Job Book with Nav & Technical Support Final Report

Job : 00122
MGL-0812

Client : Lamont Doherty Earth Observatory

Description : Mutter 3D

Revision History

Version	Description	Date	Approved
1.0	Initial Draft	06/28/2008	AH
2.0	Additional Information	06/30/2008	AH
3.0	Final Report	08/18/2008	

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Introduction

NCS Subsea has been contracted by Columbia University's Lamont Doherty Earth Observatory to provide consulting services for Navigation & Positioning, and Systems Technical Support for their 3D Seismic Vessel *Marcus G. Langseth.* These services entail the verification, integration, testing and complete in-water deployment of the full marine seismic capability of the vessel with execution of a complete 3D Seismic Survey conducted over the East Pacific Rise.

HSE

NCS conducts its business with the utmost regard for the Health and Safety of our employees, and respect for the environment.

All employees are empowered to stop work immediately in the presence of an uncontrolled hazard. Every employee must be provided access to the appropriate Personal Protective Equipment (PPE) to ensure protection from hazards.

No NCS employee is permitted to intentionally damage the environment through the emission of any substance in any form.

All NCS employees working offshore are required to pass Medical evaluations conducted by Methodist Hospital in Houston, Texas. The evaluations are conducted every two years to the Schlumberger Medtrack standard.

Similarly all personnel are required to pass Sea Survival and Helicopter Underwater Egress Training (HUET) every three years in a US Coast-Guard approved facility.

Medical Procedures

Scope

This section describes the procedures for treating medical problems onboard a research vessel(s) operated by Lamont-Doherty Earth Observatory Office of Marine Operations (OMO). Any injury or sickness, no matter how minor should be reported to a supervisor or medical person in charge as soon as possible.

Treatment of Medical Condition

The L-DEO research vessel(s) as are all UNOLS ships, is a subscriber to the Medical Advisory Service (MAS) which is on call 24 hours per day to provide medical advice via the Inmarsat telephone:

1. Determination of extent of injury or sickness.
2. Advice on procedures for treating illness or injury.
3. Provide contact with nearest medical facility if needed.
4. Instructions for making contact with MAS are detailed in the MAS Medical Protocol Handbook in the ship's Hospital library (Section 9.1.1)
5. Treat the injury or sickness as per medical protocols from the hospital library reference materials (Hospital Library (Section 9.1.1) with medical inventory on board (ref: Quarterly Medical Inventory sheets).
6. Document all treatment that is prescribed through the MAS in ship's medical log. All faxes or telexes relating to the treatment should be filed in the personal file of an injured or sick party. Treatments for minor injuries or maladies do not need to be logged.

Medications

1. All medications maintained by the vessel as medical inventory are stowed in the Ship's Hospital on the aft Port side of A-Deck.
2. Medications and emergency medical supplies are inventoried every three months.
3. No medication is prescribed unless administered by the Captain of Chief Mate.

Serious Injury Situation

1. Reference should be made to the MAS Medical Protocol Procedures Manual (Section 9.1.1 Hospital Medical Books Library) to determine if an injury is serious enough to contact the medical advisory service.
2. If an illness or injury is serious, the MAS should be contacted by telephone or fax.

3. In the event of a serious injury, illness or accident, the Columbia University Accident Report should be completed per instructions in Section 12 & 12.5 in the Administrative Procedures Manual.

Life Threatening Situation

1. In the event of a life threatening injury or accident, in consultation with the medical advisory service, Chief Scientist and Designated Person at the Office of Marine Operations, consider diverting to the nearest port for advanced medical treatment.
2. Notify the appropriate national authorities, and if possible, arrange medical evacuation at sea. The following references should be consulted in the event of a medical diversion:
    a. Medical Advisory Service (Manual, Hospital Library)
    b. Agent's List
    c. Contact numbers in the List of Radio Determination and Special Stations.

Chemical Testing

1. In the event of a serious marine accident as defined in 46 CRF4.03-2, chemical testing shall be carried out as specified in 36 CRF4.06.

Contact Information

Name	Position	Cell Phone	E-Mail
Ship's Wheelhouse	Satellite Phone	+11 8816 3183 0511	
Al Walsh	Marine Manager	+1 845 365 8868	alwalsh@ldeo.columbia.edu
Jeff Rupert	Cruise Director	+1 203 346 2892	rupert@ldeo.columbia.edu
Robert Steinhaus	Senior Science Officer	+1 409 256 0275	roberts@ldeo.columbia.edu

Job Specifications

Geodetics

East Pacific Rise

UTM Coordinate System

Name:	WGS-84	Semi-Major Axis :	6378137.000
Unit:	Meter	Semi-Minor Axis:	6356752.31424518
Datum:	None	Flattening:	0.003352810665
False Easting:	500000.0000	Inverse of Flattening:	298.257223563000
False Northing:	000000000	Eccentricity:	0.081819190843
Scale Factor:	0.9996	Second Eccentricity:	0.082094437950
Central Meridian:	117°W		
UTM Zone	13 north		

Deliverables

Description	Media	Frequency	Comments
Daily Field Log	Electronic	Daily	Client request
Job Book/Final Report	Electronic	Job Completion	Client request
Towing Configuration	Electronic	Job Completion	Client request

Deliverable Templates

Daily Field Log

Daily Field Log

Julian Day: 224 client: LDEO

Monday-August 11, 2008 Project: MGL0812

East Pacific Rise - 3D r/v Marcus G. Langseth

TIME(utc)	EVENT	COMMENTS
0000	on-line	shooting line
0038	seq119	end of line, start turn toward racetrack
0150	seq120	Start of line EPR3D1452P
0501	seq120	end of line, start turn toward racetrack
0615	seq121	Start of line EPR3D1604R
0915	seq121	end of line, start turn toward racetrack
1032	seq122	Start of line EPR3D1444R
1339	seq122	end of line, start turn toward racetrack
1340	guns	Continue ahead at reduced speed for gunners to recover and work on string 2
1440	guns	Start string 2 back out
1527	seq123	Start of line EPR3D1596P
1857	seq123	end of line, start turn toward racetrack
2011	seq124	Start of line EPR3D1436P
2306	seq124	end of line, start turn toward racetrack
2400	end of day	end of day, on turn, position 09°40'40.12N, 104°22'11.365W

Deliverable Templates II

Sequenced Line Logs

Seq# 116

Line Name: EPR3D1788R | NAVIGATION LINE LOGS | DATE: 10/08/08 | JULIAN DAY: 223

Line Brg: 262 °

CLIENT: National Science Foundation | SURVEY: East Pacific Ridge3D | MGL0812

DC SOL: -200.8m
DC EOL: -221.9m
SMG SOL: 4.5 knots
SMG EOL: 4.3 knots
WEATHER
WIND SOL: 7.4 knots
WIND EOL: 10.0 knots
SEAS SOL: 1.0m
SEAS EOL: calm

DEPTH SOL: 2858.1m
DEPTH EOL: 2948.5m
FEATHER SOL: -74.9 °
FEATHER EOL: 5.8 °
MAX FEATHER: -74.9 °

00:00 - 12:00 cst =: Mike Martello, Kaori Kobayashi
12:00 - 24:00 cst =: David Martinson, Scott Upper

NAVIGATION SYSTEM USED: C-Nav - Primary
NAVIGATION SYSTEM USED: SeaPath 200
NAVIGATION SYSTEM USED: Pos MV
GRAVITY METER: BMG-II
MAGNETOMETER: GeoMetrics
MAG DEC USED : 7.59°

SP	TIME (utc)	EVENT	COMMENTS
1538	0813	FSP	Start of line
1432	0946	FFSP	First full fold shotpoint
1121	1001	reshoot	First shot of reshoot section of line - to end of line
894	1103	LSP	End of Line
			Note: this line starts as a fill line but will terminate in the reshoot.

VESSEL POSITION

	SP	Latitude (N)	Longitude (W)
FSP	1538	09° 46' 56.800"	104° 10' 06.373"
LSP	894	00° 45' 06.684"	104° 23' 11.197"

NAVIGATION OFFSET APPLIED

NRP - Stern	-4.20m
NRP - COS	-295
NRP - CNG	-495
COS - CNG	-200
NRP - CMP	-395

General remarks:
S1C9 KO'ed
S2C6 KO'ed
G1T1 – S3T1 data absent
T5 R1 - KO'ed
maggie not used

P1 EPR3D1788R.0.p190 | P2 EPR3D1788R.0.p294

4 X 6000m X 150m

Postel locations & remarks: good - none - intermittent

Tailbuoy #1	none	Gun string #1	good
Tailbuoy #2	good	Gun string #2	good
Tailbuoy #3	good	Gun string #3	good
Tailbuoy #4	good	Gun string #4	good

Acoustic remarks:

Langseth: AXIS LM | PacificRise SCN(001) | Lang3D.RTCN

SP spacing: 37.5m

line status: Line Complete

Deliverable Contents

Survey Report

- Job Book
- Daily Logs
- Work Order
- Job Start Report

Data Deliverables

- Copies of Reports
- Copies of Towing Configuration Diagrams

Area of Operations

The project study will be done on the East Pacific Rise. This is a plate boundary area of significant interest due to the volcanic activity present. The area under study is approximately 700 miles south of Manzanillo, Mexico in the Pacific ocean. The primary survey block is 900 square kilometers.

Personnel

Client Contacts

Name	Position	Cell Phone	E-Mail
Al Walsh	Marine Manager	+1 845 365 8868	alwalsh@ldeo.columbia.edu
Jeff Rupert	Cruise Director	+1 203 346 2892	rupert@ldeo.columbia.edu
Robert Steinhaus	Senior Science Officer	+1 409 256 0275	roberts@ldeo.columbia.edu

NCS Personnel

Name	Position	Cell Phone	E-Mail
Stuart Porteous	VP Operations	+1 8326890179	stuart.porteous@ncs-subsea.com
Al Hise	Prod Line Mgr.	+1 8324952018	al.hise@ncs-subsea.com
Mike Martello	Project Mgr.	+12282381368	mike.martello@ncs-subsea.com
David Martinson	Project Mgr.	+1 7014039090	david.martinson@ncs-subsea.com

Equipment

NAVIGATION / QC

SPECTRA

Spectra is a comprehensive integrated seismic navigation system with a modular design, which allows any *innovations in navigational techniques* to be applied quickly.

Spectra is based on an expandable network of Unix or linux workstations with a dedicated real time navigation sensor acquisition system **RTNu** providing access to a tried and tested database of over 100 different navigation sensors and closure timing to a 50 micro-second resolution.

Benefits of spectra

- **Navigation acquisition and validation with real time source and streamer positioning for marine seismic surveys ranging from simple 2D and high resolution requirements to extensive 3D multi-streamer, multi-vessel configurations.**
- **Distributed Data Server provides simple connectivity to easily configure complex multi-vessel surveys. Real-time data acquisition units with integrated GPS receiver provide triggering to 50 micro-seconds, allowing remote synchronization of seismic and acoustic systems.**
- **Data logging to UKOOA P1/90, P2/91 and P2/94 standards with full redundancy, providing confidence in data integrity.**
- **Quality Control features providing alarm and audit facility meeting UKOOA guidelines. Extensive on-line graphical analysis features and end of line reporting facilities.**
- **Positioning using Kalman filtering with advanced data-snooping statistical testing techniques.**
- **DGPS and RGPS real-time re-computation.**
- **Autopilot interface controlled from instrument room leaving the navigator in charge of steering. This facility is fully integrated with a comprehensive turn planning utility, providing optimum efficiency in line changes.**
- **3D real-time binning, CMP and offset distribution displays. Fully compatible with Concept Systems off-line binning and analysis package, Reflex which includes bin expansion capabilities.**

Data Acquisition

The seismic data will be acquired using a Marconi Solid Cable system. Four streamers 6000 meters in length with (150m) sections will be used to acquire 1872 channels of data on the 24 bit system.

Positioning

Vessel positioning will be achieved using the Spectra Totally Integrated System, provided by LDEO, which accurately plots the ships position in real-time. The system generates signals by which the "DigiSHOT" commands the Air Guns to fire at pre determined intervals, based on either distance or time as previously determined. The CTB output "trigger" from DigiSHOT signals the Syntrak 960 -24 recording system to record seismic data from the four 6km streamer cables. Real Time positioning of the source and tailbuoys will be achieved with PosNet, a remote gps system which gives a direct range and bearing in real-time for all events.

GPS Systems

Primary

The C-Nav 2050 sensor consists of a 22-channel precision GPS sensor with two additional channels for receiving Satellite Based Augmentation System (SBAS) signals and an L-band demodulator for reception of the C-Nav StarFire Network correction service, for decimeter-level position accuracy, anywhere in the world, anytime. The sensor can output proprietary raw data as fast as 50HZ and Position Velocity Time (PVT) data as fast as 25HZ through two 115kps serial ports.

The C-Nav StarFire network correction service gives an immediate solution for the user utilizing the global Real-Time Gipsey (RTG) and regional Wide Area Correction Transform (WCT) solutions. Additionally, the unit can accept corrections for DGPS, WAAS/EGNOS, assuring seamless position output.

Secondary

Seapath 200 is a stand-alone system, which does not require input of data from any other sensors in order to provide accurate heading, roll, pitch and heave. Seapath requires input of DGPS corrections. Seapath provides a real-time heading, attitude, position and velocity solution by integrating the best signal characteristics of two technologies, Inertial Measurement Units (IMU's) and he Global Positioning System (GPS). Seapath utilizes the proven and reliable Seatex MRU 5 inertial sensor and two GPS carrier phase receivers as raw data providers. The raw sensor data are integrated in a Kalman Filter in the Seapath Processing Unit. The Kalman filter is a proven and effective filtering technique for integration of various sensors in a realtime environment, and the filter output provide heading, attitude, and position data required in survey applications.

Tertiary

POS/MV – Uses three sensors – the Inertial Measurement Unit (IMU) and two Global Position System (GPS) receivers. These allow the System to deliver an accurate and comprehensive data set, including:

- Geographic position (latitude, longitude and altitude)
- Heading
- Attitude (roll and pitch)
- Vertical displacement (heave)
- Velocity
- Acceleration
- Angular rate of turn
- Performance metrics
- Fault detection and reporting

Gyro

The Simrad GC80 gyro has been designated for any size vessel, to enhance the navigation capabilities and reliability. This is done by using basic gyroscopic action to form a stable directional platform.
When the 3 axes (spin axis, horizontal axis, and vertical axis) of the gyro reach a high stable revolution rate, the compass card reflects the True heading in relation to north. This is a factory preset, where a weight is added to the vertical ring (axis). Another, smaller weight is added to the sphere giving a damping effect to the oscillations created by the vertical ring weight. The GyroCompass north-seeking tendency depends upon the fact that north is a right angles to the west-to-east direction in which the earth's rotation carries the compass. A high degree of accuracy is maintained by the use of scheduled "calibration checks" where slight fluctuations (if any) are compensated in Spectra.

Energy Source

The energy source is a 4 string array, utilizing Bolt internal shuttle guns. Each sub-array dimensions are 16 meters in length with a sub-array cross line separation of 8 meters, and are composed of 10 guns with 1 of the 10 being a "spare" gun leaving a 1650cu in volume per string. Without "spare" guns, a total volume of 6600 cu in., per array (or 2-sub-arrays of 3300 cu in.) Source synchronization is achieved with a DigiSHOT Seismic Source Controller System. The DigiSHOT control's all airguns within the same array. The timing for each gun is individually controlled. The system collects and displays graphically the sensor data for all guns in the array. It also collects and displays the gun depth and air pressure supplied to each string. The sensor data is used to detect when the airgun was triggered and to make the necessary adjustments to airgun timing. The DigiSHOT system provides timing resolution of 0.1ms. Source positioning will be

derived by nominal value and actual RGPS range and bearings, and acoustic positioning pods.

Cable Compasses

Digicourse Model 5011 Compass Birds will be distributed along the streamer, and used to model the cable shape for the positioning of the receivers. These compasses will be present at every 300 meters. The Model 5011 Compass Bird provides adjustable depth control, depth measurement, ballast information, and compass heading. The heading sensor is a compass designed for in- streamer installation. A digital number (indicative of orientation relative to magnetic North) is latched to a serial pulse train output. All information is transferred to the streamer "coils" when polled and returned to the vessel by wire to the Digicourse computer and to Spectra.

PosNet

Designed to work with SARGAS reference stations, PosNet can be used in areas where coverage is not available, such as the Costa Rica and Nicaragua waters, where our survey is located. The relative position accuracy of the local targets: gun pods, tailbuoy, is unaffected, as they are independently estimated relative to the vessel, and the vessel position is known sufficient accuracy even without any DGPS correction to obtain sub meter target relative position to the ranges that are used for these operations.

All raw and computed data may be recorded. The Windows XP™ based computer used by PosNet is networked to Spectra and all received data is available for use.

GUN POSNET PODS
One located on each gun string, 23cm behind the center of source, for a total of 4.

TAILBUOY POSNET POD
One located on each tailbuoy, for a total of 4.

Streamer Cable Composition

1. Lead-in – Heavy armored cable that that packages the wires and fiber optics and is used to provide the offset from the vessel to the first active section. And to communicate (send/receive) information from the streamer.

2. RVIM – head stretch between the lead in and STU. Its length is 30m upon deployment, and it acts as a "shock absorber" reducing the effect of the vessel's movement upon the deployed streamer in the water.

3. STU –streamer tension unit is incorporated in order to monitor the tension upon the streamer. This is to protect the steamer from unnecessary "pull" causing damage or loss of streamer.

   The streamer is a Syntron Sentry Solid streamer.

4. Length of the "active streamer" is 6100 meters and is composed of 40 x 150 meter long active sections. These sections are connected by modules which control the data flow. Each section contains "communication coils," located at known positions on the cable, and is used to communicate to "cable levelers, compasses, depth indicators." This same "coil" can also communicate with the acoustic pods. All is monitored by Spectra and its QC.

5. Tail Stretch is located at the end of the active streamer, after a passive module that terminates the streamer. The 50m tail-stretch, is used similarly as the head-stretch, to reduce unwanted tugging on the streamer.

6. Stic-cable, 75m, is used to send power to the active Tailbuoy, for the electronics located there, RGPS, acoustic pod, and radio modem. This data is then, by radio link, sent to the vessel and Spectra. The active tailbuoy GPS will provide for accurate rotation of the streamer to the tailbuoy in processing, providing a highly accurate streamer shape.

Acoustic's

SIPS is the Seismic Integrated Positioning System manufactured in the U. K. by Sonardyne International Ltd.
SIPS is designed for use on marine seismic survey vessels as an acoustic positioning system for airgun arrays, streamers and tailbuoys.

In use for this survey is the 1 way ranging transceiver model number 7785.

The basic operation method of SIPS is the measurement of ranges between in-water units of a seismic system so their relative positions can be calculated.

The distance between units are measured using the principle that sound travels through water at a predictable speed. By measuring the time for sound to travel between two points the range can be calculated. Multiplying the travel time by the speed of sound gives the distance travelled.

The sound used by the SIPS system are very short pulses of a constant high frequency.

The Sips system uses intelligent acoustic transceivers placed at reference points that need to be positioned. The Transceivers have a digital data link with the shipborne equipment to transfer the measured range data.

The devices are also controlled from the surface system using these data links.
The units mounted on the streamers are battery powered and use the streamer embedded coil communications system. Other units are hard wired into the surface system using dedicated communications links. For other applications a radio modem link can be used to communicate with transceivers.

A transceiver is an intelligent unit which can be used to measure distances underwater. SIPS transceivers are commanded by Controller boards mounted in the SIPS Controller rack. The Controllers send commands to the transceivers to initiate the ranging process and then request range data from the transceivers. Transponder units do not have an associated Controller card. A Transponder will transmit an acoustic reply after a preset interval when a particular acoustic signal is received from a transceiver.

Locations: 1 on each gun string for total of 4, 2 on the streamer head, 2 placed mid streamer, 2 on the tail of the streamer and 1 on each tailbuoy for a total of 28.

Multibeam echosounder

The EM 120 multibeam is designed to perform seabed mapping to full ocean depth. The system is cost effective, reliable, and easily operated on workstations with familiar operating systems.
Key facts
The Kongsberg Maritime product is designed to perform seabed mapping to full ocean depth with an unsurpassed resolution, coverage and accuracy. The design is based on more than 50 years of hydrographical experience with echo sounders, sonars and underwater positioning for civilian and military use.
The EM 120 is a complete system. All necessary sensor interfaces, data displays for quality control and sensor calibration, seabed visualization, and data logging are a standard part of the system, as is integrated seabed acoustical imaging capability (sidescan).
The nominal sonar frequency is 12kHz with an angular coverage sector of up to 150 degrees wand 191 beams per ping as narrow as 1 degree. Achievable swath width of a flat bottom will normally be approximately six times the water depth. The angular coverage sector and beam pointing angles may be set to vary automatically with depth according to achievable coverage. This maximizes the number of usable beams.
The EM 120 transducers are linear arrays in a Mills cross configuration with separate units for transmit and receive. The arrays are divided into modules (and hence the beamwidth) may be adjusted according to particular installation requirements.
A combination of phase and amplitude detection is used, resulting in an instrument measurement accuracy practically independent of beam pointing angle.

Water Column Velocity of Propagation

Water velocity for the survey will be assumed at a static 1530 m/sec except for seismic processing.

Onboard Navigation Data Processing

Processing was performed onboard using SPRINT 3D from Concept Systems Ltd., Version 4.3.3 , running on Red Hat Linux system.

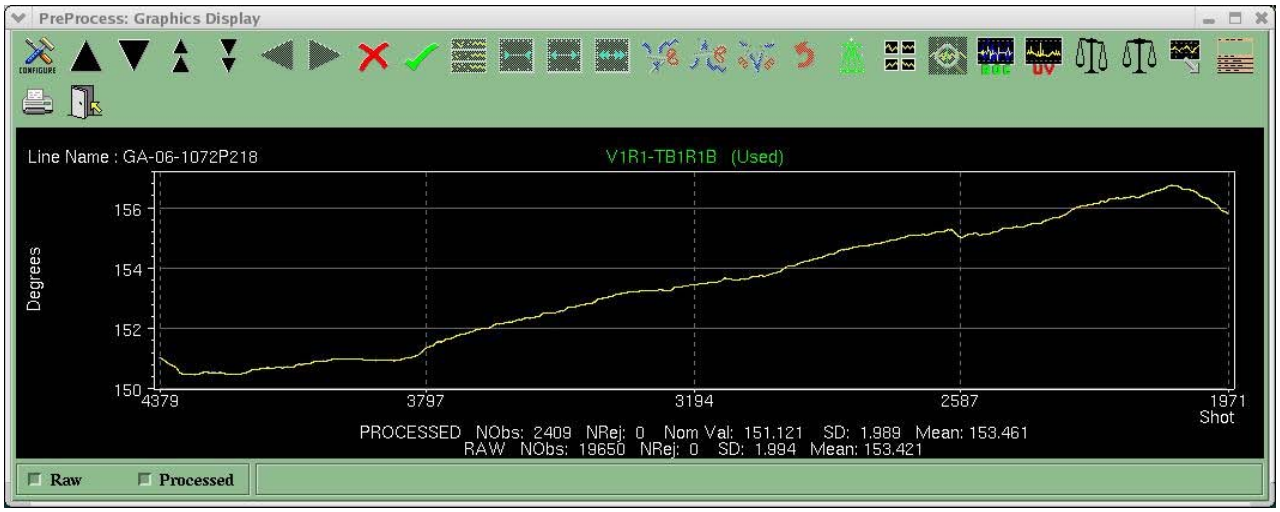
The typical operational flow consists of using standard SPRINT modules such as:

IMPORT

Import module is used to import raw navigation data in the form of P2/94 files into database. After completion of the import report is generated automatically.

PREPROCESS

PreProcess module is used to review, assess and edit (reject) raw observations so that they are ready for use in the NetAdjust module.



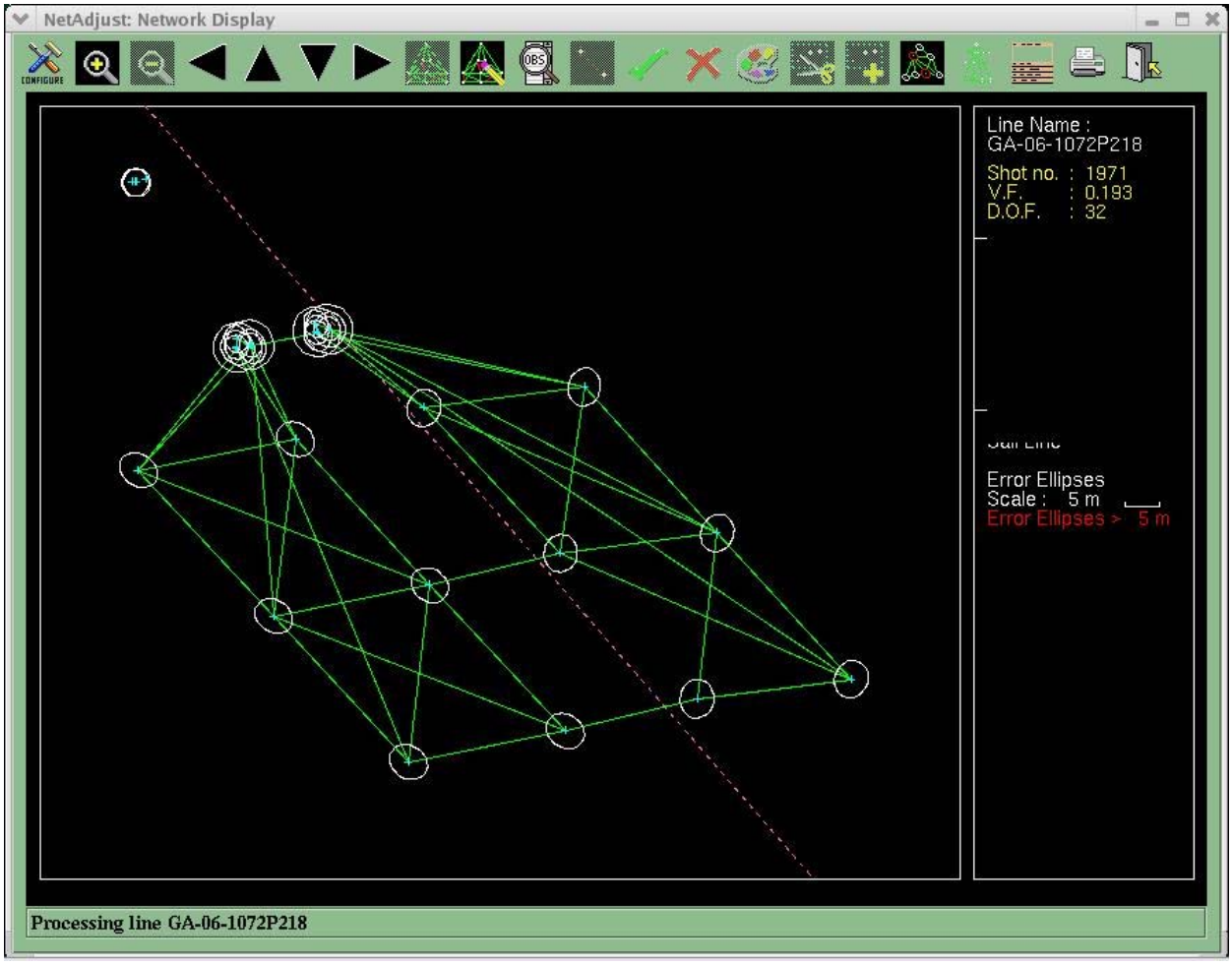
Acoustic groups	Standard dev. (SD)	Gating	Threshold	Sample size	LP filter	Inter polation	Extra polation
Vessel	1.2	ROC	0.1	11		80	20
Gun	1.5	ROC	0.1	11		80	20
Front	1.0	ROC	0.1	11		80	20
Mid	1.0	ROC	0.1	11		80	20
Tail	1.0	ROC	0.1	11		80	20
Inline	0.5	Running median	0.5	11	70	250	50

RGPS groups	Standard dev. (SD)	Gating	Threshold	Sample size	LP filter	Inter polation	Extra polation
Range	2	ROC	0.05	11	70	80	20
Bearing	0.03	ROC	0.01	11	70	80	20

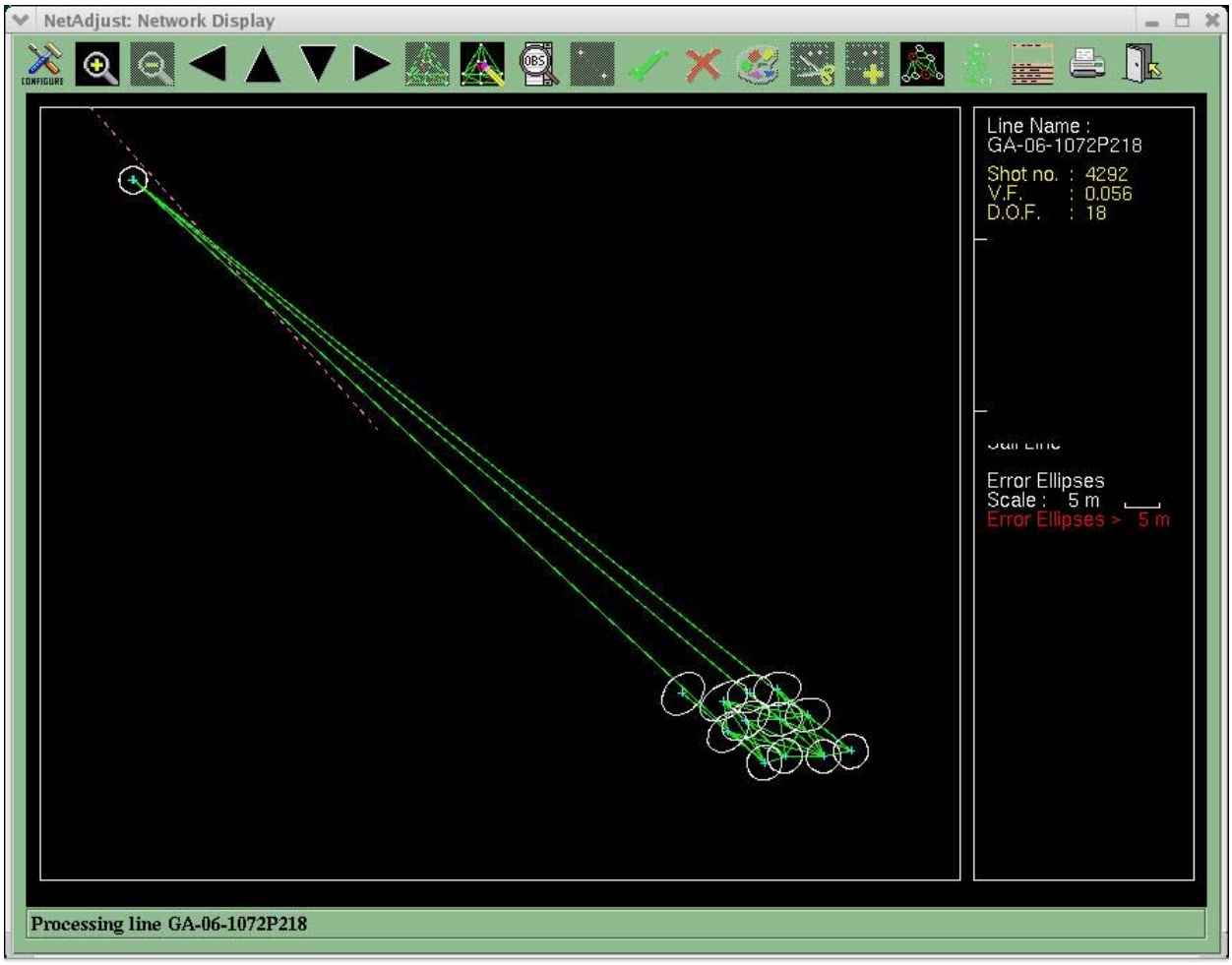
NETADJUST

The NetAdjust module is used to adjust processed navigation observations using the least square method to calculate the final navigations nodes co-ordinates (where nodes are navigation tools like RGPS or acoustic or point of navigational network like seismic receivers or centre of source).

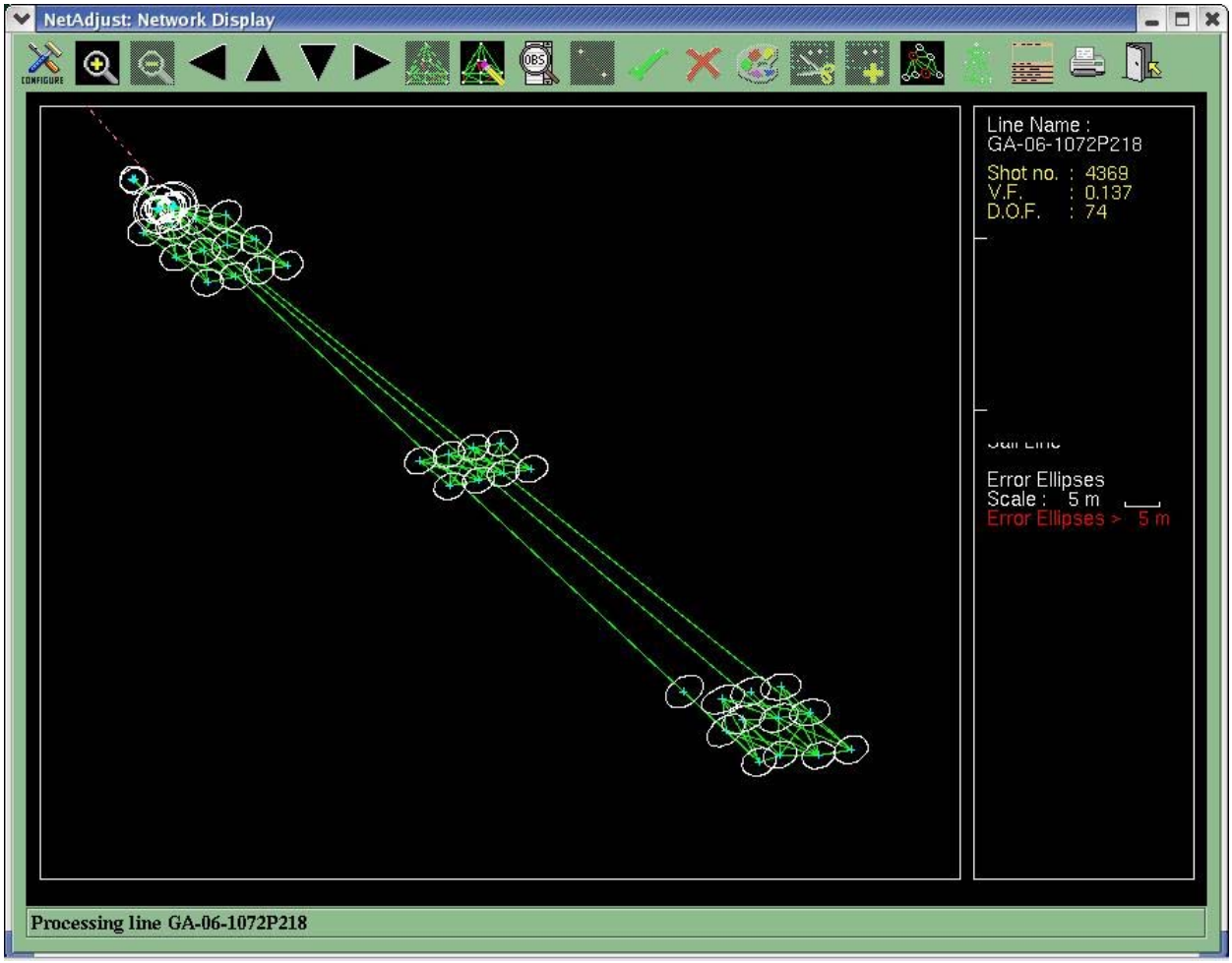
For convenience and easy control navigation network was divided by 3 stages: FRONT, TAIL and COMPLETE.



Front network. You can see absence of vessel ranges and ranges between cab



Tail network. Example of seq.218. Acoustic S4T6 doesn't work.



Complete network.

Stages were running demonstration least squares adjustments to check network accuracy. Accurate network node positions then were batched to database.

EXPORT

The Export module was used to build the final P1/90 file and export feather angle and streamer rotation attributes for plotting in REFLEX.

ANALYSE

For quality control purpose the follow graphs were plotted in the PDF format in the Analyse module.:

1. Error Ellipse Semi-Major Axes for vessel, tail buoys and first and last receivers groups.
2. North and East differences between primary and secondary DGPS.
3. Unit variance and DOF for complete network.
4. Seismic offsets for all streamers.

5. Separation for guns and streamers (front and tail).
6. Feather angle and streamers rotations.

REPORTS

During processing the follow reports were acquired for quality control purposes:

1. Compasses calibration report to find out compasses with big (>1°) BIAS.
2. Net Adjust report.
3. Processing QC report.
4. P1/90 QC report.

REFLEX

P1/90 and attribute files were imported from SPRINT to REFLEX to get coverage, water depth and streamer rotation plots.

Additional Notes:

Client was provided with standard full fold P190 files as well as full shot range P190 files. P190 files were also produced for Axis lines running down the plate boundary along the volcanic ridge as well as for all ancillary data that was acquired.