

Document:	SEISMIC OPERATIONS FOR OCEANOGRAPHIC VESSELS	
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<i>2017/06/21</i>	Version: <i>2.0 Sparker set up.</i>

Recommendations and guidelines for normal operation and proper use of on board CSIC seismic equipment managed by Marine Technology Unit .

This protocol provides some guidelines for taking appropriate decisions. Advices of the expert technicians in charge of the equipment will be always considerate as skill of management and experience. Until current and final implementation is subject to evaluations and modifications, and open to discussion.

Deck maneuvers

Follow the guidelines and safety protocols implemented by the UTM on board the CSIC vessels.

Cranes and winches maneuvers

Follow the guidelines and safety protocols implemented by the UTM on board the CSIC vessels.

Preparation and operation of the seismic acquisition system

Follow the guidelines and safety protocols implemented by the UTM on board the CSIC vessels. It also needs to take into account the risks analysis associated to each job.

Deployment and collecting seismic equipments

The technical staff and ship’s crew should know their functions and will be equipped with all the required personal protection equipment. Maneuvers will be discussed with all personnel involved. Deck operations will always be consensually agreed with the technical staff and ship crew.

The deployment / recovery will be directed at all times from the deck and monitored from the control main laboratory. Clear voice and visual communication with the bridge has to be confirmed prior to start any deployment operation.

Make sure that the sparker power supply is switched off when the source is on deck, or being deployed, or being recovered. The sparker sled can only be deployed once a suitable speed and a steady course have been established. Usually, a course against the prevailing wind direction is most

suitable. The vessel speed in the water must not exceed 1 – 2 knot. Under no conditions the vessel should make a sharp turn or stop with the sparker (being) deployed or towed.

Ground bolt on front of Sparker power supply **MUST** be connected to sea ground and the ship ground. Grounding must have clean contact surfaces. Sea Ground **MUST** be deployed -over the side- in the sea. NB a ground to the ship hull is **NOT** sufficient and may cause synchronization problems. 230V-50Hz AC mains to Sparker Power Supply can be prepared but should only be connected once the sparker sled is in the water.

In case of hydraulics system malfunction during deployment, operations will be aborted. If the malfunction is determined to be un-repairable or if reparation works take long time, the already deployed equipment must be recovered and the new conditions will be evaluated. Manual mode control of these hydraulics systems will be avoided as possible (due to the risk to equipment and people). These should be operated remotely. Remote control allows the operator to completely commands the operation.

Power block (fair lead) must be used for towed cables all times.

In case of streamer failure or need to add new sections or associated equipment, special jaws (spanners, tow ring frame and pulling inserts) must be carefully used. They must be attached to the deck with a double anchoring system. These hold all the sections under tensile stress from the rest of the streamer.

Before unscrew / assemble streamer sections, electrical HV current should always be disconnected. Failure to do this can cause electrical shock and damage to electronics.

Electrical continuity/leakage and depth control of the deployed sections will be monitored and must be continuously controlled. They never could exceed the collapsing depth, as it may cause serious breakdown.

- SENTINEL streamer collapsing depth in use with activated HV is set at 30 m. and with disabled HV is reached at 250 m. (never longer than 5 days), these parameters should always bear in mind.
- GeoEel streamer has over 500 meters collapsing depth according to manufacturer inquire. The floating balloons system has up to 5 days of recovery period in case of complete lost.

Proper functioning of the emergency shutdown devices must be ensured before starting the deployment.

Don't make abrupt manoeuvres. Deployment / recovering speed must be less than 4 knots (closer to 3 knots) over the water, and always adapted to the weather and sea conditions.

Surveying speeds should be 4 to 4.5 knots over sea water, depending on the signal quality. The data quality will determine the suitability of the survey conditions or change them (reducing or increasing speed, moving bird's wings, changing streamer depth ...). Recovery speed will be the minimum to operate the vessel, never over 2.5 knots, to avoid stress or bending tension on the rolled cable.

Never reduce speed below 3 knots over water during normal operation. At this speed or less, birds are not effective, causing the sinking of the streamer, with the risk that this entails.

In coastal areas (nearshore) or with significant maritime traffic, the client (scientific team) must inform the regional fisheries organisations and the maritime authorities about the vessel operations. It has to be done prior start the survey, avoiding obstacles in the area, such as fishing gears, moorings, etc...

These obstacles could cause severe damage to towed equipment. Releasing fishing lines or steel ropes tightly entangled on the streamer presents a potential serious risk because of the tension reached. Sailors must be warned that this is a vessel restricted in her ability to manoeuvre (limited maneuverability).

A chase boat will be required during all seismic operations. This auxiliary vessel will always be present from deployment till recovery the streamer. If the streamer length is over 1.5km, the chase boat will be one more part of the seismic system. It should be fully autonomous to sail along the vessel, streamer or tail buoy according to main vessel instructions and never disturb seismic operations. His maximum speed must be higher than 10 knots. One of its duties will be intercepting floating obstacles and fishing arts. The chase boat crew shall have proven experience. If not, the presence of a trusted and experienced person will be required. All operations will be coordinated and managed by the main vessel. A correct communication between both ships has to be ensured (radio, phone, internet...).

The “Chase Boat” will NEVER pass over the streamer track line. This ship will always communicate his position and the manoeuvres around the streamer.

The master/Captain of the main vessel (seismic towing vessel) will manage operations and orders. All decisions concerning the source and acquisition equipments (deployment, survey speed, recovery...) are the responsibility of the technical staff onboard.

The technical staff will continuously evaluate risk for deck operations and in sea equipment to decide the appropriate moment for deployment and recovery. The sea conditions and forecast will always be tracked to ensure proper functionality of the towed devices and prevent next actions to be carried out.

In coastal areas, safety distance from shore must be at least 1.5 times the streamer length. Depending on bathymetry, minimum draft and the room to safely tack, the distance away should be greater. Technical staff and master may adapt this condition to the particular circumstances of each case (dangerous zones, safe zones, significant maritime traffic,...).

In these coastal areas or with significant maritime traffic the deployment will be agreed with the vessel master (in addition to informing the regional fisheries organisations and the maritime authorities). The streamer length may be also discussed amongst technical staff and master, both due to the equipment and vessel safety. Master has the power to suspend any particular operation.

If the equipment is damaged or stressed during data acquisition, the need to recover will be considered. Assessment of the type of damage, economic cost and replicability will be done. Moreover, the feasibility and continuity of the survey in this area will be discussed. In cases where, despite the precautions taken, incidents are repeated or there is an overwhelming probability of recurrence, work will therefore stop immediately.

If the vessel propulsion stops (as "black out"), streamer recovery must start immediately, as it will be progressive sinking. Only recovered streamer sections before they reach collapsing depth could be saved. Below 30 meters, SENTINEL streamer power must be switched off before recovery process can continue.

In the event of recovering, wind and sea conditions must permit the vessel to be safely maneuvered and allow working on deck. The technical chief in conjunction with the vessel master must anticipate changes in weather conditions early enough to allow time to collect the equipment on board. Reliably and consistently weather and sea state information must be available.

Prior any deck operation, a Toolbox meeting will be carried out between all the involved people. The scope and details of the operation have to be clearly understood by everybody. All the risks have to be

evaluated, recognized and mitigated. All personnel involved on deck shall wear the appropriate PPE: Hard Hat, Steel Toe Cap boots, Life Jacket, and gloves when needed.

Operations and actions to be taken with the equipment deployed:

- Perform regular patrols (every hour) in order to inspect the equipments deployed and any anomalies that may cause breakdowns. The officer in charge at the Bridge has to be informed if a technician is working at the main deck.
- The streamer has a tensiometer connected to the lead in cable (from the winch), which measures the stress over the wire. It is a parameter to take into account at all times by the operator. It will be vital in the event of bad sea conditions or entangles with other floating objects.
- The control and recording system allows continuous monitoring the operation mode of each part and electronic device of the streamer. Malfunction of any of its parts can be detectable in real time. A sudden increase in noise in the signal is indicative of a non-optimal operation, so the cause has to be determined.
- The gun controller is equipped with a “man over board system”, MOB. It consists of emergency stop buttons placed at several locations along the guns structures at the back deck. It stops gun shooting. In this emergency case, once an emergency stop buttons is pressed, operator must also stop gun controller via software and disable all power supplies. This prevents an unwanted reset after a stop due to unexpected rearming of the MOB system.
- In the same way, the sparker power supply has an emergency button that will short the current when pressed. Operator must also stop the trigger generation software.
- The quality control system ensures that all sections and electronic devices are working optimally at any time. In the particular case of the streamer, analyzes the signal received by each channel, evaluating whether any electronic anomaly, leakage or excessive stress. This tool will be useful to evaluate and decide if recovering equipment is required, prior changes of survey conditions (depth of streamer, surveying speed, ...) and evaluating the signal quality.
- The streamer position is controlled by the birds. The safety of the equipment once deployed depends upon them. It is very important to have continuously monitored the towed equipment depth. If the streamer collapsing depth is exceeded, the piezoelectric sensors (hydrophones) will suffer irreparable damage. The functionality of each bird should be checked as well as communication and battery levels prior assembly in the streamer. Special attention should be paid to this process because it determines the streamer control once deployed.
- In case of depth control failure, the streamer has an emergency system of retrievers. These "airbags" are activated at 48 meters depth, long before reaching collapsing depth. The UTM system has OYOGEOSPACE compass-retrievers that perform this function, fully compatible with the SERCEL SENTINEL and GEOMETRICS GeoEel streamers.
- To make deployment and recover safely, the streamer block or fair lead must be always used. This facilitates maneuvers on deck for auxiliary equipment assembly, and it is responsible for directing efforts towards the tensile axis, longitudinally to the movement of the vessel. It is mandatory to inspect and keep perfect maintenance for this device throughout all the campaign.
- The streamer has a tail buoy with an installed positioning tracking system (RGPS type) and passive tracking equipment such as radar reflector and strobe light. This system is essential in

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case of breakage, in addition to marking the final position of the streamer for maritime navigation.

- Review and strengthen all threaded between each section, digitalizer and any auxiliary equipment before deployment. Make sure that thread connections are fully connected and the security screw (or tape with GeoEel devices) is well tight.
- The observers of the acquisition, control and quality monitoring systems (scientist team) should have enough proved experience with these tasks. Otherwise, they will be instructed by the technicians to operate during the first 48 hours of the survey.

Operating weather conditions as reference to evaluate deployment or recovery seismic equipment:

INSTRUMENT	OPERATION	OPERATION LIMITS	COMMENTS
Multichannel Streamer	Deployment and recover	WH=2 m. WHmax=3.5 m WS= 25 Knots. SS= 4 Spd.< 4 Knots	The vessel will be almost stopped for tail buoy deployment and recovery. Boat speed will be adjusted at any time according to the team in charge, for preventing the streamer collapse.
	In operation	WH=2 m. WHmax=3 m WS= 25 Knots. Spd.. < 4.5 Knots	
Analog short Streamer	Deployment and recover	WH=2 m. WHmax=3.5 m WS= 25 Knots. SS= 4 Spd.< 4 Knots	Boat speed will be adjusted at any time according to the team in charge, for preventing the streamer collapse.
	In operation	WH=2.5 m. WHmax < 4 m WS= 25 Knots. Spd.. < 4.5 Knots	

- WS: Wind Speed [kn]
- WH: Wave Height [m.]
- WHmax: Maximum Wave Height [m.]
- SS: Sea state (Douglas Scale)
- Spd: Vessel speed over water [kn]

INSTRUMENT	OPERATION	OPERATION LIMITS	COMMENTS
Guns String	Deployment and recover	WH=2 m. WHmax=3 m WS= 25 Knots. SS =3 Spd.= 3 Knots	The deployment will be managed at any time from the deployment ramp, transmitting orders to guide the vessel
	In operation	WH=2 m WS= 25 Knots. Spd.. < 5 Knots	
Sparker	Deployment and recover	WH=1 m. WHmax=1.5 m WS= 20 Knots. SS =3 Spd.= 3 Knots	The deployment will be managed at any time by deck crew and seismic technicians by aux crain or similar.
	In operation	WH=1.0 m WS= 20 Knots. Spd. < 4 Knots	

As always we must appeal to experience, make reasoned decisions and agreed by all the involved technical staff and crew during deck operations. The equipment should be properly treated at all times and monitored/operated by staff with proven experience. Technical staff in charge of the equipment will be who decide at any time if deployment or recovery are available/avoid. The tips and guidelines described above constitute a plan of continuous work, but always and ultimately subject to the on board technical team evaluation.

Equipment maintenance routines on board

Perform continuous electronic communication test and signal / passive noise quality measurements when the streamer is still on board and once it has been deployed. Take in consideration the active sections and the auxiliary electronic devices.

Lubricate moving parts: winch, block, slipping, ... always following the manufacturer's instructions. Hydrate o´rings. Perform periodic visual inspections to detect damage during transportation, installation or operating works.

Check the batteries of the auxiliary equipment and charge or replace them if necessary.

Check all moving parts of the birds and airbags after use. Disable the airbags pressure sensor by pulling his magnetic ring to prevent actuate on board.

Check the sparker sacrificial anodes . They must be replaced when corroded to some 50 % of its original size, or if the bolts are working loose.

Lashing properly and protect all delicate devices to prevent spoilage or breakage by rocking of the ship.

All submerged equipment must be rinsed appropriately with fresh water once they are retrieved on board.