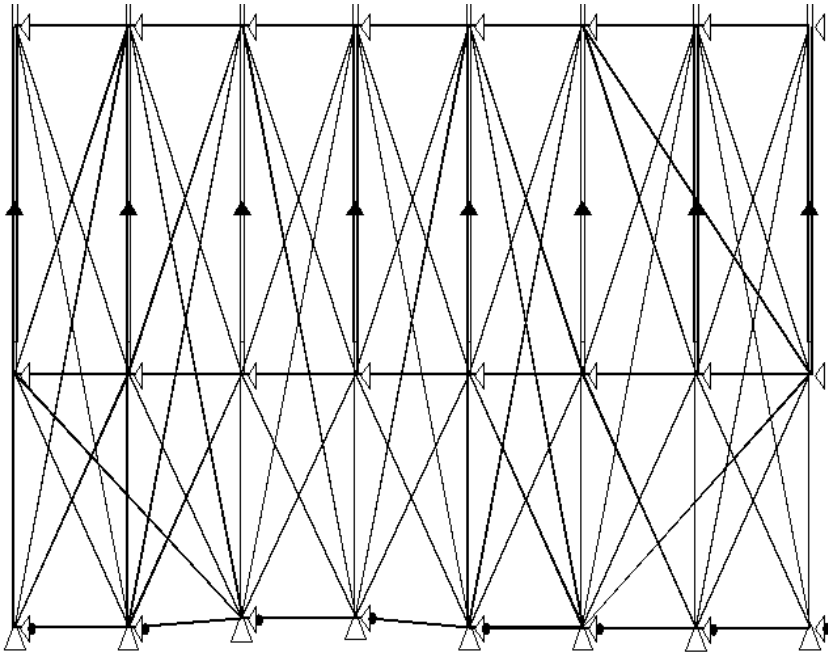
## Exhibit 5 **: Acoustic Range System**



Front Network



Mid Network



Tail Network

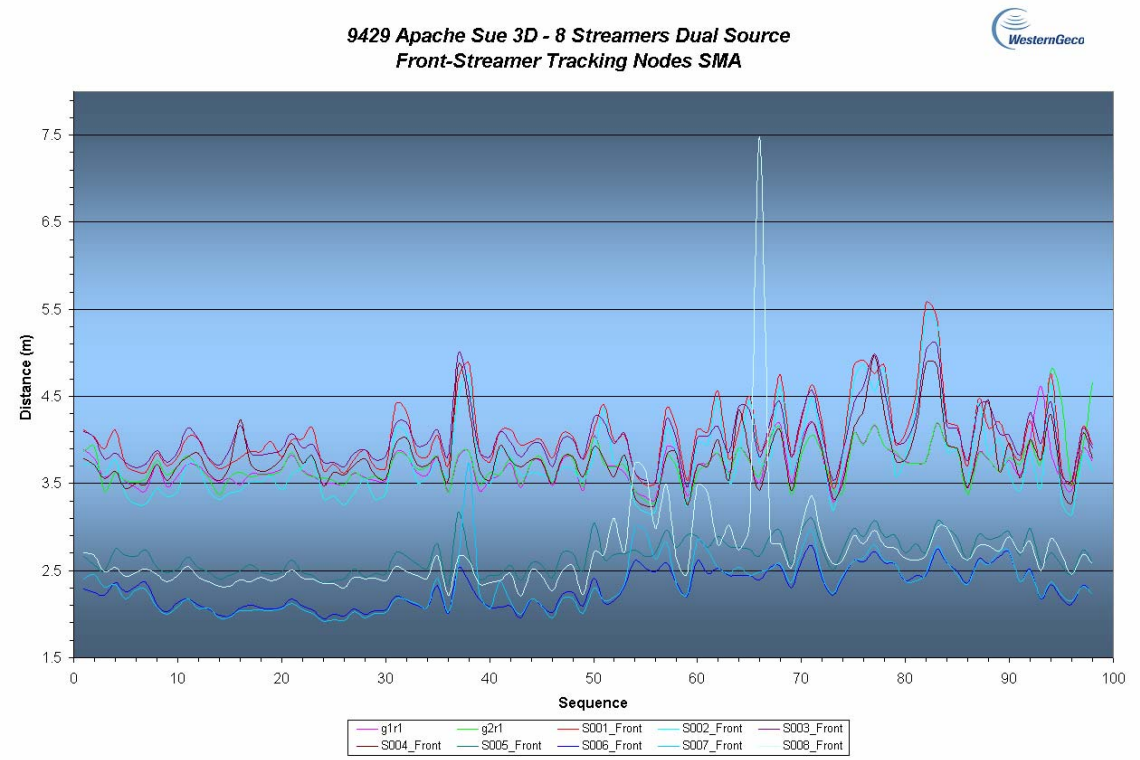
# Exhibit 6 **: Survey Definition Changes Summary**

| | | | |
|---|---|---|---|
| *Client* | Apache | Vessel | **Western Trident** |
| **Area** | Sue | **Start Date** | **15th Jan 2005** |
| **Job No.** | **9429** | **End Date** | **16th Feb 2005** |

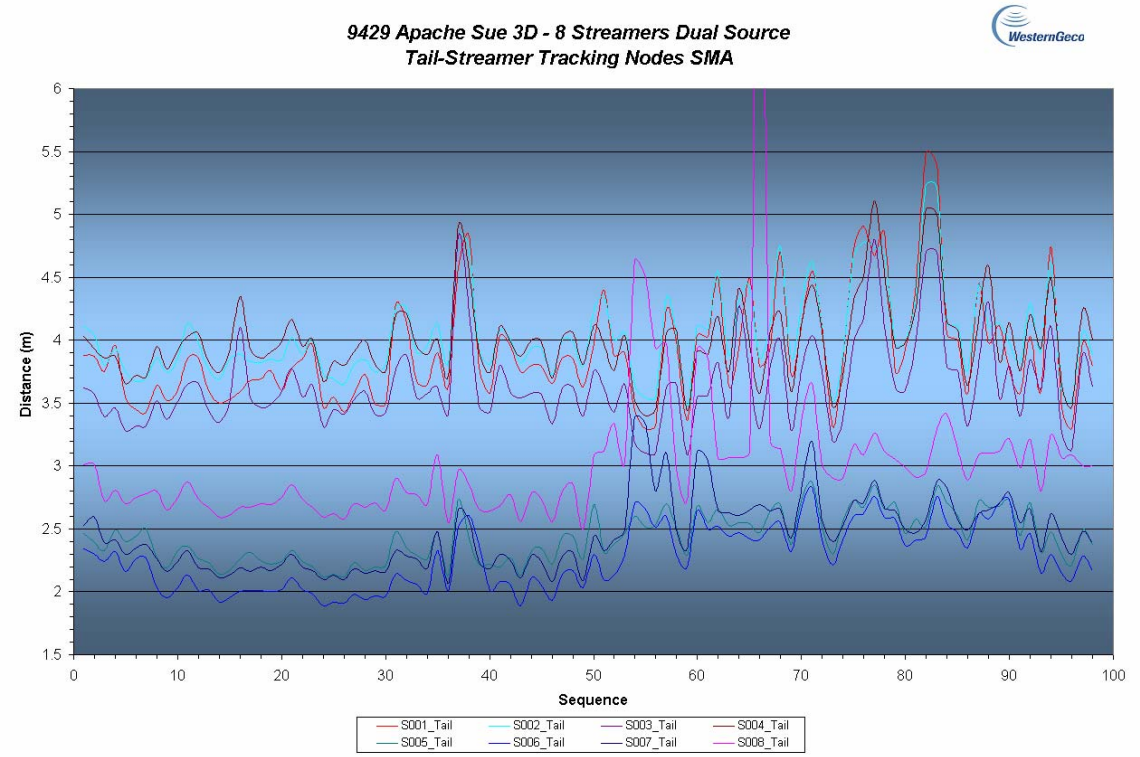
| Date | Surdef in use mas9429_ | From Seq | To ***Seq*** | Offset ***Database*** | 21. Description |
|---|---|---|---|---|---|
| 15-Jan-05 | 01 | 001 | 002 | 01 | Start of Survey |
| 16-Jan-05 | 02 | 003 | 007 | | Recreated Surdef – **No Physical Changes** |
| 18-Jan-05 | 03 | 008 | 019 | | New TS-DIP 02<br>Streamer Depth Was 1516.58 Now 1516.60<br>Water column Was 1513.55 Now 1516.72<br>New Bird S3C08 Was 17645 Now 14602 |
| 22-Jan-05 | 04 | 020 | 022 | | New Bird S7C8 was 12750 now 6860<br>New Bird S7C11 was 9589 now 19997 |
| 23-Jan-05 | 05 | 023 | 044 | | New Bird S7C11 was 19997 now 21073<br>New Bird S7C10 was 16916 now 17876<br>New Bird S8C3 was 14138 now 17024 |
| 30-Jan-05 | 06 | 045 | 045 | | New Bird S2C3 was 19864 now 7051 |
| 30-Jan-05 | 07 | 046 | 049 | | New Bird S7C11 was 21073 now 6308 |
| 31-Jan-05 | 08 | 50 | 50 | | Changed order of input for tailbuoys in SSD. FF01 and FF02 now both on Frequency 1. FF01 now coming in on slot 15 rather than slot 4. |
| 1-Feb-05 | 09 | 51 | 52 | | Adjusted offsets to reflect that the front floats had moved back after the reconfiguration for shallow water and the repair of fairing to correct strumming noise on S003. |
| 2-Feb-05 | 10 | 53 | 56 | | Changed order of input for tailbuoys in SSD. FF01 and FF02 on separate frequencies, FF01 back on Frequency 2. FF01 now coming in on slot 4 rather than slot 15. |
| 4-Feb-05 | 11 | 57 | 58 | | New Bird S6C5 14522 (was 19228) and New TS-DIP 03 |
| 5-Feb-05 | 12 | 59 | 60 | | New Bird S1C4 10238 (was 19664) |
| 5-Feb-05 | 13 | 61 | 67 | | FF02 frequency change, (Reverted to Freq.1) |
| 07-Feb-05 | 14 | 66 | 69 | | New Bird S9C11 6713 (was 17239) |
| 08-Feb-05 | 15 | 70 | 84 | | New Bird S1C19 19864 (was 12203)<br>New Bird S8C19 26361 (was 18861) |
| 11-Feb-05 | 16 | 85 | 90 | | New bird S3C6 14138 (was 17368)<br>New Bird S2C7 6550 (was 19682)<br>New Bird S5C6 19228 (was 14581) |
| 14-Feb-05 | 17u | 91 | 98 | | Two boat modifications for undershoot.<br>New Bird S3C2 15337 (was 10082)<br>New Bird S8C3 19668 (was 17024)<br>New Bird S8C2 9589 (was 18032)<br>New Bird S8C7 19702 (was 20877) |

# Exhibit 7 **: Trend Analysis**

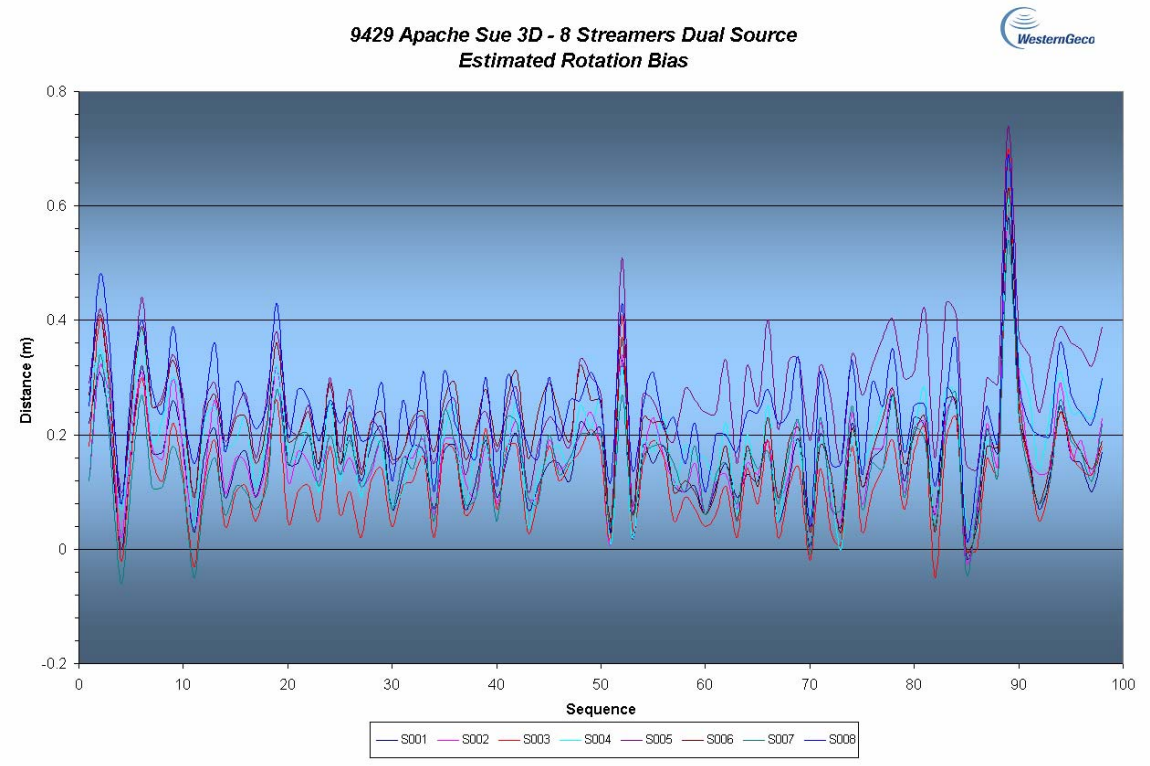
- **Tracking Node (Front) Error Ellipse Semi-major Axis (95%)**



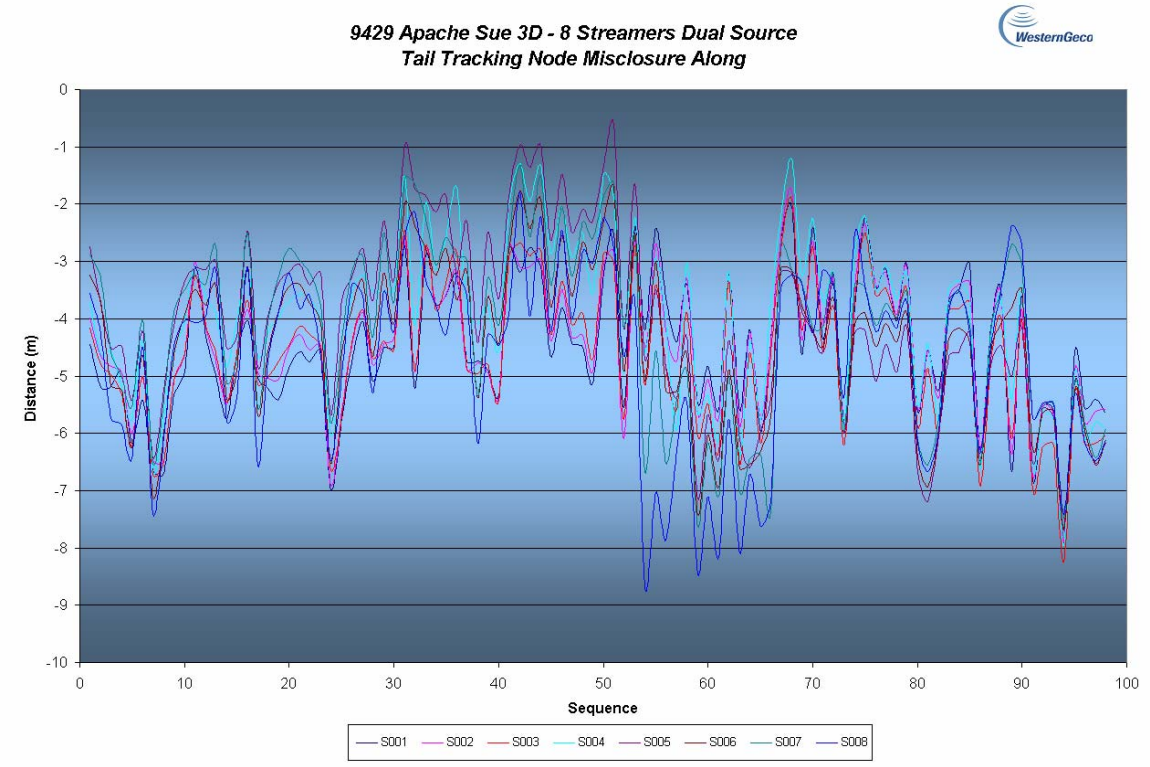

- **Tracking Node (Tail) Error Ellipse Semi-major Axis (95%)**



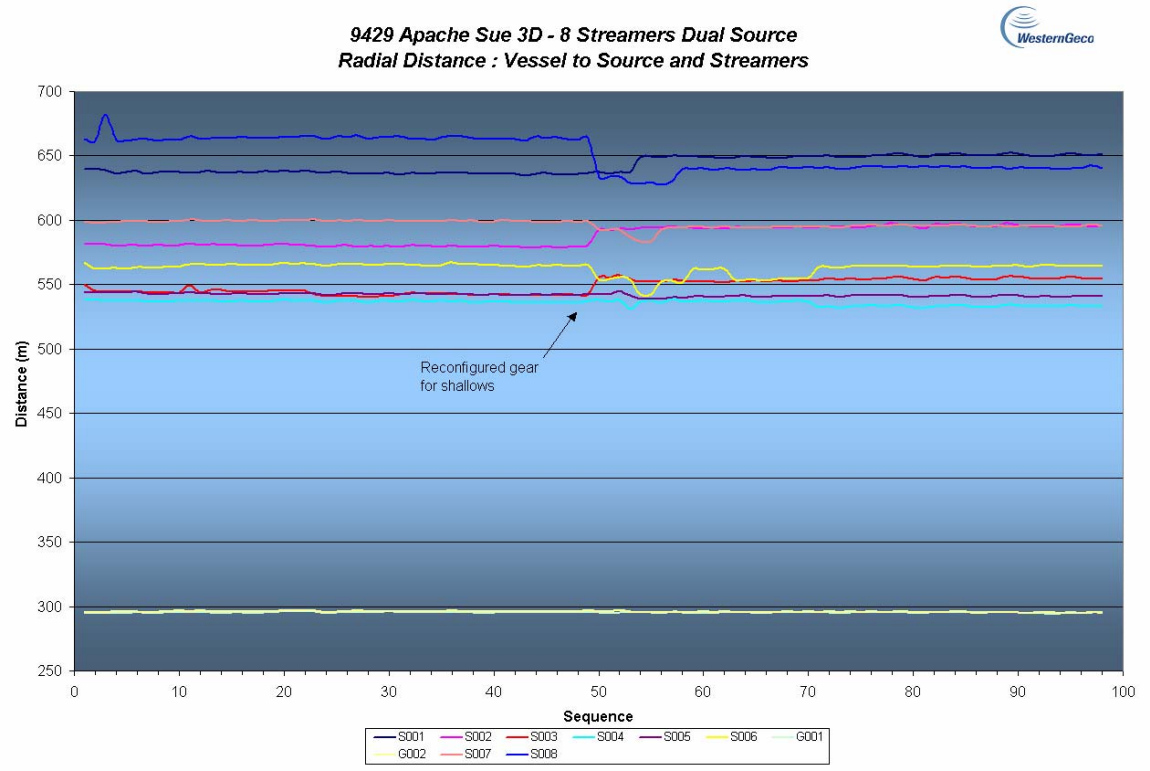
## ❑ Estimated Rotation Bias



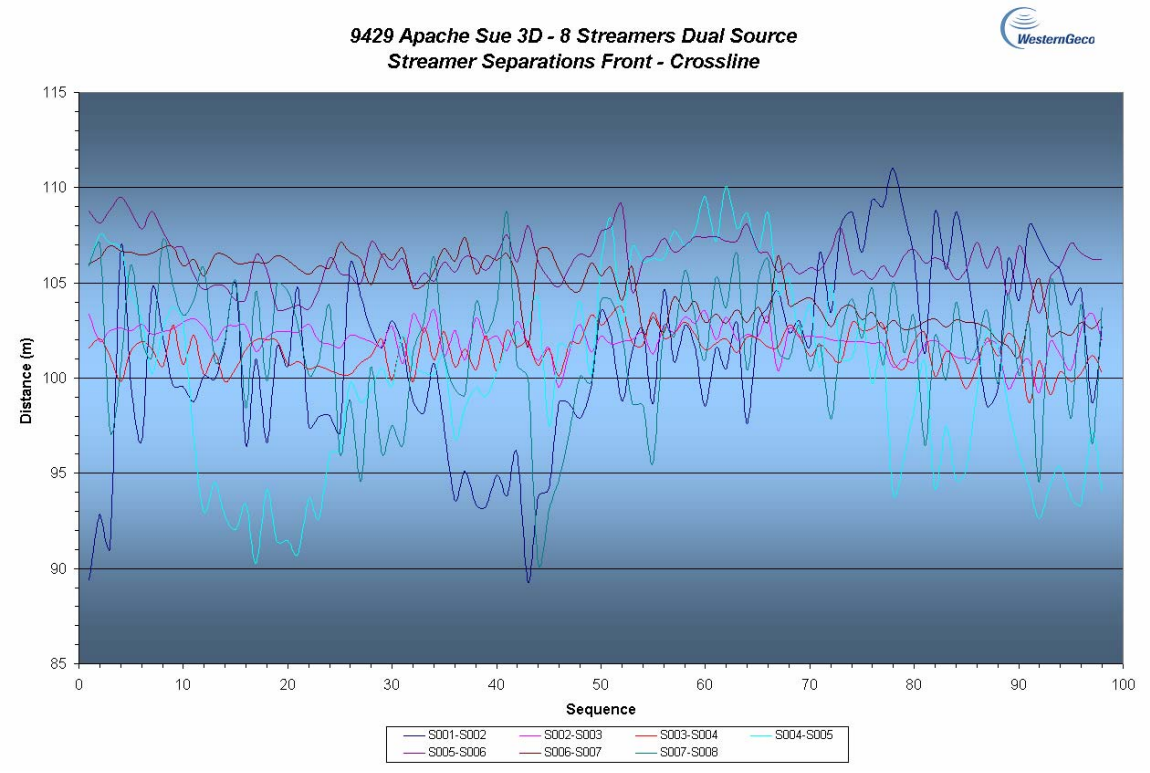

## ❑ Tail Tracking Node Misclosure Along



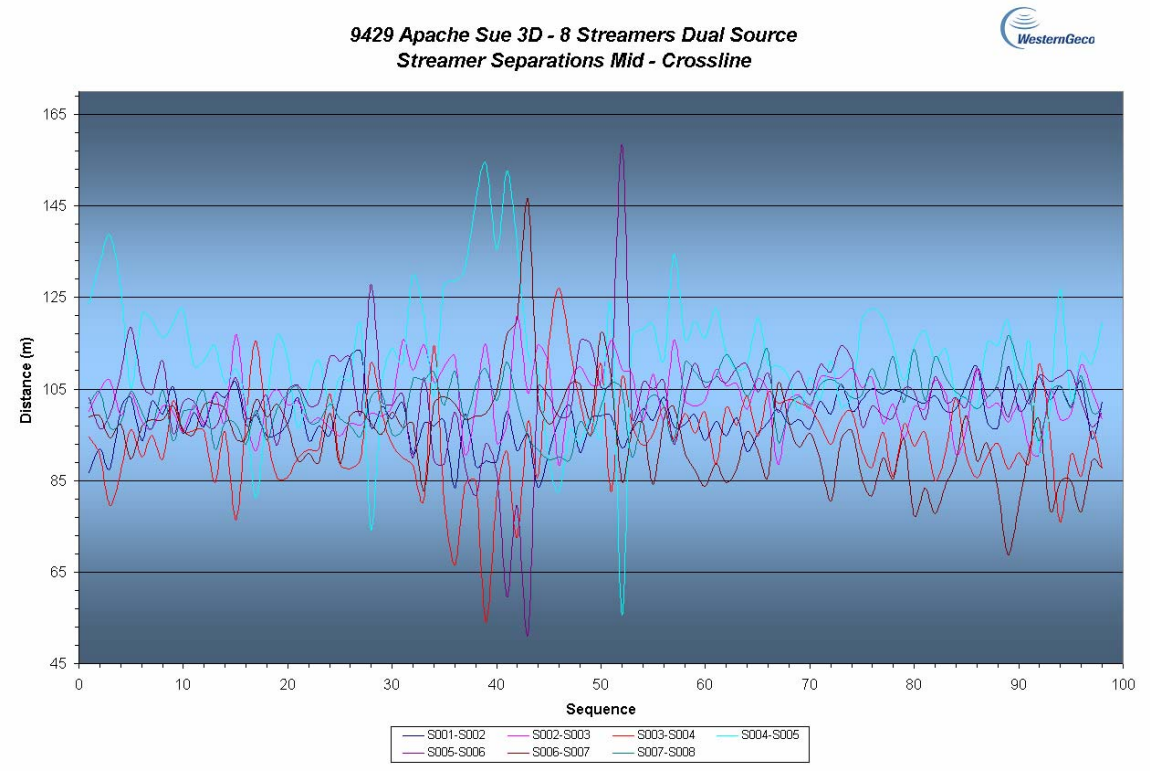
- **Radial Separation (Vessel to all streamers and sources)**



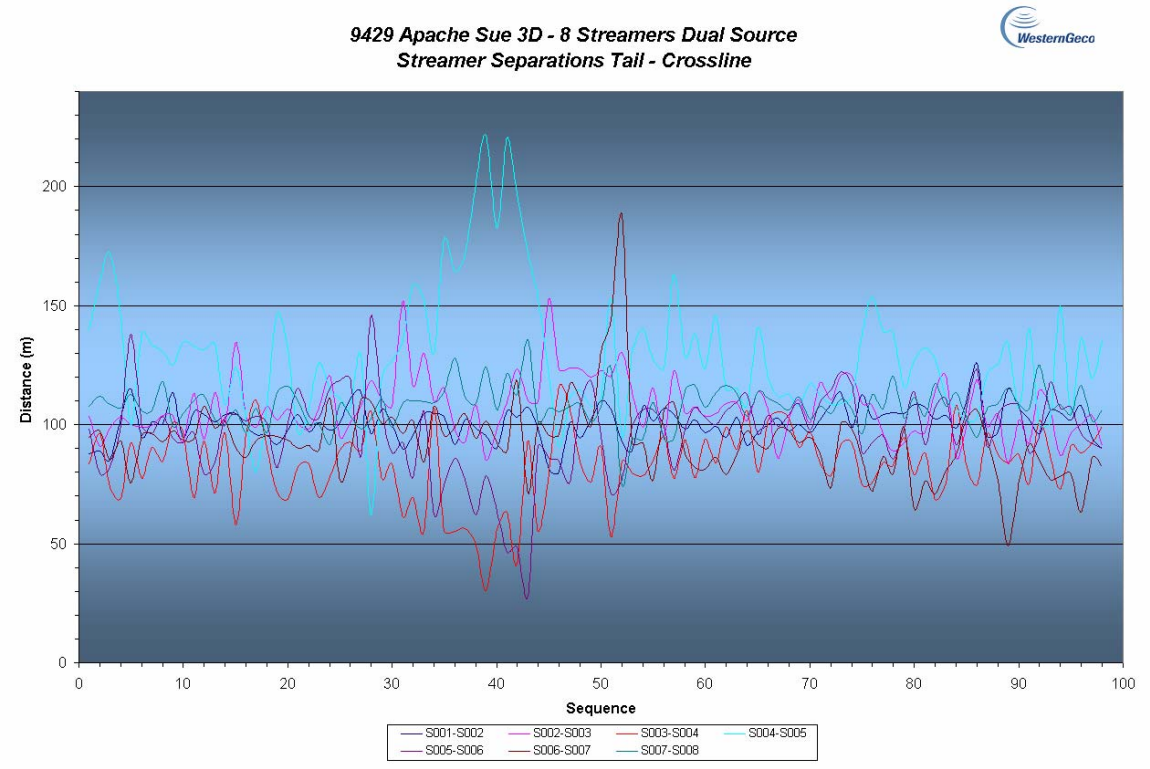

- **Cross Separation (All streamers to front)**



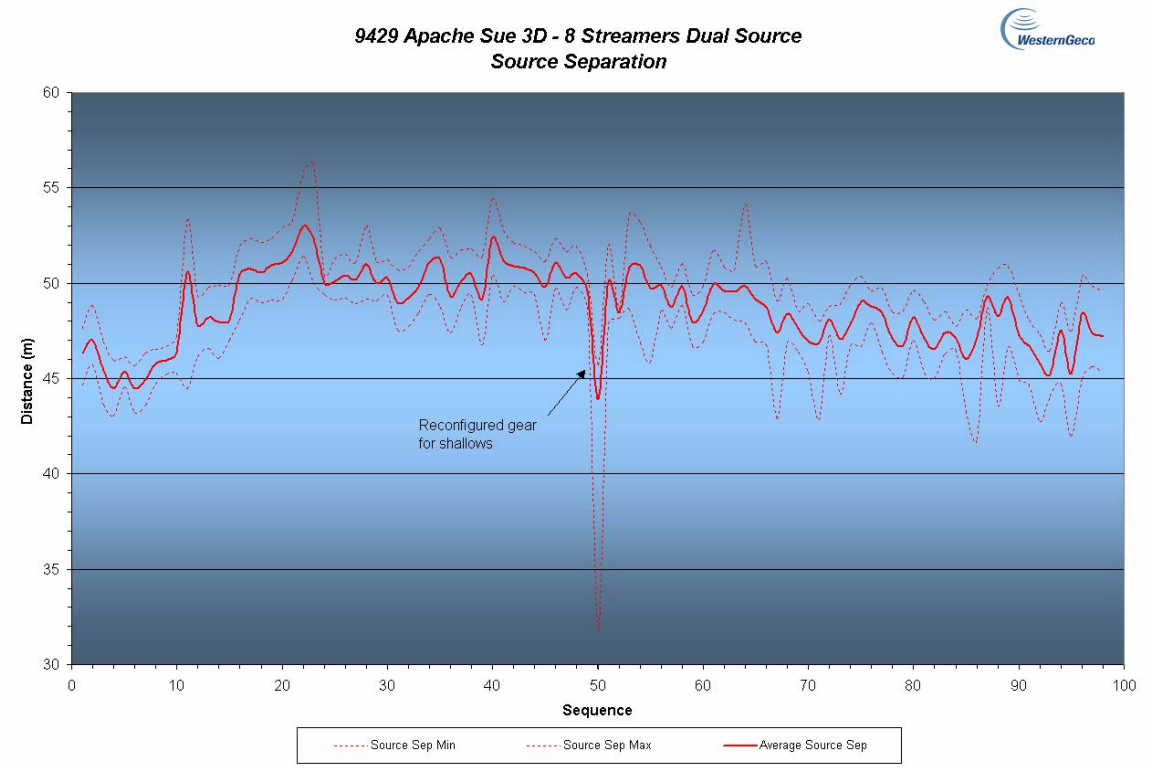
- **Cross Separation (All streamers to middle)**




- **Cross Separation (All streamers to tail)**

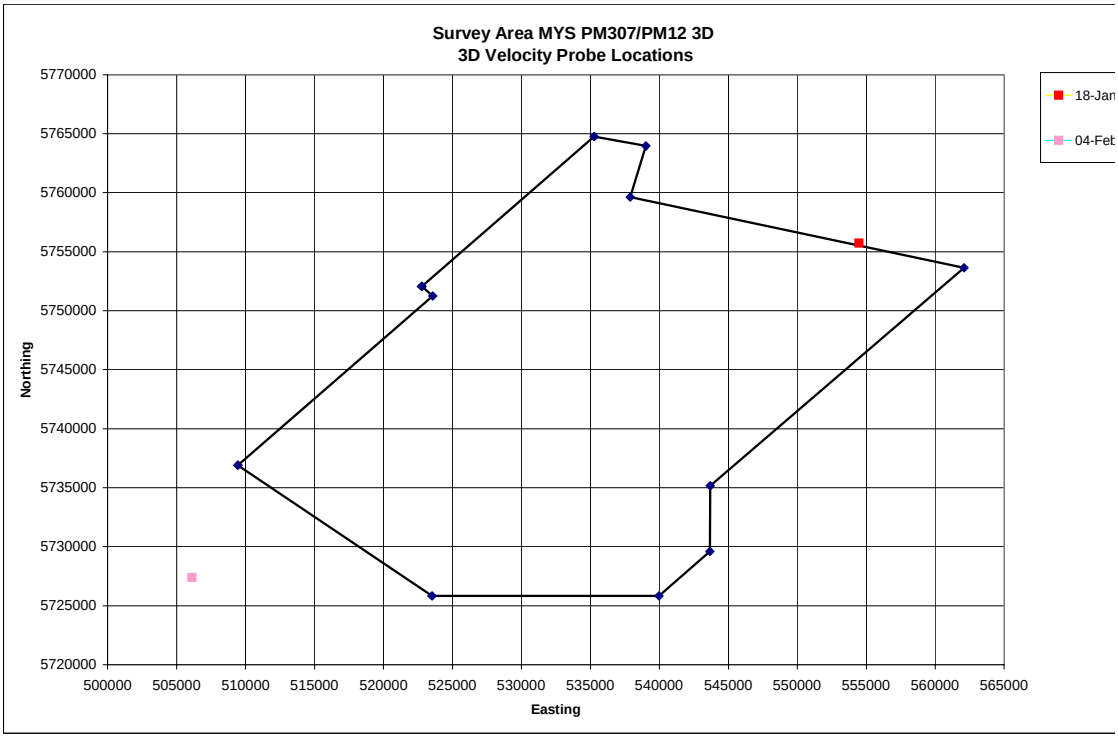


## ❑ Cross Separation (Sources)

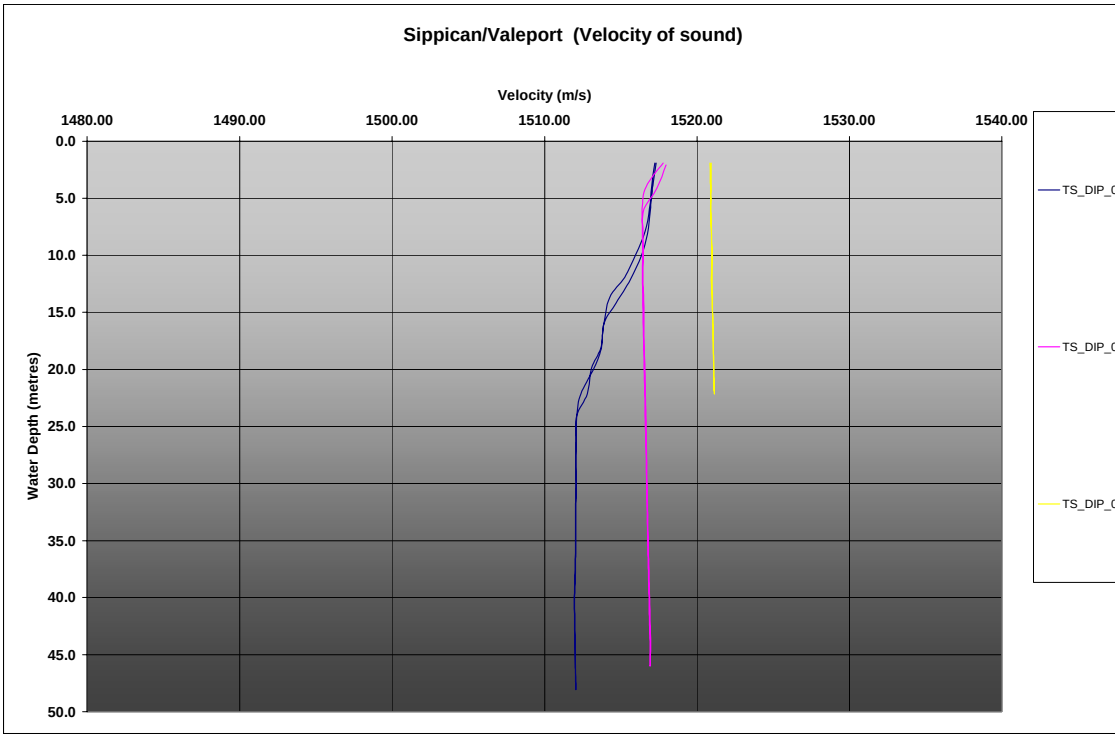


# Exhibit 8 **: Temperature & Salinity Measurements**

## ❑ Measurement Locations




## ❑ Measurement Results



# Table of Contents

# 21. Instrumentation, QC and Processing System

## Description

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

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

The majority of the QC products, less limited by processing time comparatively to on-line processing, were created offline, using the Omega Processing System configured as a small dedicated processing centre with all necessary facilities.
The processing system was connected to the other onboard departments through the vessel network which also provided an easy access to/from onshore processing centre for all required data transfer as well as for onshore support and/or hardware maintenance works. Below is a description of the onboard quality control and processing system instruments.

## Off-Line QC System

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

# 22. Instrumentation and QC Tests

## 22.1 Semi-Monthly 08 Jan 05

**8th January 2005** **APACHE AUSTRALIA**

| ble | | | | | File 1005 | File 1006 | File 1016 | File 1017 | File 1018 | File 1019 | File 1020 | File 1021 | File 1022 | File 1023 | File 1025 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cable | Location | SG | Trace | Channel | T2 @ 0 dB Harmonic Distortion < 0.0005% | T2 @ -10 dB Harmonic Distortion < 0.002% | T5 Pre-Amp Noise < .210 uB | T10 Common Mode .7250 <66dB FS | T11 Cross-Feed (odd) <2.3 mv <56dB FS | T12 Cross-Feed (even) <2.3mv <56dB FS | T 6 Impulse response 2Hz +/- 7.0% | T7 Impulse Response 8/18 +/- 7.0% | T7 Step Function 8/18 +/- 7.0% | T4 DRD 8/18 +/- 7.0% | T0 Cable Noise 8/18 |
| **1** | | | | | | | | | | | | | | | |
| | 6b | | 91 | 91 | | | | 0.7562 | | | | | | | |
| | 12b | | 186 | 186 | | | | | | 54.1 | | | | | |
| | 15a | | 225 | 225 | | | | | | | | | 14.9 | | |
| | 15a | | 227 | 227 | | | | | | | | 274.6 | 40 | 73.24 | |
| | 16b | SG | 256 | 256 | | | | | | | | | 29.6 | 68.12 | |
| **2** | | | | | | | | | | | | | | | |
| | 9b | | 523 | 139 | | | | | | | | | 29.2 | 7.15 | |
| | 13a | SG | 584 | 200 | | | | | | | | 7.22 | 24.5 | | |
| | 13b | | 589 | 205 | | | | | | 44.8 | | | | | |
| | 15a | | 615 | 231 | | | | | | | | 7.09 | 7.1 | 7.89 | |
| | 15a | SG | 616 | 232 | | | | | 35.3 | | | | | | |
| | 15b | | 617 | 233 | | | | | | 29.8 | | | | | |
| | 15b | | 622 | 238 | | | | | | 41.8 | | | | | |
| | 15b | | 623 | 239 | | | | | 31.74 | | | | | | |
| | 16a | | 627 | 243 | | | | | | | | 248 | 36.4 | 72.58 | |
| | 18a | | 661 | 277 | | | | | | | | 8.08 | 7.9 | | |
| | 24a | | 755 | 371 | | | | | | | | 9.66 | 9.5 | | |
| **3** | | | | | | | | | | | | | | | |
| | 10a | | 919 | 151 | | | | | | | | 7.13 | 7.1 | 7.7 | |
| | 10b | | 924 | 156 | | | | | | | | 8.6 | 8.6 | | |
| | 12b | | 953 | 185 | | | | | | 48.1 | | | | | |
| | 12b | | 959 | 191 | | | | | 33.303 | | | | | | |
| | 13b | SG | 976 | 208 | | | | | 43.87 | | | | | | |
| | 14a | | 978 | 210 | | | | | | 39.3 | | | | | |
| | 15a | | 993 | 225 | | | | | | | | | 20.7 | 59.7 | |
| | 16b | | 1017 | 249 | | | | | | | | 9.96 | 10 | 7.3 | |
| | 16b | | 1020 | 252 | | | | | | | | 8.96 | 8.9 | | |
| | 16b | | 1023 | 255 | | | | | | | | 8.8 | 8.8 | | |
| | 19a | | 1057 | 289 | | | | | | | | 8.33 | 8.1 | | |
| | 22b | | 1113 | 345 | | | | | | | | 8.8 | 8.5 | | |
| | 22b | | 1119 | 351 | | | | | | | | 7.5 | 7.4 | | |
| | 23a | | 1124 | 356 | | | | | | | | 24.8 | 30.2 | 64.1 | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **4** | | | | | | | | | | | | | | | |
| | 8b | | 1273 | 121 | | | | | | 53.88 | | 7.29 | | | |
| | 8b | SG | 1280 | 128 | | | | | | | | 7.22 | 7.2 | | |
| | 10a | | 1297 | 145 | | | | | | 36.5 | | | | 15.4 | |
| | 10a | | 1302 | 150 | | | | | | 40.8 | | | | | |
| | 11a | | 1313 | 161 | | | | | | 14.5 | | 11.12 | 19.7 | 34.9 | |
| | 11a | | 1314 | 162 | | | | | | 1.5 | | 22.1 | 31.5 | 53.3 | |
| | 11a | | 1315 | 163 | | | | | 0.768 | | | 8.7 | 12.3 | 30.8 | |
| | 11a | | 1317 | 165 | | | | | | 45 | | | | | |
| | 13a | | 1345 | 193 | | | | | | 35.4 | | | | | |
| | 13a | | 1349 | 197 | | | | | | 38 | | | | | |
| | 16b | | 1407 | 255 | | | | | 44.4 | | | | | | |
| | 19b | | 1449 | 297 | | | | | | 34.5 | | | | | |
| | 20a | | 1462 | 310 | | | | | | | | 12.33 | 12.2 | 10.07 | |
| | 23b | | 1518 | 366 | | | | | | | | 8.3 | 8.1 | | |
| | 24b | | 1533 | 381 | | | | | | 52.7 | | | | | |
| | 24b | SG | 1536 | 384 | | | | | 40.4 | | | | | 8.3 | |
| **5** | | | | | | | | | | | | | | | |
| | 7a | | 1633 | 97 | | | | | | 42.3 | | | | | |
| | 7a | | 1634 | 98 | | | | | | 46.44 | | | | | |
| | 7a | | 1635 | 99 | | | | | 54 | | | | | | |
| | 10a | | 1687 | 151 | | | | | | | | 9.6 | 9.65 | 7.2 | |
| | 10b | | 1692 | 156 | | | | | | | | 7.8 | 7.63 | | |
| | 16a | | 1783 | 247 | | | | | | | | 7.8 | 7.75 | | |
| | 17b | | 1806 | 270 | | | | | | | | 13.7 | 13.7 | 11.4 | |
| | 18a | SG | 1816 | 280 | | | | | | | | 265.1 | | | |
| | 19a | | 1826 | 290 | | | | | | 36.1 | | | | | |
| **6** | | | | | | | | | | | | | | | |
| | 6a | SG | 2008 | 88 | | | | | 48.8 | | | 17.1 | 17.2 | 17.97 | |
| | 8b | | 2047 | 127 | | | | | | | | 8.05 | 8.07 | | |
| | 24b | SG | 2304 | 384 | | | | | | | | 71.97 | 34.08 | 66.34 | |
| | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **7** | | | | | | | | | | | | | | | |
| | 11a | SG | 2472 | 168 | | | | | 55.7 | | | | | | |
| | 11b | | 2478 | 174 | | | | | | 51.3 | | | | | |
| | 16a | | 2546 | 242 | | | | | | 51 | | | | | |
| | 16a | | 2548 | 244 | | | | | 39 | | | | | | |
| | 16a | | 2549 | 245 | | | | | | 40.4 | | | | | |
| | 16a | | 2550 | 246 | | | | | | 23.2 | | | | | |
| | 16a | | 2551 | 247 | | | | | 18.4 | | | | | | |
| | 16b | | 2553 | 249 | | | | | | 49.5 | | | | | |
| | 18b | | 2588 | 284 | | | | | 46.8 | | | 60.33 | 60.8 | 62 | |
| | 23a | | 2658 | 354 | | | | | | 37.6 | | | | | |
| | 23b | | 2667 | 363 | | | | | 55.5 | | | | | | |
| | 23b | | 2671 | 367 | | | | | 39.6 | | | | | | |
| | 24a | SG | 2680 | 376 | | | | | 49.4 | | | | | | |
| | 24b | | 2681 | 377 | | | | | | 20.4 | | | 7.3 | 16.1 | |
| | 24b | | 2682 | 378 | | | | | | 0.396 | | 56.27 | 69.11 | 64.9 | |
| | 24b | | 2683 | 379 | | | | | 16.52 | | | 21.95 | 40.6 | 54.4 | |
| | 24b | | 2684 | 380 | | | | | 6.4 | | | | 10.1 | 22 | |
| | 24b | | 2685 | 381 | | | | | | 28.4 | | 8.55 | 18.22 | 33.4 | |
| | 24b | | 2686 | 382 | | | | | | 16.7 | | 8.48 | 15.76 | 37.5 | |
| | 24b | | 2687 | 383 | | | | | 5.2 | | | | 10.55 | | |
| | 24b | SG | 2688 | 384 | | | | | 24.2 | | | 966.4 | 9.8 | | |
| **8** | | | | | | | | | | | | | | | |
| | 10a | | 2837 | 149 | | | | | | | | | 7.9 | 14.9 | |
| | 10b | | 2842 | 154 | | | | | | | | | 15.8 | 7.7 | |
| | 11a | SG | 2856 | 168 | | | | | 44.9 | | | | | | |
| | 11b | | 2860 | 172 | | | | | 52.8 | | | | | | |
| | 11b | | 2861 | 173 | | | | | | 25.1 | | | | | |
| | 19a | | 2978 | 290 | | | | | | 50.1 | | | | | |
| | | | | | | | | | | | | | | | |

## 22.2 Daily Tests

| | Apache 9429 | | | Reel #: V30380 | | | seq 43 | | January 29, 2005 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cable** | **Location** | **SG** | **Trace** | **Channel** | **T2 @ 0 dB** | **T2 @ -60 dB** | **T5 Noise** | **T6 Impulse** | **T4 DRD** | **T7 Impulse** |
| | | | | | **+/- 0.0005%** | **+/- 0.5%** | | **+/- 7.0 %** | **+/- 10.0 %** | **+/- 10.0 %** |
| **1** | | | | | | | | | | |
| | 16a | | 243 | 243 | | | | | 72.780 | 273.29 |
| | 18a | | 274 | 274 | | | | | | |
| | 18a | | 275 | 275 | | | | | | |
| **2** | | | | | | | | | | |
| | 2b | | 413 | 29 | | | | | | |
| | 5a | | 452 | 68 | | | | | | |
| | 9a | SG | 520 | 136 | | | | | 22.199 | |
| | 10b | | 543 | 159 | | | | | | 10.51 |
| | 16a | | 627 | 243 | | | | | | 28.24 |
| **3** | | | | | | | | | | |
| | 16b | | 1017 | 249 | | | | | | 10.38 |
| | 16b | | 1023 | 255 | | | | | | 10.46 |
| | 19a | | 1057 | 289 | | | | | | 10.11 |
| | 23a | | 1124 | 356 | | | | | 24.934 | |
| **4** | | | | | | | | | | |
| | 10a | | 1297 | 145 | | | | | 10.233 | |
| | 12b | SG | 1344 | 192 | | | | | | |
| | 13a | | 1345 | 193 | | | | | | |
| | 13a | | 1346 | 194 | | | | | 14.516 | |
| | 13a | | 1349 | 197 | | | | | 10.109 | |
| | 20a | | 1462 | 310 | | | | | | 11.82 |
| **5** | | | | | | | | | | |
| | 17b | | 1806 | 270 | | | | | 11.686 | 14.98 |
| **6** | | | | | | | | | | |
| | 6a | SG | 2008 | 88 | | | | | 18.084 | 17.3 |
| | 10a | | 2065 | 145 | | | | | 15.100 | |
| | 24b | SG | 2304 | 384 | | | | | 22.871 | |
| **7** | | | | | | | | | | |
| | 18b | | 2588 | 284 | | | | | 62.145 | 60.96 |
| | 23b | | 2665 | 361 | | | | | | |
| | 23b | | 2667 | 363 | | | | | | |
| | 23b | | 2669 | 365 | | | | | | |
| | 23b | | 2670 | 366 | | | | | | 11.94 |
| **8** | | | | | | | | | | |
| | | | | | | | | | | |

| Cable | Apache 9429 | | | Reel #: V30546 | | | seq 67 | | February 7, 2005 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cable** | **Location** | **SG** | **Trace** | **Channel** | **T2 @ 0 dB** | **T2 @ -60 dB** | **T5 Noise** | **T6 Impulse** | **T4 DRD** | **T7 Impulse** |
| | | | | | **+/- 0.0005%** | **+/- 0.5%** | | **+/- 7.0 %** | **+/- 10.0 %** | **+/- 10.0 %** |
| **1** | | | | | | | | | | |
| | 16a | | 243 | 243 | | | | | 72.780 | 272.92 |
| | 18a | | 274 | 274 | | | | | | |
| | 18a | | 275 | 275 | | | | | | |
| **2** | | | | | | | | | | |
| | 2b | | 413 | 29 | | | | | | |
| | 5a | | 452 | 68 | | | | | | |
| | 9a | SG | 520 | 136 | | | | | 22.199 | |
| | 10b | | 543 | 159 | | | | | | 10.60 |
| | 11b | | 554 | 170 | | | | | 29.400 | |
| | 11b | | 555 | 171 | | | | | 66.900 | 80.40 |
| | 16a | | 627 | 243 | | | | | | 39.40 |
| **3** | | | | | | | | | | |
| | 4a | | 822 | 54 | | | | | | |
| | 12b | | 959 | 191 | | | | | | |
| **4** | | | | | | | | | | |
| | 5a | | 1220 | 68 | | | | | | |
| | 7b | | 1257 | 105 | | | | | 12.200 | |
| | 10a | | 1297 | 145 | | | | | 31.200 | |
| | 10a | | 1298 | 146 | | | | | 24.200 | |
| | 12b | SG | 1344 | 192 | | | | | | |
| | 13a | | 1345 | 193 | | | | | 24.500 | |
| | 13a | | 1346 | 194 | | | | | 10.100 | |
| | 20a | | 1462 | 310 | | | | | 15.600 | 11.70 |
| **5** | | | | | | | | | | |
| | 17b | | 1806 | 270 | | | | | 11.686 | 14.98 |
| **6** | | | | | | | | | | |
| | 6a | SG | 2008 | 88 | | | | | 18.084 | 18.08 |
| | 24b | SG | 2304 | 384 | | | | | 23.480 | |
| **7** | | | | | | | | | | |
| | 12b | | 2490 | 186 | | | | | 15.600 | |
| | 18b | | 2588 | 284 | | | | | 15.600 | 61.45 |
| **8** | | | | | | | | | | |
| | | | | | | | | | | |

## 22.3 Semi-Monthly 1 Feb 05

| ble | | | | | 1-Feb-05 | | | | APACHE 9249 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | File 1005 | File 1006 | File 1014 | File 1015 | File 1016 | File 1017 | File 1018 | File 1019 | File 1020 | File 1021 | File 1022 | File 1023 | File 1025 |
| Cable | Location | SG | Trace | Channel | T2 @ 0 dB Harmonic Distortion < 0.0005% | T2 @ -10 dB Harmonic Distortion < 0.002% | T2 @ -90 dB DRD 4% +/- 4.0% | T2 @ -100 dB DRD 4% +/- 4.0% | T5 Pre-Amp Noise < .210 uB | T10 Common Mode .7250 <66dB FS | T11 Cross-Feed (odd) <2.3 mv <56dB FS | T12 Cross-Feed (even) <2.3mv <56dB FS | T 6 Impulse response 2Hz +/- 7.0% | T7 Impulse Response 8/18 +/- 7.0% | T7 Step Function 8/18 +/- 7.0% | T4 DRD 8/18 +/- 7.0% | T0 Cable Noise 8/18 |
| **1** | | | | | | | | | | | | | | | | | |
| | 11a | SG | 168 | 168 | | | | | | | 43.440 | | | | | | |
| | 16a | | 243 | 243 | | | | | | | | | | 272.92 | 39.07 | 72.111 | |
| **2** | | | | | | | | | | | | | | | | | |
| | 9a | SG | 520 | 136 | | | | | | | | | | | 14.63 | 29.584 | |
| | 10b | | 543 | 159 | | | | | | | | | | 10.07 | | | |
| | 11b | | 553 | 169 | | | | | | | | 19.632 | | | | | |
| | 11b | | 554 | 170 | | | | | | | | 973.564 | | | | | |
| | 11b | | 555 | 171 | | | | | | | 985.063 | | | | | | |
| | 15a | SG | 616 | 232 | | | | | | | 13.066 | | | | | | |
| | 16a | | 627 | 243 | | | | | | | | | | | 20.66 | 61.942 | |
| **3** | | | | | | | | | | | | | | | | | |
| | 1b | | 780 | 12 | 0.000504 | | | | | | | | | | | | |
| | 12b | | 953 | 185 | | | | | | | | 60.577 | | | | | |
| | 12b | | 959 | 191 | | | | | | | 81.620 | | | | | | |
| | 14a | | 978 | 210 | | | | | | | | 10.664 | | | | | |
| | 23a | | 1124 | 356 | | | | | | | | | | | 18.98 | 57.173 | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **4** | | | | | | | | | | | | | | | | |
| | 9b | SG | 1296 | 144 | | | | | | | 112.631 | | | | | |
| | 10a | | 1297 | 145 | | | | | | | | 122.403 | | | | 12.861 |
| | 10a | | 1302 | 150 | | | | | | | | 12.391 | | | | |
| | 12b | | 1338 | 186 | | | | | | | | 132.612 | | | | |
| | 12b | | 1340 | 188 | | | | | | | 126.704 | | | | | |
| | 13a | | 1345 | 193 | | | | | | | | 30.472 | | | | 15.165 |
| | 13a | | 1346 | 194 | | | | | | | | | | | | 12.928 |
| | 13a | | 1348 | 196 | | | | | | | 72.999 | | | | | |
| | 13a | | 1349 | 197 | | | | | | | | 69.576 | | | | 11.839 |
| | 13a | SG | 1352 | 200 | | | | | | | 22.722 | | | | | |
| | 16b | | 1407 | 255 | | | | | | | 13.130 | | | | | |
| | 20a | | 1462 | 310 | | | | | | | | | | 11.70 | 11.61 | |
| | 24b | SG | 1536 | 384 | | | | | | | 13.138 | | | | | |
| **5** | | | | | | | | | | | | | | | | |
| | 17b | | 1806 | 270 | | | | | | | | | | 14.90 | 14.89 | 11.838 |
| | 19a | | 1826 | 290 | | | | | | | | 23.221 | | | | |
| **6** | | | | | | | | | | | | | | | | |
| | 6a | SG | 2008 | 88 | | | | | | | | | | 17.20 | 17.22 | 18.170 |
| | 10a | | 2065 | 145 | | | | | | | | 28.708 | | | | |
| | 24b | SG | 2304 | 384 | | | | | | | | | | | 18.15 | 26.383 |
| **7** | | | | | | | | | | | | | | | | |
| | 16a | | 2546 | 242 | | | | | | | | 11.262 | | | | |
| | 16a | | 2550 | 246 | | | | | | | | 59.456 | | | | |
| | 16a | | 2551 | 247 | | | | | | | 83.726 | | | | | |
| | 18b | | 2588 | 284 | | | | | | | | | | 61.00 | 61.00 | 62.260 |
| **8** | | | | | | | | | | | | | | | | |
| | 11b | | 2860 | 172 | | | | | | | 19.515 | | | | | |
| | 11b | | 2861 | 173 | | | | | | | | 28.647 | | | | |

## 22.4 QC Tests

### 22.4.1 Gain Correction Test.

The Gain parameters, determined by tests conducted at the beginning of Moby survey, were checked and accepted.
The single velocity function, used for Geospread Compensation and NMO correction is presented below.

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

| TIME(ms) | Velocities (m/s) |
|---|---|
| 0 | 1500 |
| 75 | 1500 |
| 100 | 1530 |
| 400 | 1900 |
| 700 | 2312 |
| 800 | 2372 |
| 1270 | 2600 |
| 2000 | 3200 |
| 3300 | 4400 |
| 5000 | 5400 |

# 23.QC Products and Processing Sequence

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

## 23.1 Shots and FK Analysis

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

Shot records were also displayed offline within the Omega Processing System. Every 105$^{th}$ shot, all cables were written to a QCViewer file that could be displayed on screen for identifying noisy traces and interference.
For the same shots FK analysis was performed. FK displays were used as an extra tool helping to identify the different kind of noise that could affect seismic records.

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

## 23.2 RMS Analysis

### 23.2.1 Deep and Ambient RMS Windows

Deep window RMS values were calculated in a time window from 4500 – 5000 ms of the records.
RMS values were calculated for every trace, each shot.
Ambient window RMS values were calculated in a time window from 500 – 1000 ms.
The calculation was performed for the last 100 filed channels of each streamer.

**Processing Sequence**

| | | |
|---|---|---|
| 1. | Data Input: | Deep RMS: All shots, all channels, window 4500 - 5000 ms.<br><br>Ambient RMS: All shots, field channels 285 - 384, window 500 - 1000 ms. |
| 2. | Scaling: | By 71.428571 to convert amplitudes to microbars. |
| 3. | Raw RMS Analysis: | One trace is output for each shot containing the RMS amplitude over the window for each selected channel:<br>Deep RMS analysis: field channels 1 – 384;<br>Ambient RMS analysis: field channels 285 – 384;<br><br>Minimum phase low pass filter at 8 Hz 18 dB/Oct was applied. |
| 4. | Low Frequency RMS Analysis: | One trace is output for each shot containing the RMS amplitude over the window for each channel.<br>Minimum phase low pass filter at 8 Hz 18 dB/Oct was applied. |
| 5. | Mid Frequency RMS Analysis: | One trace is output for each shot containing the RMS amplitude over the window for each channel.<br>Minimum phase band pass filter was applied:<br>Low cut 8 Hz 18 dB/Oct;<br>High cut 70 Hz 72 dB/Oct. |
| 6. | High Frequency RMS Analysis: | One trace is output for each shot containing the RMS amplitude over the window for each channel.<br>Minimum phase low cut filter at 70 Hz 72 dB/Oct was applied. |

### 23.2.2 RMS Displays

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

The first three displays, described below, are based on the same Raw Deep RMS data.
The reason to produce all of them is that each of them better highlight some of the events, that may be difficult to be spotted or measured on other plots.
The fourth display combines data, measured in different time windows and in different frequency diapasons.

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

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

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

**Average RMS values of each cable versus Shotpoint.** The Display was generated in order to identify noisy areas throughout the sail line; to detect shots, affected by electrical noise (example: telemetry error), direction of any interfering external noise.
The display was produced both **on-line** and **off-line** with Raw RMS data (2 Hz / 12 dB/Oct LCF).

**Bandpass Average Deep and Ambient RMS values versus Shotpoint.** For each shot RMS values were averaged and plotted versus Shotpoint. Correspondingly to 23.2.1, five graphs were presented on display: Raw Deep, Low frequency, Mid frequency and High frequency Deep RMS, Raw Ambient (consisting of a the last 100 traces of each cable over a window of 500-1000ms).
A possibility to observe and analyse together the RMS, registered in different time and frequencies windows, helps to identify the cause of noise and separate the real noise, particularly swell noise, from noise, caused by geological events (strong seismic signal at deep times).
This display was produced **off-line**.
An **on-line** modification produced only a pair of Raw Deep RMS and Raw Ambient RMS as a main identifier of the level of swell noise.

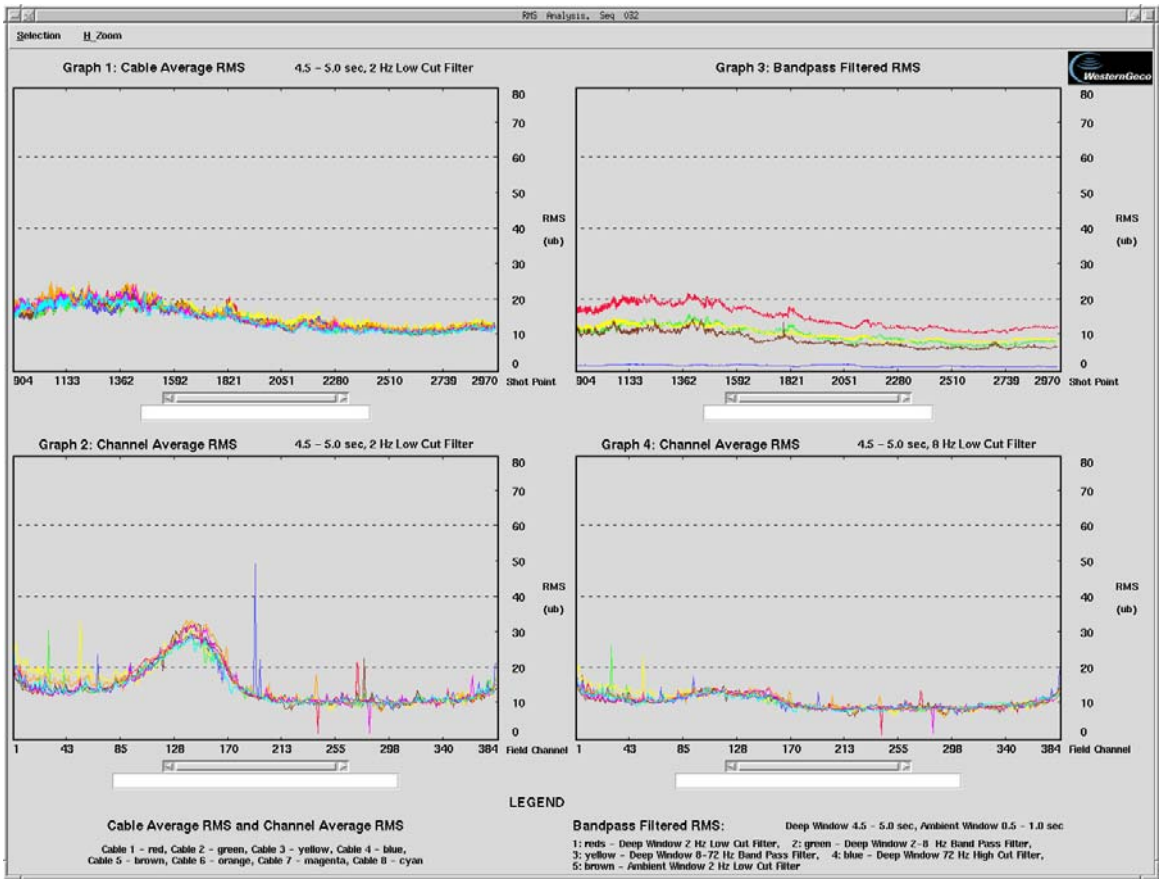



***Figure 1. RMS Attributes Display.***

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

## 23.3 Bad Traces Editing

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

Zeroed, distorted, noisy and weak traces were identified as bad and included in the acquisition log as edits.
Any shots with parity or Telemetry errors were identified and noted in the acquisition log as a shot edit for that streamer.

All shots affected by misfires, low or high pressure, or shots where synchronisation error exceeded 1.25 ms for any gun, also were added to the Edits File.

In addition, extra traces that fell out of depth specification were detected from P1/90 and output into a text file in a form "Shotpoint" – "Trace".
These depth edits also were added to a "bad traces" file.
To be able to visualize the depth edits text file and final edits file for better inspection a plot Traces vs Shotpoints with colour-coded depth were produced for each line (figure 2).

Finally, all edits from "bad traces" file also were produced as a plot Traces vs Shotpoints (figure3). These plots were presented to client's representatives on board.

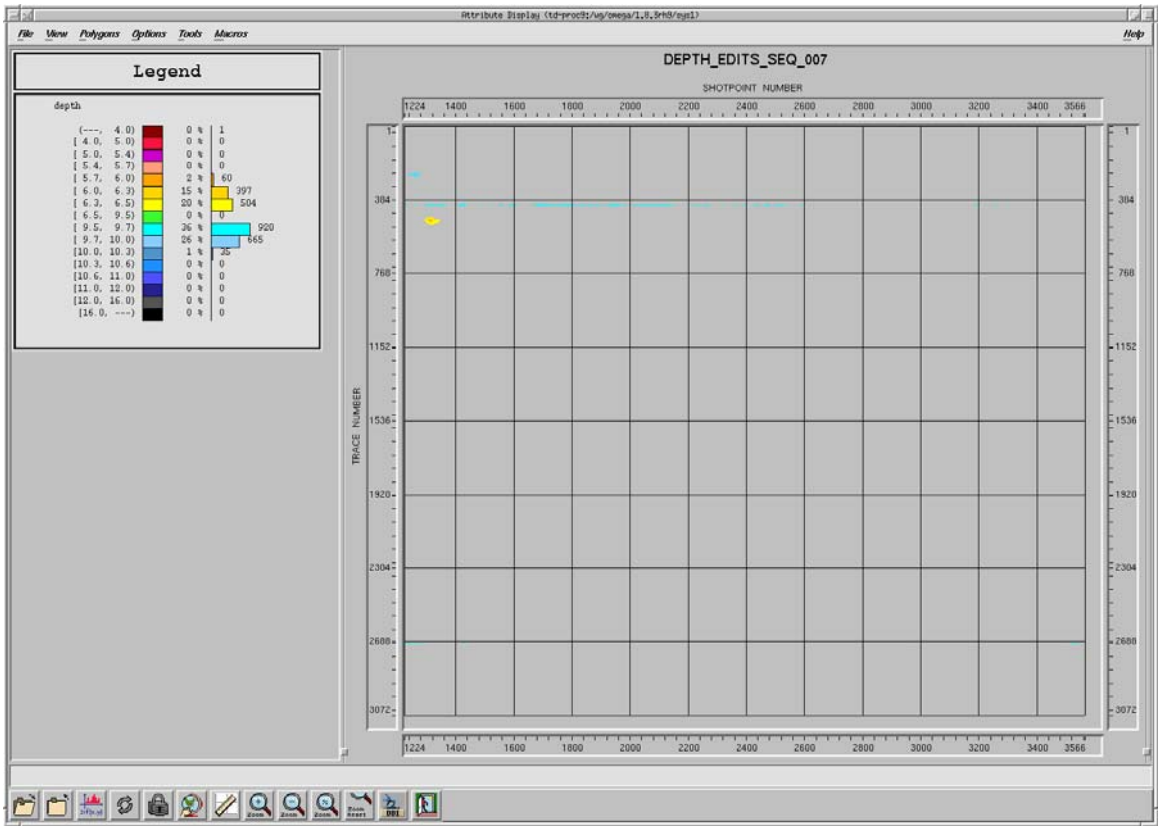



***Figure 2. Depth Edits Display (Sequence 007).***

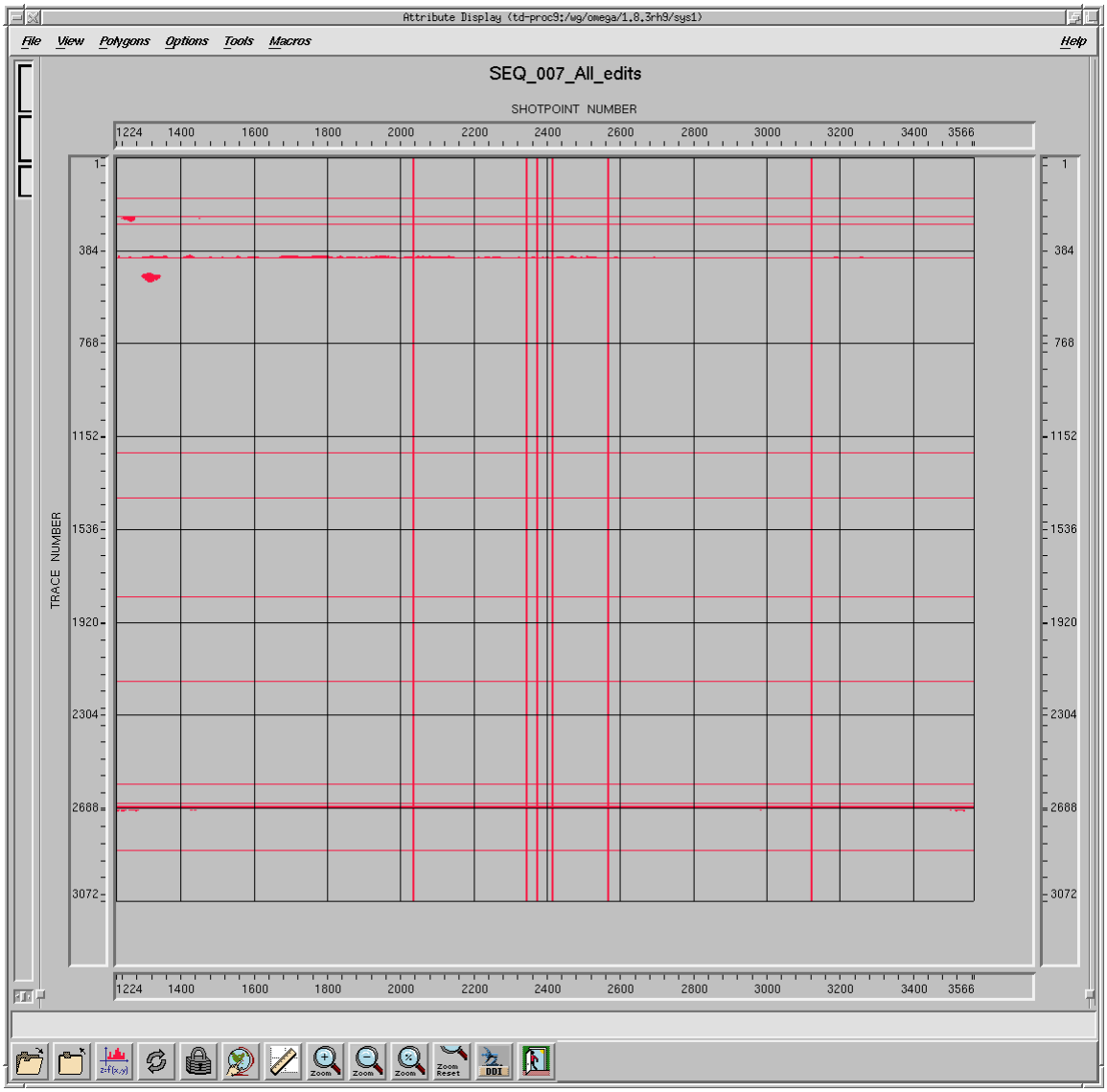



***Figure3. All Edits Display (Sequence 007).***

## 23.4 Near Trace Display

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

**Processing sequence:**

| | |
|---|---|
| 1. Collect near traces : | Field channel 9, selected source (Port or Starboard) and streamer combination. |
| 2. Bandpass frequency filter | Low cut filter 2 Hz. 12dB/oct |
| 3. Gain recovery:<br>- Geospread compensation;<br>- Exponential Gain Correction | Geospread compensation using the single velocity function (for velocity function see 22.4.1)<br>---<br>Exponential gain correction:<br>4 dB/sec, window length 2000 ms, start time 2000 ms |
| 4. Output to QCV Display : | Scale: horizontal = 35 traces/cm: vertical=23 cm/sec. |

## 23.5 Source Attributes

Source analysis of each substring was performed for every line to determine possible air leakages and any drop in source energy, detect the sources depth and guns firing time.
Header information was read from a single trace to detect the required information.
Correspondingly, three attribute displays were produced on-line and off-line:

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

Additionally, an attribute display with sources comparison information was produced off-line.
For comparison, 50 near traces from two inner streamers (streamers 4 and 5) were extracted.
For these traces for every shot RMS was calculated in the time window from
Water Bottom Time + 500 ms to Water Bottom Time + 3000 ms. The values, represented averaged values for Port and Starboard sources and their difference, were produced for every shotpoint (figure 4).
For undershoot lines as guns related information was not written into SEG-D headers and a single source was used, no Source attribute displays were produced. The guns related information was recorded separately by undershooting vessel RV Titan.

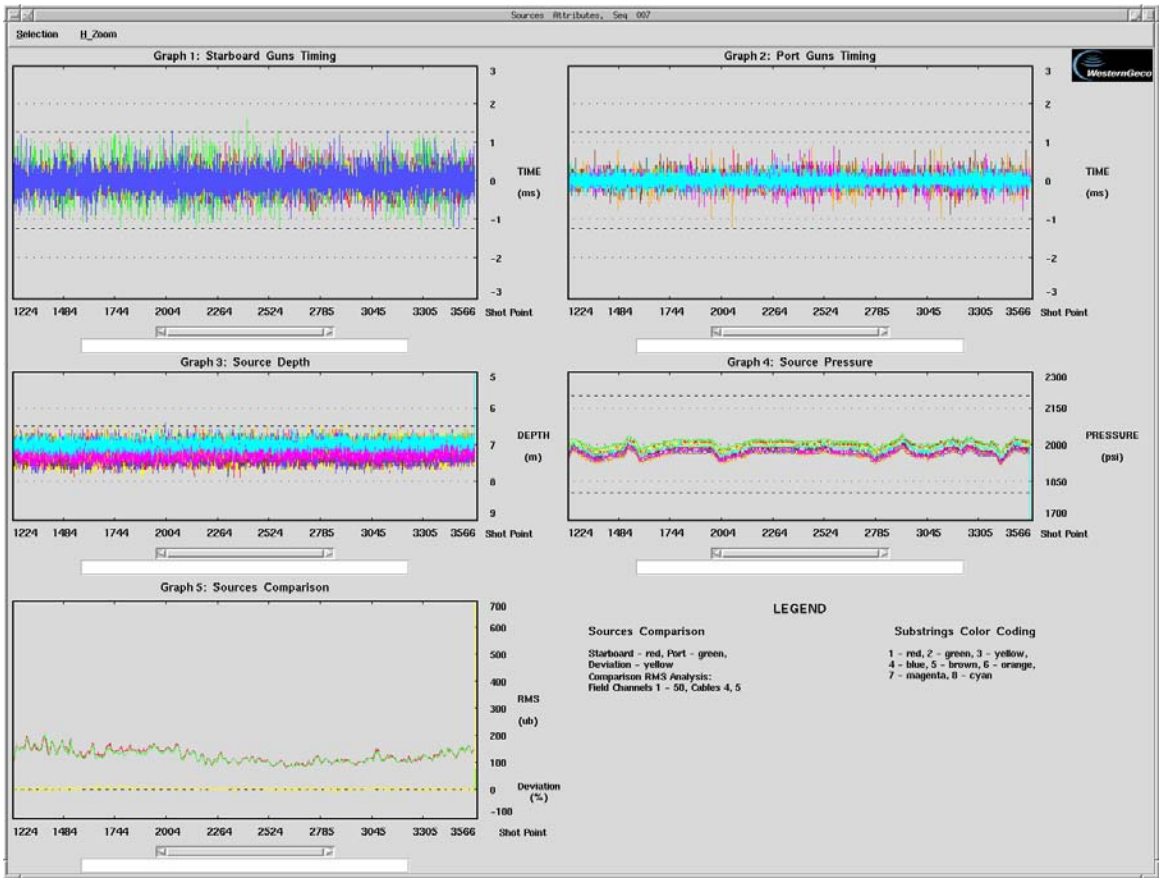



***Figure 4. Sources Attribute (Sequence 007).***

## 23.6 Brute Stack

For each sail line a different source / streamer combination was used to generate a brute stack for one subsurface CMP line.
**On-line Brute Stack**. A real time Terminal display was generated for every line. It involved selection of every second trace. At the end of the line acquisition, the QC group was able to generate paper plot with brute stack if required. This intended to give a much faster guide in identifying the extent of external noise in the data acquired until a full off-line brute stack was produced later.
**Off-line Brute Stack** was generated after bad shots and traces, derived from shots / RMS analysis, were removed from processing sequence.
A GIF file of Brute Stack was created for every line and placed in Supervision.
A paper plot also was generated for every line for QC purpose.

**Processing sequence:**

| | OFF-LINE | ON-LINE |
|---|---|---|
| Input 1 CMP line per sail line | 384 channels | 128 channels (3:1 traces decimation). |
| Line edits applied | Delete bad shots/traces derived from Observers Log file and form shots / RMS analysis | Delete spiky / noisy traces, determined from previous lines |

| | | |
|---|---|---|
| Gain Recovery | Geospread Compensation | Single Velocity Function |
| Low Cut Minimum Phase Frequency Filter | 3 Hz 18 dB/Oct | 3 Hz 12 dB/Oct |
| Nominal Marine Geometry | 2D geometry using nominal offsets<br>Group Interval 12.5 m | Group Interval 37.5 m |
| Adjacent Traces Summation ( 2:1) with Differential Move Out Correction | Single Velocity Function | Not Applied |
| Nominal Marine Geometry | 2D geometry using nominal offsets.<br>Group Interval 25 m | |
| Predictive Deconvolution. | Operator length 300 ms;<br>Gap 36 ms.<br>(Not applied for undershoot lines) | Not Applied |
| Normal Move Out Correction | Single Velocity Function | |
| Pre-stack Outside Mute with offset/time pairs: | Distance(m) Time(ms)<br>200 4<br>500 220<br>700 629<br>1560 1580<br>5000 3620 | |
| Stack Root N scaling | 64 fold for single boat operation (dual source)<br>128 for undershoot lines (single source) | |
| Output | To disk file in OMEGA format | |
| Output | To disk file in SEGY format | Not Applied |
| Trace scaling | Window length 1000 ms<br>50% overlap.<br>(applied only to a screen output) | Window length 5000 ms |
| Screen Output | Output to QCV file for QCViewer | Output to a Terminal Display |
| Output to Paper Plot | 36” OYO Plotter<br>20 traces/cm<br>10 cm/sec | Not required for this project |

## 23.5 First Break QC (P190 QC) Display

The main purpose of this QC tool is to confirm the positioning of the source and near trace of each cable within the P190. This is done by calculating the distances between the source and the near trace of each cable using the x-y coordinates in the P190. Using this distance and a water velocity of 1500 m/s, a calculated time is derived from the equation distance = velocity x time. This calculated time, or navigation spike, was superimposed onto the seismic trace and shifted 70ms earlier so that it could be compared from SP to SP. An incorrect source position in the P190 would be represented by a shift of roughly 10-30ms or 80-100ms depending on which streamer was being viewed. If this occurred, it was obvious by the way the traces were displayed for QC purposes and that SP was edited. The other purpose of this QC tool is to check the consistency of the navigation network from shot to shot. Any slight movements in the navigation spikes could represent a weak network solution if proportional movements are not seen with the first breaks of the seismic trace.

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

| | |
|---|---|
| 1. Collect near traces : | Select field channel 3 from each cable |
| 2. Geometry update | Merge selected traces with final P190 headers. A shift of 70 ms was used to offset seismic and navigation data prior to display. |
| 3. Truncate data | Truncate data below 350 ms. |
| 4. Display | Display seismic and navigation data for each subsurface line.<br>Data was output to disk in CGM format, and also viewed via QCviewer interactive display. |

## 23.7 Water Bottom Cube

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

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

**Cube Parameters:**

| | | |
|---|---|---|
| Inlines | : 931 - 2459 | Increment: 1 |
| Crosslines | : 851 - 3753 | Increment: 1 |
| Cell Size | : 18.75 m x 25.00 m | |
| Rotation | : 44.566 degrees | |
| Corners Coordinates | | |
| 931 / 851 | : X = 505414.53 Y = 5736932.37 | |
| 931 / 3753 | : X = 543597.44 Y = 5775698.15 | |
| 2459 / 851 | : X = 532629.84 Y = 5710126.27 | |
| 2459 / 3753 | : X = 570812.73 Y = 5748892.05 | |
| Data Length | : 1000 ms. | |
| Sample Rate | : 2 ms. | |

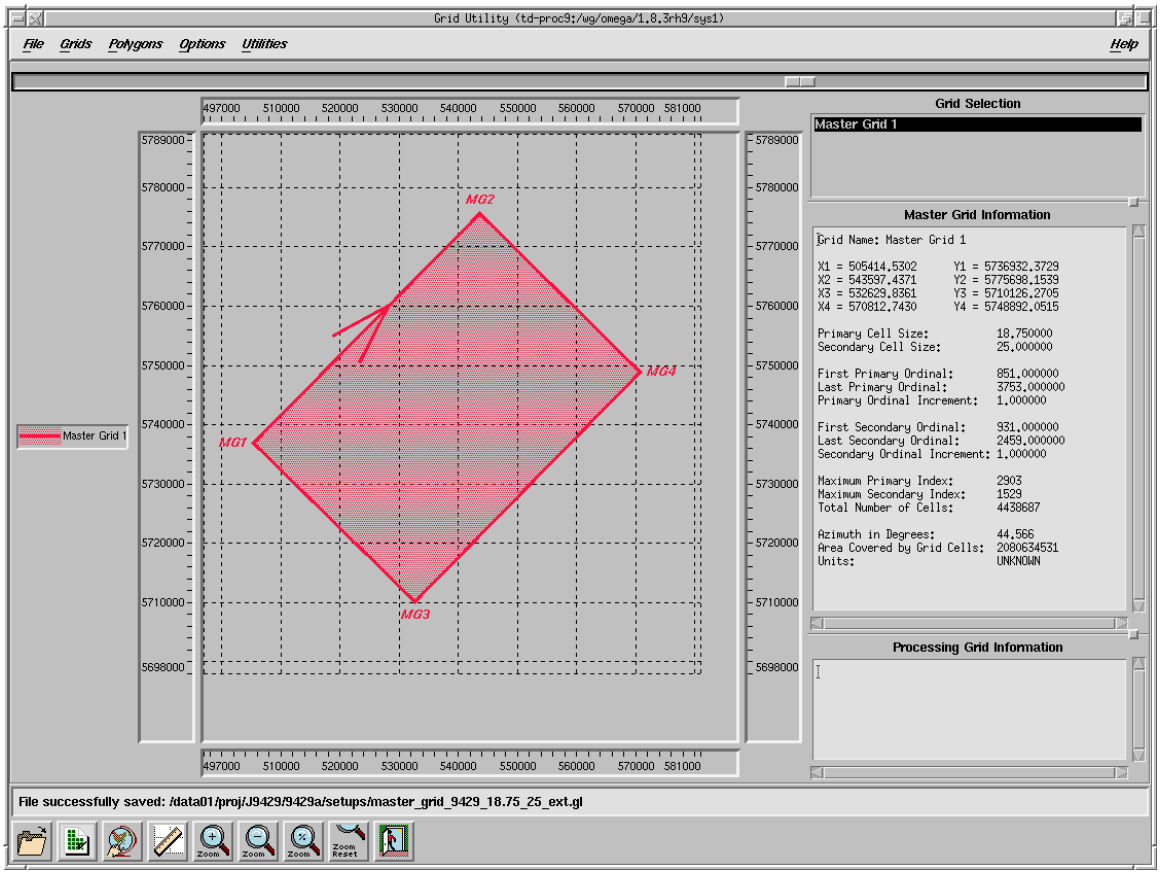



***Figure 5. The Grid used for Water Bottom Cube.***

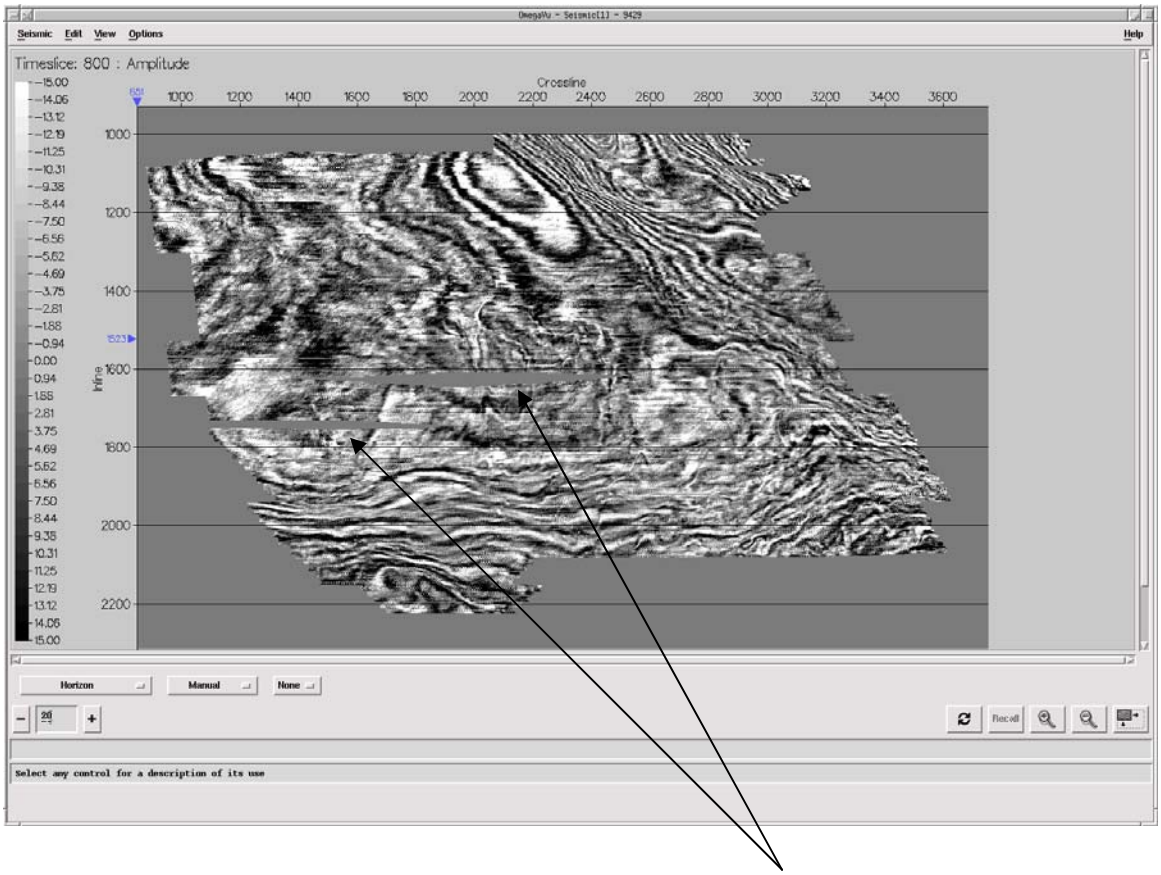



***Figure 6. Water Bottom Cube. Time Slice at 800 ms. Not filled blocks in the middle of survey correspond to undershoot areas.***

# 24. Data Quality / Observations

## 24.1 Quality Control Summary

### 24.1.1 QC Outputs

A significant number of plots and displays were produced for quality control of each sequence, allowing rapid and accurate delineation of noise types and their associated effects on data quality. A dedicated local disk directory was provided so that gif files of these displays were provided regularly after end of each acquisition line for the onboard client to evaluate. Most of the products were created offline, but a chosen number of displays were generated online in order to provide a much quicker appraisal of the data quality, using Shot display, Brute Stack display, attributes such as RMS noise level, source pressure, depth for each string. Also a gun timing display presenting firing time versus Shotpoint for each gun was produced in real time and off-line.
RMS analysis on deep and ambient windows provided very useful information for the client and crew in determining the amount of swell noise, ship's noise and other types of noise present in the data.
Analysis of RMS level for each channel, averaged for the entire line, helped to identify noisy or weak channels.

Shot gathers were plotted on the OYO plotter with an interval of 2118 metres (every 113th shot, for different cable/source combination), which were being checked by the acquisition group.

In addition, shot records were output offline every 105$^{rth}$ shot which were viewed through Omega QCviewer to identify noisy channels and electrical spikes. FK analysis was perfomed on these shots. A RMS source comparison was performed on every sequence to identify any serious problems with the source output.

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

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

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

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

### 24.1.2 Noise encountered

- **Swell Noise**

Seq 002 at end of line was affected by swell noise
This kind of noise slightly affected most of lines, though Raw Ambient RMS level never exceeded 15 uB and for most of the lines was around 5 – 6 uB.

- **Ship Noise**

No ship noise was encountered during this project.

- **Strumming Noise**

The towing noise sometimes slightly affected the front of streamers 4, 5 and 6 throughout the entire survey.
At sequences 048 and 049 strumming noise affected streamer 4 due to fairing damage.
The gear was picked up and fairing was fixed.

- **Seismic Interference**

None encountered, however the unidentified noise affected data of sequence 6, causing several blocks editing.

- **Rig noise**

None encountered

- **Source problems, autofires**

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

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

- **Parities Problems**

Any shots with parity or Telemetry errors were identified and noted in the acquisition log as a shot edit for that streamer.

- **Mud Rolls**

Due to shallow soft water bottom strong surface waves (mud rolls) are visible on most of shot plots. However, this kind of wave has a slow propagation velocity (approximately 1200 – 1300 m/s) and not visible on brute stack plots.

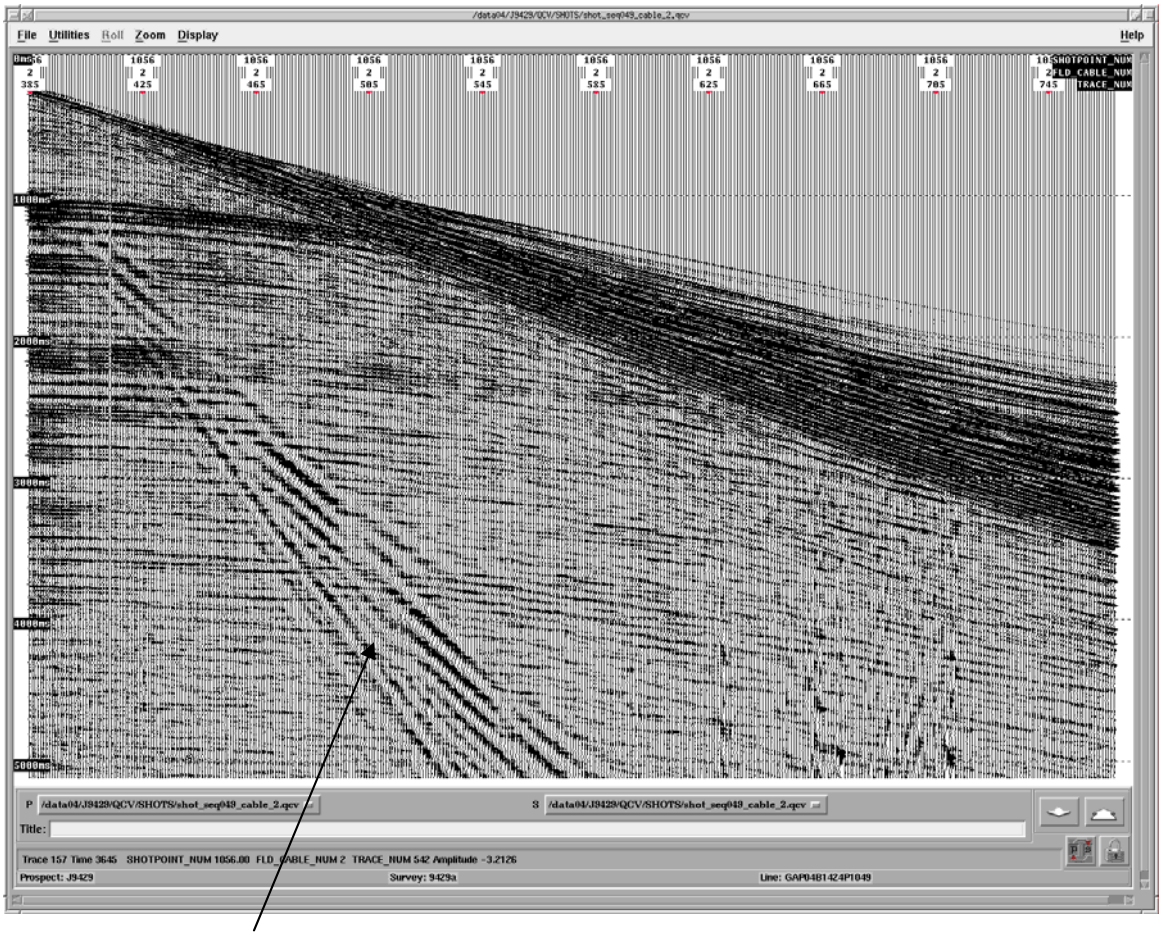



***Figure 7. Strong mud roll is visible on a shot plot.***

## 24.2 Instrument Summary

Slight strumming noise observed at the beginning of survey and affected streamer-3. The noise was getting stronger on sequence 049. We then decided to recover streamers for rectifying the problem. On sequence 50 onward the problem was fixed.

Occasionally telemetry error occurred on streamer-8 at the beginning of survey, and the affected data had been edited out from the coverage. The occurrences were noted down on the observer logs.

All noisy traces were noted down on the observer logs and some of them were edited out from the coverage.

The undershoot lines were acquired on sequences 91 to 98; the Pacific Titan was the source vessel during that operation. She used bolt guns with 3040cu.in gun volume, single source.
The time difference between recording start time and shooting time was recorded as a text file for every undershooting line.
These files allow calculating on a shot-by-shot basis the time difference, which must be applied at an early stage of seismic processing. Original time difference files and recalculated files (these recalculated text files has a format DHMS DIFFERENCE ms) are written on CD-ROM together with observer's logs.