



SERCEL SEAL HIGH RESOLUTION MULTI-CHANNEL SEISMIC SYSTEM

SSR Survey Ltd. and its partner group McGregor GeoScience own and operate a Sercel SEAL, 96-channel, 24-bit digital hydrophone array and Sercel HR SEAL 408 seismic acquisition system to enhance it's wellsite geohazard survey capabilities. The system features a state-of-the-art 1200m solid core Sentinel Streamer with 12.5 group interval. The system has been used to conduct high resolution, 2D wellsite surveys in water depths ranging from 100 – 3000m and has proven to be extremely reliable as well as offering excellent noise immunity characteristics.



Solid Streamer and Winch System

The Seal System brings advanced flexible architecture for optimal productivity and small diameter arrays.

Flexible Architecture

- On board, the Central Unit of the Seal system can be interfaced with any of the external systems used in the instrument room (i.e: source synchronizer, positioning and navigation systems, processing systems). The auxiliary channels acquisition unit can be easily placed in the most convenient location.
- Fully distributed electronics, the length of the streamer section overlap.
- Data transmission and power supply systems are both fully redundant to ensure optimal productivity.
- Streamer diameter is no bigger than 50mm and offers improved noise performance



- High level of reliability and data integrity
- Fault tolerant to power and transmission breakdowns
- Distributed waterproof electronics with few connectors
- Field proven electronics / robust mechanics
- Permanent instrument tests
- Small diameter in-sea equipment with streamlined canisters
- High resolution capability

Streamer Depth Control and Monitoring

A DigiCourse Inc, Depth Bird System 5010 is used for streamer depth control, monitoring and logging. The system includes the DigiScan software package for display, control and digital logging of streamer depth on a PC.



Deck Crew Deploying Streamer and Installing Depth Controllers

Seismic Energy Source – Sercel 150 Cubic Inch GI Gun

The GI air gun is widely popular as an energy source for high-resolution surveys because of its excellent signal characteristics and the operational simplicity that comes from deploying a single gun as opposed to an array of guns that is difficult to maintain, launch and retrieve.

The GI Gun reduces or suppresses the bubble oscillations of a traditional air gun. This is made possible by injecting air into the bubble created by the injection of air into the water from the air

Gun. When the bubble reaches its maximum volume the right amount of additional air is injected into it controlling the collapse of the bubble and its associated noise. The GI Gun is comprised of a generator to create the acoustic pulse and an injector to inject a second pulse into the cavity produced by the generator pulse, thereby reducing or suppressing the bubble, depending on the generator/injector volume ratio and injection timing.

The GI gun can be operated in bubble-suppressing, harmonic mode or “true GI mode”. The far-field signatures of a single, 150 cu.in. GI gun, operated in Harmonic and True GI Modes are described below.



Sercel GI Gun

Field Parameters:

GI Gun	150 Cu.In.,
Pressure	2,000 psi,
Depth	6.0 m,
Filtered	DFS 0-256 Hz 72 dB/o

Harmonic Mode	True GI mode
Pk to Pk Pressure: 3.7 bar-metres	Pk to Pk Pressure: 2.9-metres
Primary to Bubble ratio: 8.6	Primary to Bubble Ratio: 13.9
Generator = 75 in ³	Generator = 45 in ³
Injector = 75 in ³ - Delayed	Injector = 105 in ³ - Delayed



Seismic Air Compressor System

The air for the energy source is provided by 2 Reavell H5437 air compressors with an additional two provided as spare. The compressors are water cooled and are electronically controlled and governed. The compressors provide air into a banked storage system that has enough stored capacity to allow acquisition to continue should a unit need to be shut down while online. Power for the compressors is electrical – supplied by the ships' main and auxiliary power reserves.



Reavell H 5437 Air Compressor

Onboard QC of Multi-channel Seismic Data

A GEDCO Vista QC and processing system is provided for quality assurance for the multichannel seismic acquisition. The system includes the software, hardware and a qualified operator.

High Resolution Data Processing and Deliverables

High Resolution Data Processing is provided using our VISTA Full Pro 2d seismic processing system. Data processing can also be outsourced to a processing house.

Following is the 2D High Resolution Survey AVO-compliant processing flow:

- Read in field seismic data
- Navigation data QC
- Merge field seismic and navigation
- Shot and channel editing
- Source de-signature (zero phasing, if signature available)
- Gun/cable datum statics corrections
- Water column static corrections –if required



- Swell noise attenuation
- Seismic interference removal
- Shot and channel amplitude corrections
- Tau-p Decon
- High resolution Deconvolution
- Spectral whitening – if required
- Velocity picking (0.5m) –if not provided
- High-resolution de-aliased Radon multiple attenuation
- Sorting in common-offset planes
- Common-offset domain residual noise removal
- Q compensation (phase only)
- Output SEG Y Gathers
- Mute
- Stack
- Post-stack time migration
- Spectral boosting
- FX noise attenuation
- Time-varying band-pass filtering
- Residual scaling
- Final SEG Y

Testing

Processing parameter testing is undertaken on data that is representative of the survey area.

The following minimum tests are undertaken:

- Designature (using field recorded far-field signature)
- Gain recovery
- Deconvolution before stack (dbs)
- Base noise level 0.0001%

Operator Length (ms)	Gap (ms)
60	0.25
60	1
60	2
60	4
60	6



60	8
60	10
60	12
WB+20	6
WB+20	WB
WB+20	WB-20

- Mute (CMP gathers and variable fold stack panels)
- Deconvolution after stack with preferred design/dbs applied

Operator Length (ms)	Gap (ms)
WB+10	WB
WB+20	WB
WB+30	WB
WB+20	20
WB	20
WB-20	20

- Zero-phase conversion
- Time variant filters, post zero phase (20Hz bandpass, fixed high/variable low, fixed low/variable high)
- Display tests
- WB= water bottom period

Additional tests that may be required include:

- FK onshots
- Demultiple
- Dip moveout (DMO)
- Stack parameter tests
- Time migration
- Post-stack noise attenuation (F-K Dip Filter)

In addition the following displays are provided at the testing stage:

- Near trace display for two center lines
- Brute stack for two center lines

At a minimum, velocity analyses is nominally at 500m intervals or at points that represent the geological variation across the site. Constant velocity gathers (CVG's) or constant velocity stacks (CVS's) would be provided for the two center lines in addition to automatic velocity analyses.

Deliverables

- Workstation ready SEG Y format Exabyte cartridge(s) containing all true amplitude final processed sections.
- Processing report to be included as an appendix in Final Survey Report.

Turnaround Time

Estimated time to complete the processing with all testing outlined - 28 days from receipt of field data.

Typical Onboard System

Following is a list of the typical hardware and control systems including spares carried onboard:

Hydrophone Array

Sercel SEAL 24 bit digital array

- 1 x 35m Deck lead
- 1 x winch
- 1 x 50m towing leader
- 1 x 50m stretch sections Solid Streamer
- 8 x 150m ALS 12 trace active sections - Solid
- 1 x tail connection
- 1 x nylon stretch rope to tail buoy
- 1 x passive tail buoy
- 1 x 50m stretch sections HESE
- 4 x 150m ALS 12 trace active sections - Solid

Streamer Depth Controllers

- 9 x Digicourse 5010 Levellers
- 1 x PC c/w Digiscan software
- 1 x FSK modem
- 1 x PC c/w digiscan software
- 1 x FSK modem spare boards & PSU
- 2 x Digicourse 5010 levellers - spare



Seismic Recording System

96-Channel Sercel HR SEAL 408 System:

- 1 x SEAL HR licence & support
- 1 x Sunblade 2500 work station
- 1 x CMXL 2000
- 1 x DCXU
- 1 X FDU-4 link 4 aux channels
- 1 x network switch
- 1 x Lap top PC for log keeping
- 1 x UPS
- 2 x 320 GB NAS RAID 1 drives
- 1 x Sunblade 2500 work station
- 1 x CMXL circuit boards & APPS 4 PSU
- 1 x DCXU
- 1 x 320 GB NAS RAID 1 drive

Online Display/Plotting

- 2 x 20 inch LCD monitors

Thermal Plotters

- 1 x 12 inch ISYS plotters

Magnetic Storage

- 4 x 500 GB USB drives
- 1 x laptop for data transfer

Onboard QC

- 1 x Gedco Vista licence & support
- 1 x Windows based PC work station
- 1 x 24 inch ISYS thermal plotter

Air Guns

- 1 x Sercel 150 cubic inch GI airgun
- 1 x 30m umbilical
- 1 x Sercel 150cubic inch GI airgun
- 1 x special tooling
- 2 x rebuild kits
- 4 x solenoid kits
- 1 x umbilical service kit
- Air Gun Controller
- 1x single GI gun controller
- 1 x single GI gun controller

Near Field Hydrophone

- 1 x AG57 hydrophone plus a spare



Far Field Hydrophone	1 x Calibrated hydrophone at ~ 50 m depth
Compressors	4 x Reavell Comp Air Model H 5437 mounted below decks for a total of 360 cfm at 3000 PSI. 45kw motor 380/415/440 volts 50/60Hz Seawater cooled
Air Storage	4 x 68 litre 275-bar receivers 1 x regulator to 135 bar 1 x single airgun air controls