

# **Navigation Report**

**MGL0906**

**Lamont Doherty Earth Observatory**

**R/V Marcus G. Langseth**

**Chief Scientist:** McIntosh, Kirk and Liu, Char-Shine

## Revision History

Version	Date	Author	Comment
v 1.0	2009-01-17	D Martinson	Initial Version
v 1.1	2009-03-07	A Johnson	End-of-cruise(MGL0903) update
v 1.11	2009-04-29	M Zhang	End-of-MGL0905 update
v 1.12	2009-06-02	A Johnson	End-of-MGL0906 update

# 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 Gipseye (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 to achieve superior position. 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 the 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 real-time environment, and the filter output provide heading, attitude, and position data required in survey applications.

### **Tertiary**

POSNet GPS – See Posnet below.

## **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<sup>TM</sup> 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.

## **Acoustics**

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 traveled.

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 on the tail of the streamer and 1 on each tailbuoy for a total of 9.

## **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 and 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 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 1485 m/sec except for seismic processing.