FINAL FIELD OPERATION REPORT
MARINE SEISMIC REFLECTION SURVEY

Exxon Mobil
Tuskfish 3D
Gippsland Basin, Australia

WesternGeco Job No. 9269

ACQUIRED BY

Western Monarch

From December 31st 2002 to March 24th 2003

Report Compiled by Party Chief

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

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1. Survey Information and Objectives

The Blackback field in the Gippsland basin is a relatively shallow structure at the Top of the Latrobe group. Depths approximately 2.5 seconds (TWT). Maximum dips do not exceed 20 degrees. This field has previously been covered by a regional 2D grid and a small localised 3D survey.

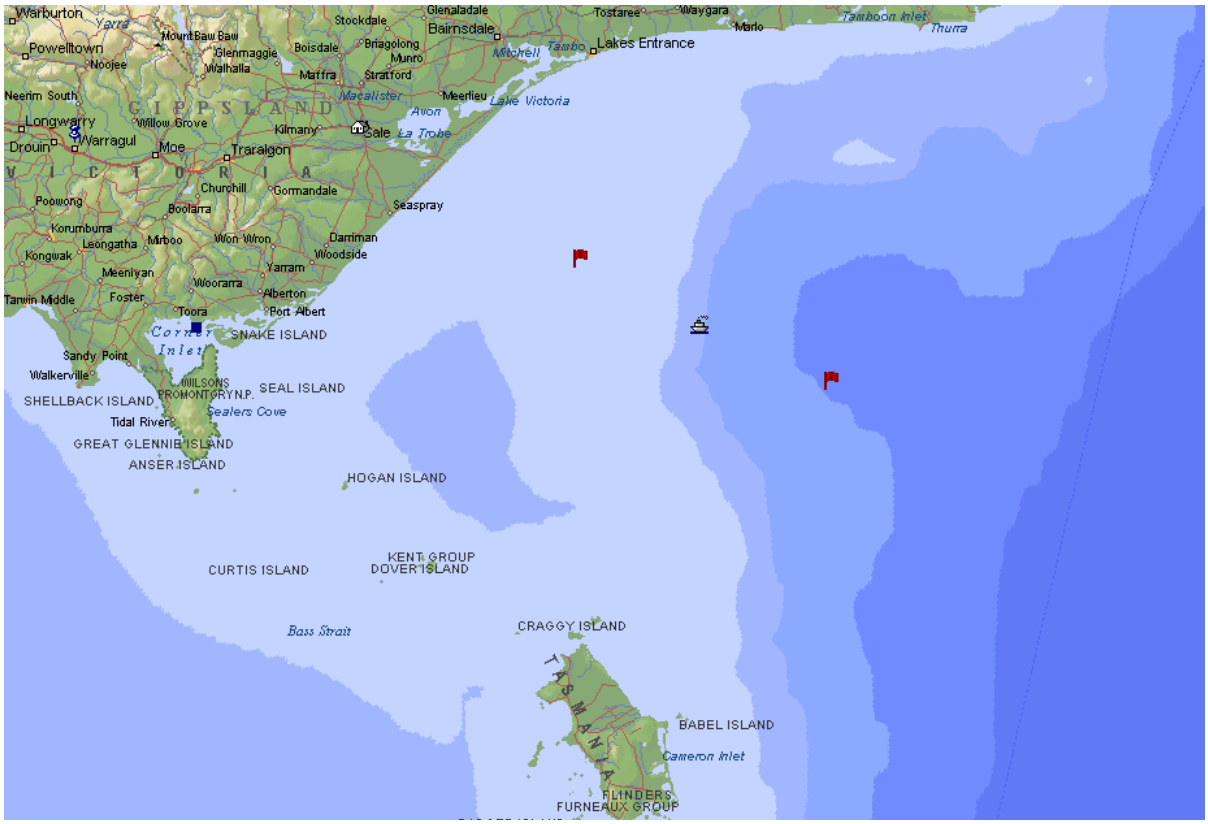
Beneath the existing Top of Latrobe accumulations there are also smaller and more complex intra-Latrobe traps. These deeper structures lie in a series of tilted fault blocks overlain and sealed by thick marine shale. Depths of these structures vary between 3 and 4 seconds (TWT), with dips of up to 20 degrees.

The primary objectives of the survey are to:
· Aid in the identification of potential infill drilling programs within the existing field
· Delineate existing static resources
· Identify and firm up commercial near field wildcat potential
· Identify deeper intra-Latrobe and Golden Beach exploration potential.

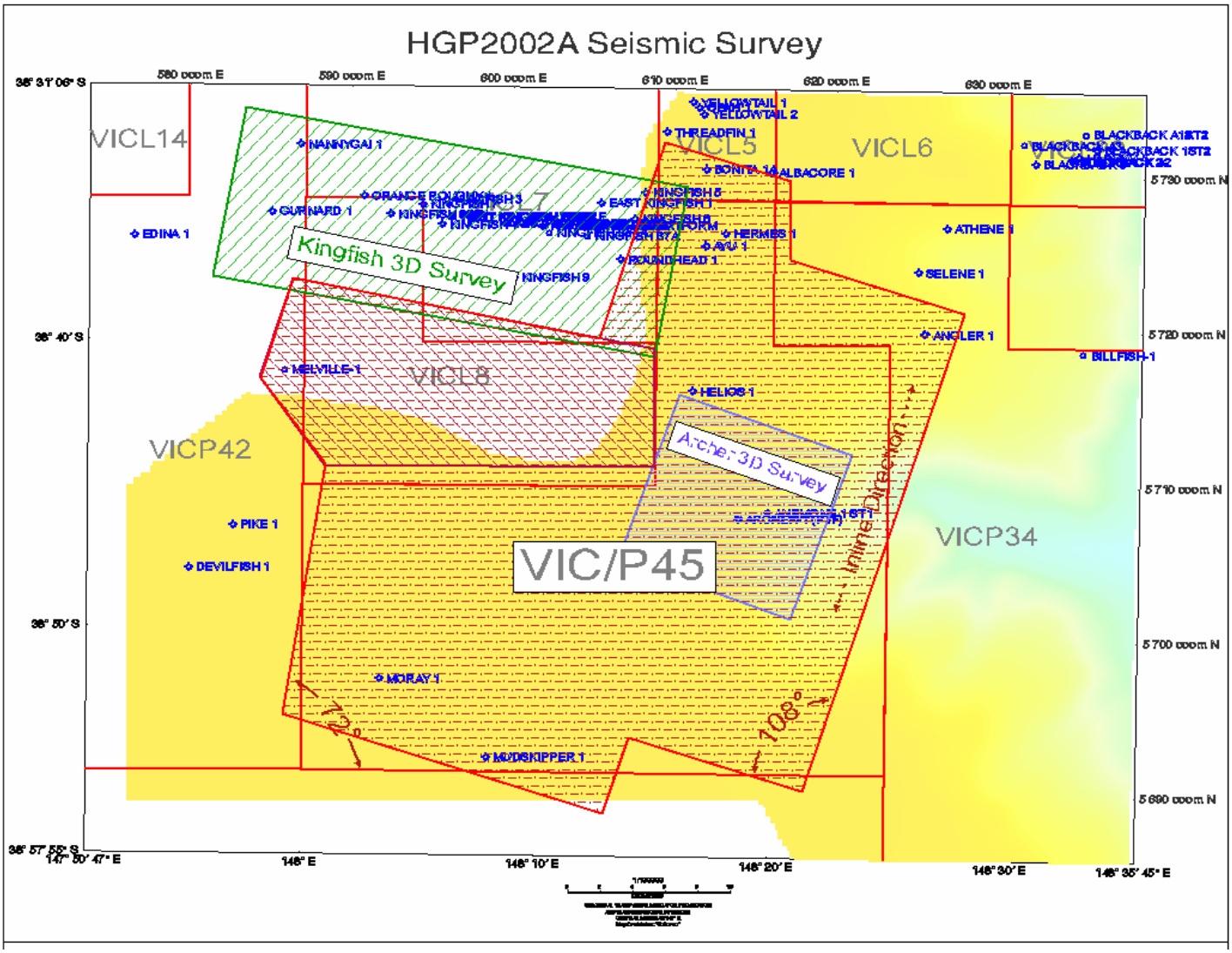
Key to achieving these objectives will be the regional mapping and attribute analysis of stratigraphic markers between existing wells:
· Attribute analysis to resolve regional depositional patterns
· Accurate mapping of the WNW-ESE trending structural grain
· Map distribution of key sealing units

Accurate positioning of faults and identification flat spots and other DHI's are critical requirements. Identification of gas and oil water contacts within the existing fields may allow reservoir depletion to be mapped.

2. Area Map


Warburton
Yarra
Mount Baw Baw
Stockdale
Glenaladale
Bairnsdale
Tostaree
Waygara
Tamboon Inlet
Thurra
Marlo
Powelltown
Noojee
Glenmaggie
Walhalla
Boisdale
Briagolong
Munro
Mitchell
Tambo
Lakes Entrance
Maffra
Stratford
Neerim South
Macalister
Meerlieu
Lake Victoria
Avon
GIPPSLAND
Longwarry
Willow Grove
Kilmany
Sale
La Trobe
Drouin
Warragul
Moe
Traralgon
VICTORIA
Churchill
Gormandale
Seaspray
Poowong
Boolarra
Korumburra
Leongatha
Mirboo
Won Wron
Darriman
Kongwak
Woodside
Meeniyan
Yarram
Wooorarra
Alberton
Tarwin Middle
Foster
Toora
Port Albert
SNAKE ISLAND
Corner Inlet
Sandy Point
Walkerville
WILSONS PROMONTORY N.P.
SEAL ISLAND
SHELLBACK ISLAND
Sealers Cove
Tidal River
GREAT GLENNIE ISLAND
ANSER ISLAND
HOGAN ISLAND
CURTIS ISLAND
KENT GROUP
DOVER ISLAND
Bass Strait
CRAGGY ISLAND
TASMANIA
BABEL ISLAND
Cameron Inlet
FLINDERS
FURNEAUX GROUP

3. Program Map



4. Job Book

Client:	ExxonMobil	**Provisional**	x
Area:	Gippsland Basin	**Ready for review**	x
Job Number:	9269	**Reviewed by Vessel**	x
Date:	21st Dec 2002	**Reviewed by Supervisor**	x
Version:	4	**Reviewed by Client**	x (startup meeting)

Project Geo:	Tim Brice	tbrice@slb.com	+603 27308843

Acquisition Parameters

General

Client	ExxonMobil
Vessel(s)	Western Monarch
Job Number	9269
Client Contract Number	
Location	Offshore Victoria, Gippsland basin
Type of Survey (2D or 3D)	3D
Area or Total km	1034sq km
Average Line Length	30.275km
Heading	108/288 deg
Estimated Start Date	Jan 2003
Estimated Duration	approx 3 months
SuperVISION required	Yes - for regional support only

Streamer Parameters

Cable type	Thompson Marconi Sentry Solid Streamer
Number of streamers	8
Group length	17.75m (14 phones per group)
Group interval	12.5m
Streamer length	5000m
Hydrophone sensitivity	14 volts/bar
Streamer depth	9m

Streamer separation	100m
Number of groups per streamer	400
Streamer tracking	Digicourse acoustics & 5011 compass units
Compass Density (number)	Every 300 m + redundancy
Requested source to receiver offset	125 – 175 m, this figure will likely be closer to the higher figure of 175m

Recording

Recording system	I-O system MSX recorder
Recording format	SEGD rev2 8048 (or equivalent) 4 Byte SEG-D Demultiplexed / 8058
Record length	6.5secs
Sample rate	2ms
Recording filter (Hi-Cut)	206 Hz @ 264 dB/Oct
Recording filter (Low-Cut)	2Hz @ 12dD/Oct
Recording filter delay	None
Filter type	Zero phase filters
Recording system delay	None
Recording media	IBM 3590
Dual recording / Tape copies	Yes - tape copies to be made

Source Parameters

Source type	WesternGeco Sleevegun
Number of sources	2
Source separation	50m
Shotpoint interval per shot	18.75m dual source
Array volume / source	3000 cu in
Operating pressure	2000 psi
Source depth	8m
Number of subarrays per source	4
Source strength (zero to Peak, 0-P)	54.6 Bar-m
Source strength (Peak to Trough, P-T)	101.5 Bar-m (through 3-128 Hz filter)
Peak to Bubble Ratio (PBR)	15.6
Subarray separation	6m
Number of Airguns per Subarray	Two 2-gun clusters + 4 individual guns
Sub array length	15.1m

Gun Timing Specification	
Alternatively fired sources (flip-flop)	yes
Source control system	Source Synchronization System
Firing delay	Variable
Record nearfields	Yes
Total SCFM required at 4.8 knots	1420 CFM
Source timing specifications	

Client:	Exxon Mobil	**Provisional**	x
Area:	Tuskfish 3D	**Ready for review**	x
Job Number:	9269	**Reviewed by Vessel**	x
Date:	13 Jan 2003	**Reviewed by Supervisor**	x
Version:	4	**Reviewed by Client**	x

Project Geo:	Name: M Boyall	Email: mboyall@slb.com	Telephone: +60 3 27308852

Positioning

Acquisition Geodetic Parameters

Spheroid	GRS80
Semi Major Axis	6378137.0
Inverse Flattening	298.257222101
Work Datum	GDA94 (Geocentric Datum of Australia)
Datum Transformation	**From WGS84 to Work Datum** ***Bursa Wolf Convention***
dX (m)	0
dY (m)	0
dZ (m)	0
rX (arc secs)	0
rY (arc secs)	0
rZ (arc secs)	0
Scale (ppm)	0
Projection	UTM
Zone if UTM	55S
Central Meridian	147E
Scale Factor	0.9996
False Easting (m)	500,000m
False Northing (m)	10,000,000m
Latitude of Origin	0 deg

Datum Transformation & Test Point

Transformation from Datum	NA
Transformation to Datum	NA
Latitude in WGS 84	NA
Longitude in WGS 84	NA
Latitude in Local Datum	NA
Longitude in Local Datum	NA
Northing in Local Projection	NA
Easting in Local Projection	NA

Post Processing Geodetic Parameters (List only if different from acquisition parameters)

Spheroid	NA
Semi Major Axis	NA
Inverse Flattening	NA
Work Datum	NA
Datum Transformation	**From WGS84 to Work Datum** ***Bursa Wolf Convention***
dX (m)	NA
dY (m)	NA
dZ (m)	NA
rX (arc secs)	NA
rY (arc secs)	NA
rZ (arc secs)	NA
Scale (ppm)	NA
Projection	NA
Zone if UTM	NA
Central Meridian	NA
Scale Factor	NA
False Easting (m)	NA
False Northing (m)	NA
Latitude of Origin	NA

Magnetic Variation & Geoidal Height

Location of Prospect Centre: Lat	38 35 07.107 S
Location of Prospect Centre: Lon	148 29 31.544 E
Magnetic Variation Data	Mag Dec - 13 deg 22min Annul Change - 1 min/year
Source of Variation Data	IGRF2000 model
Geoidal Height Data	
Date for which values calculated	15 Feb 2003 (estimated half way project point)

Vessel Positioning

1. Integrated Navigation System (Navigation/Binning/QC)

Spectra Integrated Navigation System

2. Primary Navigation System

Navigation System	Posnet v 1.72 (Spectra INS)
RTCM Delivery System	Inmarsat/SPOT
DGPS Reference Stations	Adelaide, Melbourne & Sydney / CNav
Survey & Differential Company	Thales Geo-Solutions
Contact Person	Skyfix Singapore Network Control Centre (24hrs) +65 6863 0604 CNav - Rick Shannon Rick Shannon, rick.shannon@cctechnol.com, +65 97825658

3. Secondary Navigation System

Navigation System	Thales MultiFix III
RTCM Delivery System	Inmarsat/SPOT
DGPS Reference Stations	Adelaide, Melbourne & Sydney
Survey & Differential Company	Thales Geo-Solutions
Contact Person	Skyfix Singapore Network Control Centre (24hrs) +65 6863 0604

4. Tertiary Navigation System

Navigation System	CNAV
RTCM Delivery System	Inmarsat
DGPS Reference Stations	Global Satellite Corrections
Survey & Differential Company	C&C Technologies
Contact Person	Rick Shannon, rick.shannon@cctechnol.com, +65 97825658

Streamer

Positioning	
Source Surface Positioning	Posnet rGPS
Front-Net In-Sea Positioning	Digicourse Acoustics
Mid-Streamer In-Sea Positioning	Digicourse Acoustics
Tailbuoy Surface Positioning	Posnet rGPS
Tail-Net In-Sea Positioning	Digicourse Acoustics
Compass Bird Type	Digicourse 5011
Compass Birds Per Streamer	Every 300m with redundancy at the head and tail
Line & Shotpoint Numbering	
Line Prefix	GA03
Line Name Format: Prime	GA031001ASSS
Line Name Format: Reshoot	GA031001B,C..SSS etc

Line Name Format: Infill	GA031001J,K,L..SSS
Line Name EXAMPLE	GA0312324A032 (prime line 1234 seq 32)
First Shotpoint Number: Prime	1001
First Shotpoint Number: Reshoot	same as line
First Shotpoint Number: Infill	same as line
Incrementing/Decrementing	yes
Source Firing on Even Numbers	Port (even), Starboard (odd)

Preferred Shooting Plan

Racetrack

Known Obstructions

Platforms and Surface obstructions in the vicinity

AGD66 Zone 55S (Exxon Supplied)				WGS 84 Zone 55S (calculated)			
Eastings	Northings	Latitude	Longitude	Eastings	Northings	Latitude	Longitude Name
567224.3668	5738278.485	38.501187 S	147.770945 E	567337	5738462	38 29 58.7756 S	147 46 19.9938 E Bream A
573052.9445	5736173.413	38.501187 S	147.838002 E	573165	5736357	38 31 5.4094 S	147 50 21.3959 E Bream B
558999.0321	5760885.611	38.298043 S	147.674725 E	559111	5761069	38 17 47.4579 S	147 40 33.5959 E Barracouta
625726.4143	5758529.154	38.312404 S	148.438089 E	625839	5758712	38 18 39.1302 S	148 26 21.6591 E Flounder
611475.9094	5748060.432	38.408613 S	148.276784 E	611588	5748244	38 24 25.4896 S	148 16 40.9769 E Fortescue
615172.6543	5748330.71	38.405709 S	148.319070 E	615285	5748514	38 24 15.0337 S	148 19 13.2037 E Halibut
599567.2474	5727217.436	38.597821 S	148.143381 E	599680	5727401	38 35 46.6458 S	148 8 40.7456 E Kingfish A
603347.982	5727093.442	38.598506 S	148.186807 E	603460	5727277	38 35 49.1102 S	148 11 17.0765 E Kingfish B
596150.841	5727627.158	38.594506 S	148.104099 E	596263	5727810	38 35 34.7132 S	148 6 19.3327 E West Kingfish
617007.4399	5739989.561	38.480622 S	148.341469 E	617120	5740173	38 28 44.7207 S	148 20 33.8430 E Mackerel
606755.0139	5677739.473	38.231875 S	148.219750 E	606867	5677923	39 2 28.4235 S	148 14 5.4564 E Marlin
589674.8022	5772000.634	38.195343 S	148.024090 E	589787	5772184	38 11 37.7239 S	148 1 31.2821 E Snapper
624224.9234	5774225.561	38.171193 S	148.418169 E	624337	5774409	38 10 10.7695 S	148 25 9.9403 E Tuna
558919.058	5772137.031	38.196652 S	147.672875 E	559031	5772320	38 11 42.4489 S	147 40 26.9301 E Seahorse (sub Sea)
546112.9317	5749121.115	38.404819 S	147.528133 E	546225	5749304	38 24 11.8583 S	147 31 45.8801 E Tarwhine (sub Sea)
635363.0852	5732885.742	38.542020 S	148.553221 E	635475	5733069	38 32 25.7467 S	148 33 16.1403 E Blackback (sub Sea)

635355.1166 5732873.333 38.542133 S 148.553132 E 635468 5733057 38 32 26.1535 S 148 33 15.8199 E Blackback (sub Sea) 576334.8167 5767012.988 38.241519 S 147.872301 E 576447 5767196 38 14 23.9636 S 147 52 24.8539 E Whiting 532808.8754 5739857.177 38.488893 S 147.376198 E 532921 5740041 38 29 14.5314 S 147 22 38.9285 E Dolphin 527991.0106 5730783.895 38.570825 S 147.321319 E 528103 5730967 38 34 9.4898 S 147 19 21.3724 E Perch 614113.6148 5743337.497 38.450833 S 148.307755 E 614226 5743521 38 26 57.4811 S 148 18 32.4730 E Cobia 621482.7054 5771796.782 38.193450 S 148.387287 E 621595 5771980 38 11 30.8961 S 148 23 18.7683 E West Tuna

3D Parameters

Steering Point	Steer to leave no gap in near traces and not more than 2 bins in far traces.
Survey Grid Rotation	108/288

2D Parameters

Line Shooting Mode	NA
Reference Point for Firing	NA

Water Depth & Processing

Maximum & Minimum Water Depth	70m - 2000m
Echosounder Standard Settings	VP=1500ms, Draft=0
Vertical Datum	SL
Apply Tidal Corrections in Processing?	No
Apply Velocity Corrections in Processing?	yes
Apply Draft Corrections in Processing?	yes
Tidal Corrections Source	NA

Tidal Prediction Settings (where WesternGeco predictions are used)

Standard port name	NA
Z_o	NA
Seasonal variation	NA
M_2 Phase [g°]/amplitude [h.m]	NA
S_2 Phase [g°]/amplitude [h.m]	NA
K_1 Phase [g°]/amplitude [h.m]	NA
O_1 Phase [g°]/amplitude [h.m]	NA
F_4 Phase [g°]/amplitude [h.m]	NA
F_6 Phase [g°]/amplitude [h.m]	NA
Time zone	NA
Standard port co-tide (s)/co-range (m)	NA

Binning Parameters

Offset	Segment (m)	Channels	Fold Percentage	Required / Total	Flex (xline)
Near	1-1250	1-100	93%	15 / 16	25m expanded to 37.5m
Near-Mid	1251-2500m	101 - 200	80%	13 / 16	linear taper
Far-Mid	2501-3750m	201 - 300	73 %	12 / 16	linear taper
Far	3750m-5000m	301-400	60%	10 / 16	25m expanded to 62.5 m

Please refer to the binning spreadsheet.

Gravity & Magnetics

Gravity Meter Type	NA
Gravity Recording Interval	NA
Interface to Navigation Systems	NA
Interface to Echosounder *Note raw data if realtime interface*	NA
Gravity Sub-Contractor & E-mail	NA
Magnetometer Type	NA
Magnetometer Recording Interval	NA
Magnetometer Sub-Contractor & E-mail	NA
Tape Media	NA
UKOOA P1/90 required	NA
Delivery Address	NA

Other Comments

- Weekly Sippican drops distributed around survey area
- No TS Dips, Speed of sound based on dynamic Readings from Cable mounted velocimeter.
- Current predictions requested from ExxonMobil
- Dockside DGPS/Gyro verifiation Melb 23rd Dec 2002 - Final Report (pdf file 3Mb)

5. Vessel Description

Vessel Particulars

MAIN PARTICULARS

SHIPS NAME	**Western Monarch**
CALL SIGN	HP 6387
INTERNATIONAL MARITIME ORG. (IMO) No.	9010149
OWNER	Westerngeco Seismic Shipping LLP
PREVIOUS NAME	N/A
FLAG STATE & PORT OF REGISTRY	Panamanian - Panama
PANAMA OFFICIAL No.	20002-92-B
DATE OF BUILD	30-Sep-91
YARD No. AND TYPE OF VESSEL	Ulstein B 231 - Seismic R/V
YARD BUILT	Ulstein Werft
DATE CONVERTED / POWER UPGRADED	Jun-96
YARD CONVERTED	Mjellem & Karlsen, Bergen, Norway
CLASSIFICATION SOCIETY AND CLASS	DNV - 1A1 EO HELDK ICE-C
CLASS ID No.	17176
CLASSIFICATION MACHINERY SYSTEM	Planned Maintenance System (PMS)(CMS)
CLASS APPROVED MAINTENANCE SYSTEM	TM-Master
INTERNATIONAL SAFETY MANAGEMENT, (ISM) CODE COMPLIANCE	Yes - May 12th 2000
SAFE MANNING CERTIFICATE (MINIMUM)	Yes - May 6th 1993

PRINCIPAL PARTICULARS

GROSS TONNAGE (GRT)	5222
(GRT) NATIONAL & INTERNATIONAL	N/A
GROSS TONNAGE (GRT) SUEZ CANAL	5731.53
NET. REG.TON (NRT) PANAMA CANAL	4179.93
(NRT) NATIONAL & INTERNATIONAL	1567
NET. REG. TON (NRT) SUEZ CANAL	4131.63
LIGHTSHIP DISPLACEMENT	4106.4
DEAD WEIGHT	2926.3
LENGTH OVER ALL (LOA)	94.30 MTR
LENGTH BETWEEN PERPENDICULARS	80.00 MTR
BREADTH (MOULDED)	20.00 MTR
BREADTH (EXTREME)	21.60 MTR
DEPTH (MOULDED)	9.00 MTR
DRAFT (MAX)	7.42 MTR (Summer marks + nozzles)
DRAFT (MEAN)	6.909 MTR (Summer marks)
AIR DRAFT (TO HIGEST ANTENNA)	From keel - 34.40 MTR
HELICOPTER DECK RATING	Sikorsky S61N
HELICOPTER DECK DIAMETER (D-VALUE)	22.2 MTR
HELICOPTER DECK MARKINGS STANDARD	CAA CAP 437

M/V Western Monarch

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6. List of Key Personnel

6.1. Onboard Personnel

POSITION	CREW 1	CREW 2
Party Manager	Michael Martin	Ian Halfpenny
Captain	Reid, Paul	Rudy Bless
Chief Engineer	Terrence Radonich	Kevin Joseph
Acq. Supervisor	Craig A Adams	Victor Lopes
Acq. Shiftleader	Stewart Klincke Alasdair Fleming	J.Q. Chandler Efren Gabriel
Pos. Supervisor	Neil Boughton	Johnny Olsen
Pos. Shiftleader	Nicholas L Crawford Joel Pederick	Paul Farrell Mike Gors
Handling Supervisor	Armin Roehl	Steve French
Shiftleader Mechanic	Paul Remillong Aldrin Flores	Colin Robson Paul Hollingsworth
Trilogy QC Leader	Ed Rosario	Jon de Haai
OBP Group Leader	Petr Gorbatchev	Laurent Basso

6.2. Office Support Personnel

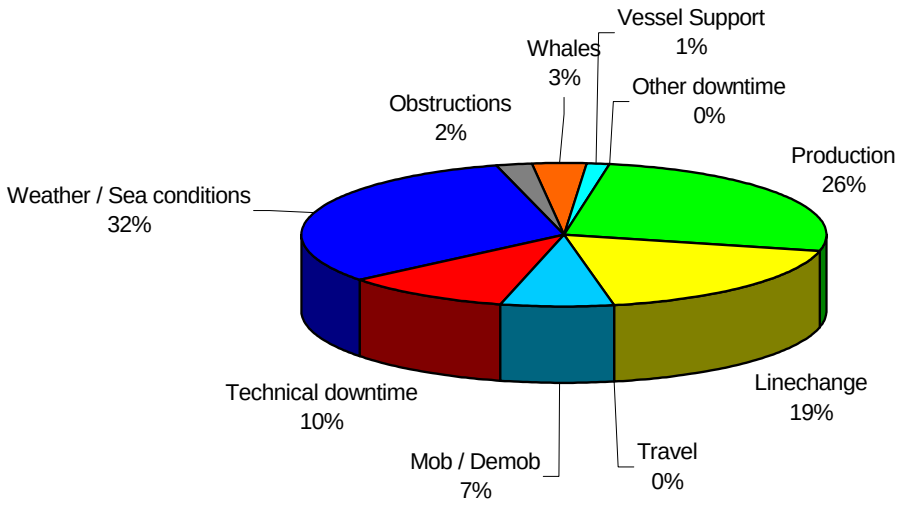
POSITION	NAME	OFFICE
Operation Manager	Jeffrey N. Mayville	Kuala Lumpur
Operation Supervisor	Terry Leighton	Perth
Maritime Superint.	John Hattendorf	Kuala Lumpur
Instrument Support	InTouch Global Operations Support.	Oslo
Navigation Support	InTouch Global Operations Support. Kumaragurubaran Krishnasamy	Oslo Kuala Lumpur
Mechanical Support	InTouch Global Operations Support Darren Parish	Oslo
Trilogy QC Support	Tim Brice	Kuala Lumpur
OBP Supervisor	Andy Lambourne	Kuala Lumpur

7. Field Information and Observations

7.1. Production Statistics

PRODUCTION (Km)		
Prime Production	44685.3750 Km	
Infill Production	17259.1688 Km	(38.6 %)
Total Production	61944.5438 Km	

TIME DISTRIBUTION (Hours)		
Production	517.5850 Hours	(25.7 %)
Linechange	373.6670 Hours	(18.6 %)
Travel	0.0000 Hours	(0.0 %)
Mob / Demob	140.1330 Hours	(7.0 %)
Technical downtime	203.3660 Hours	(10.1 %)
Weather / Sea conditions	637.8350 Hours	(31.7 %)
Obstructions	43.2820 Hours	(2.1 %)
Whales	67.1160 Hours	(3.3 %)
Vessel Support	30.1840 Hours	(1.5 %)
Other downtime	0.0000 Hours	(0.0 %)
Total Survey time	2013.1680 Hours	(100 %)



7.2. Daily Summary

PC log in UTC, (Australia, Victoria) UTC +11hours.

31st December 2002.
Vessel alongside in Melbourne for crew induction meetings split over 2 days. Sailed from Melbourne at 02:50 hrs UTC 13:20 local time on completion of crew meeting.
Safety induction tours given to new crew joining the Monarch.

01st January 2003.
Continuing to deploy streamers, presently 1,7, & 8 fully deployed. Deploying streamer 2, unable to deploy two streamers at once d/t swell conditions. Some delays fixing optical telemetry problems on the front ends of streamers 1 & 8 now resolved. Esso technical audit team checking various systems presently working on the source.
A muster and ERP drill were held yesterday, SIPP training started for the 5 new crew without SIPP. ERP telephone numbers checked. Weather forecast is for more of the same i.e. 3m swell 20 knot winds.

02nd January 2003.
Continuing to deploy streamers. 1,2, 6, 7, & 8 fully deployed. Presently deploying streamer 3 and 5. Deployment was delayed yesterday due to adverse swell conditions making deployment of two streamers in tandem impossible. Delays have also occured due to a fault at the tail end of streamer 3 which was eventually traced to a new section which had been reterminated incorrectly (the fibre connections are crossed in the section). Tailbuoy 5 had to be recovered and its towing bridle altered to stop it crossing streamer 3. A hydraulic oil leak on system #2 starboard side main flow line had to be repaired using a flexible HP hydraulic hose, as we are unable to fabricate a new section of pipe onboard. SIPP training was completed for those crew without this training.

03rd January 2003.
Continuing to deploy streamers. Streamers 1,2,3,6,7, & 8 fully deployed presently deploying 4 & 5 in tandem. Delays in deployment were due to a fault in the front end of streamer 7. This meant stacking the other streamers on the starboard side and recovering the front end of 7 to change out the faulty section 1B. The power fault on streamer 5 was traced to the front Stubby section. There is an intermittent fault on streamer 8 module 2, the plan is to change this module using the CMV. Weather conditions have deteriorated from yesterday they are still OK for deployment but not suitable for small boat operations.

04th January 2003.
All streamers were deployed at 06:07hrs. An oil spill and environmental drill were held at 02:00hrs. Swell conditions were not suitable to allow a safe deployment of the source, this caused a delay until the swell dropped to within safe deployment limits. Arrays were deployed and checked regarding pressure drop and gun depths. Many of the gun depth ropes had to be adjusted to meet the specifications for this job. We are presently testing the port arrays and recording near field hydrophone data, delays have occurred in this test due to the sightings of cetaceans within the shut down limits. The chase boat Total Voyager performed 3 successful TsDips using XSV 2000m SIPPICAN probes.
A medivac was performed for the chief engineer who was suffering from stomach pains caused by a suspected blocked bowel. The medivac was initiated at 21:17hrs and the chopper was on deck at 22:25hrs leaving the Monarch at 22:34hrs with the patient.

05th January 2003.
Production started at 07:20 hrs after successfully completing the XOM technical audit. Sequence 3 was halted early due to a sighting of Sperm whales within the 3000m shut down zone. The CMV was launched twice the first occasion for streamer maintenance changing out a module on streamer 2 and various streamer attachments. The second time to check the lead-in depths which were found to be 80m. A scheduled Helicopter operation passed without incident taking off 3 XOM personnel and returning 2 WG personnel to the vessel. Due to the low average spread with only 15 cmp km have

been charged this will be reviewed once more separation data has been assessed.

06th January 2003.
Continuous production throughout the day. The Total Voyager left the prospect earlier than planned to crew and resupply in Geelong. Unfortunately the early departure of the voyager meant a planned bunkering operation and SIPPICAN drop had to be cancelled. One Sperm whale sighting yesterday fortunately this occurred during a linechange and production was not effected. The bridge crew are now contacting the Mackerel and Copia platforms when we come within the 10k radius of the platforms in the western linechanges.

07th January 2003.
Production continued in marginal sea conditions until sequence 12 when the decision was taken to halt production and recover the gun arrays. The forecast for the next 48hrs is for 5 metres seas and wind in excess of 30 knots from the SW. The swell noise acceptance criteria is very tight for this survey resulting in sequences 9,10, & 11 being rejected after viewing the brute stack. Guns 207 and 303 were changed out as their results failed the Esso source technical audit. Leakage was found to be a problem on gun 207 but no faults were found on gun 303. Presently heading on a NE -SW race track until the weather improves. A general safety meeting was held with all crew in attendance, the Tuskfish 3D injury prevention workshop was reviewed also the RIR reports for the trip so far.

08th January 2003.
Presently down for weather with the guns onboard. Heading back towards the prospect to rendezvous with a scheduled chopper which is bringing out two whale "listeners" and taking off 4 WG personnel. Part of the PAM system will also arrive with the chopper, the mini streamer for the PAM system is on the chase boat Total Voyager.

09th January 2003.
Back in production again 3 more sequences completed after being down for weather. A scheduled helicopter arrived yesterday to deliver the 2 PAM system operators and some of their equipment. The plan is to take the Total Voyager alongside this afternoon for bunkers and supplies. The PAM system mini streamer will also be taken off the chase boat. A CMV run is planned to change some birds and transfer the Esso safety man Dave Waters across from the Total Voyager. The Total Voyager is presently performing SIPPICAN probe drops.

10th January 2003.
In production, over 8 hours were lost yesterday due to Pilot whale sightings within the 3km shut down zone. The planned bunkering operation was cancelled due to unsuitable swell conditions. Weather and sea conditions improved overnight An attempt will be made again today as the swell has dropped to 1.5m. The CMV was launched three times yesterday the first time to change defective birds on streamer 6 and to transfer Dave Waters from the Total Voyager to the Monarch. The second trip was to transfer the remaining parts required to mobilise the PAM whale monitoring system on the Monarch. The third trip was to investigate noisy traces on streamers 1 & 2 change bird S6B5 and fit a new Posnet Pod to tailbuoy 1. SIPP training was given to the two PAM operators.

11th January 2003.
In production. An attempt to bring the Total Voyager alongside to deliver bunkers was aborted yesterday when two bow ropes parted. The fair lead which protects the ropes on the Total Voyager failed. The ropes therefore had no protection and were rubbing directly onto a sharp edged deck plate. This quickly cut the ropes. A QUEST report will be submitted for this incident. The weather is forecasted to deteriorate over the next 24hrs as a cold front passes through the area. The PAM system has been built up and the operators hope to test it later today.

12th January 2003.
Presently down for weather heading back towards the prospect to take the scheduled 13:00hrs chopper. Kevin Joseph to arrive, Dave Waters, & Gordon Sanders off. It will also deliver some mini-wing parts.
We changed out gun cable 2 during this bad weather period due to skin damage and no more good spares. The PAM system was deployed without any difficulties, the operators are still fine tuning the mini streamer. So far it has not interfered with the seismic operation. The weather is forecasted to improve over the next 24hrs.

13th January 2003.
Down for weather the last 24 hrs. A chopper arrived yesterday bringing back the Ch Eng after illness and taking off Dave Waters XOM auditor and relief Ch Eng Gordon Sanders. We also received some miniwing bearings, still the bend relief's outstanding from the equipment required to use the miniwings. Presently heading back towards the prospect hoping to get some production in this afternoon as the wind and swell are forecasted to decrease.

14th January 2003.
Back in production after the bad weather period. Unfortunately we lost over 10 hours due to problems with gun bundle #2 power and data transmission lines. The gun bundle had just been fitted and started to develop electrical faults on the first sequence after the weather standby period. The mechanics managed to patch through enough spare lines to get it operational again. We plan to reterminate the onboard end of this bundle during the next weather standby period. Support has been contacted to ship spare bundles and retermination kits to Australia. The weather conditions continue to improve, and we plan another attempt to take bunkers off the Total Voyager this afternoon using the forward undamaged fairlead to make the Voyager fast alongside.

15th January 2003.
In production, time was lost due to pilot whales on two separate occasions yesterday.
The CMV was launched to change out MSX modules on streamer 4 and 3. The CMV also transferred some fresh provisions from the Total Voyager. The planned resupply from the Total Voyager was cancelled due to adverse swell conditions. The CMV was also used to photograph the hull damage sustained during the last resupply operation. The weather is forecast to deteriorate over the next two days as a cold front moves through the area. FTP drop boxes have been set up for the clients so they can transfer large files to and from the vessel.

16th January 2003.
Down for weather / streamer work / source towing problems. No production recorded today firstly due to gun string separation problems which resulted in arrays 2,3,4 & 8 becoming tangled. After sorting out the guns the weather picked up. Analysis of the bi-monthly instrument test results showed we had too many channels out of spec on streamers 4 and 7. The decision was taken to recover streamer 5 completely to allow access to the front halves of streamers 4 and 7 to change out of spec sections. Tailbuoy 5 will also be repaired. The weather has improved and we are currently down for streamers.

17th January 2003.
Down for streamers / lead-in parted. Streamer 7 parted at the lead-in yesterday evening. The break in the lead-in was approximately 200 metres from the bell housing. Streamer 7 was still attached to the vane wire by the slider and towrope. To recover streamer 7, streamer 8 and the main vane tow wire had to be recovered. Streamer 7 was disconnected from the slider and transferred back onto its streamer reel. 15 spare sections had to be transferred from reel 9 to gain access to the spare lead-in for streamer 7. Prior to the lead-in accident Total Voyager was taken alongside to deliver bunkers. 130 cu metres had been delivered before the operation was cancelled when the lead-in parted. Presently deploying streamer 7 again will then pick up the front of 4 to change out 4 faulty sections.

18th January 2003.
Down for weather. Streamers 1,2,3,4,6,7 & 8 deployed. Streamer 5 presently being deployed after repairing the tailbuoy GPS and trouble shooting bad channels. Total Voyager has been sent to perform the weekly SIPPICAN probe tests and check the water depths in the turns at the western end of the next swath. The forecast is for an improvement in the weather once the present cold front passes through the prospect area.

19th January 2003.
In production. Restarted production at 22:45 hrs local time. Part of sequence 35 will have to be reshot due to a compressor problem, which caused a reduction in air pressure. The fault was eventually traced to a leaking O-ring on the 5th stage condensate discharge valve. The back up compressor was used and the faulty compressor repaired. The weather is not suitable for small boat work so the Total Voyager was sent to continue scouting the water depths at the western end of the next swath. The results match the charts showing a flat plain with water depths of 80 metres in the north rising to 75 metres in the south.
A fire drill simulating a fire in the compressor room, and a loss of power / towing drill were held

simultaneously followed by a debrief for all crew.

20th January 2003.
Down for weather. Production was interrupted on three separate occasions yesterday. Once for Pilot Whales sighted within 3km of the source and twice for compressors problems. The timer controlling the automatic condensate drains on the compressor malfunctioned leaving the drain valve open which in turn caused a drop in the source operating pressure. The weather is forecasted to back off overnight so hopefully production will be able to restart tomorrow. Presently picking up the front of streamer 5 to change out section 4 which has 4 noisy channels.

21st January 2003.
Down for weather. Heading NE with the sea and weather most of the night. streamer control extremely difficult in the large swell. Telemetry faults appeared on streamer 1 and 4 during this bad weather period. Turned 180 degrees at 07:00 now heading back into the weather towards the prospect. Streamer control still a problem. Will try and fault find on streamers 1 and 4 when conditions improve. Telemetry errors traced to slip ring connectors, connectors cleaned now OK.

22nd January 2003.
In production, picking up reshoots of holes left for whales and compressors. Helicopter crew change of the Total Marine crew scheduled for this morning also a visit from Peter Napier and John Hefti of EAPL.. Weather conditions are fine and forecasted to last until Sunday when the next front passes through the area. Small boat work planned for this afternoon after the helicopters.

23rd January 2003.
In production, time lost yesterday due to Pilot Whales, guns, and a navigational operator error. The Total Marine maritime crew change took place yesterday with two helicopter flights in the morning. a third helicopter landed in the afternoon to take off EAPL visitors Peter Napier and John Hefti. The CMV was used to change out a noisy section on the tail of streamer 1 and replace 3 birds on streamer 4. A safety induction tour was given to the new crew members.

24th January 2003.
In production. A linechange was logged as technical downtime due to gun sync errors at the end of sequence 47. The weather picked up from the NE causing swell bursts on sequence 50. The start and end of this sequence were scratched due to ship and swell noise respectively. The wind direction has swung round to the North and the swell has dropped again. It is forecasted to pick up from the South West when the next cold front passes through the prospect on Sunday. An attempt to bunker from the Total Voyager was aborted due to adverse swell conditions, another attempt is planned for later this morning.

25th January 2003.
In production, time lost at the start of sequence 53 due to guns not firing after being aired down in the water. The Total Voyager was alongside to deliver bunkers, 170 cubic metres were received before the operation was aborted due to the deteriorating swell conditions. The Total Voyager took off a skip of scrap metal and 1 x 3000ltr Techno float for scrapping. A CMV run in the morning changed out birds S2C4 and S3C4.

26th January 2003.
In production. Picking up reshoots for ship and swell noise. Time lost due to telemetry errors on streamer 4 and a power failure in array #2 slip rings. Also an extended line change to fix various sync errors on arrays #7, 6 , & 1. The weather picked up overnight as a cold front passed through the area forecast is good until the next cold front which is scheduled to pass the area Wednesday.

27th January 2003.
In production picking up reshoots for Pilot Whales, gun sync errors and swell noise. Weather conditions improved enough to enable a CMV launch yesterday evening. Two defective birds were changed and module 3 on streamer 4 was also changed in an attempt to rectify the intermittent telemetry errors on that streamer. The Total Voyager left the prospect area at 19:40hrs bound for a resupply in BBMT she is scheduled to return to the prospect area Thursday morning. Production was halted yesterday afternoon for Pilot Whales within 3km of the source this reshoot was picked up later the same day.

28th January 2003.
In production, time was lost yesterday due to Pilot Whales within 3 km of the source. The handling department have repaired one of the faulty gun reel slip rings by replacing the wiring with twisted pairs. This unit has been run on test during a line change and is now OK. Work on the other faulty unit is ongoing. The weather forecast is for the next front to pass through the prospect area Thursday afternoon. If we go down for weather we'll take this opportunity to reconfigure to 7 streamers ready to continue production on the shallower southern swath.

29th January 2003.
In production cleaning up the last of the reshoots and infill in the northern swath. Some time was lost due to swell noise generated by a large NE swell. The weather is forecasted to deteriorate and a cold front moves through the prospect area on the 31st. Overhauled slip rings have been fitted to gun reel 2.

30th January 2003.
A lull in the weather allowed a WesternGeco crew change to be completed safely by five helicopter flights out of Longford, The last helicopter departed the vessel at 02:39z, (13:39 local).

Two infill line's were acquired before the weather deteriorated and production was halted after the completion of sequence 78 at 07:29z. All gun arrays were recovered and the vessel turned to run with the seas into deeper water. The recovery of streamer 5 commenced, the plan is to reduce to the configuration to 7 streamers thus allowing the lead-ins to be pulled in to reduce the sag depth of the lead-ins for safe acquisition of the shallower part of the prospect in the south-west. Back deck work was postponed at 19:15z with tailbuoy 5 astern of the vessel. The tailbuoy will be recovered when conditions improve and repair is made to a damaged sheave on the tailbuoy recovery winch.

At 21:00 the south-westerly wind had increased to gale force with gusts to 50Kts. Difficulty was experience with cable control with streamers surfacing.

1st February 2003.
Wave height increased to 5 to 6m in severe WSW gale force winds and streamer control was poor whilst Monarch continued to run with the weather, streamer 4 constantly on the surface. The wind gradually decreased to near gale and the vessel turned to head back to the prospect at 09:00z, the stern lee allowing the recovery of tailbuoy 5.

The swell dropped in the morning sufficiently for the recovery of streamer 4 to check on 5 birds no longer communicating. At the end of the day the streamer was recovered to bird 7 and two birds were missing, ripped of the collars which were still attached to the streamer.

Sedco 702 was reported to have passed through Monarchs prospect.

A muster was completed, all crew available donned the survival suits.

2nd February 2003.
The wind and swell decreased quickly, a turn onto line heading at 06:00z confirmed that conditions were suitable for acquisition. Streamer 4 deployment following the replacement of four birds lost in bad weather was delayed due to leakage on the bird lines. The lengthy process of breaking and cleaning connections in the front end adapters solved the fault. Streamer 5 was then recovered due to leakage caused by a shark bite.

Technical downtime was therefore logged as a result of fault finding for bird leakage at the front streamer 4. Also with the streamers recovered the opportunity was taken to change one section on streamer 4 and two sections on streamer 5 which had bad channels. Replacement of a faulty bird additionally delayed the deployment of streamer 5.

Supply vessel Total Voyager was taken alongside, supplying 304m3 of bunkers and supplies, mainly food stores. Some of the fresh provisions was spoilt as the chilled container was set to too low a temperature.

At the end of the GMT day the crew adjustment of the separations in the reconfiguration to 7

streamers was in process. This was logged as mobilisation time and Phase B started in Introspection.

2nd February 2003.
The offshore supply operation with Total Voyager was safely completed.

Reconfiguration to 7 streamers was completed. An attempt to start production heading west was aborted due to an air leak and Pilot Whales. The extra time was therefore utilised to make additional adjustments on the streamer set-up. Thirteen fishing vessels were observed fishing south of Kingfish B platform in the vicinity of Monarchs turn onto line. Although communication was established with the fleet via the trawler Pasadena Star the number of vessels meant Monarch had to turn and start the line into the prospect. Production commenced at 06:28z.

A planed launch of the CMV to check the lead-in depths and change faulty birds had to be cancelled due to increasing wind and sea.

Line sequence 80 and 81 were completed but production was shut down on sequence 83 due to swell noise and poor feather match. Strong currents were encountered of over 1 knot affecting separations and coverage.

At the end of the day Monarch was traversing to the eastern end of the prospect to attempt production heading west.

3rd February 2003.
Very little production achieved due to weather. Production was attempted on sequence 83 but the middle of line was lost due to a shut down for a whale sighting. Data is marginal due to swell. The vessel transited back to the east to circle checking noise on a westerly heading. An attempt was made sequence 84 but all data was scratched due to the swell. The forecast remains poor with strong NE'ly wind and swell persisting until late Wednesday.

An operation meeting was held with all department Chiefs attending.

4th February 2003.
Down for weather no production today. The ENE wind increased to force 7 for a period. Sea conditions deteriorated to 3.5m, waves to 5m at the beginning of the period. Attempts on line were abandoned and Monarch headed west turning at 08:00 to the ENE to clear the separation zone. Streamer control was lost after turning head seas and the vessel continued to head north-easterly. Seas improved slightly and gun recovery was completed at 15:37z. Streamer 5 remained on the surface and telemetry to the streamer was lost. It was noted that streamer 6 was towing directly astern. Recovery of streamer 5 and 6 commenced at 20:00.

The 2.0ton sheave block which tows streamer 6 off the vane wire was discovered to have failed. Streamer 6 had dived below streamer 5. The front end of the streamers were untangled and streamer 6 run back out wide on new rigging. Streamer 5 and 6 came clear at the front but remained caught together from bird 6 back. The day ended with attempts in progress to separate the streamers by diving to different depths and adjusting lead-in lengths. Weather conditions had improved rapidly and the swell was decreasing.

The Navigators experienced problems with the tailbuoy communication, the onboard radio modem lost frequency settings knocking out comms with 4 out of the 5 working tailbuoys. After extensive fault finding the problem was traced and radio reprogrammed. However the lack of tailbuoy positioning was a factor in the delay in with the observation of streamer 6 tow failure.

Total Voyager departed the prospect at 08:00 to head for crew change in Barry's beach.

5th February 2003.
Attempts to separate the streamers 5 and 6 by diving to different depths and adjustment of lead-ins failed. Duel recovery was commenced 02:45z. The streamers were discovered to be badly twisted together from bird 6 back. Untangling was completed and redeployment commenced at 06:20z

Streamer 6 was out wide at 18:15 and streamer 5 deployment commenced. Three sections with bad

channels, (failing daily tests), were replaced on deployment on streamer 6 and one on streamer 5. On streamer 6 sections 11A and 11B were swapped due to the coil not working in section 11B.

Total Voyager returned after crew change and was back on onto prospect at 19:30z

The CMV was launched at 23:25z for streamer maintenance. Bird 7 on streamer 5 was changed.

At the end of the day streamer 5 deployment was still in progress.

6th February 2003.

All equipment was repaired and re-deployed following the collapse of streamer 6 at 08:06z. Monarch turned on to line and production resumed at 11:29z as the weather was deteriorating. Sequence 85 was acquired but all data was scratched due to swell noise. At the end of the day Monarch was operational, waiting on weather..

Four hours of down was accounted to digital streamer faults as this was the estimated time to change out six section bad and a coil problems were not a result of the streamer collapse.

The CMV was launched recovered after the trip to change a bird on streamer 7 and improve the ballast on streamer 7 and the second trip to change birds on streamer 4 and 6.

A helicopter was on deck early afternoon local time primary for the Client and Whale observer crew change. The following personnel joined and departed.

Departing:
Williams, Judd Whale Observer
Mustoe, Simon Herbert Whale Observer
Gordon, Jonathan Whale Observer
Slatcher, William J. E. Client Rep
Endicott, Paul D. Client Rep
Chandler, John Q. Chief Acq

Joining:
Smith, Holly C. Whale Observer
Dalebout, Merula L. Whale Observer
Macknight, Fiona Whale Observer
Round, Paul E. Client Rep
Wood, Victor G. Client Rep
Rattray, Roland I. Chief Acq
Satyaka, Adhit Pos Operator
Dunbar, Alex, Esso trainee

7th February 2003.

The weather was better than forecast and the swell dropped allowing production to resume at 00:30z. Gun and streamer separations were badly affected by strong currents. A strong 0.6Kt head current changed to a 1.5kt tail current on sequence 86. On the linechange between seq 86 and 87 south of Kingfish B the current was setting 1.8kts to the south-west. With the vane tow technology maintaining separations within spec with the varying currents will be difficult, it was discussed with the Client to obtain the average separations over a set of lines before attempting any additional adjustments.

Line changes were over the nominal value of 2.5hrs. This was due to the slight tear drop turn required for the narrow swathes planned to efficiently avoid platform Kingfisher B. The strong currents were also a factor, reduced vessel speed and the necessity for a good turning circle for the safety of the equipment.

Tailbuoy 6 died prior to the start of the last line of the day, sequence 89. Geometry of the position of the far traces remained good in Spectra but the spec's specify only 2 adjacent buoys can be down. The Client was informed and will review the positioning.

Sequence 88 was named infill but charged as prime. This line adjusted for 8 columns of extra prime

required south of the block boundary from line 2352 and the 6 missing CMP columns from shooting the adjacent three line with 14 CMP's using 16 CMP pre-plot co-ordinates. (The extra 2 columns will be accounted for on the next catch up line).

The CMV was launched at the end of line seq 86 to sound the lead-in depths and then head for bird changes. A rapid change of weather, as wind backed to the south-west and quickly freshened, meant that the CMV had to be recalled before the bird changes were attempted. The deepest lead-in on the port side was located at 54m.

Monarchs Internet and US telephone line was again lost for a period today, second time in two days. DNS Aberdeen are investigating the case, the problem is reported to be the Southwest Bell line between DNS Houston and the WesternGeco office in Richmond avenue.

8th February 2003.
Prime line production continued on the southern swaths of the prospect. The currents are still reaching over one Knot, backing round from north-east to south-west, the Navigators having to overlap coverage at times to compensate.

Whilst crossing the shipping lane at 21:30z, communication could not be established with the motor tanker "Stellata", call sign MURB9 which passed only 0.8nm ahead of western Monarch. A report on the incident was submitted to AMSA.

Plans to bring Total Voyager alongside Sunday morning local time had to be cancelled due to increasing wind.

Sequence 89 was completed with three adjacent tailbuoys, 5, 6, 7 down. Comparison tests run on sequence 88 showed very little degradation of the port streamer positioning, the positions within a metre. At the end of line 89 the tailbuoys were reprogrammed and all tailbuoys except number 7 were again operational. For an unknown reason the tailbuoys can default back to frequency. It is unknown if this is a power glitch problem or external interference. To reprogram the tailbuoy one of the onboard radios has to be set back to channel 1, the tailbuoys reprogrammed and the radio then set back to the working frequency. An InTouch case has been submitted by the Chief Navigator.

9th February 2003.
Acquisition continued on prime coverage. Part of line sequence 93 was acquired with only 12 CMP due to Telemetry and optic problems at the slip ring bypass for streamer 1.

Total Voyager had manoeuvred alongside and was being made fast at the end of the day

10th February 2003.
Production continued on the southern swathes of the prospect. The first line of the day was catch-up infill, due to adjusting for feather and currents on adjacent lines. On the same line, sequence 96, there was shut down for Pilot whale sightings.

Total Voyager was alongside at the start of the day, 228m3 of bunkers and a small amount of stores loaded. Voyager had to be let go just before end of line due to increasing sea sate. On the same line change Monarch was unable to open out to port due to the activities of purse seine fishing vessel 'Nimrod". As the current was extremely strong to the south-west Monarch was able to start the line with zero run-in and lose no coverage.

An Emergency Response Exercise "Albatross" was held with full participate from Esso and WesternGeco contingency groups.

11th February 2003.
Excellent weather for acquisition, unfortunately production was interrupted by Pilot whales, 2.73hrs lost in the afternoon local time in the excellent calm conditions for observing whales.

The Client requested that the outstanding infill on the south of the northern swathes (from sequence 72) be acquired. It was agree to change the shooting plan to an acquire a line in the middle swathe, break off to complete the infill and then circle back to continue the prime. It was also hoped that there

would be less Pilot activity in the north.

The CMV was deployed for bird changes and to adjust the balance on streamer 7 which had been running heavy.

12th February 2003.
Acquisition continued in good weather conditions. Prime line 1840B104 was completed and production continued on prime lines in the centre swathes. The DC steering on line 1600A105 was offset to the north to cover the prospect boundary and to cover infill columns adjacent to line sequence 72.

A pod of Pilot whales was discovered on line change in the morning but no production time was lost.

13th February 2003.
The wind increased above forecast and gradually increased to SW force 6-7 before rapidly decreasing to calm seas at the end of the reporting day. 6.4 hrs standby time for weather was rerecord.

A helicopter was on deck in the morning for a visit by Peter Napier and John Hefti. Engineer Tisa Abeyansinghe departed. In the afternoon local time, in marginal sea conditions a second helicopter operation took place, Napier and Hefti departed, Senior Positioning Specialist Nick Crawford arrived to relieve Mike Gors. The swell noise was becoming marginal on line and the vessel had to abort the line at 03:31z to find a heading fair seas. The landing was safely completed in marginal conditions but swell continued to increase and the vessel shut down to wait on weather. Production resumed with a re-shoot at 09:53.

14th February 2003.
Good weather continued. One prime line catch up line (adjustment from due to acquiring with 14CMP) was complete. The last 5.4km of line sequence 112 was scratched due to miss firing gun. This is unfortunate as this in the area of diving operations on Kingfish B.

At approximately 15:30 local (04:30z) the platform Superintendent On Kingfish B called the Western Monarch Captain to state "its alleged that the Western Monarch came within 10 kilometres of the Kingfish B without first calling Kingfish B". He was not open to any discussion on the matter. The mate on watch reported that he call and spoke to Kingfish B as we approached the 10 kilometre range, he has logged this call to Kingfish B at 14:15LT. Kingfish B Supervisor has a set of operating instructions that differ from the Bridging document, which stipulates that “the vessel shouldn't enter a 10km radius during diving work (irrespective of whether the guns are firing or not). Onshore Esso representative Peter Napier is investigating. Whilst the issue is under review Monarch will call 15km from the platforms and keep out of 10km if divers were down.

A second pump on hydraulic power pack number 1 failed. This meant that only one of the three pumps on the system was operational. In addition metal filing had contaminated the hydraulic oil. The source of contamination is believed to be streamer reel 11, which contains spare sections. The hydraulic oil was undergoing flushing treatment to clear the particles; the result was that recovery of guns for service was put on hold.

Total Voyager was taken alongside at the end of the day to land onto Monarch a spare hydraulic pump. (It had been shipped directly to Monarch by mistake instead of via a service agent). The pump was installed as back up.

The mate on Total Voyager, Kevin Wear aged 35 reported a stomach complaint and advice was offered by Monarchs Medic. After discussion with Total’s management, Total Voyager departed station at 20:10local for Barry Beach so that the Mate could receive treatment and be replaced. Voyager will turn around a soon as possible and return to Monarch. Steaming time 13hrs to Barry Beach.

15th February 2003.
Acquisition continued in good weather. The hydraulic oil was filtered and system back on line for gun recovery, the spare Oilgear pump was installed.

Run-in for the line changes in the west had to be shortened due to fishing activities, no coverage was lost as the westerly current helped to straighten the streamers. Sequence 116 run-in was shorted to 4km due to fishing activity, gun work was completed in time but the soft start was delayed due to dolphins in the 500m zone of the arrays.

A rip current was encountered while on line sequence 119, south of the previously disputed infill, (currents or steering) on line sequence 72.

Two small re-shoots were left on line 116 due an RTNU hang up and a series of gun misfires.

Total Voyager was back on station at 08:20 local, 21:20z

An LPT meeting was convened.

16th February 2003.
The last line of the day was scratched due to swell noise, the south-westerly wind and swell increasing with the passage of a cold front.

Two lines were incomplete due to gun problems at the start of line. Array 2 had to be recovered on the run-in to sequence 120 due to a pigtail problem following deployment after maintenance on the linechange. Array 6 had to be recovered at the start of line seq 121 due to a fitting breaking off an airline jumper. It should be noted that at the time sea conditions were moderate to rough and sea conditions for gun deployment and recovery were not ideal.

A small re-shoot of 36 shots will be required on sequence 120 due to high speed caused by rapid change in speed after crossing rip currents. The observer checking records for ship noise, high bridge activity and work load on the Officer of the Watch, calling rigs, crossing traffic was a contribution but the current caused the high speed.

17th February 2003.
The first line attempt of the day had to be scratched due to swell noise. The South-westerly wind eased as did the south-westerly swell but an increase in the swell from the south-east resulted in a large confused swell. Production resumed at 07:18 as the swell quickly dropped.

With the change in weather currents increased to 1.8Kts with a resulting longer line change in the west. The swathe edge, on the middle west going swathe, was becoming more exaggerated causing difficulty in steering back onto line and thus a hole in the coverage was left on sequence 124. With hindsight the border edge should have been straitened up by continuing to the leave an infill thus making steering on the next adjacent line easier. The plan is to straiten the edge up on the next run.

Tailbuoy two died on the last line change of the day prior to the start of line sequence 126. This may be a result of frequency loss and attempts will be made on the next line change to re-program the buoy.

Sea conditions remained too moderate to rough and too poor for CMV activities

18th February 2003.
The weather was variable but a large swell and moderate sea state prevented any small boat work. Production continued on prime and infill, the infill line required to adjust back to nominal columns due after overlapping to maintain coverage due to currents. Strong currents up to 1.8kts were again encountered and a extended line change was required north of Kingfish B.

19th February 2003.

Production continued in marginal swell noise conditions, swell 2.5m. The moderate to strong easterly winds are forecast to move north-east and strengthen as a high moves to the east of Tasmania.

The line change after 132 was slightly extended due to the strong southerly setting current and the proximity of Kingfish B.

Line sequence 28 acquired on the 18th was under review for swell noise,

The RTNU (real time navigation unit) crashed on line sequence 130 leaving a 40sp re-shoot.

Total Voyager departed the prospect at 20:00 local to commence passage to Barry Beach Marine Terminal for bunkers and supplies.

20th February 2003.

Line sequence 133 was completed at 02:12 z. the swell noise marginal for the last 5km of the line. The wind had increased to easterly force 7 and the sea sate was becoming moderate to rough.

With the forecast predicting a rapid rise in swell height the decision was taken to recover the gun arrays and wait on weather. Strong wind warnings were received and significant sea height over 4.0m max wave height 7m was predicted. A broad area of low pressure over western and central parts of Australia is gradually expected to extend south-eastwards with a low pressure system developing near the New South Wales coast by Sunday.

After gun array was completed the vessel headed ENE with all streamer deployed, turning at 17:00z to head back to the prospect. The vessel was waiting on weather at the end of the period. Wind ENE 30kts, sea 3.0m.

21st February 2003.
Waiting on weather all streamers deployed. Monarch remained to the east of the prospect on NE-SW racetrack, turning at 14:00z to head back north towards the prospect and then 20:35z to a north-easterly course.

Strong easterly wind are forecast to persist, backing NW'ly on Monday then a strong SW'ly change before easing on Tuesday.

At the end of the day north-easterly wind was force 7, sea's 4m. Total Voyager was 30miles away, battling to catch up with Monarch.

22nd February 2003.
Waiting on weather all streamers deployed. Monarch remained to the east of the prospect on a NE-SW racetrack, clear of the shipping lane.

The strong easterly winds persisted, swell 4m. Streamer 6 surfaced in the large swell at 06:30 but was successful brought back under control. Tailbuoy comms were in and out in the swell. The vessel successful turned at 07:30z to head SSW and again at 18:00 to head ENE. There was a slight lull at dawn (17:00)z but wind and swell again increased at the end of the period to Force 6-7, 3-4m.

After battling the swell Total Voyager was on station at 10:00z

23rd February 2003.
Waiting on weather all streamers deployed. Monarch remained to the east of the prospect on a NE-SW racetrack, clear of the shipping lane. Monarch turned at 0740Z to head back SSW

The NE'ly wind and swell eased a little over night but once again started to increase from dawn local, the vessel thus continued on a S'ly heading. At the end of the day the wind NE 30Kts, swell 3.0 to 4.0m.

Still waiting for conditions to improve for small boat launch or streamer recovery to replace two adjacent birds, 11 and 12 not responding on streamer 5.

24th February 2003.
The strong NE'ly wind, force 6-7 persisted.

With a forecast predicting improvement, possibly overnight, the decision was taken to recover streamer 5 to change birds 11 and 12 and then the front end of streamer 3 to change faulty acoustic pods. The cable work was safely completed at 17:09z (04:30 local) although during the operation the wind and sea increased to a severity greater than forecast, the wind gusting over 35kts. A steep 4-5m swell developed and it was deemed unsafe to turn until the swell was observed to be dropping off at 19:00z. At the end of the day the vessel was heading back to the prospect 7hrs from start of line.

25th February 2003.
The swell decreased as Monarch headed back to the prospect. The CMV was launched to transfer Chief Observer Donny Isdaryanto from Total Voyager but swell conditions were not suitable for streamer work.

A plan to take Total Voyager alongside on route was cancelled due to a quick change and increase in wind and sea from the south-west. Guns were deployed and the start of line time was estimated at 08:30z. With a decrease in wind later on in the afternoon the decision was taken to turn and find a suitable heading for supply boat operations. Total Voyager was taken alongside at 05:58z. 261m3 of fuel was loaded, fresh supplies, lube and hydraulic oil. Cargo operations were suspended during the operation because of vessel movement and three containers (4 drums lube oil, tapes and engine parts) were not loaded. Due to the swell conditions Monarch had to alter onto a reciprocal course and 11.85hrs was logged for supply boat operations. Total Voyager remained on location to be in attendance for helicopter operations and TMS crew change on Thursday. They will then proceed to Belle Bay Tasmania to load 450m3 fuel.

Production resumed at 20:21z but the line was shut down briefly at 22:09 due to a sighting of killer whales.

After a misty start to the day had cleared the CMV was launched on line to replace GPS units on tailbuoys 2 and 3, with success on tailbuoy 2. Streamer 1 bird line comms are more intermittent after the latest period of bad weather. (As streamer 1 is connected to the vane this is a long job requiring good weather).

The weather forecast for the end of the week is poor with gales force winds forecast.

26th February 2003.
Production continued in calm sea and low swell. Currents were strong and a rip on sequence 134 required trace edits due to bend noise. The two extra infill runs requested by the client in the northern swathes were acquired sequence 135, 137. Both lines were east going and two prime lines in the centre swathes were acquired heading west. From sequence 135, streamer 1 bird line comms were intermittent due to leakage and as the streamer could not be positioned only 12 CMP were charged.

The CMV was launched for streamer maintenance, bird changes and tail buoy GPS replacement. The repeater module was changed on streamer 5, to try and solve bird line drop out in the tail of the streamer and the GPS pod was changed on tail buoy 3.

27th February 2003.
The Total Marine crew change by helicopter was completed by two flights out of Longford. Fog affected the operations with delays to the helicopter flights following the late departure of the charter flight to West Sale. Monarch then had to circle to avoid entering a fog bank as the first helicopter was on route to the vessel, 4hours was logged as crew change time.

Mike Greenwood of Esso joined for a brief stay between helicopter landings to carry out an environmental audit.

Strong currents up to 1.8kts affected the coverage and is expected to increase the infill percentage due to large opposing feathers on some segments of lines. Bend noise from currents was evident on sequence 141. Ship noise caused by a large super tanker required a large edit on sequence 139.

Streamer 1 remained unusable due to leakage on the bird lines. Due to a rising forecast it was not deemed safe to consider stacking operations to repair the streamer, production continued acquiring 12 CMP.

Supply vessel Total Voyager departed the prospect at 05:00z to proceed to Devonport for Bunkers.

28th February 2003.
The south-westerly wind increased and line sequence 143 was aborted (all data scratched) for swell noise at 08:55z. The vessel turned to clear the shipping lane whilst all guns were recovered. With conditions still deemed to be suitable for streamer work on the centre streamer, streamer 4, was recovered to change 3 sections with bad channels. The streamer was fully onboard at 20:45z. Streamer work then ceased whilst the hydraulic oil tank was drained to check for and remove any metal filings from the earlier winch failures.

Strong south-westerly winds are forecast and not expected to ease until late Sunday.

A fire and lifeboat muster was held, to check the muster duties of all new crew. All donned survival suits.

1st March
Waiting on weather. With strong winds forecast Monarch turned at the start of the day to head SSW with the aim of locating some lee to the east of Flinders Island.

After completing the clean out and change of oil in the Hydraulic tank, work commenced on recovery of streamer 5. Four sections and one module were changed due to bad channels and test failures. The streamer was fully recovered at 11:43z in order to facilitate the recovery of streamer one when weather conditions improve sufficiently for the recovery of the vane.

Monarch turned to head back north at 19:30z with 5 streamers deployed and tailbuoy comms dropping out. Sea conditions deteriorating, wind SW 34Kts, swell 3.0m.

Total Voyager was back on location at 15.30z.

2nd March 2003
The south-westerly wind rapidly increased, gusts over 50kts. The sea height quickly increased and Monarch, heading north, to east of Flinders Island, turned west and then south to try and remain in the lea of land outside the 100m depth contour. The wind remarkably dropped following a squall and change of wind at 07:00. Monarch was able to take the opportunity make to another turn to head back north. Swell height increased as the vessel ran north and control of streamers 3 and 6 was unstable. At dawn 20:00z, the swell, still occasionally 3 to 4m, was considered to have sufficiently decreased to commence the stacking of streamers 2 and 3 to port.

On recovery of streamer 2 front end the main tow 2.0 ton sheave block was discovered to have failed, the bolt was missing and the block flanges frayed out. The streamer was towing from the secondary tow. The PMI-rod and streamer 1 main tow also need to be replaced. At the end of the day the crew were busy replacing the PMI rods on lead-in 1.

3rd March 2003
Whilst waiting on weather, the starboard vane was recovered and bad coil line on streamer 1 fixed. Numerous adapters were changed at the front end, water ingress in the cable head section, MSX module due to power dropouts and active section 2A due to a suspected shark bite. The vane deployment was not easily in a 3-4m swell and several attempts required before the vane pulled wide. With the starboard side streamers back in position streamers 4 and 5 were deployed

in tandem. Deployment of streamer 4 was delayed by the need to change 3 sections with bad coils. It was expected the streamers would be deployed by 19:00z, and with swell conditions improving and possibly suitable for production 19:00z to 24:00 was logged as streamer downtime. Streamers were to their marks at the end of the day. Three hours weather down time will still be claimed for the gun deployment.

At the end of the day Monarch had turned north and preparation were in progress to take Total Voyager alongside for bunkering.

4th March 2003

Total Voyager was made fast at the start of the day and Monarch steamed on a northerly heading for 6.6 hrs, a course most suitable to form a lea for Voyager from the SW wind and SSE'ly swell. 428m3 of bunkers was loaded and remaining cargo completed.

The northerly course meant than Monarch had to overshoot the intended line and then turn back to start production in the centre of the block on re-shoots and infill. 10.4 hours was logged down to supplies at sea.

The first line was a series of re-shoots and infill, line sequence 144. The first segment (for vessel speed) was agreed to be non chargeable. A strong change in current caused the speed to increase, a combination of factors caused all departs did not to react in time, observers QC of ship noise and bridge dealing with ships traffic. The second segment was chargeable rip currents.

Total Voyager was released at 07:00z to proceed to Barry Beach Marine Terminal for crew change.

The separation between streamers 5 and 6 was noted to be down, the crew suspect cross currents and swell but on the last line change of the day the streamer had to be deployed past the marks to improve the separation. It is therefore suspect that the main tow could have failed on the streamer and the streamer will be recovered once the vessel completes the last line of the day and turns away from the shallows.

5th March 2003

Sequence 146 line 2000Y146, was completed. This was named Y, a second catch up prime line in the centre swathe. The separation between streamers 5 and 6 was observed to be reduced and to correct for this streamer 6 had to be deployed 35m. It was therefore evident that the main tow had failed and the streamer was being towed from the lead-in secondary tow point. Production therefore halted at 02:31z, at the end of sequence 146, to inspect the rigging. The guns were recovered and streamer 5 and 6 stacked across. It was discovered that the 3ton G hook boss ring on streamer 6 main tow had failed. Additional inspection was made on streamer 7 tow rigging. The following was observed; The shackle bolt from the second tow was missing and shackle bolts in use had excessive wear on the threads and part of the Yale grip on streamer 7 was also discovered to have failed. The 3ton G hooks from all port side tow points were replaced with 4.75t shackle.

Production resumed at 13:07z concentrating on closing the gab between the centre swathes. This necessitated a teardrop turn in the west to clear Kingsfish B.

Total Voyager was back on location at 16:30z.

6th March 2003

Infill and re-shoot production continued with the aim of closing in the northern centre swathe border and tidying up the infill and reshoots. Line changes were extended due tear drop turns, the need to clear Kingsfish B and a ship which would not answer on a line change in the east.

Barnacle growth on the streamers is believed to have accelerated over the past week and the resulting drag in turns, which are mainly to starboard, is causing streamer 7 to cross over in front of streamer 6. This is being handled by the crew by diving and lengthening streamer 6. The CMV was launched to change bird 9 on streamer 1 and investigate the towing of tailbuoy 7. The

retrieval rope of the tailbuoy is tangled but this is not believed to be the main cause of the streamer tracking in on turns.

7th March 2003
Acquisition continued, closing the gab between the centre swathes and acquiring re-shoots lines in the centre swathes.

The CMV was deployed on a tear drop linechange north of Kingfish B to clean streamer 7 from the tail to bird 11 to try and reduce the drag of the streamer into the turn due to Barnacle growth. Vessel speed was kept low on the run-in against a strong current to maximise the cleaning operation. The CMV had to return early to Monarch before planned work on tail buoy 4 due to overheating of the port engine.

At 21:38hz 6th, Western Monarch reported to Kingfish B that she was entering within 15km of the platform, Western Monarch asked if there were any diving operations in progress or planned. The person who answered the radio said no diving was in progress and none were planned.
On a tear drop turn north of the platform the vessel was always with-in 10km radius of the platform. The officer on the 8-12 watch reported leaving the 8km but the officer on the 12-4 did not report Monarch re-entering 8Km zone later on in the turn. At 01:55 Kingfish B contacted the Western Monarch and asked what her distance off was. Western Monarch reported that she was 6.2 km off the platform and the operator then requested that we report once Western Monarch was 10 km from the platform. This was agreed. At 03:25 a complaint was received via the on board Client Representative that an official complaint was logged that Western Monarch had fired airguns within 8Km of diving operation off Kingfish B platform. Full RIR and statement of facts was issued and mitigation measures put in place.

The vessel had to abort near the end of line sequence 153 to keep clear of fishing vessel Lady Miriam engaged in trawling and not able or prepared to alter course.

8th March 2003
Infill and re-shoot production continued in the centre swathes, completing the major runs in the west of the prospect to the north-east of Kingfish B platform. Strong currents and the need for a skewed tear drop line change to avoid Kingfish B resulted in a long extended linechanges. A long circle back to pick up a re-shoot for ship noise added to the total standby for the day.

The CMV was launched to collect fresh provisions from Total Voyager before continuing with streamer maintenance. After collecting the first load of provisions the CMV had to return to Monarch due to failure of the port engine. The fault was with the SEPAR primary filtration unit between tank and engine.

A general QHSE meting was held in the mess room with all crew not on duty attending.

9th March 2003
The last major re-shoot line in the centre swathe was completed and the vessel transited south to pick up a whale re-shoot. Production then continued on prime and infill lines in the southern swathes. A segment of sequence 161 was lost due to ship noise. The swell increased on line sequence 163 and the line was aborted before the end of the day and a last good SP called.

Following a re-boot of the MSX system, DC offset removal was not applied on sequences 162 and 163. This will need to be adjusted in processing. Log clearly marked.

10th March 2003
Production was affected by the swell which had increased from the SSE. A large segments of sequence 165 was rejected and all of sequence 166.

The strange phenomena of streamers 1, 2 and 3 and the front end of 7 suffering less from swell noise was observed. The theory is that these streamers have a greater barnacle growth, perhaps the increased drag results in less noise. Streamers 4, 5 and 6 have been onboard and half of streamer 7 cleaned by the CMV crew.

Sperm whales were detected audibly in dark by the PAM system, although the distance could not be determined.

11th March 2003
Production continued to be interrupted by swell noise. Sequence 167 was scratched. Swell, ship noise and feather miss-match all contributed to aborting 168. This allowed recovery of the gun arrays to overcome intermittent GPS problems on arrays 2 and 4. Production resumed sequence 169, the start of line was missed due to a Spectra hang-up. The power was lost for streamer 6 on sequence 170 for 58 shots; to prevent re-occurrence the power supply was changed on the next line change.

Preparations were made at daybreak to take Total Voyager alongside for fuel and stores. However the plan had to be aborted due to freshening winds.

12th March 2003
Acquisition continued on the southern swathes. Two shut downs were required for sperm whales. The first shut down on line 22208I172 line necessitated a change in shooting plan, attempting to complete the line on sequence 2240J175 although the last 7shots were lost due to another whale sighting.

Sequence 174 had a late start due to gun depths. Array 6 was recovered for maintenance problems developed with gun depths and a air leak on the run-in to line. The array was recovered and line started late. The end of the line had also to be scratched due to excessive misfires.

The CMV was launched to change malfunctioning birds. Sea's were choppy from a NW breeze and after safely completing two bird changes the CMV was recovered whilst the vessel had a good lea.

13th March 2003
Good production picking up infill/prime and reshoots. Weather conditions improving throughout the day. Crew change performed in the morning using 5 helicopter flights out of Longford.

14th March 2003
Weather conditions improving throughout the day. Seismic crew change complete using 5 helicopter flights out of Longford, Nav merge data was sent ashore in the last helicopter flight. Problems with Posnet GPS pod on the source caused downtime, production was also halted due to Pilot whale sightings within 3 Km of the source. The PAM system was derigged ready to be sent ashore via the Total Voyager. A safety induction tour of the vessel
was given to the new crew members.

15th March 2003
Continuous production picking up the last infill and reshoots expect to be completed by Tuesday evening / Wednesday morning hopefully before the next front passes through the area. The Total Voyager was taken alongside yesterday afternoon to deliver fuel and spares. The PAM system was back loaded onto the Voyager to be offloaded in BBMT. We received the spare hydraulic motor for streamer reel 11 and also the spare hydraulic pump for power pack #1, we will need good weather to allow the mechanics to install these units.

16th March 2003
Production continued in marginal sea conditions. Preparation work ongoing to change out streamer reel 11 drive motor. Problems continuing with tailbuoy Posnet pods presently down to only 2 working tailbuoys numbers 3 & 5. Picking up small reshoots and infill as we approach the end of the survey hopefully we'll have it all completed before the next weather front passes through on Wednesday. The Total Voyager performed a TS-dip yesterday and will have three more to complete before the end of the job. A general muster for all crew and lifeboat training for the new joiners were held.

17th March 2003
In production picking up remaining infill and reshoots. Lost time this morning d/t Pilot whales, then shut down again for a Sperm whale. Estimated completion now back to Wednesday evening /

Thursday morning this could also change depending on the severity of the cold front which is forecasted to pass through the area Wednesday. The Total Voyager has completed the TS-Dip program and will be released Tuesday evening to be in BBMT 06:00hrs Wednesday for resupply. With the delay in completion our ETA Freemantle will be 08:00 hrs. 28th March. Sequences 186, 187, 189, & 190 had trace edits either side of bird S5C14 d/t suspected depth control anomalies.

18th March 2003
Presently down for weather as the cold front passes through the area, sea conditions are forecasted to improve Thursday evening this puts completion back to Friday evening / Saturday morning. ETA Freemantle now 08:00hrs 30th March. Time was also lost yesterday d/t Sperm and Pilot whale sightings within the 3km zone. The Total Voyager has been sent into BBMT for resupply after completing the last of the TS-dip program.

19th March 2003
Presently down for weather source on board all streamers deployed following a racetrack at the eastern end of the prospect. The vessel turned onto line heading to check the noise at 07:00hrs but control of the streamers was not possible d/t the large swell. The forecast is for the weather to start to improve overnight Thursday. ETA Freemantle 30 / 31 March.

20th March 2003
Down for weather. Strong F9 gale, headed towards the coast to seek shelter. Streamers 6, 3, 5 , & 4 difficult to control due to the sea conditions. Once in sheltered conditions the streamers were brought under control and set to depth. The wind has dropped and sea conditions are improving presently heading back towards the prospect and hope to be in production Friday afternoon. Lost contact with 2 birds on streamer 6 will check these out by CMV when conditions are suitable.

21st March 2003
Down for weather. Conditions still not suitable for production. Picked up streamer 4 to bird 14 to check on faulty compass readings birds 12,13 & 14 which were off the collar also changed bird 6 d/t high bias. Section 1A (bad coil) and 3B bad channels were also changed. One Techno float was lost during deployment d/t the high swell this has been picked up by the Total Voyager which returned from BBMT yesterday @ 09:00 UTC. Presently heading for the prospect deploying guns hope to start production again this afternoon. CMV launched to change birds on streamers 3,4, & 6.

22nd March 2003
Some production yesterday in the weather window but swell conditions becoming marginal again later in the day causing two sequences to be scratched. The CMV was launched to replace two missing birds on streamer 6 and change faulty birds one each on streamer 4 and 3. Food stores were also transferred from the Total Voyager using the CMV. Tailbuoys 3 and 4 tangled during the turn onto sequence 203 but separated again afterwards. Presently heading for infill / reshoots in the west on the prospect where swell conditions are hoped to be better d/t the shallower water. Estimated completion date 24th March depending on sea and weather conditions ETA Freemantle 1st / 2nd March. Due to the delays in completion we will have to take the Total Voyager alongside for bunkers before departing for Freemantle.

23rd March 2003
Down for swell noise. Managed to shoot one small infill segment before the swell noise shut down production.The swell is forecasted to decrease later on the 24th so hopefully we'll be able to complete the job. We have experienced problems with the tailend of streamer 3 passing over streamer 4 during turns, this is thought to be due to barnacle growth causing extra drag on streamer 3. Streamers 1, 2 & 3 are noticeably quieter than the other streamers again this is thought to be due to barnacle growth on these streamers. As the other streamers had been cleaned of barnacles. Trace edits due to depth control are being applied to the front of streamer 1 which is deep because of a missing Techno float lost during the previous bad weather period. Expect to complete the job on the 25th ETA Freemantle 02.03.03. Due to the delays we will also need to top up our bunkers from the Total Voyager before departure to Freemantle.

24th March 2003

Completed the survey at the end of sequence 212. Presently recovering in sea equipment, all guns onboard working with the streamers transferring streamer 4 onto reel 10 in preparation for the next contract. A helicopter will arrive at 13:00hrs LT to take off the clients and departing crew members no data will leave the vessel with the helicopter. Data shipments will be made on arrival Freemantle ETA 02.04.03. The Total Voyager will be brought alongside after the helicopter operation to deliver bunkers.

7.3. Field Information and Encountered Problems

7.3.1. Obstructions / Installations on the Field

There were no known man-made obstructions, such as platforms, located in the prospect area. The Exon Mobil production platforms Kingfish B and Mackerel were the closest obstructions to the prospect area lying approximately 4.5 miles and 6.5 miles respectively from the western boundary of the prospect.

7.3.2. Traffic / Shipping Lanes

The prospect was on the route for shipping traffic between Melbourne and Sydney. The shipping traffic separation zone runs throught the south west corner of the prospect. Local shipping was observed. The majority of traffic responded to Monarchs requests to keep clear but a few Merchant ships apparently kept a poor radio VHF watch and responded very late. Therefore a chase boat is definitely required in this area.

7.3.3. Fishing Activity

Very little Fishing activity was encountered. The pre-survey contact and dialogue made by Exxon Mobil with the local fishing cooperatives to keep local fishermen informed of the survey probably helped avoid the interference between fishing and survey activities. In addition to the above a weekly report with the Western Monarch predicted movements was sent to via operations to the local fisherman to keep them informed of the survey vessels expected movements. Fishing activity was mainly observed in the vicinity of Kingfish B platform.

Western Monarch had to abort near the end of line sequence 153 on 7th March to keep clear of fishing vessel Lady Miriam engaged in trawling. She was not able or prepared to alter course.

7.3.4. Seismic Interference and Time Share

No significant seismic interference affected the data.

7.3.5. Environmental Obstacles

The greatest environmental obstacle was the weather and notably the swell. Waves generally arriving from the south-west were on average 2 to 3.5m high. Days with a swell height less than 2m were very rare.

Cetaceans are frequently seen in the Bass Strait area therefore the survey had procedures in place in the event of cetacean contact. The Management Strategy was to follow Environmental Australia's "Management Guidelines for Seismic Vessels Operating in Australian Waters so as to Avoid or Minimise Interference with Whales and Certain Other Larger Cetaceans". A whale avoidance distance was 3km any sighting within this distance resulted in production being halted and the energy source shut down.

Dedicated cetacean observers from Applied Ecology Solutions Pty. Ltd. (AES) joined the vessel on the 31st December to undertake continuous observations. Aerial surveys were used prior to commencement of the survey to establish if any cetacean were in the prospect area.

A Cetacean Passive Acoustic Monitoring System (PAM) arrived onboard the Western Monarch on the 09th January and became operational on the 11th January. The primary function of the system was to maintain a detecting and locating tool for vocalizing marine

mammals, with the objective of monitoring the 3 kilometers exclusion zone around the (Western Monarch) seismic source. This PAM system was experimental and was only used as a cross reference to the visual sightings. It was therefore only operational in daylight hours.

AES was commissioned by Esso Australia Pty. Ltd. to design, implement and manage legal compliance monitoring and mitigation for the Tuskfish 3D seismic survey in eastern Bass Strait. A range of measures was required by Commonwealth government law and policy including the Environment Protection and Biodiversity Conservation Act 1999 and the Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 to assist in an effort to mitigate serious impacts on cetaceans.

Aim of visual monitoring:
Ensure that observation was undertaken continually by at least two people while seismic guns were firing and for the statutory pre start-up period; and that observation took place at any other time when conditions were favourable for doing so.

Aim of acoustic monitoring:
To conduct a trial of a towed array system for Passive Acoustic Monitoring and test the effectiveness of this technology as a mitigation tool within a framework of Australian environment law.

Project Statistics:

Visual and acoustic summary details from 15th January to 12th March 2003.

Date project commenced	4th January 2003
Date completed	Project due to finish 17th March
Number of days of visual observation	49 days
Total number of hours of visual observation	564 hrs 55 min
Average hours per day of observation	11 hrs 37 min
Average hours per week of observation	71 hrs 10 min
Species Name	Sperm Whale (*Physeter macrocephalus*) Pilot Whale (*Globicephala* sp.) Killer Whale (*Orcinus orca*) Bottlenose Dolphin (*Tursiops truncatus*) Common Dolphin (*Delphinus delphis*) Risso's dolphin (*Grampus griseus*)
Other species sighted	Fur seals (*Arctocephalus* sp.) Oceanic white tip shark (*Carcharhinus longimanus*) Sunfish (*Mola mola*) Leatherback Turtle (*Dermochelys coriacea*) Manta Ray (*Manta birostris*) Large jellyfish Seabirds (albatrosses, shearwaters, gannets, crested terns, Arctic jaegers, silver gulls, Fairy penguins) * several terrestrial birds also seen
Number of days of acoustic monitoring	55
Total number of hours of acoustic monitoring	512 hrs

Total number of acoustic detections	127
Average hours per week of monitoring (from 19th Jan – 12th March)	61 hrs 17 min
Species detected acoustically	Bottlenose dolphins (*Tursiops truncatus*) Common dolphins (*Delphinus delphis*) Sperm Whales (*Physeter macrocephalus*) Pilot Whales (*Globicephala* sp.)
Number of combined acoustic & visual detections (from 2nd Feb – 12th March)	25
Number of shutdowns required	13

Visual Monitoring team	Simon Mustoe	AES Applied Ecology Solutions
	Judd Williams	Queensland
	Steve Benn	QLD Marine Parks Authority
	Graham Ross	Canberra (formerly with Environment Australia)
	Merel Dalebout	University of Auckland, New Zealand
	Holly Smith	Western Australia
Acoustic Monitoring team	Josh Jones	Scripps Institute of Oceanography, California
	Jonathan Gordon	Ecologic, UK
	Jane Griffiths	Ecologic, UK
	Michelle Lemon	Macquarie University, Sydney
	Fiona Macknight	University of Queensland, Brisbane

7.3.6. Operational Observations

Total Voyager was Western Monarchs support vessel for the duration of the project. She acted both as a chase vessel and supply vessel. Due to some of her fuel tanks containing contaminated fuel, a condition that was in existence prior to the survey, Total Voyager was only able to supply 300m^3 of fuel at a time. This figure was increase to near 450 m^3 towards the end of the survey in March. The limit increased the number of supply boat operations required to keep Monarch topped up with fuel. There are very few weather windows in the Bass Strait where conditions were acceptable for taking her alongside. The transfer of fuel and stores on line heading was not always possible due to wind and sea conditions. Monarch had to break off from the prospect to complete supply operations on the following dates.

25th February 11.85 hrs
4th March 10.36 hrs

There was limited opportunity to deploy the small boats due to sea and swell. Transfer of personal by small boat could not be relied upon, one man (Donny Isdaryanto, Chief Observer) had to wait 10 days before being successfully transferred from the Total Voyager to Monarch. However the CMV was launched on several occasions to change out malfunctioning Digicourse acoustic POD's and birds, the fast speed of the craft proved its efficiency. The CMV crew also completed one section change successfully. Nevertheless the CMV crew can only successfully change out a section in very good sea conditions and the work position for the crew in the boat is not good for prolonged operations.

Technical downtime accounted for 10% and of the total time. Breakdown was as follows;

HOURS			PROBLEM
12.133	-0.6 %	-	Navigation Systems
18.833	-0.9%	-	In sea positioning
71.667	-3.5%	-	Digital streamer
44.617	-2.2%	-	Tow equipment
4.4	-0.2%	-	Compressor
21.36	-1.00%	-	Operator error
30.317	-1.5 %	-	Source
0.33	-0.1%	-	Recording system

The serious downtime under WesternGeco SQ RIR reporting system was listed as follows.

Report #	Description	Event Date	Category	HSE Severity	SQ Severity
20030305093102	Main tow streamer 6 failure, damage on 7 tow	Mar 05, 2003	Accident/Failure		Serious
20030207025338	Compromised positioning d/t digicourse set up prob	Feb 02, 2003	Accident/Failure		Serious
20030205215024	Spreader sheave failure streamer 6.	Feb 04, 2003	Accident/Failure	Serious	Serious
20030201045853	Birds ripped off streamer.	Feb 01, 2003	Accident/Failure	Serious	
20030118032304	Streamer 7 lead-in parted.	Jan 18, 2003	Accident/Failure	Serious	
20030106093731	Received repaired section with swapped fibers.	Jan 03, 2003	Accident/Failure		Serious

Streamer 7 lead-in parted Jan 18, 2003

After performing streamer maintenance number 7 streamer was being deployed. The streamer had two techno floats fitted and was connected to the vane wire by a spreader rope and slider. Deployment had been halted to untangle the second techno float rope, which had passed the wrongside of the lead-in. The lead-in started to pay out rapidly as it broke approximately 20mtrs from the stern and 200mtrs from the bell housing.

Streamer 7 was taken under tow again when the slider reached the end of the vane wire. Streamer 8 and the vane wire were recovered this also brought in streamer 7. When streamers 7, 8 and the vane were recovered to the stern a rope from the spare main tow winch was attached to No 7 slider. In addition to this another rope was attached from streamer reel 7. The slider locking bolt was removed and the weight of streamer 7 transferred back on to reel 7. A spare lead-in was fitted and streamer 7 was redeployed.

Action Item: Due to the plastic coating and hairy fairing on SouthBay lead-ins it is impossible to visibly check if the lead-in stress members are corroded. The lead-in that failed was manufactured in 1997 and received on the Monarch in September 2002 after being re-terminated. The point where it broke looked in good condition from the outside but inside the stress members were badly corroded. We should start rotating the lead-ins through cable repair shop (CRS) after a specific time period. The condition of the lead-ins under the plastic coating and hairy fairing to be assessed using NDT methods to determine if the lead-in is fit to be returned to the field. In order to achieve this rotation we need more lead-ins available in the Marine asset Pool.

Follow up: Duncan (Ely) you review if the technique raised by the Monarch would be viable for the checking of leadins at CRS. If we could evaluate the status of the armouring without removing the plastic covering it might be worth looking further into. More leadins are being brought into MEA pool 5 from the US and 1 more from Singapore
(NM 6/02/03).

Singapore CRS are currently investigating the status of the armouring of lead-ins at CRS. Waiting for return of I/O engineer in order to complete retermination and follow up on NDT options available. NDT methods were also discussed at the intersite meeting with SCD. They are coming back with some possible options. We are also following up (via InTouch) the load testing required for the SouthBay lead-ins - there is some discussion here because they do not actually take a direct load of the Barovane - only the load of the streamer....
(D.Eley 19/02/2003).

Compromised positioning d/t Digicourse set up problem, Feb 02

Following a reconfiguration from 8 to 7 streamers, during which the streamer offsets were shortened by 80m the acoustic ranges from the port source to the heads of the port streamers tracked outside the gate window set up in Digicourse. The new offsets as determined on a heading of 288 had been entered in Spectra and transferred to Digicourse, however, when we turned on to line heading 108, the separations were 40 to 50m to wide and the streamers offsets had to be adjusted again to correct this. This last adjustment caused the ranges to track on to the very edge of the Digicourse aperture gate.

The data became very intermittent when on the gate edge, as when crossing the gate edge the range is not processed. Unfortunately, there was sufficient good data for Spectra to indicate that both the ranges and network were sound on line. In processing it was found that what data there was from the Port source did not fit the network solution, resulting in poor geometry to the port streamer heads. Even though the data passed the statistical tests required of it, the onboard client did not accept it due to the poor geometry.

SQ Severity: Serious
Delay in Delivery Process: 6.3 hrs

Action Item: New procedures Digicourse Acoustics
Create in-touch ticket with lesson-learned case ID 3543672
Brief department on need for closer monitoring
Reference to be included in handover notes

Follow Up: Lesson learned, created and reviewed by senior navigators, submitted, now awaiting verification by ITE (8-02-03)
Department briefed, new item added to line check lists (8-02-03) Reference and brief description included in handover notes (13-02-03)

Birds ripped off streamer, Feb 03, 2003

Report Number: 20030201045853,
Four Birds ripped off streamer
During gale force weather communication was lost with birds 5, 7 8 and 9 on streamer 4. When sea conditions improved the streamer was recovered and birds were discovered missing. The collars (release catches tie rapped) were still on the streamer, the metal forced open at the connection point.
The reason is unknown. Sea conditions rough, maximum wave height 6m. Safety strops are used. Retriever units in the area had been ripped off the streamer but were still handing on the safety strop.

Action Item: Check condition of collars
Ensure all collars used are in good condition.
Follow Up: All collars will be visually inspected for damage/ware before use. This was discussed in departmental tool box Feb. 03, 2002 See minutes QUEST # 20030203145827

Spreader sheave failure streamer 6, Feb 04

Western Monarch operating in the Bass Strait Tuskfish prospect was towing 7 by 5000m streamer using a Western conventional tow configuration. The vessel was down for weather at the time of the incident with all guns onboard. At an unknown time the 2.0ton sheave block which tows streamer 6 from the vane wire failed. Streamer 6 dived below streamer 5. The collapse was identified after streamer 5 developed telemetry errors and recovery commenced at 20:00z.

The front end of the streamers was untangled and streamer 6 run back out wide on new rigging. Streamer 5 and 6 came clear at the front. However attempts to separate the streamers by diving to different depths and adjustment of lead-ins failed. Duel recovery was commenced 02:45z on the 5th and the streamers discovered to be badly twisted together from bird 6 back.

The exact time of collapse is unknown due to problems with the tailbuoy communication at the time (See separate RIR). The first indication was telemetry problems on streamer 5. Streamer 4 was set clear to starboard on the starboard vane wire. Weather earlier in the period had been was force 6, seas 3.0m, maximum wave height 5m. Conditions quickly improved for the recovery but the weather was probably a factor in the streamers twisting together to such extent. Duel recovery commenced at 20:00z.

Action Item: Replace 2.0ton blocks with Geco PDN lead-in collar on streamer 7. As soon as possible replace all 2.0ton blocks on outer streamers with lead-in collars.
All main tow sheave blocks replaced with lead-in collars 3rd March.
Check list for lead-in tow equipment implemented.

Received repaired section with swapped fibers. Jan 03 2003.

During deploying/reconfiguring the streamers from 4600 to 5000mtr, 4 new sections (including 1 repaired by TMS) were added to streamer 4. While trouble shooting the streamer for bad channels, and after various attempts changing sections and modules at the faulty position (24B), the problem needed to be pursued further, as no improvement or worsening were visible as the sections at position (24B) were replaced, found that section 4515 in position 22A had the fibers swapped, reversing the modules position (Odd-Even aft part of the MSX system data flow) and the bad channels were actually part of section in position 25B.

Conclusion: Substandard QC being performed on repaired sections from the Thales repair facility allowed a faulty section to be returned to the vessel as a good spare.

Action item: Investigate & review repaired sections QC with Supplier.

Follow up: I sent a mail to Thales asking for an explanation on the 9th January, no feedback has been received yet.
Thomas O. 13/01/03

Below is the reply from Thales. - Thomas O. 13/01/2003
Thomas,
I am sorry to hear about section 4515 and at this time, I can not give you an answer as to why this happened. All the paperwork from our Adelaide repair facility is in storage and I will need to locate this before I can give a reply.
This brings me to your request for "fast" turn around times.
As you have been informed, our Adelaide repair facility has been closed down and all the equipment has been transported to Sydney, where it is now being installed. As you can understand, this is a major exercise and it will not be until early to mid February, that we will have the benches and special tooling in place to start surveying the cables.
I have to apologise for this, but there is absolutely nothing I can do until this equipment is installed. Rest assured, that once all is in place, we will do our best to get the sections turned around as fast as possible.
Best regards.
Bob

Main Tow streamer 6 failure, damage on 7 tow. Mar 05 2003.

On restarting production after bad weather on the 4th March it was observed that the separation between streamers 5 and 6 was reduced. To correct for this streamer 6 had to be deployed 35m. It was therefore evident that the main tow had failed and the streamer was being towed from the lead-in secondary tow point. Production was halted to inspect the rigging and it was discovered that the 3ton G hook boss ring on streamer 6 main tow was missing.
Additional inspection was made on streamer 7 tow rigging. The following was observed;
a) The shackle bolt from the second tow was missing. Shackle bolts in use had excessive

wear on the threads.
b) The Yale grip on streamer 7 was also discovered to have failed.

Action item: Replace 3ton G hooks from all other tow points with 4.75t shackle.
Action item: Check maintenance schedule for all tow equipment and how long shackle bolts and Yale grips have been in service.

Follow up: Checked over maintenance schedule and created a checklist to prevent this happen again. Port side replaced 5th March.

8. HSE Summary

The survey was conducted in safe and efficient manor with no injuries taking place.

25 equipment or process failures were reported, 8 of these reports were deemed serious incidents due to the time lost or repair cost.

A total of 209 reports (including HSE and quality) were submitted during the survey. They were logged into the WesternGeco QHSE database tool known as QUEST. Out of the total number of reports 170 were the identification of hazardous situations and 14 were the reporting of near accidents. There was no crew Lost Time Incidents during the survey.

Western Monarch and Total Voyager (TV) WEEKLY QHSE SUMMARY

	Week 01		Week 02		Week 03		Week 04		Week 05		Week 06		Week 07		Week 08	
	WM	TV	WM	TV	WM	TV	WM	TV	WM	TV	WM	TV	WM	TV	WM	TV
General Safety Meetings	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0
LPT Meetings	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Toolbox Meetings	14	1	15	0	17	0	17	0	25	8	27	3	31	10	25	1
MQSMS Meetings	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0
Operation Meetings	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0
Weekly Department QHSE Meetings	3	0	4	0	3	0	3	0	2	0	4	0	4	0	6	0
MOB boat launched	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Workboat launched	1	0	4	0	1	0	2	0	0	0	2	0	2	0	0	0
RIR & STOP	9	0	14	0	14	0	10	0	14	0	30	0	17	0	5	0
Fire Drill	0	0	1	0	1	0	0	0	1	1	0	1	2	1	1	0
Evacuation Drill	1	0	0	0	0	0	1	0	1	1	0	0	0	1	0	1
MOB Drill	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
SOPEP Drill	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
Other Drills	0	0	0	0	0	0	0	0	0	1	0	2	0	0	1	2
Induction Tours	12	0	3	0	0	0	5	0	7	0	5	2	0	1	0	2
Training	2	0	6	0	6	0	1	0	2	1	2	0	1	4	1	4
Helicopter ops	0	0	2	0	1	0	3	0	4	0	1	0	2	0	0	0
	Week 09		**Week 10**		**Week 11**		**Week 12**		**Week 013**		**Week 13**		**Week 14**		**Week 14**	
	WM	TV	WM	TV	WM	TV	WM	TV	WM	TV	WM	TV	WM	TV	WM	TV
General Safety Meetings	0	0	1	1	0	0	0	0								
LPT Meetings	0	0	0	0	0	0	0	0								
Toolbox Meetings	22	3	24	8	19	3	17	8								
MQSMS Meetings	0	0	1	0	1	0	0	0								

Operation Meetings	0	3	2	5	0	0	1	0								
Weekly Department QHSE Meetings	5	0	5	0	1	0	1	0								
MOB boat launched	0	0	0	0	0	0	0	0								
Workboat launched	2	0	3	0	1	0	4	0								
RIR & STOP	34	0	12	0	5	2	7	0								
Fire Drill	1	1	1	2	0	1	1	0								
Evacuation Drill	1	0	0	1	1	1	0	1								
MOB Drill	0	0	0	0	0	0	0	0								
SOPEP Drill	0	0	0	0	0	0	0	0								
Other Drills	0	2	1	3	0	0	0	1								
Induction Tours	4	0	0	0	5	0	0	0								
Training	0	0	1	1	0	0	1	1								
Helicopter ops	2	0	0	0	5	0	0	0								

9. Shipment List

Mon-03002od-ext	21 SEGY NavMerge test tapes.	30 Jan 03	Handcarried to P.Napier.
Mon-03003od-ext	Omega format NavMerge tapes seq 001-078.	05 Feb 03	WesternGeco.
Mon-03004od-ext	Near trace cube tapes seq 001-078.	05 Feb 03.	Exxon Mobil.
Mon-03005od-ext	Omega format NavMerge tapes seq 081-103.	12 Feb 03	WesternGeco.
Mon-03008od-ext	Omega format NavMerge tapes seq 101,104-133.	26 Feb 03.	Exxon Mobil.
Mon-03009pd-ext	Reflex sampled data config 1 CD-ROM.	26 Feb 03.	Exxon Mobil request.
Mon-03015ad-ext	Seg-D copy &P2/94 tapes seq 001-212.	28 Mar 03.	Exxon Mobil.
Mon-03018od-ext	Omega format NavMerge tapes seq 134-169.	13 Mar 03.	WesternGeco..
Mon-03019od-ext	SEGY format NavMerge seq 001-078.	13 Mar 03.	WesternGeco.
Mon-03023od-ext	Omega format NavMerge seq170-212.	27 Mar 03	WesterGeco.
Mon-03024ad-ext	Brute stack & near trace cube.	28 Mar 03	Exxon Mobil.
Mon-03025pd-kul	Navigation P1 & P2 data seq 001-212.	28 Mar 03	WesternGeco.
Mon-03026ad-per	Seismic data & P190 seq 001-212.	28 Mar 03	westrenGeco.

10. Logs

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 Exxon Mobil in the data shipments.

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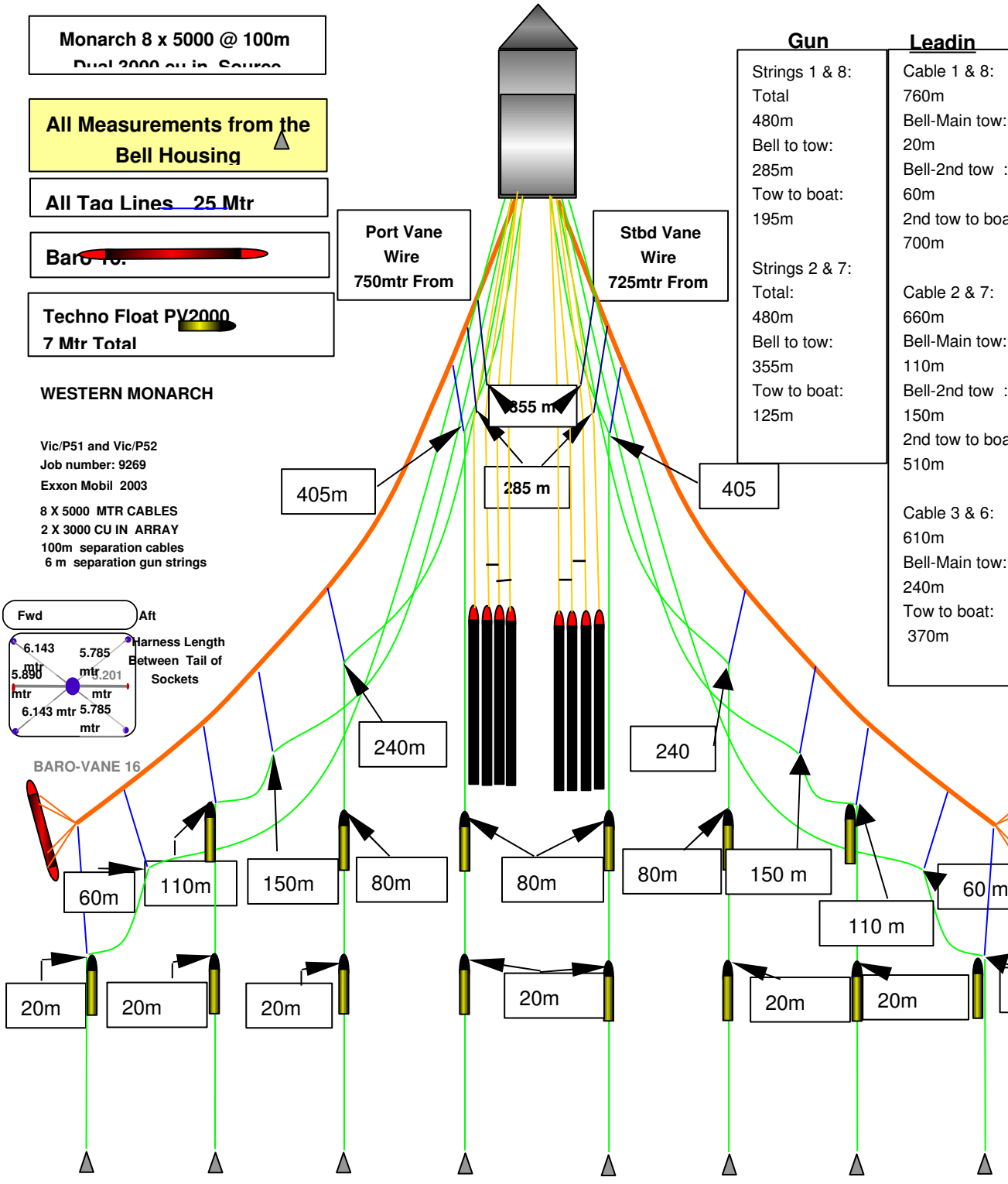
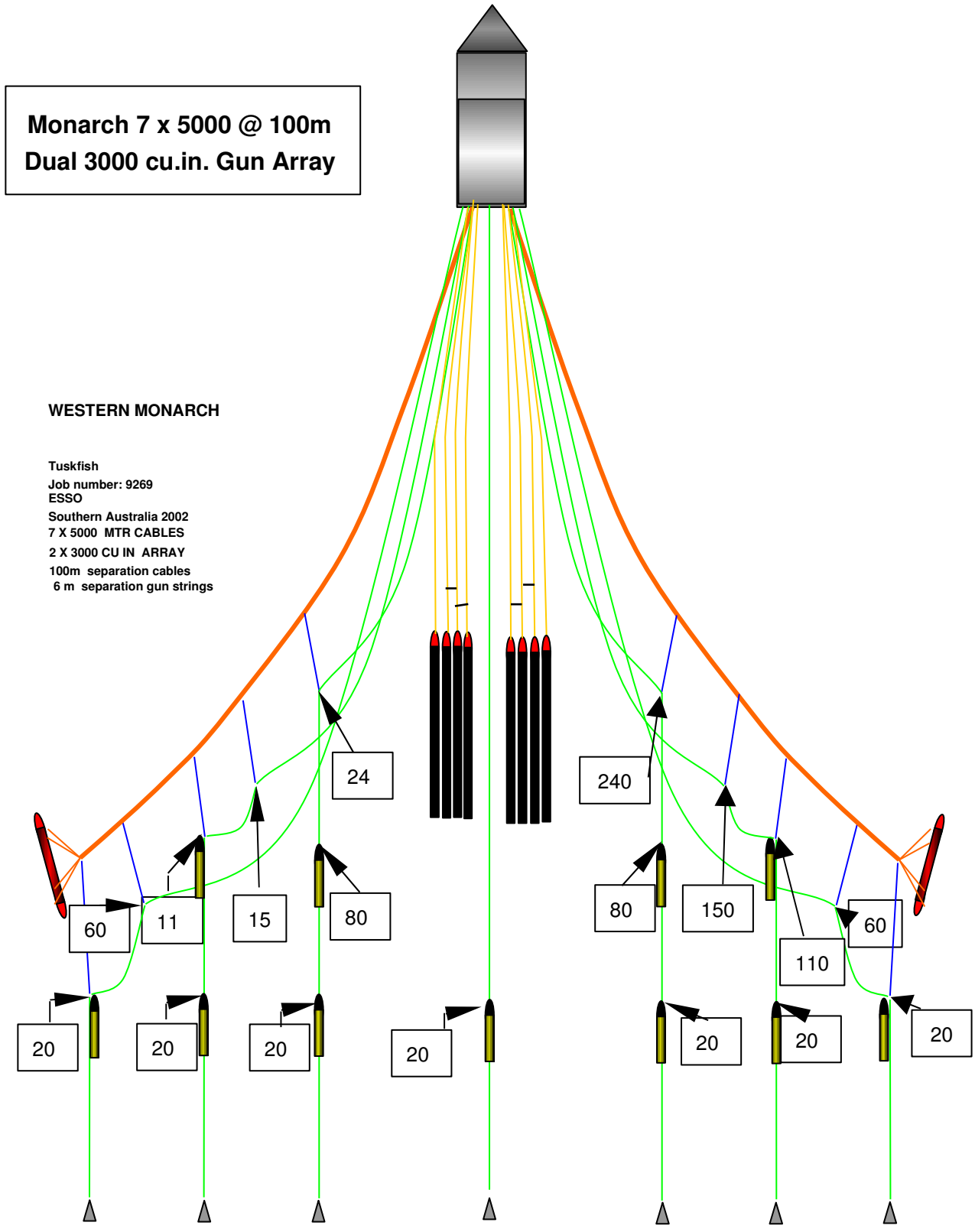
11.1.Towing System Layout

8 Streamer configuration





7 Streamers Configuration

12.Streamer Configuration

12.1.Streamer System Description

Streamer System Parameters	
Number of Streamers	8 (seq 001-078) 7 (seq 079-end of job)
Type of streamer	Thompson Marconi Sentry Solid
Streamer length	5000 m
Groups per streamer	400
Group intervals	12.5 m
Outside diameter	64 mm
Jacket (type-thickness)	Polyurethane, 3.5 mm
Breaking strength	60kN
Ballast fluid	None
Modules (diameter-length)	Max. Dia. 25cm, length 40cm
Channels per module	16
Data transmission link	Fibre Optic
Power	320 – 340 V AC
Active group lengths	17.75 m
Nearest offset available	200 m
Streamer depth	9 m
Streamer separation	100 m
Number of stretch sections	
in front of each streamer	1
end of each streamer	0
No of compasses per streamer	19 (21 on streamer 1 & 8)
No of depth transducers per streamer	19 (21 on streamer 1 & 8)

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

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 (at 7m depth)	14 V/bar

12.2.Streamer Layout

Streamers 1 & 8 (for 8 streamers configuration) or
Streamer 1 & 7 (for 7 streamers configuration)

Loc	Serial #	Module	Bird	Acoustic	SRD	Channels		+/-	Buoy ancy	wgt
LI	SB42552-005									x
Stub	8090		AB01 -17357							x
RVIM	40322									x
Stub	8111			AA01-7322						x
CHS	0100-110805-012	HSX -80019								x
1A	2895	MSX -62342	AB02 -15203			1	8		-3.93	0
1B	3332	CSX -72229		AA02-8097		9	16		-4.01	0
2A	3468	MSX -61242	AB03 -14110			17	24		-3.89	0
2B	1359	CSX-73190		AA03-8561	SRD-	25	32		-9.58	0
3A	3791	MSX -62721	AB04 -8969			33	40		3.95	2
3B	2788	CSX -71691				41	48		-3.68	0
4A	3871	MSX -60071	AB05 - 20538		SRD-	49	56		-4.23	1
4B	2638	CSX -70442				57	64		-4.06	0
5A	2690	MSX -60269	AB06 - 7851			65	72		-3.99	0
5B	3318	CSX -71200			SRD-	73	80		3.8	0
6A	2365	MSX -61830	AB07 - 16590			81	88		-4.08	0
6B	3943	CSX -70069	AB08 - 7016			89	96		4.2	1
7A	2759	MSX -61483			SRD-	97	104		-2.22	2
7B	2495	CSX -70152				105	112		-4.00	1
8A	3159	MSX -60292	AB09 - 10830			113	120		-3.85	0
8B	2772	CSX -70298			SRD-	121	128		-4.2	0
9A	1917	MSX - 61752				129	136		-2.06	0
9B	4001	CSX -72226	AB10-17812			137	144		-4.14	1
10A	2794	MSX -62546			SRD-	145	152		-3.96	0
10B	2673	CSX -71954				153	160		-3.76	0
11A	2038	MSX - 61390	AB11 - 5977			161	168		-1.69	0
11B	2129	CSX -71938			SRD-	169	176		-1.94	0
12A	2603	MSX -62512		AA04-8527		177	184		-4.18	0
12B	3997	CSX -72240	AB12 - 10250			185	192		-4.46	0
13A	3126	MSX - 61870			SRD-	193	200		-4.18	0
13B	2549	CRX-00017				201	208		-4.00	2
14A	3809	MSX -61858	AB13 - 10082			209	216		3.9	2
14B	3331	CSX -72091			SRD-	217	224		4.04	5
15A	3149	MSX -62530				225	232		4.14	2
15B	3319	CSX -72233	AB14 - 17125			233	240		-4.12	0
16A	2816	MSX -62490			SRD-	241	248		-3.98	4
16B	2755	CSX -70067				249	256		-3.98	0
17A	2500	MSX -60368	AB15 - 12823			257	264		-3.94	0
17B	3169	CSX -71629			SRD-	265	272		-4.05	2
18A	2606	MSX -61777				273	280		-4.05	0
18B	2668	CSX -71102	AB16 - 19963			281	288		-3.92	0
19A	3258	MSX-61209			SRD-	289	296		-3.87	0
19B	1567	CSX-71426				297	304		-3.87	2
20A	1980	MSX-60378	AB17 - 14581			305	312		-1.93	3
20B	3132	CSX-71978			SRD-	313	320		-3.86	5
21A	3038	MSX-60375				321	328		-3.97	3
21B	4189	CSX-71374	AB18 - 20756			329	336		-1.91	4
22A	3834	MSX-62021			SRD-	337	344		-6.91	2
22B	4410 Gold	CSX-71308				345	352		-4.27	0
23A	2124	MSX-61382	AB19 - 11934			353	360		-4.24	0
23B	2369	CSX-71986				361	368		-4.00	5
24A	2696	MSX-60103			SRD-32322	369	376		-4.05	0
24B	3959 Gold	CSX-70598	AB20 - 8865			377	384		-3.70	0
25A	3510	MSX-61834		AA05-9962		385	392		-4.06	0
25B	2570	CSX-70560	AB21 - 8566		SRD-7617	393	400		-6.16	0
DUM	3451	TSX-		AA06-8530					-3.97	0
SW	397-083840-01									

Loc.	Serial #	Module	Bird	Acoustic	SRD	Channels		+/-	Buoyancy	wgt
LL	0599-191100-001									x
stub	8102		BB01-15266							
RVIM	40103									
stub	8034			BA01-9992						
CHS	0400-114453-002	HSX-80241								x
1A	3992	MSX-60250	BB02-13028			1	8		-3.80	0
1B	3009	CSX-70216		BA02-7344		9	16		-4.2	0
2A	2689	MSX-61954	BB03-16656			17	24		-4.2	1
2B	2120	CSX-72305			SRD-	25	32		-3.9	0
3A	2688	MSX-60294		BA03-8995		33	40		-3.85	0
3B	4118	CSX-70080	BB04-6458			41	48		-4.41	0
4A	2135	MSX-60339			SRD-	49	56		2.10	0
4B	2615	CSX-71208				57	64		-4.23	0
5A	2057	MSX-60107	BB05-14008			65	72		-4.19	1
5B	3164	CSX-71717			SRD-	73	80		-4.42	0
6A	3918	MSX-60382				81	88		-4.04	1
6B	2704	CSX-70155	BB06-10464			89	96		-3.98	4
7A	2684	MSX-61714			SRD-	97	104		-9.61	1
7B	2653	CSX-70300				105	112		-4.08	2
8A	2293	MSX-60402	BB07-20261			113	120		-3.79	3
8B	4076	CSX-73088			SRD-	121	128		-3.90	0
9A	2600	MSX-61123				129	136		4.10	1
9B	3037	CSX-72018	BB08-14014			137	144		-3.95	2
10A	2703	MSX-60344			SRD-	145	152		-4.0	1
10B	3921	CSX-71848				153	160		-4.3	0
11A	3144	MSX-60277	BB09-19968			161	168		-4.0	2
11B	3491	CSX-70125			SRD-	169	176		4.0	2
12A	2973	MSX-62000		BA04-7899		177	184		-3.8	2
12B	3067	CSX-72303	BB10-16930			185	192		-3.9	0
13A	3993	MSX-60098			SRD-	193	200		-1.8	2
13B	1651	CRX-0021				201	208		-4.0	2
14A	2563	MSX-60356	BB11-6398			209	216		-4.2	1
14B	4109	CSX-71985			SRD-	217	224		-4.0	4
15A	2880	MSX-60792				225	232		-10.6	4
15B	3001	CSX-70317	BB12-16849			233	240		-3.8	5
16A	3233	MSX-60739			SRD-	241	248		-4.08	2
16B	2630	CSX-70365				249	256		-4.00	1
17A	2609	MSX-60331	BB13-16968			257	264		-4.00	0
17B	2594	CSX-71703			SRD-	265	272		-3.50	0
18A	2712	MSX-60696				273	280		-3.50	3
18B	3064	CSX-72164	BB14-15391			281	288		-4.00	2
19A	3346	MSX-60335			SRD-	289	296		-3.52	2
19B	3678	CSX-70293				297	304		-4.00	0
20A	3360	MSX-60369	BB15-12082			305	312		-3.87	4
20B	2776	CSX-70203			SRD-	313	320		-2.34	4
21A	3382	MSX-62526				321	328		-3.90	2
21B	2165	CSX-70741	BB16-7608			329	336		-2.46	1
22A	3225	MSX-60559			SRD-	337	344		-3.86	2
22B	1609	CSX-72234				345	352		-4.44	4
23A	2612	MSX-62453	BB17-17241			353	360		-3.89	2
23B	1947	CSX-70654				361	368		-1.95	
24A	2740	MSX-60172			SRD-	369	376		-3.76	2
24B	2607	CSX-73232	BB18-11982			377	384		-3.82	2
25A	2957	MSX-60430		BA05-9418		385	392		-3.87	2
25B	2070	CSX-73880	BB19-9380		SRD-	393	400		-2.08	2
DUM	3008	TSX-90008		BA06-9732					-3.73	2
SW	196-038240-01									
Stic	897-095470-01									

Streamer 2,3,4,5,6 and 7 (for 8 streamers configuration)

Streamer 2,3,4,5 and 6 (for 7 streamers configuration)

Loc	Serial #	Module	Bird	Acoustic	SRD	Channels		+/-	Buoyancy	wgt
LL	0599-191100-001									x
stub	8102		BB01-15266							
RVM	40103									
stub	8034			BA01-9992						
CHS	0400-114453-002	HSX-80241								x
1A	3992	MSX-60250	BB02-13028			1	8		-3.80	0
1B	4067	CSX-72344		BA02-7344		9	16		-4.2	0
2A	2689	MSX-61954	BB03-16656			17	24		-4.2	1
2B	2120	CSX-72305			SRD-	25	32		-3.9	0
3A	2688	MSX-60294		BA03-8995		33	40		-3.85	0
3B	4118	CSX-70080	BB04-6458			41	48		-4.41	0
4A	2135	MSX-60339			SRD-	49	56		2.10	0
4B	2615	CSX-71208				57	64		-4.23	0
5A	2057	MSX-60107	BB05-14008			65	72		-4.19	1
5B	3164	CSX-71717			SRD-	73	80		-4.42	0
6A	3918	MSX-60382				81	88		-4.04	1
6B	2704	CSX-70155	BB06-10464			89	96		-3.98	4
7A	2684	MSX-61714			SRD-	97	104		-9.61	1
7B	2653	CSX-70300				105	112		-4.08	2
8A	2293	MSX-60402	BB07-20261			113	120		-3.79	3
8B	4076	CSX-73088			SRD-	121	128		-3.90	0
9A	2600	MSX-61123				129	136		4.10	1
9B	3037	CSX-72018	BB08-14014			137	144		-3.95	2
10A	2703	MSX-60344			SRD-	145	152		-4.0	1
10B	3921	CSX-71848				153	160		-4.3	0
11A	3144	MSX-60277	BB09-19968			161	168		-4.0	2
11B	3491	CSX-70125			SRD-	169	176		4.0	2
12A	2973	MSX-62000		BA04-7899		177	184		-3.8	2
12B	3067	CSX-72303	BB10-16930			185	192		-3.9	0
13A	3993	MSX-60098			SRD-	193	200		-1.8	2
13B	1651	CRX-0021				201	208		-4.0	2
14A	2563	MSX-60356	BB11-6398			209	216		-4.2	1
14B	4109	CSX-71985			SRD-	217	224		-4.0	4
15A	2880	MSX-60792				225	232		-10.6	4
15B	3001	CSX-70317	BB12-16849			233	240		-3.8	5
16A	3233	MSX-60739			SRD-	241	248		-4.08	2
16B	2630	CSX-70365				249	256		-4.00	1
17A	2609	MSX-60331	BB13-16968			257	264		-4.00	0
17B	2594	CSX-71703			SRD-	265	272		-3.50	0
18A	2712	MSX-60696				273	280		-3.50	3
18B	3064	CSX-72164	BB14-15391			281	288		-4.00	2
19A	3346	MSX-60335			SRD-	289	296		-3.52	2
19B	3678	CSX-70293				297	304		-4.00	0
20A	3360	MSX-60369	BB15-12082			305	312		-3.87	4
20B	2776	CSX-70203			SRD-	313	320		-2.34	4
21A	3382	MSX-62526				321	328		-3.90	2
21B	2165	CSX-70741	BB16-7608			329	336		-2.46	1
22A	3225	MSX-60559			SRD-	337	344		-3.86	2
22B	1609	CSX-72234				345	352		-4.44	4
23A	2612	MSX-62453	BB17-17241			353	360		-3.89	2
23B	1947	CSX-70654				361	368		-1.95	
24A	2740	MSX-60172			SRD-	369	376		-3.76	2
24B	2607	CSX-73232	BB18-11982			377	384		-3.82	2
25A	2957	MSX-60430		BA05-9418		385	392		-3.87	2
25B	2070	CSX-73880	BB19 - 9380		SRD-	393	400		-2.08	2
DUM	3008	TSX-90008		BA06-9732					-3.73	2
SW	196-038240-01									
Stic	897-095470-01									

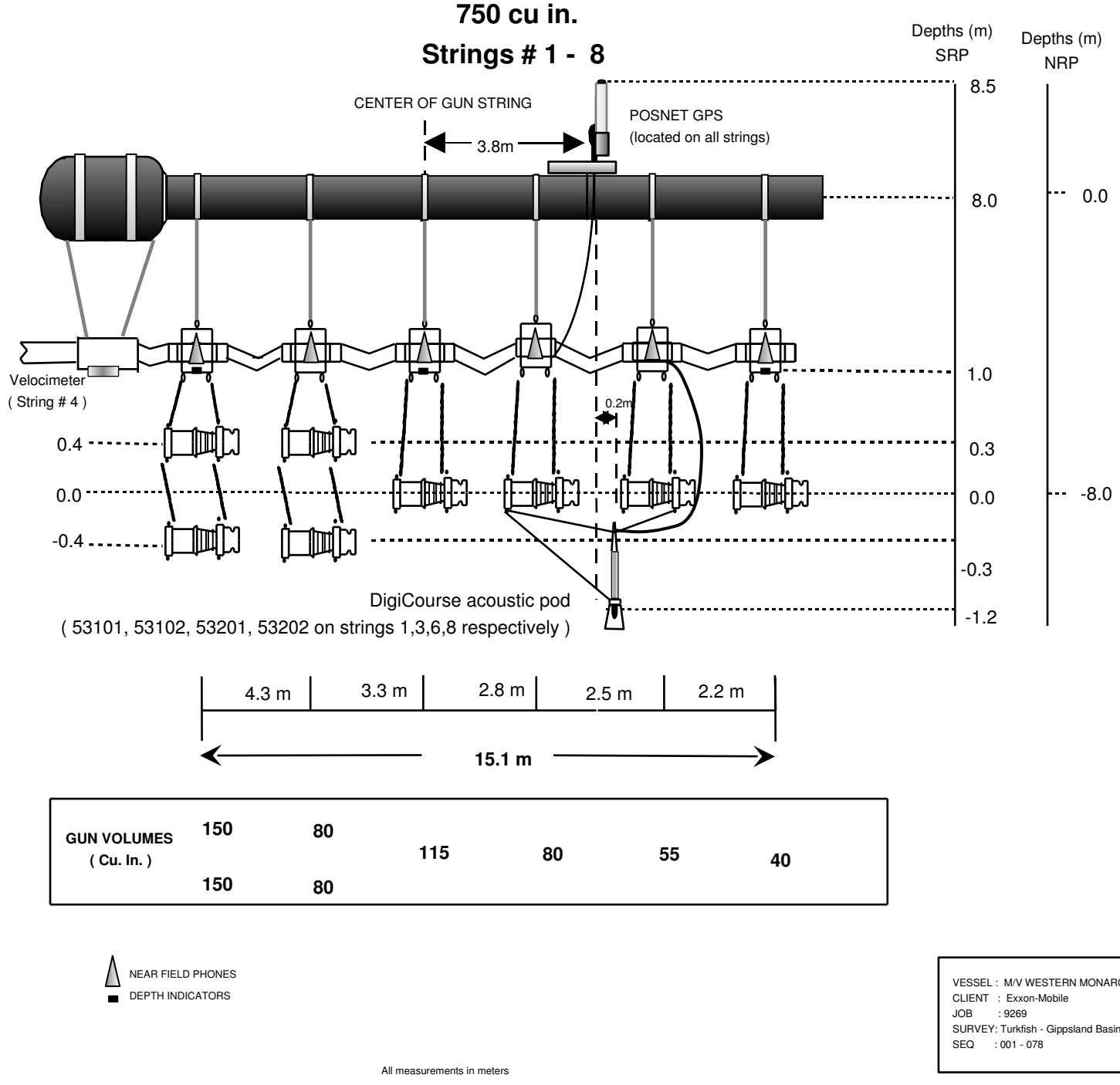
13.Source Configuration

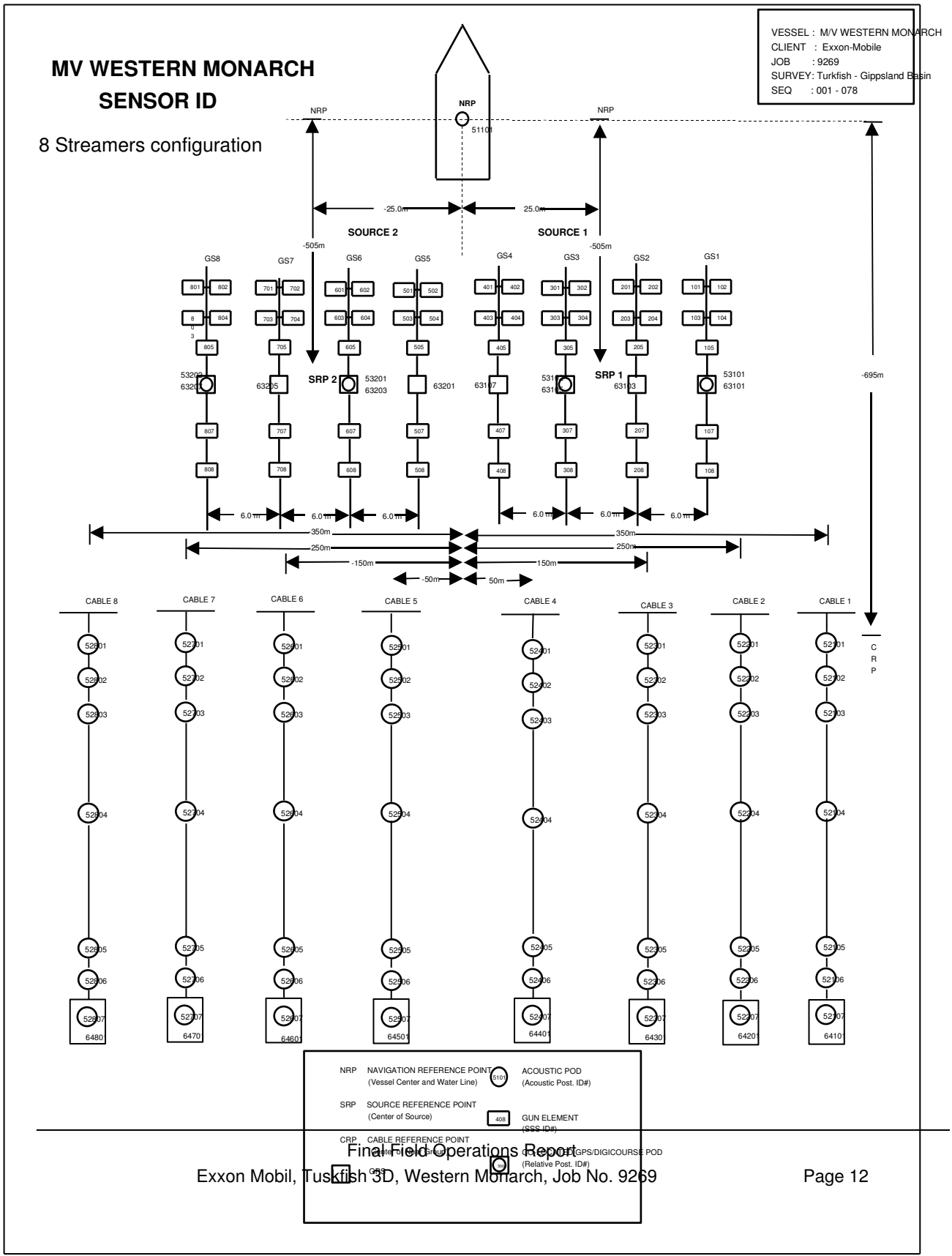
13.1.Source System Description

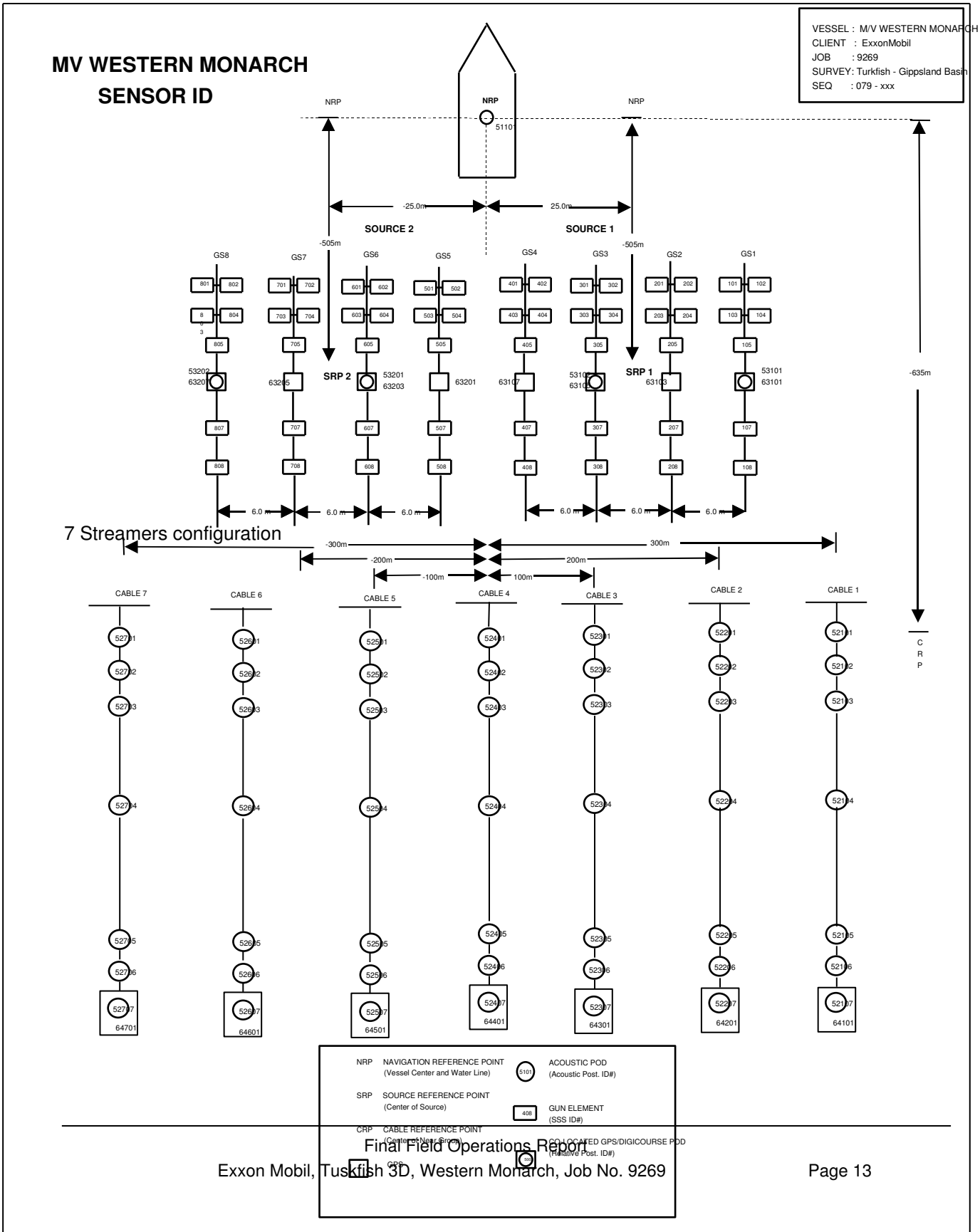
Source Parameters	
Number of source arrays	2
Array separation	50 m
Array length	15.1 m
Array width	18 m
Number of strings/array	4
Separation from centre track	25 m
Source volume	3000 cubic inches
Number of hydrophones per array	24
Number of depth transducers per array	12
Number of guns per array	32

Number of clusters per array	8
Airgun type	WesternGeco Sleeve Air Gun
Operating pressure	2000 psi
Depth of guns	8 m
Zero to Peak amplitude	54.6 Bar-m
Primary to Bubble ratio	15.6

13.2.Source Layout

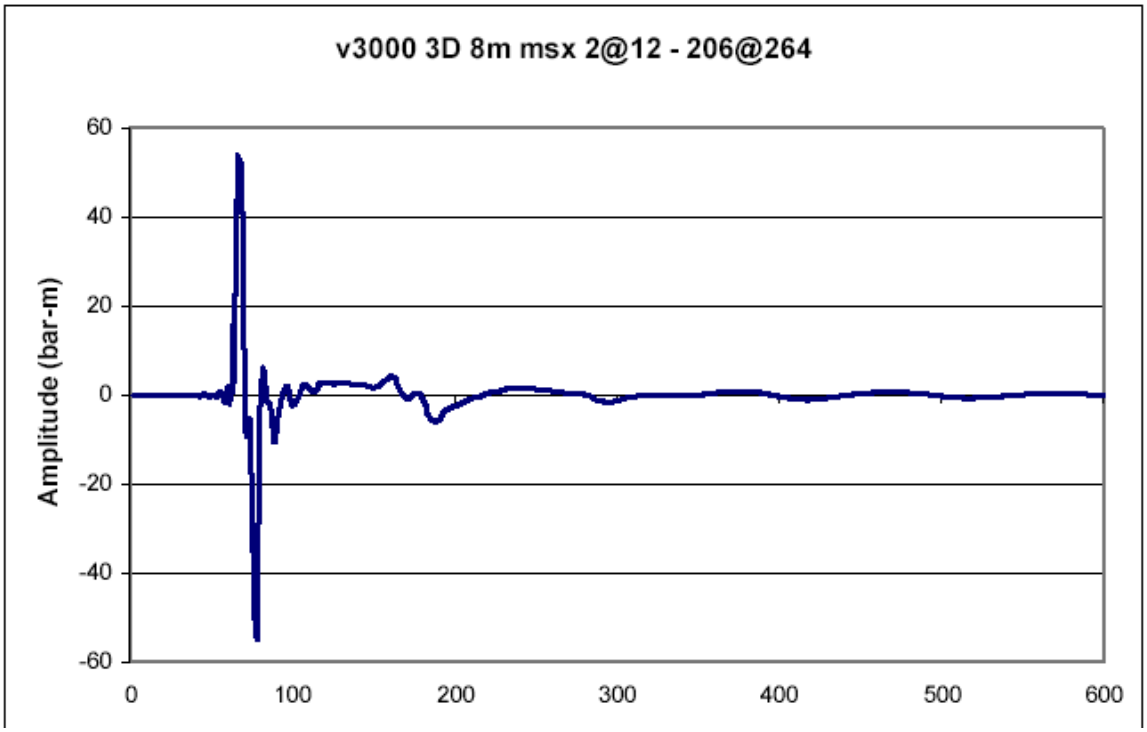


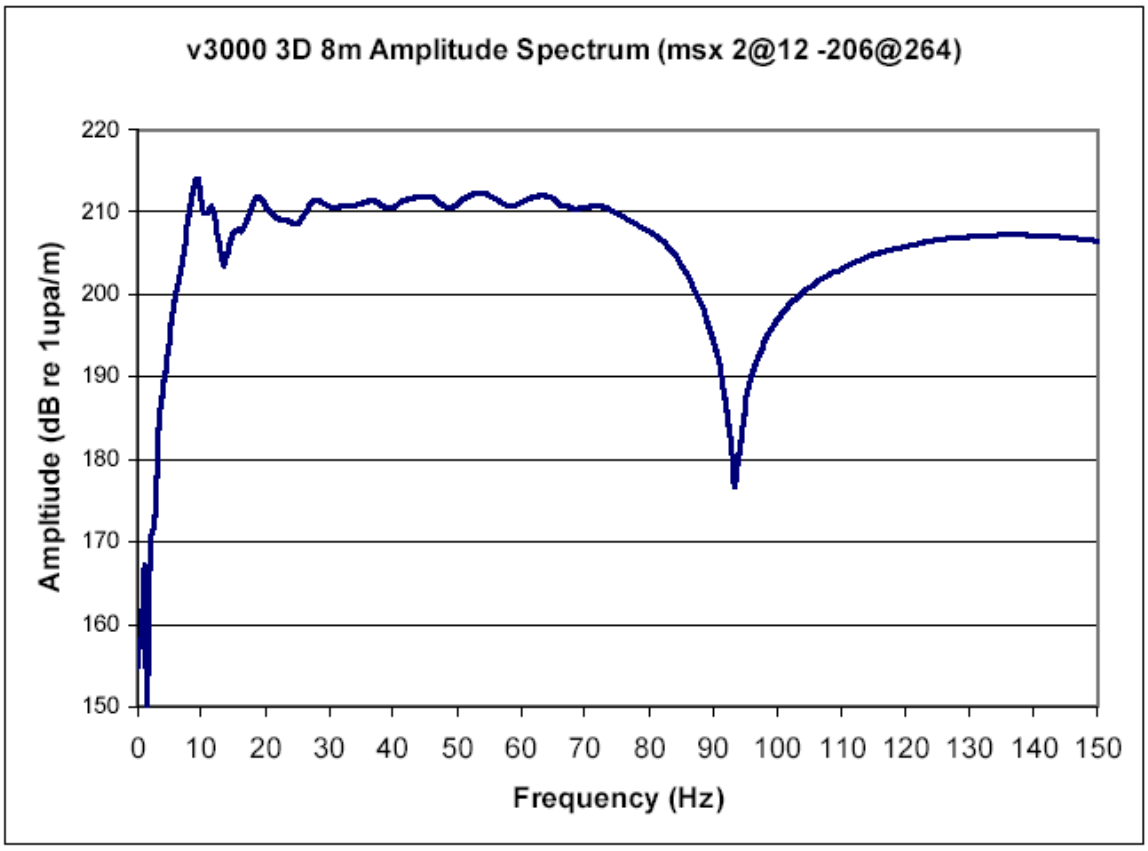

MV WESTERN MONARCH
SENSOR ID
8 Streamers configuration
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 001 - 078
NRP
51101
-25.0m
25.0m
SOURCE 2
SOURCE 1
-505m
-505m
GS8
GS7
GS6
GS5
GS4
GS3
GS2
GS1
SRP 2
SRP 1
-695m
6.0 m
350m
250m
-150m
150m
-50m
50m
CABLE 8
CABLE 7
CABLE 6
CABLE 5
CABLE 4
CABLE 3
CABLE 2
CABLE 1
CRP
6480
6470
6460
64501
6440
6430
6420
6410
NRP NAVIGATION REFERENCE POINT (Vessel Center and Water Line)
SRP SOURCE REFERENCE POINT (Center of Source)
CRP CABLE REFERENCE POINT (Cable Head Buoy)
ACOUSTIC POD (Acoustic Post. ID#)
GUN ELEMENT (SSS ID#)
GPS/DIGICOURSE POD (Relative Post. ID#)


MV WESTERN MONARCH
SENSOR ID
VESSEL : M/V WESTERN MONARCH
CLIENT : ExxonMobil
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 079 - xxx
NRP
5110
-25.0m
25.0m
SOURCE 2
SOURCE 1
-505m
SRP 2
SRP 1
GS8
GS7
GS6
GS5
GS4
GS3
GS2
GS1
6.0 m
-635m
CRP
7 Streamers configuration
-300m
300m
-200m
200m
-100m
100m
CABLE 7
CABLE 6
CABLE 5
CABLE 4
CABLE 3
CABLE 2
CABLE 1
64701
64601
64501
64401
64301
64201
64101
NRP NAVIGATION REFERENCE POINT (Vessel Center and Water Line)
SRP SOURCE REFERENCE POINT (Center of Source)
CRP CABLE REFERENCE POINT (Center of Near Group)
ACOUSTIC POD (Acoustic Post. ID#)
GUN ELEMENT (SSS ID#)
CO-LOCATED GPS/DIGICOURSE POD (Relative Post. ID#)
GPS

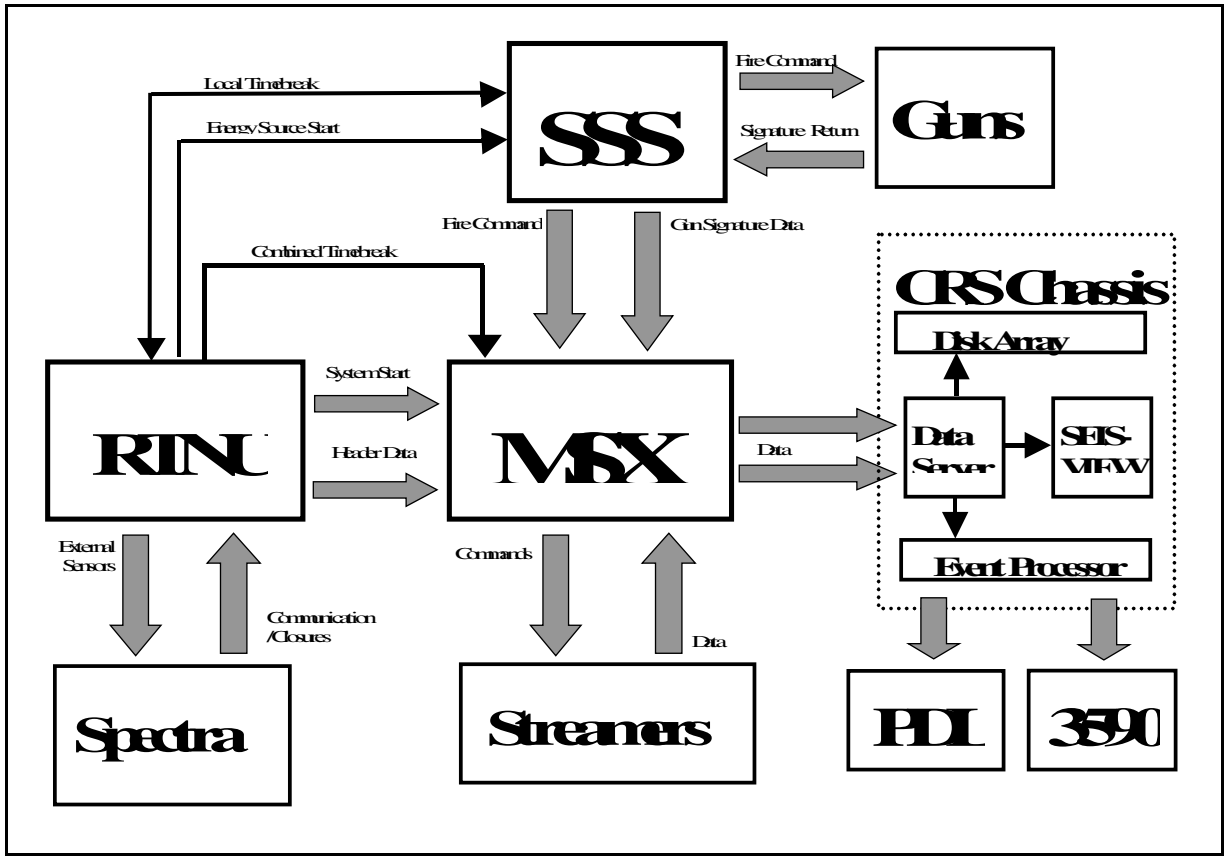
13.3.Pulse Response

Gun signature for 3000 cu in recorded using MSX recoding system with 2Hz @ 12dB; low cut and 206Hz @ 18dB high cut filters.





14.Instrumentation Room System Diagram



15.Equipment Offset Diagrams

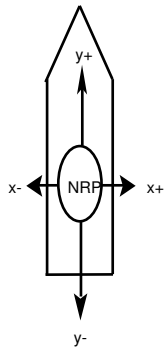
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY : Turkfish - Gippsland Basin
SEQ : 001 -

ANTENNA FARM

M/V WESTERN MONARCH SENSOR OFFSETS

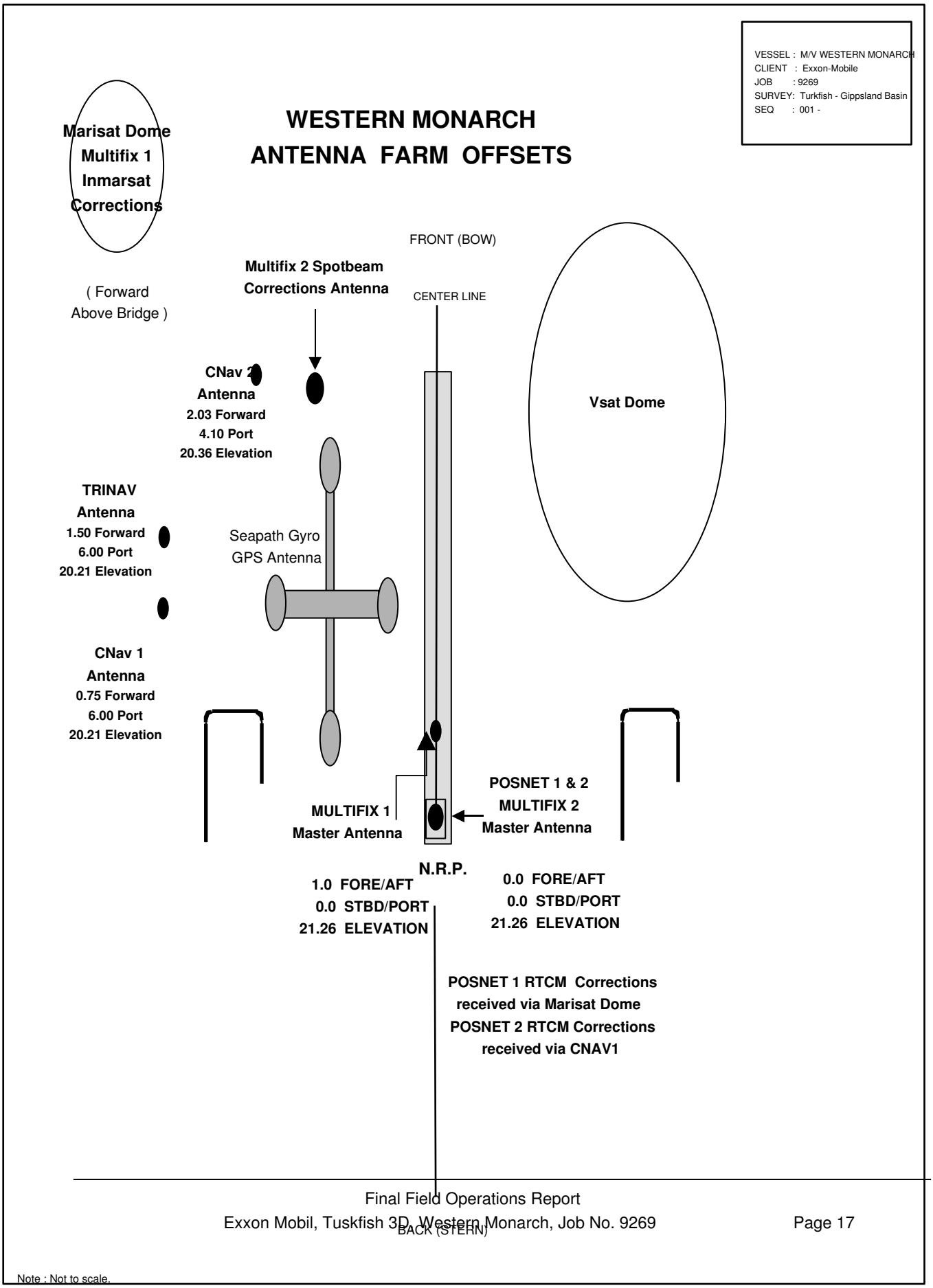
VESSEL LENGTH: 92.5 VESSEL WIDTH: 20.0 VESSEL DRAFT: 9.0

ALL MEASUREMENTS IN REFERENCE TO THE NAVIGATION REFERENCE POINT (X,Y,Z =0)
NRP IS INLINE WITH POSNET ANTENNA PROJECTED TO MEAN SEA LEVEL

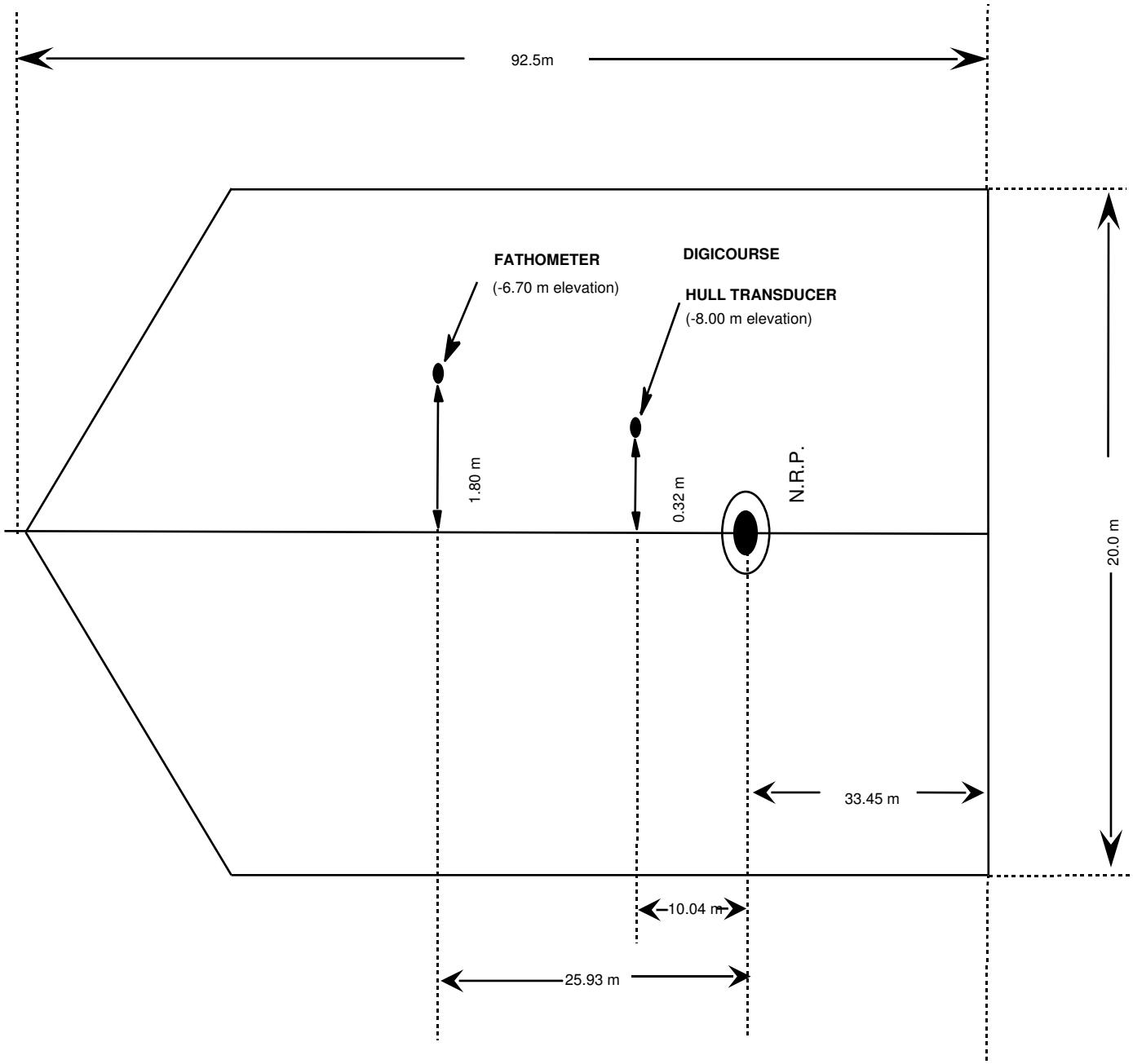


	+FORE/-AFT	+STBD/-PORT	+UP/-DOWN
N- NAVIGATION REFERENCE POINT	0.00	0.00	0.00
1- POSNET 1 ANTENNA	0.00	0.00	+21.26
2- POSNET 2 ANTENNA	0.00	0.00	+21.26
3- THALES MULTIFIX 1	1.00	0.00	+21.26
4- THALES MULTIFIX 2	0.00	0.00	+21.26
5- CNAV 1	0.75	-6.00	+20.21
6- CNAV 2	2.03	-4.10	+20.36
7- TRINAV	1.50	-6.00	+20.21
D- DIGICOURSE HULL TRANSDUCER	+10.04	+0.32	-8.00
S- SIMRAD ECHO SOUNDER	+25.93	+1.80	-6.70
G- GYRO			

All measurements in meters

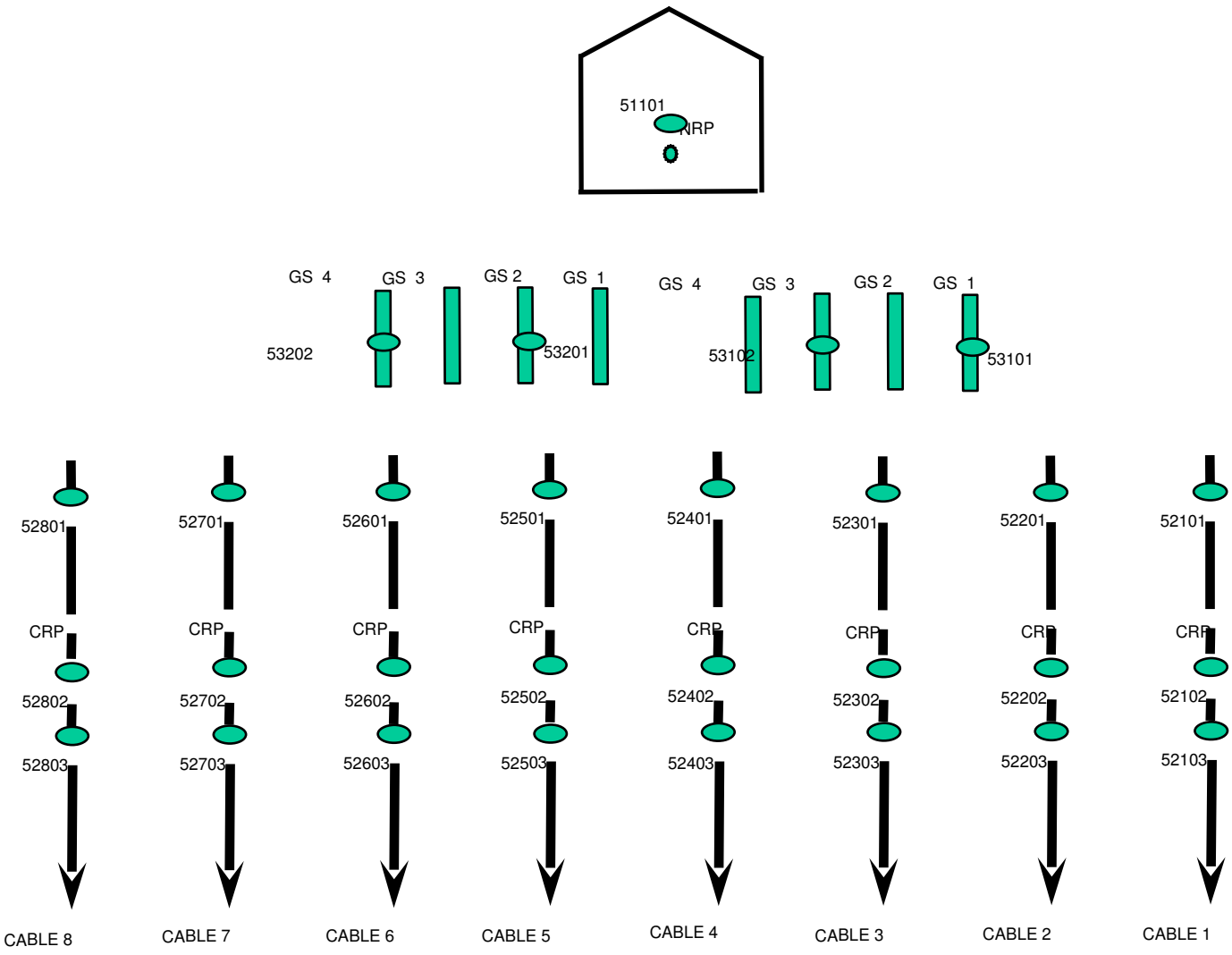

VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 001 -
WESTERN MONARCH
ANTENNA FARM OFFSETS
Marisat Dome
Multifix 1
Inmarsat
Corrections
(Forward
Above Bridge)
FRONT (BOW)
Multifix 2 Spotbeam
Corrections Antenna
CENTER LINE
CNav 2
Antenna
2.03 Forward
4.10 Port
20.36 Elevation
Vsat Dome
TRINAV
Antenna
1.50 Forward
6.00 Port
20.21 Elevation
Seapath Gyro
GPS Antenna
CNav 1
Antenna
0.75 Forward
6.00 Port
20.21 Elevation
POSNET 1 & 2
MULTIFIX 2
Master Antenna
MULTIFIX 1
Master Antenna
N.R.P.
1.0 FORE/AFT
0.0 STBD/PORT
21.26 ELEVATION
0.0 FORE/AFT
0.0 STBD/PORT
21.26 ELEVATION
POSNET 1 RTCM Corrections
received via Marisat Dome
POSNET 2 RTCM Corrections
received via CNAV1
BACK (STERN)
Note : Not to scale.

WESTERN MONARCH
ACOUSTIC HULL RECEIVERS TO N. R. P.



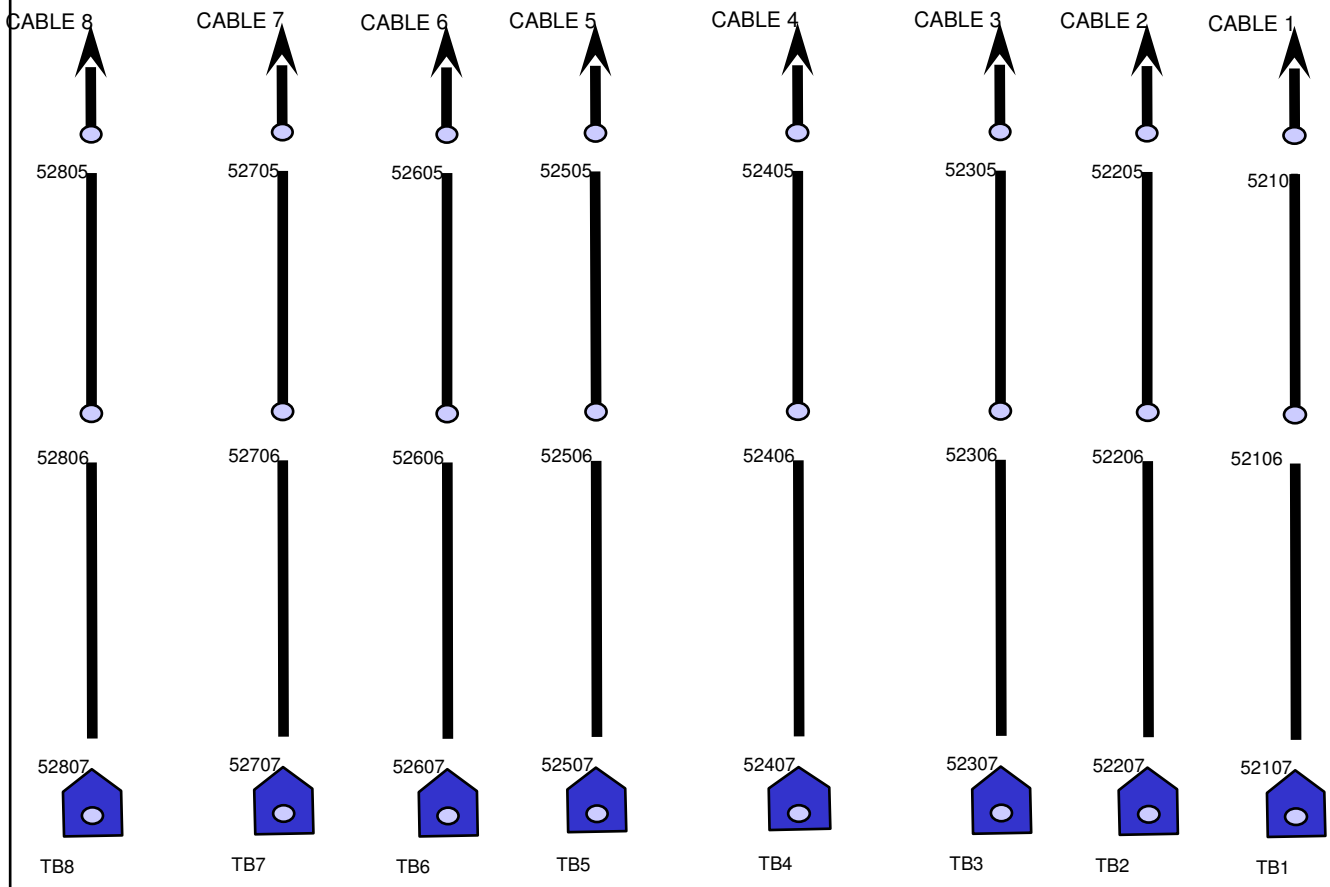
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 001 - 078

DIGICOURSE ACOUSTIC SENSOR SCHEMATIC
FRONT-NET, 8 CABLE CONFIGURATION



VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 001 - 078

DIGICOURSE ACOUSTIC SENSOR SCHEMATIC
TAIL - NET, 8 CABLE CONFIGURATION

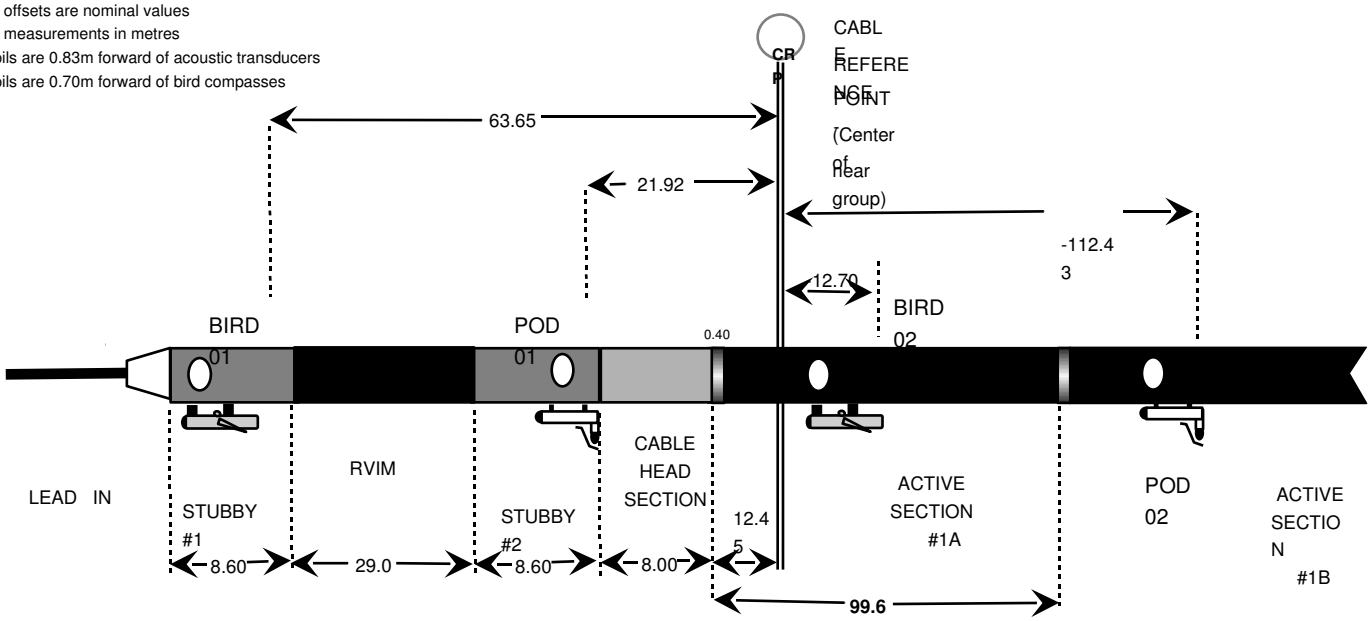


VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY : Tuskfish - Gippsland Basin
SEQ : 001- 078

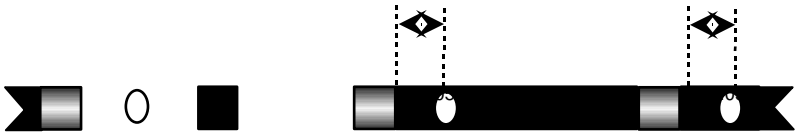
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 001 - 078

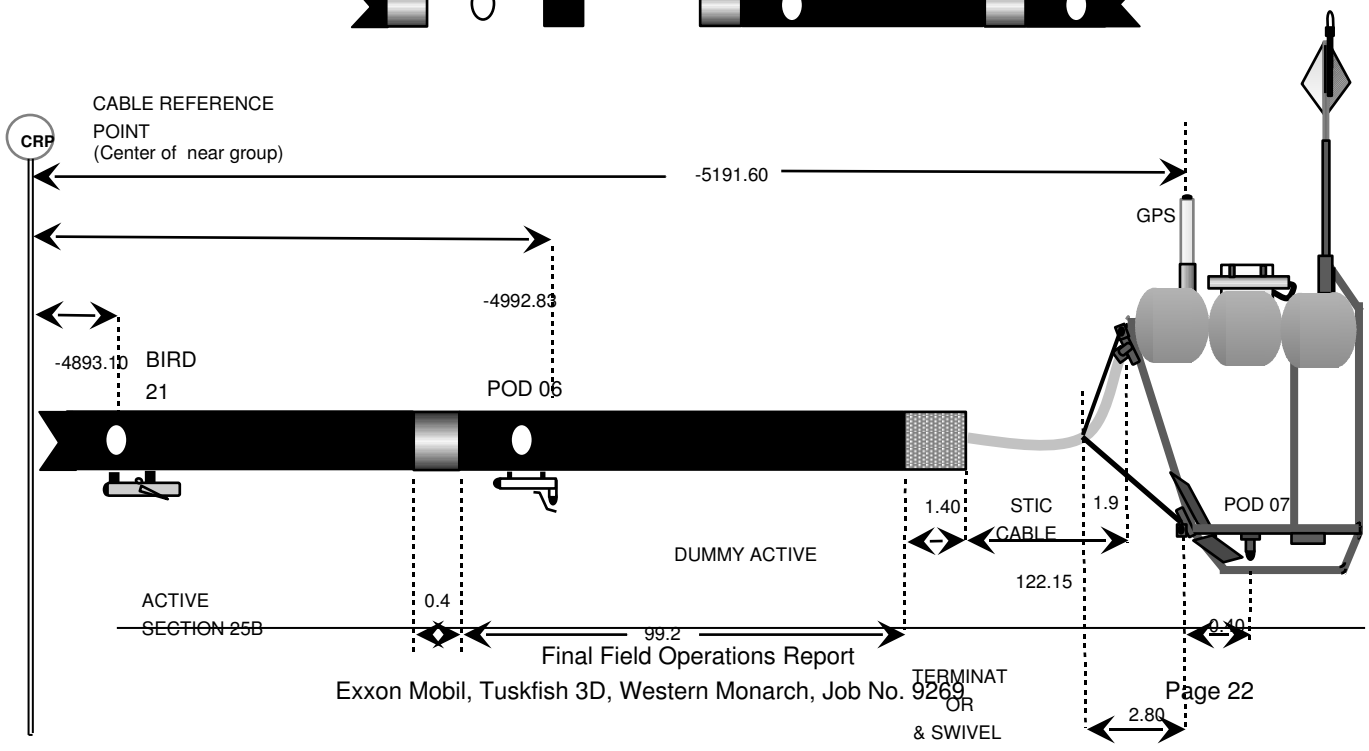
SENSOR OFFSET DIAGRAM CABLE 1

All offsets are nominal values
All measurements in metres
Coils are 0.83m forward of acoustic transducers
Coils are 0.70m forward of bird compasses



NOTE: ACTIVE SECTIONS ARE 99.2 m; modules are 0.4 m; Total Length 99.6 m

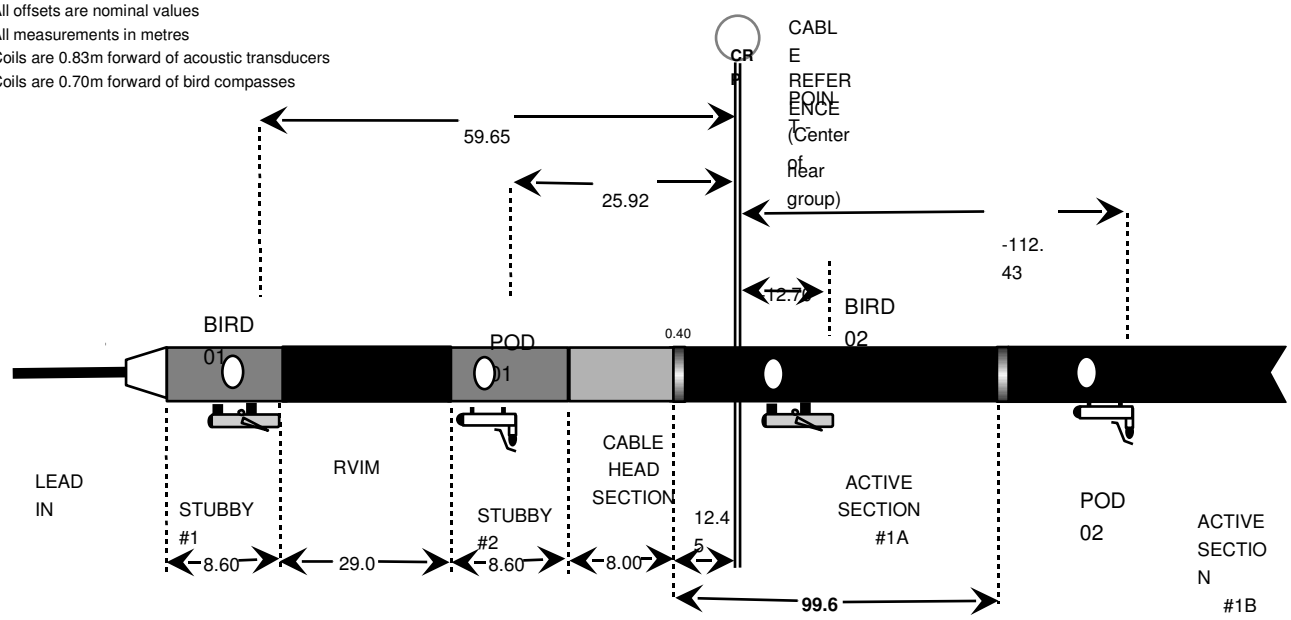




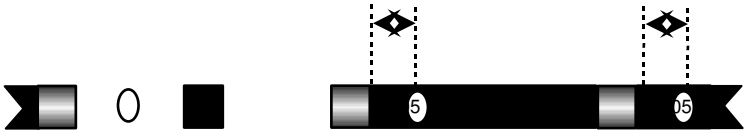
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 001 - 078

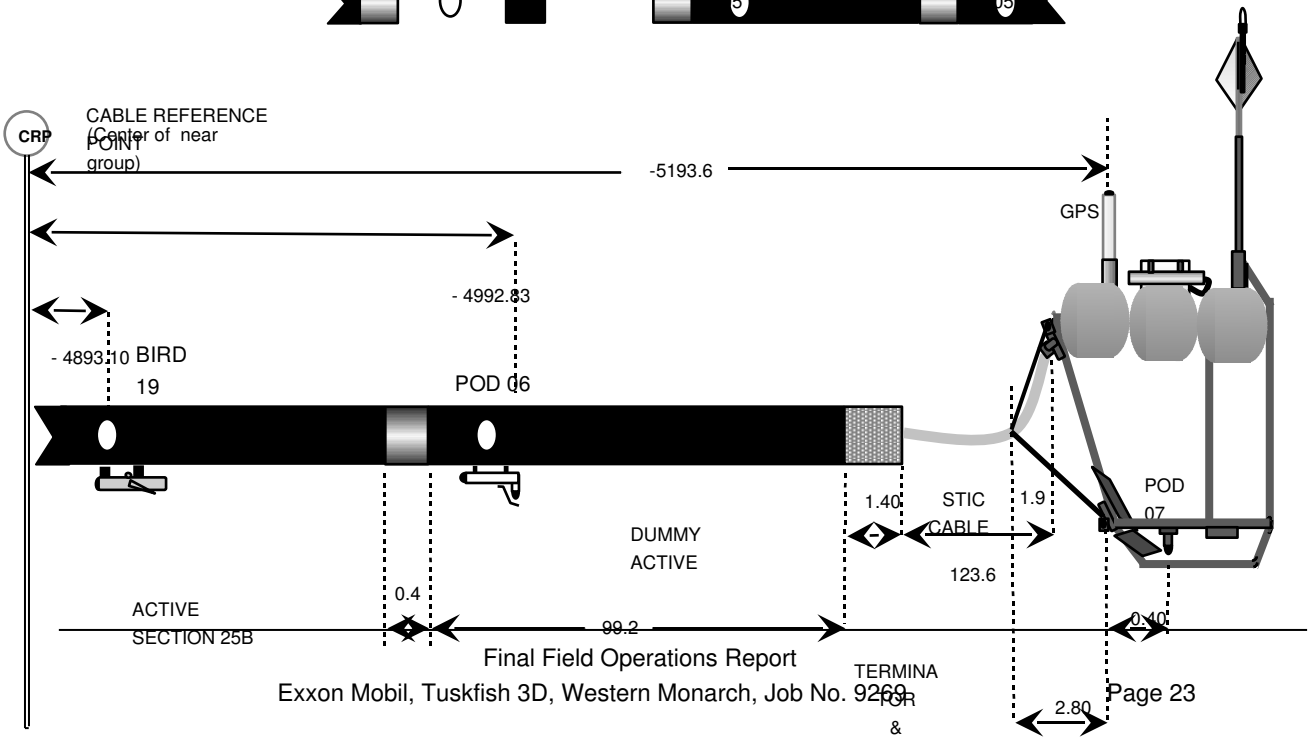
SENSOR OFFSET DIAGRAM
CABLE 2

All offsets are nominal values
All measurements in metres
Coils are 0.83m forward of acoustic transducers
Coils are 0.70m forward of bird compasses



NOTE: ACTIVE SECTIONS ARE 99.2 m; modules are 0.4 m; Total Length 99.6 m

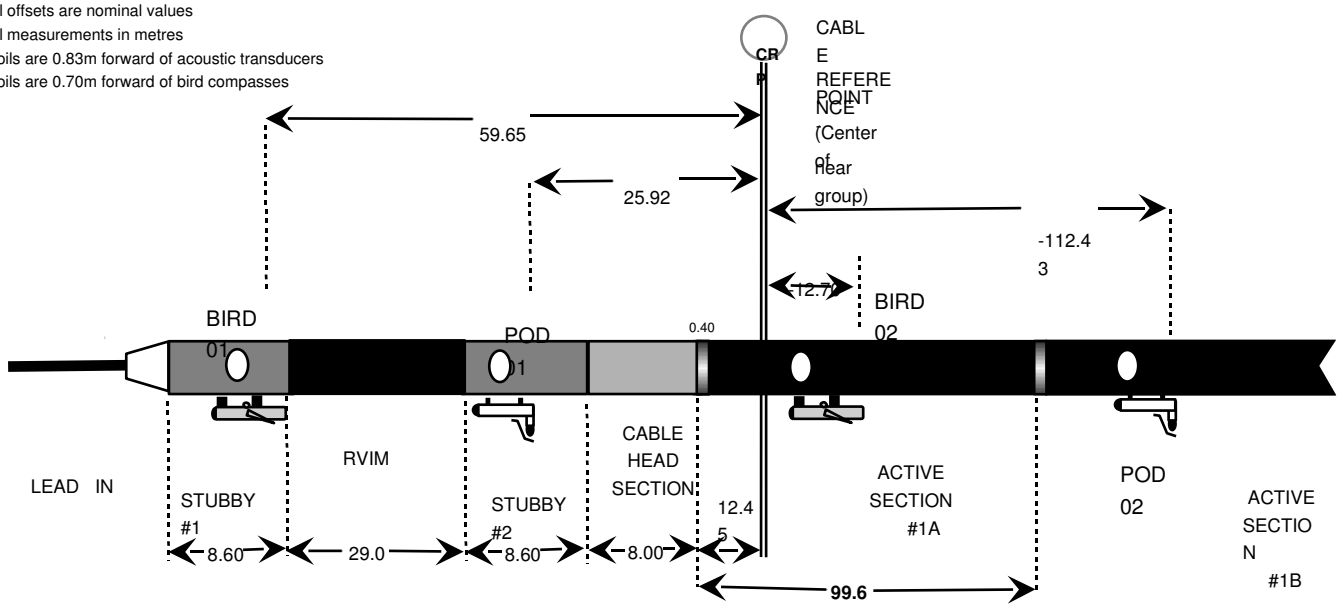




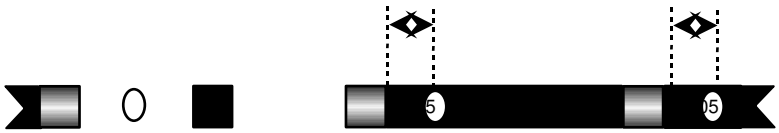
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 001 - 078

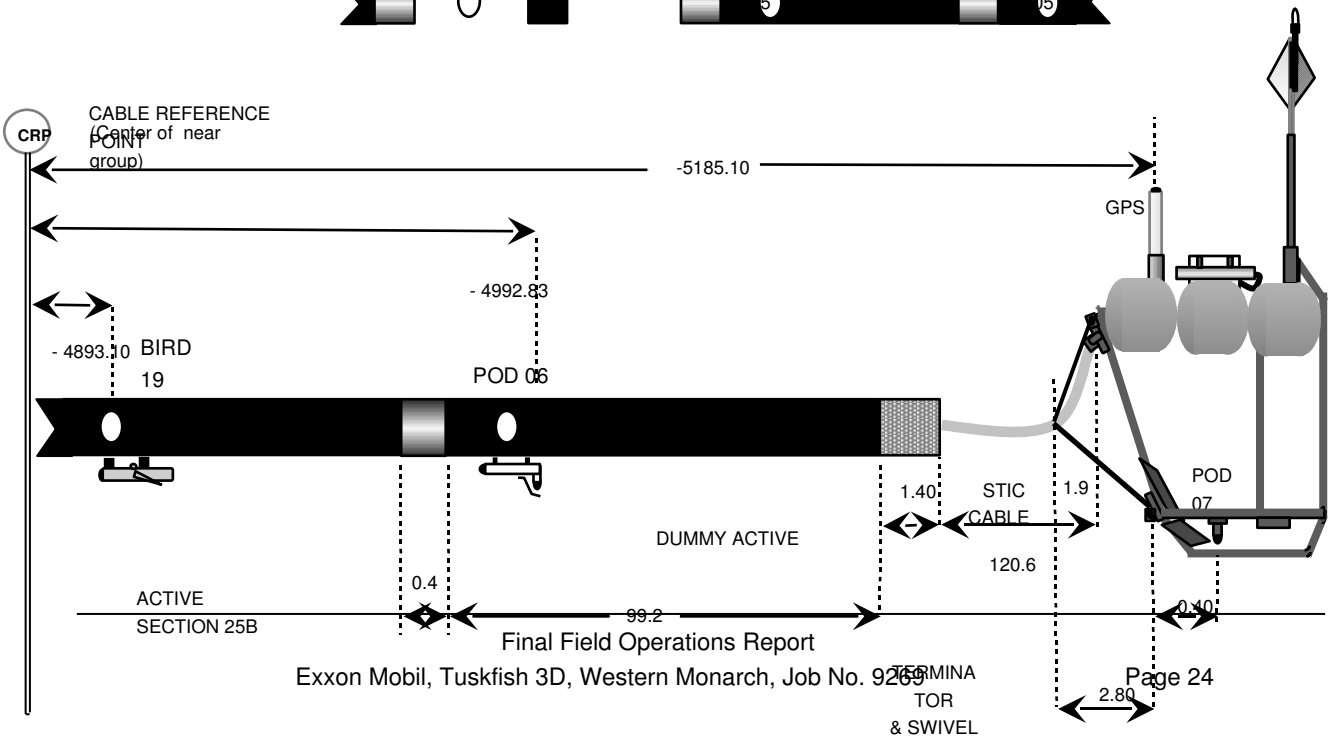
SENSOR OFFSET DIAGRAM
CABLE 3

All offsets are nominal values
All measurements in metres
Coils are 0.83m forward of acoustic transducers
Coils are 0.70m forward of bird compasses



NOTE: ACTIVE SECTIONS ARE 99.2 m; modules are 0.4 m; Total Length 99.6 m

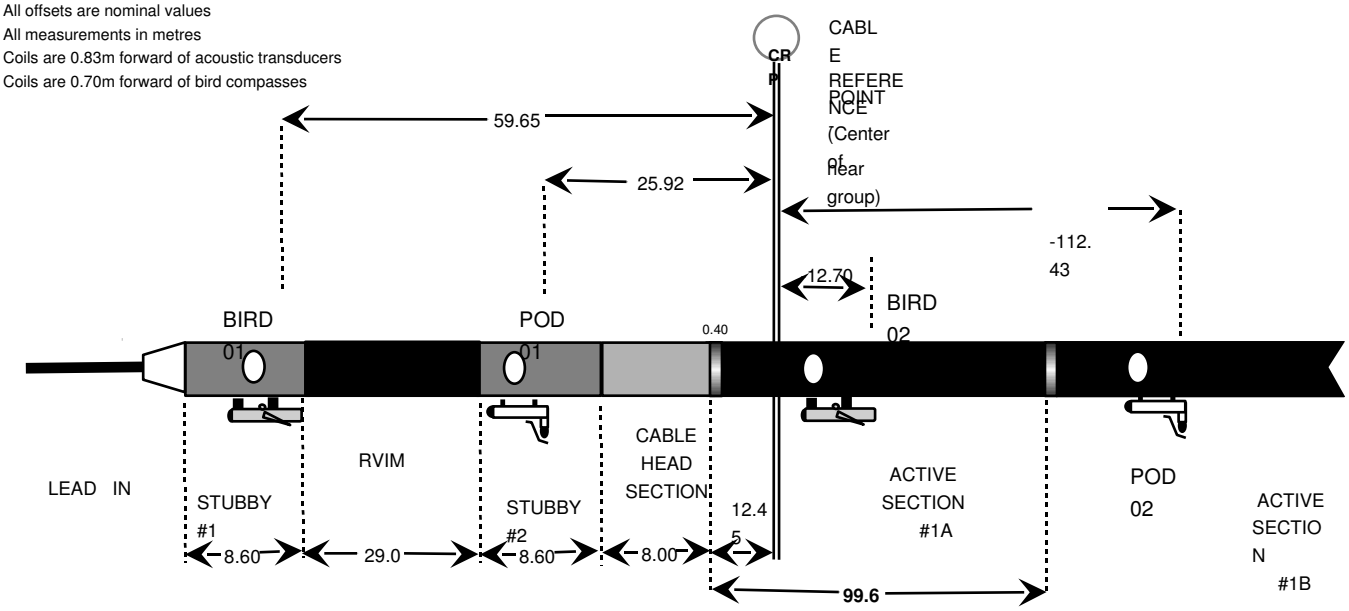




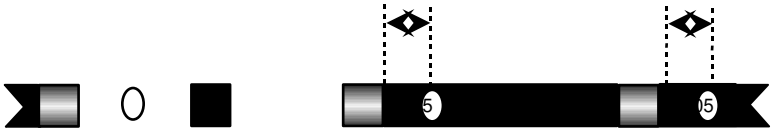
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY : Turkfish - Gippsland Basin
SEQ : 001 - 078

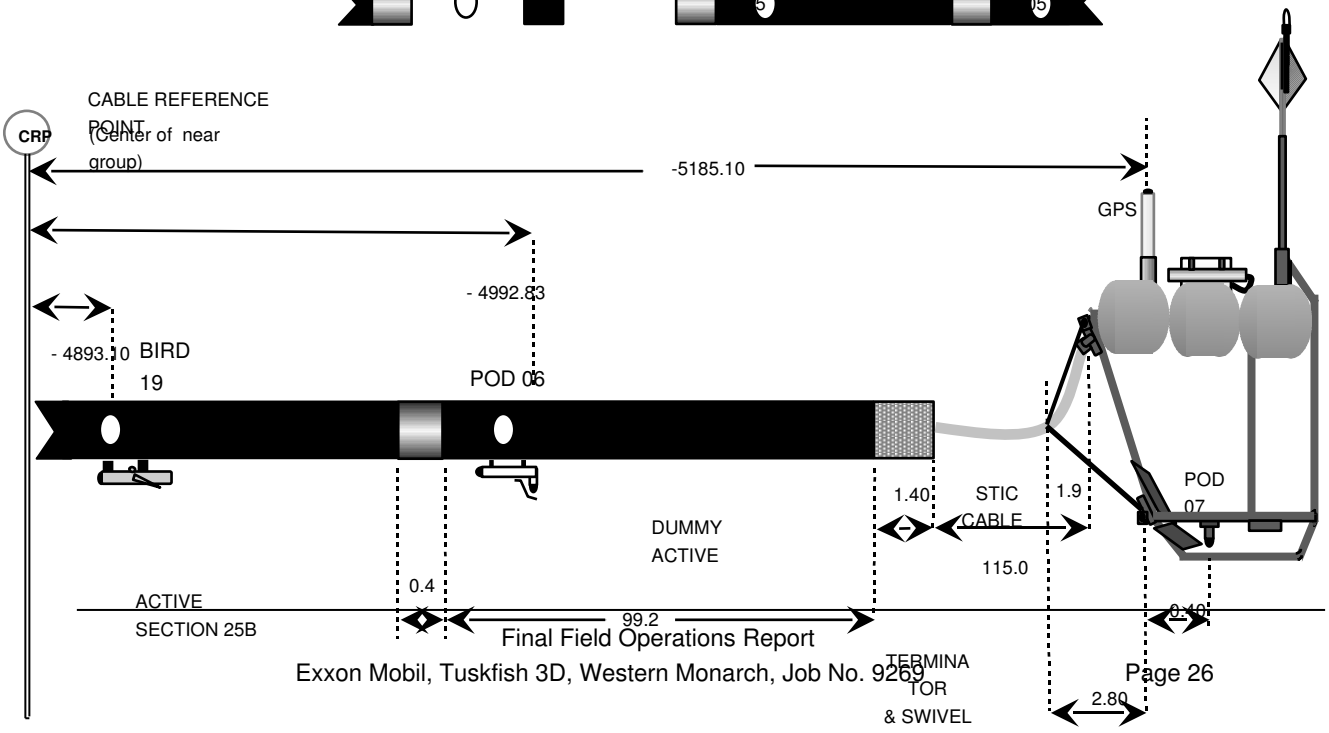
SENSOR OFFSET DIAGRAM
CABLE 4

All offsets are nominal values
All measurements in metres
Coils are 0.83m forward of acoustic transducers
Coils are 0.70m forward of bird compasses



NOTE: ACTIVE SECTIONS ARE 99.2 m; modules are 0.4 m; Total Length 99.6 m

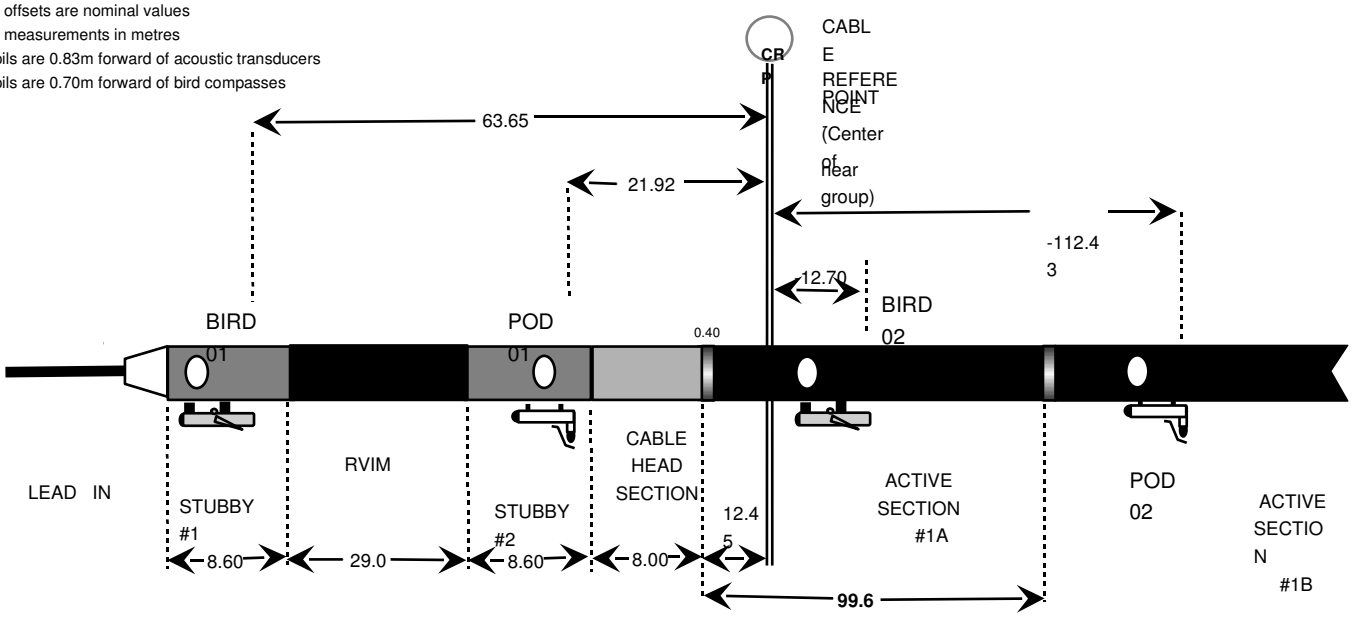




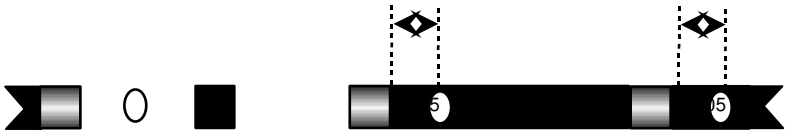
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY : Turkfish - Gippsland Basin
SEQ : 001 - 078

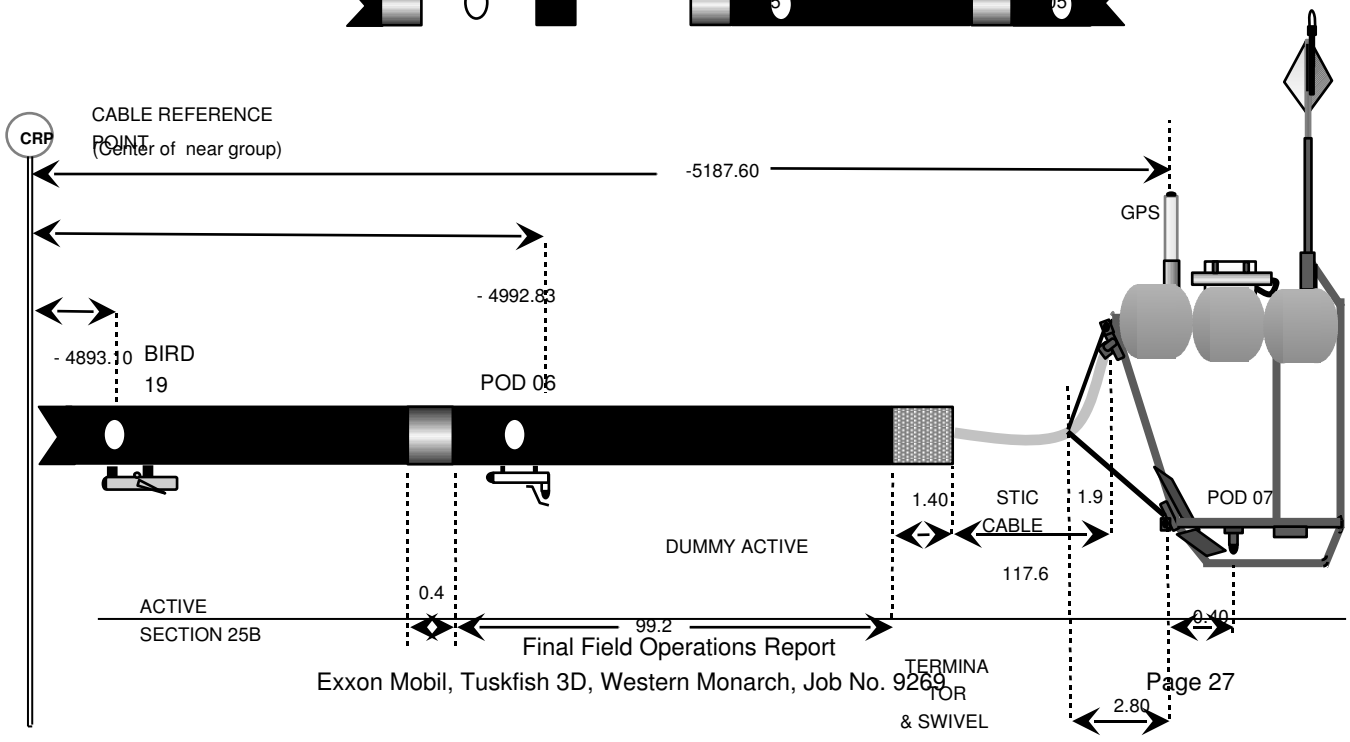
SENSOR OFFSET DIAGRAM CABLE 5

All offsets are nominal values
All measurements in metres
Coils are 0.83m forward of acoustic transducers
Coils are 0.70m forward of bird compasses



NOTE: ACTIVE SECTIONS ARE 99.2 m; modules are 0.4 m; Total Length 99.6 m

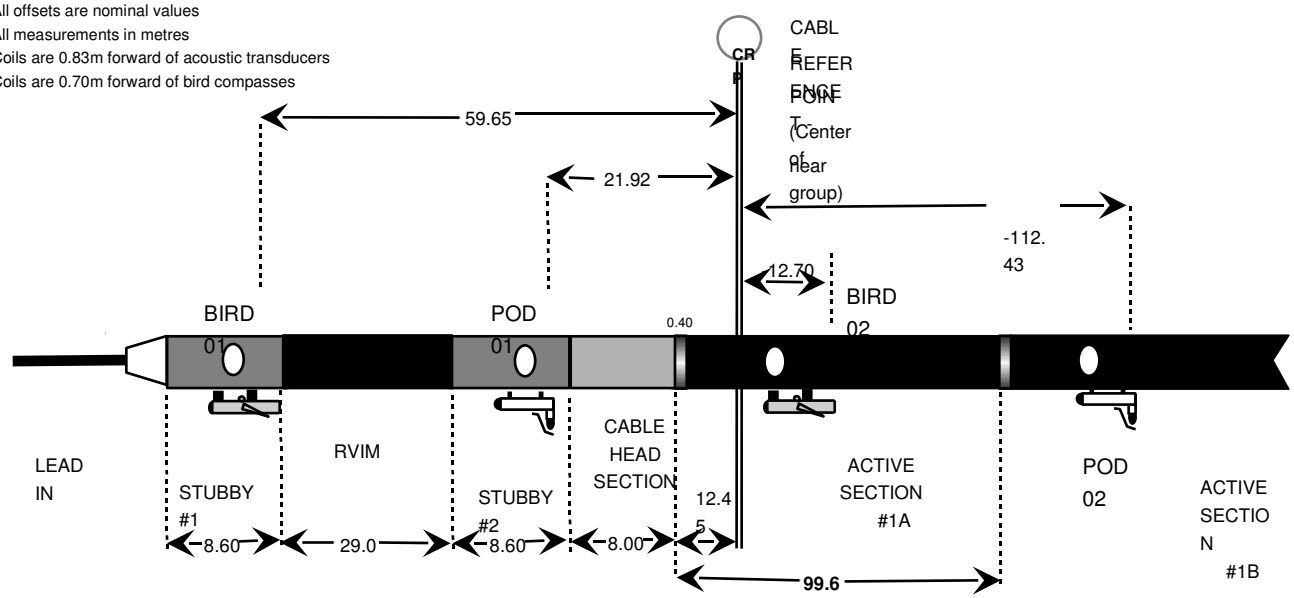




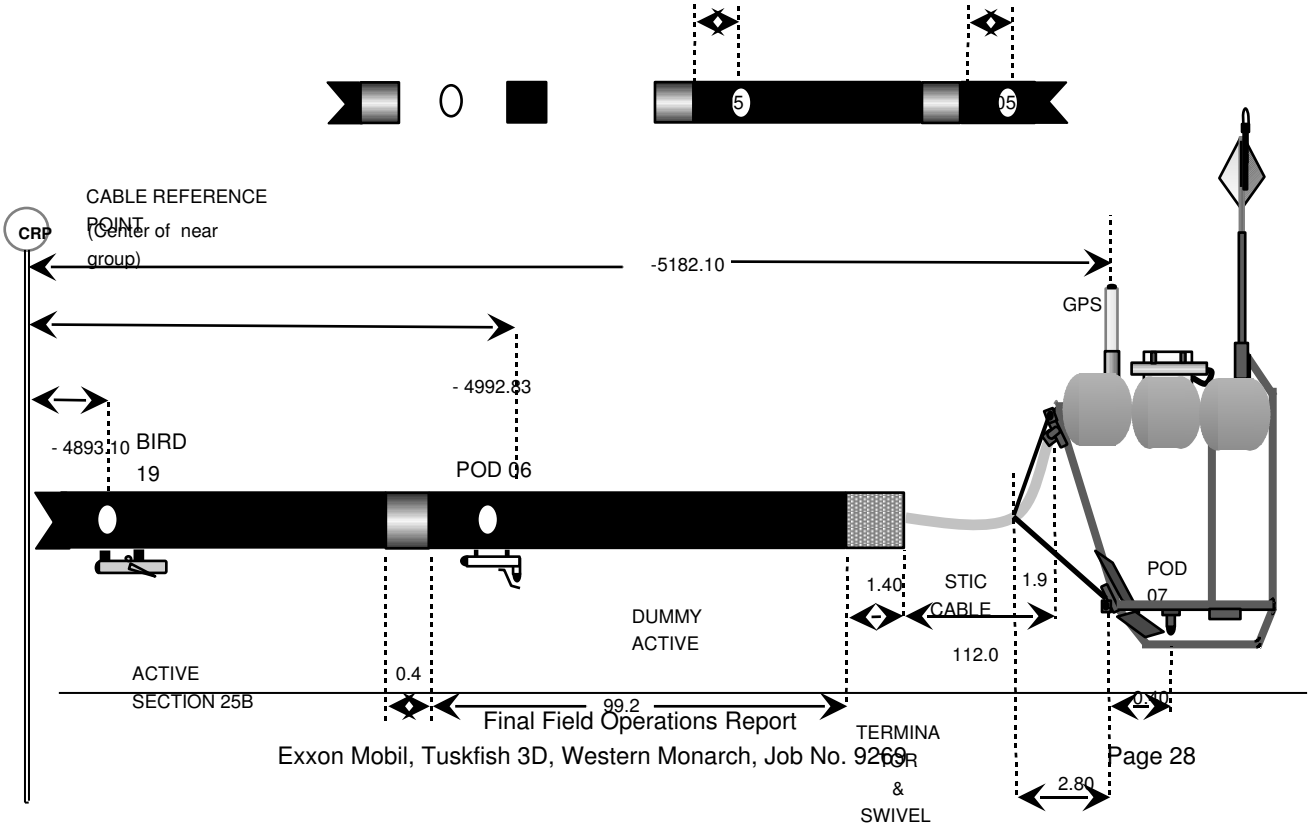
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY : Turkfish - Gippsland Basin
SEQ : 001 - 078

SENSOR OFFSET DIAGRAM
CABLE 6

All offsets are nominal values
All measurements in metres
Coils are 0.83m forward of acoustic transducers
Coils are 0.70m forward of bird compasses



NOTE: ACTIVE SECTIONS ARE 99.2 m; modules are 0.4 m; Total Length 99.6 m

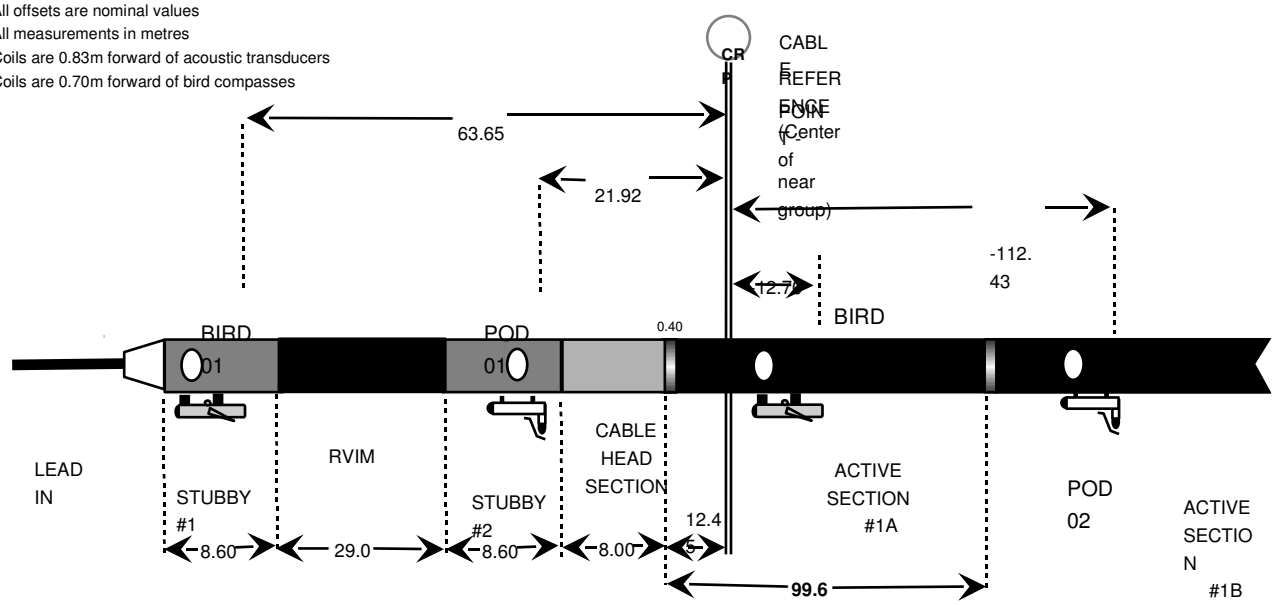


Connector
Module

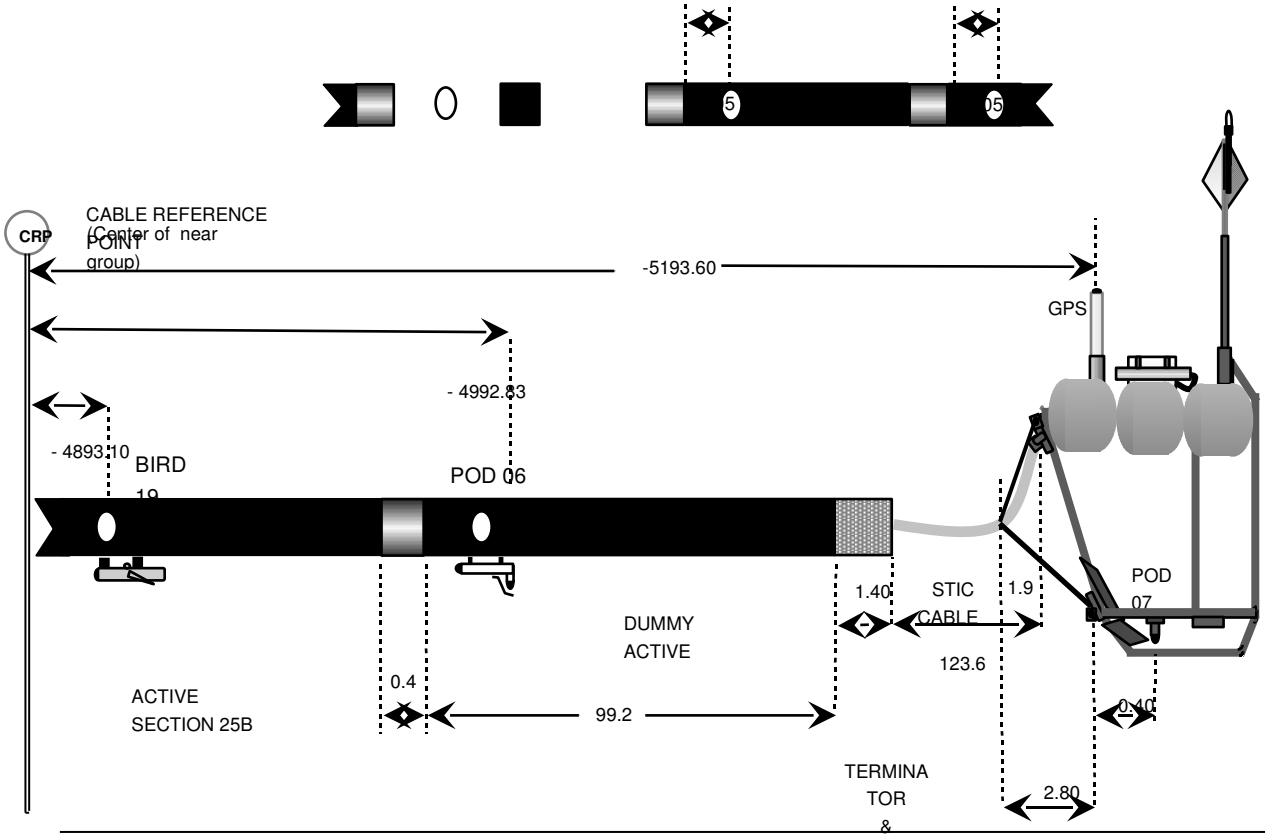
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY : Turkfish - Gippsland Basin
SEQ : 001 - 078

SENSOR OFFSET DIAGRAM
CABLE 7

All offsets are nominal values
All measurements in metres
Coils are 0.83m forward of acoustic transducers
Coils are 0.70m forward of bird compasses



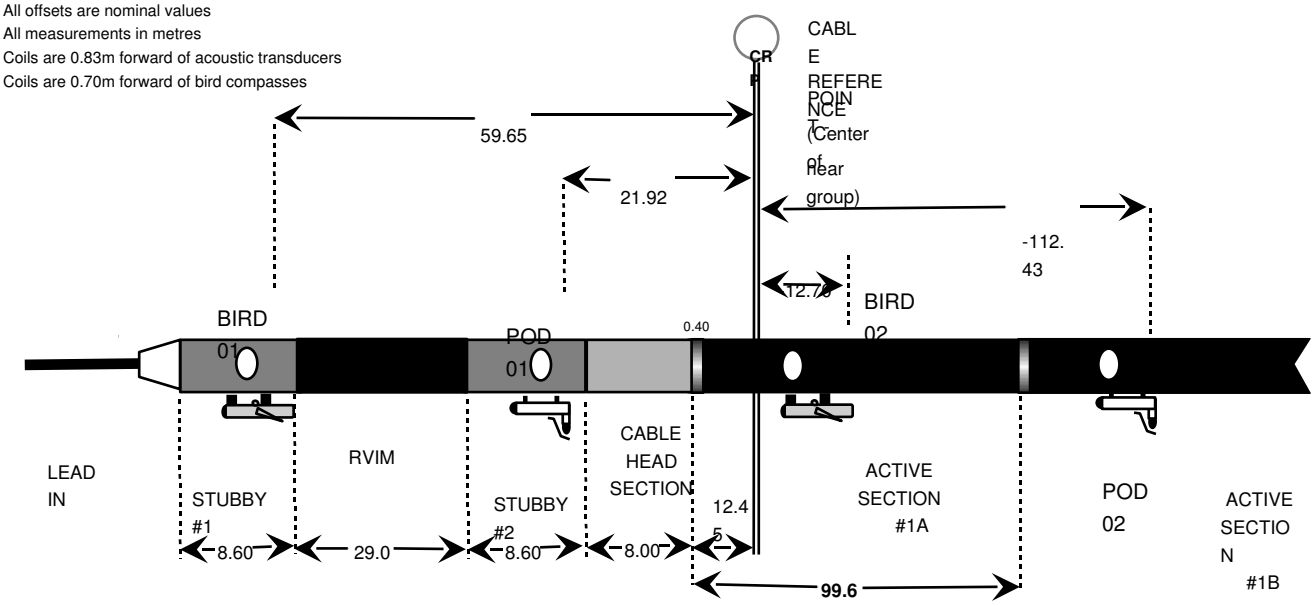
NOTE: ACTIVE SECTIONS ARE 99.2 m; modules are 0.4 m; Total Length 99.6 m



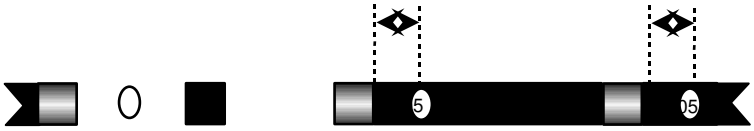
VESSEL : M/V WESTERN MONARCH
CLIENT : Exxon-Mobile
JOB : 9269
SURVEY: Turkfish - Gippsland Basin
SEQ : 001 - 078

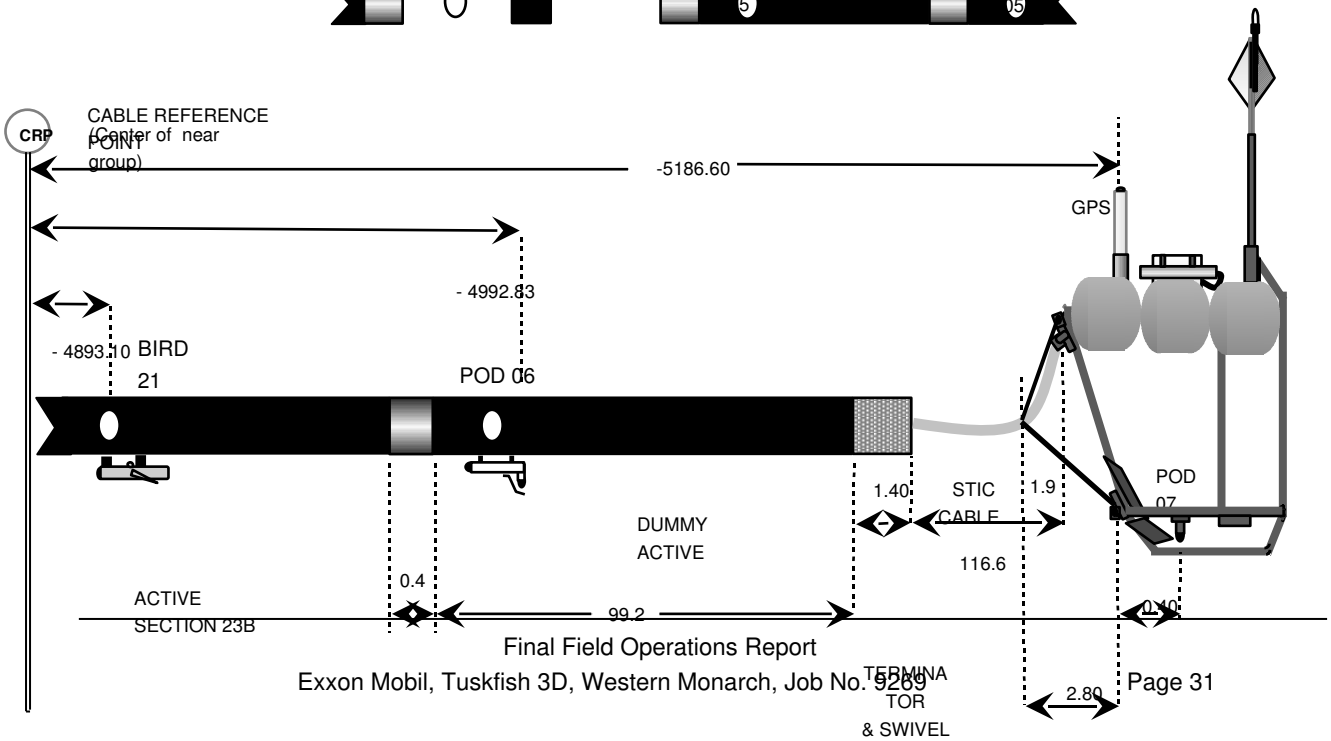
SENSOR OFFSET DIAGRAM
CABLE 8

All offsets are nominal values
All measurements in metres
Coils are 0.83m forward of acoustic transducers
Coils are 0.70m forward of bird compasses



NOTE: ACTIVE SECTIONS ARE 99.2 m; modules are 0.4 m; Total Length 99.6 m





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16.Navigation and Positioning System Description

16.1.System Configuration

16.1.1.Navigation Hardware and Software

System	Hardware (Type and Serial No.)	Software Version & Patch Level
Spectra	Concept Systems – Spectra	7.6.06
Reflex	Concept Systems - Reflex	1.8.1
UNAVCHK	WesternGeco System	Version 2001.0
Acoustic System	Digicourse – System 3 DigiRANGE	4.31
Echo Sounder	Simrad Subsea EA 500	Version 2.6
Current Meter	RDI Instruments ADCP	SeisADCP v1.14

16.1.2.System Description

Spectra is an integrated navigation system for marine geophysical surveys supplied by Concept Systems Limited. It is a modular system, comprising various software modules or nodes. The Open System standard of Spectra software allows it to be continuously upgraded in line with advances in computer and software technology. Once data has been acquired online by Spectra, the data, in P190 and P294 format, is passed to UNAVCHK for QC, Processing and final deliverable production.

The main features of the Spectra System comprise:

Navigation data acquisition and validation, shot prediction and header output.
Real time source and streamer positioning, supporting multi-vessel configurations.
Kalman filtering plus advanced integrated computation techniques with built in statistical reliability testing.
Steering displays and data monitoring.
Optional navigation logging.
Optional QC analysis and integrated quality control of real time data through to processed data.
Bias estimation.
System configuration/parameter entry, plus optional traditional calibration.
Binning displays are of the same format as the off-line binning package (Reflex) used onboard, allowing seamless integration when steering for coverage online.

A bridge monitor (X-Terminal) displays the deviation of the ship's position from the defined sailing line in a map view overlaid with survey hazards, and information. Off-line distance, rate of closure, and distance to Beginning/End of line are also shown, and are updated continuously.

All "Raw" data from external devices are logged on disk and 3590 tapes in industry standard UKOOA P2/94 format. All system parameter changes are logged in Spectra. In addition, the graphic terminals provide convenient, simple, and easily understood graphic displays of a multitude of navigation statistics pertinent to precision geophysical surveying, conforming to the Delft standards.

Spectra have the ability to use a multi-fix solution. This allows the user to select a number of DGPS solutions to derive the vessel's position and is written to the P1/90 processed data tape. Depending upon conditions and comparisons on the run-in to line, the Spectra solution would be chosen on the stability of the individual systems.

16.1.3.System Timing

The Real Time Navigation System (RTNU) is a VME racked system, performing data acquisition, validation and time stamping for the Spectra system. The RTNU is a physically separate piece of equipment on the network that communicates with the rest of the Spectra system via the Ethernet. It interfaces with the Closure unit (an external trigger input/output unit) providing multiple trigger inputs/outputs to the recording system and other sensors.

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, from the start of the job until sequence 79. From this point, the survey was continued using WesternGeco's standard mode of operation for 7 streamers and dual source surveys. The reconfiguration was necessitated by the need to reduce the maximum depth at which the lead-ins towed, due to shallower waters in the South West corner of the prospect.

Positioning of the vessel was by differential GPS, utilizing Thales Multifix III Dual Phase System v 1.29, WesternGeco PosNet DGPS and CNAV. Both Multifix III and Posnet used Thales SKYFIX corrections delivered in standard RTCM SC104 format, a secondary Posnet used corrections derived from CNAV.

The centre near group of each streamer and the sources were positioned relative to the vessel using a network consisting of the Posnet rGPS system, with 8 units, one mounted on each source sub array, Digicourse acoustic ranges and compass azimuths.

The centre last group of each streamer was positioned using a network consisting of Posnet rGPS system units mounted on each tailbuoy, streamer mounted compass heading units and Digicourse acoustics.

The mid streamer network consisted of ranges between 8 acoustic transceivers mounted 2098 meters from the centre first group of each streamer.

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

16.3.Surface Positioning

16.3.1.Vessel Navigation

System 1: Thales Multifix 3 (Multi 1)
RTCM Delivery Systems
Thales Skyfix SF via Inmarsat-A (POR)
DGPS Stations: Adelaide (205), Sydney (206), Melbourne (208)

System 1A: Thales Multifix 3 (Multi 2)
RTCM Delivery Systems
Thales Skyfix SF via Optus Spotbeam
DGPS Stations: Adelaide (205), Sydney (206), Melbourne (208)

System 2: PosNet 1
RTCM Delivery Systems
Thales Skyfix SF via Inmarsat-A (POR)
DGPS Stations: Melbourne (208)

System 2A: PosNet 2
RTCM Delivery Systems
CNAV Multireference Stations

System 3: C&C Technolgy C-NAV dual frequency system using Wide area Correction Transform (WCT) Australia correction service.

Primary vessel positioning was provided by the third party multi-reference positioning product, Thales Geosolutions Multifix III - Dual Phase System. 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.

Thales Geosolutions provide its Multifix III Differential GPS System using the BT Concert Packet Switch Network (85%), V-Sat uplinked to IntelSat (10%) and V-Sat over other Telco-Providers (5%), via an onboard INMARSAT-A and Optus communications systems, as the differential data

link. The link capacity of 1200 bits per second allows data from a number of networked reference stations to be sent simultaneously without introducing unacceptable delays between reference station and user. With three reference stations each generating correction data for ranges from eight satellites, an update rate of better than three seconds is achieved by the Multifix III system. The differential corrections generated at each reference station are brought to the data hub and control centre in Singapore where the system is monitored for performance and quality. For the IOR satellite, a composite message containing full RTCM-104 formatted data from all reference stations is broadcast over the satellite from Perth, Australia, but "controlled" from Singapore.

The Skyfix differential corrections are fed into the Multifix system, where a solution is processed, and then passed on to Spectra.

GPS positioning quality was also monitored on-line using the Mobile QC (MQCW) software package. GPS satellite status, data age, Northing and Easting Dilution of Precision (NDOP, EDOP), VDOP, and semi-major and minor axis of the error ellipse were monitored on line.

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.

16.3.2.Float Navigation

System	:	PosNet
Manufacturer	:	WesternGeco
System Type	:	Satellite Relative Position
Hardware	:	2 x Trimble 4000 SSE Receiver
		Trimble DSM in remotes
		1 x Dell OptiPlex GXPro
		1 x Dell OptiPlex DGX 5133
		2 x 16 Port Digiboard
		6 x Navigation Pod Controllers
		1 x Colour Monitor
		1 x Pitch / Roll meter
Number of Remote Units		14 (6 tailbuoys, 8 gunbuoys)

Float, both tailbuoy and source, surface navigation was provided by PosNet. 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, for the tail buoys. 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.

PosNet has the ability to range to a number of local L1 (single band) targets in the vicinity of the PosNet mobile unit and to compute the position of targets relative to the mobile unit. Data communications may be via radio or cable depending on location and environment. The system is comprised to two key components:

- rGPS Target Pods. These pods contain GPS receiver modules (12 channel L1/single band) and a local microprocessor that provides interface communications for the UHF transceiver and modem. The addition of a UHF antenna in the tailbuoy pods allows communication of data up to 20 kilometres. These components are housed in a rugged waterproof enclosure.

- The PosNet system located on the vessel.

GPS data is received from inwater GPS Target Pods by radio or cable and passed to the PosNet Dell computer via the Navigation Pod Controller. The Controller also provides power to both the Gun-buoy mounted units and the ships mounted Radio modems. Time Division Multiplexing (TDM) has been implemented by the modems to make better use of bandwidth and the radio spectrum. Any one radio may address 5 targets on any one of eight pre-set frequencies.
The target positions are computed by using the L1 C/A pseudo range and carrier phase from the vessel receiver and identical raw observables from each GPS off vessel target, in multiple instances of a Kalman filter. This produces estimates of the DeltaLat/DeltaLong for each target relative to the primary vessel position. The Ionospheric observable is not required due to the relative short baseline between the primary receiver and the targets. The 'Absolute' position can be obtained by summing the DeltaLat /DeltaLong to the vessel primary position, when the primary position is estimated in differential mode.

16.4.Streamer and Source Positioning

16.4.1.Acoustics

Acoustic data in the front, mid, and tail networks was provided by Digicourse System 3. This system comprises a rack mounted Controller, Processor and Graphical Display Unit which are located in the instrument room. CTX (Hull and Gun Positioning System) transceivers mounted on the hull and on each source provide vessel relative source positioning. CMX (Cross Streamer Ranging System) transceivers mounted on the streamers and CTX on the tailbuoys provide vessel and tailbuoy relative streamer positioning.

16.4.2.Streamer Compasses

Series 5000 Digibird combined magnetic compass and streamer depth controllers were attached to each streamer.

Compass Sampling Rate	=	1 second
Averaging constant	=	7 seconds

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

16.4.3.Gyro Compass

Primary Gyro (Monarch)

Manufacturer	:	Sperry Marine Systems
Type	:	Mk 227
Serial Number	:	470
C-O Correction	:	0.30
Speed Correction	:	0 knots
Latitude Correction	:	38 degrees
Hemisphere	:	S

The consistency of gyro 1, as demonstrated by the calibration history maintained on-board was inferior to that of gyro 2, hence it was decided to use gyro 2 as master gyro for this survey.

The Mk 227 gyrocompass provides a true north azimuth reference. It has been designed for larger vessels and includes a data transmission system, which provides heading information to remote systems and indicators.
The gyrocompass contains a gyroscope controlled in a manner to make it seek and continuously align itself with the meridian. An external gimbal system mounts the gyrocompass binnacle to provide a penduously stabilised horizontal reference plane for azimuth data.
The gyrosphere containing the gyroscope rotor is immersed in silicone fluid and is designed and adjusted to have neutral buoyancy. The weight of the gyrosphere in the fluid is cancelled by the buoyant force of the displaced fluid. This results in the following advantages:

- The weight of the gyrosphere is removed from the sensitive-axis bearings.
- The gyrosphere and bearings are protected from excessive shock loads.
- Sensitivity to shifts of the gyrosphere centre of mass relative to the sensitive axis is eliminated, thus providing improved accuracy.
- The effects of accelerations are minimised because the gyrosphere centre of mass and the centre of buoyancy are coincident.

Mechanical and electronic systems compensate the gyrocompass for errors associated with latitude and speed.
No speed correction is applied at either of the gyrocompasses. This correction was applied within Spectra.

Secondary Gyro (Monarch)

Manufacturer	:	Sperry Marine Systems
Type	:	Mk 227
Serial Number	:	488
C-O Correction	:	+0.54°
Speed Correction	:	0 knots

Latitude Correction	:	38 degrees
Hemisphere	:	S

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: Mk12 Ocean Data Acquisition System (Sippican Probe).

Mk12 Ocean Data Acquisition System (Sippican Probe) is disposable. The velocity is used for deep-water velocity profiles for depth reduction (XSV-02 to 2000m, XCTD to 1000m). The probe is a profiler allowed to free fall and is not recovered; data is transmitted back via a thin copper wire and an interface card fitted to a PC. The PC computes speed of sound.

Type: Odim Digibar Model WP 1100

Odim Digibar Model WP 1100 Velocimeter Sensor is a gun-string mounted temperature and conductivity probe. The information is measured and data is passed back to the vessel along the gun bundle lines in real time.

The sound Velocity spread sheets are included in Navigation Exhibit 7

16.4.5.Echo Sounder (Fathometer)

A Simrad EA 500 echo sounder was used. It is a high performance modular dual frequency hydrographic echo sounder with accurate receiving system and independent parallel processing within each of the frequency channels.
The echo sounder speed of sound was set to 1500 m/s. A draught correction of zero was entered in the echo sounder. The speed of sound for the total water column was derived on the prospect area using Sippican probes. However the speed of sound used for water depth processing was 1500m/s as agreed with the onboard client. The draught values, determined from draught measurements taken during the survey, were applied in post processing to produce water depth corrected P190s.

16.5.Auxiliary Navigation Sensors

16.5.1.Current Meter

Data from an Acoustic Doppler Current Profiler, or Current Meter, was acquired throughout the survey. This data was used to assist the survey planning throughout the operation and so reduce the infill. The sensor used was a RDI Instruments ADCP.

17.Navigation Systems Verification and Monitoring

17.1.Echo Sounder Verification

The draught was determined by reading of the vessel's draught marks and correcting for the vertical position of the transducer with reference to the draught marks (usually indicated on the vessel drawings).

The draught measurements are in Navigation Exhibit 2

17.2.Gyro Monitoring

Continuous monitoring of the vessel gyros was performed using PosNet vessel heading derived from a GPS baseline onboard.

The gyro correction estimates provided by PosNet were monitored and compared with previous dockside verification values and previous surveys.

A dockside verification was performed in one direction at Victoria Dock 24, Melbourne on the 23rd December by the Thales Geosoultions (Australasia) Limited.

The gyro verification results are in Navigation Exhibit 3

17.3.GPS Monitoring

Continuous monitoring was carried out offshore to verify that the installation was operating satisfactorily (data reception, transmission, processing and logging were verified) and that the operational settings were correct**.** Each system used, including duplicates, was verified, and an onboard spreadsheet was kept to compare all the systems with each other. All systems were generally within +/- 1.0m.

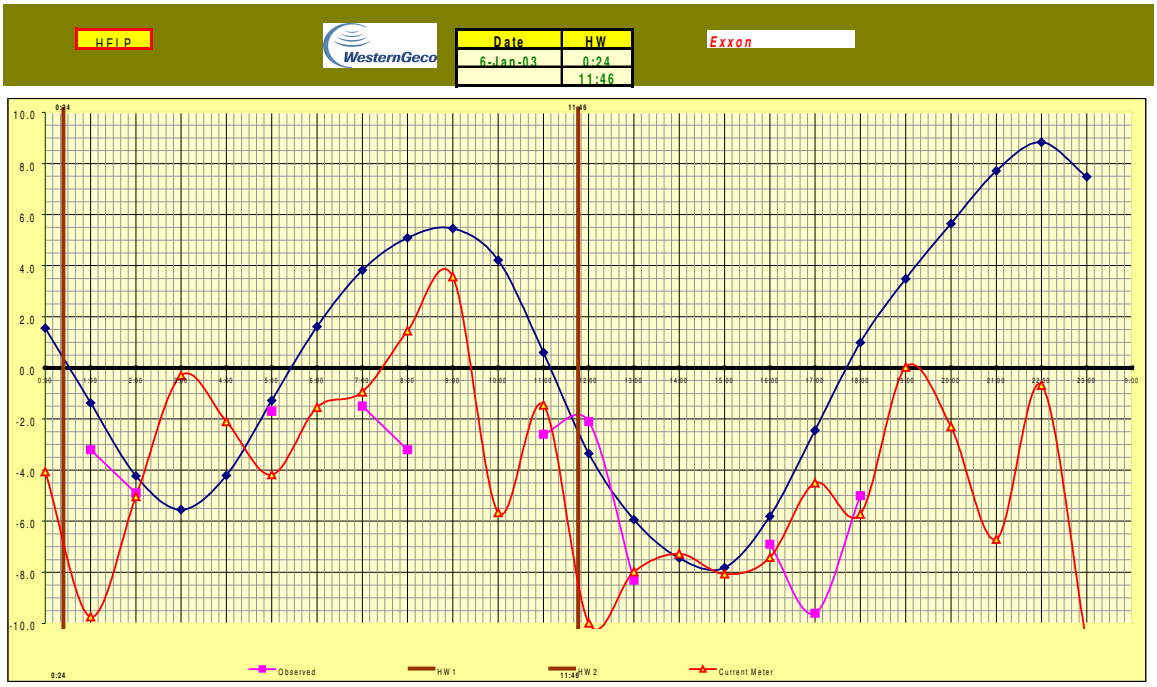
DGPS Health Check using Shore Control were carried out to verify that datum shift parameters and antenna offsets were correctly entered in Spectra. Satisfactory performance of the hardware was also verified (data reception, transmission, processing and logging) and that operational settings were correct**.** Each system used, including duplicates, was verified.
This was performed in Melbourne Australia on the 23rd December 2002 in conjunction with the gyro verification.

The onshore Health Check results are in Navigation Exhibit 3.

17.4.Current Meter Monitoring

To confirm that the Acoustic Doppler Current Profiler ADCP is operating correctly, with optimum configuration and, in so doing, providing a high quality data set for real-time and post-survey use, a test data sets were sent fortnightly 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.

In addition an onboard spreadsheet is kept, which computes feathering based on the current meter values, this also predicts feather based on current predictions supplied by Exxon. Both feather, current meter and predictions are then plotted to check for trends and current changes.



The currents were found to be difficult to predict as prevailing weather influenced the flow of water. Typically feathers became strong Southerly as cold fronts approached.

18.Navigation Processing

18.1.The UNAVCHK System

The UNAVCHK interactive navigation data quality control and post-processing system was designed for use with the IBM RISC 6000 UNIX based mini-computers. It performs the following major tasks:

Extracts and decodes raw navigation data from Spectra P2/91 or P2/94 UKOOA format files.
Processes decoded navigation data from the following sensors, for both ships and tailbuoys:

Lat-Lon Devices (e.g. dGPS)
Acoustic Devices (e.g. DigiRANGE)
Magnetic Streamer Compasses
Fathometer
Gyrocompass
Velocimeter

Calculates vessel, tailbuoy, energy source, and receiver group co-ordinates.
Outputs raw and processed sensor plots, fix error plots, position comparison plots, and streamer shape plots.
Prints statistical reports for both raw and processed data.

Corrects water depths to Lowest Astronomical Tide (LAT) or Mean Sea Level (MSL) where required.
Outputs final computed co-ordinates in UKOOA P1/90 Postplot Data Exchange format.

The UNAVCHK system is specifically designed to analyse and process marine navigation data. from 2D or 3D seismic surveys involving single or multiple streamers, sources, and vessels.

Final and raw navigation data in UKOOA standard formats was generated directly from UNAVCHK. Available media are 3590 cartridges and 8mm Exabyte cartridges.

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

18.1.1.UNAVCHK General Processing Parameters

The following UNAVCHK filtering and standard deviation (SD) parameters should be used. Any change is noted, as these values were sufficient for most conditions encountered during this survey.

The "Default SD" describes the random behaviour of the filtered variable, and is used to generate the variance matrix of the observations fed into the least squares adjustment. Note that correlation between observations is not modelled.

Operation	Default SD	Despike Window	Despike Threshold	Smoothing Window
DGPS	0	7	1.5m	5
Gyrocompass		3	2.0°	1
Fathometer		11	1.5	5
Velocimeter		9	2.5	9
Hull Acoustics	1.5m	15	2.83	11
Inline Acoustics	1.0m	15	1.0m	13
Front Net Acoustics	1.0m	9	1.5m	9
Mid Net Acoustics	1.0m	11	1.5m	11
Tail Net Acoustics	1.0m	13	1.5m	13
Head Net Compasses	0.5°	11	0.8°	13
Mid Net Compasses	0.5°	11	0.9°	11
Last Compass	2.0°	13	1.0°	15

rGPS Headbuoy Range	3.0m	11	1.5m	9
rGPS Headbuoy Bearing	0.42°	11	1.0°	9
rGPS Gunstring Range	3.0m	11	1.5m	9
rGPS Gunstring Bearing	0.35°	11	1.0°	9
rGPS Tailbuoy Range	3.0m	11	2.5m	9
rGPS Tailbuoy Bearing	0.03°	11	0.2°	9
Source Depths		11	2.8m	11
Cable Depths		11	1.0m	9

* In UNAVCHK rGPS values now default to using an angle, which gives a crossline distance of 5m at the tail end.
** Acoustic and Compass SD's are 'minimum standard deviations' which are added to the 'dynamic SD's' computed on a shot by shot basis for each measurement.

The above values are based on the processing results of the first accepted line(s) and previous experience. These are revised as necessary.

18.1.2.Sensor Data Processing

Three main processing techniques can be applied to any type of navigation sensor data to enhance the signal and attenuate any noise present. These processes are listed below in the order in which they must be applied:

Manual editing
Despiking
Smoothing

Each process attenuates noise and/or modifies data in a different way:

Manual Editing

Manual editing involves modifying portions of the recorded data by replacing recorded values with user entered values, or interpolating values from neighbouring data points. Clipping is a form of manual editing whereby values outside a user-defined window are automatically excluded from the data sequence and are replaced by values interpolated from neighbouring data values. Manual editing is used only where despiking and smoothing cannot accurately predict and remove noise. Typically, manual editing and clipping are used when there are large omissions in recorded data or when much of the data recorded consists of absurd values.

Despiking

Despiking is an automatic editing procedure, which detects and replaces obviously absurd data values. Spikes or outliers are rather isolated and can therefore be identified by comparison with adjacent data values. These spikes are removed by the use of a windowed median despike

algorithm. A "window" of data samples is established around the sample being investigated and the median of these values is then determined. Any investigated value differing from the median by a value greater than the despike threshold value is designated a spike and is replaced by the median value. Despiking is controlled by two parameters: the despike operator length and the despike threshold, both of which are user defined.

Smoothing

Smoothing is a filtering operation designed to attenuate low-level fluctuations in measured data. Smoothing is achieved by the use of a cosine weighted averaging filter. A window of data is established around the desired sample. Samples closer to the centre of the data window contribute more heavily to the computed average. The window is scaled by the appropriate weights and the scaled products are then summed to obtain the output sample value. Smoothing is controlled by a single parameter: the smoothing operator length, which is user, defined.

18.1.3.Network Analysis

WesternGeco's UNAVCHK navigation processing software comprises a two-stage network process:

Pre-network analysis
Network refinement

Pre-Network Analysis

"Prenet" provides a preliminary estimate of the co-ordinates of all navigation sensors. These preliminary positions provide the starting point for network refinement. Prenet works in the following manner:

All measurements are gathered together. Special processing of some of the observations is required, i.e. slant ranges must be reduced to the horizontal using depth information and cable compass bearings must be reduced to chord azimuths.

The standard deviations of each measurement are calculated to use as a method of weighting in the network solution. These standard deviations can be over-ridden by the user to increase or decrease the weighting of a particular measurement.

Sensors within 5.0 meters of one another can be co-located or aliased. This is done because the accuracy of some observations is not enough to discern one node from another. When a node is aliased to another, the aliased node is not used in the network process. Observations linked to aliased nodes are corrected to account for the offset differences between the aliased nodes and the nodes they are aliased to.

The initial co-ordinates for all unaliased nodes are calculated. Absolute position co-ordinates are translated to the NRP. Relative position nodes (e.g. Fanbeam nodes) are derived from range and bearing measurements. Two acoustic ranges produce a 'two-way' fix to derive initial co-ordinates for the acoustic nodes. Nominal offsets and compass azimuths position the remaining acoustic and compass nodes.

Prenet allows additional or pseudo-measurements to be input into the solution to be used in network refinement. These are measurements that remain constant throughout a line and which haven't been measured by a navigation sensor.

Network Refinement

Observations input into the network solution are either actual measurements of range, azimuth, latitude and longitude observed by electronic instrumentation, or configuration measurements made onboard. Both are important for a competent network solution. Configuration measurements are known before shooting and are measurements such as:

> The distances fore/aft and starboard/port of NRP to vessel hull receivers;
> Distances fore/aft and starboard/port between; DigiCOURSE and rGPS units on the gun strings and between them and the geophysical defined centre of source;
> Distances along the cable, between the cable reference point and all nodes on the cable; relative locations of underwater sensors on the tailbuoys.

WesternGeco's navigation processing software uses a sequential, extended Kalman filter to position all nodes. Prenet's special processing of some observations, e.g. slant ranges being reduced to the horizontal and cable compasses being reduced to chord azimuths, enables the mixing of compass and acoustic observations in a single integrated adjustment. Network nodes are positioned as a function of all the navigation observations, each observation being weighted by its standard deviation. Along the cables, a cubic spline interpolation process calculates the co-ordinates of the receivers as functions of along-cable distances of nodes and receivers. From each node on the gun strings, an estimate of centre of source position is obtained by simple layback. From these positions a centre of source position is derived.

While processing this data, an integrated network solution is produced for every shotpoint. For normal lines non-iterative option is chosen, where only the first shot is iterated, and the state vector and covariance matrix are carried forward to the next shot. This continues from shot to shot on down the line. If there are large bends in the streamers (eg due to rip currents or steering around obstructions), iterative option is used for that shotpoint range. This enables the iteration of every shot which models shape change in a better way.

18.2.P1/90 Processing Flow

18.2.1.Raw Data Collection

The raw navigation data collected on-line is stored on disk on the Spectra workstation, in UKOOA P2/94 format. These are then collectively databased by UNAVCHK machine.

18.2.2.Sensor Processing

The initial run for the T1028 UNAVCHK Processing module is then run up to, but not including, the network calculations. At this stage default filtering parameters are used to remove the majority of expected "normal" noise in the data. At the same time, plots and statistical reports are created

for every node/measurement in the network. This provides the maximum number of nodes and ranges from which to evaluate those that are unusable, those that can be left with default (minimal) filtering, or those that require further filtering, editing or clipping.

Once any additional processing is completed, the following QC checks are performed:

Shot-Time Plot - A shot-time vs. shotpoint plot is produced and checked for spikes, enabling, for example, identification of missing shotpoints.

Raw vs. Processed Data Plots and Statistical Reports - Each sensor processed generates these plots and reports, which are inspected by the processor for evaluation of filter parameters and any erroneous values.

Acoustic Geometry Report - Comprised of a list of the differences between nominal and measured acoustic ranges. The report enables the navigation data processor to identify anomalous measurements, judged in accordance with their position in the network. For example, in-line ranges are expected to deviate much less than cross-line ranges and head-net ranges are expected to deviate less than tail-net ranges.

Sensor vs. Sensor Plots and Statistical Reports- Enables comparison of each of the various means of directly locating the vessel, sources and cables in order to double-check for accuracy, for example:

- Vessel positioned by Primary Navigation / Vessel positioned by Secondary Navigation.
- Sources located by rGPS / DigiCOURSE acoustics.

18.2.3.Network Analysis

The UNAVCHK T1028 program is then run through Prenet/network as described above. The validity of the network is checked using the following:

Prenet Residuals - Prenet computes a residual for each measurement. This is the difference between the measured value and the value derived from the pre-network position. The Prenet residual report provides information of the mean, maximum and minimum residuals for all processed shotpoints. These residuals are reviewed and values greater than expected are analysed.

Prenet Maps - Sensor configuration maps are produced from Prenet processing and are evaluated to ensure that nodes are in approximately the correct positions with respect to each other.

Network Residuals - The Network processing stage computes a residual for each measurement. This is the difference between the value calculated from the Prenet position and the refined position. The plots are checked for stretching of ranges and for spikes left in after processing the raw sensor data.

Refined Network Node Variance report - Quality measures calculated for the final position of each node are DRMS values, Error Ellipse sizes and External Reliability statistics (the effect of an MDE on the node position).

Network Map - a map depicting the selected nodes and ranges, indicating areas of strength or weakness in the network.

Layback Model Comparison - Indicates the difference between the final refined position and a position derived from a crude layback model. An unusually large variance from the expected position would flag a possible erroneous value in the network solution.
Source and Receiver Offset Plots and Maximum Node Movement Plots - Identifies any nodal position jumps, which can occur when measurements are dropped for a section of a line, for example.
Adjusted Information - these statistical plots give an overall indication of the quality of the network, and the processing thereof. They are checked to ensure that no spikes are evident, usually indicating a bad measurement, and that the recommended values are approximately met:

W Statistic	< 3
Variance Factor	= 1
Variance Factor - Tolerance	= 0

18.2.4.P1/90 Creation

Once a satisfactory network adjustment has been achieved, the final P1/90 UKOOA is produced. The P1/90 UKOOA is checked using the following methods:

Sail-line Plot - This gives a plan view of the entire line shot, plotting vessel, source, cable-head, cable-tail and tailbuoy positions, as well as cable shape, for each shotpoint. Distinct errors in their positioning are apparent from position jumps, cable shapes and the positional relationship of the plotted points.
Source and Receiver Offsets Comparison - A number of offset distances between chosen deployed instruments, e.g. vessel, sources, individual receivers, and tailbuoys are calculated from the UKOOA and mean values entered into a spreadsheet for every line. These figures are not expected to vary much from line to line in a prospect, and any ambiguities are investigated. The offset calculation program also uses the final UKOOA to output the velocity, distance and track of vessel and source positions, in-line individual receiver separations and fathometer readings.
Cosmetic Quality Control - The P1/90s are run through a program which checks for line name, first and last shotpoint, shotpoint continuity, source vs. the shotpoint parity and rounding errors.

18.2.5.Statistical Summary

Most of the statistical reports associated with the QC procedures outlined above are combined and summarised with other reports using a program, which selects areas of concern. These include: large DRMS values; acoustic ranges with large differences from their nominal values; number of acoustic ranges in each net; compass biases; target positions; vessel position statistics; shotpoint exceptions; network modelled bias corrections such as cable rotation and stretch.

18.2.6.Choice of Despiking and Smoothing Parameters

During early stages of navigation data processing, despiking and smoothing parameters are selected to "fit" each particular type of navigation sensor data. Tests are carried out to determine the optimum processing parameters for each sensor type by using a variety of despiking and smoothing operators. Raw versus processed data plots and statistical tables are evaluated and then the T1028 module is run with each alteration to the set-up until the quality of the final product is satisfactory.

18.3.P2/94 Processing Overview

18.3.1.P2/94 Processing Flow and QC Procedures

The P2/94 files are created by Spectra. The P2/94 created at the start of the job is carefully checked and updated to ensure all information contained therein is correct for the current line.

The P2/94 file is then run through the P294.chk program. This reads the input QC file, which contains all records in the Spectra P2/94 that don't conform to UKOOA standard and reformats these header records and the event data records for the first shotpoint. It outputs a report file that is easier to comprehend and QC than the original P2/94 file. The P294.chk also contains automatic QC checks in the form of logic tests of header versus header records and header versus event records.

The P2/94's are then run through a program that strips off the header records for each UKOOA and sequentially compares them, producing a report, which contains the differences found in consecutive headers. This enables the processor to monitor parameter changes that are supposed to have occurred and detect parameter changes that are incorrect. Any incorrect parameter changes are then rectified.

18.3.2.P2/94 General Processing

A table of offsets for the various sensors, cable and source offsets used at the start of the job, i.e. for the first sequence of Deployment are to be found in Section 3: Equipment Configuration. These are supplemented with a table of offset changes, where any changes in description, measurement or physical position are recorded and carefully verified. P2/94 UKOOA header changes can also be found in

Exhibit 6: Survey definition & Changes Summary

18.4.Quality Control

18.4.1.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 (after any editing in UNAVCHK)
5. Header and 2 shots of Spectra P2 data
6. Report file detailing edits applied to Spectra P2 (if applicable)
7. P6/98 format bin grid exchange from Reflex
8. Line Acceptance form
9. Line Analysis form
10. Job Book (as supplied from the supporting office)
11. P1/90 preplot file
12. Minutes from Start-up meeting (if relevant)
13. 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 List, MWWD/F052.
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.

18.4.2.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 position and recomputes 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.

18.4.3.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 analysed every 20 lines to ensure consistency throughout the data set.

18.5.Water Depth Processing

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

corrected for draught
filtered to de-spike and interpolate missing data

The final data was dispatched on 3590 tapes 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.Spectra/Reflex

Crew 2 – Trip 1

Spectra performed well throughout the survey. However, during two sequences a RTNU hangup was experienced. A reboot of the RTNU had to be done. This created two small gaps, of less than 8 shots, and as such they could be interpolated during processing. No downtime was experienced as a result of these.

Crew 1 – Trip 1

Spectra performance continued to be marred by RTNU\Spectra lockups, in addition to several experienced offline the following were experienced online and caused lost production, during Sequence 116, in which 29 shots were lost and Sequence 130, in which 39 shots, the lock up was probably caused by the automatic restart of Virtual Interface Programs that had crashed on both pnav1 and pnav2, the main Spectra hosts. The restart process caused such a high CPU load that Spectra was apparently unable to process data from the RTNU, necessitating a restart of the RTNU to clear the problem. Suffered a further Spectra crash, at least so many processes locked up that it seemed better to restart it that any other course of action. The problem was triggered by trying to go back to an earlier configuration after trying out one with the extra acoustic on the starboard source. Unfortunately we were unable to get it going quickly enough and lost the first 18 sp of seq 169, the guns didn't sync until a few shots after this.

Crew 2 – Trip 2

A Spectra crash was experienced during sequence 187. An attempt were done to look at an earlier SCN configuration, and pnav2, the main Spectra hosts rebooted itself. This caused a 113 shot gap in the line. This is not to be confused with the incident on seq 169.

19.1.2.Thales Multifix 3 (Primary)

Crew 2 – Trip 1

The Multifix systems performed reasonably well during the survey. However it was seen that Multifix 2 provided a better solution than Multifix 1, consequently offline processing tended to use Multifix 2.

Crew 1 – Trip 1

Multifix continued to perform well apart from one instance when both PC programs terminated, shortly after restart a message was broadcast by Thales stating that normal service was resumed, leading one to suspect that the system was adversely affected by an earlier broadcast, other systems using the Skyfix corrections were unaffected and no positioning problems resulted.
The Skyfix corrections suffered a few outages during week 5, mostly, very short lived, however on Saturday 15th Feb during sequence 116 there was a outage from 04:48 to 05:30 UTC on due to a problem with Thales servers in Australia. CNAV provided adequate navigation during this period.

Crew 2 – Trip 2

Multifix continued to perform well to the end of the survey.

19.1.3.PosNet GPS (Secondary)

Crew 2 – Trip 1

The PosNet GPS performed reasonably well during the survey.

19.1.4.C&C Technology CNAV (Tertiary)

Crew 2 – Trip 1

The CNAV performed reasonably well during the survey. The difference was within 2 meters compared to the other systems. However, it was noted that the height output from the CNAV was decoded by Spectra as the height above sea level, not above the Geiod. This is different to what Multifix is providing. A technical query was raised via WesternGeco's in-touch support system regarding this.

19.1.5.rGPS (Tailbuoys, Front Floats and Guns)

Crew 2 – Trip 1

Guns

Posnet performed well throughout the survey. Some of the Posnet gunpods experienced failures however in general the faults were minor and were able to be corrected during line changes. One line had to be scratched and another attempt aborted due to Posnet failures. Whenever a Posnet on the guns failed, the gun string in question would be retrieved at the following line change to re-instate the Posnet Pod keep the front net integrity

Tailbuoys

Tailbuoy 1 died soon after the survey was started and Tailbuoy 5 soon after. Tailbuoy 5 was checked during streamer work later on and the Posnet pod changed. All verified working OK on deck. After redeployment the buoy again went down

We had two nights were it seemed like the buoys on frequency 2 were affected by radio interference. A frequency change was attempted, but it was not successful.

Crew 1 – Trip 1

Guns

Until sequence 157 the performance was good, with comparatively few pod failures, the practise of fixing the pod during the next line change having been continued. From sequence 157 to 160 data from the pod on sub array 4 (measurement G1R07) was present for less than 50% of the time, despite every effort being made to fix it on each line change. The situation was recovered by sequence 161, with the drop out periods being reduced to only a little above normal incidence. However, from sequence 166 to 168 inclusive the performance of Pod on sub array 2 (measurement G1R03) was so poor as to render the data un-useable. Following 2 pod changes, replacement of all the wiring on the gun array and re-routing of the umbilical wires, by sequence 169 the pod performance had been improved sufficiently to render the data useable, although still with more than the usual amount of drop out. The pod on string 4 failed again on sequence 177, with 20+V on the data line, due to leakage. Swapped the lines and the Pod during line change and, it finally came back in a few hundred shots in to seq 178. The clients were kept fully appraised of the situation and at no time did they say we could not continue, they were obviously not 100% happy, since sub-array separation monitoring was below specification, but the lines were accepted.

Tailbuoys

The performance of the Tailbuoy Posnet was markedly worse than the Gun sting mounted units, telemetry seeming to be the main problem as for a considerable time we experienced data from the pods dropping out for indefinite and random periods up to several hours. Predominantly they went down during poor weather and reappeared once the weather calmed and the sun came out, data was frequently restored on line changes when the Tailbuoys were a little closer to the vessel.

During week 5 we experienced particularly bad telemetry problems, with both the onboard Radios and the Pod radios loosing their (modulation) frequency settings. On February 4th the onboard radio loosing its frequency settings contributed to the severity of a tangle, experienced when the tow arrangement of streamer 6 failed, as we were unable to detect it the geometry change due to the very weak network solution resulting from the lost TB data. February 7th saw the second bout of telemetry problems with Tailbuoys five and six go down, in addition to the long term loss of Tailbuoy 7, thus putting up theoretically out of spec. for Sequence 89. During the recovery process on the following line change, we recovered Tailbouys 1 and 6. TB5 came back in of its own accord once closer to the vessel during the turn, once captured it stayed in. T/B 1 had been down

since before crew change, as reported above. It was not possible to carry out the TB re-programming on line as it involves re-programming the onboard radio to ch1, the one to which the TB keep defaulting, and would thus cause the loss of data from any other floats on the same frequency.

Several brief tailbuoy Posnet Pod outages were been experienced, following the incident on sequence 89, though none as serious, mostly data from the Pods being recaptured during the turn on to the next line. On 25th February prior to sequence the Pods on both TB 2 and 3 were changed, prior to sequence 134 the pod on TB 3 was changed out for a second time on the 26th during sequence 135. The pod on TB 2 ceased to work again later on the 26th during sequence 137. Several days later the pod on TB 2 began to work again intermittently and continued in this fashion until the end of the survey, however, its periods of reliable function were seldom as long as an entire sequence. In addition, TB 4 and 5 have also been intermittent, but usually rarely simultaneously, with the exception of sequence 166 on March 10th, but this was later declared NTBP due to swell noise.

Crew 2 – Trip 2

Guns

During the first sequence of our trip both Gunstring 3 and 4 died. It was decided that both arrays had to be taken onboard for repairs. Gunstring 3 was due the Posnet POD failing, while array 4 was found to be due to leakage on the lines through the gun bundle. This led to a downtime of 9 hours before the clients decided to continue. Both gunstring 2 and 4 continues to be intermittent from seq 180 to the end of job. Both due insufficient number of spare lines in the gun bundles.

Later on gunstring 7 died on seq 190. The arrray was retrieved the following line change and the 17m jumper on the array was found to have a big cut in it. The jumper was replaced and the array deployed with GPS working.

Tailbuoys

The performance of the Tailbuoy Posnet was markedly worse than the Gun sting mounted units, telemetry seeming to be the main problem as for a considerable time we experienced data from the pods dropping out for indefinite and random periods up to several hours. Predominantly they went down during poor weather and reappeared once the weather calmed and the sun came out, data was frequently restored on line changes when the Tailbuoys were a little closer to the vessel

A few lines were shot with only two working tailbuoys, and as such were out of spec. However, after discussing the affected lines with the onboard client representative they were accepted. It has to be noted they both the other crew and we have tried changing the PODS affected by this phenomen, but to no avail.

19.1.6.Acoustics

Crew 2 – Trip 1

The acoustic unit on array 3 (G1T03) gave us some problems initially and took several tries to get working. It was found to be a bad jumper between the electronics unit and the pinger itself. S3T01 also failed after 15 sequences, most likely caused by the unit being off the collars. S2T03 was found to have the same problems later on in the survey. S5T07 has been inoperative for most of the survey. This is most likely due to a faulty swivel section on streamer 5. The unit was checked when streamer 5 was onboard for maintenance, and found to be working OK when streamer 5 was deployed again, just to fail a few sequences later.

Crew 1 – Trip 1

External problems (coil lines) aside (see comments under compasses) with the exception of a DMU lock up on sequence 102, which caused 29 shots to be lost the Digicourse system was generally reliable, the most frequent problem being the loss of pods from the streamer. It seems that the collars used are not strong enough to resist the continuously varying strain placed upon them by the pods as the streamer moves during prolonged periods of bad weather. It was noticeable that only front-end pods, where the streamer motion is most violent were lost. Pods replaced for this reason include S2T03, S3T03 and S5T01. During the trip several units had to be moved (in one case removed) due to failures of the coils in individual cable sections. S3T01 (which had not since early in the survey, see above) was left off following re-deployment prior to sequence 135, as no working coil could be found on the front end of streamer three. Prior to sequence 144, both S1T01 and S4T01 were re-sited from the stubbie to the respective cable head sections, due to failure of coils on the stubbies. Unit S4T04 was also moved one section ahead, due to coil line problems during this bout of streamer work.

The transducer head of the hull pinger, data from which the data had been un-useable from the start of the survey was replaced prior to sequence 144. From this sequence onwards data quality form the hull pinger was good.

The most serious Digicourse problem was mostly caused by operator inexperience, however, ranges slipping outside the range gate, which seems to serve little useful purpose, have caused minor problems throughout the survey. Even near continuous monitoring of the Digicourse PC has not prevented these problems during this survey, due to the rapid current variations that cause large fluctuations in separations. Following the reconfiguration from 8 to 7 streamers the streamer offsets were adjusted in one direction to get the correct cross-line separations, on turning on to the opposite line heading we experienced a large current change which pushed the overall separation back up to 640m, necessitating a further change in offsets. Unfortunately, this change resulted in the Digicourse ranges between the port source and the streamer heads slipping on to the edge/outside their range gates. There was sufficient data present for the problem not to be flagged clearly in the Spectra display, but offline, the little data that was present did not fit with the GPS well enough to be included in the Unavchk solution. The result of this failure being poor geometry to the port side streamer heads, whilst obviously not an ideal situation we believed the data to be within specification. The FLQC check by ECL confirmed this, whilst obviously flagging problems with the geometry. However, the client was not prepared to accept the data despite the various tests we ran to confirm our initial analysis, consequently sequence 80 and the first 100sp of 81 were rejected.

Crew 2 – Trip 2

One sequence was shout without any acoustics on array 3. The array was retrieved the following linechange and the jumper from the electronics to the pod itself was found to be cut. Jumper was replaced and the unit worked well to the end of the job.

19.1.7.Compasses

Crew 2 – Trip 1

Numerous compass changes were carried out during the survey for poor depth readings and poor compass headings. These units were set passive and changed out for good units when logistically possible. The overall compass performance was good.

Crew 1 – Trip 1

The pattern of compass behaviour continued as above, many of the compasses identified for swapping out because of the high biases recorded for them during the bias monitoring routines in place turned out to have simply become detached from one or other collar.

The major problem affecting both compass and acoustic data was coil line leakage, which had been suffered to some extent on various streamers throughout this trip. However, it came to a head when Monarch emerged from the bad weather suffered for several days prior to 24th February. The coil line leakage on streamer 1 became so bad that from sequence 134 to sequence 143 it was not possible to include streamer 1 in the online network solution and hence on-line binning. The data for sequence 134 was recovered offline for sequence 134, but there after the leakage worsened rendering off line recovery impossible.

Crew 2 -Trip 2

During a bad weather period towards the end of the survey two compasses in a row on streamer 2 started to show high biases. It was decided to retrieve the streamer and both compasses were found to be hanging on the aft collar only. Both were reseated and the compasses worked well to the end of the survey.

19.1.8.Gyro

Crew 2 – Trip 1

The main gyro was satisfactory for the whole of the survey and the C-O produced by the dockside verification was verified to be correct based on a GPS heading comparison shown in Navigation Exhibit 3.

19.1.9.Echo Sounder

No problems were noted for the echosounder for the entire survey

19.1.10.Sound Velocity

The sound velocity value from the gun string mounted Odim Digibar Model WP 1100 Velocimeter Sensor agreed very well with data extracted from the appropriate depth range from the Mk12 Ocean Data Acquisition System (Sippican Probe) sound velocity values.

19.1.11.Current Meter

The current meter provided excellent real time current information and this was used to help plan both the approach to lines and steering strategy along the lines. No data for independent checking was rendered by crew 2 during trip 1, but observed current was seen to correlate quite closely with predicted tidal stream data. Data was rendered during crew 1's trip and no discrepancies were reported by Fugro, the observed feather continued to correlate well with reported current.

19.2.Processing and QC Summary

As per WesternGeco procedures, an external QC was carried out by ECL Ltd on sequence 001. No major problem was encountered during this QC of the data set. This process was repeated for sequence 81, following the reconfiguration to seven streamers, again no major problems were reported. An end of job QC was also performed on sequence 196, no major problems was encountered during the QC of this data set.

19.3.Conclusions

The use of 3 different DGPS systems offered redundancy during the operation. HDOP was continuously available and monitored. PDOP was also continuously available and monitored. For vessel positioning, the semi-major axis of the a-posteriori horizontal error ellipse did not exceed 5 meters for at least 90% of shot points on a line and shall not exceed 7 meters for more than 5% of shotpoints on a line. The 95% a-posteriori horizontal error ellipse of the 2-dimensional position was used as the basis for acceptance.
For vessel positioning, the semi-major axis of the a-posteriori horizontal error ellipse did not exceed 5 meters for at least 90% of shot points on a line and shall not exceed 7 meters for more than 5% of shotpoints on a line.
In instances when the Marginally Detectable Error (MDE) indicates a possible horizontal movement of greater than 5 metres, the positions were carefully investigated and other pertinent QC parameters checked.

Gun string separations were difficult to monitor on several lines through the survey due to lack of redundancy on acoustics on every array. As several gun bundles were showing leakage some arrays were left without any positioning for periods of lines. This is currently being looked into, as

several reterminations of gun bundles will take place, and new Posnet Gun pods are being sent to the vessel.

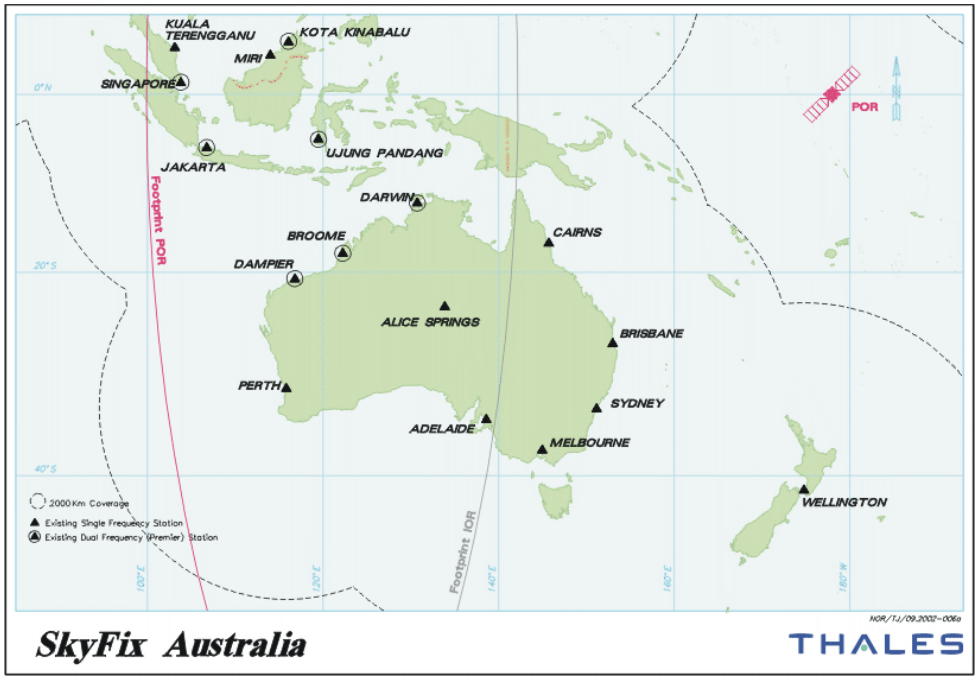
Tailbuoy performance has also been a major problem. Several buoys were dropping out during periods of bad weather only to come back again when the weather were improving. Some lines have been shot with 2 adjacent tailbuoys out of order (Which is out of spec) and other lines with a minimum number of tailbuoys working. It was tried several times to change tailbuoy pods only to experience the same problems. New refurbished PODS are on their way to the vessel.

20.Navigation Exhibits

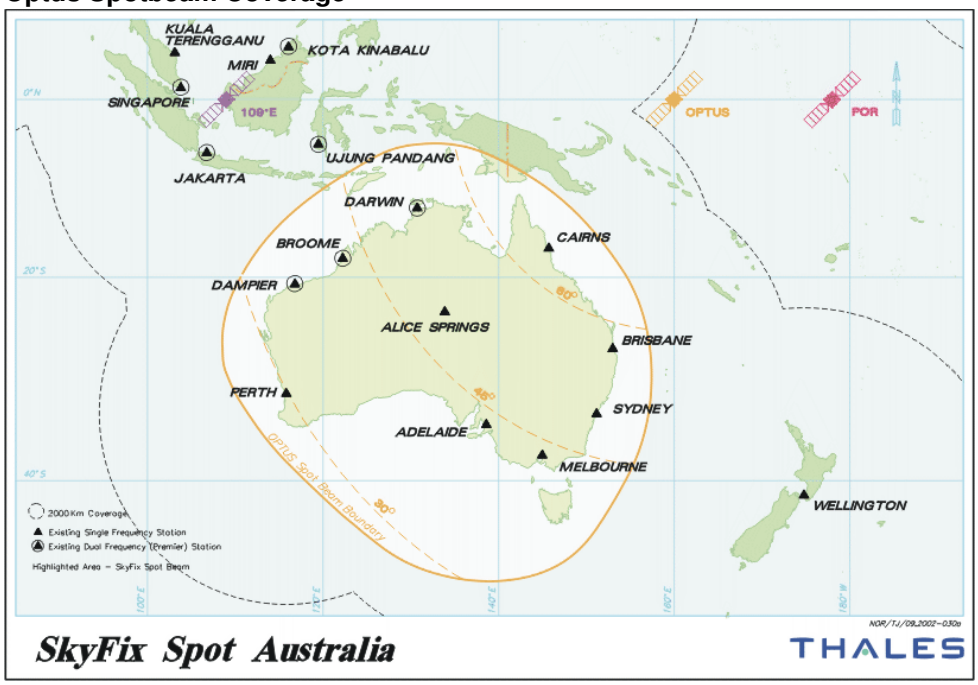
Exhibit 1 **: Navigation System**

DGPS Coverage Maps for RTCM Sources

Inmarsat POR Coverage



Optus Spotbeam Coverage



GPS System Installation Forms

VESSEL: Western Monarch	SHEET: 1 OF 1
DGPS SYSTEM: Thales Multifix III	
DATE: 19 November 2002	

CHECK		ACTIVE UNIT	SPARE UNIT
GPS receiver	type	Trimble MS750	Trimble MS-750
	serial no.	0220244189	0220248842
	no. channels	12	12
	software		
	firm ware		
GPS Antenna	type		
	serial no.		
Cables	max. recommended length		
	actual length		
	type		
	line amps installed Y/N		
	joints checked Y/N		
Satellite link	Correct Inmarsat antenna	Inmarsat 10 R	Optus Spot Beam
	splitter used Y/N	Splitter OK	
	demodulator serial number		
	demodulator frequency	JPR 10 R	Optus Spotbeam
	demodulator expiry date		
Radio link	frequency	NA	NA
Raydome blind spots relative to ship's head		No	No
Contractor computer	type	Dell Optiplex GX240	Dell Optiplex GX240
	serial no.		
Virus Check Y/N		No not networked	No not networked
	program version	NA	NA
	result	NA	NA
Visual inspection installation Y/N		Y	Y
Units securely mounted Y/N		Y	Y
Power on check Y/N		Y	Y
Manuals onboard Y/N		Y	Y
DGPS software	name, version	Multifix III, v 1.29	Multifix III, v 1.29
Data output format to Spectra		Trimble	Trimble
Interfaced to Spectra		Yes	Yes
Satellite selection mode		All in view	All in view
Position calculation mode fixed/constrained		Height aiding	Height aiding
Antenna height above MSL			
Geoid-spheroid separation			
Std dev of antenna height input			
PDOP limit		No	No
Elevation mask		10 deg	10 deg
SV Sync time		1 sec	1 sec
Max age corrections		150 sec	150 sec

	Name (Print)	Signature
Checked by:	Joel Pederick	----------
Company	Western Geco	
Positioning Supervisor:	Jevie de Guzman	----------

VESSEL: Western Monarch	SHEET: 1 OF 1
DGPS SYSTEM: C-NAV	
DATE: 19/11/02	

CHECK		CNAV 1	CNAV 2
GPS receiver	type	C-NAV	C-NAV
	serial no.	250334	250378
	no. channels	10	10
	Software	Version 12.5	Version 12.0
	Hardware	Version 1.7	Version 1.7
GPS Antenna	type	C-NAV	C-NAV
	serial no.	7140	6923
	Software	Version 2.14	Version 2.1
	Hardware	Version 3.0	Version 3.0
Cables	max. recommended length	100 feet	100 feet
	actual length	100 feet	100 feet
	type	8 core comms cable	8 core comms cable
	line amps installed Y/N	Y	Y
	joints checked Y/N	Y	Y
Satellite link	Correct Inmarsat antenna splitter used Y/N	NA	NA
	RF serial number	7307	6923
	demodulator frequency	1545.545 MHz	1545.545 MHz
	demodulator expiry date	27 June 2003	26 June 2003
Satellite		109 E	
Raydome blind spots relative to ship's head		NA	NA
Contractor computer	type	NA	NA
	serial no.	NA	NA
	program version	NA	NA
Virus Check Y/N		NA	NA
	program version	NA	NA
	result	NA	NA
Visual inspection installation Y/N		Y	Y
Units securely mounted Y/N		Y	Y
Power on check Y/N		Y	Y
Manuals onboard Y/N		Y	Y
CNAV Correction Type used		WCT/RTG	WCT
Data output format to Spectra		NMEA	NMEA
Interfaced to Spectra		Y	
Satellite selection mode		All in view	All in view
Position calculation mode fixed/constrained		Auto	Auto
Antenna height above MSL			
Geoid-spheroid separation			
Std dev of antenna height input			
PDOP limit		20	20
Elevation mask		10 deg	10 deg
SV Sync time		1 sec	1 sec
Max age corrections		150 sec	150 sec

Exhibit 2 **: Echo Sounder Calibration**

Echo Sounder Check (In Port)

Vessel:	M/V "Western Monarch"	Date :	11/16/2002
Client:	Santos Ltd.	Check started (GMT):	3:30
Job no.	9257	Check ended (GMT):	3:37
Location:	Port 2, Portland, Australia	E/S draught:	6.90 m
E/S type:	Simrad EA500	Vertical offset keel to E/S:	0.00 m
Serial no:		Bridge E/S reading	xx.xx

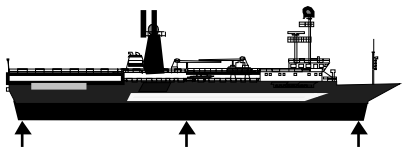
Observed

Draught (m)			Lead Line Depth (m)	
Bow	Mid-ships	Stern	Stbd (1)	Port (2)
7.00		6.80	13.50	13.20
Draught at E/S		6.90	LL Depth at E/S	13.35

Echo Sounder Readings	
Freq 1 (m) 38 MHz	
6.00	
6.00	
6.00	
6.00	
Average =	6.00
+ vertical offset keel to E/S transducer	0.00
+ draught (keel to sea surface)	6.90
Total water depth (m)	12.90

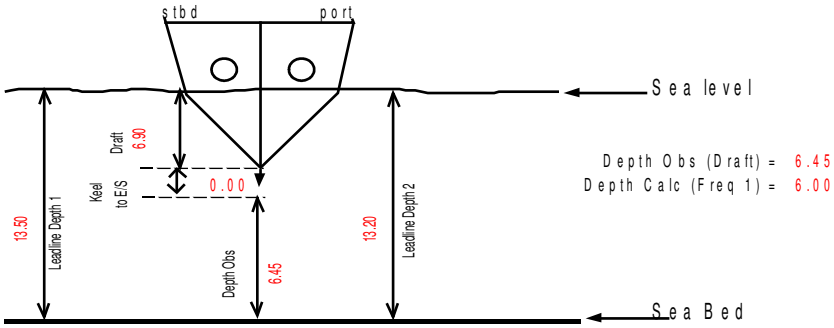
Observed - Echo Sounder = 0.45 m Freq 1

Sounder Settings Check:	Factory Defaults (from manual)	Check ✓
RangeA	xx.xx	
Absorption coefficient	10 dB	✓
Transmit power	2000 U	✓
Transducer Depth	0.00	✓
Speed of sound	1500 m/s	✓
two way beam angle	-20.6 dB	✓
Transducer gain	26.5 dB	
Sample distance	0.10m	✓



Stern draft Marks — E/S Probe — Fwd Draft Marks

Offsets above are relative to VRP
Echosounder probe is close to the middle of the vessel



Depth Obs (Draft) = 6.45
Depth Calc (Freq 1) = 6.00

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 Monarch for ExxonMobil 01st Jan to 25th March 2003 on the Tuskfish Survey prospect (WesternGeco job number 9269), the DGPS, 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:

DGPS Comparison Monitoring allows continuous system comparisons. Primary, Secondary and Tertiary GPS receivers share a common antenna via a splitter, enabling a direct comparison of GPS receiver and system performance.

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

II. Differential GPS Verification

M/V Western Monarch utilised the following DGPS systems throughout the survey: Thales Multifix III DGPS with Thales RTCM corrections delivered by Optus and Inmarsat A.

Secondary vessel positioning was provided by WesternGeco's PosNet withThales Skyfix RTCM corrections delivered by Inmarsat POR and also CNAV RTCM corrections delivered by CNAV.

Tertiary vessel positioning was provided by a CNAV DGPS using WCT corrections.

Method used

The main GPS antenna is located at the NRP (Navigation Reference Point) and connected to 5 Trimble GPS receivers via a 5-way splitter. Because the receivers share the same antenna, the positional data for each DGPS system can be directly compared and these comparisons used to verify that each system is performing correctly.

Results

Chapter VI contains a summary of the statistics taken from the dGPS monitoring files derived from the data logged by UNAVCHK.

Chapter VII contains numerical data from dGPS monitoring files derived from the data logged by UNAVCHK.

Figure 1 shows the average misclosure of the primary dGPS system against the other systems in graphical form (separated into in–line and cross-line components) for all the sequences acquired.

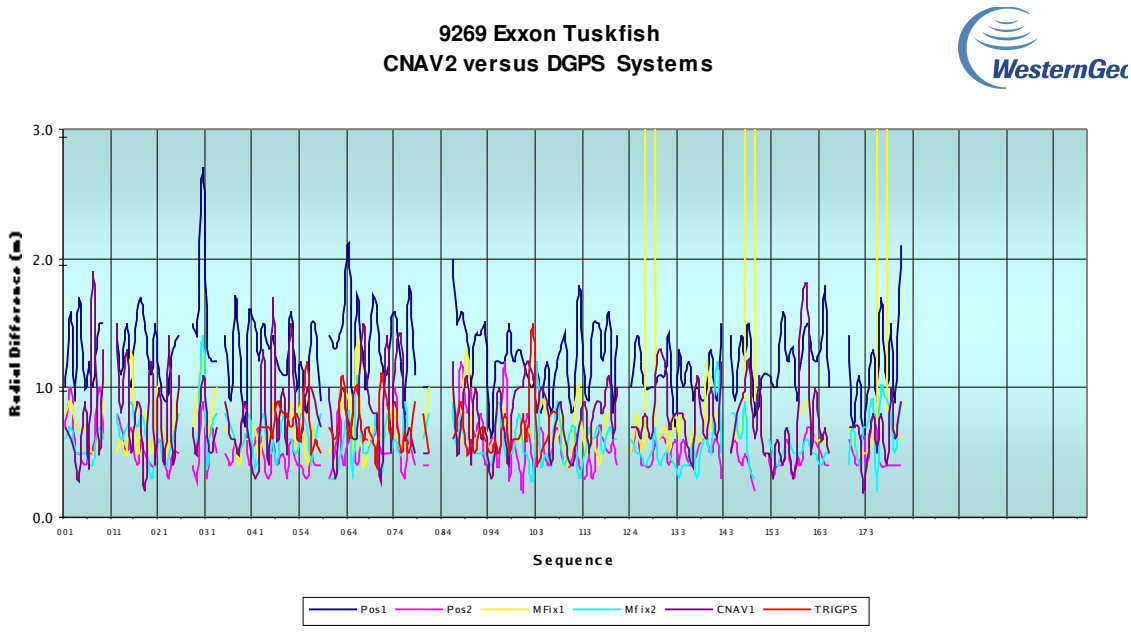


Figure 1 & 2: DGPS System Comparison Trends to demonstrate GPS quality during the survey.

IV. Gyro Calibration

M/V Western Monarch is fitted with two gyrocompasses, a main survey gyro of type Sperry 227 (S/N 488 – Sperry1) and a secondary gyro of type Sperry 227 (S/N 470 – Sperry2) and tertiary gyro Seapath for comparison and backup use. PosNet 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 receiver, of the same type. The second receiver's antenna is mounted 33.43 m astern 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.

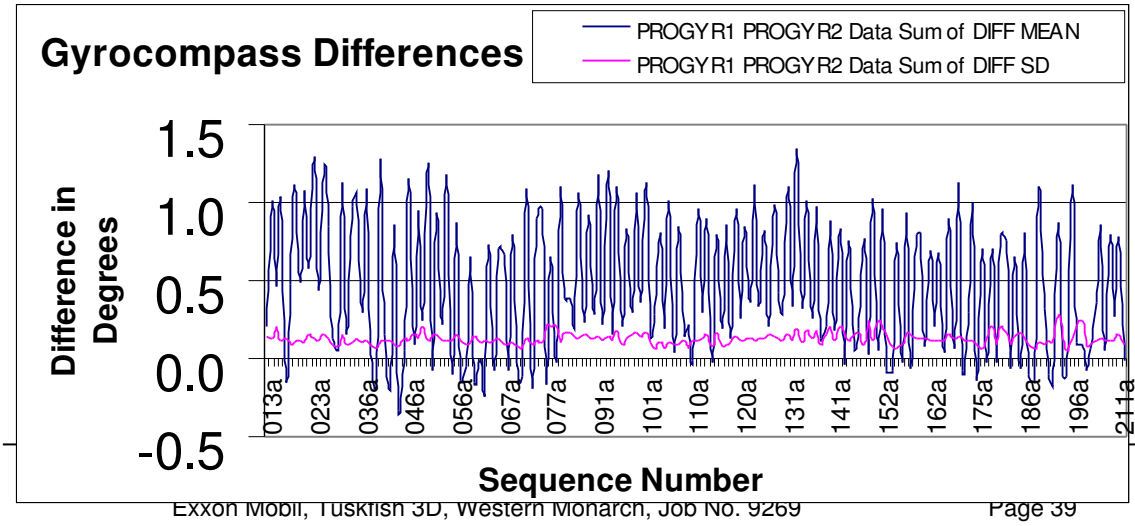
Method used

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

Results

In order to monitor gyro reliability the difference between the gyros headings are recorded for each shot and averaged for each line. The mean difference between selected gyros and the moving average is plotted in the graphs below.

Figure 3: Difference plot between all gyros with the Posnet Gyro as the reference.



V. Conclusions and Comments on Data Quality

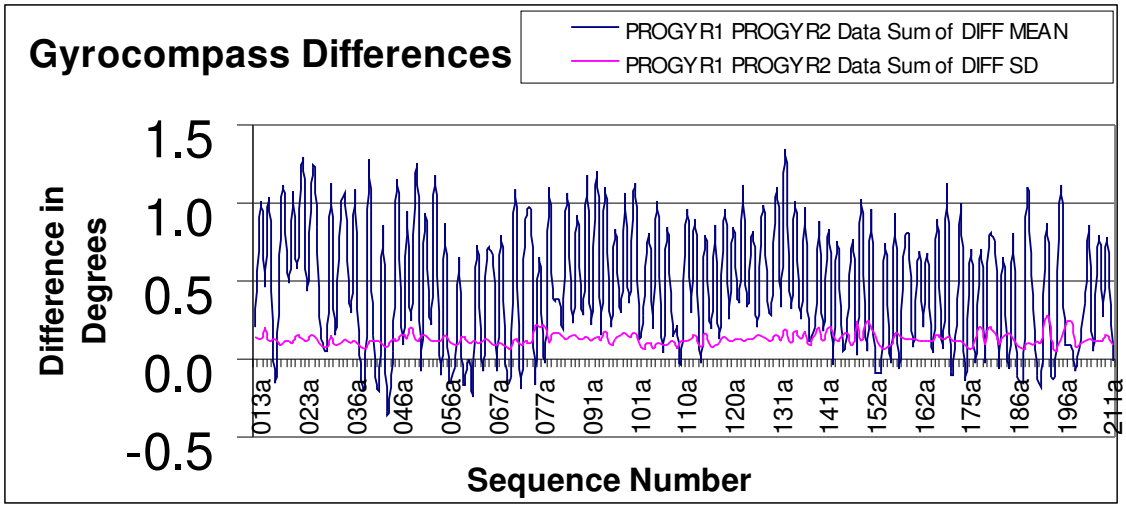
It is quite normal for the standard deviations of the differences between gyrocompass and PosNet derived heading to be slightly higher than Gyro to Gyro standard deviations. This is due to the PosNet headings faster response time and dependence upon satellite geometry and atmospheric effects.

Online Gyrocompass verification report for the Western Monarch Exxon Mobil Tuskfish 3D Survey.
Sequences 013 to 212, 08 cable and 07 cable configuration.
Gyrocompass data recorded 09 January 2003 to 25 March 2003.
Simon Overend 25 March 2003.

The Monarch has three gyros on board
Gyro 1 is Sperry MK277 s/n 488
Gyro 2 is Sperry MK277 s/n 470
Gyro 3 is a ship heading derived from a PosNet pod mounted on the vessel centreline.

In order to monitor gyro reliability the difference between the gyros headings are recorded for each shot and averaged for each line. The mean difference between selected gyros and the standard deviation of the differences is plotted in the graphs shown below.

Gyros are behaving reliably if the difference between them is stable and small and the standard deviation of the differences is low.



1: Difference plot between Gyro 1 and 2.

Gyro 1 and 2 are magnetic gyrocompasses that respond to ship motion and changes of direction in the same fashion. Consequently the Standard deviation of the differences between them is very low.
The difference between the two gyros is relatively stable over time.

Online Compass verification report for the Western Monarch Exxon Mobil Tuskfish 3D Survey.
Sequences 001 to 212, 08 and 07 cable configuration.
Compass data recorded 05 January 2003 to 25 March 2003.
Simon Overend 25 March 2003.

In order to monitor compass performance an average “bias” is calculated for each compass mounted on the cable for every line that is shot. The bias is the difference between the actual compass reading for each shot and a smoothed, deskewed, average reading for the whole cable for each shot. A compass with a high bias will be reading significantly differently from the other compasses in the spread. Compasses with high biases may need attention (flat battery, debris) or they may need to be removed and returned to the manufacturer for repair. A high compass bias is also often seen when recording during poor sea conditions, or during infill when there is a lot of cable movement. Consequently a high bias does not always mean that a compass is bad, merely that it needs some explanation for its behaviour.

A compass is considered to be suspect when it records an average bias between -0.5 and 0.5 degrees for fewer than 60% of the times that it is used on the cable.

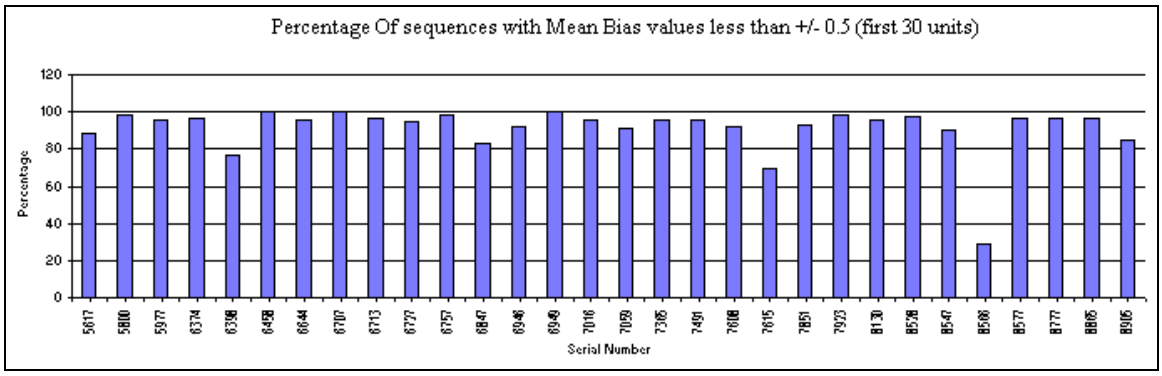
The compass bias information for each line and for each compass is tabulated in a database and we can query the database to pick out the units which fall out of spec. The query in the diagram

below is taken from the Monarchs compass data. Four compasses have marginal bias histories 8566, 9707, 15266, and 16114.

SERIAL NUMBER	Expr2
8566	28.9
16114	37.5
15266	40.0
9707	45.2
17357	63.0
9140	66.3
7615	69.4
19756	73.6
6398	76.4
19752	81.4
19702	82.4
6847	83.1
17674	84.5
11934	84.7
8905	84.7
5617	88.1
17063	88.2
12033	88.5
13028	88.5
9380	88.5

1: Compass s/n against percentage within spec.

Table above showing compass serial numbers against the percentage of compass biases that are out of specification. The table is sorted in order of increasing percentage so that the failing compasses are listed at the top of the table.



2: Percentage of sequences with mean bias +/- 0.5 degrees.

In the diagram above compass 8566 was in spec for less than 30% of the sequences (out of 212 sequences), and its performance needs to be investigated.

The table below shows that six compasses had bias greater than 0.5°

SERIAL NUMBER	CABLE NUMBER	RU NUMBER	AvgOfTOTAL BIAS CORRECTION	AVERAGE HEADING	AvgOfBIAS SD
8566	1	1121	-0.57	0.00	1.09
19360	4	1406	0.67	0.00	0.59
9707	3	1406	0.60	0.00	1.19
19756	4	1409	-0.53	0.00	0.55
7615	5	1619	-0.52	0.00	1.66
19752	7	1714	-0.65	0.00	0.81

3: Average bias vs. compass s/n.

The table below shows the compasses that have greater than 0.5° bias in both directions of the survey.

PROD DIRECTION	SERIAL NUMBER	RU NUMBER	Avg Of TOTAL BIAS CORRECTION	FCCV Average	Total Bias VS FCCV
107	8566	1121	-0.677	0.000	-0.677
287	15266	1201	-0.675	0.000	-0.675
107	6398	1211	0.558	0.000	0.558
287	9707	1406	0.593	0.000	0.593
287	19360	1406	1.310	0.000	1.310
107	9707	1406	0.607	0.000	0.607
107	9707	1406	0.603	0.000	0.603
107	19756	1409	-0.567	0.000	-0.567
287	9140	1501	0.533	0.000	0.533
287	15229	1608	0.670	0.000	0.670
287	21674	1610	-0.503	0.000	-0.503
287	13773	1610	-0.760	0.000	-0.760
107	7615	1619	-0.708	0.000	-0.708
107	19752	1714	-0.549	0.000	-0.549
287	19752	1714	-0.756	0.000	-0.756
107	16114	1801	0.570	0.000	0.570
287	16114	1801	-0.914	0.000	-0.914

4: Average bias vs. compass s/n per direction.

The outer streamers have 21 compasses and other streamers in the spread have 19 compasses mounted on it.

Compass 8566 is mounted on the cable at position 1121 (cable 01, Last compass on the cable) for the entire survey.

Compass 15266 was mounted on the cable at position 1201 (cable 02, First compass on the cable) for the entire survey.

Compass 6398 is mounted on the cable at position 1211 (cable 02, 11th compass down the cable) for the entire survey.

Compass 9707 was mounted on the cable at position 1406 (cable 04, 06th compass down the cable) for sequences 044-199.

Compass 19756 is mounted on the cable at position 1409 (cable 04, 09th compass down the cable) for sequences 001-043. This compass was also mounted at position 1304 (cable 03, 04th compass down the cable) for sequences 135-212.

Compass 9140 is mounted on the cable at position 1501 (cable 05, First compass on the cable) for sequences 001-078. This compass was also mounted at position 1110 (cable 01, 10th compass down the cable) for sequences 150-212.

Compass 13773 is mounted on the cable at position 1504 (cable 05, 04th compass down the cable) for sequences 001-078. This compass was also mounted at position 1610 (cable 06, 10th compass down the cable) for sequences 200-212.

Compass 19360 is mounted on the cable at position 1518 (cable 05, 18th compass down the cable) for sequences 001-078. This compass was also mounted at position 1406 (cable 04, 06th compass down the cable) for sequences 200-212.

Compass 15229 is mounted on the cable at position 1602 (cable 06, 02nd compass down the cable) for sequences 001-078. This compass was also mounted at position 1502 (cable 05, 02nd compass down the cable) for sequences 079-084 due to reconfiguration from 8 cables to 7 cables. It was also mounted at position 1608 (cable 06, 08th compass down the cable) for sequences 200-212.

Compass 21674 is mounted on the cable at position 1710 (cable 07, 10th compass down the cable) for sequences 001-078. This compass was also mounted at position 1610 (cable 06, 10th compass down the cable) for sequences 079-199 due to reconfiguration from 8 cables to 7 cables.

Compass 19752 is mounted on the cable at position 1714 (cable 07, 14th compass down the cable) for sequences 001-064. This compass was also mounted at position 1502 (cable 05, 02nd compass down the cable) for sequences 085-212.

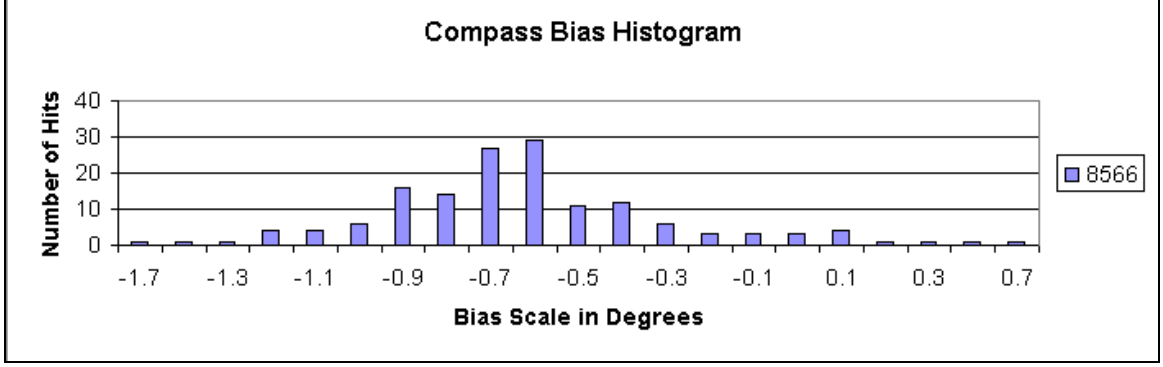
Compass 7615 is mounted on the cable at position 1719 (cable 07, Last compass on the cable) for sequences 001-078. This compass was also mounted at position 1619 (cable 06, Last compass on the cable) for sequences 079-212 due to reconfiguration from 8 cables to 7 cables.

Compass 16114 is mounted on the cable at position 1801 (cable 08, First compass on the cable) for sequences 001-078. This compass was also mounted at position 1701 (cable 07, First compass on the cable) for sequences 079-212 due to reconfiguration from 8 cables to 7 cables.

The individual behaviour each of the compasses listed above is shown in the following histograms as an attempt is made to determine whether the compass is performing acceptably or needs re-calibration.

In the diagrams below the RU number is the location of the compass on the cable. The number of hits on the Y axis is the number of times the compass recorded a bias of the value given on the X axis.
The serial number of the compass is written to the right of the histogram.

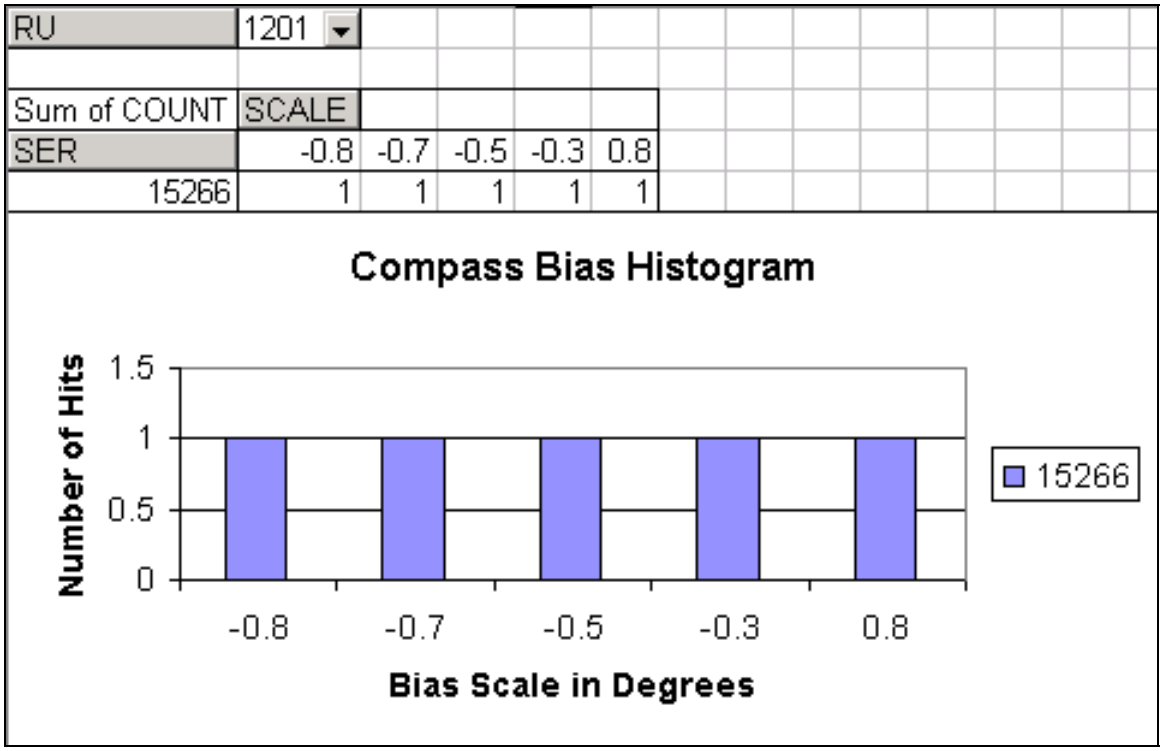
RU	1121																				
Sum of COUNT	SCALE																				
SER	-1.7	-1.4	-1.3	-1.2	-1.1	-1.0	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.6	0.7
8566	1	1	1	4	4	6	16	14	27	29	11	12	6	3	3	3	4	1	1	1	1



5 : Compass s/n 8566.

- Compass 21 cable 1 serial number **8566** was not changed out during the survey as this is a tail compass on the cable which can have a slightly higher than usual bias due to towing characteristics of the tailbuoy. This compass will be monitored during the next survey.

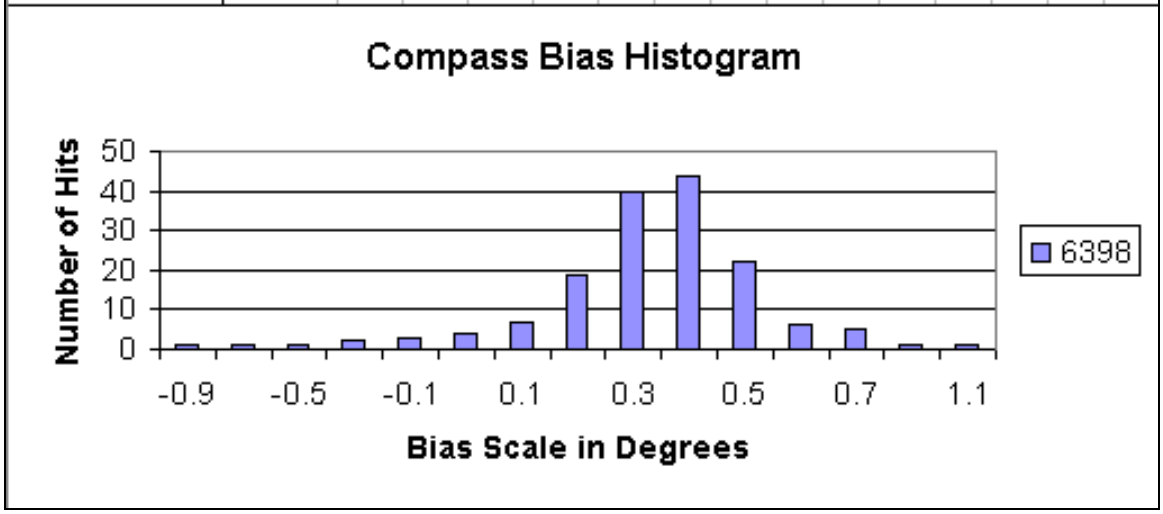
RU	1201				
Sum of COUNT	SCALE				
SER	-0.8	-0.7	-0.5	-0.3	0.8
15266	1	1	1	1	1



6: Compass s/n 15266.

- Compass 01 cable 02 serial number **15266** was not changed out during the survey as this is a front compass on the cable which can have a slightly higher than usual bias due to towing characteristics of the cable and is generally noisy. It had a mean bias of -0.675° in the 287° direction. This is a front compass on the cable and only five sequences shot with this compass in place. Five sequences is too smaller sample for good bias analysis. This compass will be monitored during the next survey.

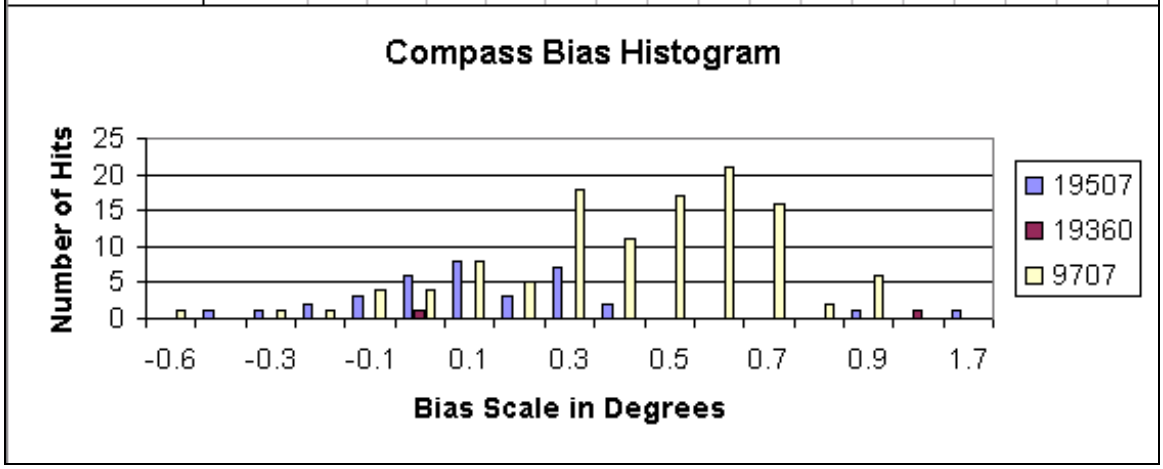
RU	1211														
Sum of COUNT	SCALE														
SER	-0.9	-0.6	-0.5	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.1
6398	1	1	1	2	3	4	7	19	40	44	22	6	5	1	1



7: Compass s/n 6398.

- Compass 11 cable 02 serial number **6398** was not changed out during the survey as it was had marginal high bias and was not reported till later in the survey. It had a mean bias of +0.558° in the 107° direction. This compass will be monitored during the next survey.

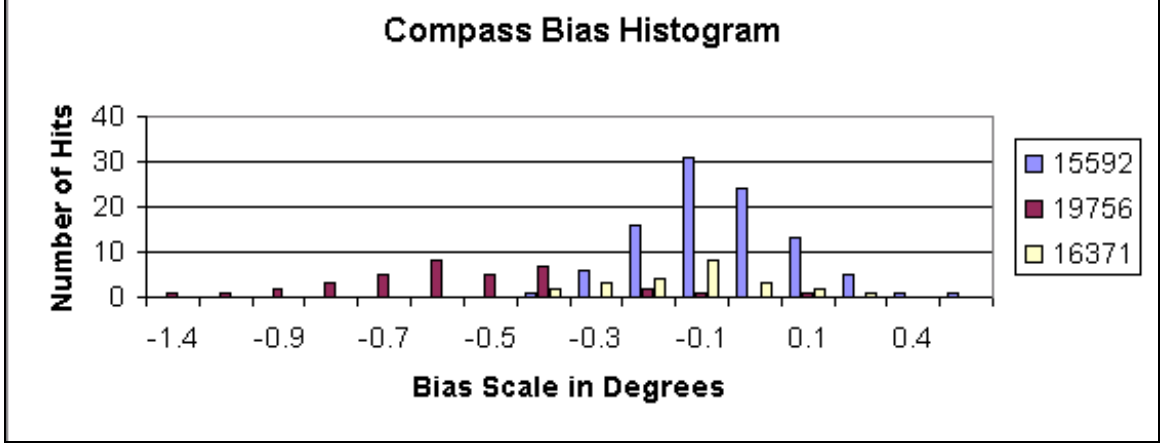
RU	1406																
Sum of COUNT	SCALE																
SER	-0.6	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.3	1.7
19507	0	1	1	2	3	6	8	3	7	2	0	0	0	0	1	0	1
19360	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
9707	1	0	1	1	4	4	8	5	18	11	17	21	16	2	6	0	0



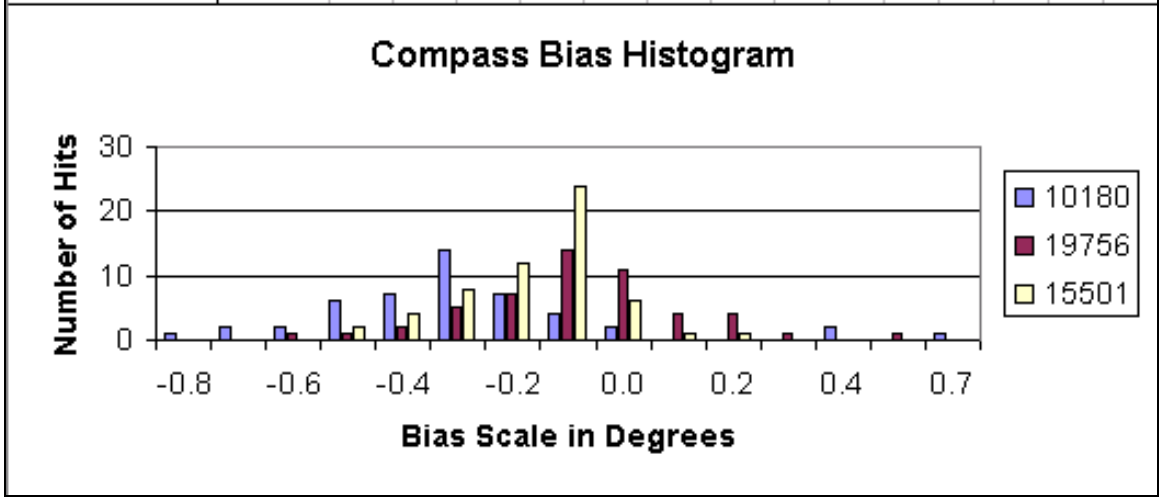
8: Compass s/n 9707.

- Compass 06 cable 04 serial number **9707** was on the cable for sequences 044-199. It had a mean bias of +0.60° in both the 107° and the 287° direction. It had a mean bias of +0.593° in a 107° direction and +0.605° in the 287° direction. Compass 19507 was on the cable at this location for sequences 001-043 and compass 19360 was at this location for sequences 200-212. This compass **9707** will be sent for re-calibration.

RU	1409															
Sum of COUNT	SCALE															
SER	-1.4	-1.1	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.4	1.2
15592	0	0	0	0	0	0	0	1	6	16	31	24	13	5	1	1
19756	1	1	2	3	5	8	5	7	0	2	1	0	1	0	0	0
16371	0	0	0	0	0	0	0	2	3	4	8	3	2	1	0	0



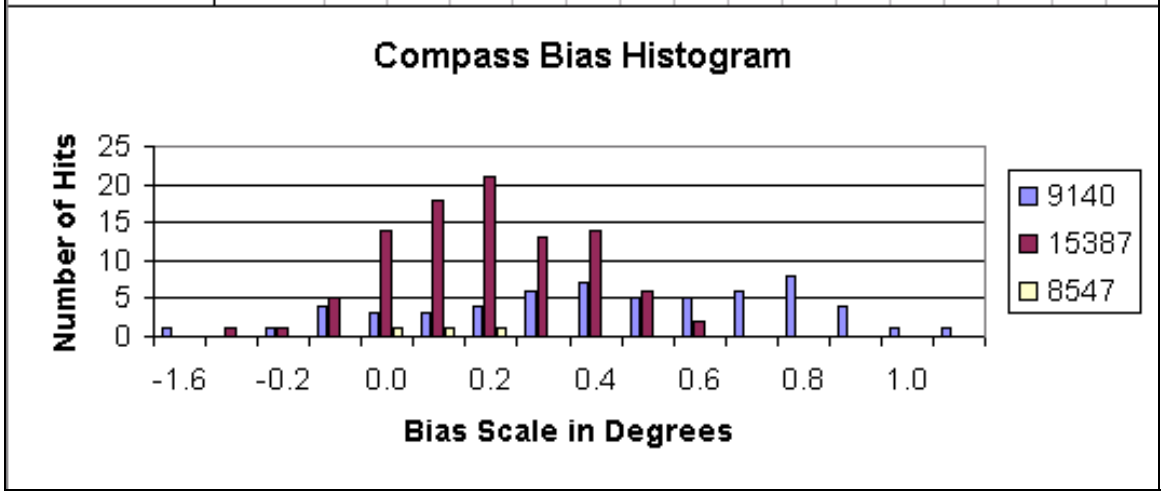
RU	1304														
Sum of COUNT	SCALE														
SER	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.7
10180	1	2	2	6	7	14	7	4	2	0	0	0	2	0	1
19756	0	0	1	1	2	5	7	14	11	4	4	1	0	1	0
15501	0	0	0	2	4	8	12	24	6	1	1	0	0	0	0



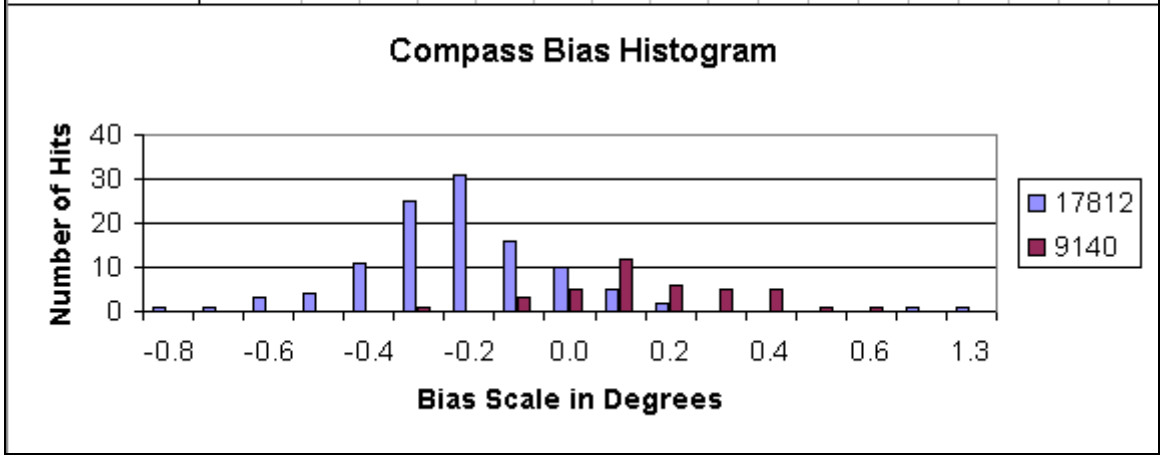
9: Compass s/n 19756.

- Compass 09 cable 04 serial number **19756** was on the cable for sequences 001-043. It was also Compass 04 cable 03 for sequences 135-212. This compass had been flagged for bias early in the survey and was taken off the cable before sequence 044. The compass was found to have a broken motor arm and loose screws holding the compass. The compass was repaired onboard and used later in the survey where it was found to work within specification. It is considered that there is no need for re-calibration for this compass.

RU	1501															
Sum of COUNT	SCALE															
SER	-1.6	-1.2	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
9140	1	0	1	4	3	3	4	6	7	5	5	6	8	4	1	1
15387	0	1	1	5	14	18	21	13	14	6	2	0	0	0	0	0
8547	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0



RU	1110															
Sum of COUNT	SCALE															
SER	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.9	1.3
17812	1	1	3	4	11	25	31	16	10	5	2	0	0	0	0	1	1
9140	0	0	0	0	0	1	0	3	5	12	6	5	5	1	1	0	0

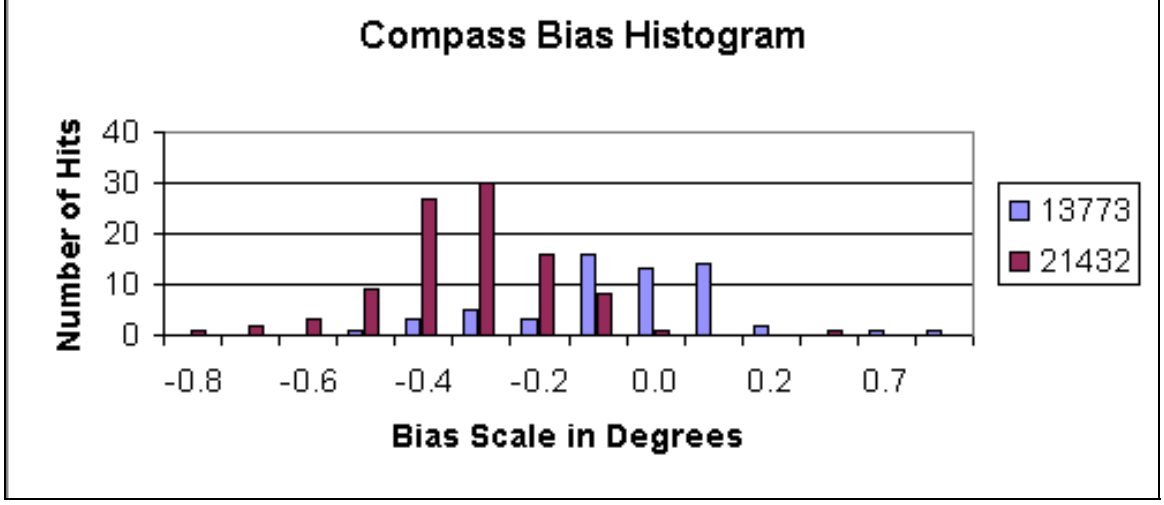


10: Compass s/n 9140.

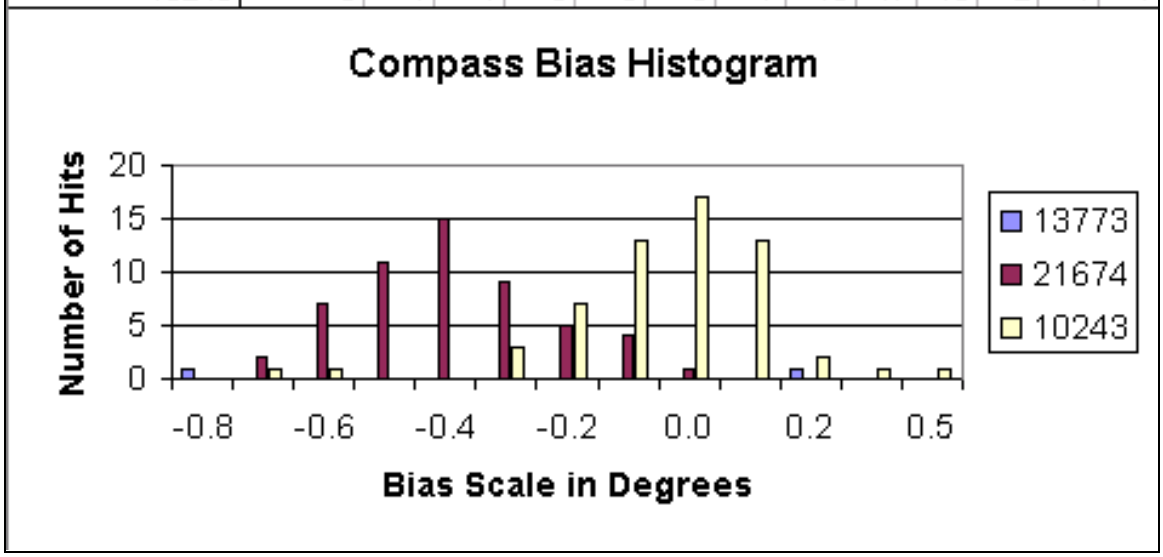
- Compass 01 cable 05 serial number **9140** was on the cable for sequences 001-078. It was also Compass 10 cable 01 for sequences 150-212. This compass had been flagged for bias while it was in the first location of cable 5. It had a bias of 0.533° in the 287°

direction. When used in location 10 cable 01 it had no mean bias over 0.5° and is to be considered to be working well within specification.

RU	1504													
Sum of COUNT	SCALE													
SER	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.4	0.7	0.9
13773	0	0	0	1	3	5	3	16	13	14	2	0	1	1
21432	1	2	3	9	27	30	16	8	1	0	0	1	0	0



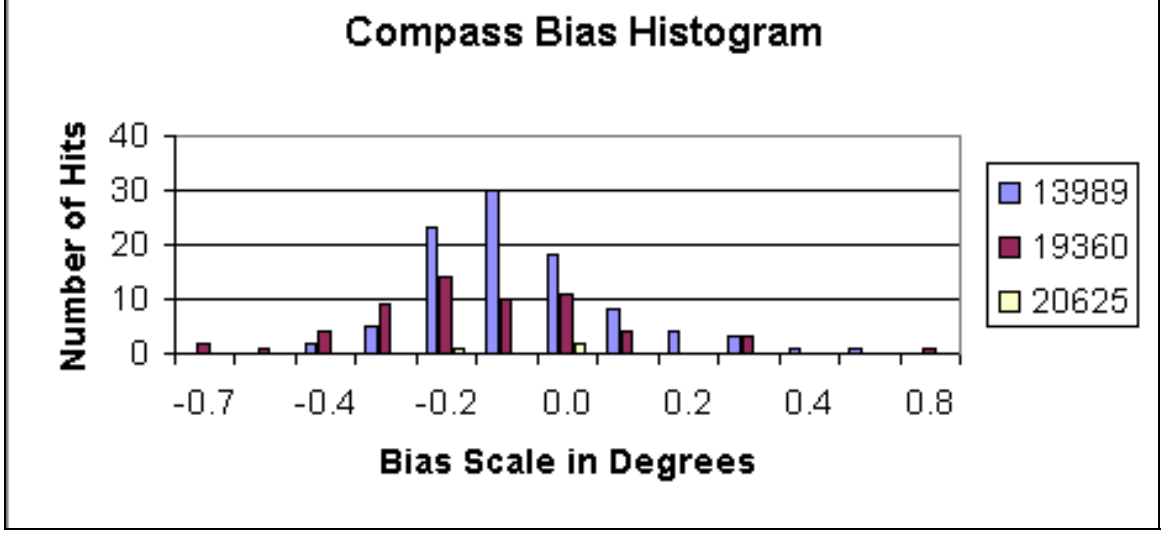
RU	1610												
Sum of COUNT	SCALE												
SER	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.4	0.5
13773	1	0	0	0	0	0	0	0	0	0	1	0	0
21674	0	2	7	11	15	9	5	4	1	0	0	0	0
10243	0	1	1	0	0	3	7	13	17	13	2	1	1



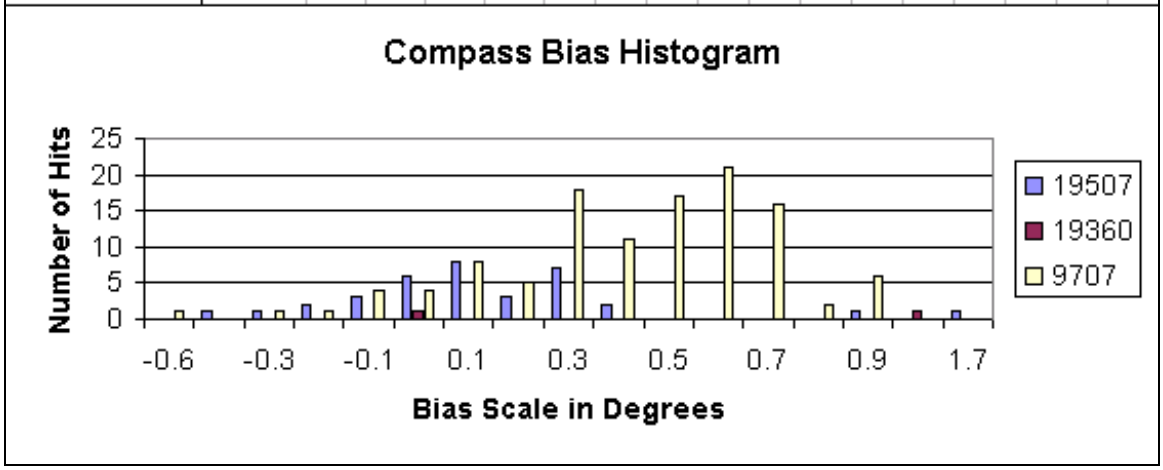
11: Compass s/n 13773.

- Compass 04 cable 05 serial number **13773** was on the cable for sequences 001-078. It was also Compass 10 cable 06 for sequences 200-212. This compass was not flagged for high bias while it was in location 4 cable 5 and was only flagged when used in location 10 cable 6. This is due to short lines and a small sample interval of only two sequences during later stages of the survey while small portions of infill and reshoots were being acquired. It is considered that the compass is working within a mean bias of +/-0.5° and there is no need for re-calibration.

RU	1518												
Sum of COUNT	SCALE												
SER	-0.7	-0.6	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.8
13989	0	0	2	5	23	30	18	8	4	3	1	1	0
19360	2	1	4	9	14	10	11	4	0	3	0	0	1
20625	0	0	0	0	1	0	2	0	0	0	0	0	0



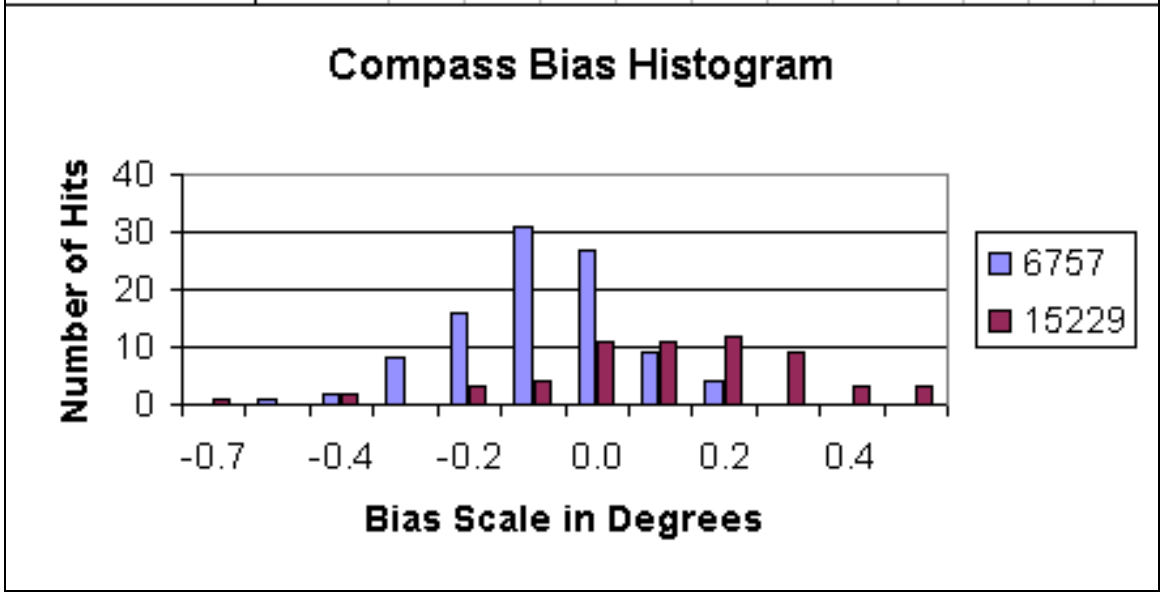
RU	1406																
Sum of COUNT	SCALE																
SER	-0.6	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.3	1.7
19507	0	1	1	2	3	6	8	3	7	2	0	0	0	0	1	0	1
19360	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
9707	1	0	1	1	4	4	8	5	18	11	17	21	16	2	6	0	0



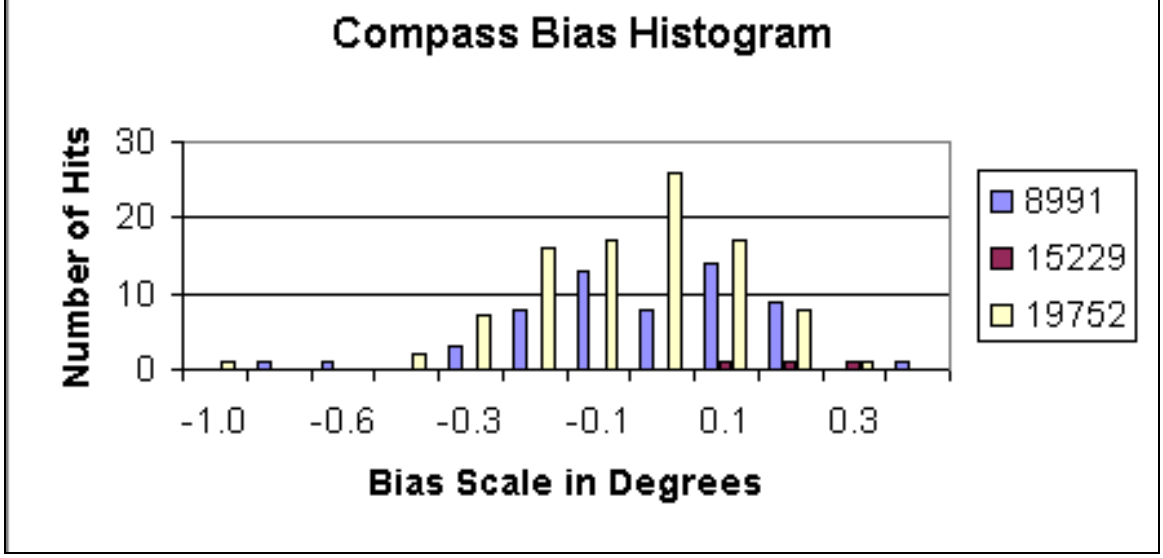
12: Compass s/n 19360.

- Compass 18 cable 05 serial number **19360** was on the cable for sequences 001-078. It was also Compass 06 cable 04 for sequences 200-212. This compass was not flagged for high bias while it was in location 18 cable 05 and was only flagged when used in location 06 cable 4. This is due to short lines and a small sample interval of only two sequences during later stages of the survey while small portions of infill and reshoots were being acquired. It is considered that the compass is working within a mean bias of +/-0.5° and there is no need for re-calibration.

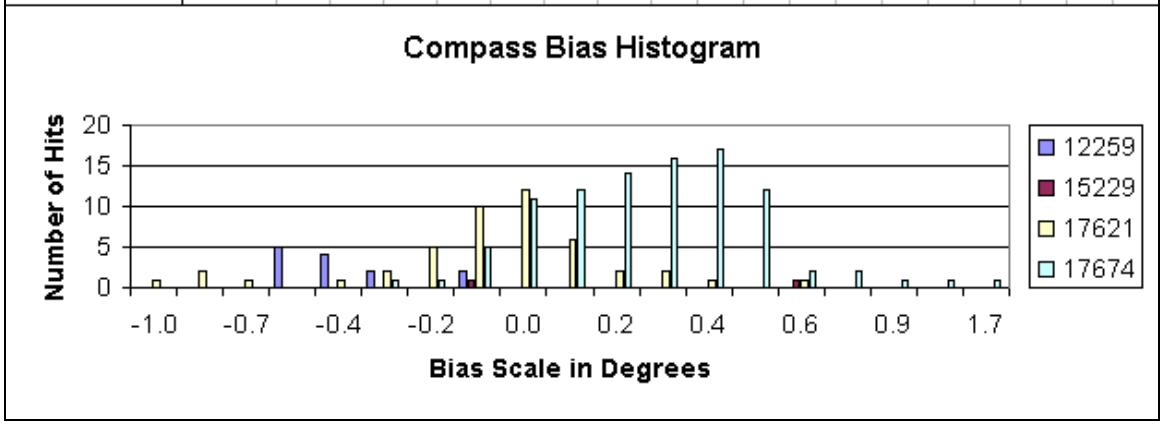
RU	1602											
Sum of COUNT	SCALE											
SER	-0.7	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5
6757	0	1	2	8	16	31	27	9	4	0	0	0
15229	1	0	2	0	3	4	11	11	12	9	3	3



RU	1502											
Sum of COUNT	SCALE											
SER	-1.0	-0.8	-0.6	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.5
8991	0	1	1	0	3	8	13	8	14	9	0	1
15229	0	0	0	0	0	0	0	0	1	1	1	0
19752	1	0	0	2	7	16	17	26	17	8	1	0



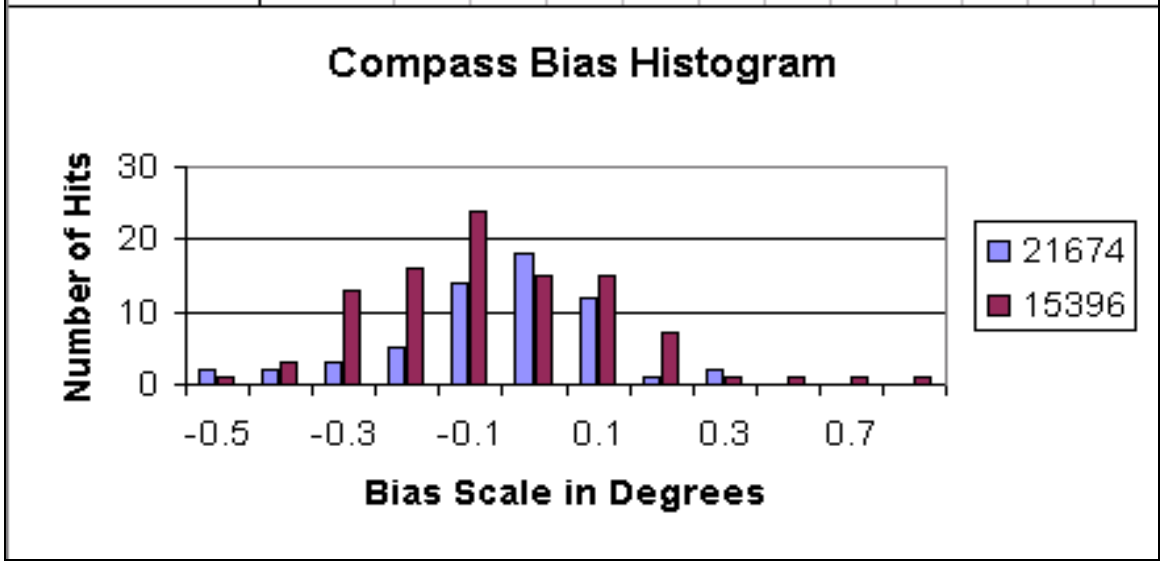
RU	1608																		
Sum of COUNT	SCALE																		
SER	-1.0	-0.8	-0.7	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.7
12259	0	0	0	5	4	2	0	2	0	0	0	0	0	0	0	0	0	0	0
15229	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
17621	1	2	1	0	1	2	5	10	12	6	2	2	1	0	1	0	0	0	0
17674	0	0	0	0	0	1	1	5	11	12	14	16	17	12	2	2	1	1	1



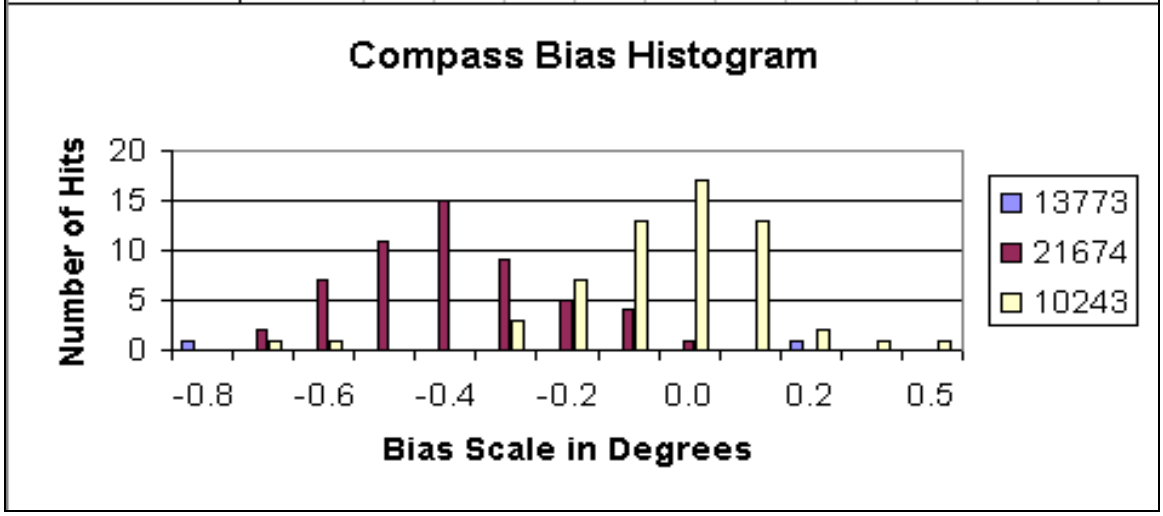
13: Compass s/n 15229.

- Compass 02 cable 06 serial number **15229** was on the cable for sequences 001-078. It was also Compass 02 cable 05 for sequences 079-084 due to reconfiguration from 8 cables to 7 cables. This compass was used later in the survey at location 08 cable 6 for sequences 200-212. This compass was not flagged for high bias while it was in location 02 cable 05 or cable 6 and was only flagged when used in location 08 cable 6. This is due to short lines and a small sample interval of only two sequences during later stages of the survey while small portions of infill and reshoots were being acquired. It is considered that the compass is working within a mean bias of +/-0.5° and there is no need for re-calibration.

RU	1710											
Sum of COUNT	SCALE											
SER	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.7	0.9
21674	2	2	3	5	14	18	12	1	2	0	0	0
15396	1	3	13	16	24	15	15	7	1	1	1	1



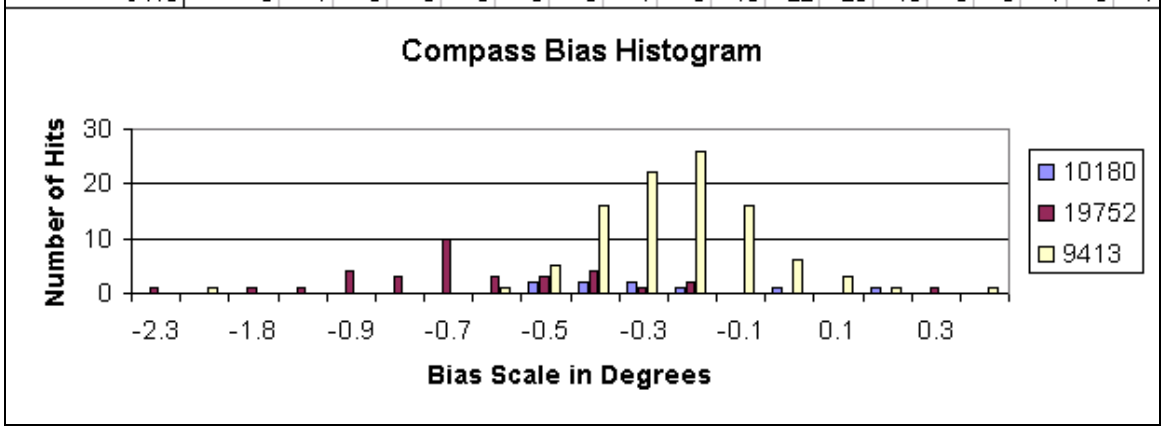
RU	1610												
Sum of COUNT	SCALE												
SER	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.4	0.5
13773	1	0	0	0	0	0	0	0	0	0	1	0	0
21674	0	2	7	11	15	9	5	4	1	0	0	0	0
10243	0	1	1	0	0	3	7	13	17	13	2	1	1



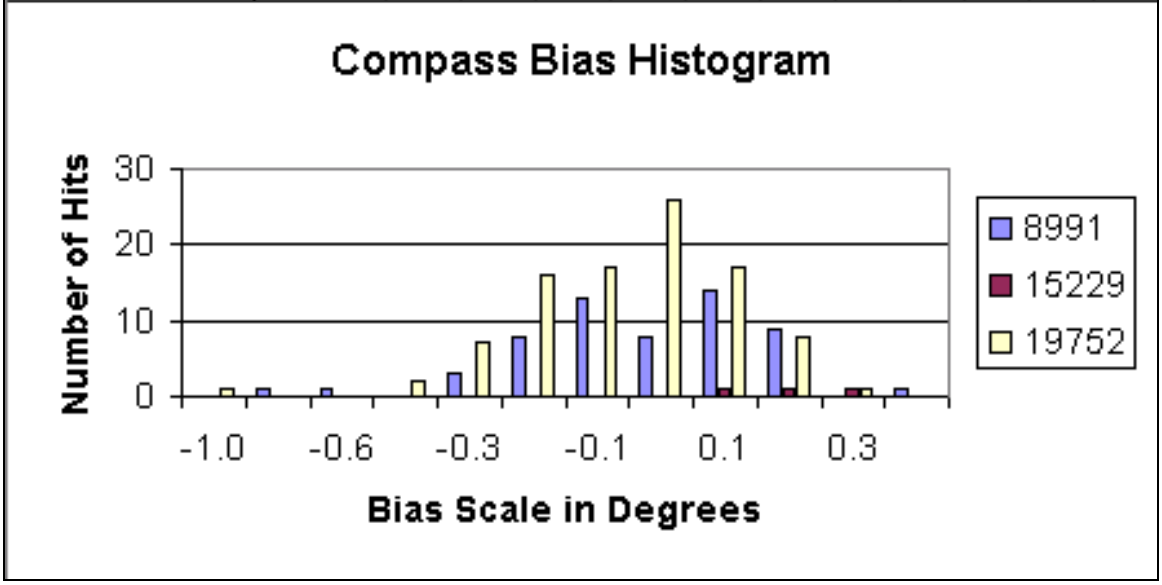
14: Compass s/n 21674.

- Compass 10 cable 07 serial number **21674** was on the cable for sequences 001-078. It was also Compass 10 cable 06 for sequences 079-199 due to reconfiguration from 8 cables to 7 cables. This compass was not flagged for high bias while it was in location 10 cable 07 and as can be observed from the histograms above the bell shaped curve seems to have shifted towards a bias of –0.503 which is just outside the mean bias limit of +/- 0.5°. This compass needs to be monitored during the next survey.

RU	1714																	
Sum of COUNT	SCALE																	
SER	-2.3	-1.9	-1.8	-1.2	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.5
10180	0	0	0	0	0	0	0	0	2	2	2	1	0	1	0	1	0	0
19752	1	0	1	1	4	3	10	3	3	4	1	2	0	0	0	0	1	0
9413	0	1	0	0	0	0	0	1	5	16	22	26	16	6	3	1	0	1



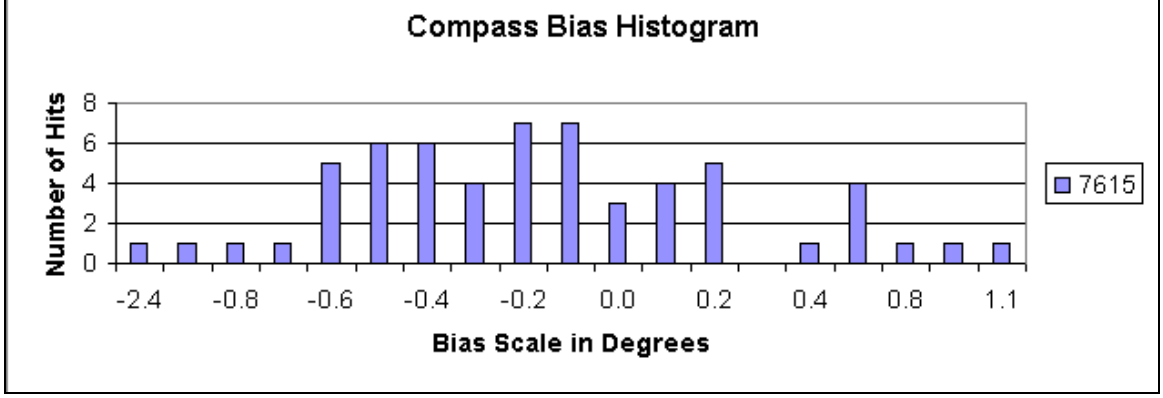
RU	1502											
Sum of COUNT	SCALE											
SER	-1.0	-0.8	-0.6	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.5
8991	0	1	1	0	3	8	13	8	14	9	0	1
15229	0	0	0	0	0	0	0	0	1	1	1	0
19752	1	0	0	2	7	16	17	26	17	8	1	0



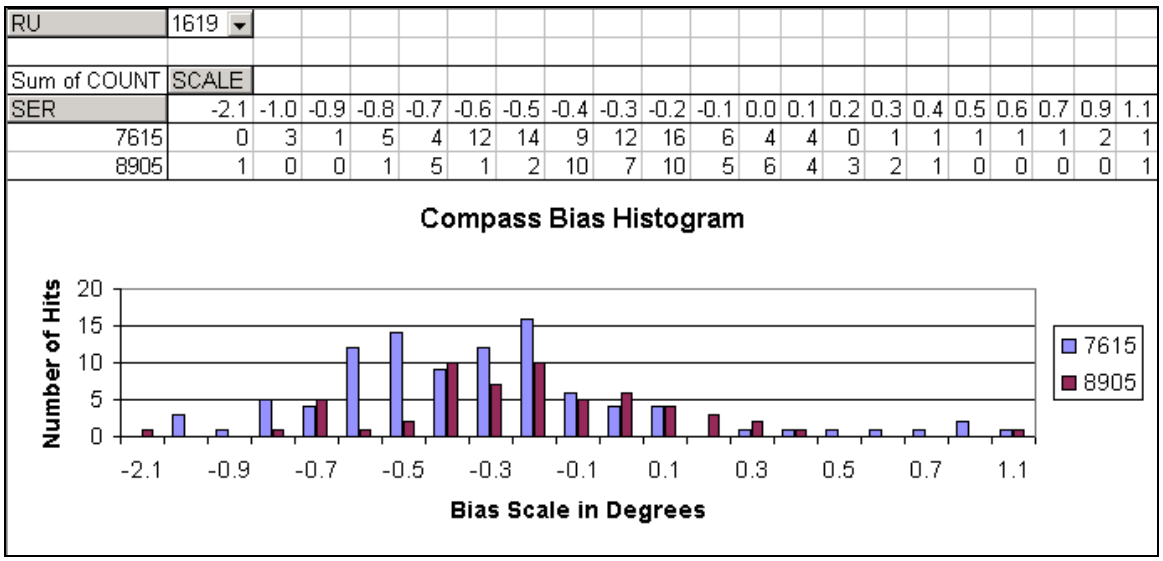
15: Compass s/n 19752.

- Compass 14 cable 07 serial number **19752** was on the cable for sequences 001-064 when it was removed for reported mean bias of –0.65°. It had a mean bias of –0.549° in a 107° direction and a mean bias of –0.756° in a 287° direction. When the compass was removed from the cable it was reported that it had a broken aft collar. It was also Compass 02 cable 05 for sequences 085-212, which has no mean bias over the +/-0.5°. This compass is considered to be functioning within specifications and no need for re-calibration.

RU	1719																		
Sum of COUNT	SCALE																		
SER	-2.4	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.7	0.8	1.0	1.1
7615	1	1	1	1	5	6	6	4	7	7	3	4	5	0	1	4	1	1	1



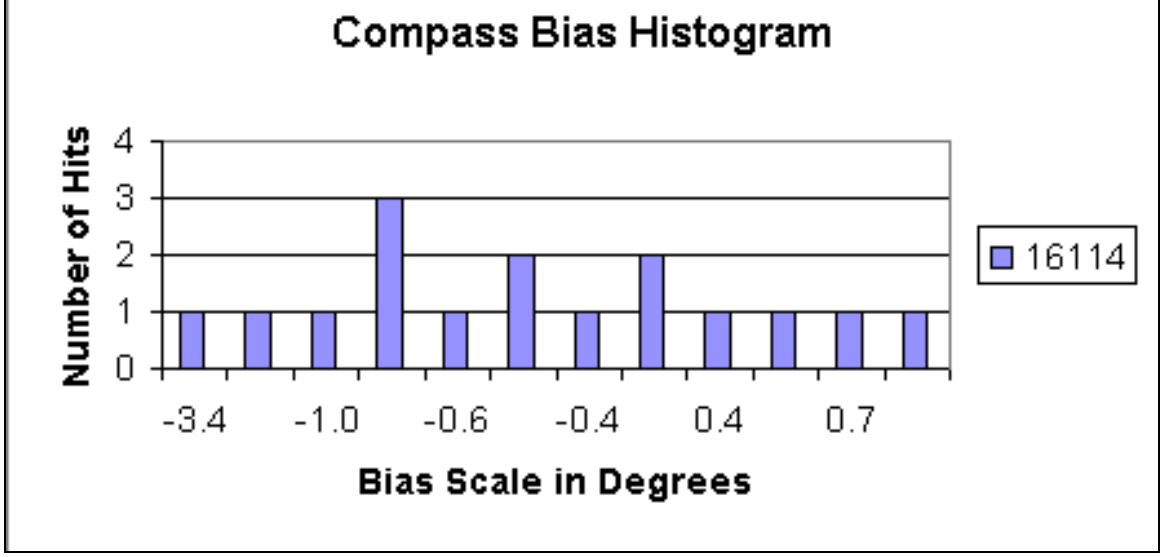
RU	1619																				
Sum of COUNT	SCALE																				
SER	-2.1	-1.0	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.1
7615	0	3	1	5	4	12	14	9	12	16	6	4	4	0	1	1	1	1	1	2	1
8905	1	0	0	1	5	1	2	10	7	10	5	6	4	3	2	1	0	0	0	0	1



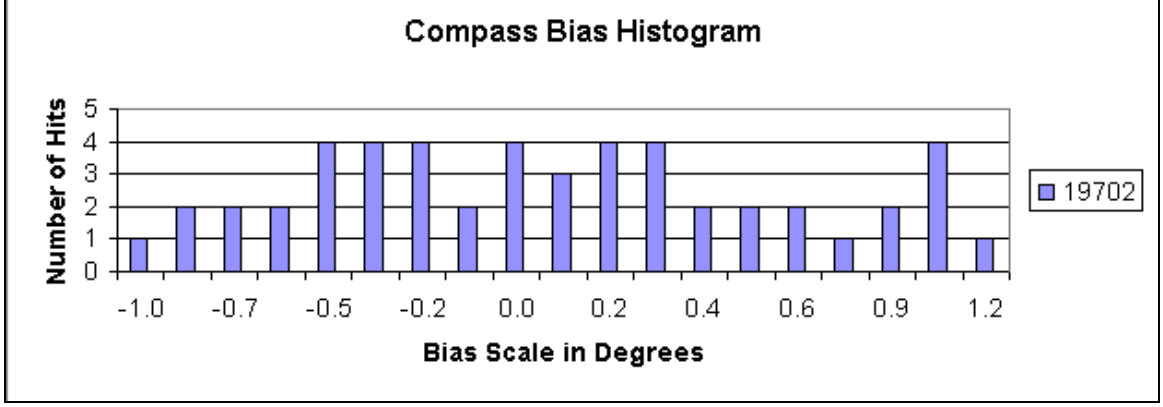
16: Compass s/n 7615.

- Compass 19 cable 07 serial number **7615** was on the cable for sequences 001-078. It was also Compass 19 cable 06 for sequences 079-212, due to reconfiguration from 8 cables to 7 cables. This compass was not changed out during the survey as this is a tail compass on the cable which can have a slightly higher than usual bias due to towing characteristics of the tailbuoy.

RU	1801											
Sum of COUNT	SCALE											
SER	-3.4	-1.1	-1.0	-0.7	-0.6	-0.5	-0.4	0.3	0.4	0.6	0.7	0.9
16114	1	1	1	3	1	2	1	2	1	1	1	1



RU	1701																		
Sum of COUNT	SCALE																		
SER	-1.0	-0.8	-0.7	-0.6	-0.5	-0.4	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.1	1.2
19702	1	2	2	2	4	4	4	2	4	3	4	4	2	2	2	1	2	4	1



6: Compass s/n 16114.

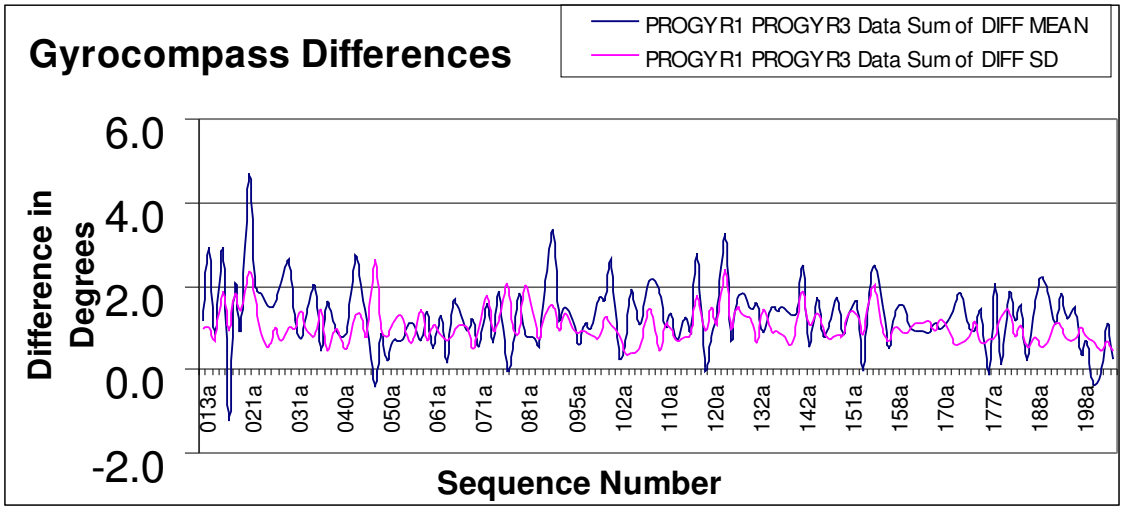
- Compass 01 cable 08 serial number **16114** was on the cable for sequences 001-078. It was also Compass 01 cable 07 for sequences 079-212, due to reconfiguration from 8 cables to 7 cables. This compass was not changed out during the survey as this is a front compass on the cable which can have a slightly higher than usual bias due to towing characteristics of the cable.

Conclusion:

Of the 165 compasses used by the Monarch over the ExxonMobil Tuskfish 3D Survey period of this report six compasses were out of specification when compared in both directions. A further seven compasses were noted to have a high bias in one direction only.

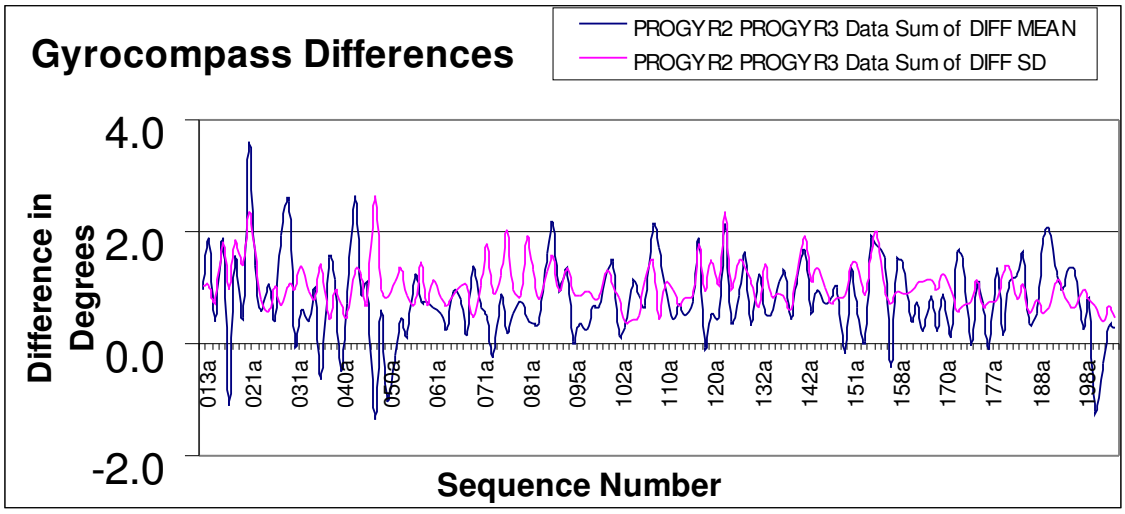
The results for this survey may be a little misleading due to the reconfiguration from 8 cables to 7 cables at sequence 079. Cable 5 was brought onboard for the reconfiguration to 7 cables.

One compass (serial number 9707) will be shipped for re-calibration. All other compasses within the spread will continue to be monitored.



2: Difference plot between Gyro 1 and 3.

Average difference between Gyro 1 and PosNet gyro is 1.3°. Standard deviation is also higher than between the two standard gyros.



3: Difference plot between Gyro 2 and 3.

Average difference between Gyro 2 and PosNet gyro is 0.8°.

The PosNet gyro responds instantaneously to changes in ships direction, and is affected by changes in satellite geometry and atmospheric effects. The standard deviations of the differences between either gyrocompass and a PosNet gyro is normally higher than between two gyrocompasses. Over the period of this report the standard deviations of the differences are around 1.0°.

Conclusion:

Both Gyrocompasses 1 and 2 have been relatively stable during the entire survey.

Gyro Calibration Results:

Results from Onshore Gyro Calibration and GPS Health Check

Surveying service were provided by Thales Geosolutions (Australasia) Limited (thales) for calibration of three gyrocompasses and confirmation of Differential GPS onboard the Western Monarch for WesternGeco. Services were provided whilst the Western Monarch was moored alongside Victoria Dock, Melbourne on the 23rd of December 2002.

The results of the preliminary checks and calibrations are summarised below:

This report details the surveying services provided by Thales GeoSolutions (Australasia) Limited (Thales) for WesternGeco while the seismic vessel Western Monarch was alongside Berth 24 Victoria Dock, Melbourne, Australia.

Observations were undertaken to calibrate the vessel's gyrocompasses and carry out Static Differential GPS checks between 0800 and 1500 on 22 December 2002.

The results of the calibrations and checks are summarised below:

A. Gyrocompass Calibration Results

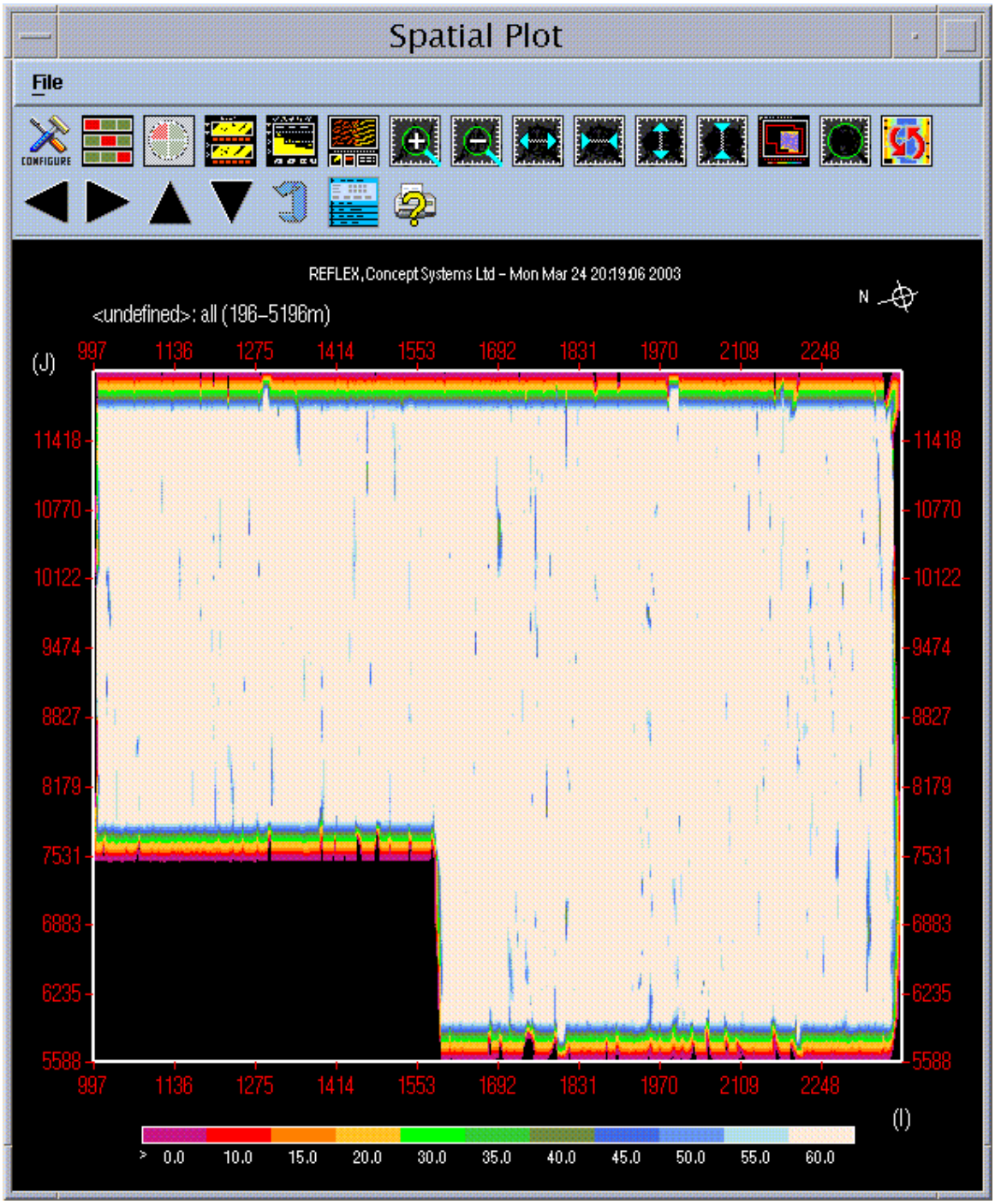
	Mean C-O
Primary Sperry 227 (S/N 488)	: +0.30°
Secondary Sperry 227 (S/N 470)	: +0.54°
POSNET Gyrocompass C-O	: +0.38°

B. Differential GPS Check Results

	Mean Linear Misclose
Multifix 1	: 0.54m
Multifix 2	: 0.40m
CNav 1	: 1.44m
POSNET 1	: 1.34m
POSNET 2	: 0.68m

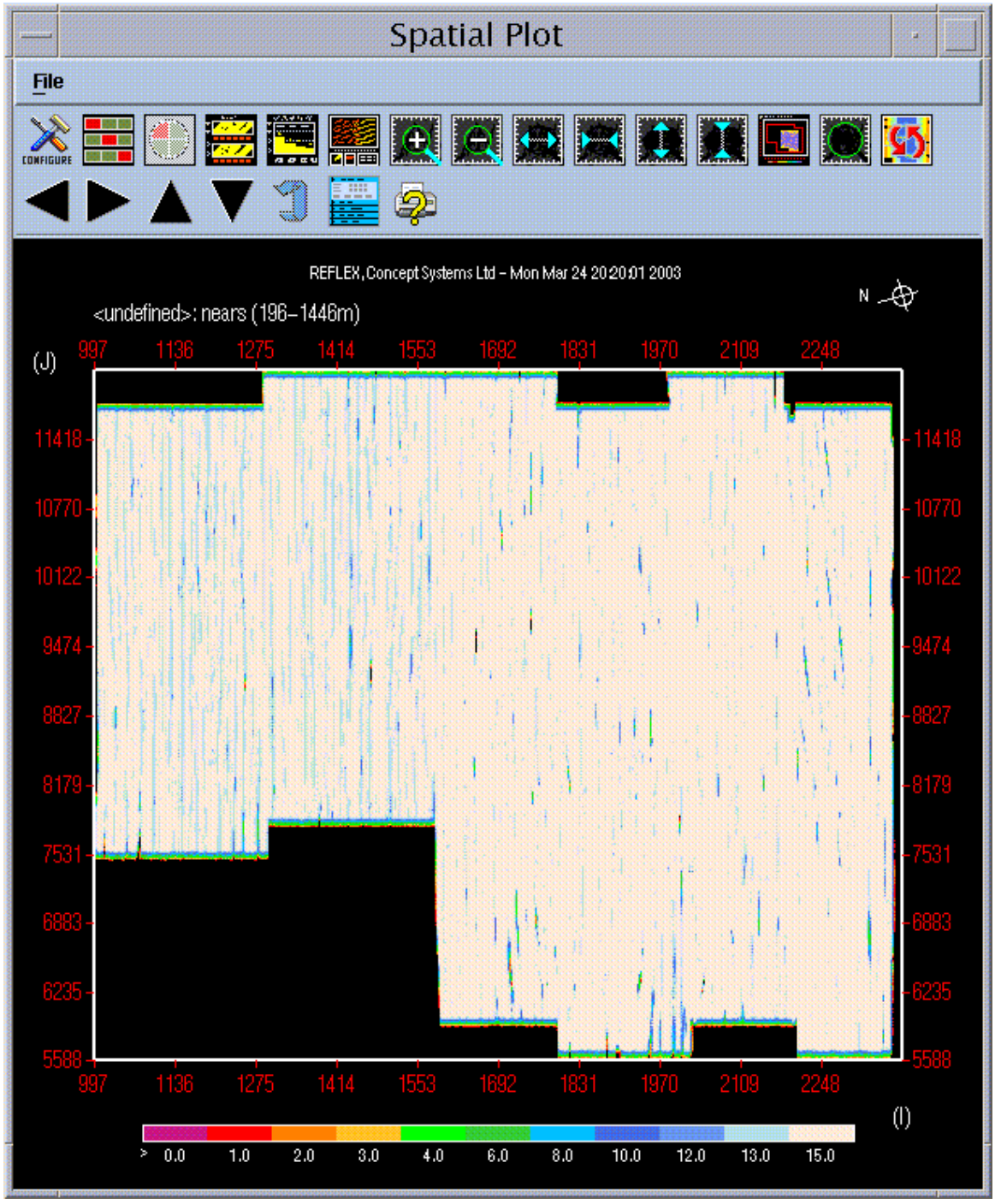
Exhibit 4 **: Coverage Maps**

Flex All

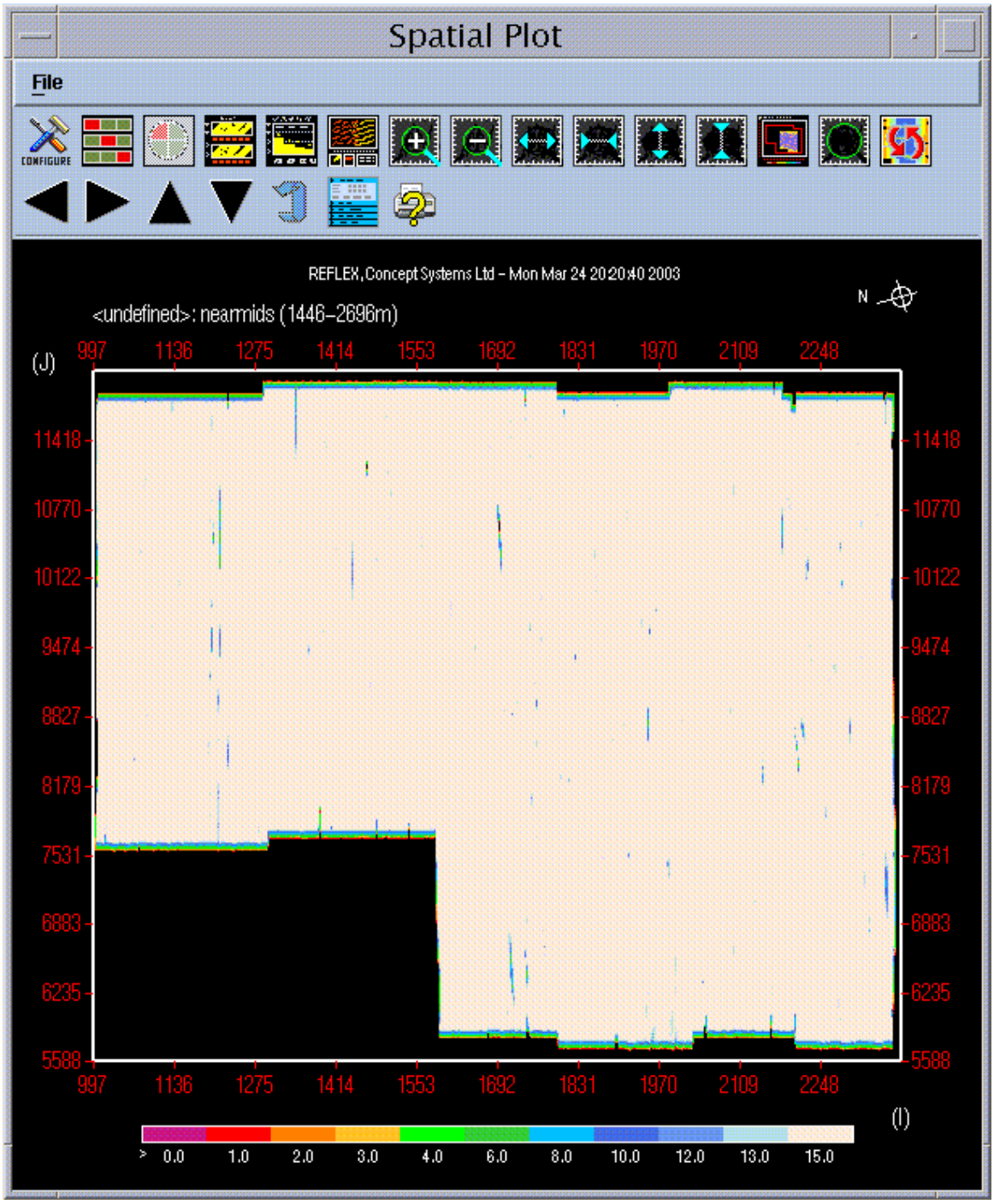


20.1.

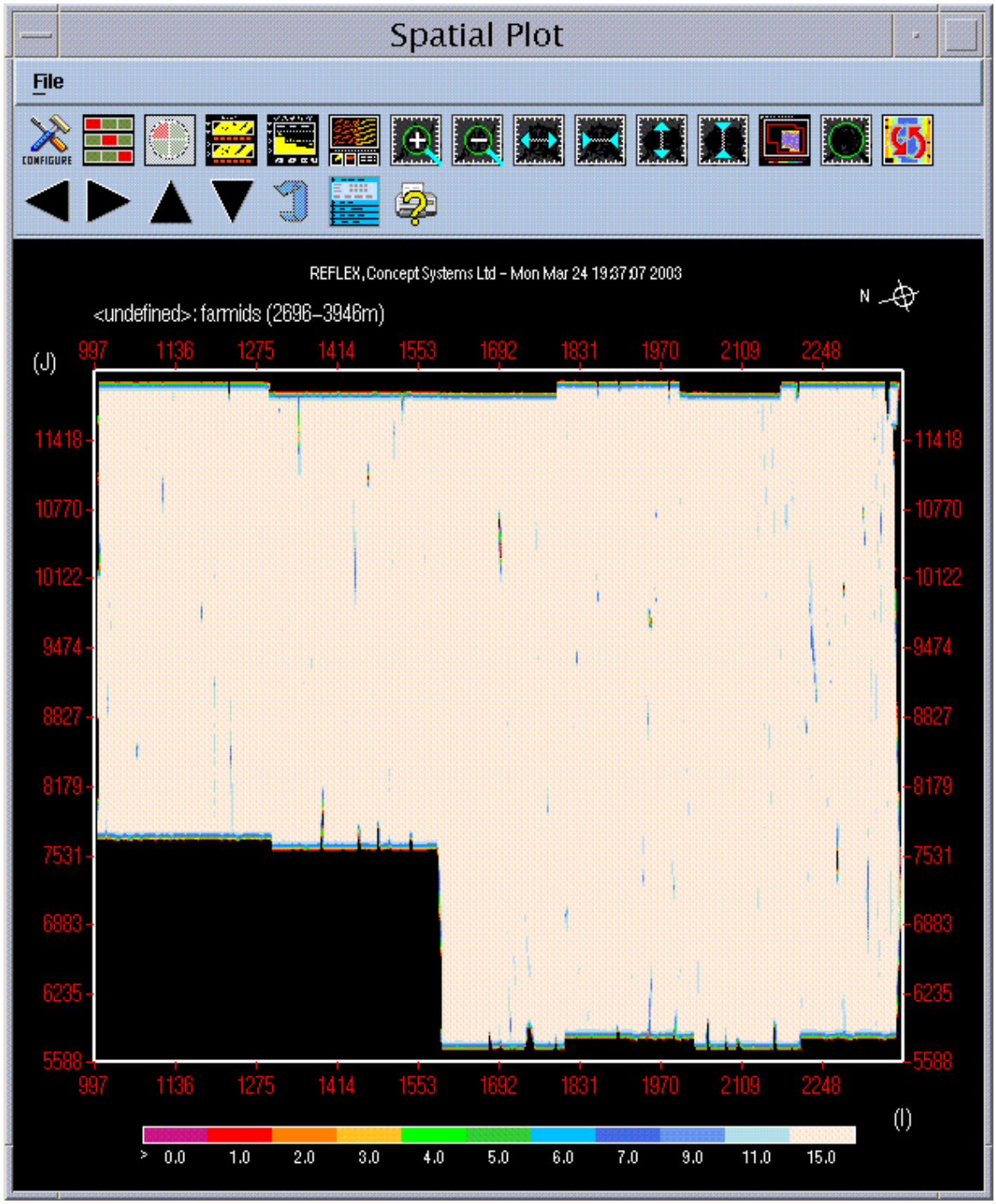
Flex Nears



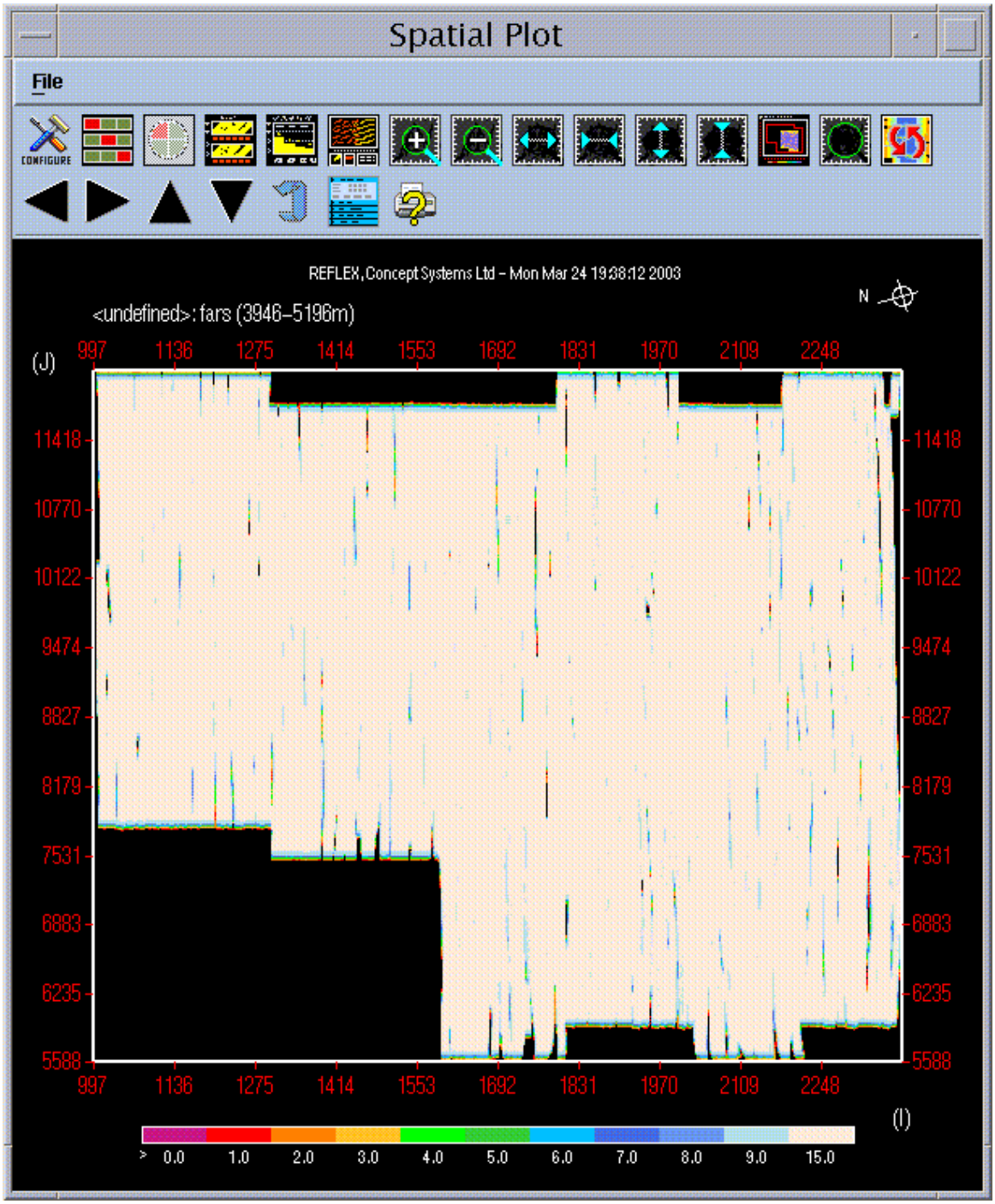
Flex Near Mids



Flex Far Mids


Spatial Plot
File
CONFIGURE
REFLEX, Concept Systems Ltd - Mon Mar 24 19:37:07 2003
<undefined>: farmids (2696-3946m)
N
(J)
997
1136
1275
1414
1553
1692
1831
1970
2109
2248
11418
10770
10122
9474
8827
8179
7531
6883
6235
5588
(I)
> 0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
9.0
11.0
15.0

Flex Fars


Spatial Plot
File
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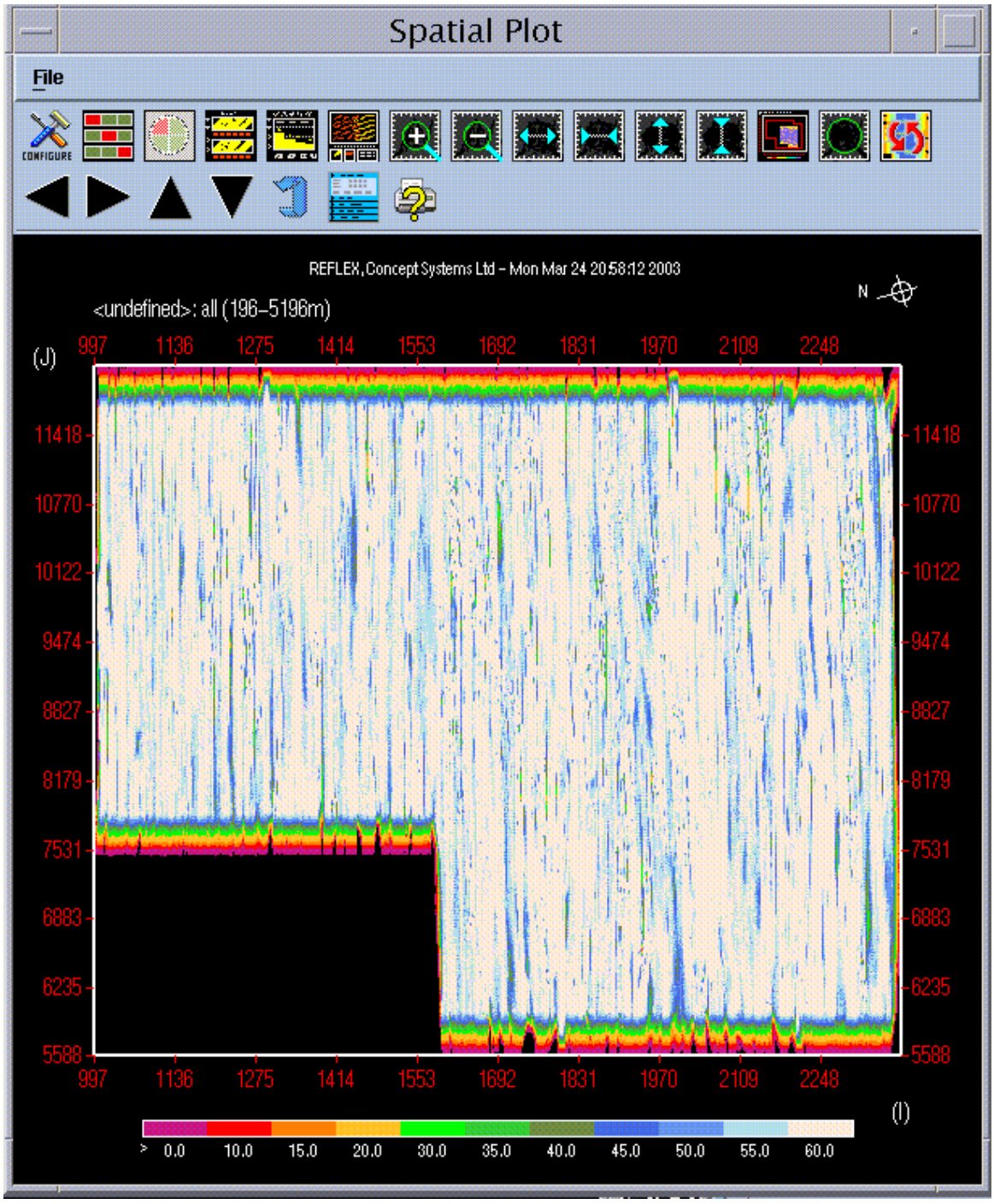
N
(J)
997
1136
1275
1414
1553
1692
1831
1970
2109
2248
11418
10770
10122
9474
8827
8179
7531
6883
6235
5588
(I)
> 0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
15.0

No Flex Alls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File
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(J)
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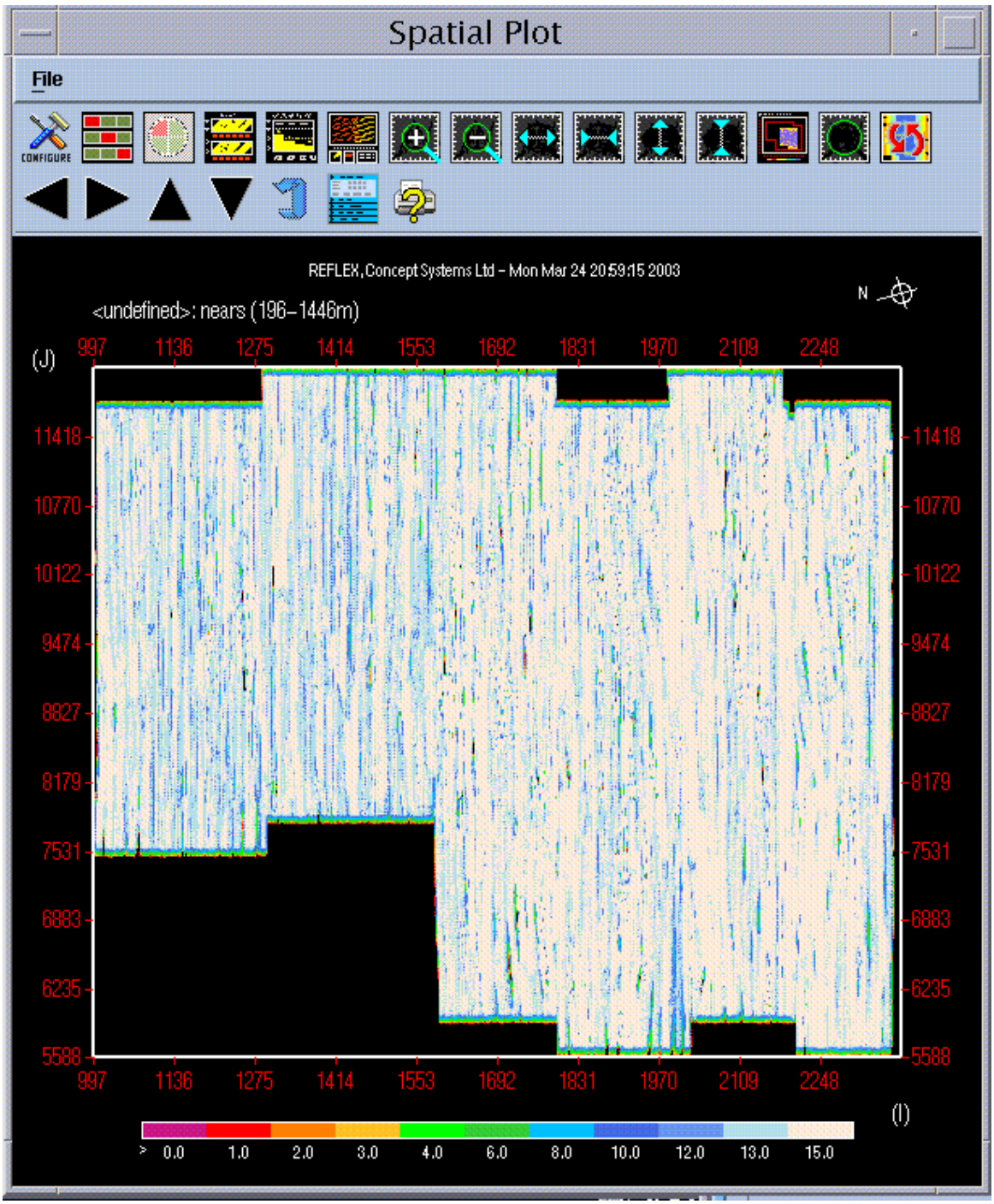
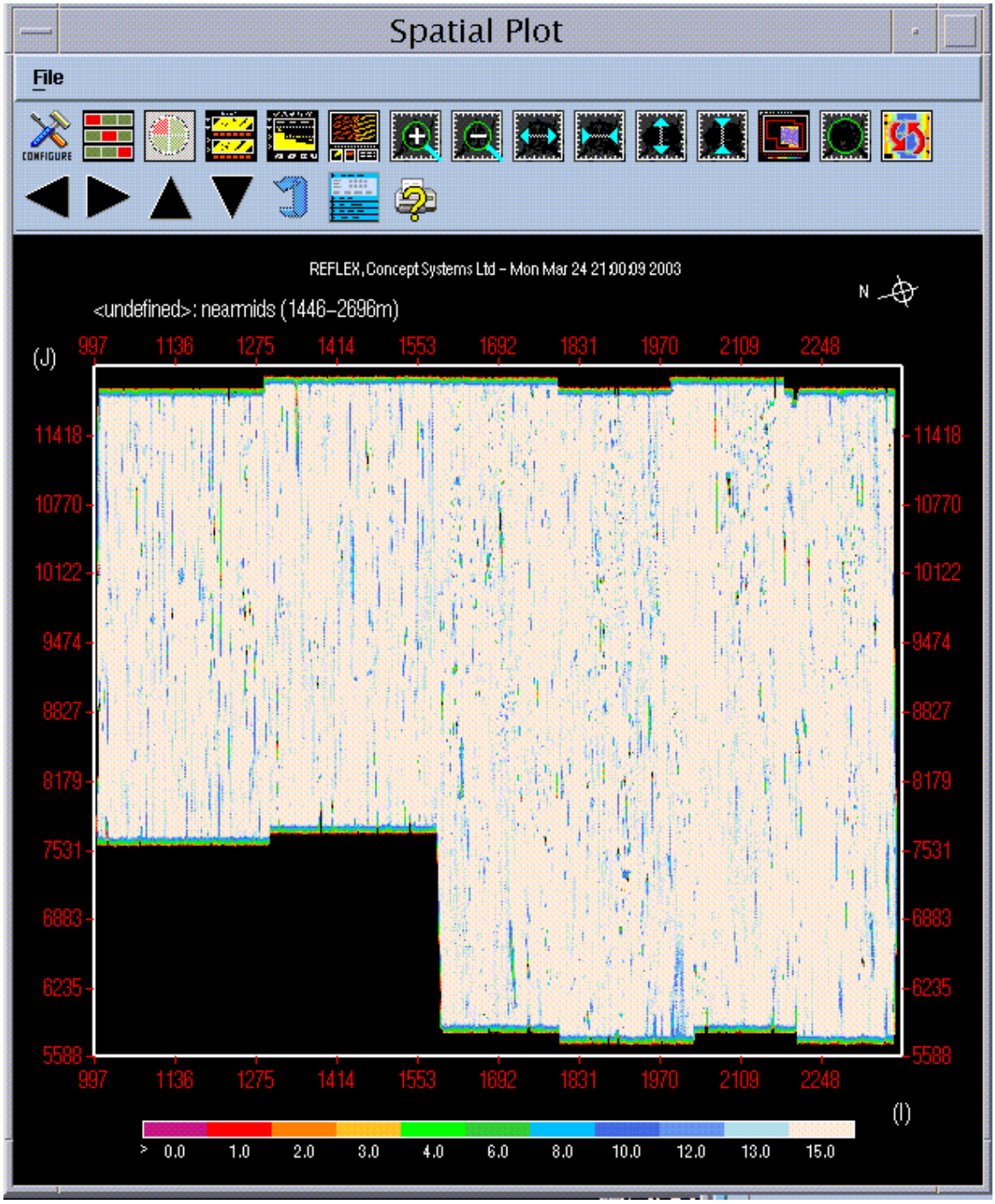
1136
1275
1414
1553
1692
1831
1970
2109
2248
11418
10770
10122
9474
8827
8179
7531
6883
6235
5588
(I)
> 0.0
10.0
15.0
20.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0

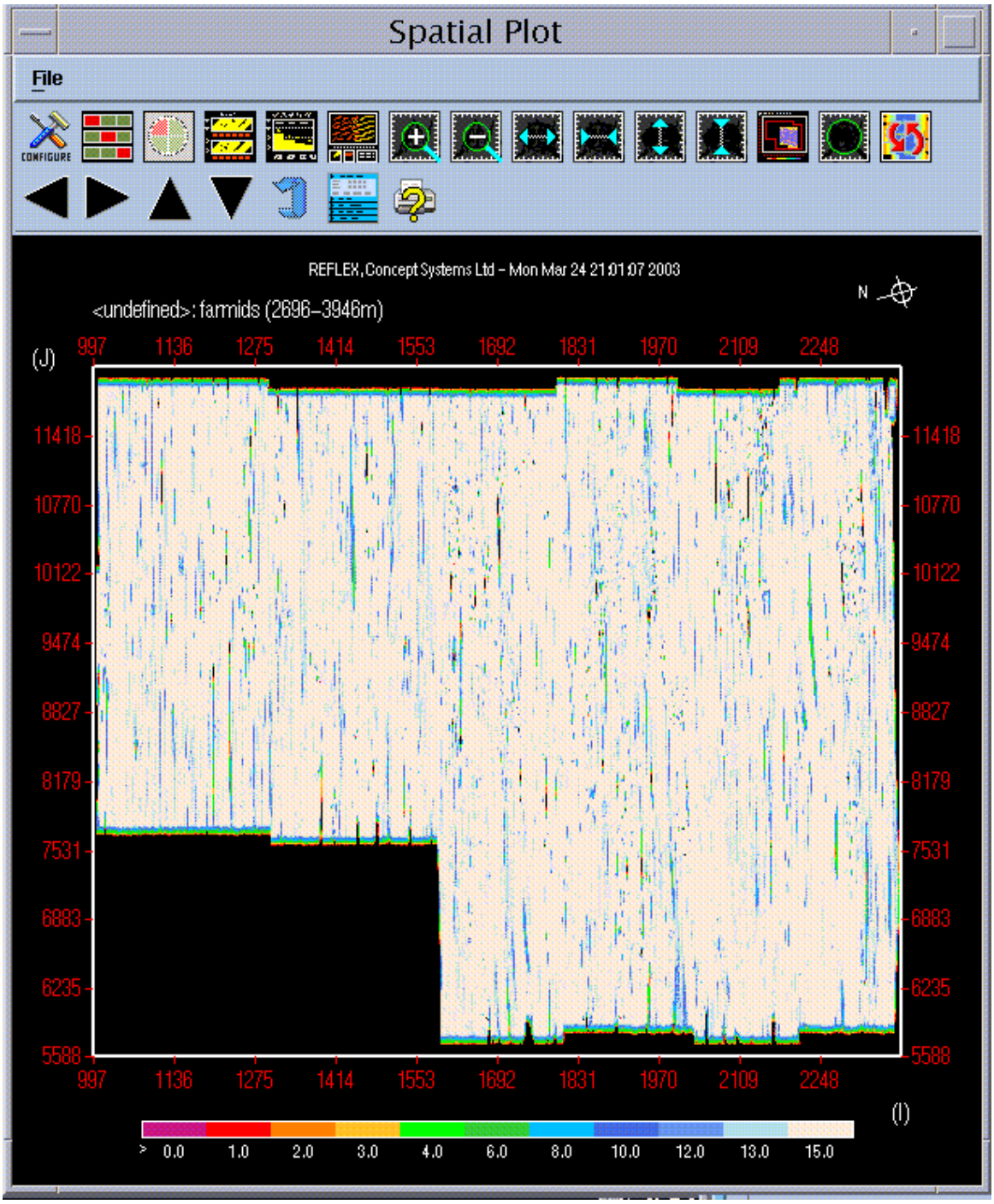
No Flex Nears



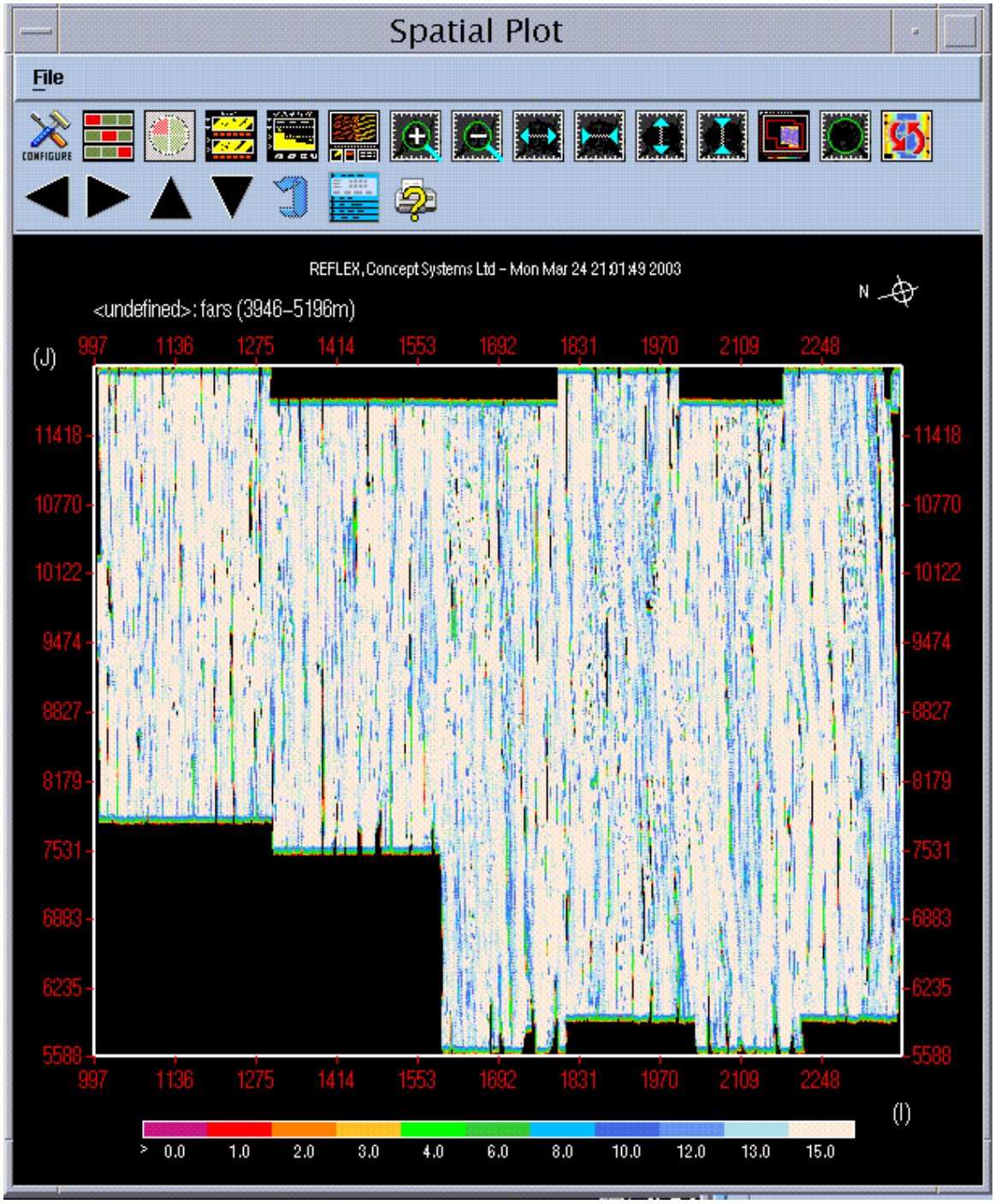
No Flex Nears Mids



No Flex Far Mids



No Flex Fars


Spatial Plot
File
CONFIGURE
REFLEX, Concept Systems Ltd - Mon Mar 24 21:01:49 2003
N
<undefined>: fars (3946-5196m)
(J)
997
1136
1275
1414
1553
1692
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10122
9474
8827
8179
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> 0.0
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2.0
3.0
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6.0
8.0
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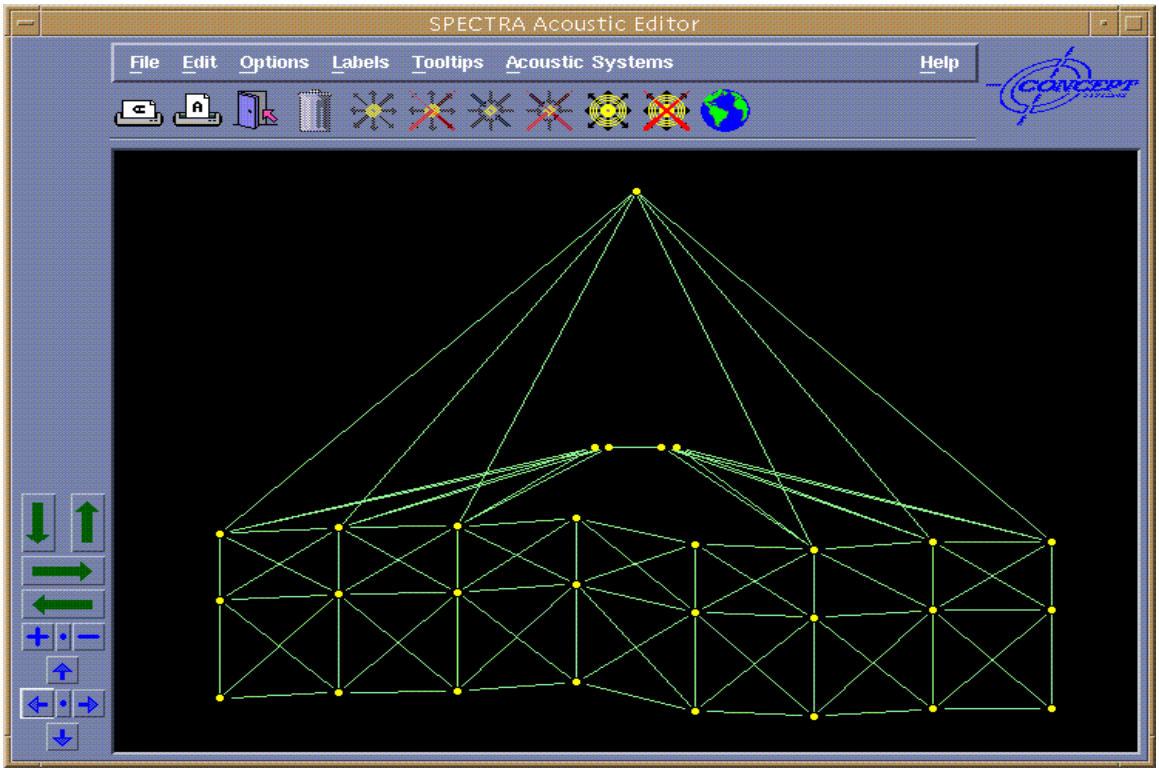
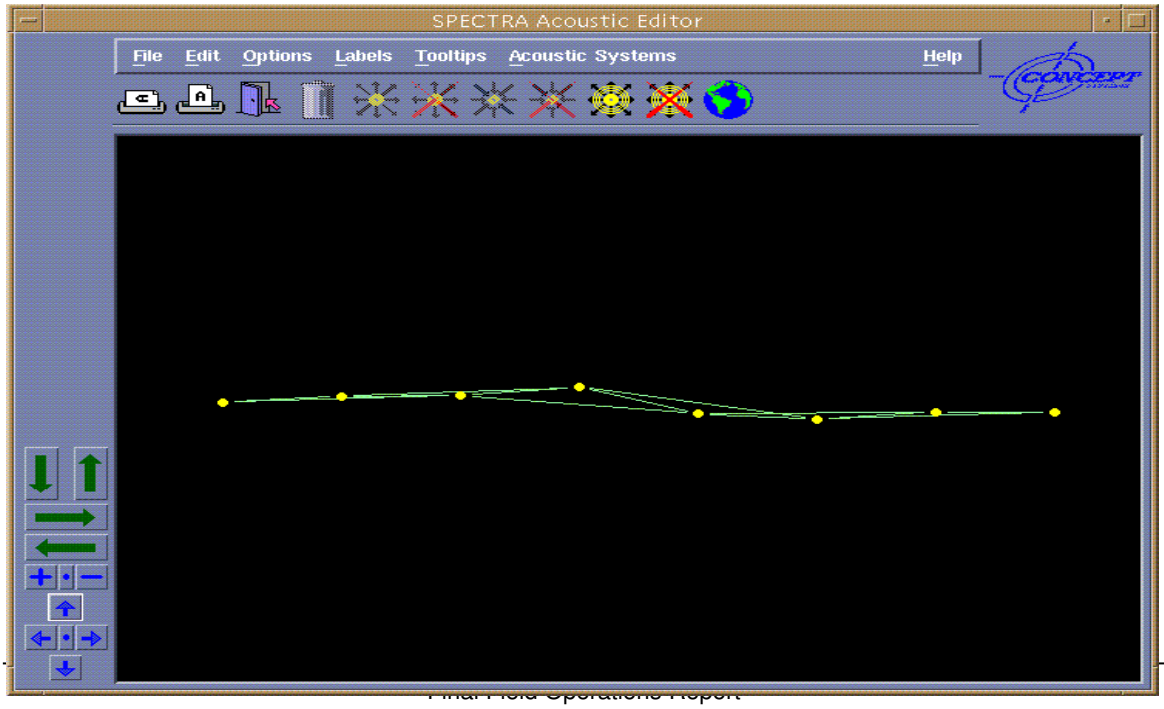
12.0
13.0
15.0

Exhibit 5 **: Acoustic Range System**

Front network



\mid network



\tail network

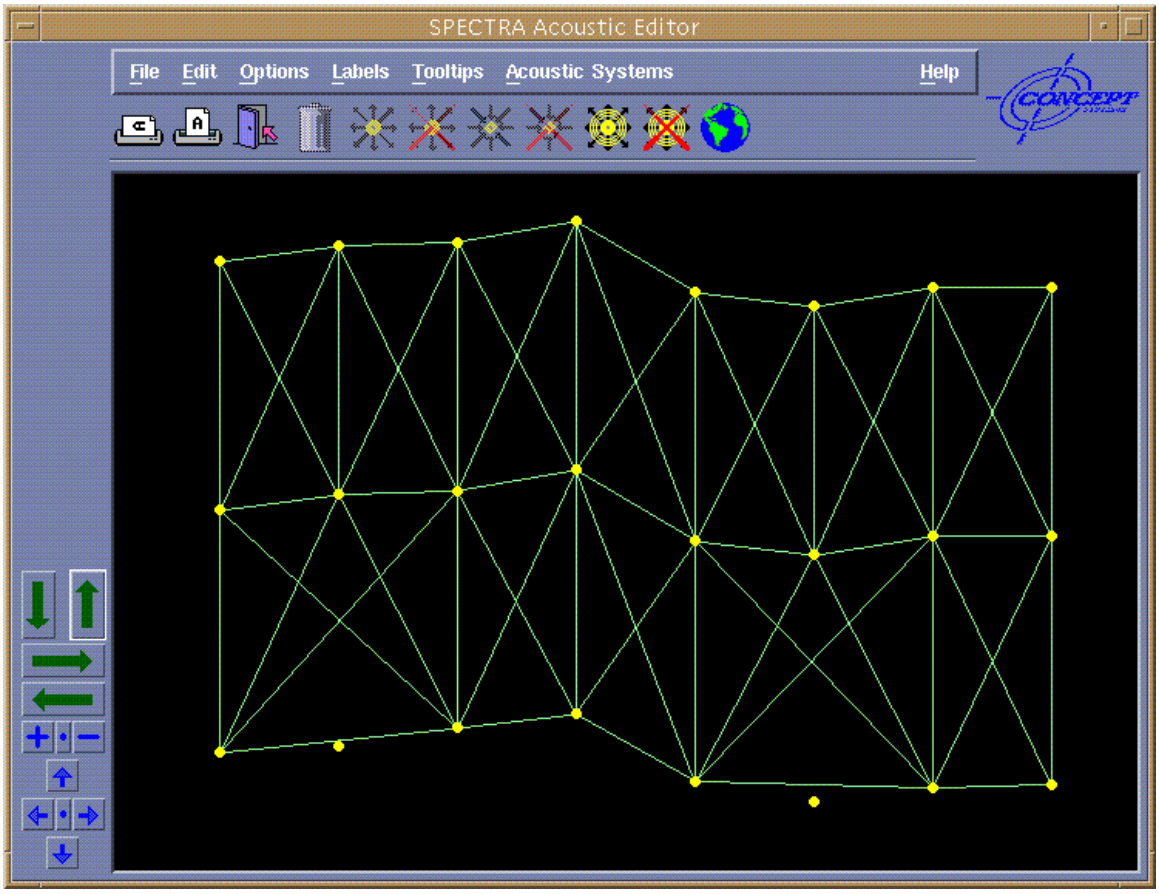
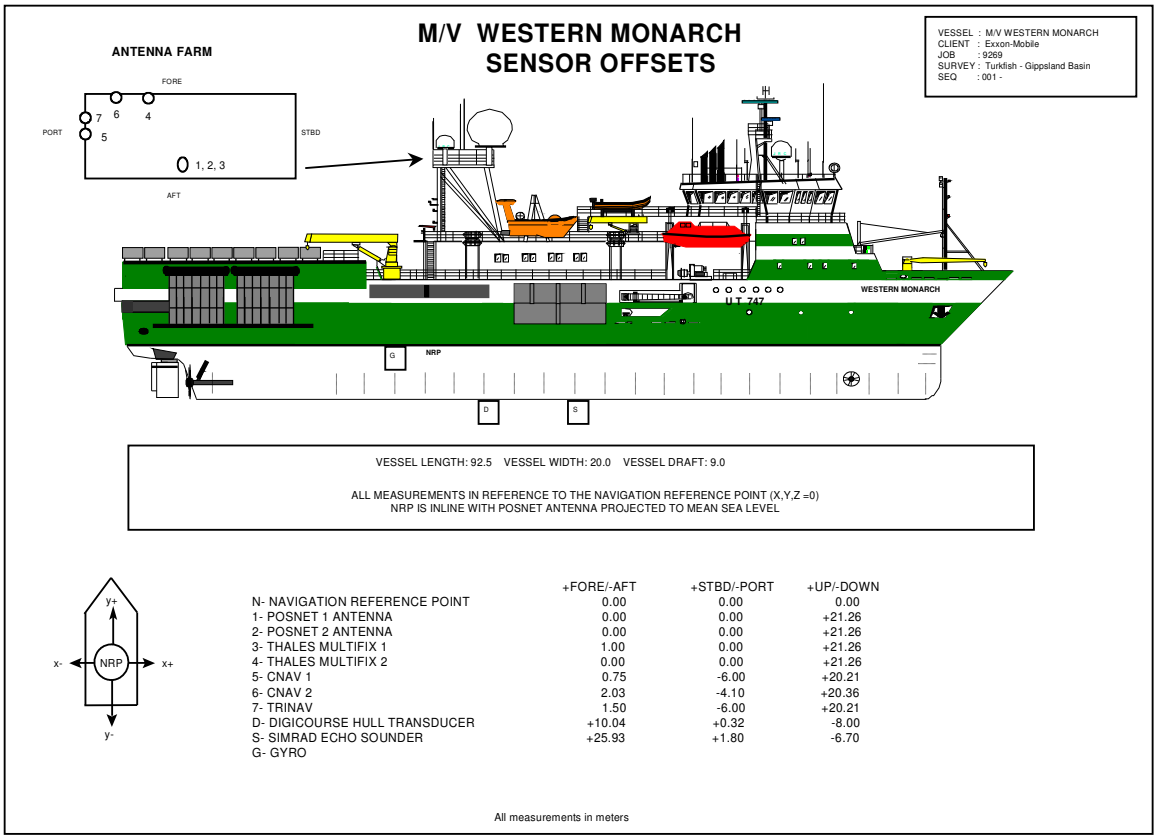


Exhibit 6 Survey Definition & Changes Summary

Vessel Positioning Offsets

Positive values forward/starboard, negative values aft/Port - all measurements are made to the relative receivers reference point. The Posnet Master Antenna is internally corrected to sea level.

Vessel reference point = **NRP**
The offsets below are valid for sequences: 001 -



	+FORE/-AFT	+STBD/-PORT	+UP/-DOWN
N- NAVIGATION REFERENCE POINT	0.00	0.00	0.00
1- POSNET 1 ANTENNA	0.00	0.00	+21.26
2- POSNET 2 ANTENNA	0.00	0.00	+21.26
3- THALES MULTIFIX 1	1.00	0.00	+21.26
4- THALES MULTIFIX 2	0.00	0.00	+21.26
5- CNAV 1	0.75	-6.00	+20.21
6- CNAV 2	2.03	-4.10	+20.36
7- TRINAV	1.50	-6.00	+20.21
D- DIGICOURSE HULL TRANSDUCER	+10.04	+0.32	-8.00
S- SIMRAD ECHO SOUNDER	+25.93	+1.80	-6.70
G- GYRO			

Acoustic Offsets – Eight (8) Cables

Any changes documented in P2/94 Header Differences table.

Range/Bearing Sensor Offsets – Eight (8) Cables

Any changes documented in P2/94 Header Differences table.

Cable 1
(8-cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 001**					
1	F. stubby	63.6	17357					
2	1A	-12.7	15203					
3	2A	-211.9	14110					

			COMPASS SERIAL NUMBERS AND OFFSE					
4	3A	-411.1	8969					
5	4A	-610.3	20538					
6	5A	-809.5	7851					
7	6A	-1008.7	19985					
8	6B	-1108.3	7016					
9	8A	-1407.1	10830					
10	9B	-1705.9	17812					
11	11A	-2004.7	5977					
12	12B	-2303.5	10250					
13	14A	-2602.3	10082					
14	15B	-2901.1	17125					
15	17A	-3199.9	12823					
16	18B	-3498.7	19963					
17	20A	-3797.5	14581					
18	21B	-4096.3	20756					
19	23A	-4395.1	11934					
20	24B	-4693.9	8865					
21	25B	-4893.1	8566					

Note: Bird 1 on forward coil of front stubby.

Cable 2
(8 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 001**	**SEQ 056**				
1	F. stubby	59.6	15266					
2	1A	-12.7	13028					
3	2A	-211.9	16656					
4	3B	-510.7	13632	6458				
5	5A	-809.5	14008					
6	6B	-1108.3	10464					
7	8A	-1407.1	20261					
8	9B	-1705.9	14014					
9	11A	-2004.7	19968					
10	12B	-2303.5	16930					
11	14A	-2602.3	6398					
12	15B	-2901.1	16849					
13	17A	-3199.9	16968					
14	18B	-3498.7	15391					
15	20A	-3797.5	12082					
16	21B	-4096.3	7608					
17	23A	-4395.1	17241					
18	24B	-4693.9	11982					
19	25B	-4893.1	9380					

Note: Bird 1 on aft coil of front stubby.

Cable 3
(8 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 001**	**SEQ 056**	**SEQ 065**			
1	F. stubby	59.6	12033					
2	1A	-12.7	17305					
3	2A	-211.9	6707					
4	3B	-510.7	10180	15501				
5	5A	-809.5	14602		13632			
6	6B	-1108.3	6644					
7	8A	-1407.1	17911					
8	9B	-1705.9	10218					
9	11A	-2004.7	10802					
10	12B	-2303.5	16152					
11	14A	-2602.3	21528					
12	15B	-2901.1	13945					
13	17A	-3199.9	9212					
14	18B	-3498.7	16858					
15	20A	-3797.5	18212					
16	21B	-4096.3	11323					
17	23A	-4395.1	16438					
18	24B	-4693.9	17361					
19	25B	-4893.1	12919					

Note: Bird 1 on aft coil of front stubby.

Cable 4
(8 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 001**	**SEQ 044**				
1	F. stubby	59.6	13172					
2	1A	-12.7	20644					
3	2A	-211.9	15581					
4	3B	-510.7	21225					
5	5A	-809.5	5617					
6	6B	-1108.3	19507	9707				
7	8A	-1407.1	15999					
8	9B	-1705.9	6847					
9	11A	-2004.7	19756	16371				
10	12B	-2303.5	17162					
11	14A	-2602.3	13956					
12	15B	-2901.1	8777	12259				
13	17A	-3199.9	13629					
14	18B	-3498.7	7059					
15	20A	-3797.5	13122					
16	21B	-4096.3	14103					
17	23A	-4395.1	7491					
18	24B	-4693.9	9628					
19	25B	-4893.1	17063					

Note: Bird 1 on aft coil of front stubby.

Cable 5
(8 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 001**					
1	F. stubby	63.6	9140					
2	1A	-12.7	8991					
3	2A	-211.9	19965					
4	3B	-510.7	13773					
5	5A	-809.5	15478					
6	6B	-1108.3	6946					
7	8A	-1407.1	16947					
8	9B	-1705.9	15169					
9	11A	-2004.7	15592					
10	12B	-2303.5	15387					
11	14A	-2602.3	12810					
12	15B	-2901.1	13989					
13	17A	-3199.9	16855					
14	18B	-3498.7	10074					
15	20A	-3797.5	11385					
16	21B	-4096.3	17583					
17	23A	-4395.1	5800					
18	24B	-4693.9	19360					
19	25B	-4893.1	16590					

Note: Bird 1 on fwd coil of front stubby.

Cable 6
(8 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 001**	**SEQ 017**	**SEQ 020**			
1	F. stubby	59.6	8547					
2	1A	-12.7	15229					
3	2A	-211.9	8906					
4	3B	-510.7	21432					
5	5A	-809.5	6727	20876	6727			
6	6B	-1108.3	21040					
7	8A	-1407.1	16870					
8	9B	-1705.9	12259	17621				
9	11A	-2004.7	20604					
10	12B	-2303.5	10243					
11	14A	-2602.3	20745					
12	15B	-2901.1	16952					
13	17A	-3199.9	8130					
14	18B	-3498.7	10107					
15	20A	-3797.5	14683					
16	21B	-4096.3	20877					
17	23A	-4395.1	15550					
18	24B	-4693.9	20625					
19	25B	-4893.1	8905					

Note: Bird 1 on aft coil of front stubby.

Cable 7
(8 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 001**	**SEQ 065**				
1	F. stubby	63.6	19702					
2	1A	-12.7	6757					
3	2A	-211.9	19974					
4	3B	-510.7	12901					
5	5A	-809.5	15306					
6	6B	-1108.3	12669					
7	8A	-1407.1	17300					
8	9B	-1705.9	17674					
9	11A	-2004.7	17094					
10	12B	-2303.5	21674					
11	14A	-2602.3	15380					
12	15B	-2901.1	6713					
13	17A	-3199.9	18978					
14	18B	-3498.7	19752	10180				
15	20A	-3797.5	12750					
16	21B	-4096.3	20862					
17	23A	-4395.1	20978					
18	24B	-4693.9	20882					
19	25B	-4893.1	7615					

Note: Bird 1 on forward coil of front stubby.

Cable 8

(8 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 001**					
1	F. stubby	59.6	16114					
2	1A	-12.7	17016					
3	2A	-211.9	14196					
4	3A	-411.1	11930					
5	4A	-610.3	16906					
6	5A	-809.5	22006					
7	6A	-1008.7	8577					
8	6B	-1108.3	7365					
9	8A	-1407.1	12007					
10	9B	-1705.9	15396					
11	11A	-2004.7	15473					
12	12B	-2303.5	7923					
13	14A	-2602.3	6374					
14	15B	-2901.1	9413					
15	17A	-3199.9	20634					
16	18B	-3498.7	13159					
17	20A	-3797.5	8528					
18	21B	-4096.3	10701					
19	23A	-4395.1	21263					
20	24B	-4693.9	13235					
21	25B	-4893.1	15459					

Note: Bird 1 on aft coil of front stubby.

Cable 1

(7 cable configuration)

Note : When changing from 8 cable setup cable 5 retreived so existing cables 6,7,8 are now 5,6,7 respectively.

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 079**	**SEQ 085**	**SEQ 150**			
1	F. stubby	63.6	17357					
2	1A	-12.7	15203					

			COMPASS SERIAL NUMBERS AND OFFSE					
3	2A	-211.9	14110					
4	3A	-411.1	8969					
5	4A	-610.3	20538					
6	5A	-809.5	7851					
7	6A	-1008.7	19985	16590				
8	6B	-1108.3	7016					
9	8A	-1407.1	10830		6946			
10	9B	-1705.9	17812		9140			
11	11A	-2004.7	5977					
12	12B	-2303.5	10250					
13	14A	-2602.3	10082					
14	15B	-2901.1	17125					
15	17A	-3199.9	12823					
16	18B	-3498.7	19963					
17	20A	-3797.5	14581					
18	21B	-4096.3	20756					
19	23A	-4395.1	11934					
20	24B	-4693.9	8865					
21	25B	-4893.1	8566					

Note: Bird 1 on forward coil of front stubby.

Cable 2
(7 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 079**					
1	F. stubby	59.6	15266					
2	1A	-12.7	13028					
3	2A	-211.9	16656					
4	3B	-510.7	6458					
5	5A	-809.5	14008					
6	6B	-1108.3	10464					
7	8A	-1407.1	20261					
8	9B	-1705.9	14014					
9	11A	-2004.7	19968					
10	12B	-2303.5	16930					
11	14A	-2602.3	6398					
12	15B	-2901.1	16849					
13	17A	-3199.9	16968					
14	18B	-3498.7	15391					
15	20A	-3797.5	12082					
16	21B	-4096.3	7608					
17	23A	-4395.1	17241					
18	24B	-4693.9	11982					
19	25B	-4893.1	9380					

Note: Bird 1 on aft coil of front stubby.

Cable 3
(7 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 079**	**SEQ 135**	**SEQ 200**			
1	F. stubby	59.6	12033					
2	1A	-12.7	17305					
3	2A	-211.9	6707					
4	3B	-510.7	15501	19756				
5	5A	-809.5	13632					
6	6B	-1108.3	6644					
7	8A	-1407.1	17911					
8	9B	-1705.9	10218					
9	11A	-2004.7	10802					
10	12B	-2303.5	16152					
11	14A	-2602.3	21528					
12	15B	-2901.1	13945					
13	17A	-3199.9	9212					
14	18B	-3498.7	16858					
15	20A	-3797.5	18212		17094			
16	21B	-4096.3	11323					
17	23A	-4395.1	16438					
18	24B	-4693.9	17361					
19	25B	-4893.1	12919					

Note: Bird 1 on aft coil of front stubby.

Cable 4
(7 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 079**	**SEQ 100**	**SEQ 101**	**SEQ 102**	**SEQ 135**	**SEQ 20**
1	F. stubby	59.6	13172					
2	1A	-12.7	20644					
3	2A	-211.9	15581					
4	3B	-510.7	21225					
5	5A	-809.5	15478					
6	6B	-1108.3	9707					19360
7	8A	-1407.1	16947					
8	9B	-1705.9	15169					
9	11A	-2004.7	15592					
10	12B	-2303.5	17162					
11	14A	-2602.3	13956					
12	15B	-2901.1	12259	8777	12259	8777	14602	
13	17A	-3199.9	13629					
14	18B	-3498.7	7059					17583
15	20A	-3797.5	13122					
16	21B	-4096.3	14103					
17	23A	-4395.1	7491					
18	24B	-4693.9	9628					
19	25B	-4893.1	17063					

Note: Bird 1 on aft coil of front stubby.

Cable 5
(7 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 079**	**SEQ 085**	**SEQ 086**	**SEQ 134**	**SEQ135**	**SEQ14**
1	F. stubby	59.6	8547	15387				
2	1A	-12.7	15229	19752				
3	2A	-211.9	8906					
4	3B	-510.7	21432					
5	5A	-809.5	6946		6949	16855		
6	6B	-1108.3	21040					
7	8A	-1407.1	16870					
8	9B	-1705.9	17621					
9	11A	-2004.7	20604					
10	12B	-2303.5	10243					
11	14A	-2602.3	20745			20625	9211	
12	15B	-2901.1	16952			17082		
13	17A	-3199.9	8130					
14	18B	-3498.7	10107					
15	20A	-3797.5	14683					
16	21B	-4096.3	20877					
17	23A	-4395.1	15550				5800	5800
18	24B	-4693.9	20625		13989			
19	25B	-4893.1	8905					

Note: Bird 1 on aft coil of front stubby.

Cable 6
(7 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 079**	**SEQ 085**	**SEQ 200**			
1	F. stubby	63.6	19702					
2	1A	-12.7	6757					
3	2A	-211.9	19974					
4	3B	-510.7	12901					
5	5A	-809.5	15306					
6	6B	-1108.3	12669	8991				
7	8A	-1407.1	17300	12810				
8	9B	-1705.9	17674		15229			
9	11A	-2004.7	17094	11385				
10	12B	-2303.5	21674		13773			
11	14A	-2602.3	15380					
12	15B	-2901.1	6713					
13	17A	-3199.9	18978					
14	18B	-3498.7	10180					
15	20A	-3797.5	12750					
16	21B	-4096.3	20862					
17	23A	-4395.1	20978					
18	24B	-4693.9	20882					
19	25B	-4893.1	7615					

Note: Bird 1 on forward coil of front stubby.

Cable 7
(7 cable configuration)

			COMPASS SERIAL NUMBERS AND OFFSE					
BIRD #	**SITE**	**OFFSET**	**SEQ 079**	**SEQ 176**				
1	F. stubby	59.6	16114					
2	1A	-12.7	17016					
3	2A	-211.9	14196					
4	3A	-411.1	11930					
5	4A	-610.3	16906					
6	5A	-809.5	22006					
7	6A	-1008.7	8577					
8	6B	-1108.3	7365					
9	8A	-1407.1	12007					
10	9B	-1705.9	15396					
11	11A	-2004.7	15473					
12	12B	-2303.5	7923					
13	14A	-2602.3	6374					
14	15B	-2901.1	9413					
15	17A	-3199.9	20634					
16	18B	-3498.7	13159					
17	20A	-3797.5	8528	20625				
18	21B	-4096.3	10701					
19	23A	-4395.1	21263					
20	24B	-4693.9	13235					
21	25B	-4893.1	15459					

Note: Bird 1 on aft coil of front stubby.

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Survey Definition Changes

Exhibit 6 : **Survey Definition Changes Summary**

Sequence	P2/94 Header	Comments / Changes made
Seq 001		Survey Start-up
Seq 007	H2110	Laybacks changed: C3 was –729.5 is –702.5 C4 was –718.5 is -702.5 C6 was –678.5 is –687.5 C7 was –681.5 is –692.5 C8 was –693.5 is –682.5
Seq 013	H5211 H5411	Seapath Gyro (gyro #3) removed from Spectra
Seq 014	H4110	Tailbuoy 7 offset was –5193.6m, New –5191.6m
Seq 017	H2210 H2310	Compass changes: 1608 was 12259 is 17621 1605 was 6727 is 20876
Seq 020	H2110 H2310	Compass change: 1605 was 20876 is 6727
Seq042	H0211 H5110 H600# H0221	TRINAV GPS added to SCN Acoustic S2T03 taken out of SCN. New Digicourse configuration Many records change due to renumbering.
Seq043	H5110 H5201 H600# H620#	Acoustic S3T01 taken out of network. New Digcourse configuration VESREF # reordering: 1 POSNET1 2 POSNET2 3 MF2 4 MF1 5 CNAV1 6 CNAV2 7 TRIGPS
Seq044	H2210 H2310 H5201	Compass changes: S4C06 was 19507 is 9707 S4C09 was 19756 is 16371 S4C12 was 8777 is 12259 New Digicourse configuration.
Seq056	H2210 H2310	Compass changes: S2C04 was 13632 is 6458 S3C04 was 10180 is 15501

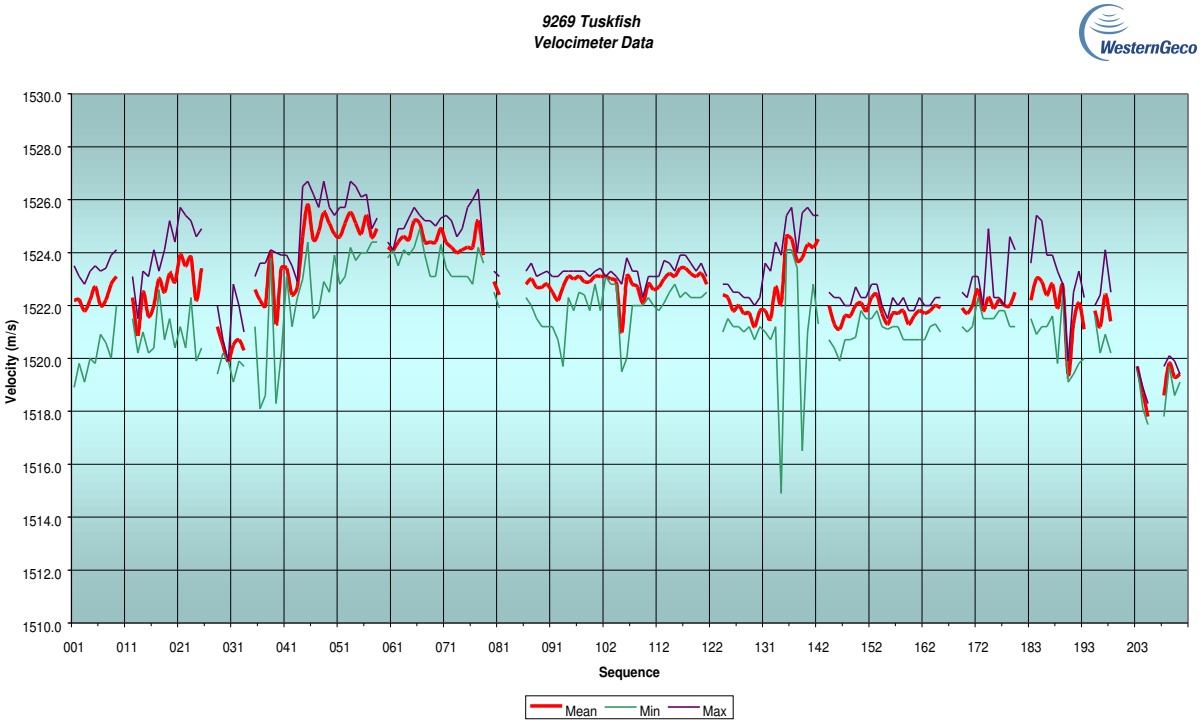
Seq065	H2210 H2310	Compass changes: S3C05 was 14602 is 13632 S7C14 was 19752 is 10180
Seq079	 H2210	**CONFIGURATION CHANGE TO 7 STREAMERS** **Note**: Cable 5 was retreived so remaining cables 6,7,8 are now cables 5,6,7 respectively. Compass Changes: S4C05 was 5617 is 15478 S4C07 was 15999 is 16947 S4C08 was 6847 is 15169 S4C09 was 16371 is 15592 S5C05 was 6727 is 6946
Seq081	H2210	Layback Cable 1 was –714.5 is –639.5 Layback Cable 2 was –714.5 is –659.5 Layback Cable 3 was –702.5 is –620.5 Layback Cable 4 was –702.5 is –618.5 Layback Cable 5 was –687.5 is –597.5 Layback Cable 6 was –692.5 is –605.5 Layback Cable 7 was –682.5 is –628.5
Seq 085	H2210 H2310	Compass changes S1C07 was 19985 is 16590 S5C01 was 8547 is 15387 S5C02 was 15229 is 19752 S6C06 was 12669 is 8991 S6C07 was 17300 is 12810 S6C09 was 17094 is 11385
Seq 086	H2210 H2310	Compass changes S5C05 was 6946 is 6949 S5C18 was 20625 is 13989
Seq 093	H2210	Changed Cable Laybacks Layback Cable 1 was –639.5 is –625.5 Layback Cable 5 was –597.5 is –567.5 Layback Cable 6 was –605.5 is –569.5 Layback Cable 7 was –628.5 is –572.5
Seq100	H2210 H2310	Compass Changes S4C12 was 12259 is 8777.
Seq 101	H2210 H2310 H5110 H5201 H5110	Compass changes S4C12 was 8777 is 12259 S2T03 put back in SCN New Digicourse Configuration.
Seq 102	H2210 H2310 H5110	Compass change S4C12 was 12259 is 8777. S2T03 offset was –311.6 is –411.2.
Seq 114	H5401	Speed of Sound Changed for Acoustics was 1520.0 is 1522.0.
Seq 121	H5401	Speed of Sound Changed forr Acoustics was 1522.0 is 1520.00
Seq 124	H5401	Speed of Sound Changed for Acoustics was 1520.0 is 1522.0.
Seq 134	H2210 H2310	Compass change S5C05 was 6949 is 16855 S5C11 was 20745 is 20625 S5C12 was 16952 is 17082
Seq 135	H2210 H2310	Compass change S3C04 was 15501 is 19756 S4C12 was 8777 is 14602 S5C11 was 20625 is 9211

Seq 144	H5110	Acoustic Offset Change S1T01 was 21.9 is 13.7 S4T01 was 25.9 is 13.7 S4T04 was 2204.0 is 2104.0
Seq 145	H2210 H2310	Compass Change S5C17 was 15550 is 5800
Seq 147	H2210 H4110 H5201	Layback Cable 2 was –659.5 is –622.5 Layback Tailbuoy 5 was –5182.1 is 5186.2 New Digicourse Configuration.
Seq 150	H2210 H2310	Compass Change S1C09 was 10830 is 6946 S1C10 was 17812 is 9140
Seq 162	H2110	Changed Cable Laybacks Cable 1 was –625.5 is –637.5 Cable 5 was –567.5 is –597.5 Cable 6 was –569.5 is –603.5 Cable 7 was –572.5 is –611.5
Seq 176	H2210 H2310	Compass changes: S5C14 was 10107 is 6727 S7C17 was 8528 is 20625
Seq 200	H2210 H2310	Compass changes: S3C15 was 18212 is 17094 S4C06 was 9707 is 19360 S4C14 was 7059 is 17583 S6C08 was 17674 is 15229 S6C10 was 21674 is 13773
		End of Survey.

P2 Header Changes

Exhibit 7 **: Sound Velocity**

Insert Sound Velocity Spread sheets here.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Velocimeter Data
WesternGeco
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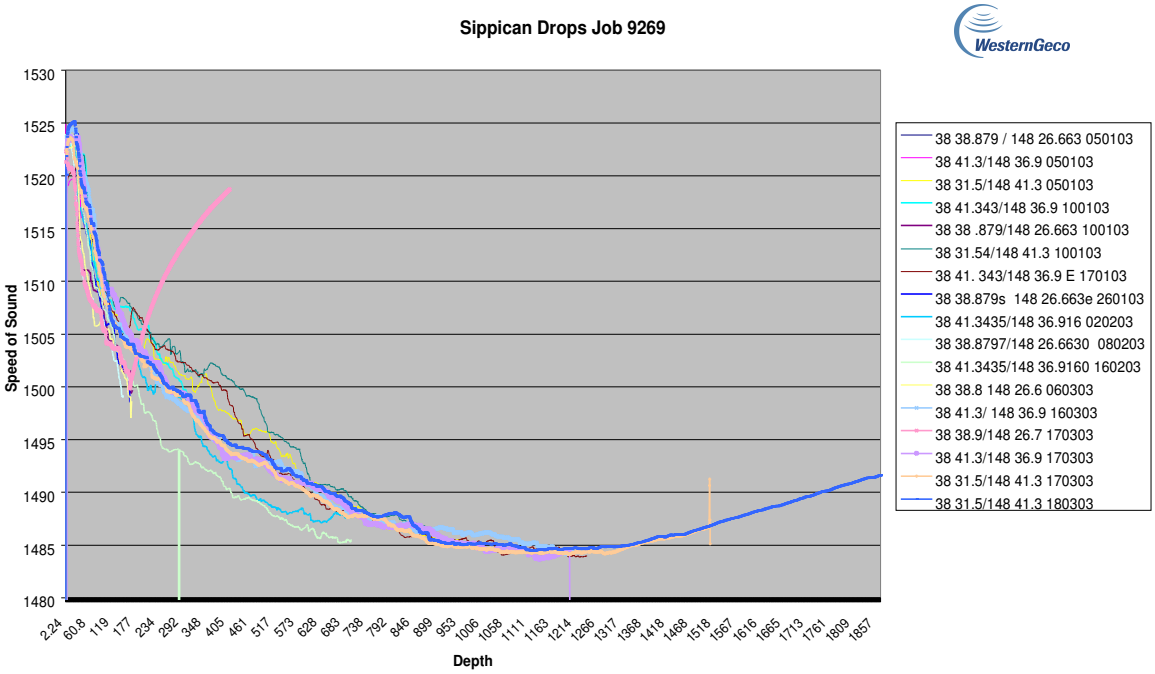
1524.0
1522.0
1520.0
1518.0
1516.0
1514.0
1512.0
1510.0
001
011
021
031
041
051
061
071
081
091
102
112
122
131
142
152
162
172
183
193
203
Sequence
Mean
Min
Max


Sippican Drops Job 9269
WesternGeco
Speed of Sound
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1525
1520
1515
1510
1505
1500
1495
1490
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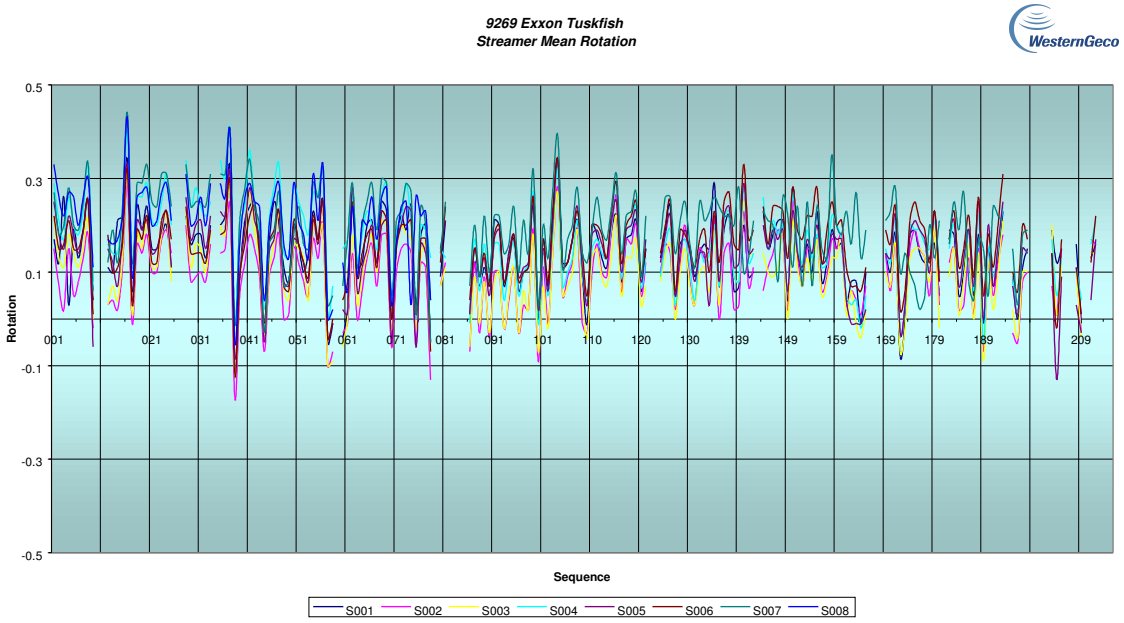
2.24
60.8
119
177
234
292
348
405
461
517
573
628
683
738
792
846
899
953
1006
1058
1111
1163
1214
1266
1317
1368
1418
1468
1518
1567
1616
1665
1713
1761
1809
1857
Depth
38 38.879 / 148 26.663 050103
38 41.3/148 36.9 050103
38 31.5/148 41.3 050103
38 41.343/148 36.9 100103
38 38 .879/148 26.663 100103
38 31.54/148 41.3 100103
38 41. 343/148 36.9 E 170103
38 38.879s 148 26.663e 260103
38 41.3435/148 36.916 020203
38 38.8797/148 26.6630 080203
38 41.3435/148 36.9160 160203
38 38.8 148 26.6 060303
38 41.3/ 148 36.9 160303
38 38.9/148 26.7 170303
38 41.3/148 36.9 170303
38 31.5/148 41.3 170303
38 31.5/148 41.3 180303

20.2.

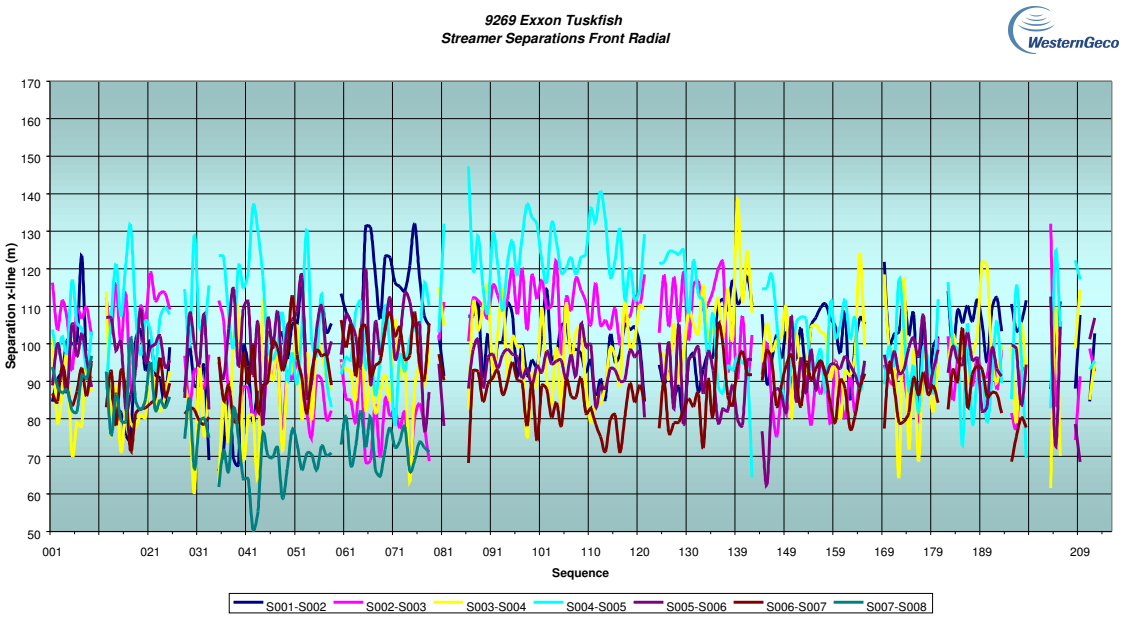
20.3.

Exhibit 8: **Trend Analysis**

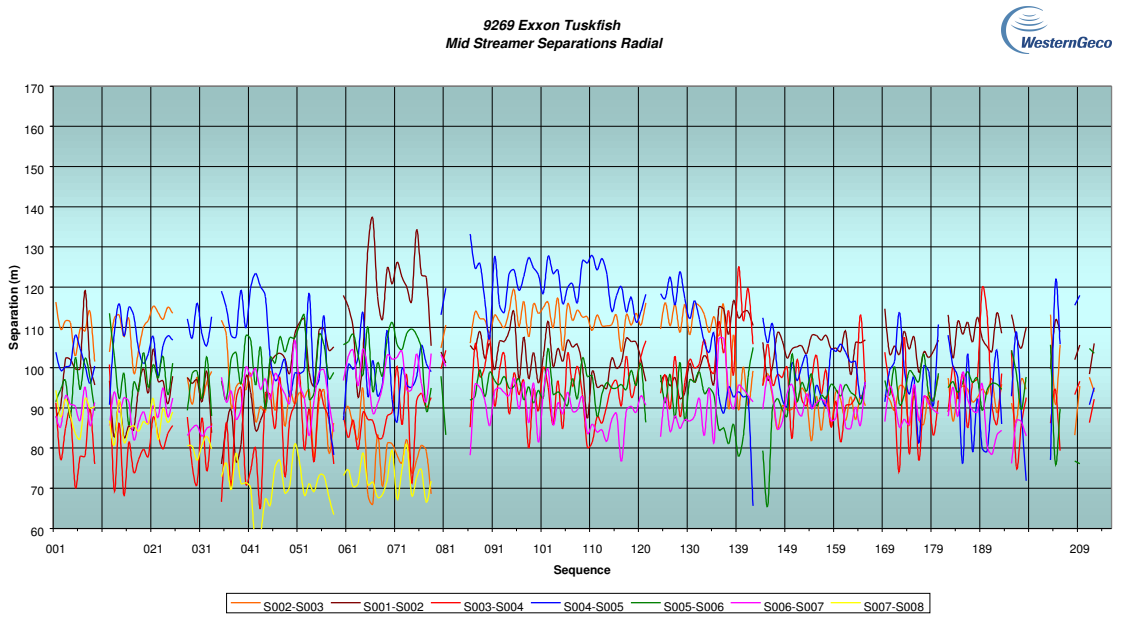
Estimated Rotation Bias



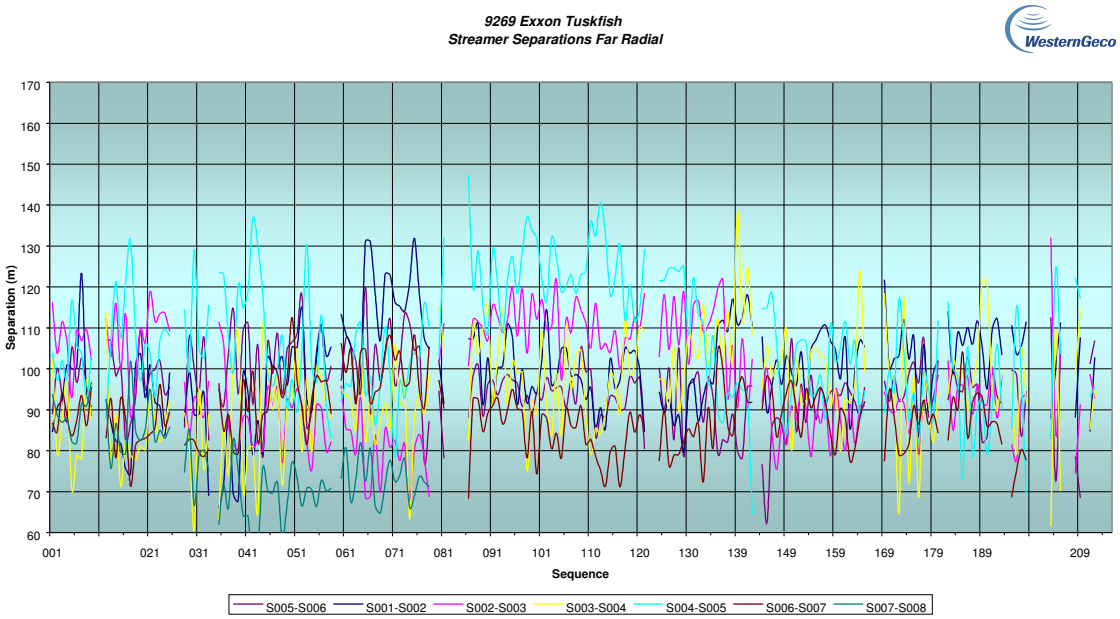
Cross Separation (All streamers to front)



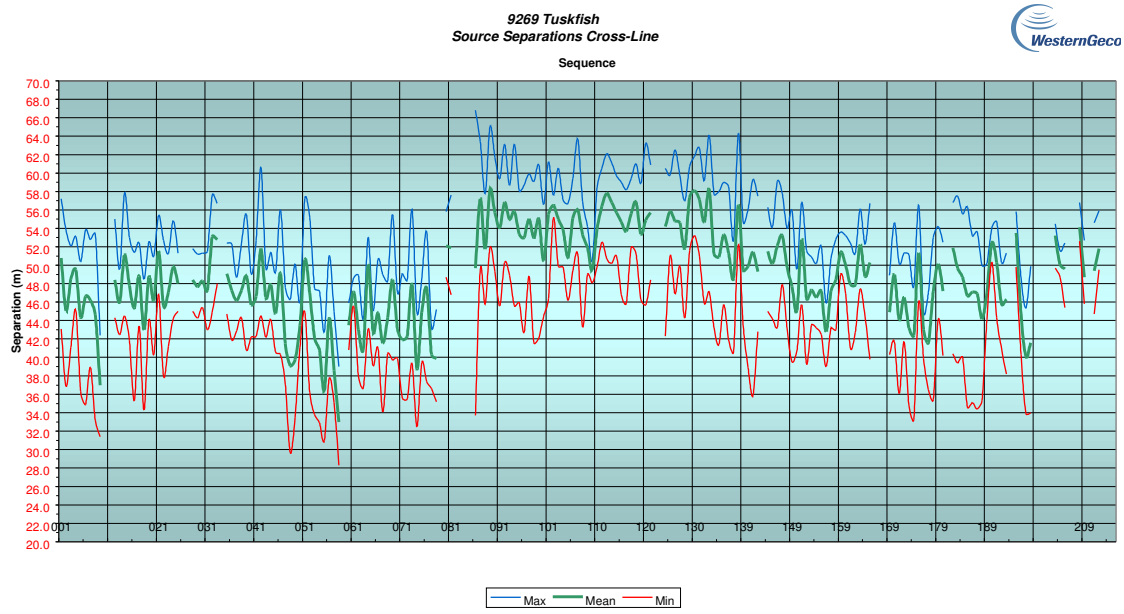
Cross Separation (All streamers to mid)



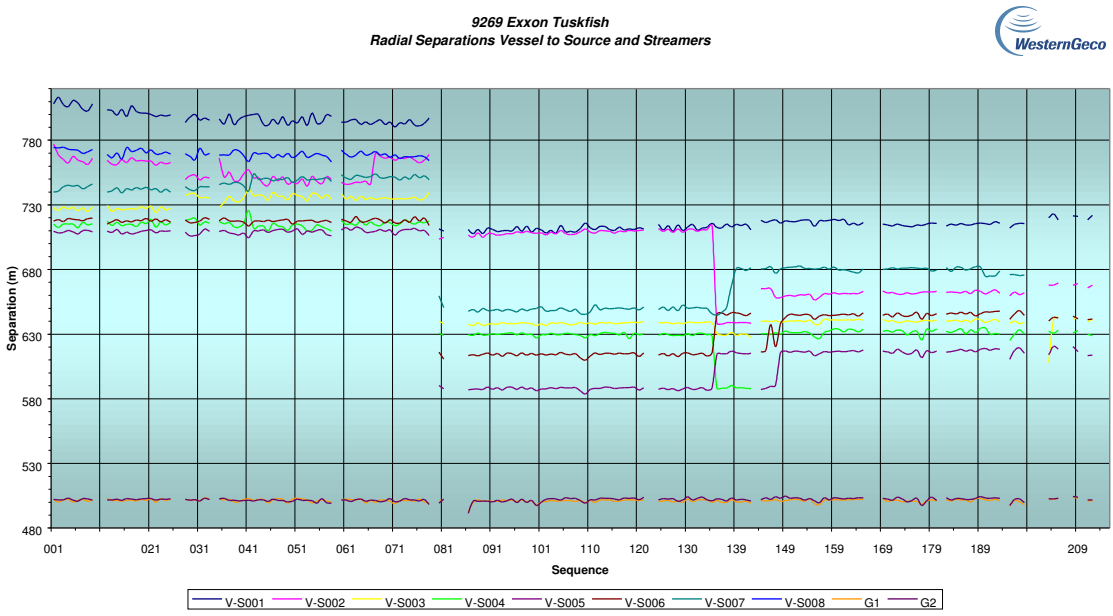
Cross Separation (All streamers to tail)



Cross Separation (Sources)



Separations Vessel to Streamers & Source (Radial)



Shot point interval

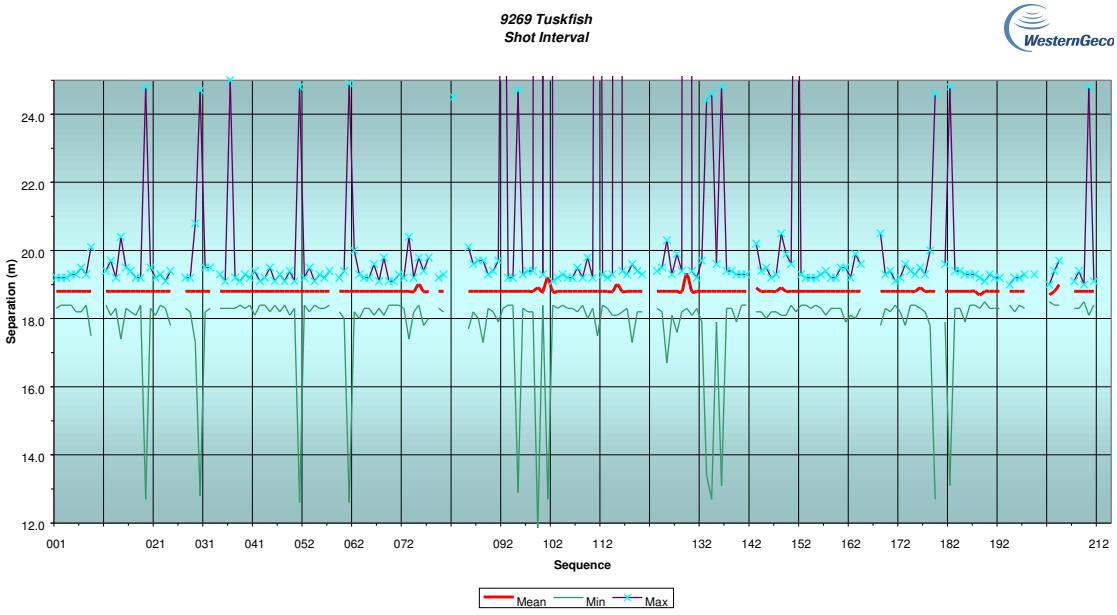


Table of Contents

21. Instrumentation,QC and Processing System

Description

System	Hardware	Software
Recording	Input/Output MSX system	Version 2
Tape drives	4 each IBM 3590 cartridge	
Plotter	OYO Geospace: 24 inch	
Onboard QC	Seisview via the CRS	Omega 1.8.1
Source Controller	Input/Output Source Synchronisation System	Version 2.1
Auxiliary Systems	WesternGeco Continuous Recording System (CRS)	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(running with Omega) such as RMS noise analysis, gun pressures/depths display, shot gathers display and a real time channel RMS. The majority of the qc products are 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:

QC and Processing System

System	Hardware	Software
OMEGA SPS Onboard Processing (IBM operating System)	2 x IBM RS/6000 B80s • 5.00 TBytes data disk IBM SP-2 UNIX based super computer • 26 thin nodes • 3 wide nodes • 22 × 1 Gbyte Memory • 1.85 TBytes data disk • 440 MBytes spool disk • 86 MBytes scratch disk 1 × 3590 IBM tape drives (stand alone drive) 4 × Tektronics work stations 1 × Tektronics dual-screen workstation 1 x 36” HP designjet colour plotter 1 × 36” OYO plotter	OMEGA version 1.8.2.1
EMASS Silo Tape System PC EMASS (OS/2 operating system)	24 × 3590 Tape drives connected to SILO.	

22. Instrumentation and QC Tests

22.1. Start-up Tests

The job start tests consist of the following 22 tests.

T13 All Ones	T13 50/50	T13 All Zeros	T13 Sine 15.625 Hz	T2 @ 0 dB Harmonic Distortion < 0.0005%	T2 @ -10 dB Harmonic Distortion < 0.002%	T2 @ -20 dB Harmonic Distortion < 0.005%	T2 @ -30 dB Harmonic Distortion < 0.016%	T2 @ -40 dB Harmonic Distortion < 0.05%	T2 @ -50 dB Harmonic Distortion < 0.16%	T2 @ -60 dB Harmonic Distortion < 0.5%
T2 @ -70 dB Harmonic Distortion < 1.6%	T2 @ -80 dB Harmonic Distortion < 5%	T2 @ -90 dB Harmonic Distortion +/- 4.0%	T2 @ -100 dB Harmonic Distortion +/- 4.0%	T5 Pre-Amp Noise < 2.9 uv	T10 Common Mode <70dB FS	T11 Cross-Feed (odd) <56 dB FS	T12 Cross-Feed (even) <56dB FS	T6 Impulse Response 2/12 +/- 7.0%	T7 Impulse Response 2/12 +/- 7.0%	T4 DRD 8/18 +/- 7.0%

Only tests with failing channels shown below.

Semi Monthly Test Results 4th Jan 03

Cable	Location	T13	T13	T13	T13	T2 @ 0 dB	T2 @ -10 dB	T2 @ -20 dB	T2 @ -30 dB	T2 @ -40 dB	T2 @ -50 dB	T2 @ -60 dB	T2 @ -70 dB	T2 @ -80 dB	T2 @ -90 dB	T2 @ -100 dB	T5	T10	T11 (odd)	T12 (even)	T6 I	T0 8/18	T7 8/18	T7 8/18	T4 8/18
		All Ones	50/50	All Zeros	Sine 15.625 Hz	< 0.0005 %	< 0.002 %	< 0.005 %	< 0.016 %	< 0.05%	< 0.16%	< 0.5 %	< 1.6 %	< 5%	+/- 4.0 %	+/- 4.0 %	< 2.9 uv	455.4uv	<2.3 mv	<2.3 mv	+/- 7.0%		<7 %	<7 %	+/- 7.0 %
1																									
	58																3.5								
	59																						7.9		
	63																						8.1		
	116																	564							
	164																								39
	170																			15					
	176																								12
	195																		15						
	337																			813					
	339																						7.7		

	343																					17		8.7
	344																	128				16		
	361																					7.2		
	385																466							
	399																458							
2																								
	3																					-8		-8
	16																					454		41
	17																455							
	70					0																		
	71																					-8		-8
	95																617							
	96																470							
	112																	164						
	113																		125					
	161					0																		
	201																					-7		
	217																		36					
	256																	6.2						
	343																							41
	348																	7.3						
	395																489							
3																								
	88																					-8		
	102																					-9		
	105																		13					
	106																		999					
	107																	999						
	108																	13mv						
	343																484							
	351																464							
	400																	14						
4																								
	40																					502		40
	64																							38
	71																					17		14
	77																					-9		

	104					0																		
	113																					496		40
	136													4.1										
	161																					-7		
	196																							34
	197																							37
	239																476							
	339																					-7		
	379																464							
	386																		2.8					
5																								
	9																464							
	14																490							
	33																							8.8
	83															4.4								
	91															2.9								
	128																	8						
	129																		41					
	130																		12					
	135																	6.3						
	147																	3.1						
	299																662							
	306																					12		28
6																								
	41																		5.6					
	98															3.4								
	116																					15		19
	159																	18						59
	253																462							
	272																566							
	275																							7.1
	322																							8.2
	356																471							
	376																							-7
7																								
	42																		17					
	46																		9.3					

	48																	61						
	49																		20					
	52																	11				-62		168
	53																		29					
	54																		3.3					
	56																	5.6						
	61																464							
	101																		3.5					
	105																999							
	106																799							
	107																999							
	108																831							
	109																999							
	110																775							
	111																999							
	112																880							
	143																657					-7		
	145																		8.3					
	148																	6.6				9.2		8.4
	149																		2.6					
	150																		8.3					
	151																	18						
	171																							39
	256																		3.3					
	272																	2.9mv						
	328																					81		25
	364																					-63		999
	400																	12						8.8
8																								
	134																		3.3					
	154																		7					
	255																	7.6						
	257																456							
	351																462							
	354																							7.3

22.2. Daily Tests

The daily test will produce 06 files

T2 @ 0 dB	T2 @ -80 dB	T6 Impulse	T4 Dynamic Range Distortion (DRD)	T7 Impulse	T-0
+/- 0.0005%	+/- 5.0%	+/- 6.0 %	+/- 7.0 %	+/- 7.0 %	Cable Noise

Daily test results were provided to onboard client representative daily

PRIOR TO Seq 59	ExxonMobil Gippsland Tuskfish 3D 9269							Jan. 26, 2003	
Cable	Location	SG	Trace	Channe	dB +/-	dB +/- 5.0%	Impulse +/- 7.0 %	Impulse +/- 7.0 %	T4 DRD +/- 7.0 %
1									
	4b		59	59				-8.7	
	4b		61	61				-10.4	
	4b		63	63				-9.7	
	7b		106	106				-8.4	
	11a		164	164					-35.1
	11b	SG	176	176					12.7
	17a		260	260					-7.2
2									
	1a		403	3				-7.6	
	1b	SG	416	16				1021	58.5
	4b		459	59				-8.7	
	5a		470	70	0.00171				
	5a		471	71				-9.2	
	11a		561	161	0.0013				
	13b		602	202				-10.8	
	14b		622	222					11
	24b		781	381				-7.4	
3									
	6a	SG	888	88				-8.9	-7.5
	7a		901	101				-8.3	
	7a		902	102				-11.3	-7.1
	11b		974	174				-8	
4									
	4b		1259	59				-8	
	5b		1277	77				-9.2	-8.3
	11a		1361	161				-8.7	
	22b	SG	1552	352				-52.9	
	24b		1581	381				55.7	41
5									
	9a		1730	130				-7.7	-7.8
	9a		1734	134					-7.2
	15b		1838	238					7.2
	19a		1890	290				-7.4	
	20a		1906	306				31.29	27
6									
	2a	SG	2024	24				-8.7	
	7b		2106	106					56.8
	8a		2116	116				47.5	36.5
	17b		2266	266				-7.4	
	24a	SG	2376	376				-9.3	
7									
	9b		2539	139				-7.9	
	11b		2571	171					10
	13b		2606	206				-7.2	
	21a	SG	2728	328				260.4	53.4
	23b		2764	364				-63.3	-171.3
	25a		2788	388				-7.6	
8									
	3b		2841	41				-16.1	
	8b		2921	121				12.9	11.6
	17b		3065	265				12.2	8.5
	23a		3154	354					-7.2

22.3. End of Job Test

The end of job test consists of 22 tests, same as start up tests.

Semi Monthly Test Results 25th Mar 03

Cable	Location	T13	T13	T13	T13	T2 @ 0 dB	T2 @ -10 dB	T2 @ -20 dB	T2 @ -30 dB	T2 @ -40 dB	T2 @ -50 dB	T2 @ -60 dB	T2 @ -70 dB	T2 @ -80 dB	T2 @ -90 dB	T2 @ -100 dB	T5	T10	T11 (odd)	T12 (even)	T6 I	T0 8/18	T7 8/18	T7 8/18	T4 8/18
		All Ones	50/50	All Zeros	Sine 15.625 Hz	< 0.0005 %	< 0.002 %	< 0.005 %	< 0.016 %	< 0.05%	< 0.16%	< 0.5 %	< 1.6 %	< 5%	+/- 4.0 %	+/- 4.0 %	< 2.9 uv	455.4uv	<2.3 mv	<2.3 mv	+/- 7.0%		<7 %	<7 %	+/- 7.0 %
1																									
	16																						-31	-31	-43
	18																						-44	165	33
	61																								28
	116																	562							
	145																			11					39
	148																		15						
	164																							37	18
	170																			16			48		
	173																			2			45		
	176																				14	23	40		29
	195																		14						
	238																			7			61	61	-144
	251																					11	37	39	
	385																	468							
	399																	459							
2																									
	3																						-7	-7	-8
	10																			2					
	16																						1033	32	40
	17																					459			
	25																				19				
	26																				11				

	28																		40					
	33																			29				
	39																		44					
	70															0.0104								
	71																					7	7	
	96																	613						
	109																					9	9	
	112																			147	20	22	49	
	114																			545	10			
	141																							29
	161					0.0168																		
	202																					-11		
	204																					-9		
	213																					-7		
	216																		5					
	222																						34	35
	256																	3						
	272																	8						
	330																			267				
	331																	256						
	341																							30
	346																			52				
	348																4							
	395																	490						
3																								
	5																	462						
	51																16							
	66																			11				
	97																					7	7	
	102																					9	9	
	103																					10	10	
	105																			12				
	106																			2263				
	107																2303							

	108																13							
	118																2							
	148																					22	65	15
	149																					16	42	23
	174																					-7		
	182																2							
	185																		5			-62	-65	164
	343																	488						
	351																	472						
	400																11				168	14	19	12
4																								
	2																			3				
	37																	4						
	63																					13	55	15
	169																			14				
	170																			2263		1076	38	38
	171																2274					986	39	38
	172																15							
	239																	476						
	264																13							
	379																	479						
	381																456							
5																								
	41																			39				
	45																			12				
	46																			37				
	48																47							
	53																			2				
	122					0.00055																		
	134																		41			-62	-62	-169
	169																			2				
	170																			2160		34	78	15
	172																853							
	173																			68	10		10	

	174																			28			9	
	175																86							
	176																1324					35	87	18
	253																	473						
	268					0.33	0.1	0.01								16								
	272																	561						
	321					2.206	5.176	0.019							80	11	665			17	169			
	356																464							
6																								
	1																			642	20	10	54	8
	3																41							
	5																			4				
	6																			74				
	7																10							
	8																628				19		18	
	61																	470						7.1
	102																					52	34	28
	118																					7	7	
	143																	659						
	249																			3				
	265																			8				
	328																				27	172	164	34
	341																					38	16	
7																								
	27																104				20	19	40	11
	29																			11				
	41																					-10		
	80																					-9		
	118																	11				-9	26	
	121																					31	39	31
	126																				12	25	7	
	134																			3				
	154																			3				
	159																2							
	204																					10		

	206																			6			62	162
	219																							28
	240																					7	7	
	255																13							
	257																	457						
	265																					38	39	7
	300																					10	8	
	351																	466						
	395																							28

23. QC Products and Processing Sequence

23.1. Brute Stack

For each sail line a different source-streamer combination was used to generate a brute stack for one subsurface CMP line. Paper plots of the raw stacks were produced at the end of the line. In the latter stage of the acquisition, the processing/qc group was able to generate online brute stack. It involved selection of every third trace until it reads the last shot of the line. This is intended to give a much faster guide in identifying the extent of external noise in the data acquired until a full brute stack is produced later.

Processing sequence**:**

Input 1 cmp line per sail line: (4 ms data)	400 channels
Line edits applied	Delete bad shots/traces
Gain Recovery	Gain Exponent of 1.0 applied
Marine Geometry	2D geometry using nominal offset
Normal moveout correction	Velocity function provided by client
Pre-stack mute with offset/time pairs:	350/4 500/100 1400/2600 5100/5000 350/4 650/300 1600/2800 5100/5000 350/4 800/450 1800/3000 5100/5000 350/4 1100/700 2000/3200 5100/5000 350/4 1600/1500 2400/3300 5100/5000 350/4 2200/2000 2600/4000 5100/5000 350/4 2700/2700 3100/4300 5100/5000 Water bottom dependent outside mute applied
Stack Root N scaling	66 fold
Output:	To disk file

Raw Brute Stack

Relative amplitude scaling

Display: Scale 25 traces/cm 12 cm/sec

23.2. Shots and FK Spectral Analysis

Shot records were displayed online by rotating cable/source combinations. Paper plots were also produced every 57th shot (in order to allow plotting to be done by rotating each cable and rotating starboard-port source) during the line to check noisy and spiking channels, swell noise, seismic interference and other types of noise encountered. Every 57th shot was also displayed online in the FK domain. This helped to identify noise sources and QC data outside the windows used for Attributes analysis.

23.3. RMS Analysis

23.3.1.Ambient RMS Window

Calculating RMS values above the first break (last 200 traces of each streamer) with a time window from 100 to 1000 ms produced an overview of the ambient noise distribution during a line. The analysis was created both online and offline and a GIF file was created for later perusal.

Data Input:	All shots, last 200 trace of each streamer, window 100 – 1000ms.
Scaling:	By 71.428571 to convert amplitudes to microbars.
RMS analysis:	One trace is output for each shot containing the RMS

	amplitude over the given window for each channel.
Bandpass Filter	Zero phase low cut filter 5 Hz. 12 dB/oct.
Output:	To disk file.
Online display:	Using Attribute Display packages.

23.3.2. Deep RMS Window

Window analysis from 5500 – 6000 ms of the records were calculated for every trace, each shot to obtain RMS values. The output analysis generated an attribute display showing all channel numbers versus shotpoints and a selection of colours to show signal amplitude in microbars. QC attribute paper plots were also generated for all cables. The attribute display showed channel numbers versus signal amplitude value for each shot and all cables. Average RMS values of each trace for the entire line was also generated in order to identify noise sources and noisy traces.

Processing Sequence

1.	Data Input:	All shots, all channels, window 5500 - 6000 ms.
2.	Scaling:	By 71.428571 to convert amplitudes to microbars.
3.	RMS Analysis:	One trace is output for each shot containing the RMS amplitude over the window for each channel. Zero phase low cut filter at 5 Hz 12 dB/oct was applied.
4.	Output:	To disk file.
5.	Online display:	Using Attribute Display packages.

23.3.3. Signal RMS Window

RMS amplitude were calculated below water bottom (water bottom dependent), with a time delay of 1500 ms and a window length of 1500 ms. Average RMS signal values of each trace for the entire line was generated to show signal strength. The output attribute file illustrated a graph showing the amplitude values against channel numbers in every cable.

1.	Data Input:	All shots, all channels, water bottom dependent : water bottom + 1500ms + 1500 ms window length.
2.	Scaling:	By 71.428571 to convert amplitudes to microbars.
3.	RMS Analysis:	One trace is output for each shot containing the RMS amplitude over the window for each channel.
4.	Output:	To disk file.
5.	Online display:	Using Attribute Display packages.

All RMS displays were placed on supervision.

23.4. Near Trace Display

As part of the quality control process, near trace data from all source/ streamer combinations were selected for every sail line acquired. To reduce the amount of display, it was decided in the early part of the survey to generate paper plot of one cable/source combination and rotate the display from the said combination. The near trace gathers provide an initial overview of the data acquired.

1. Collect near traces :	Channels 1, 401, 801, 1201, 1601, 2001, 2401 & 2801 were collected
2. Bandpass filter	Low cut filter 3 Hz. 18dB/oct
3. Gain recovery	Gain Exponent of 1.0 applied
4. Residual Amp. Compensation	RAAC file created to correct recorded amplitudes.
5. Display :	Scale: horizontal = 10 traces/cm: vertical=12 cm/sec.

23.5. Linear Moveout (LMO) Display

Near traces from each streamer and source were selected. As soon as the final navigation data (P190) is available, the near traces are merge with the processed navigation data. The x / y (inline/crossline) source and receiver positions were written to the trace headers. The LMO process requires a linear moveout correction by using the water velocity (1541 meters/sec) to correct only the direct arrival. The main purpose of this QC tool is to check for erroneous positioning, such as any trace detected by a jump in the time of the first break.

1. Collect near traces:	Channels 1, 401, 801, 1201, 1601, 2001, 2401 & 2801 were selected
2. Bandpass filter	3/18 low cut and 90/72 high cut
3. Geometry update	Merge near traces selected with final P190 headers. A shift of 50ms. was used to offset seismic and navigation data prior to display.
4. Display	Window 150ms Port and Starboard data was output to disk and viewed via QCviewer interactive display.

23.6. Source Performance Comparison

Source analysis of both and starboard arrays was performed for every line to determine possible air leakages and any drop in pressure in source energy. Channels 1 to 50 of the two inner cables (4 and 5) were selected for amplitude analysis during the 8 cable configuration. As soon as the configuration was changed to 7 cables, cable 4 was picked as the innermost cable. The display consisted of a comparison of sources showing graph of shotpoint versus amplitude and the average difference between port and starboard arrays.

1. Collect near traces:	Near 50 channels of two inner cables
2. Output:	To disk file
3. Display:	Read file and script used to display both sources.

23.7 Seismic Cubes

All cubes are referenced to the following grid origin (centre cell 1,1):

618392.8363	X co-ordinate
5751529.5998	Y co-ordinate

21.23.7.1. Near Trace Cube

The first 6 near traces from each streamer were used to produce a near trace cube. On sequence 144, channel 2001 of cable 6 became noisy and spiking. It was decided to drop this channel and to be able to attain enough data; channel 2007 of cable 6 was selected. The seismic and navigation data were merged with the near traces 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 grid the near traces and assigns true offsets for each near trace. The data was NMO (normal moveout) corrected using an average velocity taken from the client's supplied velocity file from a previous survey in the area. The main purpose of this QC tool is to check for erroneous positioning during the acquisition.

Parameters

Inlines	: 908 - 2452	Incr: 1
Crosslines	: 2601 - 9056_	Incr: 1
Cell Size	: 6.25 m x 25.00 m	
Rotation	: 107.997	

Data Input (common offset)	: Channels 1 to 6 for all streamers both Port and Starboard
Data Length	: 6496 ms.
Sample Rate	: 8 ms.

Inlines are equivalent to CMP lines, and crosslines are equivalent to shot point number.

Processing Sequence

1. Input near traces	: near 6 traces from each cable
2. Shot/trace edit	: Delete bad records and traces
3. Bandpass Filter	: Zero phase low cut, 5Hz 12dB/Oct
4. Merge seismic with processed navigation data	: Merge based on time of day
5. Grid Definition	: Update headers and define proximity of the data
6. NMO	: Apply normal moveout using velocities supplied by the client
7. Outside Mute with offset/time pairs	: 400/4 500/1500 800/2100 4000/4100
8. Stack	: Near trace 1 to 2 fold progressive stack
9. Instantaneous Gain	: 1000ms AGC time window
7. Resample	: Data resampled to 8.0 ms.
10.OmegaVu Output	: OmegaVu load (interactive display)

24. Data Quality / Observations

24.1. Quality Control Summary

A significant number of plots and displays were produced for quality control of each sequence. A dedicated local disk directory was provided so that gif files of these displays were provided every daily 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 using attributes such as RMS noise level, signal strength and source performance comparison. RMS analysis on deep window provided very useful information for the client and crew in determining the amount of swell noise, ship noise and other types of noise present in the data. Shot gathers were plotted on the OYO plotter every kilometre (every 57th shot, for different cable/source), which are being checked by the acquisition group. In addition, shot records were

output offline every 53rd shot which were viewed through Omega QCviewer to identify noisy channels and electrical spikes. A RMS source comparison was performed on every sequence to identify any serious problems with the source output.

The predominant noise type during the survey has been swell-noise. Some lines were affected by cross current or riptides and strong ship's noise, which was later edited from the data.

22.24.1.1. Noise Types Encountered

Swell Noise

Line directions of 302 degrees and 122 degrees put the Monarch on a "side seas" orientation to the predominant swell direction of 240 degrees. This kept the swell noise encountered to a minimum. All sequences in heavier weather conditions were shot with the streamers still set at 9m depth. Several sequences were scratched due to the adverse effects of swell noise in rough weather. The level of swell noise on the accepted data was negligible.

Ship Noise

Seq 28 had screw noise visible, but acceptable. In sequence 72, some ship was noise present, but at a low enough level to be considered acceptable.

Seismic Interference

None encountered

Rig noise

None encountered

Source problems

Sequence 34 was scratched due to gun string separation problems. Sequence 183, there were problems due to gun separations. Sequence 181 was scratched due to gun positioning problems. Occasional misfires resulting in shot edits for most sequences.

Parities Problems

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

24.2. Instrument Summary

For 8 streamers configuration, bird depths for the front ends of streamers 1 & 8 were unstable throughout the survey due to wash from the Baro-16 deflectors, with streamer 8 having the majority of the problems in heavier weather.

Similar problem also occurred on 7 streamers configuration where the outer streamers depths were unstable due to vane wash.

On sequence 162 and 163, the DC offset removal was not applied after MSX being rebooted. The qc/processing specialists had been informed for checking the data for any irregularities. In Touch help request issued to clarify the problem, and the answered that as far as the digital low cut filter applied then the data should be acceptable.
The last test performed onboard was to apply a debias filter using OMEGA's BPFilter seismic function module to compensate the low bias noise of the data. An amplitude spectral analysis was also generated for both the raw data (no DC offset) and debias filter applied to check the acceptability of the data. The client accepted these lines after the results were evaluated.

Table of Contents

25. Onboard Processing System

For Onboard Processing System details please refer to Section5_Instrumentation, Part 22 “Instrumentation, QC and Processing System Description”, of the current report.

26. Processing Objectives

26.1. Production Objectives

The processing objectives were production of tapes in SEGY and internal Omega format of seismic data merged with navigation data.
When the client awarded the full processing contract to WesternGeco’s Perth office the production of the SEGY format tapes was stopped and only internal Omega format tapes were produced. The SEGY tapes stopped being produced after sequence 079.

26.2. Survey Details

To facilitate the quality control of merge result a grid covering the survey area was created.

Coordinates of grid corners:
MG1: x = 618392.8363, y = 5751529.5998;
MG2: x = 656762.6750, y = 5739064.7033;
MG3: x = 606466.7015, y = 5714818.1941;
MG4: x = 644836.5402, y = 5702353.2976.

Cell size in shooting direction: 6.25m.
Cell size in cross-line direction: 25.00m.
Rotation 107.997 degrees.

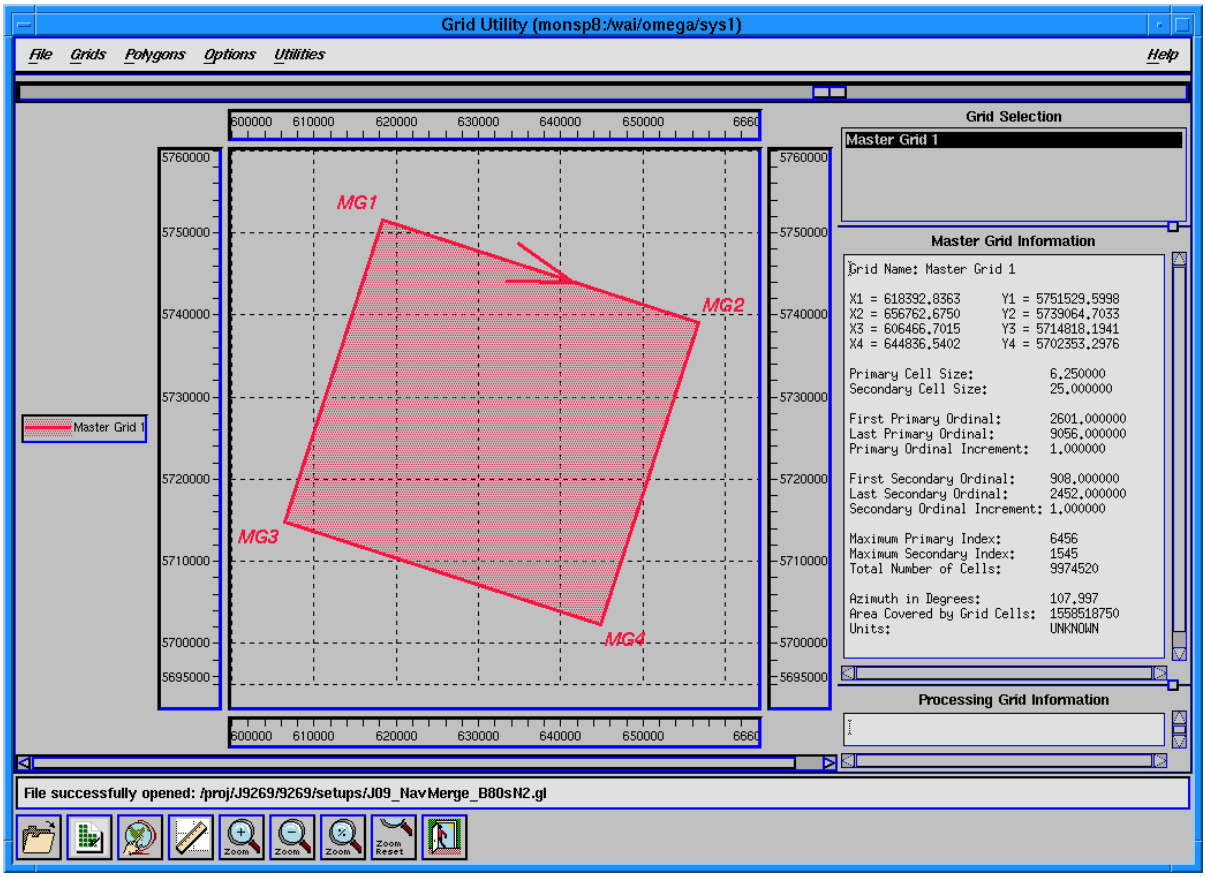


Figure 1. Survey Grid.

27. Processing Production

27.1. Main Seismic Processing Parameters

To optimize the usage of installed system hardware, the processing sequences were divided into 2 main production phases:

1. Input data from the copy field tapes, removing bad shots, merging seismic and navigation data, assign grid parameters to the seismic traces header, flag bad individual traces listed in observers, flag shots and corresponding traces listed in navigation log as traces with depth out of specification, output data to disk.

2. Output data to 3590 tape in Omega format.

Quality control for these steps included control of seismic headers at different stages of processing flow, and control of readability of produced Omega tapes.
Quality control of correct merging of seismic and navigation data, as well as control of navigation data itself was done at earlier stages by producing First Break QC Plots and Cube and Near Trace Cube (see QC part of Section5_Instrumentation).

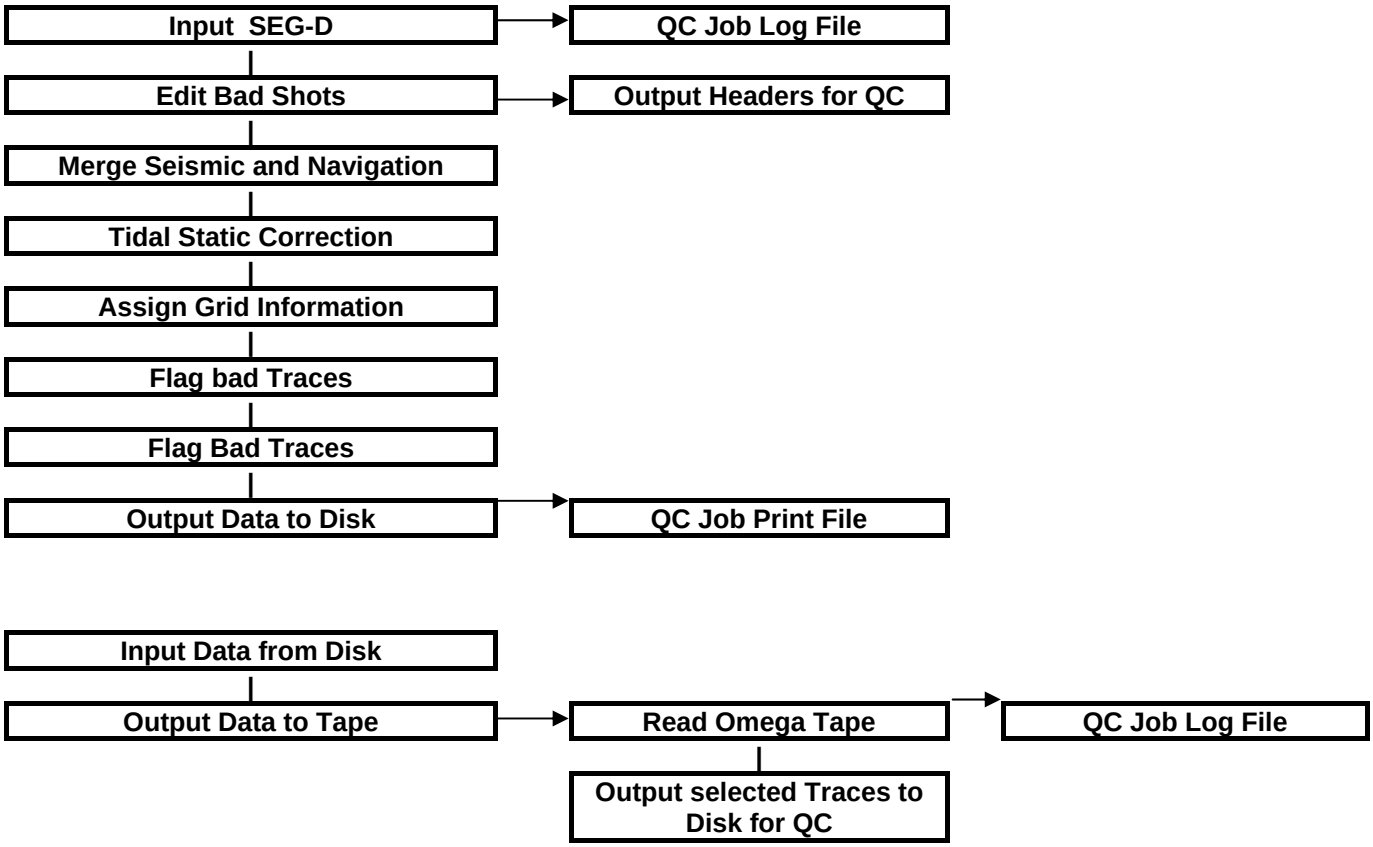
The following table represents processing sequence:

Phase	No	Processing Steps	Detail of the processing steps
PROD1	**1**	**Input Data From Copy Tapes**	SEGD format: 8058-ieee Number of traces: 3200 for the north block (8 streamers) 2800 for the south block (7 streamers) Data length: 6656 ms @ 2ms sample interval
	2	**Bad Shots Editing**	Deleting bad shots listed in obslog from the future processing
	3	**Merge Seismic with navigation data**	Assign X and Y coordinates of source and receiver position to trace header.
	4	**Processing Grid Definition**	Assign grid information to the trace header.
	5	**Flag Bad Traces**	Flag traces listed as bad in observers and Navigators log files.
	6	**Seismic Data Output**	Apply gain correction, calculate RMS for the window 2000 – 2500 ms, and output data to disk and terminal display for qc.

Phase	No	Processing Steps	Detail of the processing steps
Prod2	**1**	**Input Seismic Data From Disk**	Read shots from disk
	10	**Seismic Data Output**	Output data to 3590 tapes in SEG-Y format

27.2. Processing Flow & Quality Control

Schematic Job Flow



27.3. Products & Shipments

List of products delivered

Product	*Shipment no.*	*Comments*
SEGY Format 3590 Tapes	Mon-03002od	Navmerge test for ExxonMobil
Omega Format 3590 Tapes	Mon-03003od	Navmerge for Perth Office
SEGY Format 3590 Tapes	Mon-03004od	Near Trace Cube for ExxonMobil
Omega Format 3590 Tapes	Mon-03005od	Navmerge for Perth Office
Omega Format 3590 Tapes	Mon-03008od	Navmerge for Perth Office
Omega Format 3590 Tapes	Mon-03018od	Navmerge for Perth Office