# Focus on Operational Efficiency and Crew Safety - Introducing Advanced ROV Technology in Marine Towed Streamer Seismic

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## SUMMARY

Barnacles have been hampering the seismic industry since the start of the offshore seismic era. They attach to the streamer and impact signal to noise. Particularly in the areas close to the equator, there is a constant fight against the barnacles. In-sea cleaning of streamers is typically performed from workboat, exposing the crews to risk.

A method is presented that removes the human interaction in barnacle cleaning and at the same time significantly improves cleaning window and hence operational efficiency. The method is based on a recently developed Remotely Operated Vehicle (ROV). Unlike traditional ROV's, typically operated close to zero forward speed, this ROV is launched and operated at seismic speed. The ROV is launched off the deck of support vessels capable of operating over the streamer spread. A typical operational mode for the ROV is to carry self-propelled streamer cleaners and place them on the streamer while at operational depth. The streamer cleaners then travels along the streamer while performing the cleaning duty and are finally recovered by the ROV after having reached the streamer tail end.

## Introduction

The offshore seismic industry has over the years and in certain areas of the world been hampered by barnacle growth on the streamers. In areas close to equator it is often a constant fight against barnacles. It is also observed that barnacles are migrating to new areas and even in the North Sea green slime have been observed. As the streamer designs have improved in terms of signal to noise, the need for mitigating the barnacle noise problem has increased. Several preventive methods exist. Streamlining the streamer design and hence removing the barnacle attachment points is one measure that can be taken. Applying anti fouling paint on hard surfaces is another complementary approach. However, still barnacles do attach to the streamer skin. Manual scraping from work boats (Figure 1) is a well-known mitigation method widely used in the industry. There also exist methods involving deployment of self-propelled streamer cleaners. Let us refer to them as Streamer Cleaner Units (SCU's). SCU's are deployed by work boat crew at the front end of the streamers and picked up at the tail.

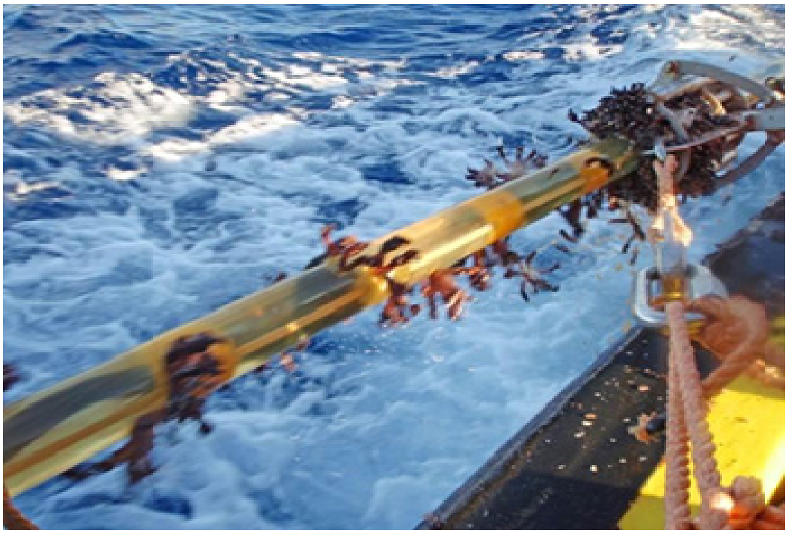

***Figure 1*** *Work boat based streamer cleaning.*

Work boat operations are limited to daytime and reasonable weather. To keep an effective cleaning operation going this puts strain on the work boat crews which is undesirable from an HSE perspective. IAGC reports that the 4 major seismic companies launch a workboat every 45min and between years 2006-2010 there were recorded 6 fatalities related to workboat operation. Other industries like offshore diving and fish farming are moving away from human interaction in risky operations often replacing humans by remotely operated tools. So in addition to increased drag from in-sea equipment and noise on data all caused by barnacles there is a HSE motivation for cleaning streamers without use of workboat.

## A Remotely Operated Streamer Tool

A remotely operated tool for in-sea cleaning of streamers without the use of workboat has been developed. The tool is an underwater Remotely Operated Vehicle (ROV) and both the project and the key tool are called **Remotely Operated Streamer Tool (ROST).** The ROST is operated off one of the new support vessels recently entered the market place. During ROST based cleaning operations the support vessel operates over the streamer spread. The first field introduction of the ROST involves two operational modes. The primary mode is to place and pick-up SCU's onto/from the streamer without raising the streamer to the surface. See Figure 2. This replaces launch/recovery of SCU's from the workboat. The second mode is to clean the streamer for barnacles that have grown beyond what the self-propelled SCU can remove. This replaces manual streamer scraping from workboat. For this purpose the team has developed a heavy duty motorized streamer cleaner (SCUR). The SCUR gets power from the vessel through the ROST tether cable, and during this mode of operation the

SCUR is attached to the ROST at all times. It is designed in such a way that it is capable of removing barnacles even on deformed streamer sections. We will in this abstract focus on the first mode.

Further to these two primary modes the ROST is a scalable streamer tool. It may also be used for visual inspections of the towing equipment and additional accessory tools may be developed in the future.

It is worth noting that the ROST is something very different from a traditional ROV. Traditional ROV's operate from 0-2 knots, are generally box shaped and their degrees of freedom are controlled by a set of thrusters. The ROST is unique in the sense that it operates from 3-6 knots, which probably makes it the world's fastest civil payload carrying ROV. Due to the high speed, its control measures are more similar to that of airplanes than traditional ROV's, applying a combination of thrusters and hydrofoils. Internal controllers control the heading, pitch and maintain depth.

The ROST is equipped with an acoustic node for positioning. Sensors, thrusters and hydrofoils control speed and movement in the spatial degrees of freedom. Further a number of cameras are installed as well as a sonar and camera lights for locating the streamer during night time operation.

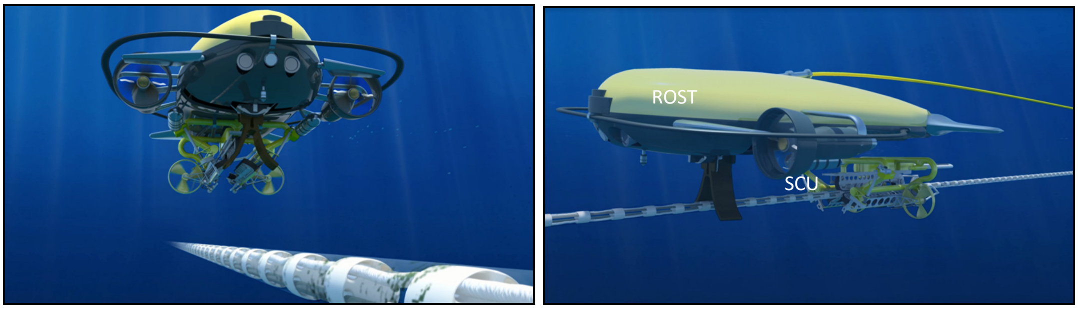


***Figure 2*** *The ROST in a landing situation bringing a cleaner (SCU) to the streamer (left) and a take-off situation having launched a SCU on the streamer (right).*

Not only the ROST but the handling system is unique to the ROST system. ROST is deployed into the water by purpose built Launch And Recovery System (LARS) seen in Figure 3 (left). The ROST is the only ROV system known to the team that launches the ROV at forward speed (Figure 3, right). Indeed the ROST is launched at the same speed as the streamer vessel operating speed. During deployment the ROST is attached beneath a heavy piece of weigh that we call TMS for Tether Management System (Please note the TMS on Figure 3, left and right to be able to follow the text). The TMS has two functions. Its weight pushes the ROST through the splash zone and down to operating depth during launching, and it contains a cable traction system for feeding out the tether cable. To keep stable in the water at speed, it is towed off a painter line (forward pointing tow line) and has a "dart tail" in order to stay in-line with the flow while keeping a stable behavior. It is important that the TMS moves in a stable way through the water in order to provide a safe launch and recovery platform for in- and out- latching of the ROST.

***Figure 3*** *The ROST ready for deployment by the Launch and Recovery System (left) and during deployment at forward speed (right).*

During launching, an active heave compensating system can be engaged ensuring that the TMS and ROST are kept relatively unaffected by wave induced motion. This ensures safe launch and recovery in conditions that would make work boat deployment prohibitive from an HSE perspective.

**The User Experience**

The ROST control room contains two pilot chairs (Figure 4, mid and right), each chair being equipped with a set of buttons and switches. In front of the pilots there are a number of monitors for all the relevant information. The pilot controls the ROST, while the co-pilot controls the tether and the ROST tools including lock and release of SCU's to/from the ROST.

Prior to launching a pre-check is conducted and bridge is called. The co-pilot maneuvers the crane over the side and lowers the ROST down to a depth significantly deeper than the splash zone. If there are waves, the pilot activates the active heave compensating system. At this point the ROST (with a SCU attached) is hanging under the TMS, TMS being much heavier than the ROST holding the ROST down. The ROST is not in hydrodynamic equilibrium as it is clamped to the TMS while the vessel is moving forward at seismic speed. A step-wise un-latching of the ROST from the TMS is then performed, where the ROST latches out from the TMS but is towed off a separate painter line (forward pointing tow line). After a little while the ROST will be in hydrodynamic equilibrium and can safely be unlatched from the painter line.

From this point the pilot drives the ROST towards the streamer. On the navigation overlay the pilot can see the seismic vessel, the streamers, the support vessel, the TMS and the ROST. When spotting the streamer, either by camera, or by sonar during night, the ROST will be positioned just above the streamer and the heading is aligned with the streamer. ROST landing gear is enabled, and the pilot can put the ROST down onto the streamer and by a camera see that the streamer lands into the landing gear. This can be seen in the monitor view shown in Figure 4 (left). The co-pilot then enables the locking actuators that lock the SCU onto the streamer. Cameras are implemented to QC that this is done correctly. Then the co-pilot releases the SCU from the ROST with a release button, and the pilot can start heading home towards the Support Vessel. The SCU moves towards the tail of the streamer while performing its cleaning duties. On recovering the ROST back onto the vessel, the pilot positions the ROST just aft of and under the TMS which is still hanging from the crane while being towed to the side of the Support Vessel. The co-pilot pulls in the tether until the ROST and the TMS latches together. Then the co-pilot recovers the ROST with the crane and another SCU can be prepared for deployment.


***Figure 4*** *Left: An example of ROST control screen. Middle: Pilot co-pilot chair. Right: ROST control monitors.*

## Conclusions

At the time of submitting this abstract engineering tests have proven the key functionalities of the ROST system including safe deployment and recovery of the ROST at speed as well as the ROST's ability to launch and recover streamer cleaners onto/from the streamer at seismic speed.

## Acknowledgments

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## References

Skadberg, T., Tønnessen, R. [2015] PGS Going Subsea. *A poster presented at PGS' technology day* October 13, 2015.