ACQUISITION REPORT

PGS Geophysical

CDEX-JAMSTEC

M.V. *NORDIC EXPLORER*

2006 KUMANO-NADA 3D
NANKAI TROUGH, JAPAN

2006020

10th April to 19th May 2006

version 1

PGS Geophysical – Marine Acquisition, SINGAPORE

AUTHORISATION

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Operations Manager — [signature] — 12 June 2006

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REVISED VERSIONS

NUMBER	CHANGES	AUTHOR	DATE

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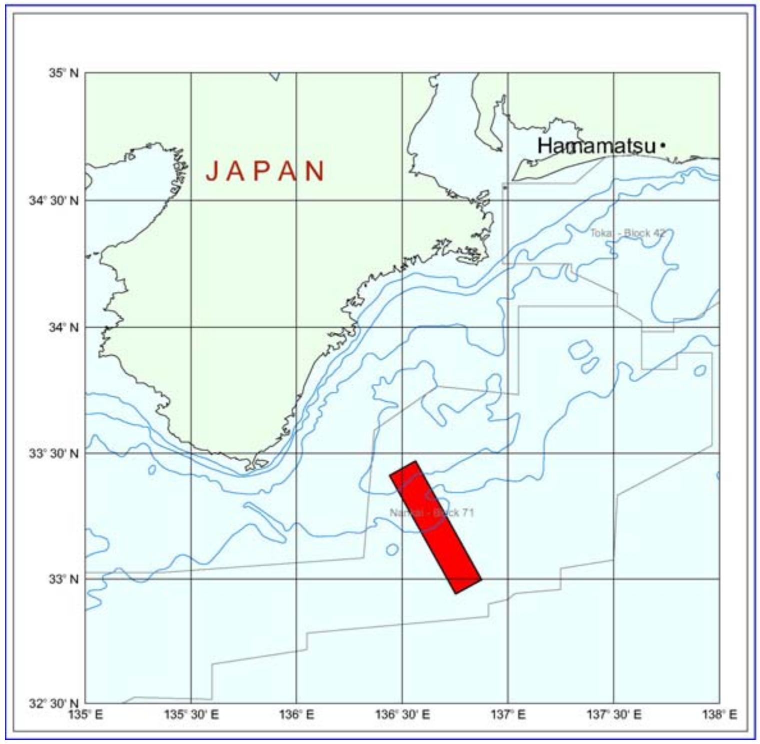
1 Introduction

1.1 Summary

The M.V. *NORDIC EXPLORER* was contracted by CDEX-JAMSTEC to undertake a 3D seismic survey over the Nankai Trough some 70 nm to the SSE of Shingu port, Japan.



The survey commenced on 10 April 2006 following a start up meeting alongside in Kobe port on April 9. The survey was 792 sq km in size, with the original agreed pre plot requiring sail lines from 1004-1348, to be acquired. However, during the survey (5 May 2006), a pre-plot adjustment was agreed and sail lines 1060-1404 were designated as the data to be acquired.

Acquisition was completed on 17 May 2006 at 13:56. Due to a change in the client's priorities, the acquisition had been focused on completing the coverage of the central data block and prime lines 1364-1404 were never attempted. Upon completion, the in-sea equipment was recovered and the vessel transited to Kobe, Japan.

The dominant feature of the area was the strong 4.0 to 4.5 knot current from WSW which coincided with the 3000 m depth contour, although it did not remain consistent in strength. As a result of this current, very high feather angles were frequently noted and feather matching was not possible, resulting in, the high amount of infill data required, 48%.

The weather was mixed throughout the survey, and we experienced five periods of poor weather which influenced the survey. Deployment of the in sea equipment was delayed during periods 10-12 April and 14-16 April, and acquisition suspended on 20-21 April, 7, 12 and 13 May 2006.

Shipping lanes lay to the north of the survey area and crossed the northern turning zone. Good co-operation was maintained throughout the project, with chase vessels successfully managing all approaching shipping.

The survey chase boats consisted of three vessels, *NIPPON MARU*, *SHIN DOKAI MARU* and the *MIRAI*.

Fishing by long liners was noted to the south and south east of the survey area. However, fishing in the area was well managed and the long liners were kept fully aware of our operation.

1.2 Key parameters

Source	:	2 x 3090 in^3
Streamers	:	4 x 4500 m
Streamer spacing	:	150 m
Streamer depth	:	7 m
Near trace offset	:	87 m

1.3 Systems

Source type	:	Sodera G-gun
Streamer type	:	RDHS(reduced diameter solid streamer)
Recording system	:	HTI NTRS/gAS
Navigation	:	SkyFix.XP, clock and orbit corrected GPS
	:	StarFix.HP, dual frequency DGPS
Float positioning	:	Seatex Seatrack 220/320 RGPS
Acoustic ranging	:	Sonardyne SIPS2

1.4 Production

	Sail line km	**CDP km**
Prime chargeable	1920.45	15363.60
Infill	926.02	7408.20
Infill percentage	48%	
Total	**2846.47**	**22771.80**

1.5 Survey timing

	Hours		Hours	% of total
Production	567.73	Production prime	308.09	33.3
		Production infill	145.46	15.7
		Line change	114.18	12.3
Standby	205.25	Sea Creatures	7.08	0.7
		Weather	155.47	16.8
		Currents	4.55	0.5
		Standby – no charge	38.15	4.1
Mob / Demob	88.15	Mob	47.38	5.1
		Demob	40.77	4.4
Downtime	64.57	Instruments	3.15	0.3
		Streamers	7.00	0.7
		Navigation	0.70	0.1
		Mechanical	31.85	3.4
		Maritime	21.87	2.6
Total	**925.70**		925.70	100.00

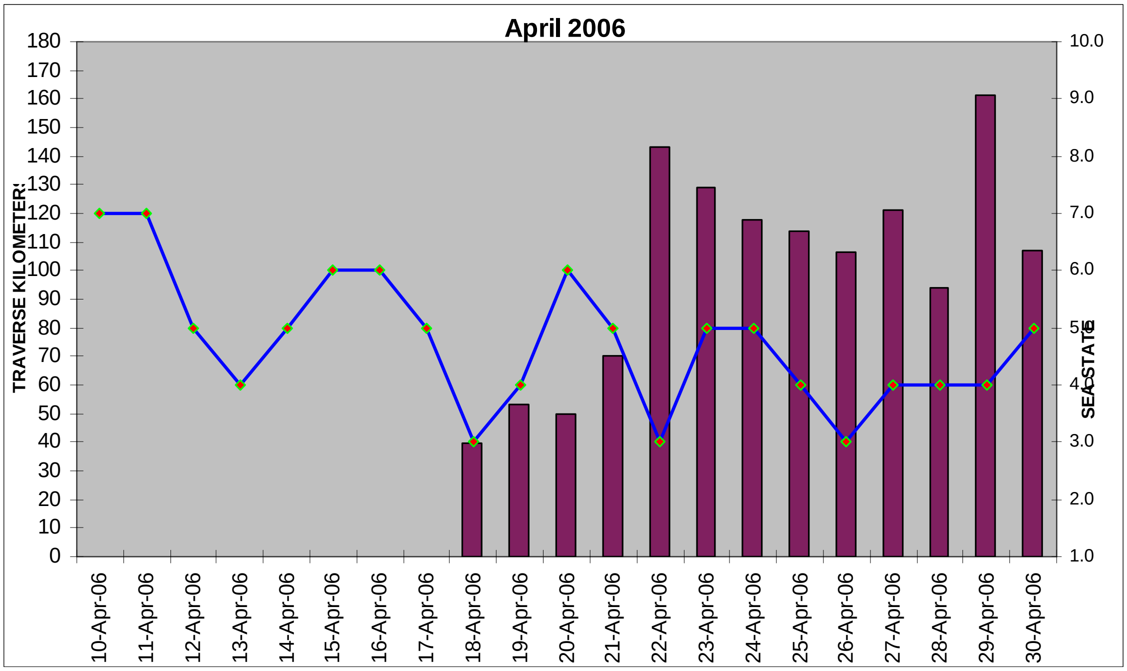
2 Sequence of events

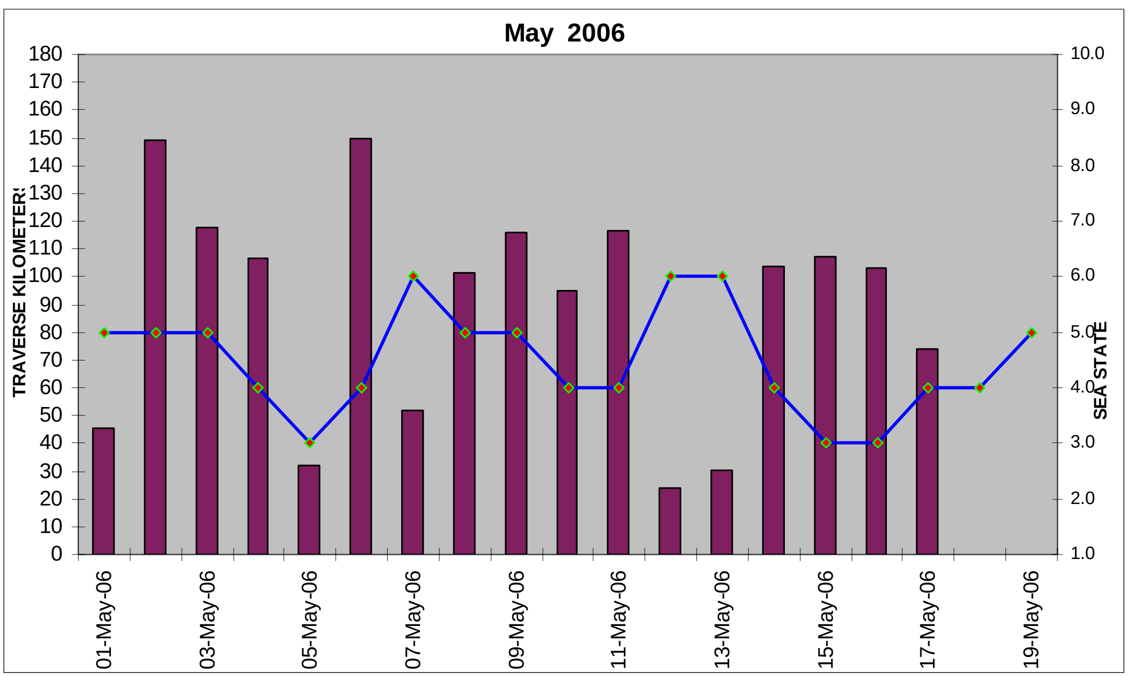
2.1 Daily log

Date	Daily km	Location	Comments
10-Apr-06	0.000	Anchorage	Alongside Kobe, Japan – sail outside the anchorage to perform engine speed trials – trials complete – head to anchorage to shelter from the weather.
11-Apr-06	0.000	Prospect	At anchor sheltering.
12-Apr-06	0.000	Prospect	At anchor sheltering – heading through the weather to the prospect area.
13-Apr-06	0.000	Prospect	On prospect re-tensioning cables.
14-Apr-06	0.000	Prospect	On prospect re-tensioning cables – re-tensioning of cables and SW's complete – last cable fully deployed with a full complement of birds – holding off further deployment d/t impending bad weather.
15-Apr-06	0.000	Prospect	Down for weather with one cable out.
16-Apr-06	0.000	Prospect	Down for weather with one cable out – mid-afternoon deployment continues as the weather drops.
17-Apr-06	0.000	Prospect	All cables deployed - setting up the final spreads and offsets.
18-Apr-06	39.413	Prospect	Setting up the spreads - production sequence 1 - downtime for airleaks.
19-Apr-06	53.175	Prospect	Downtime for low gun separations and airleaks - production Sequence 3-4 - standby for currents.
20-Apr-06	49.838	Prospect	Production Sequence 5 - weather - guns come onboard.
21-Apr-06	70.463	Prospect	Weather - production Sequence 7.
22-Apr-06	143.475	Prospect	Production Sequence 8-10.
23-Apr-06	129.300	Prospect	Production Sequence 11-12.
24-Apr-06	117.563	Prospect	Production Sequence 13-15.
25-Apr-06	113.625	Prospect	Infill Sequence 16-17.
26-Apr-06	106.163	Prospect	Production Sequence 18-20, downtime for Robtrack 0.70 hours line change extended to 3.27 hrs.
27-Apr-06	120.975	Prospect	Production Sequence 20-22.
28-Apr-06	94.013	Prospect	Downtime for main engine failure d/t fuel leak, production 23-24.
29-Apr-06	161.138	Prospect	Production Sequence 24-27.
30-Apr-06	106.875	Prospect	Production Sequence 28-30.

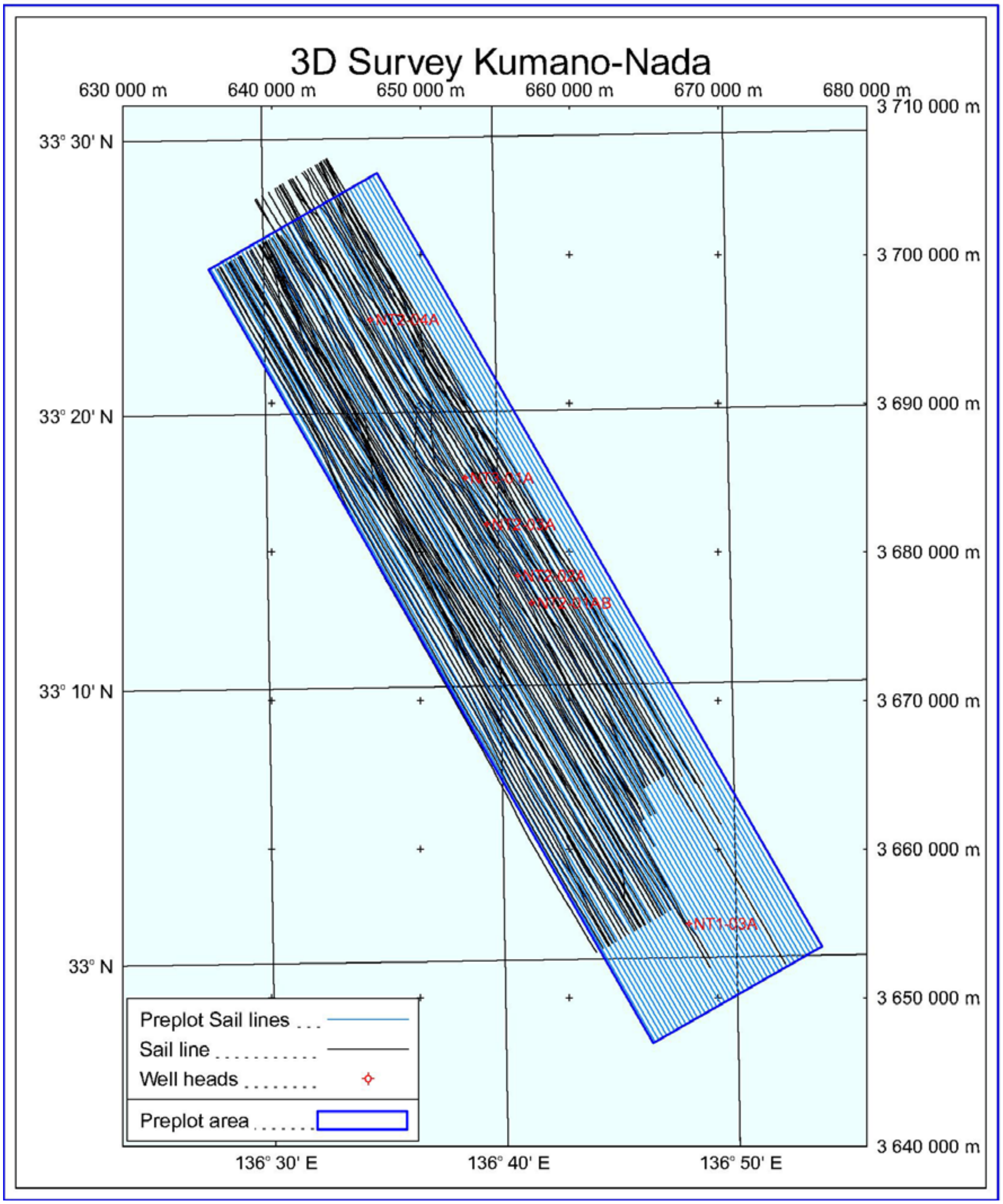
Date	Daily km	Location	Comments
01-May-06	45.563	Prospect	Production Sequence 30-31, downtime fuel leak main engines, thrusters speed test.
02-May-06	149.138	Prospect	Production Sequence 31-33.
03-May-06	117.525	Prospect	Infill Sequence 34-35, production Sequence 36.
04-May-06	106.650	Prospect	Production Sequence 36-38.
05-May-06	31.988	Prospect	Production Sequence 36-39, downtime fuel leak repairs, infilll Sequence 40.
06-May-06	149.813	Prospect	Infill Sequence 40-41, production Sequence 42.
07-May-06	52.088	Prospect	Production Sequence 43-44, terminated 44 NTBP WOW, infill 45.
08-May-06	101.325	Prospect	Infill Sequence 45, production Sequence 46.
09-May-06	115.875	Prospect	Production Sequence 47-49.
10-May-06	94.688	Prospect	Production Sequence 49, downtime spreader rope string 4-5, production Sequence 50, infill Sequence 51-52.
11-May-06	116.513	Prospect	Infill Sequence 52, production Sequence 53-54.
12-May-06	23.963	Prospect	Production 54, standby due to shark bite streamer 3, WOW.
13-May-06	30.263	Prospect	WOW, infill Sequence 56 NTBP, WOW, infill Sequence 57.
14-May-06	103.913	Prospect	Downtime autofire gun 4-02 Sequence 58 NTBP, production Sequence 59-60.
15-May-06	107.138	Prospect	Production Sequence 60, infill sequence 61-64.
16-May-06	103.163	Prospect	Infill Sequence 64-66, reshoot Sequence 67, infill Sequence 68.
17-May-06	73.950	Prospect	Infill Sequence 68-70 survey complete, demobilisation.
18-May-06	0.000	Prospect	Demobilisation.
19-May-06	0.000	Kobe	Demobilisation, transit to Kobe.

2.2 Daily production and sea state





2.3 Post plotted vessel positions



3 Key personnel

	10 to 26 April 2006	26 April to 19 May 2006
Party Chief	Simon Graham	Neil Henderson
Chief Observer	Thor Uppstad	Mikael Bjork
Chief Navigator	Shannon Murray	Stephen Pitcher
Chief Mechanic	Andrew Davies	Peter Smith
Chief Geophysicist	Dave Cox	Jason Norman
Client representative onboard	Tamio Yohroh	Hideki Tanaka
	Glen Reynolds	Glen Reynolds
	Fumio Terayama	Fumio Terayama
	Nathan Bangs	Greg Moore
Client contacts onshore		Tamio Yohroh

4 HSE

4.1 Statistics

Exposure hours	Marine crew	20454
	Seismic crew	25160
	Third party crew	7581
	Total	53195

Workboat operations	30
Workboat exposure hours	101.65

Safety meetings	2
Safety training meetings	5
Toolbox meetings	27
Audits	16
Drills	8
STOP cards	53

4.2 Incidents

Report no.	Date	Action by	Classification	Status	Comments
3101/06	24.04.06	Maritime	Emergency	OPEN	Work boat has engine failure and has to be towed back to Nordic.
3275/06	28.04.06	Maritime	Technical	Closed	Fuel leak to main engine fuel supply caused shut down of main engines.
3275/06	01.05.06	Maritime	Technical	Closed	Fuel leak to main engine supply, leak contained until repaired.

5 Survey area information

Prior to mobilisation, two chase vessels departed from Kobe at midnight on Sunday 9 April 2006 to scout the survey area. However, very poor weather prevented them from doing so and the two chase vessels sought shelter in Shingu Harbour. Due to the bad weather the M.V. *NORDIC EXPLORER* remained at anchor delaying mobilisation from 17:00 on 10 April 2006 to 06:51 on 12 April 2006. When weather conditions allowed, the vessel transited to the survey area, accompanied by the remaining chase boat and met up with the two other chase vessel at the survey site.

Mobilisation began at 21:00 on 13 April 2006, but was suspended at 04:00 on 14 April 2006 due to poor weather, with only streamer 1 deployed. Deployment recommenced at 15:00 on 16 April 2006 and finally completed at 07:23 on 18 April 2006. The lack of scouting prior to deployment did not delay mobilisation due to the very deep water in the area.

The first production line commenced on 18 April 2006 at 07:23 local time and the last production shot took place on 17 May 2006 at 13:56 local time.

Crew change took place at sea via helicopter from Osaka on 26 April 2006.

The initial stages of the acquisition were hampered by repeated problems with guns from 12:12 on 18 April 2006 to 10:25 on 19 April 2006. Thorough work by the gun mechanics fully resolved these problems.

As noted previously, the only fishing encountered during the survey was long liners seen to the south and south-east of the area. Fishing did not impact on acquisition during the survey, although a significant amount of fishing equipment was discovered at the tail of streamers 3 and 4 during recovery.

The very strong west-north-west current - “Kuroshio” - dominated acquisition, resulting in very high feather angles, which contributed to the high percentage of infill data acquired. The currents were noted to be exceedingly strong to the south of the survey area and on early sequences acquisition was attempted for the full pre-plot line length. However, in each case, the line was terminated at the client’s request due to the extreme feather angles and very low BSP (0.1 knots was noted). Subsequently, it was the accepted practice, agreed with the client, that lines on the 150° heading would be terminated at shot point 1200. The turning of the vessel and steamers following a 150° azimuth line was often made more difficult by the strong currents and required the vessel to make a starboard turn, rather than a port turn, and then slide across the survey with the strong current, aiming to pick up the next 330° azimuth line at shot point 1400 or sooner. However, the variable nature of the currents in the South sometimes made it possible to make a quicker starboard turn without risking the in sea equipment. On lines heading 330° the variable nature of the strong current was more in evidence as traverse times to acquire a line on this heading were noted to vary from as little as 6 hr 27 min. on sequence 26 to 15 hr 45 min. on sequence 30.

The sea state and weather affected acquisition on three occasions and acquisition was suspended on 20 and 21 April, and 7, 12 and 13 May. Outside of these times, much of the weather was “marginal” i.e. noise induced into the data by swell was clearly present and during some sequences was noted as excessive, the only limiting factor applied to data acceptance by the client was the ability to maintain streamer control.

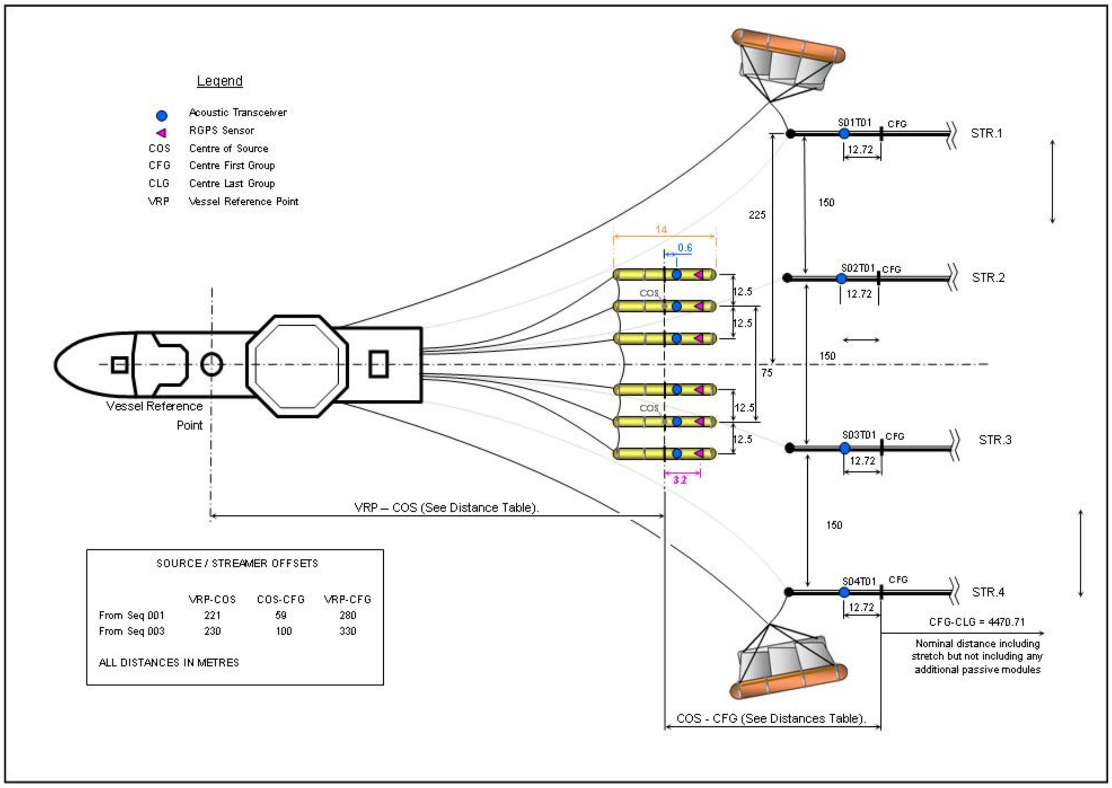
Contractor downtime amounted to 64.57 hours or 7% of the survey. This was split between the various departments, Navigation 0.70 hours, Mechanical 31.85 hours, Maritime 21.87 hours and 10.15 hours for Seismic department. The Navigation downtime was caused by a software failure. The majority of the Mechanical downtime came from auto firing guns as well as a spreader rope failure and air leaks. The Maritime downtime resulted from two leaks on the fuel supply to the main engine, the first caused an immediate shut down of the main engine and good management by all crew enable the vessel to turned in the current and taken under tow by the chase vessel *NIPPON MARU*, whilst maintaining control of the in sea equipment. The second leak was less severe and was able to be contained until a controlled shut down of the engine could be carried out whilst under tow from the *NIPPON MARU*. The Seismic department accrued downtime from sequence 67, the reshoot of the gAS recording system crash during sequence 21, and 7.00 hrs due to the recovery of streamer 3 after it had been damaged. Opinions differ as to the cause of the damage, being either from a shark bite or in-sea debris.

6 Seismic energy source

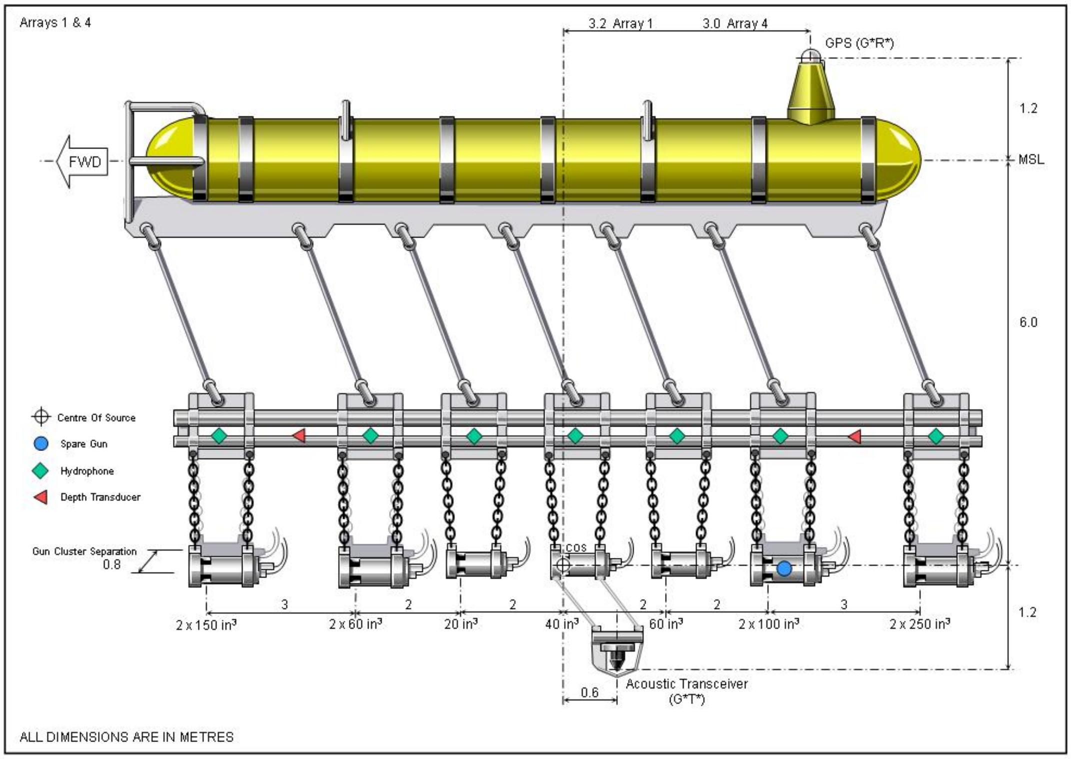
6.1 Source details

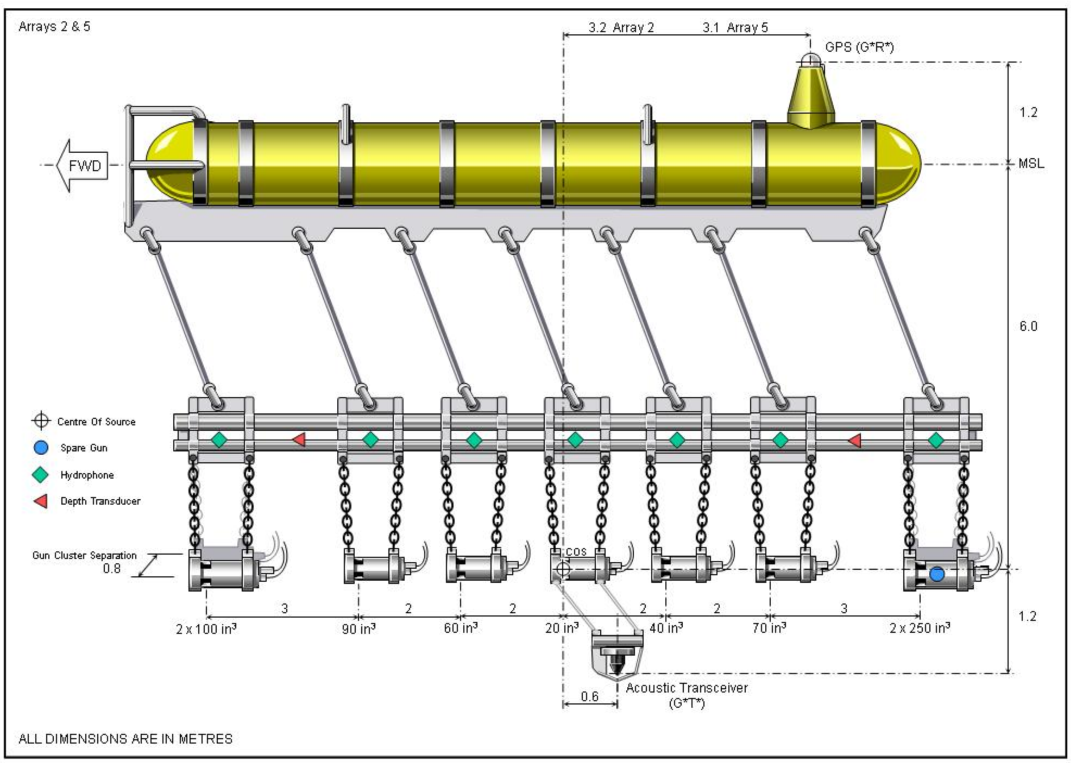
Source type	:	Sodera G gun
Air pressure	:	2000 psi
Volume	:	3090 in^3
Number of sources	:	2
Number of sub-arrays	:	3 x 2
Source separation	:	75 m
Sub-array separation	:	12.5 m
Source length	:	14 m
Gun synchronisation	:	± 1.0 ms
Drop-out specification	:	15% on primary to bubble ratio
Shot interval	:	37.50 m
Depth	:	6 m
Depth control	:	Fixed depth ropes
Depth monitoring	:	Sercel & Seamap depth transducers, GCS90
Spacing control	:	Spread-ropes on sliding collars
Near field signatures	:	7 phones per subarray
Compressors	:	LMF FCP 500 L/4 (3 units)
Source controller	:	GCS-90, version 4.76

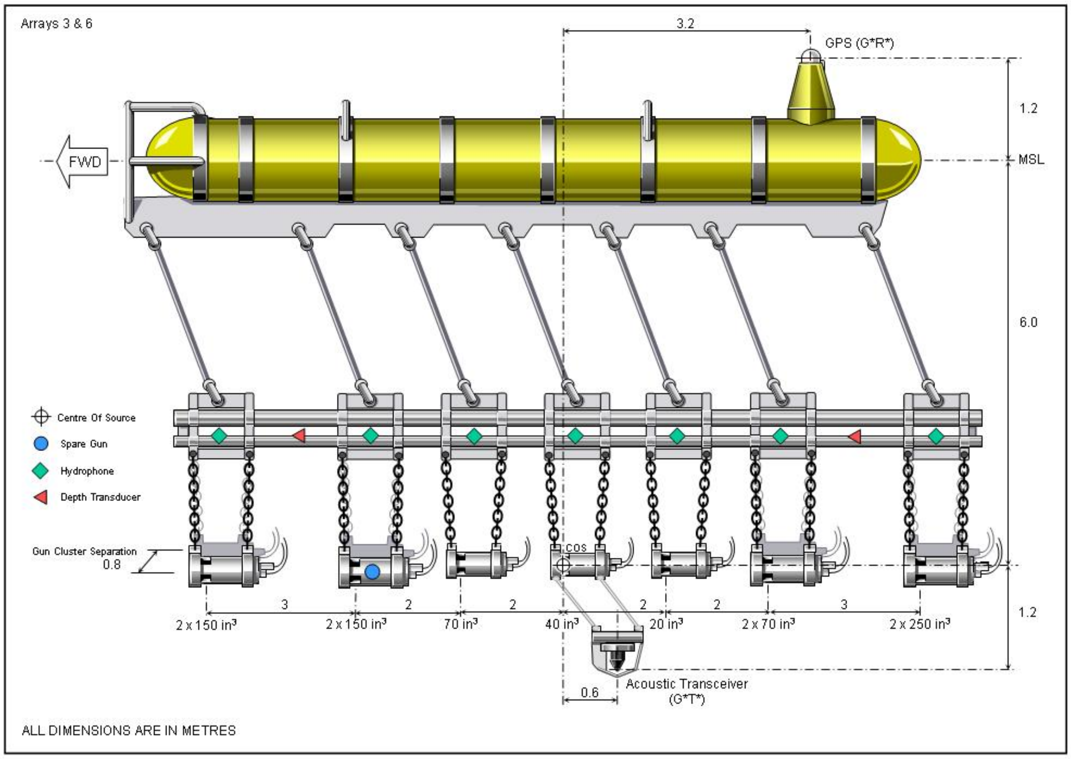
6.2 Offset diagram



6.3 Gun array layout





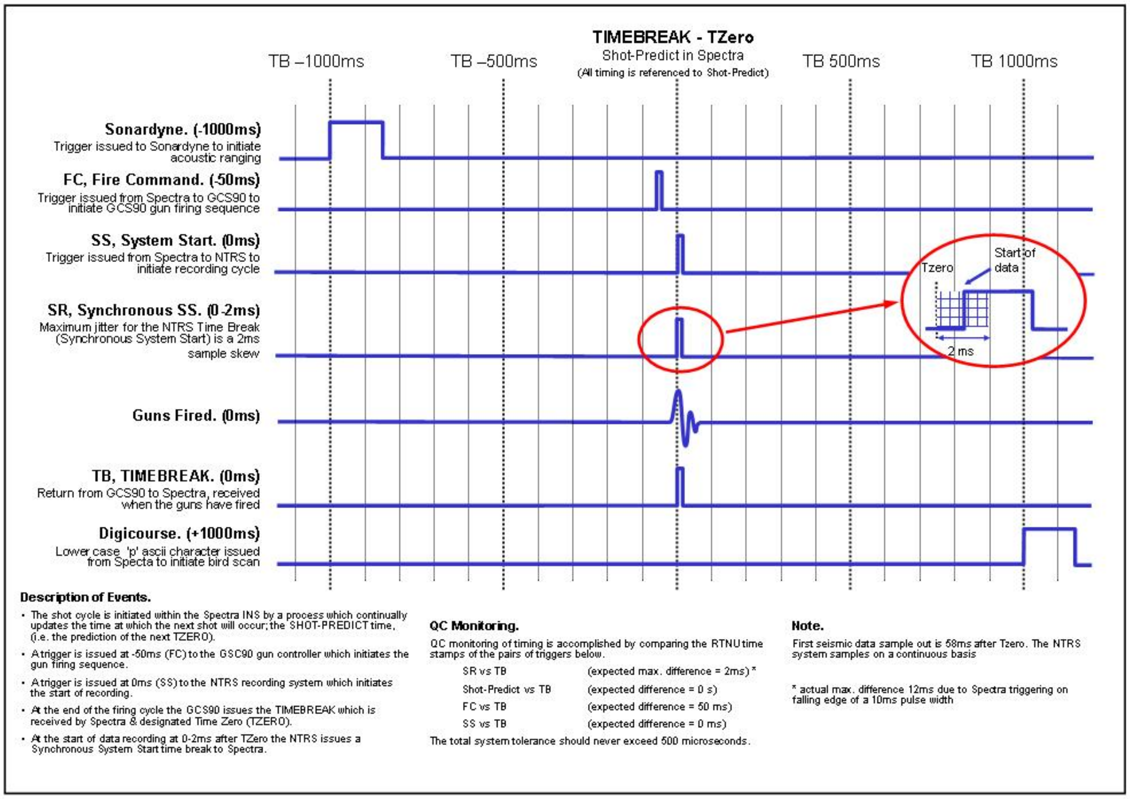

Arrays 3 & 6
3.2
GPS (G*R*)
1.2
FWD
MSL
6.0
Centre Of Source
Spare Gun
Hydrophone
Depth Transducer
Gun Cluster Separation
0.8
COS
3
2
2
2
2
3
1.2
2 x 150 in³
2 x 150 in³
70 in³
40 in³
20 in³
2 x 70 in³
2 x 250 in³
0.6
Acoustic Transceiver
(G*T*)
ALL DIMENSIONS ARE IN METRES

7 Seismic acquisition system

7.1 System details

Recording System	:	HTI/NTRS2 / gAS
Software Version NTRS2	:	A.5a build 8736
Software version gas	:	3.03-1, patch 3.03-2
Amplitude resolution	:	24 bit
Data Channels	:	360 per streamer
Auxiliary Channels	:	48
Tape Transports	:	6 x IBM 3590 cartridge drives
Tape Format	:	SEG D, 8036 Rev. 1.0, 64kb blocks, 6 traces/block
Recording Media	:	Emtec & Imation 3590 cartridge
Record Length	:	11264 ms
Deep water delay	:	0 ms
Sample Rate	:	2 ms
High Cut Filter	:	206Hz / 214dB/octave
Low Cut Filter	:	4.6Hz / 6dB/octave
Gain Setting	:	12 dB
Amplifier	:	Voltage Mode Differential, high impedance
A/D Converter	:	24 bit, Crystal cs5320 Delta-Sigma modulator
Cross-Feed Isolation	:	95 dB
Power Consumption	:	7.1 W per module
Polarity Convention	:	SEG, positive pressure gives negative number
SEG-D header description	:	see Appendix section 14.3

7.2 System timing



7.3 Streamers

7.3.1 Streamer details

Type of streamer	:	RDH-S
Number of streamers	:	4
Streamer sensitivity	:	20 V/bar
Streamer length	:	4500 m
Number of groups	:	360
Group interval	:	12.5 m
Group length	:	12.5 m
Hydrophone type	:	T-2BX
Streamer depth control	:	Digibird 5011
Streamer depth	:	7 m
Number of compass-birds	:	18

7.3.2 Trace Numbering

STREAMER	TRACE
Streamer 1	1 to 360
Streamer 2	361 to 720
Streamer 3	721 to 1080
Streamer 4	1081 to 1440
Auxiliaries	1 to 48, appended to streamer 1

7.3.3 Component dimensions

	NUMBER per STREAMER	NOMINAL LENGTH (m)
Lead-in	1	700
Head Stretch Sections	1	3
Dead Sections	1	15
HTI Sea Track Module	30	0.341
Live Sections	60	75
Tail Stretch Sections	2	50
Power Adapter	1	3.80

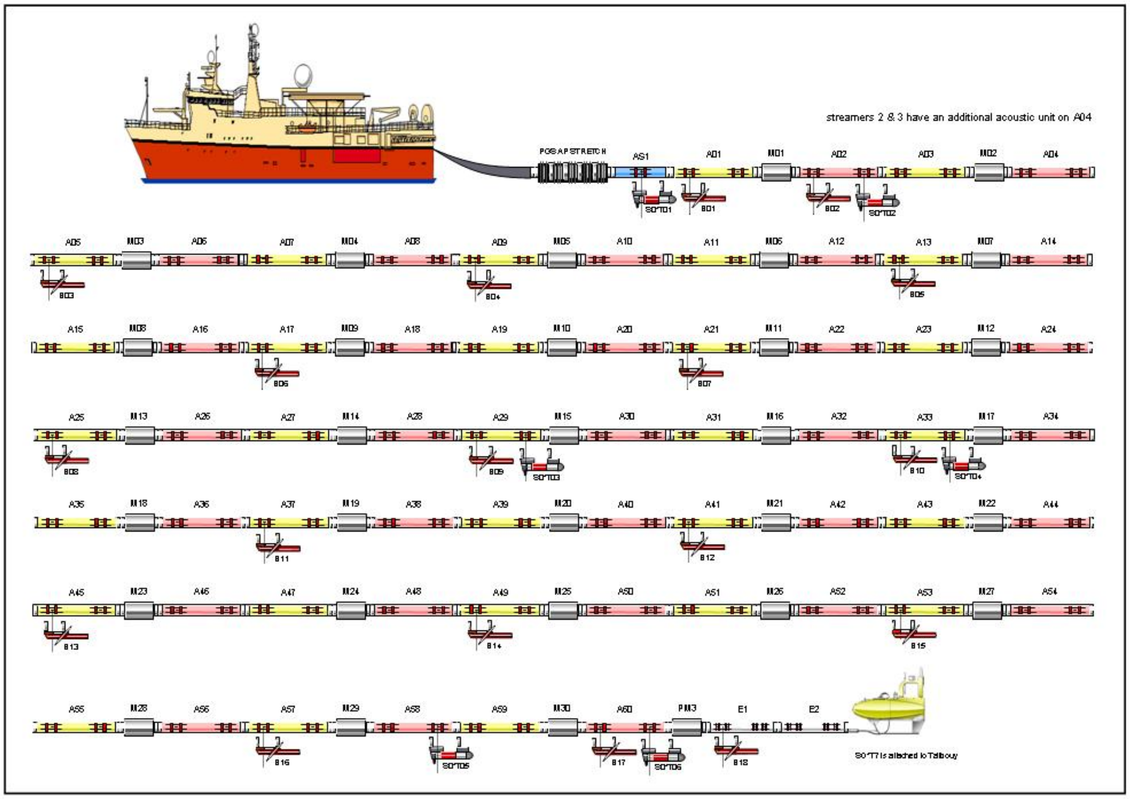
7.4 Recording System performance

Recording systems have behaved well during the survey.

Streamer 1 stopped recording due to a power loss during sequence 021, lost 68 shots.

Streamer 3 had one occasion when it stopped recording during sequence 054 due to a power leakage. As the weather was not suitable for the workboat, that streamer was recovered and section A48 changed out. Streamer 3 lost power again during sequence 057 and 20 shots was lost.

7.5 Streamer layout



8 Navigation and Positioning

8.1 Geodetic reference

8.1.1 Survey Datum

Survey datum	:	WGS84
Ellipsoid	:	WGS84
Semi Major Axis	:	6 378 137 m
1/Flattening	:	298.257223563

GPS Datum	*:*	*WGS84*
Ellipsoid	*:*	*WGS84*
Semi Major Axis	*:*	*6 378 137 m*
1/Flattening	*:*	*298.257223563*

8.1.2 Geoid height

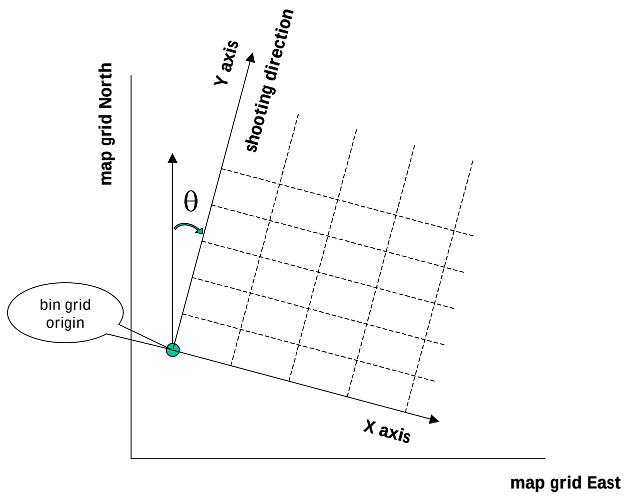
EGM96 model	:	34.9 m, position 33º 12' N, 136º 40' E

8.1.3 Map projection

Projection	:	Transverse Mercator
Projection System	:	UTM
Latitude of Origin	:	0º N
Central Meridian	:	135º E

False Easting	:	500000 m
False Northing	:	0 m
Scale Factor on Central Meridian	:	0.9996

8.2 Binning grid



Origin Easting (m)	:	664866.56367
Origin Northing (m)	:	3643045.6321
Rotation (deg)	:	330.1227º

	X	Y
Origin bin number	987	921
Bin number increment	1	0.333333
Area size (m)	19350.0	66037.5
Bin interval (m)	37.5	12.5
Flexed Bin size minimum (m) at 100 m offset	37.5	12.5
Flexed Bin size maximum (m) at 4600 m offset	112.5	12.5

The tapered flex was provided by the onboard Client Representative.

8.3 Surface positioning

8.3.1 System I

Type	:	SkyFix.XP, orbit and clock corrected GPS
Differential Corrections via	:	Inmarsat POR / Spot APsat
Software	:	MultiFix 4, v 1.09
GPS receiver	:	Trimble MS750
Sub-Contractor	:	Fugro-Survey AS

The SkyFix XP was excellent throughout the survey.

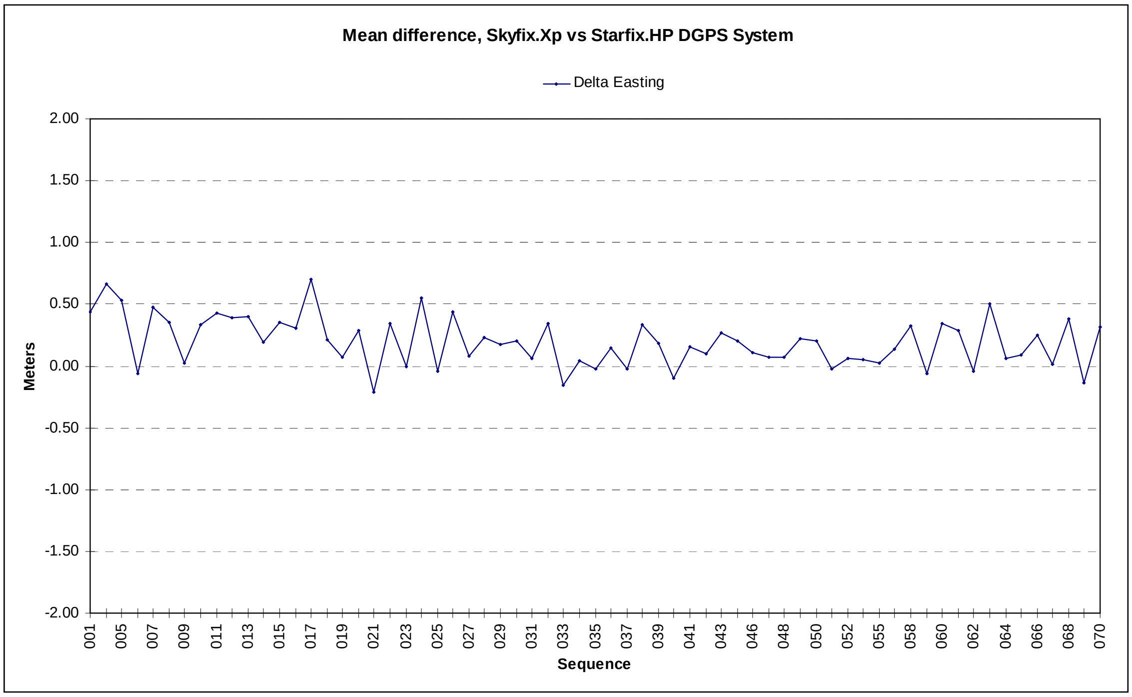
8.3.2 System II

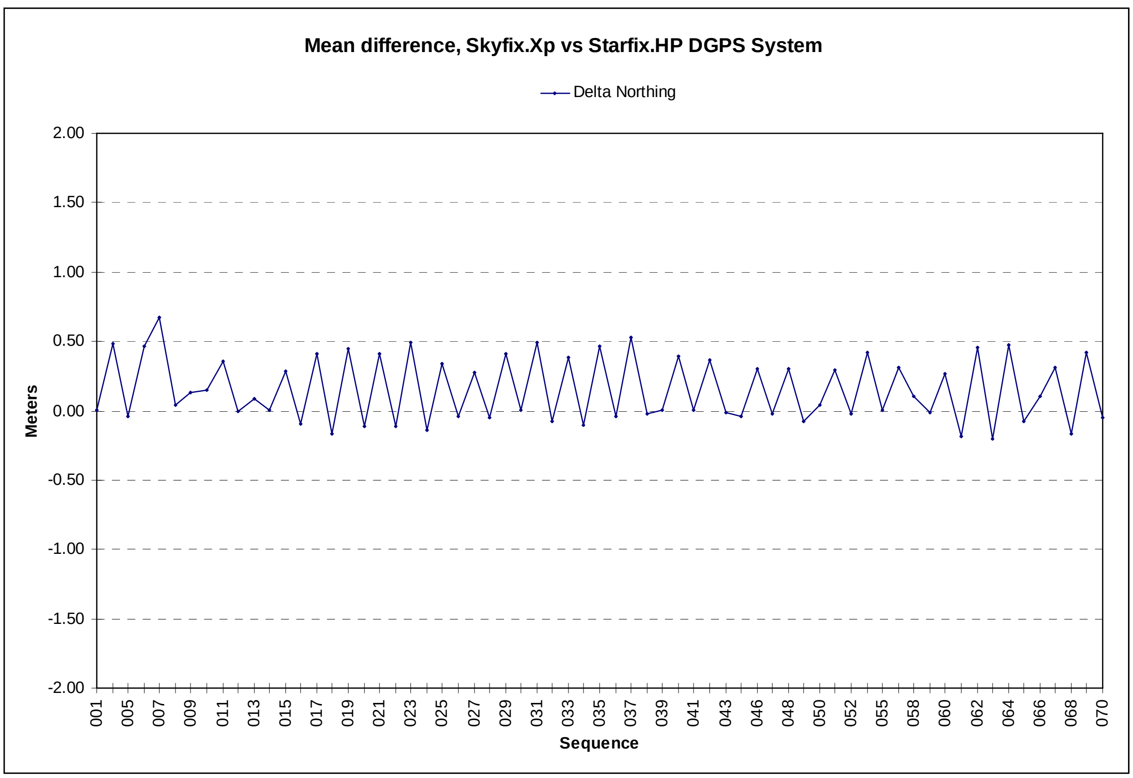
Type	:	StarFix.HP, carrier phase DGPS	
Differential Corrections via	:	Spot APsat	
Reference stations	:	Seoul	1000 km distant
		Okinawa	1160 km distant
		Asahikawa	1280 km distant
		Tanggu	1820 km distant
Software	:	SPM v 4.15	
GPS receiver	:	Ashtech 12 channel	
Sub-Contractor	:	Fugro-Survey AS	

StarFix.HP was stable but the system was prone to very occasional spiking of the raw data. Sequences 001, 014, 015, 016, 061 and 063 had short periods of intermittency/absence of data.

The mean differences in east and north components between StarFix.HP and SkyFix.XP, with equal weight, were excellent and typically well below 1.0 m. Two time series are posted below.

8.3.3 System I vs System II





8.3.4 Float positioning

Relative GPS	:	Seatex Seatrack 320/220
GPS receiver	:	Ashtech G 12-L-1
UHF communication	:	Wood&Douglas, frequency 450-470 MHz
Software version	:	StarFix Suite 6.2 (SP2), RGPS v. 3.02.05 Seadiff v. 7.05n

The range and bearing data from the gun floats and tailbuoys was typically excellent and reliable. The occasional noise present did not cause a problem in navigation processing. The Seadiff data was only used on the rare occasions when the StarFix rgps data was temporarily absent but Seadiff was not.

The RGPS pod on tailbuoy 2 failed before sequence 027 and was replaced during the earliest period of good work boat weather on sequence 037.

The tailbuoy 1 pod stopped working during sequences 034 and 036 when the power failed; because of a streamer power problem the battery was solely dependent on solar power for charging. A new combi box, with a fully charged battery, was installed during sequence 037.

The mount for the array 6 pod came off the array during sequence 061. A new pod and mount were installed before sequence 062.

8.3.5 Heading reference

GPS Heading / Attitude system	:	Seapath 200 v. 1.02.06 (primary)
Gyro	:	SG Brown 1000S (secondary up to Sequence 030) SG Brown 1000B (secondary from Sequence 031)

Seapath was used for all lines. The secondary gyro was switched from the SGBrown 1000S to the 1000B due to occasional drifting of the 1000S data after line starts in the extreme currents of the south of the prospect area.

8.3.6 Delivered P190 and P294

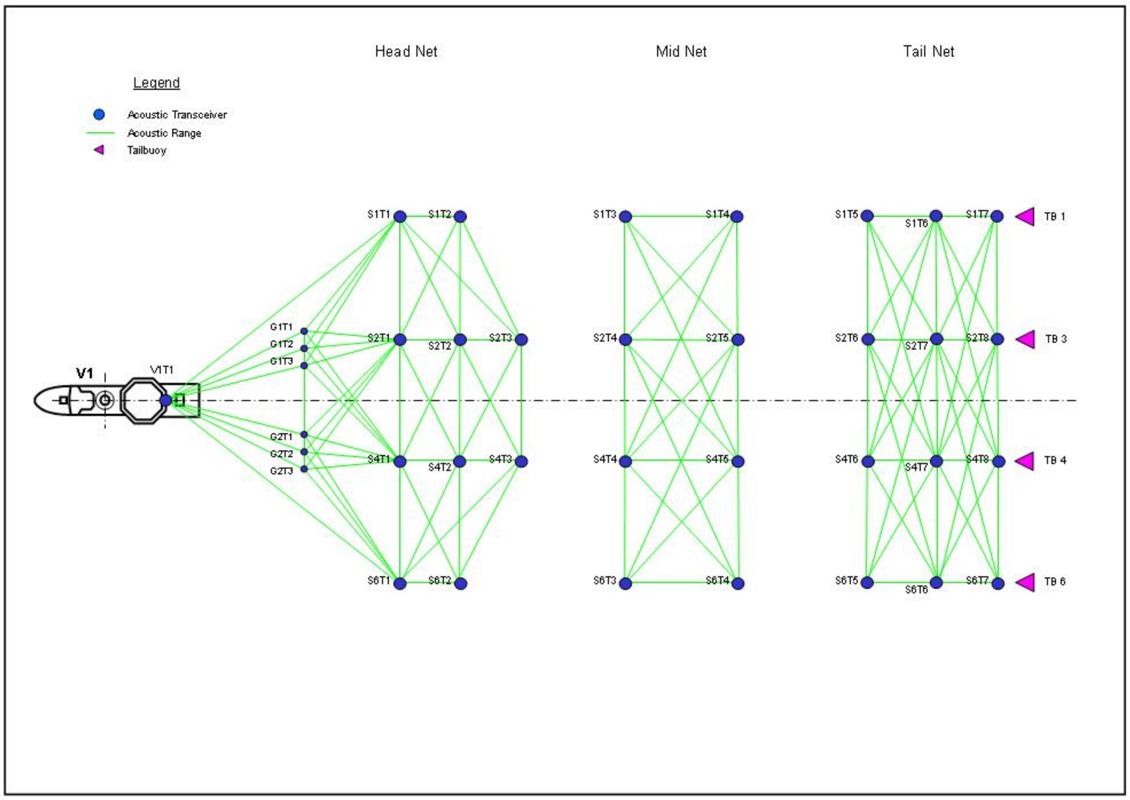
Navigation data was shipped from the vessel on 3590 cartridges, with a maximum of 30 sequences per tape, as outlined in Appendix 13.1. Two formats and two sets of each format, the raw P294 and processed P190 data sets were delivered.

8.4 Underwater positioning

8.4.1 Acoustic ranging system

System name	:	Sonardyne SIPS2
Software version	:	2.20.0
Frequency	:	75.0kHz & 76.8kHz (digital), 65 –110 kHz (tone)

8.4.2 Acoustic network



The performance of the acoustics was generally very good; a few nodes suffered some reduced ranging performance, but there was always sufficient redundancy in the three networks to allow correct positioning of the streamers.

The gun bubble and propeller wash adversely affected ranges in and around the front ends of streamers 2 and 3; setting these ranges to a three pulse frequency signal rather than a single pulse digital signal optimised transmissions through the aerated water.

A few sequences suffered from poor tailbuoy ranging due to heavy rain showers. The poor tailbuoy ranges during sequence 033 however, were not during a time of heavy rain; it is not known what caused the severe disruption of the ranging to and from the tailbuoys during this sequence.

Following sequence 033 tailbuoys 1 and 4 used acoustic units installed on the tail of the rear stretch sections in place of the tailbuoy mounted units, this was to try and avoid a recurrence of the weak sequence 033 tailbuoy ranging. But damage to the streamer 4 stretch unit meant the buoy mounted transducer had to be used again from sequence 055.

8.4.3 Magnetic compasses

Bird Compasses	:	DigiCOURSE System 3, 5011 Bird
Software version	:	System 3, v 3.12
Magnetic variation, IGRF-10 (20-Nov-05)	:	-6.42º, position 33º 12' N, 136º 40' E

Compasses with bias greater than 0.7º were not used in navigation processing. The occasional compasses that failed or continually demonstrated bias were changed out at sea and caused no problem with the streamer positioning.

During post processing a standard deviation of 0.5º was used for all compasses, except for sequence 006 and 057, when standard deviation was set to 0.7º.

8.4.4 Echosounder

Type and model	:	SIMRAD EA500
Transceiver Frequency	:	38kHz / 200kHz (Master)
Heave compensated	:	Yes (Seapath 200 / MRU5)

There was very little depth data recording to the P294 Spectra files as the 38 KHz transceiver could only range to approximately 2000 m. No E records were output in the final P190 data.

8.4.5 Sound velocity

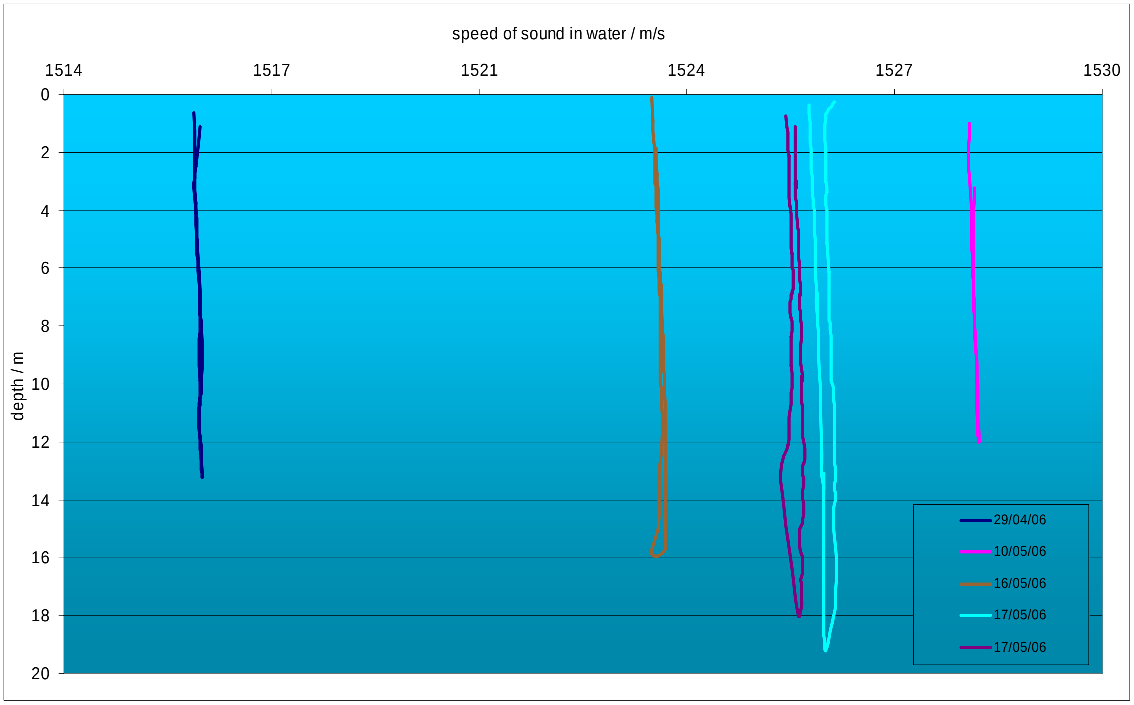
CDT probe	:	Valeport Midas SVP ser. no. 23764
Real time sensors	:	Sonardyne SIPS2 8018 ASV XSRS transceiver x 2

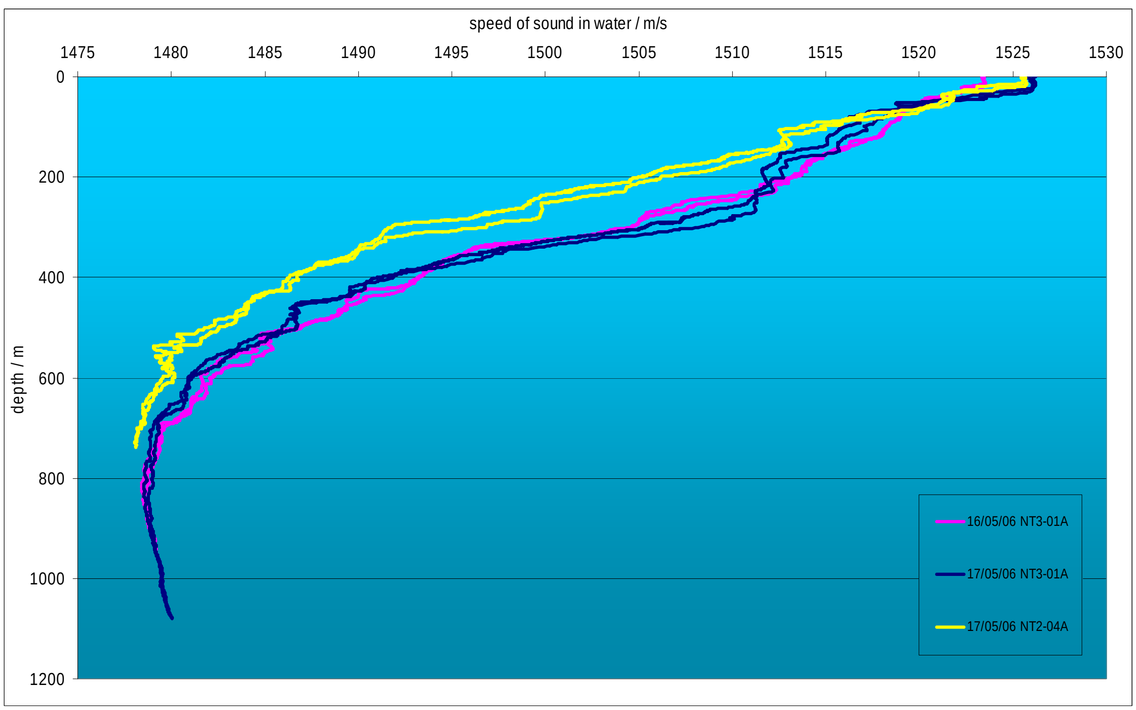
The real time velocimeters were mounted at the head of streamer 1 and the tail of streamer 4. The probes produced reliable data with no significant difference in values between the head and tail of the streamers.

Damage to the probe on the tail of streamer 4 meant there was no real time speed of sound data for the tail net from sequence 055.

The streamer depth profiles produced by the Valeport probe are plotted below along with three deeper profiles. The deeper dips were performed from the chase boat, Mirai, on the 16 and 17 May at the approximate locations of prospective well heads NT2-04A and NT3-01A.

8.4.6 Velocity Profiles





8.5 Navigation and binning systems

8.5.1 Integrated navigation system

Type	:	SPECTRA
Supplier	:	Concept Systems Ltd.
Software version	:	10.9.01
Real Time Interface	:	RTNU v OS9 3.0.3
Machine type	:	2 x Dell PowerEdge 4600
Tape storage	:	3590/ 4 mm DAT tape
External disks	:	SCSI RAID 5

8.5.2 Binning system

Type	:	CENSUS
Supplier	:	I/O Inc.
Software Version	:	4.4.1
Machine type	:	IBM RS/6000: H50 (Offline), H50 (Online)
Tape storage	:	IBM 3590
External disks	:	Raid 11 x 9.1 GB (Offline), Raid 5 x 9.1 GB (Online)

9 Navigation processing

9.1 Introduction

Data were processed using SPRINT. The processing was comprised of the following steps:

- Data import
- Data pre-processing
- Network adjustments
- Data export
- Final quality control

Each of these steps is covered in more detail below.

9.2 Data import

Raw data were recorded to tape and disk in P294 format. After the end of line these data were checked, and if necessary, corrections were made to the header to produce a final archived version. These data were then imported into Sprint, and a QC report generated. Included in this report were:

- P2/94 format errors or inconsistencies
- differences in configuration between successive files
- changes in gun sequence
- time between shots not within specified limit
- jump in shot numbers
- number of headers

9.3 Pre-processing

All data were pre-processed to ensure consistent results in the adjustment phase.

During pre-processing, observations were grouped by sensor type. Predefined spike rejection gates and noise suppression filters were applied to the raw data. Configuration files were used to save all gating and filter values. After analysis, the final values were applied in a batch mode.

Where circumstances dictated, the values were changed interactively before the data were batched.

After pre-processing of all the observations, a quality report was generated containing the following information:

Nobs	:	Number of raw observations.
Nrej	:	Number of data observations missing after processing.
Bad block	:	Maximum block of missing raw data (in seconds).
Nominal	:	Nominal values computed from the logged offsets, or user assigned.
Mean	:	Mean value of the observation.
Max. Delta	:	The maximum shot to shot increment.
Units	:	In which unit data is recorded.

9.4 Network adjustments

The network adjustment stage consisted of a least squares adjustment of the processed observations for each shot point. The software allows the observations to be treated as either a complete net, or a series of sub nets (e.g.: vessel antenna, front net, tail net, etc.). Sub nets were used for analysis of problem lines. A complete net was used for final adjustment after the individual sub nets were solved.

The streamer-shaping algorithm in use was an arc of curve fit through the pre-processed compasses. The streamer shape is adjusted through network computed node positions.

At the end of the net adjustment, a quality report was generated. Items included were:

- Network configuration
- Statistics on node covariance's
- All observations scale/correction/SD in use
- Statistics on node shot point intervals
- Statistics on observation residuals
- Statistics on network variance factor and degrees of freedom
- The error ellipse (semi-major axis/skew) of all defined nodes
- Streamer rotation

9.5 Data analysis

Data analysis were performed for all lines and allowed all data from the Postgres database to be displayed. There were two main uses for this facility. The first was to produce a standard set of QC plots for each line, and the second was to act as an investigation tool for problems seen at any stage of processing.

Configuration files were defined to create a standard set of QC plots for every line.

The following plots were included:

Inline misclosure
Streamer rotations
Steamer separation on front and tail
Distance vessel-sources, vessel-streamer heads
Shot point interval (distance and time) of vessel ref. position
Gyro and course made good of vessel ref.
Position comparisons (Field position vs. Post-processed position)
Network variance factor and degrees of freedom

All the QC plots were created as a PDF files and were available to navigation client onboard.

9.6 Data export, P1/90 output

During the export process the receiver positions were computed and a P190-file was generated. The in-line misclosure error was accounted for by applying a linear distribution of the error to computed receiver positions. A header was added to the data during export. Due to the poor echo sounder readings, no E records were output in the final P190 data.
The data were written to 3590 tape cartridges.

9.7 Data quality control procedures

The first line was sent to the office for QC. Both the P1 and P2 headers were checked. The line was processed and the solution was compared with the P190 file from the vessel. This procedure was repeated after each crew change to make sure there were no errors introduced. In addition, lines were sent to the office when the QC parameters exceeded the thresholds given in the PGS standard procedures, or the Client's specifications.

The final P294 tapes were checked using PGS internal software **p2list**. This program checked and returned the following information:

- Which files were on a tape and if each file had a complete header.
- Number of end-of-file markers and if the last record had an EOF mark.
- The filename, the sequence, the media label identifier (H0003), the number of shots, the number of shot inconsistencies (missing or double shots) and the number of records.
- A checksum, which were used to verify that data on tape were identical to data on disk.
- For every file the first and last E1000 record was printed.
- If there were shot inconsistencies, the E1000 records surrounding the inconsistency were printed.

Final quality control performed on the data included a number of streamer comparisons, both inline and streamer-to-streamer.

- Vessel, source and receiver positions were checked for internal consistency.
- The applied streamer rotations and the inline misclosures were checked.
- Latitude/longitude and grid coordinates were checked against the datum/projection defined in the header.

The final P1/90 files were also checked using a Sprint QC tool, which checked:

- Contents of the first and last vessel record.
- Source id of the first and last source record.
- Number of even and odd shot points with different source id.
- Number of header records found.
- Number of vessel, source, tail buoy and receiver records expected and how many were found.
- Number of new line characters found.

The final P1/90 files were checked using a PGS internal software **p1check**. This program checked and returned the following information:

- Tape name and date of issue.
- Datum/projection information from the header.
- For every line in the file: start/end shot and start/end co-ordinates.
- Standard comment record (H2600) concerning lines and shots in the file.
- Linefeeds in the file.
- All records 80 bytes long.
- Number of end-of-file markers and if the last record had an EOF mark.
- Grid co-ordinates correspond to the latitude and longitude with the given datum and projection.
- A checksum, which were used to verify that data on tape were identical to data on disk.

The final P190 tapes were checked using PGS internal software **p1list**. This program checked and returned the following information:

- Which files were on a tape and if each file had a complete header.
- Number of end-of-file markers and if the last record had an EOF mark.
- The filename, the tape version identifier (H0202) and the number of records.
- A checksum, which were used to verify that data on tape were identical to data on disk.
- For every line in the file the line name, FSP, LSP and the position of SOL and EOL was given.

Results of the P2list, P1list and p1check were saved and copies are archived in the Oslo office.

All tape labels were created using PGS internal software **mklab**. All information on the labels was extracted from the files on the tapes.

9.8 Computer systems

Computer	:	Dell PowerEdge 2850
Disk Storage	:	RAID 10, 219 GByte
Tape Storage	:	1x IBM Magstar 3590 B1A
Printer / Plotter	:	HP LaserJet 5M / DesignJet 755CM
Operating System	:	Redhat Enterprise Linux 3 WS
Processing System	:	Concept System's SPRINT v.4.3.3

10 Seismic data quality

The objectives of the onboard QC processing system were to ensure that high-quality seismic and navigation data were acquired; to run tests and generate displays that demonstrate the quality of the data, and to evaluate the noise levels of that data in order to assist in the determination of its acceptability. This is performed both real-time through geophysical Acquisition System (gAS), which is used to both record and monitor, and offline through the VIPER QC system.

10.1 Swell noise

The weather was consistently poor throughout the survey resulting in swell noise observed on a large percentage of the data. Due to the nature of the survey all swell noise was accepted by the client despite being above PGS thresholds on a number of occasions.

10.2 Strum Noise

Using RMS values it has been possible to analyse channels 7-18 at the front end of each of the streamers, with a 3-6-20-25Hz filter applied, in order to get a representative idea of the level of strum noise is experienced on a sequence-by-sequence basis.

Evidence of strum noise was seen throughout the survey but mostly occurred on streamer 1.

10.3 NTBP sequences

The following lines were deemed Not To Be Processed (NTBP):

- **Sequence 002** Line deemed NTBP due to an air leak on port arrays.
- **Sequence 004** NTBP d/t abnormal feather, shot in time mode, and is outside of the area of immediate interest.
- **Sequence 044** NTBP due to Bad weather (poor cable control).
- **Sequence 056** NTBP d/t depth control/swell noise.
- **Sequence 058** NTBP d/t airleak gun string 4.

10.4 Bad channels

Traces were investigated for noise both during and after the end of each line.

The Observing Department utilising the gAS (geophysical Acquisition System) online QC would log traces which were bad and would request more in-depth analysis of shots/traces that they deemed needed more attention using the offline QC system - Viper.

gAS also produces a series of postscript files of the various RMS signal and noise window displays for each sequence which, by way of an interactive graphical interface on Viper, were interrogated for the purpose of identifying noise bursts and higher than average noise, with all traces that failed this analysis being appropriately logged in the Observer log.

Daily Instrument tests were also produced and any traces that failed the test would be checked and logged in the Observer logs.

As a result traces were logged as N=Noisy, W=Weak, D=Dead, I=Failed Instrument Tests, S=Spiking, L=Leakage, X=Crossfeed, or any combination of these.

10.5 Depth Edits

Throughout the survey, all streamers depths were analysed at the end of each line and any streamer that was outside a ±1.5m allowance for more than 20 shots had depth control edits applied.

The following sequences requiring depth edits: 006, 010, 012, 014, 021, 026, 028, 032, 033, 035-037, 039, 043, 045, 047, 049-053, 055, 057, 059-062, 066, and 069.

10.6 RMS and noise analysis

RMS values are generated both real-time through gAS, and online through Viper. In both, cases the RMS calculations were performed for all 1440 channels (4 streamers each with 360 channels) for each shot in five distinct and constant time windows:

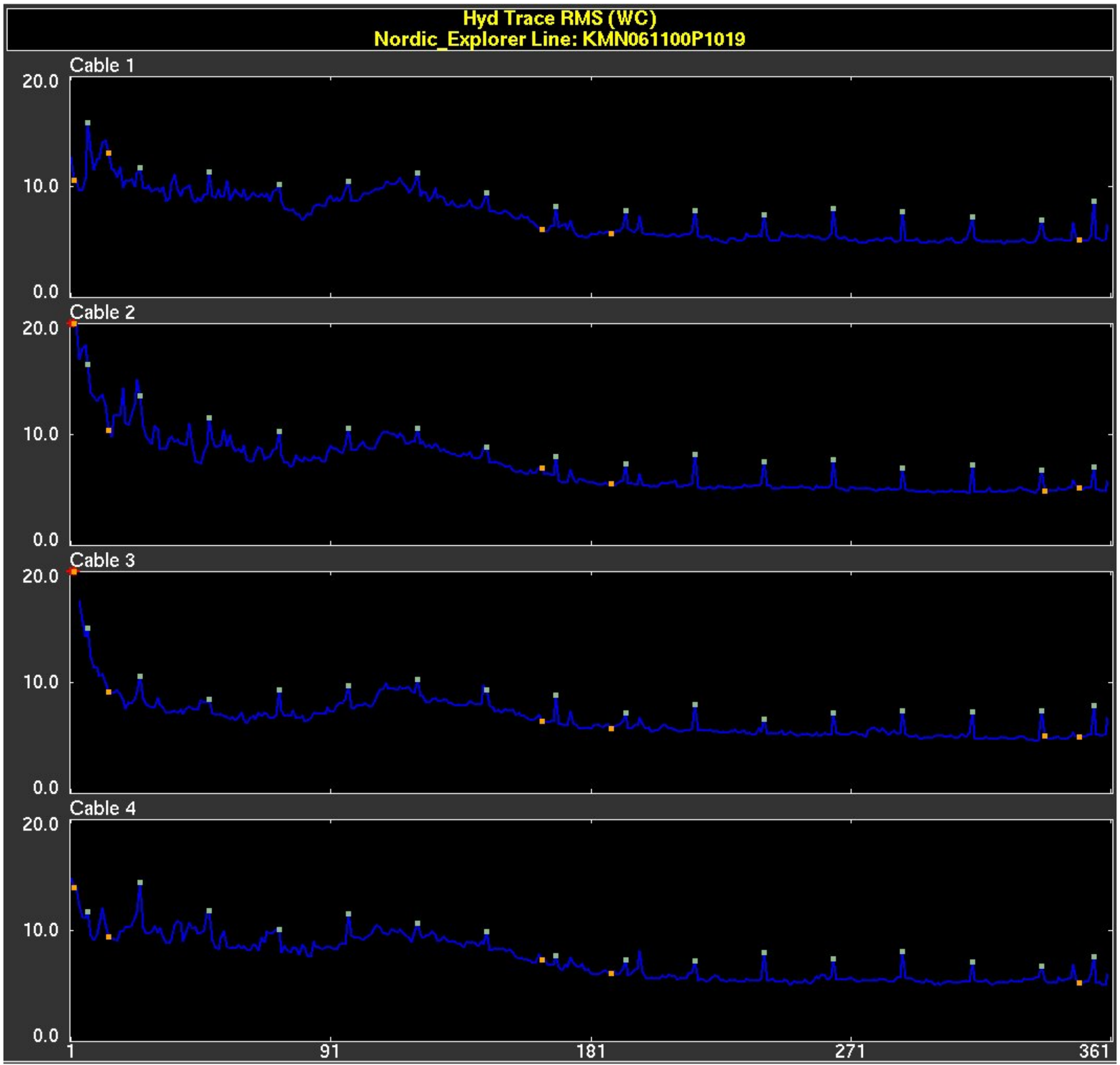
RMS Windows	Time	
Water-Column	1000 ms -	1500 ms
Direct Arrival	-250 ms -	250 ms
Signal 1	500 ms -	1000 ms (Below water bottom)
Signal 2	2000 ms -	2500 ms (Below water bottom)
End-of-Record	10500 ms -	11000 ms

RMS Graphical representation

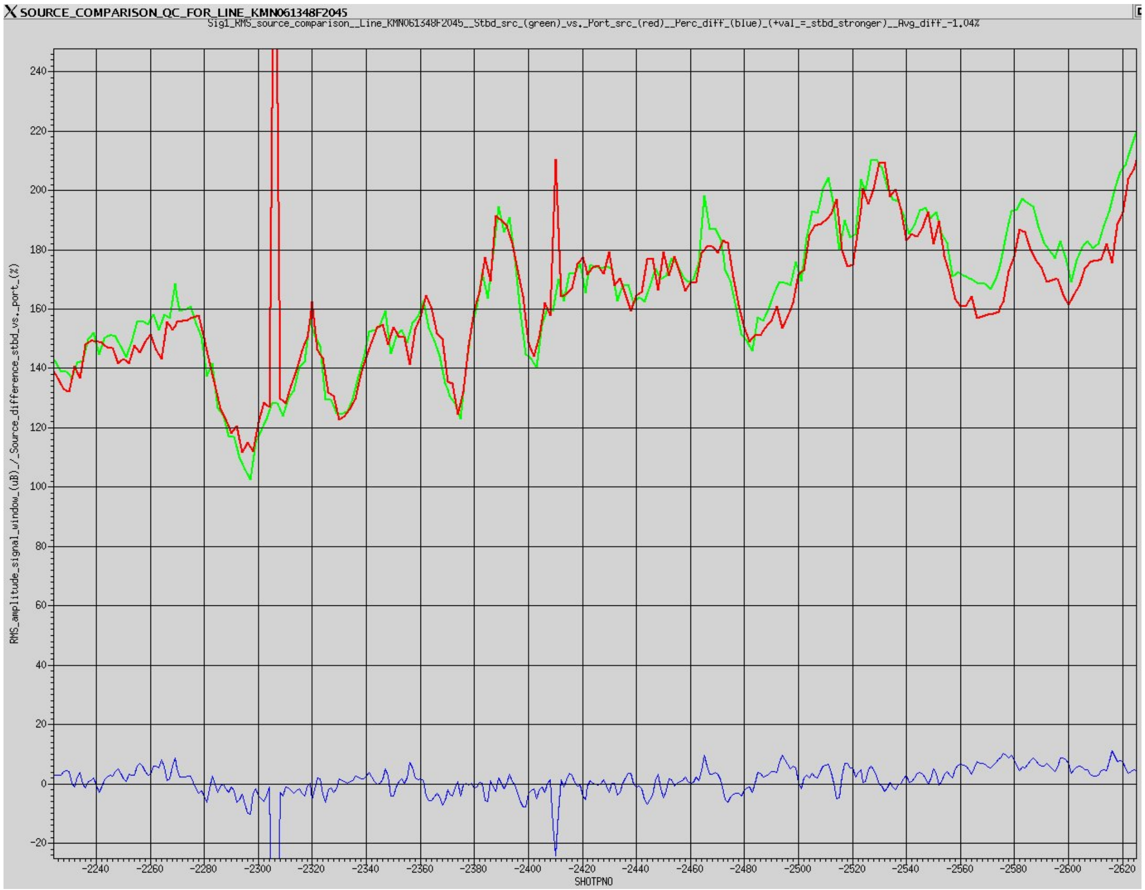
The end of record "noise" window is analysed both online (through gAS) and offline (through Viper) to check RMS noise levels. This window will display any residual noise energy which can be noted as appropriate. It is also used to identify any bad channels and/or shot records. In addition, the raw shot plots are also interrogated and shot point and channel edits confirmed/established against those already highlighted on a sequence-by-sequence basis. It is also possible to analyse the ambient "Water-Column" noise window to identify similar features, as well as any localised areas affected by ship or swell noise.

The Average Trace RMS display is obtained directly from the raw data captured and transferred to Viper from the gAS recording system as postscript files. This graph is then viewed interactively via Tool Command Language (TCL) and the display can be used to identify the noise characteristic of channels.

A further offline display compares the % difference in the signal window 1 and signal window 2 and is used to check for gun imbalances. Localised variation in structure and geology (i.e. shallow pockets of gas, folding and faulting, etc) as well as variations in the geometry of the source configuration need to be taken into account when analysing this display as they will have dramatic effects on any noted % differences, beyond those purely as a result of gun related problems.



Above is a display of the Average Trace RMS, for line KMN06-1100P1-019, over a line for each streamer (streamer 1 at the top of the display) with bird and pinger locations annotated along each baseline

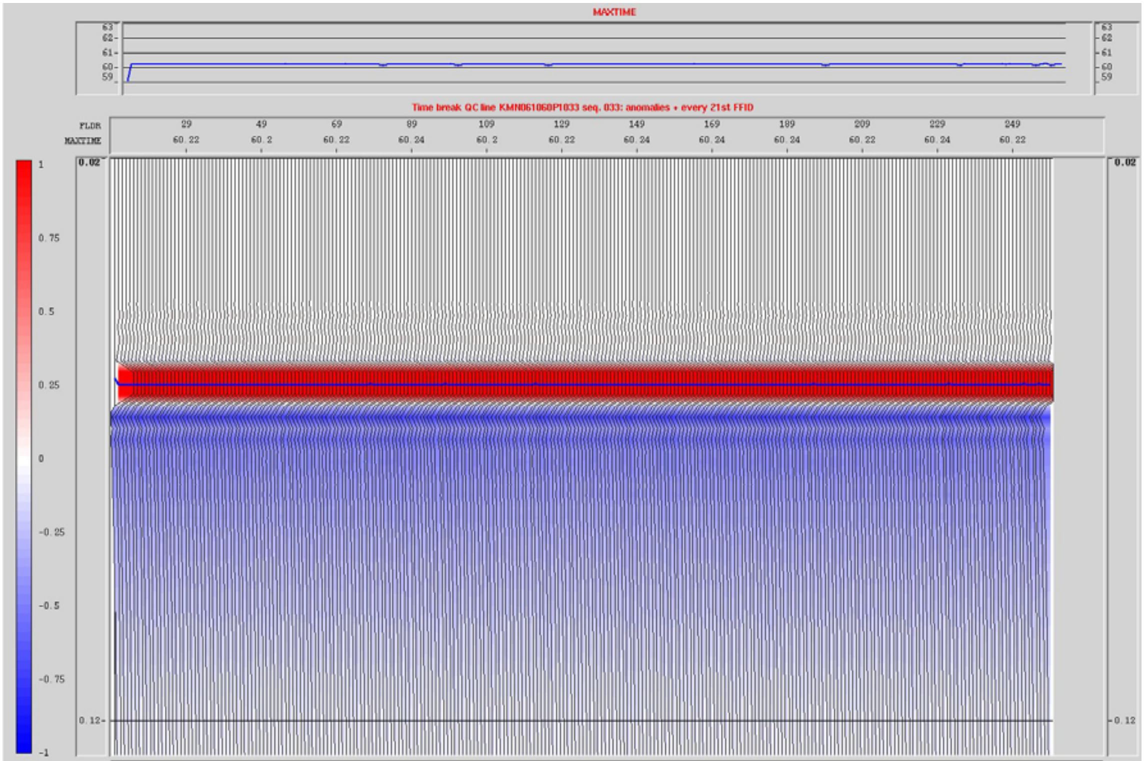


Above is an example display, for line KMN06-1348F2-045, of the RMS signal window for starboard (green) and Port (red) with the % difference graph given at the bottom (note: this is based on a signal window of 1000-1500ms below water bottom).

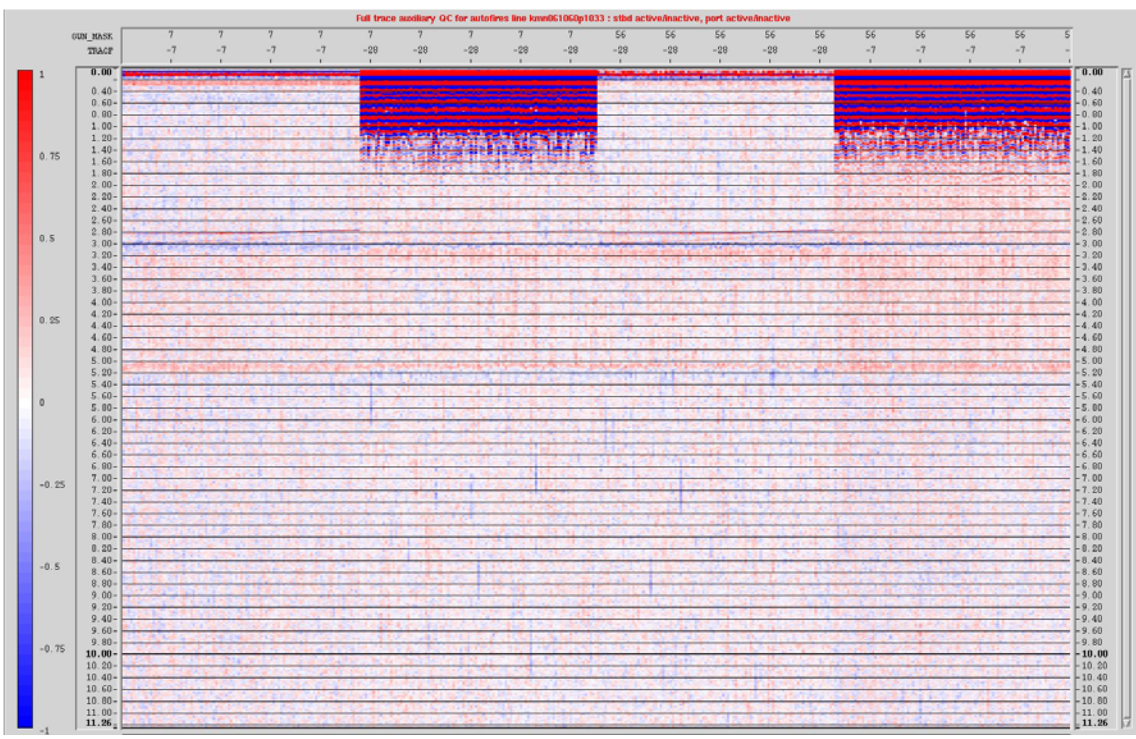
10.7 Near Field Hydrophone (Auxiliary Channel) QC

The output of the near field hydrophones mounted on the gun strings were recorded on the auxiliary channels, together with the system time-break in order to identify gun-timing errors.

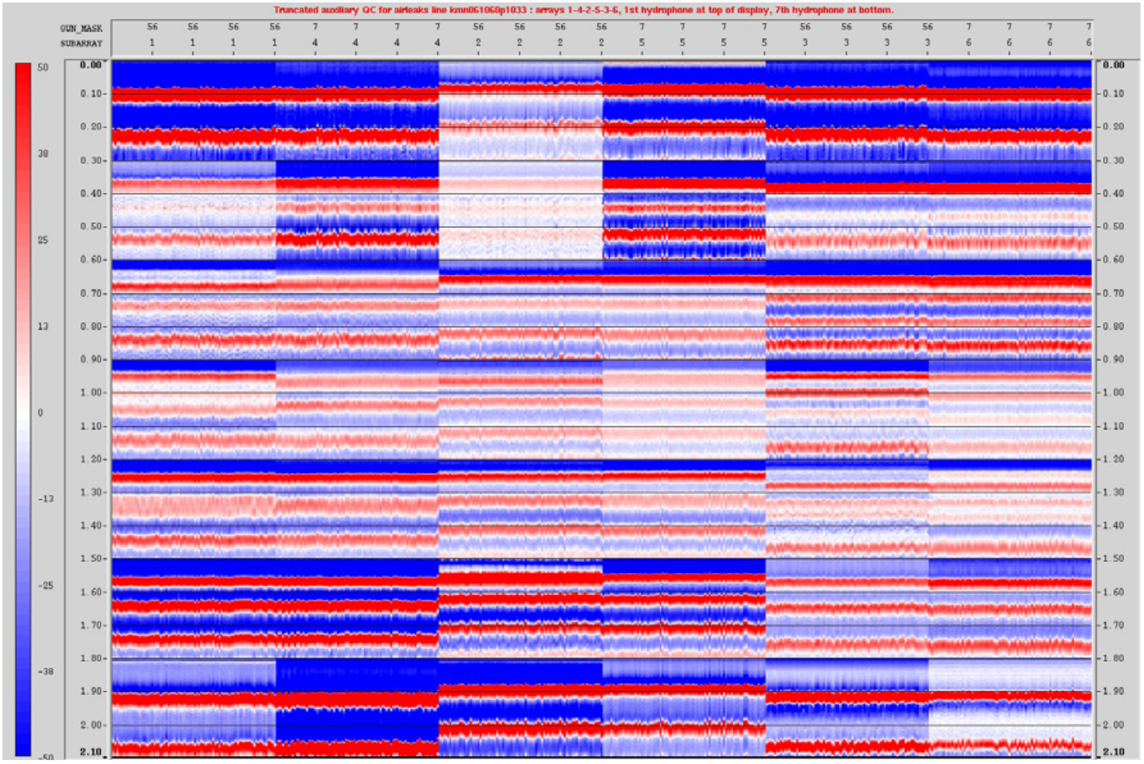
The auxiliaries of all gun strings were stacked together as a real-time autofire QC display. A real-time source QC screen display was produced to find any shot errors. An airleak QC display was also produced every sequence.



An example of a time-break display, for line KMNO61060P1033



An example, for line KMNO61060P1033, of an autofire QC display sorted by gun mask

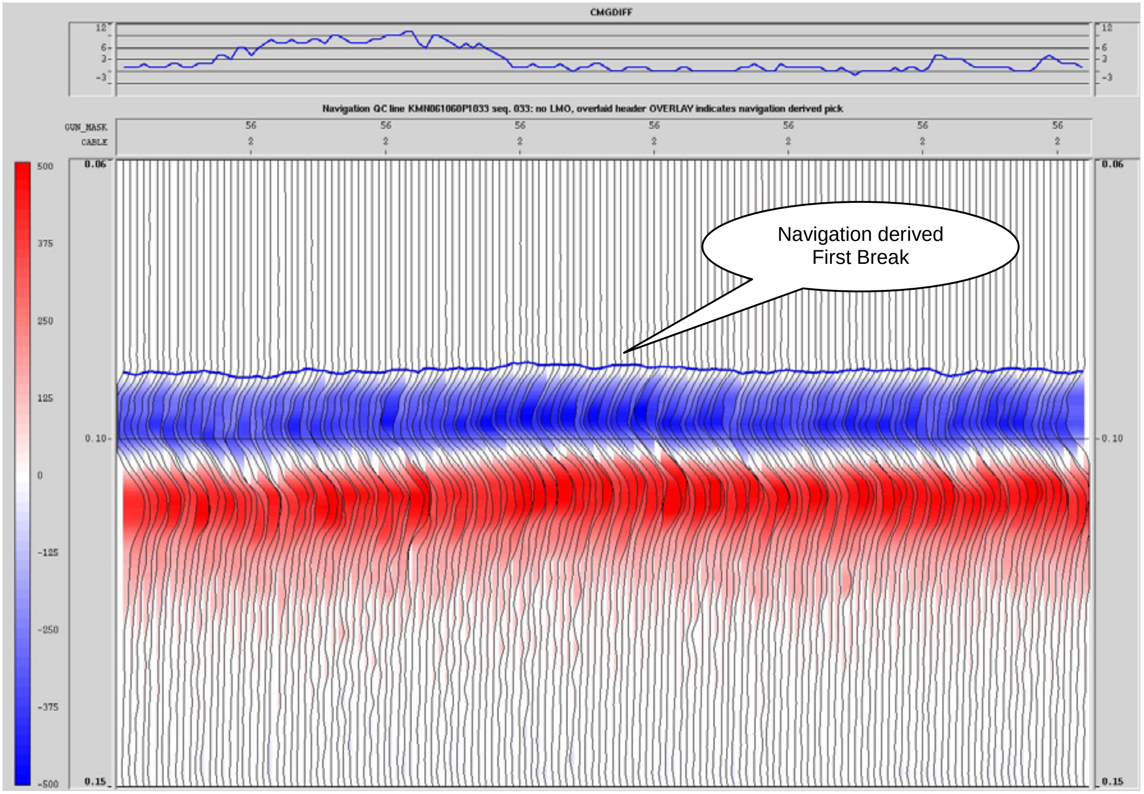


An example, for line KMNO61060P1033, of an airleak QC display showing all auxiliaries

10.8 First break / P1 offset check

The final processed P190 navigation data was merged with the seismic data for every line acquired. This merge process created a navigation derived first break (FB_NAV), using a given water velocity at streamer depth (on average 1522 m/s, as defined by regular TS-Dip readings). This could then be overlaid as a horizon on a subset of seismic data and checked on screen to ensure a match between the seismic and the computed arrival time, before being plotted. At some locations where there were shallow areas, the direct arrival was contaminated by refraction energy, but in general there was a good match between the P190 and the seismic data; any discrepancies would alert errors within navigation or navigation processing techniques.

The navigation network was strong and there were no major problems with the positioning of the data. High redundancy on the acoustic network produced very reliable final navigation positions.

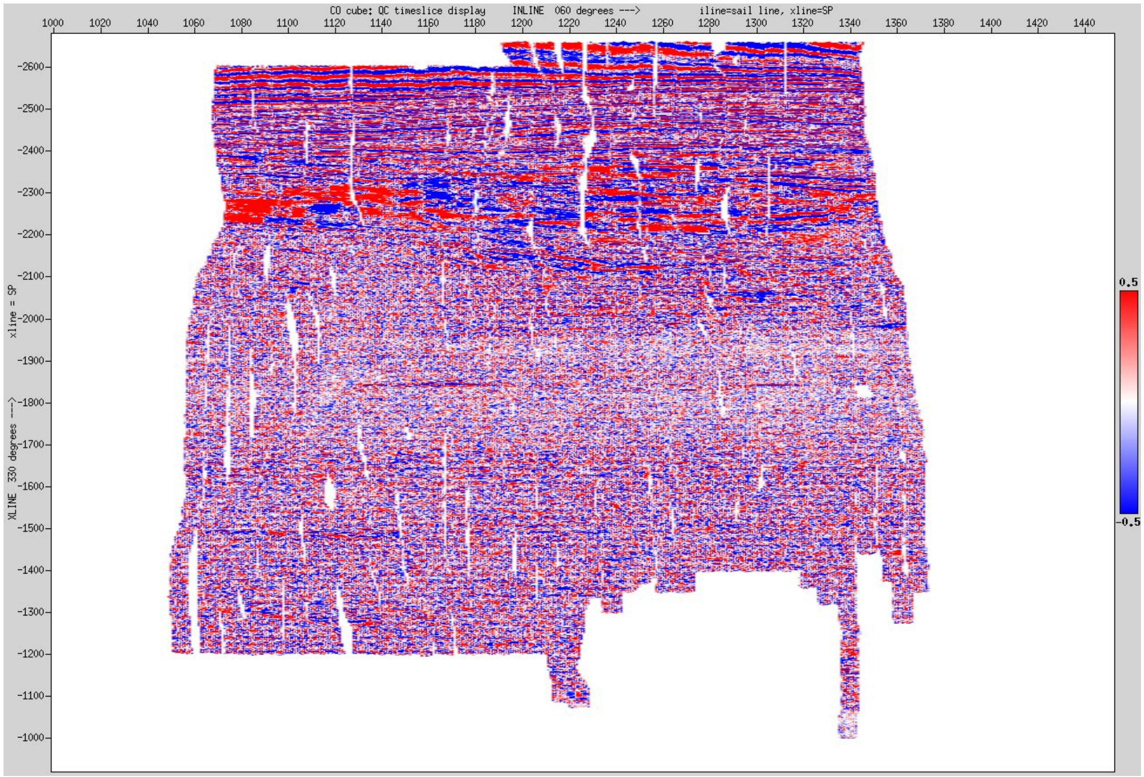


Above is a display of the first break picks as a navigation QC.

10.9 Common offset cube

Each shot, for each source, was merged with the P190 navigation data and a common offset (CO) range of 200-399 m was selected, and from this range, one trace was selected with the closest offset to 300 m. This CO data was then pre-processed, and NMO corrected prior to loading to the cube.

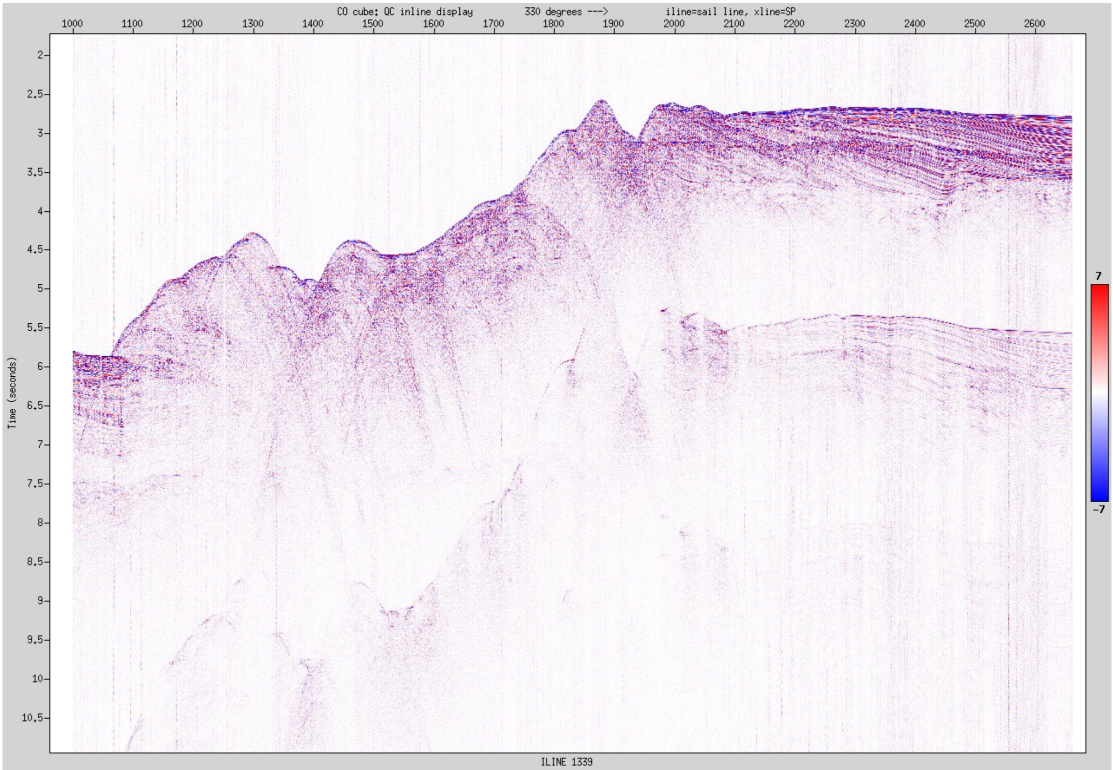
Once loaded to the cube, inline, cross-line displays and time-slices were viewed to check for potential navigation merge errors. The CO cube was not intended as an interpretive tool, but rather as an aid to determine the integrity of the navigation versus seismic data. Any deviations or badly merged navigation would easily show up in cross-line mode (‘jumps’ in the trace) and in the time-slice displays (‘striping’ effects). As a whole the Cube performed well as a positive QC of the P190 data.



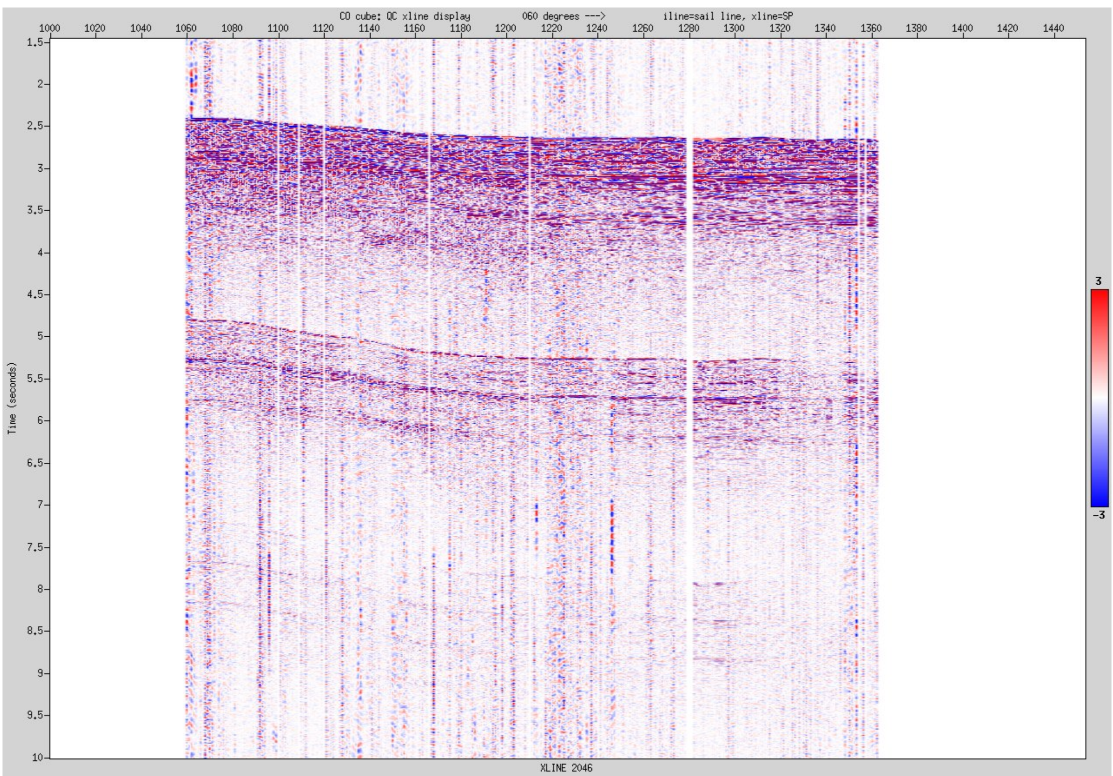
Common Offset Cube Time-slice (5784ms)

The narrow gaps in the inline direction correspond to where, as a result of the feather, no bin hits for that specific common offset trace/gun combination occurred. This is most usually seen between adjacent sail-lines.

Note that the Common Offset cube is a Navigation/Seismic QC tool only not an interpretation tool, (despite giving good structural definition) as it takes only a single common offset trace per streamer, per shot loaded into the Cube.



An example inline (1339), from the common offset Cube



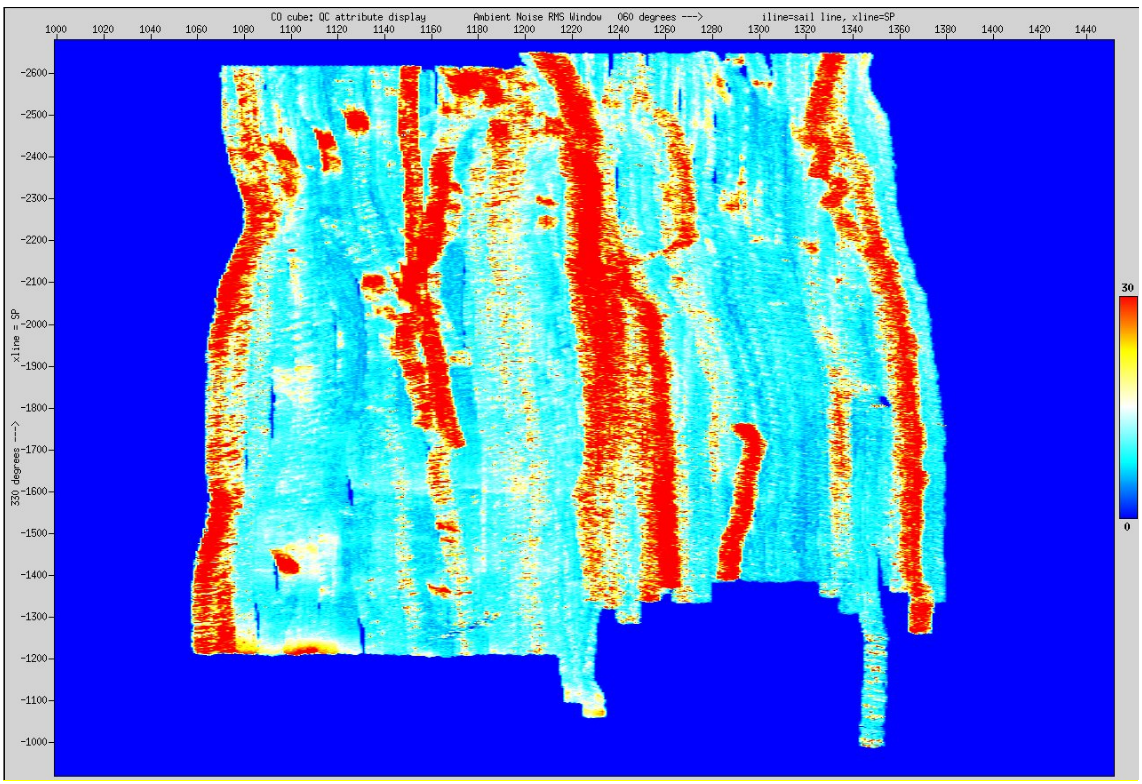
An example xline (2046) from the common offset Cube

10.10 Attribute Cube

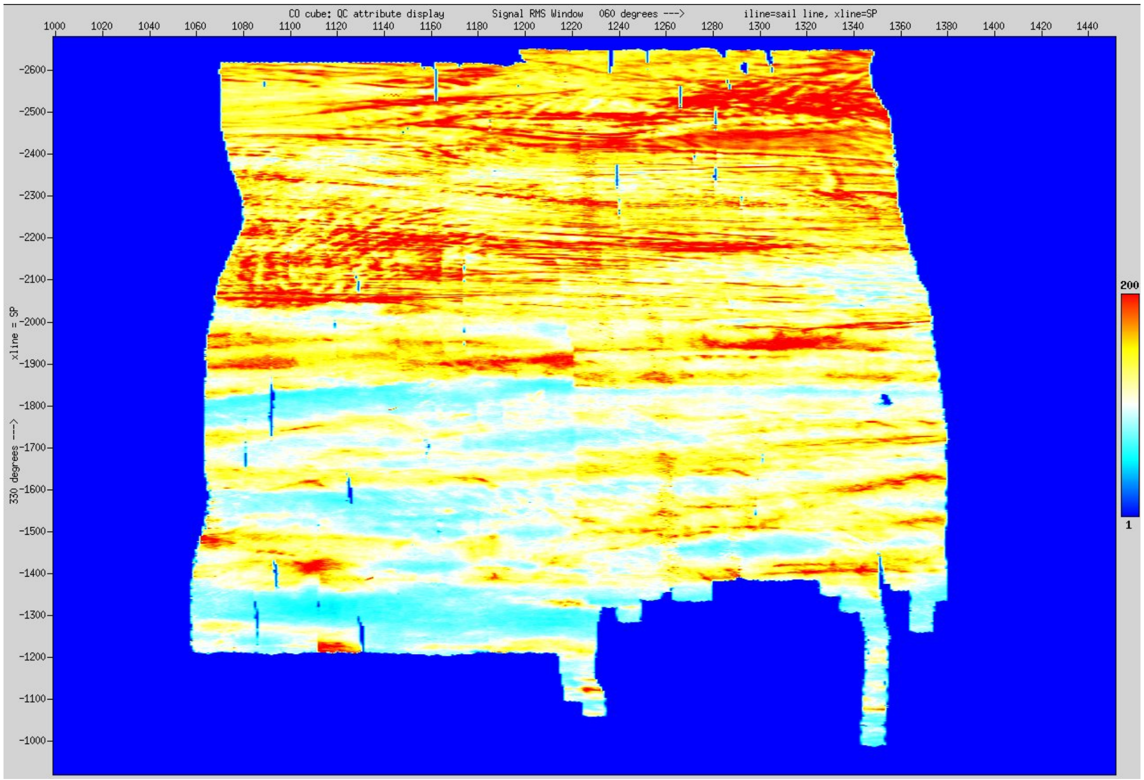
Viper was also used to display the aerial RMS information across the survey. The RMS attributes consisted of a single value for each window/streamer/shot containing navigation information. This data could then be loaded into an RMS cube and display the ambient (1000-1500 ms) and the two signal (500-1000 ms below the water bottom and 2000-2500 ms below the water bottom) windows.

The most common displays that are produced are:

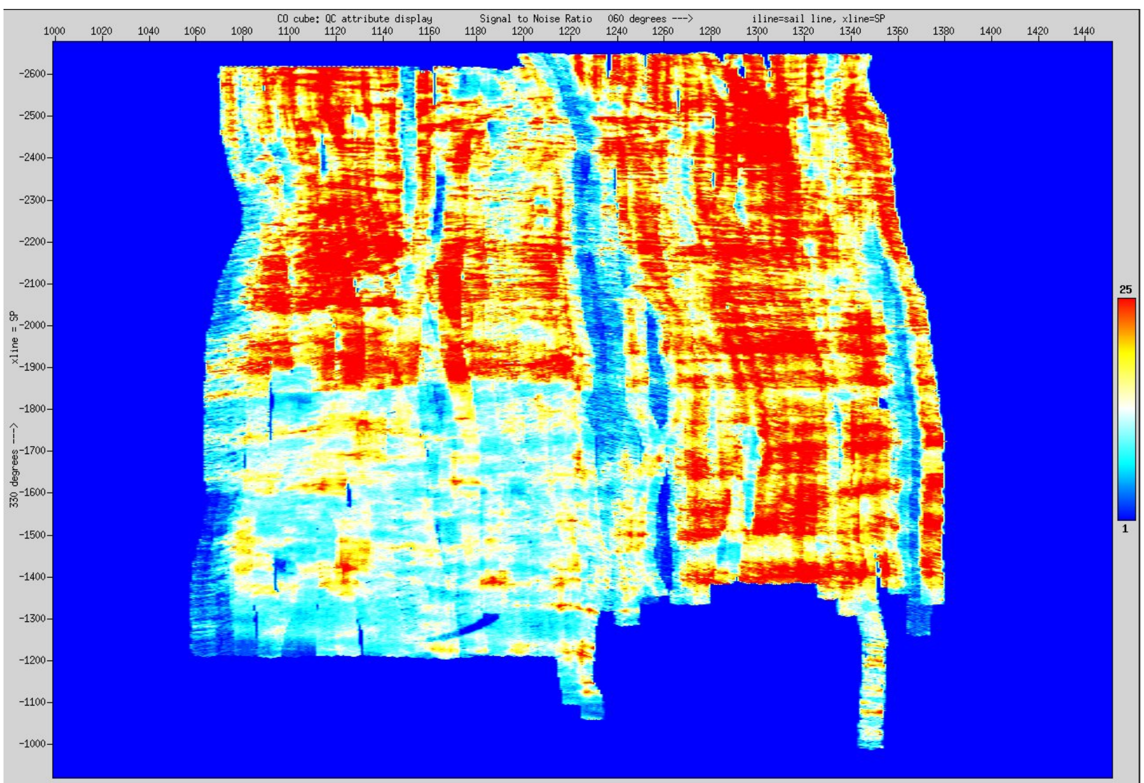
- RMS noise average
- Signal Average RMS
- Signal to Noise Ratio
- Average water depth



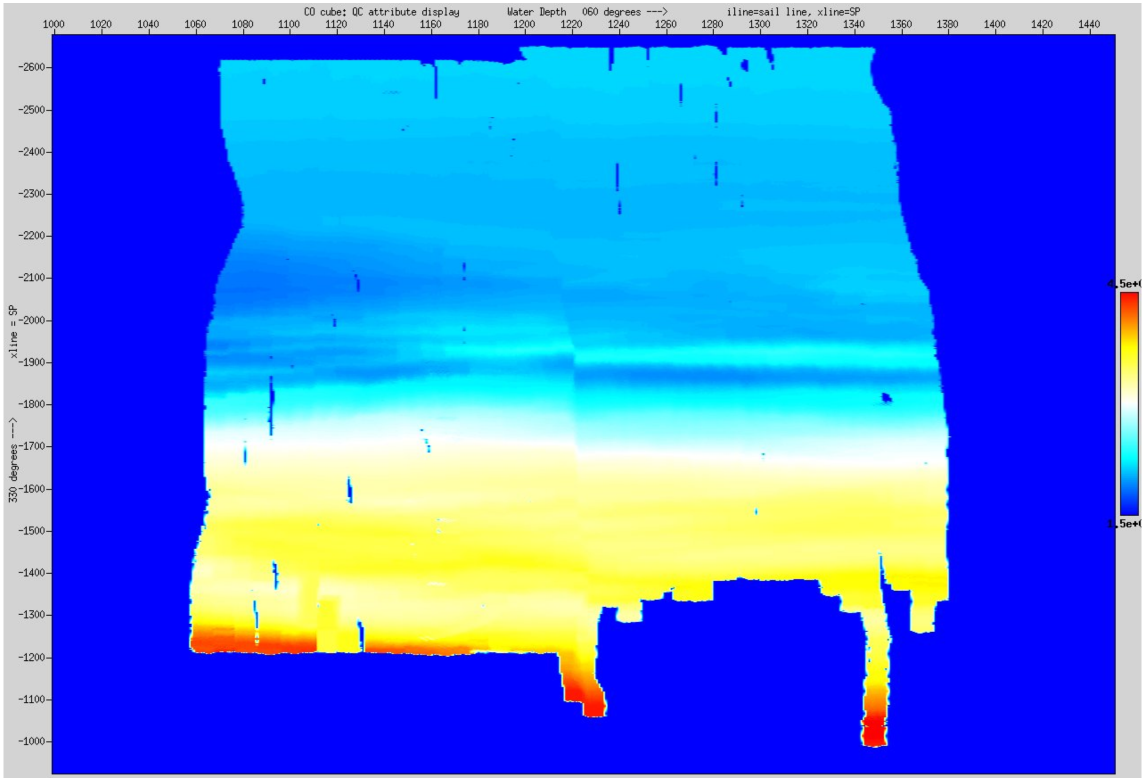
RMS noise average - with amplitude range of 0-30μbar



RMS Signal average



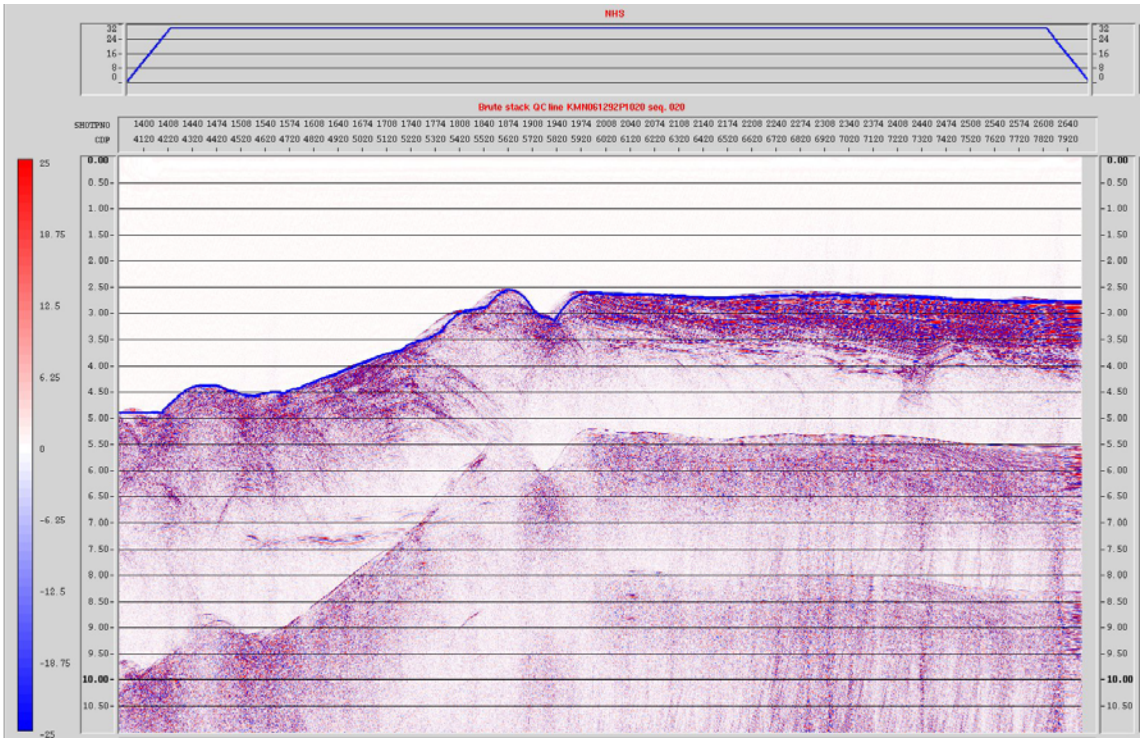
Signal-Noise-ratio RMS



Water depth (1500-4500m range) at CMP

10.11 2D Brute Stack

2D brute stacks were processed and plotted for each acquired line. In most cases, reviewing the quality of the stacked data could assess the impact of noise and any geometry problems.



Above is a completed RAW 2D Brute stack, KMN061292P1020, streamer 4, port source.

11 QC Processing

Geophysical Acquisition System (gAS) was used to both record and monitor data in real-time. The Viper QC system was then utilised for subsequent offline QC processing. Problems that occurred during production were investigated using all the available tools.

The acquisition QC involved several different aspects including:

- Real-time monitoring of acquisition via gAS functionality.
- Online (via gAS) and offline (via Viper) QC of RMS windows, auxiliary channels, near traces, and raw shots.
- Offline production of a 2D brute stack for selected streamer (rotated each line).
- Seismic/Navigation merge and navigation QC.
- Production of a common offset cube.
- Production of an Attribute cube (RMS).
- Investigation of problems as necessary.

11.1 Online QC

The gAS QC system performs “real-time” QC on data captured via the network card from the NTRS2 recording system. A graphical user interface shows all messages that have been received from the QC functions and a colour coded system highlights the status of all the shots.

The gAS user interface, the following on-line displays can be displayed, spanned across 6 monitors:

- Shot record display – a different cable for every shot, one cable per screen.
- Colour RMS noise display of all channels for each cable – spanning 50 shots.
- Time series display updated every shot – RMS values for all channels for each cable in the signal window.
- Time series display updated every shot – shot average RMS values (from signal window 1) spanning 50 shots showing shot to shot variations.
- Hydrophone display updated every shot – autofire/airleak/general noise detector.
- Stacked hydrophone display spanning 100 shots over full record length – autofire detector.
- Layered individual hydrophone display spanning 100 shots from 30 to 140 ms – airleak detector.
- Time series display spanning 100 shots – gun pressures for each string and total fired volume.
- Single trace display spanning 100 shots over full record length.
- Colour streamer depth display spanning 100 shots – all birds/cables including error exceptions (extraction count errors, misfires, autofires).

Furthermore, the displays are saved to disk as both comma-delimited files and postscript files. Colour postscript displays can be automatically printed at the end of line. Typically these would be:

(i) Shot Average RMS display for each cable – 1 plot for all cables/shotpoints.
(ii) Channel Average RMS display – 1 plot for all channels/cables.
(iii) Average streamer depth – 1 plot for all channels/cables.
(iv) Average Gun depth for each subarray, front and tail recorded for each shot.
(v) Average Gun pressure for each subarray.

All the postscript files for each sequence are available for off-line QC in both gAS and Viper systems.

An additional option available is to concatenate multiple postscript plot files into one file and produce a PDF document. This document may then be sent across to the PC server and made available to the onboard client representative.

gAS real-time RMS calculations were performed for all 1440 channels of each shot in five different time windows:

RMS Windows	Time	
Water-Column	1000 ms -	1500 ms
Direct Arrival	-250 ms -	250 ms
Signal 1	500 ms -	1000 ms (below water bottom)
Signal 2	2000 ms -	2500 ms (below water bottom)
End-of-Record	10500 ms -	11000 ms

11.2 Offline QA/QC sequence

Any data that is captured in real time using gAS is also exported (via shared memory segments) to the Viper nodes.

All data from all streamers is captured in real time and written to disk in Viper. Additionally, specific datasets are created on disk for on-line and off-line QC.

For 2D stack:
- All shots for one cable per swath – fixed channel set.

For shot QC:
- All shots for one cable per swath – rotating channel set.

For navigation QC and single trace displays:
- Near traces from each cable

For common offset cube and RMS attribute cube:
- Selected common offset near traces – for nominal single fold 3D cube.
- Selected common offset mid traces – for RMS attribute timeslice cube.

For off-line RMS QC:
- Shallow ambient noise window in the water column – for channel QC.
- Signal windows flattened using water bottom times – for source comparison QC.

For autofire QC:
- All 48 auxiliary channels (including time break).

Standard QC products include:

- Shot record screen display – all streamers for one shot.
- Near-field hydrophone screen display – both sources, all gun strings.
- Brute stack CGM display – with basic processing.
- Common offset single fold cube displays:
  - time-slice, x-line and in-line displays at regular intervals.
- RMS attribute cube – aerial displays of:
  - signal average RMS,
  - RMS noise average,
  - signal-noise-ratio RMS,
  - average water depth.
- Autofire display from auxiliary channels.
- Airleak display from auxiliary channels.
- Time break display from auxiliary channels.

In addition, a verification of all the edits was completed after each sequence and any additional edits were added to the Observer's logs.

11.2.1 2D QC stack

For each sail-line, a 2D QC brute stack was generated using the following sequence:

- SEG-D Input of one streamer/gun combination (2D CDP), fixed chset.
- –58 ms static correction for the digital filter recording delay.
- Nominal 2D geometry applied.
- Zero phase 3-6-90-120 trapezoidal bandpass filter.
- Resample to 4 ms.
- Channel and shot point edits.
- NMO regional velocities.
- Gun/cable static +8 ms.
- Stack.

11.2.2 Navigation / seismic merge QC

A near trace display for the selected QC streamer was generated for both sources on every line to monitor bad and missing shots, especially auto fires and internal time breaks, and to ensure that a the navigation data was correct. Direct arrivals from the near traces were merged with the P190, and the navigation derived first break was overlaid on the seismic data and checked. The measured sound velocity was used to determine the calculated arrival time from the P190 offset.

- Input near offset trace from each streamer.
- Shift of –58 ms due to recording delay.
- Merge using shot point with xyz file (navigation, P190).
- Trace equalisation - apply a dB gain in order to equalise the amplitudes of the arrival on the different streamers.
- Display on screen with LMO applied.
- Display on screen without LMO applied.

In general, there was a good match between the P190 and the seismic data.

11.2.3 Common offset cube

A second P190 QC step was to build a common offset cube in Viper to check for anomalies and offset miss-ties between sail lines on cross-line sections and time slices.

- Input all shots for each source from disk.
- –58ms static correction for the digital filter recording delay.
- Merge seismic data using shot point with xyz file (navigation, P190).
- Edit bad channels and shots.
- Zero phase 3-6-90-120 trapezoidal bandpass filter.
- Resampling to 4 ms.
- Select one trace from a range of 200 m-399 m with the closest offset to 300 m.
- NMO using a single regional velocity function.
- Load data to cube.

Once loaded to the cube, in-line, cross-line displays and time-slices were viewed to check for potential navigation merge errors.

11.2.4 Other QC products

The output of the near field hydrophones mounted on the gun strings was recorded on the auxiliary channels, together with the system time-break in order to identify gun-timing errors. The auxiliaries of all gun strings were stacked together and displayed online as a real-time auto-fire QC display. Another display was produced with the auxiliary traces truncated and spliced in one trace per source. With this display air leaks could be detected. The system time-break was also analysed on screen to verify that there were no time break errors.

11.3 RMS and noise analysis

A number of windows were parameterised in gAS, recording RMS levels for every channel for each shot point within constant time windows. These windows in turn could be viewed both online and offline to determine the noise levels.

Real-time RMS calculations were performed for all channels of each shot for the last 500 ms of the record (10500 to 11000 ms).

End of Record noise window, (10500 to 11000 ms)
This end of record noise window displays the residual noise energy due to the presence of multiple energy, etc. The same features of the ambient noise window can roughly be seen, as well as the localised areas affected by ship or swell noise.

Also, RMS values were obtained directly from the raw data captured and transferred to Viper from the gAS recording system as postscript files which could be interactively viewed via TCL graphs. This display can be used to identify the noise characteristic of channels.

11.4 Computer systems

gAS On-line QC System	**Helium ('collector')**
Software:	
Linux	Redhat Linux 7.3
gAS	RPM 3.0.3-1 with Patch RPM 3.0.3-2
Bit 3 (for real time data capture)	Model 923 interface card & support software
Hardware	
Workstation:	Supermicro Dual Pentium 2.8Ghz PC
Physical Memory:	1 x 2 Gb RAM
Hard Disk (internal):	2 x 36 Gb
Graphic adapter:	Predator Pro 4 Graphics
Monitors:	1 x Viewsonic P20F 21"
Data capture:	Network card
Tape drives:	6 x IBM 3590 B1A 10Mb external
gAS On-line QC System	**Neon ('QC-1 Master')**
Software:	
Linux	Redhat Linux 7.3
gAS	RPM 3.0.3-1 with Patch RPM 3.0.3-2
Hardware	
Workstation:	Supermicro Dual Pentium 2.8Ghz PC
Physical Memory:	1 x 2 Gb RAM
Hard Disk (internal):	2 x 36 Gb
Graphic adapter:	Predator Pro 4 Graphics
Monitors:	4 x Viewsonic 19" LCD
Tape drives:	2 x IBM 3590
gAS On-line QC System	**Argon ('QC-2 Slave')**
Software:	
Linux	Redhat Linux 7.3
gAS	RPM 3.0.3-1 with Patch RPM 3.0.3-2
Hardware	
Workstation:	Supermicro Dual Pentium 2.8Ghz PC
Physical Memory:	1 x 2 Gb RAM
Hard Disk (internal):	2 x 36 Gb
Graphic adapter:	Predator Pro 4 Graphics
Monitors:	2 x Viewsonic 19" LCD
Off-line System (QC)	**Mamba ('control'), CPU01, CPU02, Holoseis**
Software	
Linux	Redhat 7.3 and Redhat Enterprise 3.6
Viper	3.0.3-3

<u>Hardware</u>	
Workstation:	3 x IBM eServer 'X' series 335 Intel Xeon nodes 1 X Dell Precision 470 Intel Xeon node
Processor	Dual 2.8Ghz Pentium III processors per node. Dual 3.0Ghz Pentium III processors - Holoseis.
Physical Memory:	1.5 Gb RAM per node. 2.0 Gb RAM - Holoseis 2 x 146Gb SCSI disks per IBM eServer node. 2 x 500Gb SCSI disks - Holoseis 2 x Intel Ethernet Pro 1000 network adapters per node
Hard Disk (internal):	7 x 146.8 GB
Monitor:	1 x Viewsonic 19" LCD 2 x Viewsonic 22" LCD
Tape drives:	2 x IBM 3590 B1A drives 2 x IBM 3590 B1A drives + Autoloader
Plotter:	OYO GS 634 24" Thermal Plotter OYO GS 636 36" Thermal Plotter (not used)
<u>Network Hardware</u>	
Switch	Online systems 1 x Hewlett Packard Procurve Offline systems 1 x Hewlett Packard Procurve
Switching Speed	1GHz/100MHz* base T
Plotters	OYO GS 624 Thermal Plotter
Printers	Hewlett Packard Colour Laserjet 5500DTN

** The switching speed for both Helium-Neon-Argon and Mamba-Cpu01-Cpu01 is 1Ghz whilst between Argon-Mamba (i.e. between the online and offline systems for real time data transfer) is 100Mhz.*

12 Appendix

12.1 Data shipments

Date	Proforma	Content	Boxes	Wt	Shipping address	Comment
19-05-06	NOR17002373A	ORIGINAL SEGD data tapes Set A, (Seq. 001-070) and QC deliveries	9	74 kg	Centre for Deep Earth Exploration) Yokohama Institute for Earth Sciences 3173-25 Showa-machi, Kanazawa-ku Yokohama Kanagawa 236-001 Japan	Project : 2006020 Area : Nankai through, Japan.
19-05-06	NOR17002374A	ORIGINAL SEGD data tapes Set B, (Seq. 001-070)	8	64 kg	Centre for Deep Earth Exploration) Yokohama Institute for Earth Sciences 3173-25 Showa-machi, Kanazawa-ku Yokohama Kanagawa 236-001 Japan	Project : 2006020 Area : Nankai through, Japan.
19-05-06	NOR17002377A	ORIGINAL Navigation P1/90 and P2/94 3590 data tapes (Seq. 001-070)	1	1 kg	Centre for Deep Earth Exploration) Yokohama Institute for Earth Sciences 3173-25 Showa-machi, Kanazawa-ku Yokohama Kanagawa 236-001 Japan	Project : 2006020 Area : Nankai through, Japan.
19-05-06	NOR17002378A	COPY Navigation P1/90 and P2/94 3590 data tapes (Seq. 001-070)	1	1 kg	Centre for Deep Earth Exploration) Yokohama Institute for Earth Sciences 3173-25 Showa-machi, Kanazawa-ku Yokohama Kanagawa 236-001 Japan	Project : 2006020 Area : Nankai through, Japan.
31-05-06	NP-35-2006	2 P1/90 KMN06V011 2 Vessel pos. plots 2 CD vessel pos. plots	1		Centre for Deep Earth Exploration Yokohama Institute for Earth Sciences 3173-25 Showa-machi, Kanazawa-ku Yokohama Kanagawa 236-0001 Japan Attn: Mr Tamio Yohro	Vessel pos. Scale 1:100 000 Cgm file

12.2 Source modelling

SIGNATURES FROM MARINE AIRGUN SOURCE LIBRARY
NUCLEUS - Marine Source Modeling 4.4.2
Modeling by Claire Grubb, PGS Technology – Geophysical Support, March 2006

Survey name	:	Kumano-nada
PGS project No	:	2006020
Survey area	:	Kumano-nada, Japan
Vessel	:	M/V NORDIC EXPLORER
Array	:	3090G__60_2000_125
Source type	:	G-gun
Source volume	:	3090 cu.in.
Air pressure	:	2000 psi
Source depth	:	6.0 m
Subarray separation	:	12.5 m
Recording filter	:	Hydroscience system, 4.6(6) – 206(276) Hz (dB/oct.)
Receiver depth	:	7.0 m
Hydrophone group length	:	12.5 m
Full system response filter name	:	Hydroscience system, 4.6(6) – 206(276) Hz (dB/oct.)
Sea temperature	:	20 ° C

Enclosed are:

Figure 1: Array configuration top view, i.e. positive Y denotes starboard.

Figure 2: Modeled far-field signature and amplitude spectrum with Hydroscience recording filter (without receiver ghost).

Figure 3: Modeled far-field signature and amplitude spectrum with DFS-V recording filter (without receiver ghost).

Figure 4: Modeled far-field signature and amplitude spectrum with full system response filter effect applied (without receiver ghost).

Figure 5: Far-field signature listing with 2 ms sampling interval (without receiver ghost).

Figure 6: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (with receiver ghost).

Figure 7: Far-field signature listing with 2 ms sampling interval (with receiver ghost).

Figure 8: Directivity plot for constant azimuth of 0° and 90°.

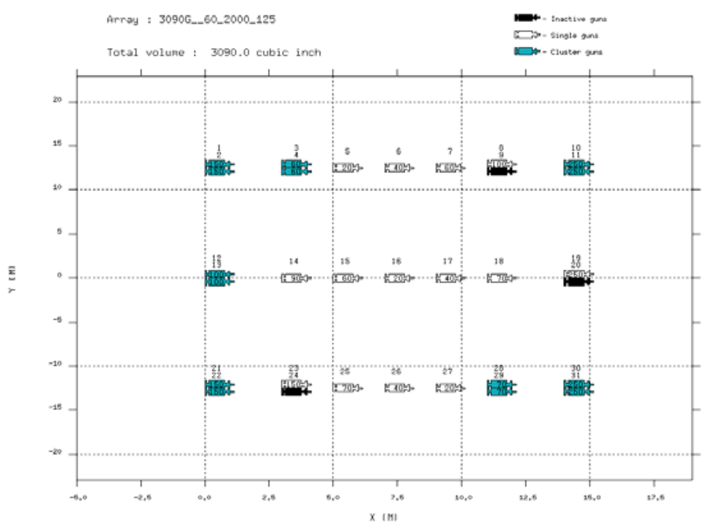


Figure 1: Array configuration top view, i.e. positive Y denotes starboard.

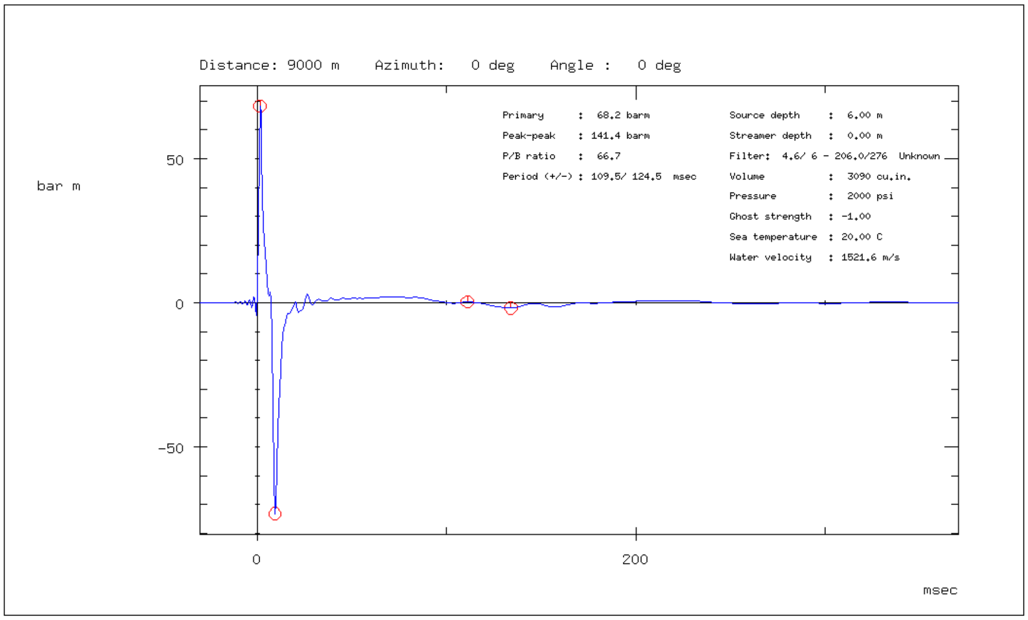
ARRAY LISTING

ARRAY NAME : 3090G__60_2000_125
NUMBER OF ACTIVE GUNS: 28
TOTAL ACTIVE VOLUME : 3090 CU.IN.
NUMBER OF SPARE GUNS : 3

GUN #	GUN TYPE	X (m)	Y (m)	Z (m)	VOLUME (cu.in)	PRESSURE (psi)	DELAY (ms)	CLUSTER NUMBER
1	14	0.00	12.90	6.00	150	2000	0.00	1
2	14	0.00	12.10	6.00	150	2000	0.00	1
3	14	3.00	12.90	6.00	60	2000	0.00	2
4	14	3.00	12.10	6.00	60	2000	0.00	2
5	14	5.00	12.50	6.00	20	2000	0.00	0
6	14	7.00	12.50	6.00	40	2000	0.00	0
7	14	9.00	12.50	6.00	60	2000	0.00	0
8	14	11.00	12.90	6.00	100	2000	0.00	0
9	14	11.00	12.10	6.00	100	SPARE	0.00	0
10	14	14.00	12.90	6.00	250	2000	0.00	3
11	14	14.00	12.10	6.00	250	2000	0.00	3
12	14	0.00	0.40	6.00	100	2000	0.00	4
13	14	0.00	-0.40	6.00	100	2000	0.00	4
14	14	3.00	0.00	6.00	90	2000	0.00	0
15	14	5.00	0.00	6.00	60	2000	0.00	0
16	14	7.00	0.00	6.00	20	2000	0.00	0
17	14	9.00	0.00	6.00	40	2000	0.00	0
18	14	11.00	0.00	6.00	70	2000	0.00	0
19	14	14.00	0.40	6.00	250	2000	0.00	0
20	14	14.00	-0.40	6.00	250	SPARE	0.00	0
21	14	0.00	-12.10	6.00	150	2000	0.00	5
22	14	0.00	-12.90	6.00	150	2000	0.00	5
23	14	3.00	-12.10	6.00	150	2000	0.00	0
24	14	3.00	-12.90	6.00	150	SPARE	0.00	0
25	14	5.00	-12.50	6.00	70	2000	0.00	0
26	14	7.00	-12.50	6.00	40	2000	0.00	0
27	14	9.00	-12.50	6.00	20	2000	0.00	0
28	14	11.00	-12.10	6.00	70	2000	0.00	6
29	14	11.00	-12.90	6.00	70	2000	0.00	6
30	14	14.00	-12.10	6.00	250	2000	0.00	7
31	14	14.00	-12.90	6.00	250	2000	0.00	7

THE GUN TYPES ARE:
14: G-GUN

Far-field signature of array : 3090G__60_2000_125



Amplitude spectrum of far-field signature of array : 3090G__60_2000_125

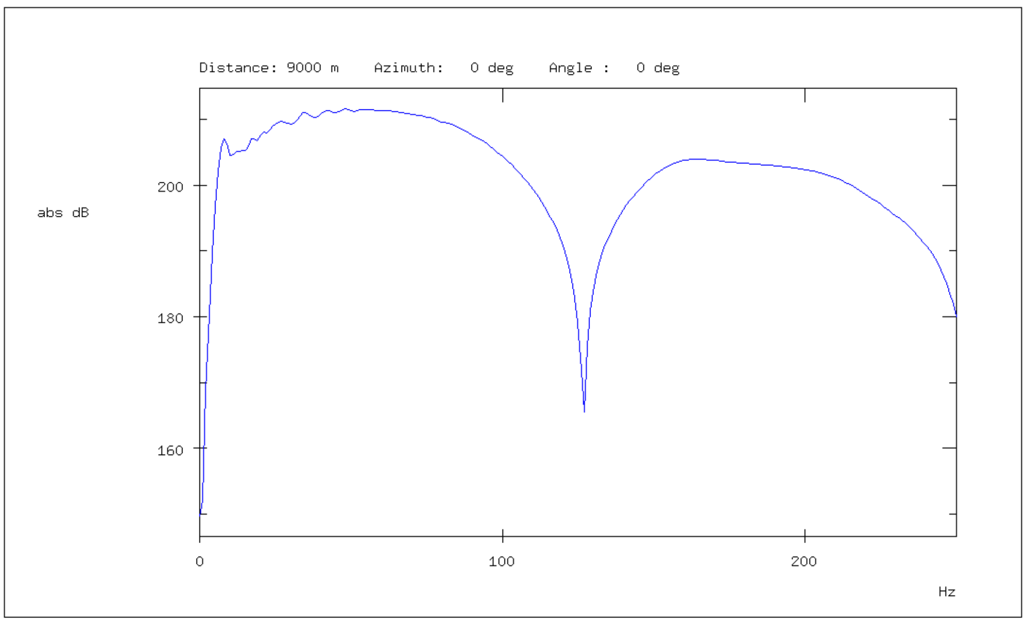
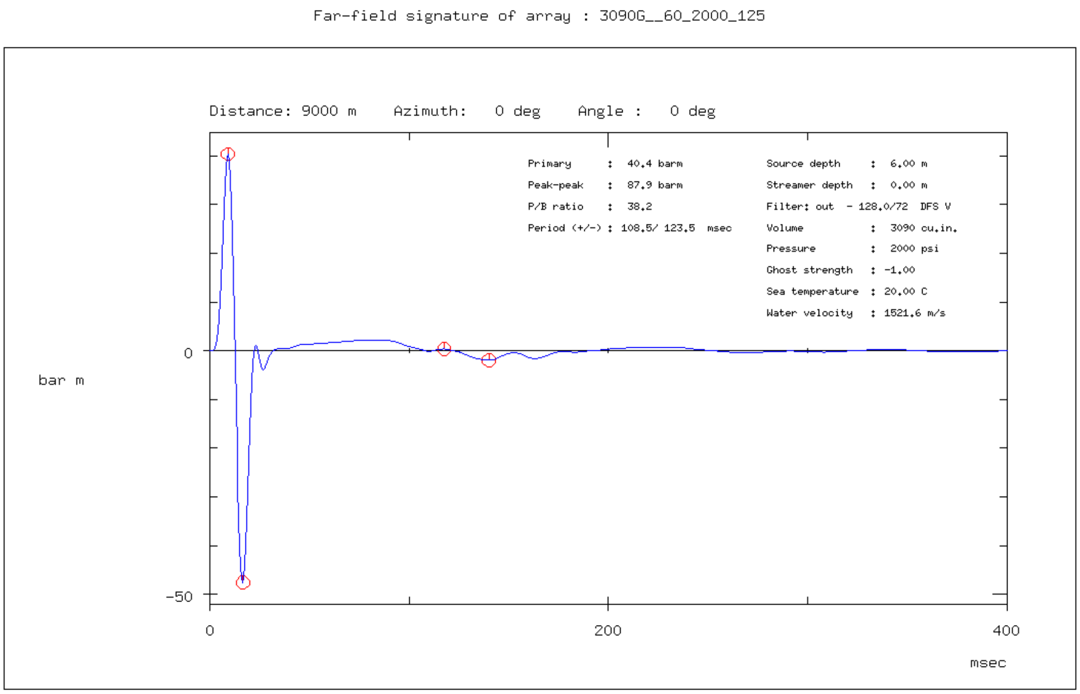


Figure 2: Modeled far-field signature and amplitude spectrum with Hydroscience recording filter (without receiver ghost).



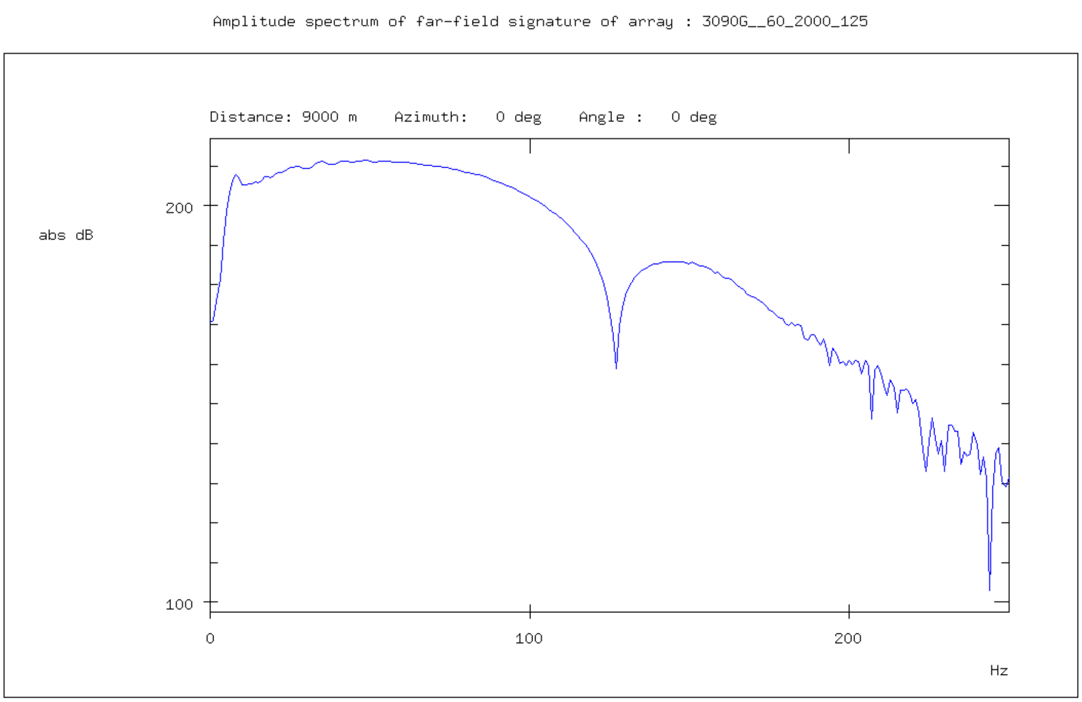
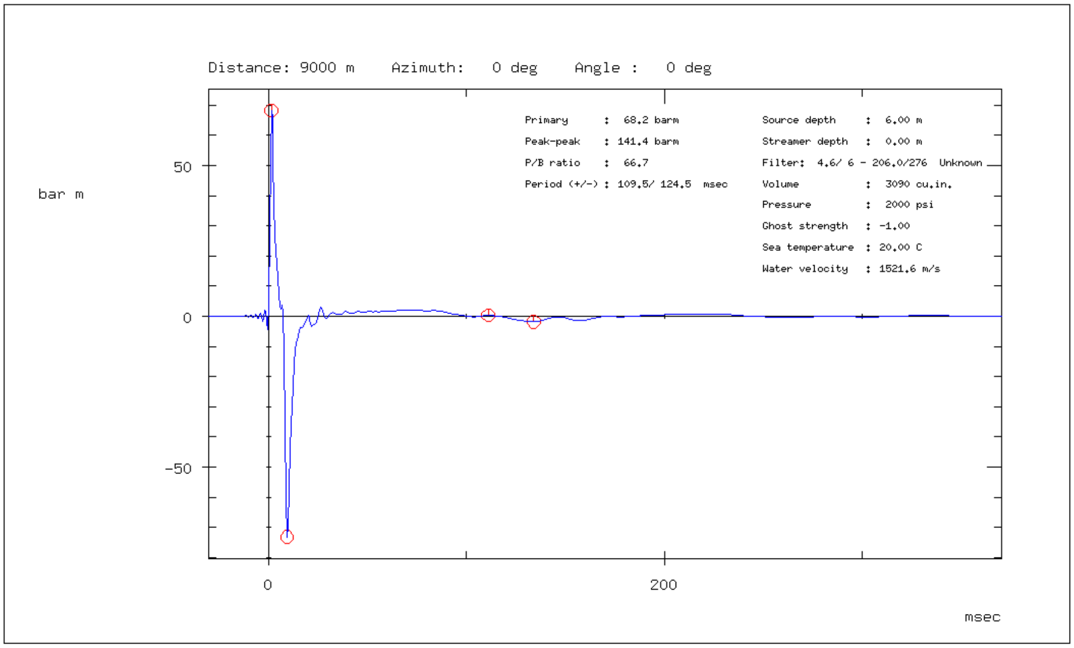


Figure 3: Modeled far-field signature and amplitude spectrum with DFS-V recording filter (without receiver ghost).

Full system response with source ghost only

Far-field signature of array : 3090G__60_2000_125



Amplitude spectrum of far-field signature of array : 3090G__60_2000_125

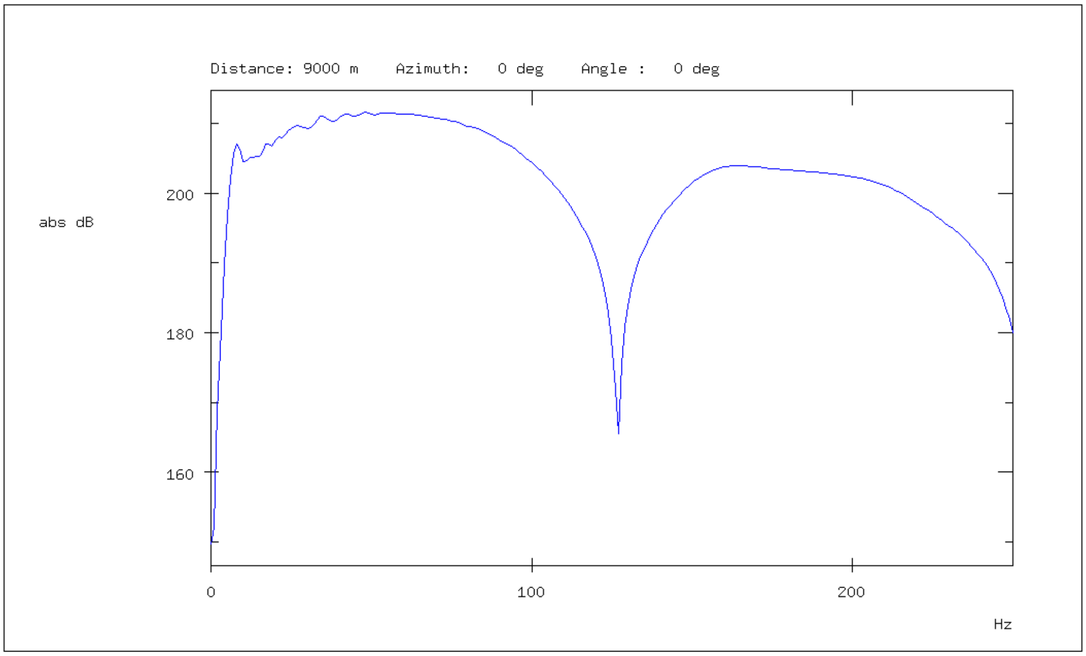


Figure 4: Modeled far-field signature and amplitude spectrum with full system response filter effect applied (without receiver ghost).

Full system response with source ghost only

```
FAR-FIELD SIGNATURE LISTING
Array name          :  3090G__60_2000_125
Total volume        :    3090 cu.in.
Source depth        :    6.00 m
Streamer depth      :    0.00 m
Group length        :   12.50 m
Average pressure    :    2000 psi
Ghost strength      :   -1.00
Seawater temperature:   20.00 C
Seawater velocity   :  1521.6 m/s
Filter              :
  Low-cut frequency :    4.60 Hz
  Low-cut slope     :    6.00 dB/oct
  High-cut frequency:  206.00 Hz
  High-cut slope    :  276.00 dB/oct
  Instrument        :  Unknown
  Time of 1st sample:  -30.00 msec i.e. index of time zero =  16.0
Sample interval     :    2.00 msec
Far-field position  :
  Distance          : 9000.00 m
  Azimuth           :    0.00 deg
  Angle of vertical :    0.00 deg

Amplitudes are in bar m
Time is increasing horizontally
```

0.000	-0.004	-0.009	-0.016	-0.028	-0.018	0.010
0.062	0.077	-0.048	-0.263	-0.312	0.137	1.102
2.062	5.175	65.771	21.328	2.981	-12.639	-69.687
-29.830	-8.904	-3.608	-2.474	0.246	-3.296	-2.334
2.274	0.483	-0.218	1.153	0.774	0.686	1.283
1.495	1.014	1.263	1.560	1.205	1.504	1.512
1.520	1.477	1.681	1.642	1.701	1.821	1.839
1.889	1.945	1.948	1.931	1.890	1.848	1.810
1.833	1.851	1.770	1.535	1.189	0.863	0.638
0.493	0.318	0.086	-0.145	-0.216	-0.082	0.130
0.269	0.257	0.132	-0.018	-0.157	-0.379	-0.703
-1.031	-1.300	-1.485	-1.631	-1.771	-1.839	-1.729
-1.438	-1.046	-0.669	-0.400	-0.271	-0.317	-0.550
-0.895	-1.229	-1.439	-1.449	-1.272	-0.989	-0.681
-0.394	-0.172	-0.053	-0.044	-0.114	-0.192	-0.220
-0.170	-0.076	0.021	0.092	0.152	0.211	0.272
0.343	0.412	0.455	0.490	0.518	0.536	0.568
0.596	0.616	0.633	0.642	0.641	0.632	0.618
0.606	0.604	0.607	0.609	0.594	0.550	0.463
0.350	0.238	0.139	0.074	0.022	-0.027	-0.087
-0.158	-0.225	-0.282	-0.315	-0.326	-0.329	-0.333
-0.340	-0.342	-0.329	-0.301	-0.258	-0.211	-0.168
-0.127	-0.087	-0.054	-0.030	-0.021	-0.033	-0.057
-0.094	-0.139	-0.181	-0.217	-0.239	-0.243	-0.235
-0.217	-0.190	-0.157	-0.115	-0.064	-0.010	0.043
0.089	0.127	0.160	0.188	0.212	0.234	0.250
0.260	0.260	0.245	0.221	0.187	0.144	0.101
0.057	0.015	-0.022	-0.057	-0.083	-0.100	-0.111
-0.115	-0.113	-0.116	-0.120	-0.132		

Figure 5: Far-field signature listing with 2 ms sampling interval (without receiver ghost).

Full system response with source and receiver ghost

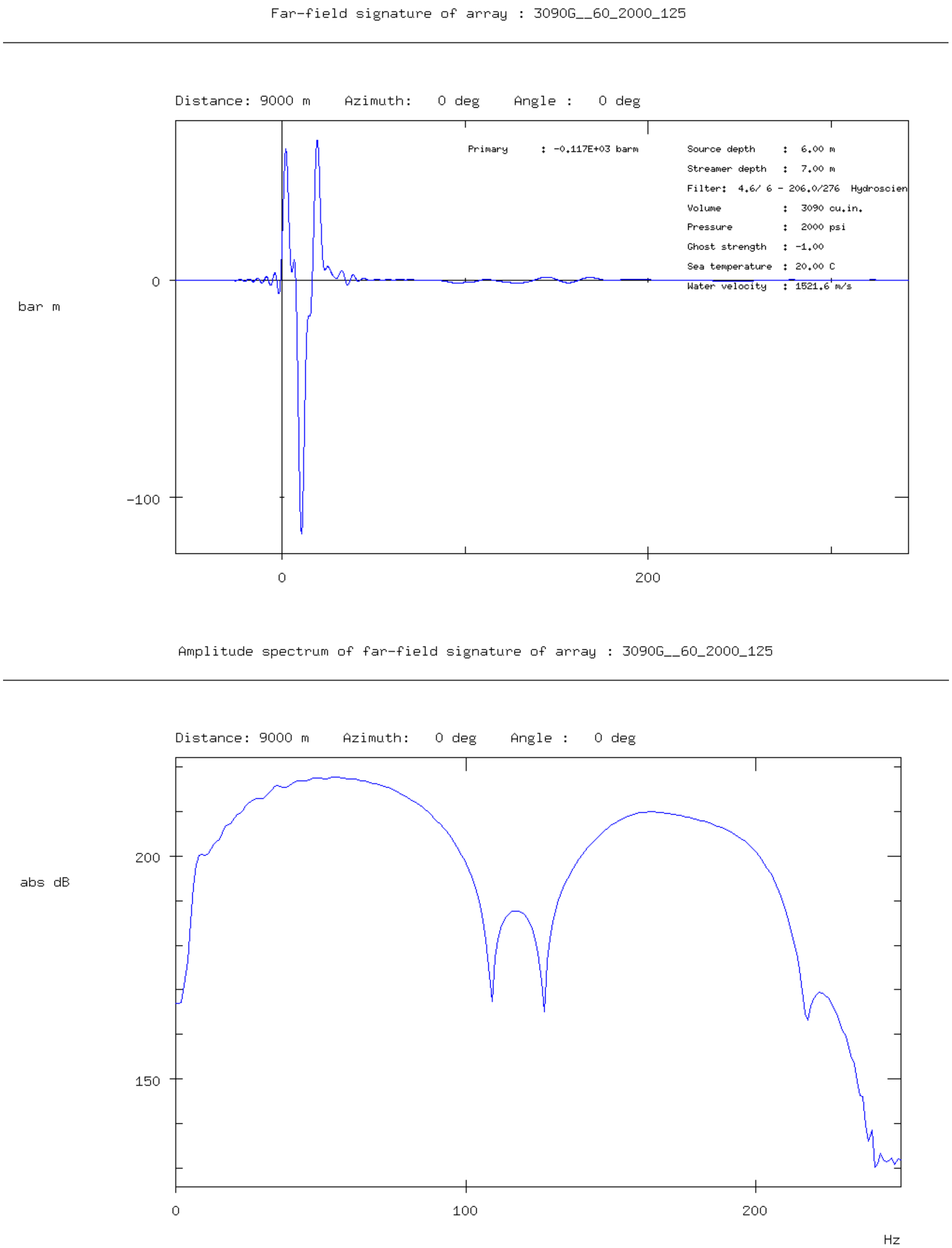


Figure 6: Modeled far-field signature and amplitude spectrum with recording and hydrophone filter effect applied (with receiver ghost).

Full system response with source and receiver ghost

```
FAR-FIELD SIGNATURE LISTING
Array name          :  3090G__60_2000_125
Total volume        :    3090 cu.in.
Source depth        :    6.00 m
Streamer depth      :    7.00 m
Group length        :   12.50 m
Average pressure    :    2000 psi
Ghost strength      :   -1.00
Seawater temperature:   20.00 C
Seawater velocity   :  1521.6 m/s
Filter              :
  Low-cut frequency :    4.60 Hz
  Low-cut slope     :    6.00 dB/oct
  High-cut frequency:  206.00 Hz
  High-cut slope    :  276.00 dB/oct
  Instrument        :  Hydroscience
  Time of 1st sample:  -58.00 msec i.e. index of time zero =  30.0
Sample interval     :    2.00 msec
Far-field position  :
  Distance          : 9000.00 m
  Azimuth           :    0.00 deg
  Angle of vertical :    0.00 deg

Amplitudes are in bar m
Time is increasing horizontally
```

0.000	-0.014	-0.022	-0.024	-0.022	-0.007	0.003
0.019	0.028	0.007	0.055	-0.012	0.006	0.061
-0.126	0.177	-0.176	0.092	0.089	-0.365	0.631
-0.830	0.824	-0.498	-0.162	1.199	-2.524	4.150
-6.664	18.953	59.465	21.702	8.463	-25.368	-101.760
-74.436	-23.806	-2.976	39.447	49.956	19.232	4.404
6.073	2.192	0.975	3.760	1.433	-0.993	1.049
1.348	-0.054	0.619	0.611	-0.162	0.168	0.423
0.089	0.124	0.362	0.201	0.181	0.338	0.254
0.214	0.272	0.221	0.130	0.061	-0.047	-0.139
-0.127	-0.081	-0.108	-0.285	-0.612	-0.968	-1.192
-1.227	-1.142	-1.045	-0.972	-0.818	-0.493	-0.062
0.308	0.426	0.245	-0.084	-0.390	-0.631	-0.831
-1.010	-1.167	-1.254	-1.215	-1.064	-0.809	-0.414
0.110	0.689	1.194	1.460	1.388	0.984	0.345
-0.345	-0.895	-1.157	-1.037	-0.576	0.044	0.633
1.048	1.205	1.114	0.840	0.474	0.136	-0.077
-0.120	-0.015	0.149	0.279	0.347	0.354	0.326
0.313	0.305	0.275	0.243	0.203	0.162	0.147
0.142	0.133	0.118	0.089	0.051	0.013	-0.014
-0.026	-0.023	-0.005	0.009	-0.002	-0.052	-0.150
-0.272	-0.378	-0.444	-0.445	-0.398	-0.345	-0.307
-0.298	-0.307	-0.303	-0.270	-0.210	-0.137	-0.079
-0.049	-0.033	-0.014	0.024	0.084	0.150	0.198
0.220	0.213	0.186	0.152	0.113	0.069	0.018
-0.042	-0.102	-0.155	-0.186	-0.183	-0.148	-0.087
-0.014	0.049	0.103	0.143	0.167	0.186	0.202
0.211	0.216	0.213	0.196	0.172	0.141	0.107
0.078	0.050	0.022	-0.010	-0.050		

Figure 7: Far-field signature listing with 2 ms sampling interval (with receiver ghost).

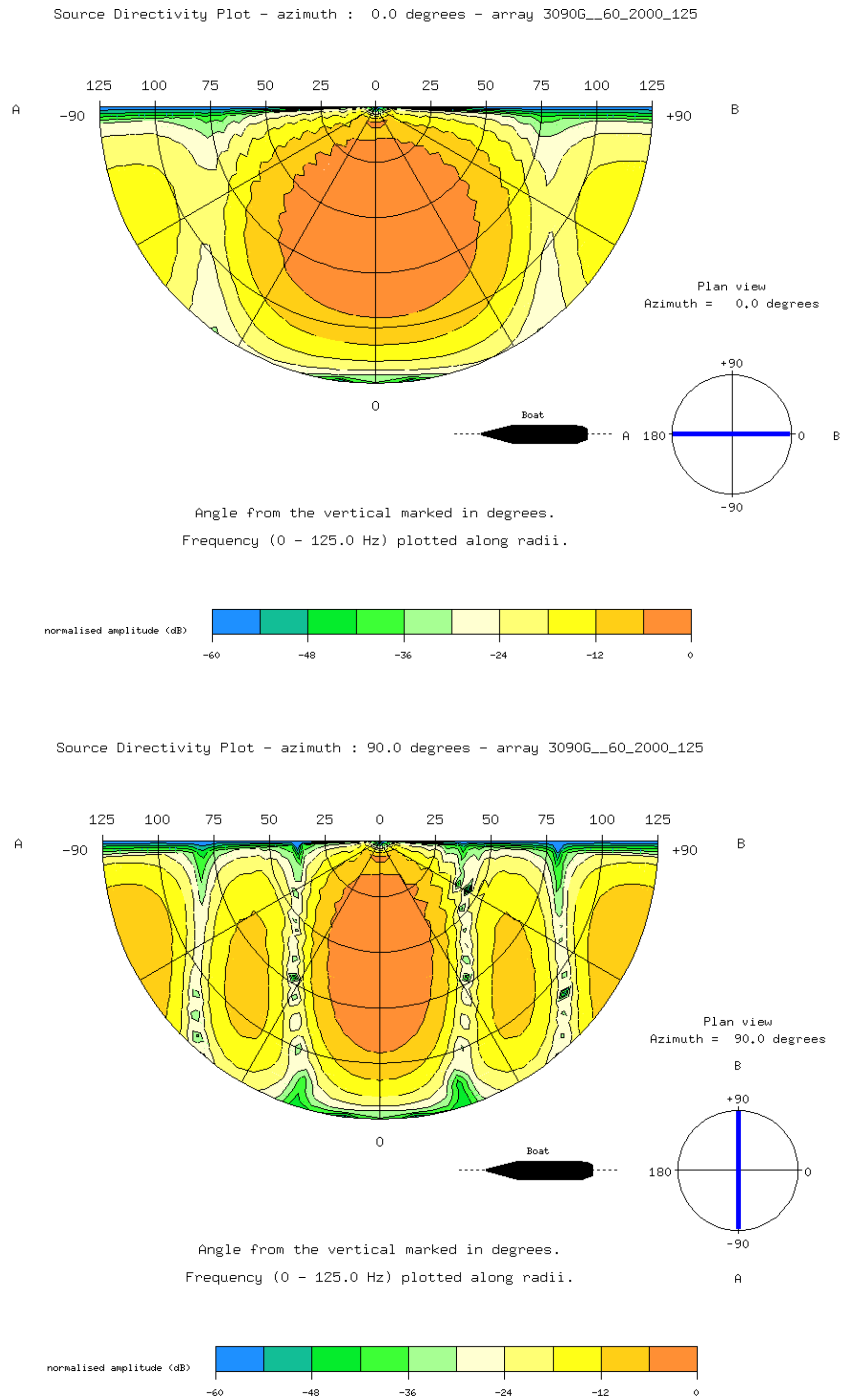


Figure 8: Directivity plot for constant azimuth of 0° and 90°.

12.3 SEG-D header

```
--------------------------------------------------------------------------------
GENERAL HEADER #1                        Starting byte 0
Bytes     Description                    Value
--------------------------------------------------------------------------------
01-02     File Number                    777
03-04     SEGD Format                    8036
          Bits Per Sample                24
05-10     General Constants
11        Year                           2006
12        Additional Header Blocks       2
12-13     Day                            120
14        Hour                           2
15        Minute                         8
16        Second                         48
17        Manufacturer's Code            41
18-19     Manufacturer's Serial Number   21
20-22     Not Used
23        Base Scan Interval (ms)        2.0
24        Polarity
25        Scan/Block Exponent
26        Record Type                    Normal Record
27        Record Length (ms)             170496
28        Scan-types / Record            1
29        Channel Sets/Scan Type         5
30        Skew Blocks                    0
31        Extended-Header Blocks         0xFF
32        External-Header Blocks         87

--------------------------------------------------------------------------------
GENERAL HEADER #2                        Starting byte 32
Bytes     Description                    Value
--------------------------------------------------------------------------------
01-03     Expanded File Number           0
04-05     Extended Channel Sets          0
06-07     Extended Header Blocks         511
08-09     External Header Blocks         1000
10        Reserved
11-12     SEG-D Revision Number          Rev. 0.0
13-14     General Trailer
15-17     Extended Record Length         200
18-19     General Header Block Number    2
20-31     Reserved
32        Extended Record Length         6

--------------------------------------------------------------------------------
GENERAL HEADER #3                        Starting Byte 64
Bytes     Description                    Value
--------------------------------------------------------------------------------
01-03     Reserved
04-06     Source Line Number (int)       0
07-09     Source Line Number (fract)     0
10-12     Source Point Number (int)      2166
13-15     Source Point Number (fract)    0
14        Source Point Index             Not Used
15        Phase Control                  Not Used
16        Type Vibrator                  Not Used
17-18     Phase Angle                    Not Used
19        General Header Block Number    3
20        Source Set Number              0
21-32     Reserved
```

```
--------------------------------------------------------------------------------
CHANNEL SET HEADER #1                  Starting Byte 96
Bytes     Description                   Value
--------------------------------------------------------------------------------
01        Scan Type Number              1
02        Channel Set Number            1
03-04     Channel Set Start Time (ms)   0
05-06     Channel Set End Time (ms)     11264
07-08     Pre-Amp Gain (dB)             0
09-10     Number of Channels            360
11        Channel Set Type              Seismic Data
12        Scans per Base Scan           1
13-14     Alias Filter Frequency        206
15-16     Alias Filter Slope            214
17-18     Low Cut Filter                5
19-20     Low Cut Filter Slope          6
21-22     First Notch Filter            0
23-24     Second Notch Filter           0
25-26     Third Notch Filter            0
27-28     Extended Channel Set Number   0
29        Extended Header Flag          0
30        Vertical Stack                0
31        Cable Number                  0
32        Array Forming                 0

--------------------------------------------------------------------------------
CHANNEL SET HEADER #2                  Starting Byte 128
Bytes     Description                   Value
--------------------------------------------------------------------------------
01        Scan Type Number              1
02        Channel Set Number            2
03-04     Channel Set Start Time (ms)   0
05-06     Channel Set End Time (ms)     11264
07-08     Pre-Amp Gain (dB)             0
09-10     Number of Channels            48
11        Channel Set Type              AUX Data
12        Scans per Base Scan           1
13-14     Alias Filter Frequency        206
15-16     Alias Filter Slope            214
17-18     Low Cut Filter                5
19-20     Low Cut Filter Slope          6
21-22     First Notch Filter            0
23-24     Second Notch Filter           0
25-26     Third Notch Filter            0
27-28     Extended Channel Set Number   0
29        Extended Header Flag          0
30        Vertical Stack                0
31        Cable Number                  0
32        Array Forming                 0
```

```
--------------------------------------------------------------------------------
CHANNEL SET HEADER #3                  Starting Byte 160
Bytes     Description                    Value
--------------------------------------------------------------------------------
01        Scan Type Number               1
02        Channel Set Number             3
03-04     Channel Set Start Time (ms)    0
05-06     Channel Set End Time (ms)      11264
07-08     Pre-Amp Gain (dB)              0
09-10     Number of Channels             360
11        Channel Set Type               Seismic Data
12        Scans per Base Scan            1
13-14     Alias Filter Frequency         206
15-16     Alias Filter Slope             214
17-18     Low Cut Filter                 5
19-20     Low Cut Filter Slope           6
21-22     First Notch Filter             0
23-24     Second Notch Filter            0
25-26     Third Notch Filter             0
27-28     Extended Channel Set Number    0
29        Extended Header Flag           0
30        Vertical Stack                 0
31        Cable Number                   0
32        Array Forming                  0

--------------------------------------------------------------------------------
CHANNEL SET HEADER #4                  Starting Byte 192
Bytes     Description                    Value
--------------------------------------------------------------------------------
01        Scan Type Number               1
02        Channel Set Number             4
03-04     Channel Set Start Time (ms)    0
05-06     Channel Set End Time (ms)      11264
07-08     Pre-Amp Gain (dB)              0
09-10     Number of Channels             360
11        Channel Set Type               Seismic Data
12        Scans per Base Scan            1
13-14     Alias Filter Frequency         206
15-16     Alias Filter Slope             214
17-18     Low Cut Filter                 5
19-20     Low Cut Filter Slope           6
21-22     First Notch Filter             0
23-24     Second Notch Filter            0
25-26     Third Notch Filter             0
27-28     Extended Channel Set Number    0
29        Extended Header Flag           0
30        Vertical Stack                 0
31        Cable Number                   0
32        Array Forming                  0
```

```
--------------------------------------------------------------------------------
CHANNEL SET HEADER #5                 Starting Byte 224
Bytes     Description                   Value
--------------------------------------------------------------------------------
01        Scan Type Number              1
02        Channel Set Number            5
03-04     Channel Set Start Time (ms)   0
05-06     Channel Set End Time (ms)     11264
07-08     Pre-Amp Gain (dB)             0
09-10     Number of Channels            360
11        Channel Set Type              Seismic Data
12        Scans per Base Scan           1
13-14     Alias Filter Frequency        206
15-16     Alias Filter Slope            214
17-18     Low Cut Filter                5
19-20     Low Cut Filter Slope          6
21-22     First Notch Filter            0
23-24     Second Notch Filter           0
25-26     Third Notch Filter            0
27-28     Extended Channel Set Number   0
29        Extended Header Flag          0
30        Vertical Stack                0
31        Cable Number                  0
32        Array Forming                 0

--------------------------------------------------------------------------------
HOST RECORDING SYSTEM STATUS BLOCK #1   Starting Byte 256
Bytes     Description                   Value
--------------------------------------------------------------------------------
01        External Header Status        OK
02        Tape Unit for Writing         0
02        Buffer Used                   2
03-04     Number of Channels (Cable 1)  360
05-06     Number of Channels (Cable 2)  360
07-08     Number of Channels (Cable 3)  360
09-10     Number of Channels (Cable 4)  360
11-12     Number of Channels (Cable 5)  0
13-14     Number of Channels (Cable 6)  0
15-16     Number of Channels (Cable 7)  0
17-18     Number of Channels (Cable 8)  0
19-20     Reserved
21        Transient Removal             No
22        Filter Samples Removed        0
23        Additional Host Blocks        0
23        Module Type                   24-bit
24        Number of Physical Cables     4
24        Not Used
25        Number of Receiver Lines      0
26        System Type                   Non-Receiver Line
27        Record Status                 Production Record
28        Header Revision               1
29        Software Revision             1
30-31     Blocks after SEG-D Area       198
32        Number of Cables              4
```

```
--------------------------------------------------------------------------------
LINE ID BLOCK #1                       Starting Byte 288
Bytes     Description                  Value
--------------------------------------------------------------------------------
01-08     Cable 1 Line ID              cable01
09-08     Cable 2 Line ID              cable02
17-24     Cable 3 Line ID              cable03
25-32     Cable 4 Line ID              cable04

--------------------------------------------------------------------------------
REEL NUMBER HEADER                     Starting Byte 320
Bytes     Description                  Value
--------------------------------------------------------------------------------
01-02     Shot Time: Day               120
03        Shot Time: Hour              2
04        Shot Time: Minute            8
05        Shot Time: Second            48
06-08     Shot Time: Microseconds      0
09        Acquisition Hardware         Seatrak System
10-12     Not Used
13        External Header 1            Nav & GCS90 Combined
14        External Header 2            Digicourse Header
15        External Header 3            Not Defined
16        External Header 4            Not Defined
17-32     Reel Number

--------------------------------------------------------------------------------
CLIENT NAME                Starting Byte 352
Bytes     Description                  Value
--------------------------------------------------------------------------------
01-32     Client Name                  JAMSTEC

--------------------------------------------------------------------------------
CONTRACTOR NAME            Starting Byte 384
Bytes     Description                  Value
--------------------------------------------------------------------------------
01-32     Contractor Name              PGS Geophysical

--------------------------------------------------------------------------------
SURVEY NAME                Starting Byte 416
Bytes     Description                  Value
--------------------------------------------------------------------------------
01-32     Survey Name                  Kumano-Nada 3D

--------------------------------------------------------------------------------
PROJECT CODE               Starting Byte 448
Bytes     Description                  Value
--------------------------------------------------------------------------------
01-16     Project Code                 2006020
17-18     Line Type                    Off Line
19-24     Swath Number                 0000.0
25-32     Sequence Number              28
```

```
--------------------------------------------------------------------------------
CABLE #1  STATUS BLOCK 1              Starting Byte 480
Bytes     Description                   Value
--------------------------------------------------------------------------------
01-03     Transmitted Scan Count        0
04-06     Received Scan Count           0
07-09     Transmitted Extraction Count  0
10-12     Received Extraction Count     0
13        Scan/Extraction Count Status  No Error
14        Time Break Status             No Error
15        Logical Cable                 0
16-17     Not Used
18        First Channel Set             0
19        Last Channel Set              0
20-23     Not Used
24        Physical Cable Number         0
25-32     Not Used

--------------------------------------------------------------------------------
CABLE #2  STATUS BLOCK 1              Starting Byte 512
Bytes     Description                   Value
--------------------------------------------------------------------------------
01-03     Transmitted Scan Count        0
04-06     Received Scan Count           0
07-09     Transmitted Extraction Count  0
10-12     Received Extraction Count     0
13        Scan/Extraction Count Status  No Error
14        Time Break Status             No Error
15        Logical Cable                 0
16-17     Not Used
18        First Channel Set             0
19        Last Channel Set              0
20-23     Not Used
24        Physical Cable Number         0
25-32     Not Used

--------------------------------------------------------------------------------
CABLE #3  STATUS BLOCK 1              Starting Byte 544
Bytes     Description                   Value
--------------------------------------------------------------------------------
01-03     Transmitted Scan Count        0
04-06     Received Scan Count           0
07-09     Transmitted Extraction Count  0
10-12     Received Extraction Count     0
13        Scan/Extraction Count Status  No Error
14        Time Break Status             No Error
15        Logical Cable                 0
16-17     Not Used
18        First Channel Set             0
19        Last Channel Set              0
20-23     Not Used
24        Physical Cable Number         0
25-32     Not Used
```

```
--------------------------------------------------------------------------------
CABLE #4  STATUS BLOCK 1              Starting Byte 576
Bytes     Description                   Value
--------------------------------------------------------------------------------
01-03     Transmitted Scan Count        0
04-06     Received Scan Count           0
07-09     Transmitted Extraction Count  0
10-12     Received Extraction Count     0
13        Scan/Extraction Count Status  No Error
14        Time Break Status             No Error
15        Logical Cable                 0
16-17     Not Used
18        First Channel Set             0
19        Last Channel Set              0
20-23     Not Used
24        Physical Cable Number         0
25-32     Not Used

--------------------------------------------------------------------------------
NAVIGATION HEADER #1                    Starting Byte 16608
Bytes     Description                   Value
--------------------------------------------------------------------------------
01-02     Master Block ID               $1
03-06     Length of Message             1666
07-10     Program Revision              0002
11-12     Shot Switch                   On-Line
13-26     Shot Time                     020848.31170620060430
34-36     Time Reference                UTC
37-42     Shot Number                   002166
43-58     Current Line Name               KMN061268P1028
59-69     Master Latitude                 33.327777
70-80     Master Longitude               136.613882
81-86     Water Depth (meters)          2017.5
87-97     Source Latitude                 33.326901
98-108    Source Longitude               136.616128
109-113   Master Gyro (degrees)         286.3
114-118   Master CMG (degrees)          325.2
119-122   Master Speed (knots)           1.5

--------------------------------------------------------------------------------
GCS90 GUN-CONTROLLER HEADER #1          Starting Byte 16730
Bytes     Description                   Value
--------------------------------------------------------------------------------
01-06     ID String                     *GCS90
07-10     Length of Block               1550
11-16     Line Number                   8P1028
17-20     Shot Number                   2166
21-22     Active Array Mask             07
23        Trigger Mode                  External
24-25     Current Sequence Number       02
26-28     Number of Sub-Arrays          006
29-31     Number of Guns in Array       066
32-34     Number of Active Guns         028
35-37     Number of Delta-Errors        000
38-40     Number of Auto-Fires          000
41-43     Number of Mis-Fires           000
44-46     Delta Spread                  004
47-52     Volume Fired                  003090
53-66     Spare
67-70     Manifold Pressure             0000
```

```
71-74     Deep Tow                       0000
75-78     Sub-Array String Pressure      1970
79-82     Sub-Array String Pressure      1956
83-86     Sub-Array String Pressure      1981
87-90     Sub-Array String Pressure      1885
91-94     Sub-Array String Pressure      1947
95-98     Sub-Array String Pressure      1870
```

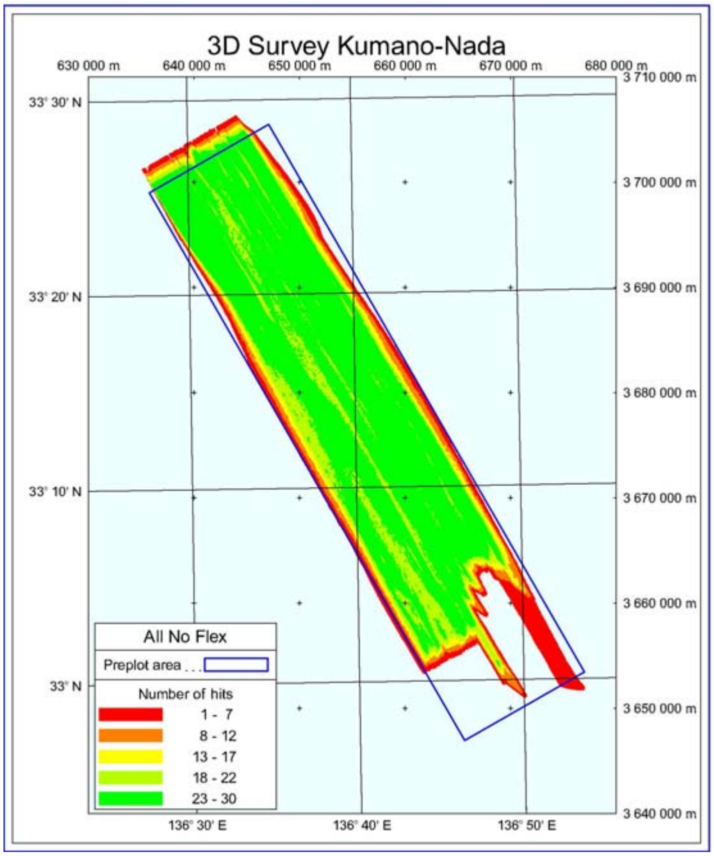
12.4 P1/90 header

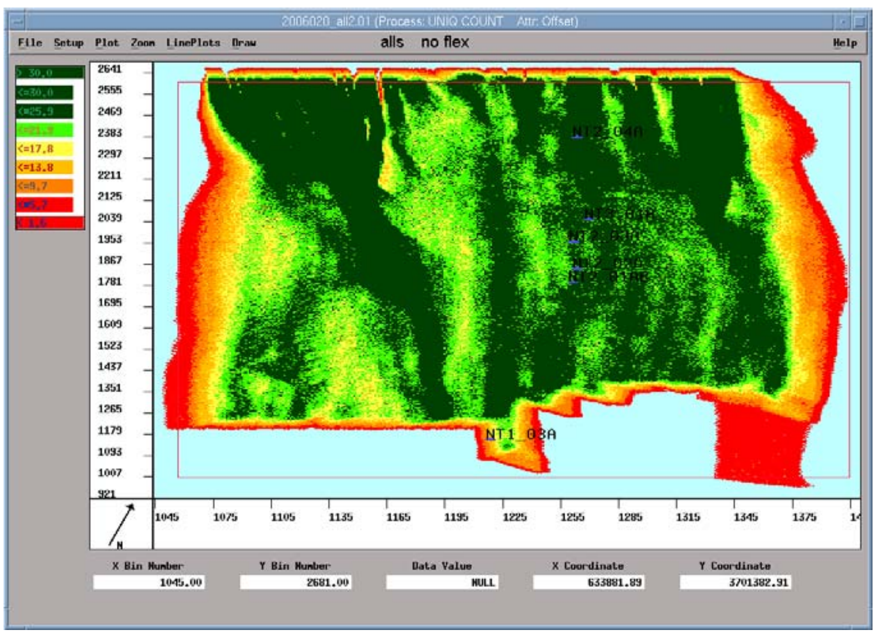
```
H0100 AREA                      NANKAI TROUGH, JAPAN
H0101 GENERAL SURVEY DETAILS    3D, SINGLE VESSEL, DUAL SOURCE, FOUR STREAMERS
H0102 VESSEL DETAILS            NORDIC EXPLORER            1
H0103 SOURCE DETAILS            STBD SOURCE G1             1   1
H0103 SOURCE DETAILS            PORT SOURCE G2             1   2
H0104 STREAMER DETAILS          STREAMER  1 360CH (STBD)   1       1   1
H0104 STREAMER DETAILS          STREAMER  2 360CH          1       2   2
H0104 STREAMER DETAILS          STREAMER  3 360CH          1       3   3
H0104 STREAMER DETAILS          STREAMER  4 360CH (PORT)   1       4   4
H0105 OTHER DETAILS             N/A
H0200 DATE OF SURVEY            02 APRIL 2006 - CONTINUING
H0201 DATE OF ISSUE OF TAPE     DD MMMMM YYYY
H0202 TAPE VERSION IDENTIFIER   KMN06P011
H0203 LINE PREFIX               KMN06
H0300 CLIENT                    JAMSTEC
H0400 GEOPHYSICAL CONTRACTOR    PGS GEOPHYSICAL, MARINE ACQUISITION
H0500 POSITIONING CONTRACTOR    FUGRO SURVEY AS
H0600 POSITIONING PROCESSING    PGS GEOPHYSICAL, MARINE ACQUISITION
H0700 POSITIONING SYSTEM        NAV SYSTEM 1: SKYFIX XP
H0700 POSITIONING SYSTEM        NAV SYSTEM 2: STARFIX HP
H0700 POSITIONING SYSTEM        INTEGRATED NAV.SYSTEM: SPECTRA VERSION 10.9.01
H0800 COORDINATE LOCATION       CENTER OF SOURCE
H0900 OFFSET SYSTEM TO SOURCE 1    1   2   37.5  -221.00
H0901 OFFSET SYSTEM TO SOURCE 2    1   2  -37.5  -221.00
H0902 OFFSET SYSTEM TO E/S    1    1   2    0.00   12.4
H0903 OFFSET SYS TO NAV REF PT     1   2    0.00    0.00
H1000 CLOCK TIME                GMT
H1100 RECEIVER GROUPS PER SHOT  1440
H1400 GEODETIC DATUM AS SURVEY  WGS84       WGS84        6378137.000 298.2572236
H1401 WGS84 TO WGS84            -0.000 0.000 0.000 0.000 0.000 0.000 0.000
H1500 GEODETIC DATUM AS POSTPR. WGS84       WGS84        6378137.000 298.2572236
H1501 WGS84 TO WGS84            -0.000 0.000 0.000 0.000 0.000 0.000 0.000
H1600 DATUM SHIFTS H1400-H1500     0.0   0.0   0.0 0.000 0.000 0.000 0.000
H1700 VERTICAL DATUM            ES                      ECHO SOUNDER POSITION
H1800 PROJECTION                001 UTM NORTH
H1900 ZONE                      53N
H2000 GRID UNITS                1 INTERNATIONAL METERS    1.000000000000
H2001 HEIGHT UNITS              1 INTERNATIONAL METERS    1.000000000000
H2002 ANGULAR UNITS             1 DEGREES
H2200 CENTRAL MERIDIAN          135 0 0.000E
H2600**********************************************************************
H2600 THE Z OFFSET OF THE ECHO SOUNDER TRANSDUCER IS -5.7 METERS FROM THE
H2600 VESSEL REFERENCE POINT AT SEA LEVEL.  TRANSDUCER DEPTH CORRECTIONS WERE
H2600 NOT APPLIED TO WATER DEPTHS.  THE SOUND VELOCITY SET IN THE ECHO SOUNDER
H2600 WAS 1500 METERS/SECOND.
H2600**********************************************************************
H2600             FORMAT OF SHOT RECORDS
H2600      COLUMN           DESCRIPTION
H2600         1             'V', 'E', 'Z', 'S', 'C' OR 'T'
H2600                       V=VESSEL REFERENCE POINT
H2600                       E=ECHO SOUNDER
H2600                       Z=INDIVIDUAL SOURCE POSITION
H2600                       S=CENTER OF SOURCE
H2600                       C=COMMON MID POINT
H2600                       T=TAILBUOY POSITION
H2600       2-13            LINE NAME
```

```
H2600         17           VESSEL IDENTIFIER
H2600         18           SOURCE IDENTIFIER
H2600         19           TAILBUOY/OTHER IDENTIFIER
H2600      20-25           SHOT POINT NUMBER
H2600      26-35           LATITUDE (DDMMSS.SS)
H2600      36 46           LONGITUDE (DDDMMSS.SS)
H2600      47-55           MAP GRID EASTING IN METERS
H2600      56-64           MAP GRID NORTHING IN METERS
H2600      65-70           WATER DEPTH
H2600      71-73           JULIAN DAY
H2600      74-79           TIME HHMMSS
H2600
H2600         FORMAT OF RECEIVER RECORD
H2600          1           'R'
H2600        2-5           RECEIVER NUMBER
H2600       6-14           MAP GRID EASTING IN METERS
H2600      15-23           MAP GRID NORTHING IN METERS
H2600      24-27           RECEIVER DEPTH REFERENCED TO SEA LEVEL
H2600      28-31           RECEIVER NUMBER
H2600      32-40           MAP GRID EASTING IN METERS
H2600      41-49           MAP GRID NORTHING IN METERS
H2600      50-53           RECEIVER DEPTH REFERENCED TO SEA LEVEL
H2600      54-57           RECEIVER NUMBER
H2600      58-66           MAP GRID EASTING IN METERS
H2600      67-75           MAP GRID NORTHING IN METERS
H2600      76-79           RECEIVER DEPTH REFERENCED TO SEA LEVEL
H2600         80           STREAMER CODE
H2600**************************************************************************
H2600 STREAMER AND TAILBUOY NUMBERING INCREMENTS FROM STARBOARD TO PORT.
H2600
H2600 STREAMER  1: RECEIVERS NUMBERED    1 (NEAR) TO  360 (FAR)
H2600 STREAMER  2: RECEIVERS NUMBERED  361 (NEAR) TO  720 (FAR)
H2600 STREAMER  3: RECEIVERS NUMBERED  721 (NEAR) TO 1080 (FAR)
H2600 STREAMER  4: RECEIVERS NUMBERED 1081 (NEAR) TO 1440 (FAR)
H2600
H2600 STREAMER ROTATIONS HAVE BEEN APPLIED ON A SHOT BY SHOT BASIS.
H2600
H2600 SPRINT CALCULATED STREAMER STRETCH IS DERIVED ON A SHOT BY SHOT BASIS.
H2600 THESE STRETCH VALUES ARE DISTRIBUTED LINEARLY OVER THE ACTIVE STREAMER
H2600 LENGTH. THE CORRECTED STREAMER LENGTH IS USED TO COMPUTE THE FINAL
H2600 RECEIVER POSITIONS.
H2600
H2600 SPRINT VERSION 4.3.3 USED FOR ONBOARD NAVIGATION PROCESSING.
H2600
H2600 PGS JOB NUMBER 2006020
H2600
H2600 ALL SHOTS FOR ALL STREAMERS ARE INCLUDED IN THIS FILE, DATA NOT TO BE
H2600 PROCESSED (NTBP) IS INDICATED BELOW AS NECESSARY.
H2600
H2600 *************************************************************************
H2600 LINES CONTAINED IN THIS FILE:
H2600
H2600 LINE:                      SEQUENCE:        FSP:          LSP:
H2600
```

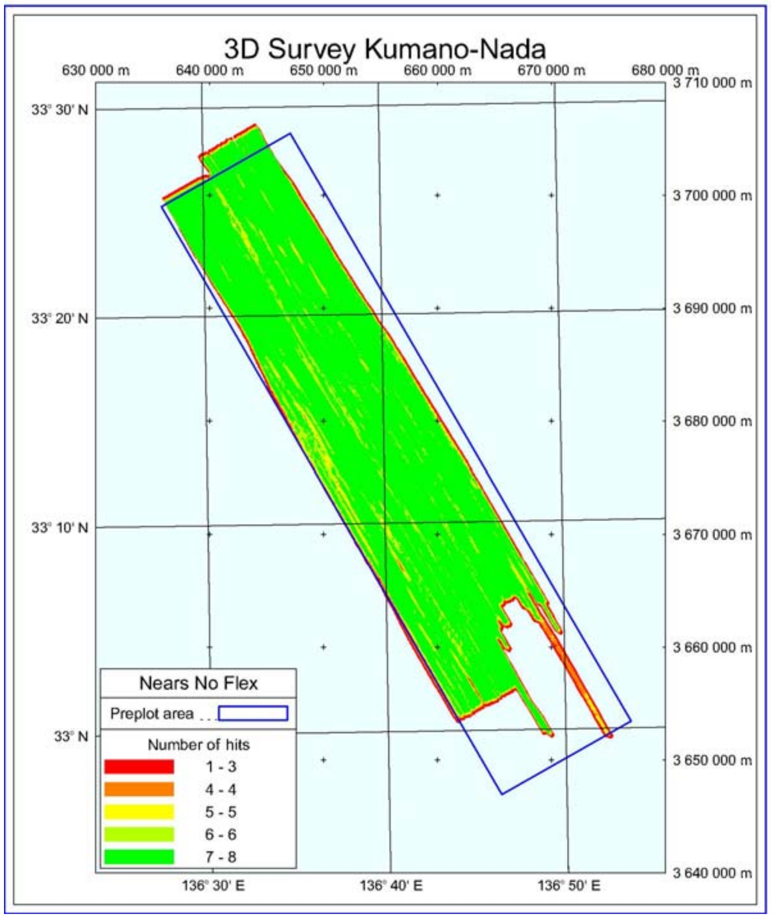
12.5 Final Coverage Displays

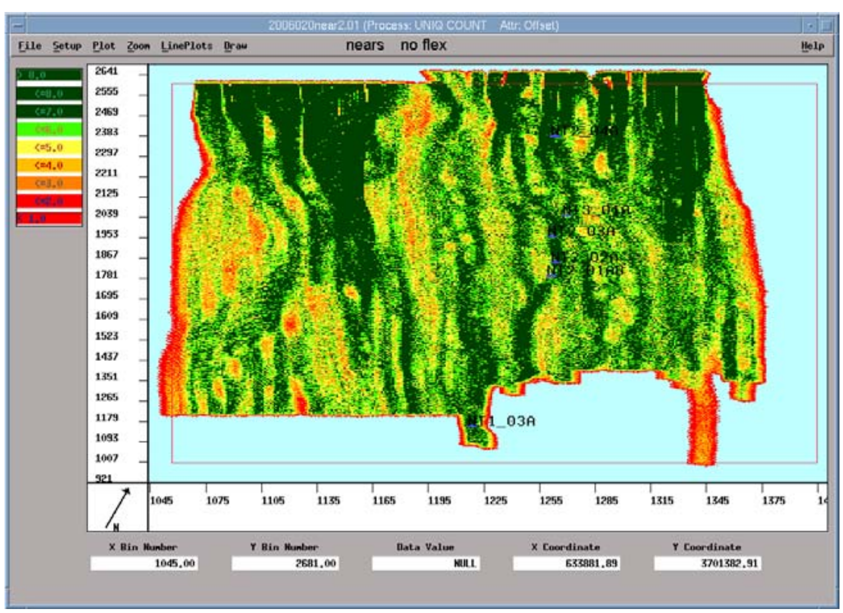
12.5.1 All No Flex



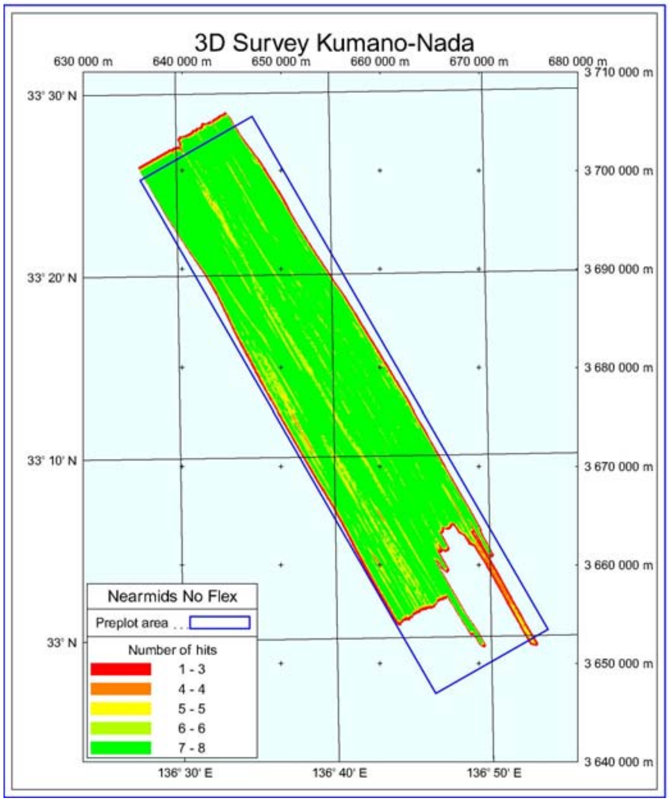


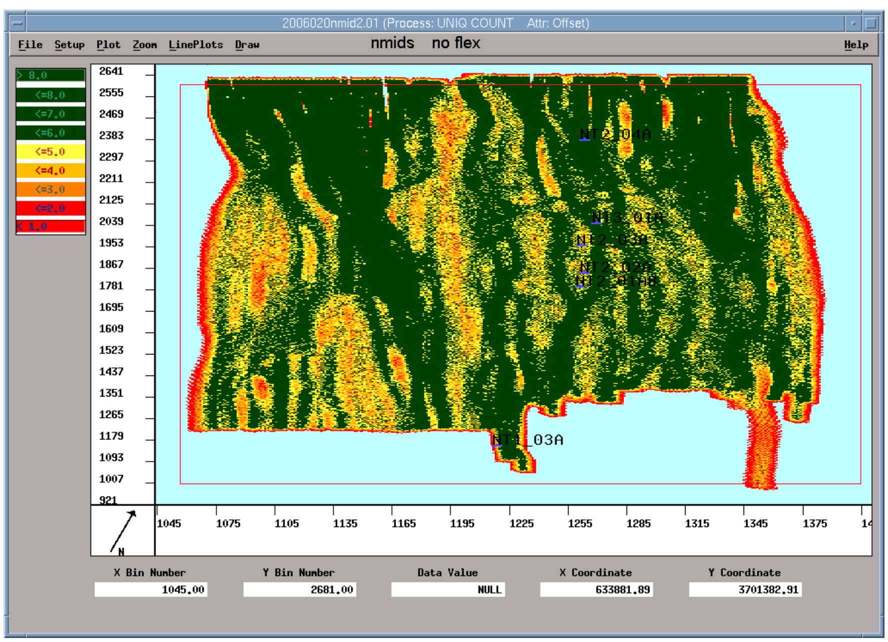
12.5.2 Nears No Flex



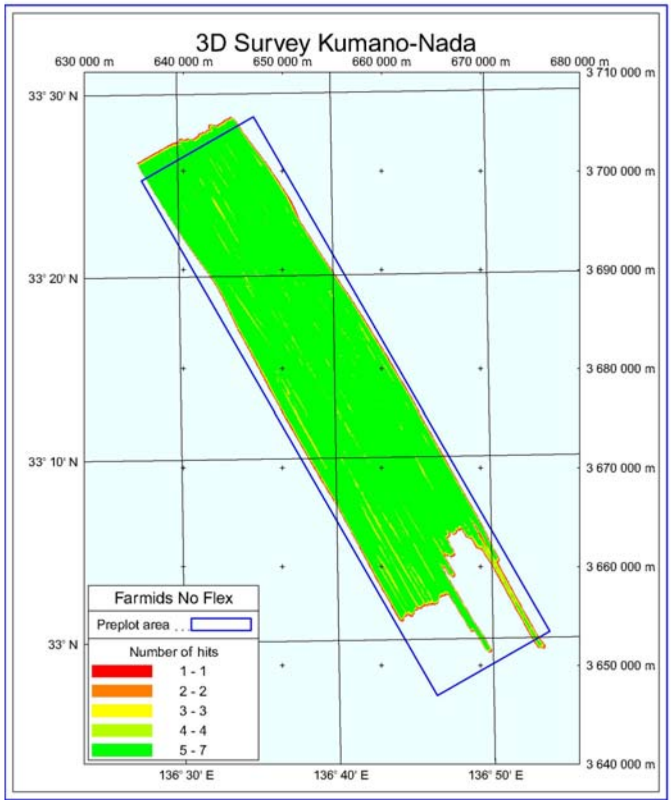


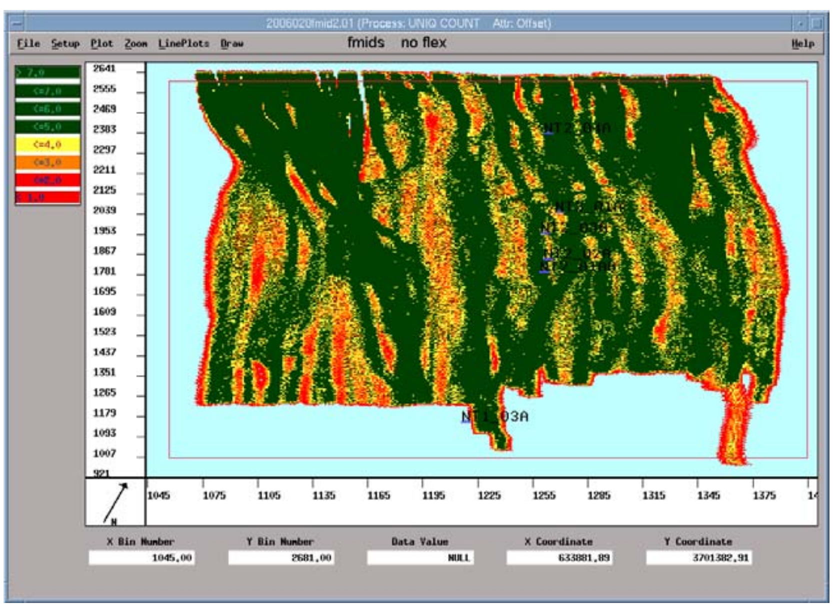
12.5.3 Nearmids No Flex



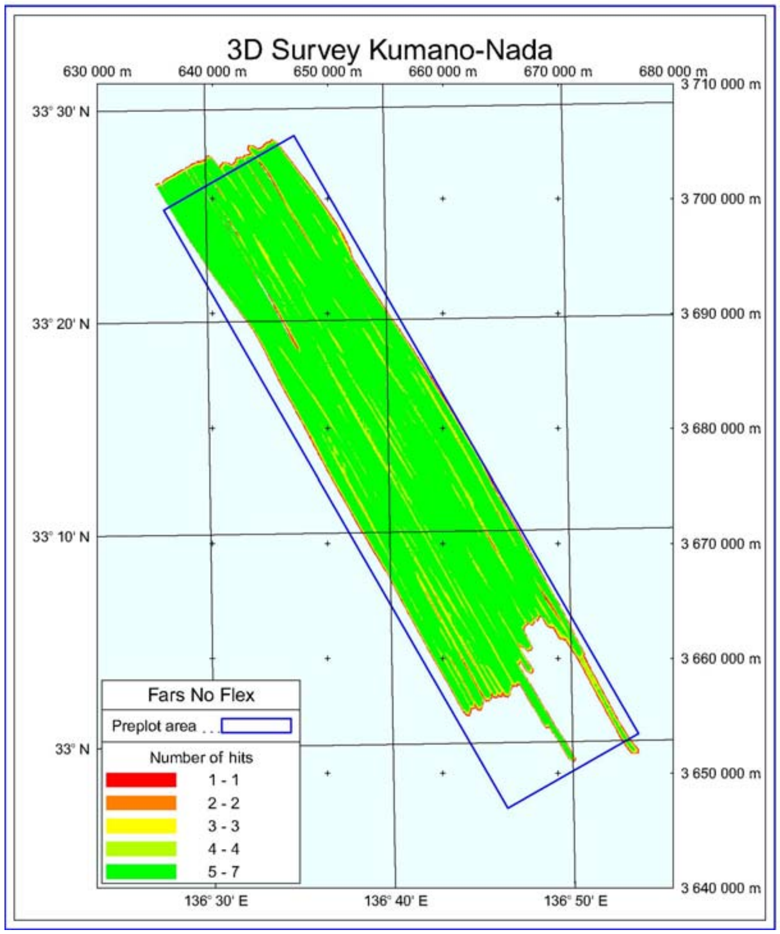


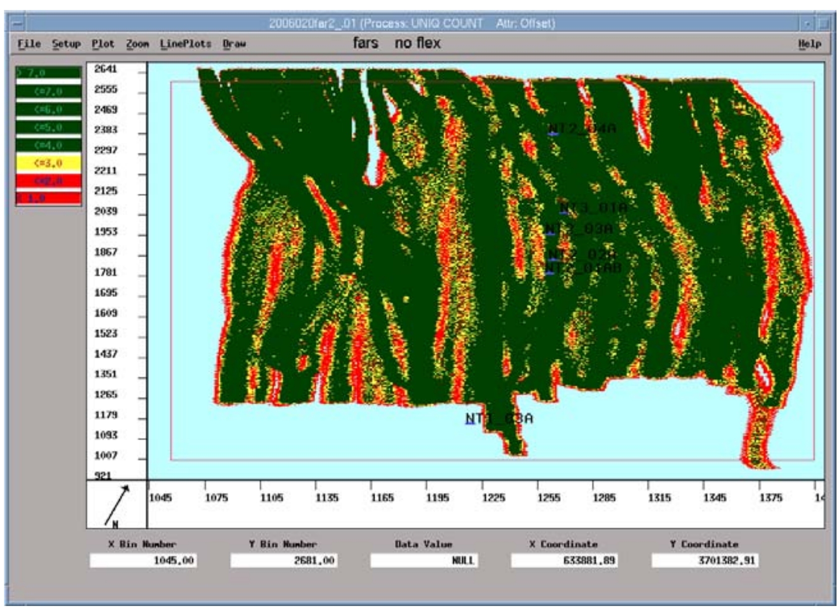
12.5.4 Farmids No Flex



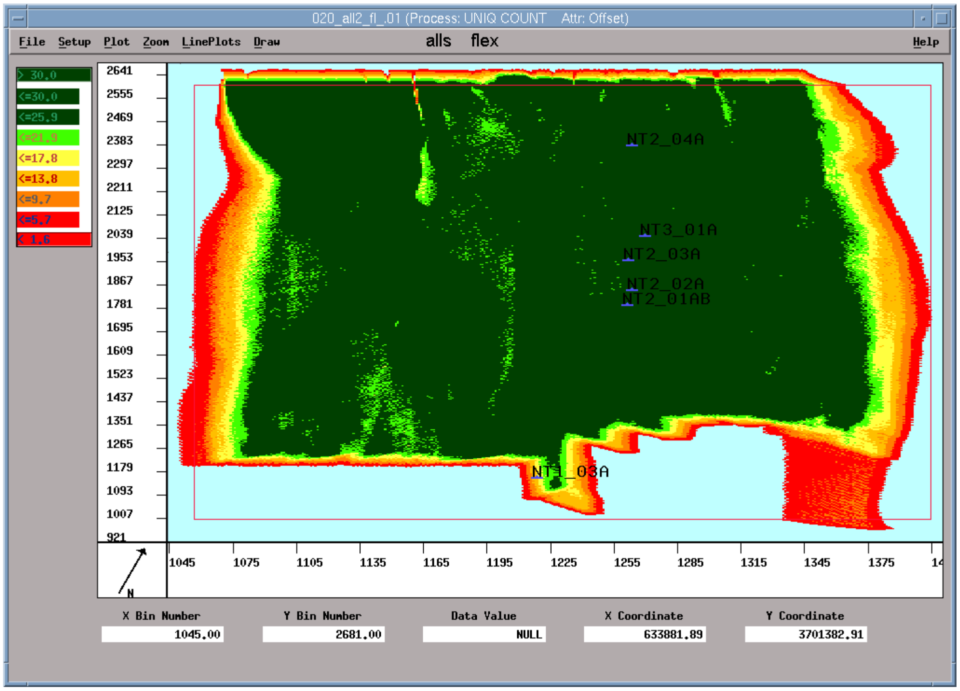


12.5.5 Fars No Flex

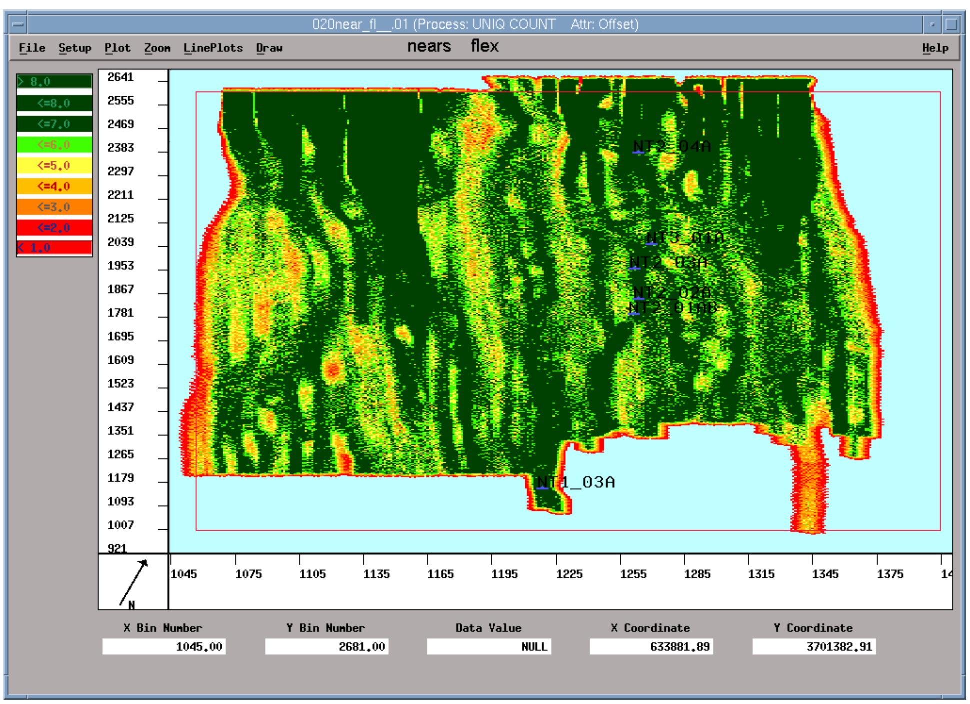




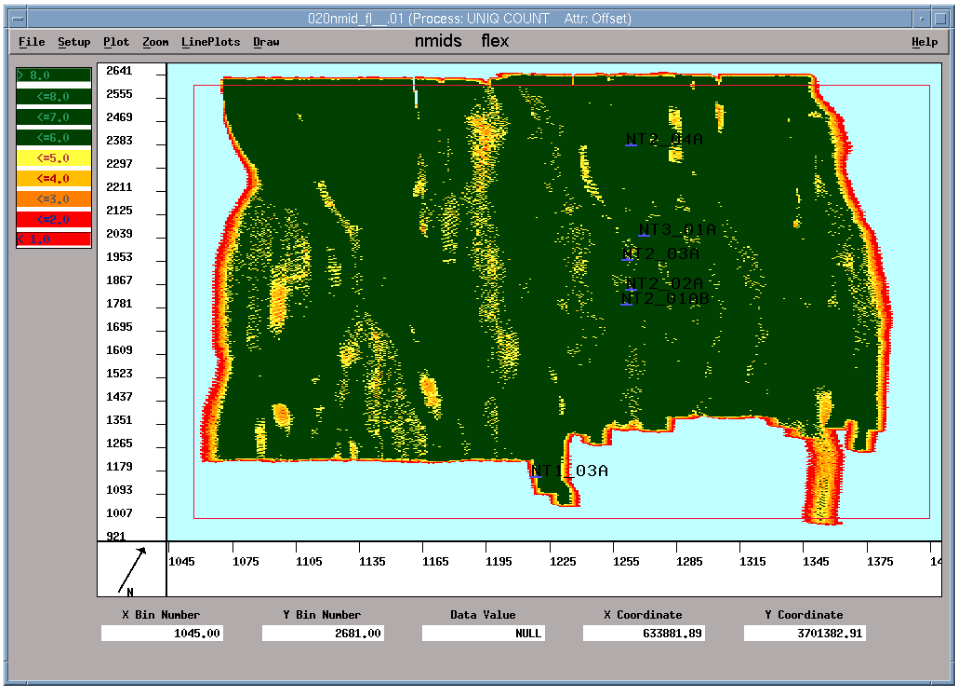
12.5.6 Alls Flex



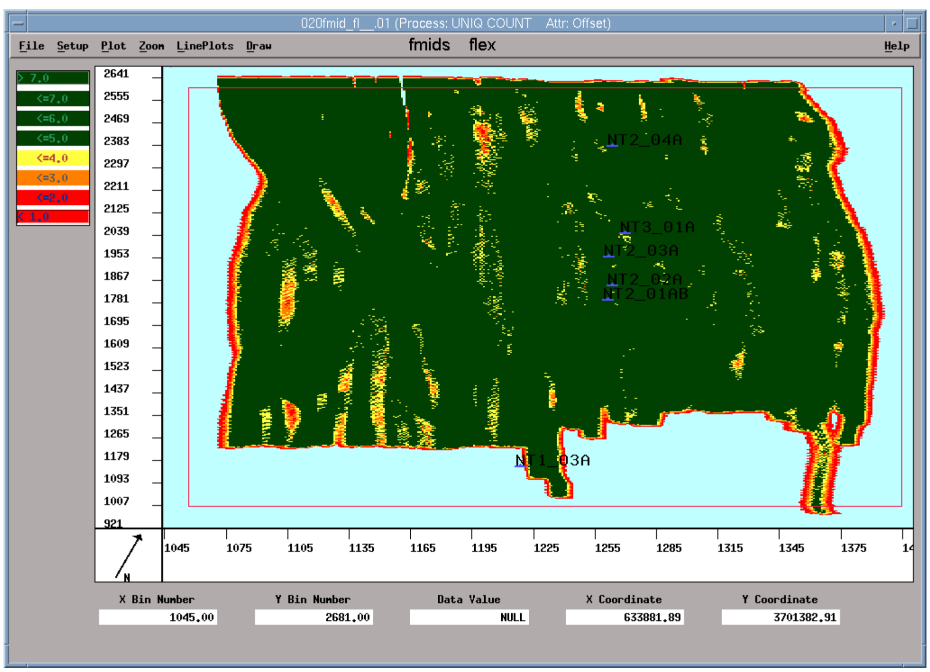
12.5.7 Nears Flex



12.5.8 Near Mids Flex



12.5.9 Far Mids Flex



12.5.10 Fars Flex