EAGE ANNUAL 2019
81ST CONFERENCE + EXHIBITION
LONDON | THE UNITED KINGDOM

Th_R03_01

Improved HSEQ and Survey Efficiency Demonstrated with a New Remotely Operated Streamer Cleaning Tool

T. Skadberg[1]*, R. Toennessen[1], J. Wright[1]

[1] Petroleum Geo-Services

Summary

Barnacle growth on seismic streamers creates noise on the recorded signals. Keeping a low noise level in barnacle areas is challenging to the seismic crews. Frequent workboat trips are required for streamer cleaning. Workboat operations are weather dependent and are considered undesirable from an HSE perspective. In 2007 a purely mechanical and autonomous Streamer Cleaner Unit (SCU) was introduced. The SCU is launched and recovered from the workboat. In 2016 Tønnessen and Skadberg (2016) presented a Remotely Operated Streamer Tool (ROST) capable of launching and recovering SCUs to/from the streamer without the use of a workboat, and which is less dependent on weather. The ROST is operated from a Support vessel. Experiences from four surveys are presented. Operation in high sea states is demonstrated on a survey offshore Namibia and operation in extreme currents demonstrated on another survey east of South Africa. A noise removal method is presented that allows operation of the system while online. The method was first applied on a survey offshore South Africa and later on two surveys offshore Angola. It is demonstrated that work boat hours can be reduced by 70-80%, and a 14 streamer spread can be cleaned twice a week while acquiring seismic.

Introduction

Following the introduction of multisensor streamer technology in 2007, PGS followed up with several associated engineering projects to fully utilize the potential of the new platform. Some of the initiatives have been related to barnacle prevention and mitigation. All clamp-on devices have been replaced or are in the process of being replaced by in-streamer substitutes, hence minimizing the number of barnacle anchoring points. Notably, a streamer cleaning unit (SCU) was also introduced in 2007. This is a purely mechanical, autonomous, self-propelled device deployed onto the streamer from workboats. It travels down the streamer while removing barnacles. In 2011 a new version was introduced that is able to pass three-wing birds. The SCUs were initially used only during line changes and no data recording, but the introduction of a noise removal algorithm has enabled online operation (Widmaier et al., 2015), which has now become standard. Although this device has served us well, its usage depend on allowable workboat weather. In periods with sea states beyond safe workboat weather, the barnacles may grow beyond what the SCU can handle. A worst case consequence may be full recovery of the streamers. Frequent SCU deployments are therefore key.

A desire to mitigate those limitations, and a desire to minimize the amount of work boat hours used for SCU launches and manual barnacle scraping led to the development of the Remotely Operated Streamer Tool (ROST) presented by Tønnessen and Skadberg (2016). This is a remotely controlled underwater vehicle carrying the SCUs and capable of deploying and recovering SCUs to/from the streamer independent of weather, and without involving workboat operations.

During the technology validation stage the system was exposed to a large variety of operational conditions that demonstrated the operational range. In 2018 the system was used for the first time as an integral part of commercial operations. We describe our experience from four surveys, and present a noise removal method that allow the ROST to be operated over the streamer spread while acquiring seismic data.

The underwater vehicle and its operational mode

The underwater ROST vehicle (Figure 1) is controlled remotely from a support vessel through a tether cable. Unlike traditional ROVs having thrusters in multiple directions, the vehicle's degrees of freedom are controlled by control surfaces. It is deployed at seismic operational vessel speed from the side of a support vessel (see Fig 2A). Figure 2B shows the support vessel positioned just behind the streamer front end while having the ROST deployed.

The launch and recovery system is key to the success of the system. The ROST is deployed into the sea while being latched into a TMS (Tether Management System); a heavy unit that has the dual function of pushing the ROV through the splash zone and to feed the tether in and out. The TMS is towed by a painter line, allowing deployment at speed. Furthermore, the TMS can be steered by a rudder. This allows safe deployment in strong shear currents, often present in regions such as offshore West Africa.

Figure 1: *Landing on the streamer (left). The vehicle after having deployed a SCU on the streamer (right).*

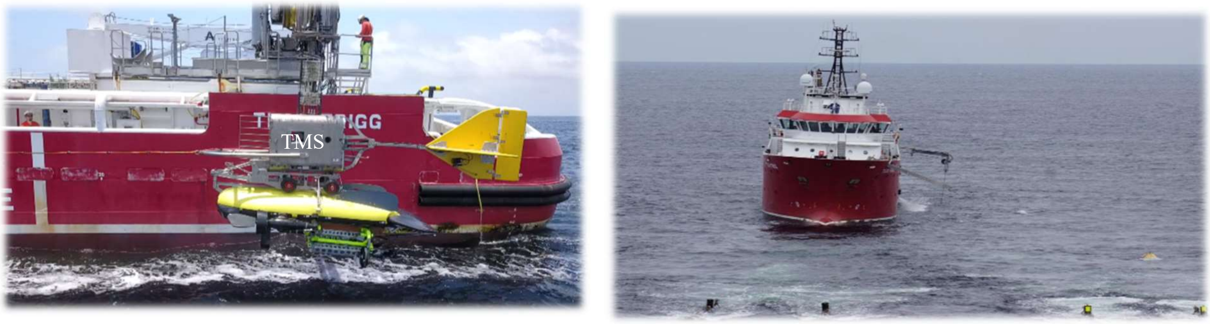

***Figure 2**: **A)** The ROST deployed off the side of a support vessel while latched into a TMS (left), and **B)** Support vessel positioned over the streamer front while the vehicle is deployed.*

To cope with the large relative motions between the vehicle and the TMS in rough weather, a robust latching system and deployment method was developed. The crane is heave compensated, and in the process of latching the vehicle in/out from the TMS, the vehicle is towed from the tether cable. This method is very robust and also ensures that in case of a power black-out, the vehicle will be towed as a tow fish in a stable manner. This feature has been demonstrated and proven to minimize risks associated with the operation.

Operations in rough weather offshore Namibia

Namibia is affected by seasonal barnacle growth and generally rough weather conditions. The first time the ROST system was used as part of the seismic operation was during a project acquired offshore Namibia during January-March 2018. For several weeks the workboats could not be deployed, quickly providing an opportunity to demonstrate the usefulness of the system.

Figure 3 shows wave height (dotted orange, right axis) and wind speed (dotted red, left axis) throughout the duration of the project. Wave and wind limitations for workboat operations (blue) and for the new system (green) are indicated. It is observed that the system was weather-wise operational throughout the entire period in seas up to 3.5 m and wind of 25 kn. In the same period there were limited possibilities for workboat operations. Analysis of weather statistics from other areas show wave and wind peaks above the ROST operational limits but only for short periods not long enough to affect the cleaning mission.

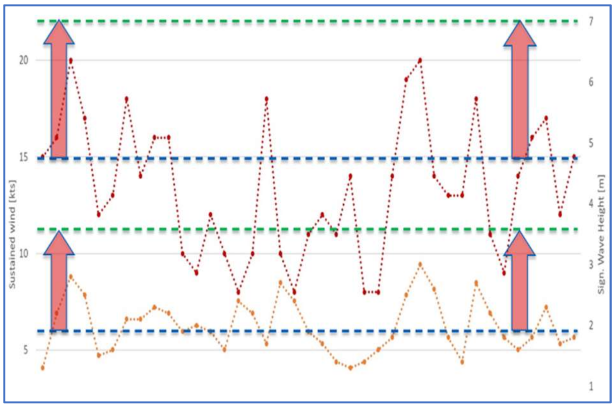

***Figure 3:** The graph shows wave and wind statistics for a period of 1 ½ months offshore Namibia during 2018. The blue dotted lines indicate workboat operation cut off limit for wave at 2m and wind limit at 15 knots. The green dotted lines shows the ROST system operational limits of 3.5m wave height and 25 knot wind.*

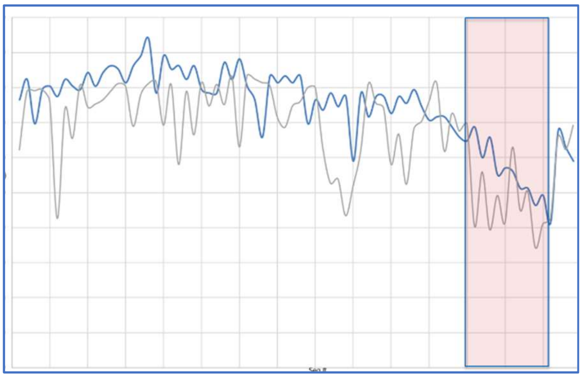

***Figure 4:** Vessel speed versus time. Pink area is the period where the system was unavailable as the support vessel carrying the ROST went to port.*

Noise from barnacle growth is often compensated by reducing vessel speed. Figure 4 shows that once the ROST became unavailable, the seismic acquisition speed went down, and rapidly came back up again once the ROST came back to the prospect and commenced cleaning. Prior to start-up of the aforementioned project it was a requirement to have clean streamers. With limited workboat availability the contribution from the ROST prevented a full recovery of the streamer spread saving time and cost.

Managing shear currents offshore South Africa

The preferred nature of seismic operations is to stay on a defined racetrack regardless of changing wind and current directions. Hence, there will most likely never be a lee side for deployment of the ROST as the support vessel follows the streamer track. Strong currents were experienced during a project offshore eastern South Africa where the strong Mozambique/Agulhas current is present, combined with the Agulhas return current coming in from the Indian Ocean. Rapid current changes and shear currents up to 3 kn affected the entire seismic operation. Raising streamers to the surface for cleaning with a workboat in such conditions involves a high risk of streamer tangling. By utilizing the ROST, SCU deployment without surfacing the streamers minimized the risk of tangling and made a great difference for a successful barnacle-free data acquisition. Hence, seismic data quality and crew safety were maintained in these challenging conditions.

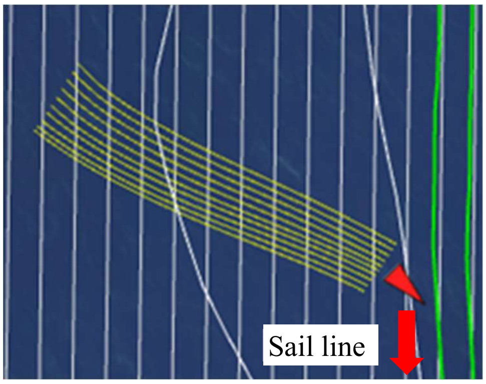

Figure 5: *Vessel affected by heavy side currents offshore South Africa as the Agulhas current hits the streamers.*

Efficiency of ROST demonstrated

The marine growth on seismic streamers varies with sea temperature and the amount of nutrients in the water, and is often categorized into three groups: low, medium and high. In areas with the most active growth, streamers must be cleaned daily. Experience in a high barnacle growth area a 14 streamer spread was cleaned in 15 hours twice a week to maintain clean streamers. In these areas the weather conditions were not an issue, hence all cleaning could have been done in the traditional way using workboat operations. However, the HSE uplift gained by using the ROST was highly appreciated in reaching the goal of better crew safety by reducing workboat exposure.

Flexibility in when to clean streamers is also important to maintain efficiency. The ROST design was specified for 24 hour operations. This capability was demonstrated offshore Angola, operating on instrumentation and illuminated camera vision irrespective of light conditions or underwater visibility.

During the various surveys in 2018, it became clear that operating the system online during seismic acquisition provides a great contribution to improved efficiency.

Noise removal during online operations

Noise generated by the SCU is seen on all sensor types as the unit travels along the streamer. Noise generated by the underwater ROST vehicle itself is usually a minor component of the SCU noise. The support vessel motors also act as a noise source (Figure 6). Noise attenuation from these operations needs to be rigorous, but to limit any impact on the data signal the denoise is targeted as much as possible. The location of the SCU on the streamer can be determined for each shot from analysis of the RMS noise levels. The location of the support vessel is known from

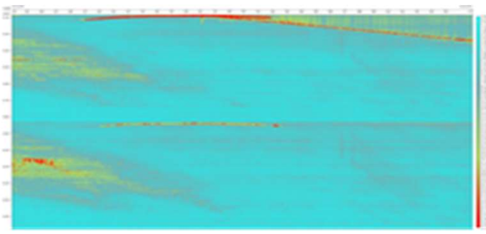

Figure 6: *RMS amplitude plot showing support vessel noise in red along the top with SCU noise descending diagonally as it moves back along the streamer.*

navigation system, so by using these data we limit (moving) SCU denoise to approximately +/- 40 traces from the noise generator, and for the support vessel a horizontal distance of 100-120 m is used (Figure 7).

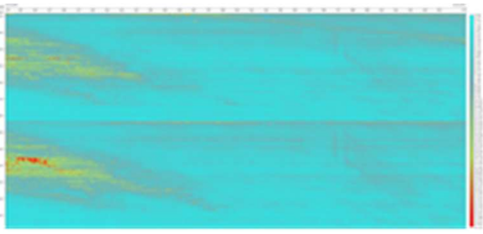

Figure 7: *Figure 6* ***after denoise***

As with many other types of noise, we can isolate large amplitudes in the frequency-space (FX) spectrum compared to the surrounding signal. This works by using overlapping localized time-space (TX) windows that are Fourier transformed to the FX domain. The noisy amplitudes are first detected and then replaced by interpolated values using FX predictive filtering.

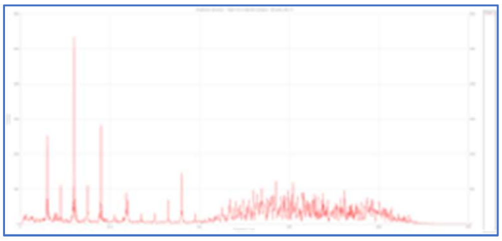

Figure 8: *Amplitude spectra showing the harmonic nature of noise from support vessel motors*

If the support vessel noise is particularly intractable we can also use an additional denoise targeting the harmonic frequencies generated by the vessel's motors. If alternative support vessels are introduced this will need to be tested further.

HSE

One of the main objectives for the development of the system was to improve crew safety by reducing workboat exposure hours. With increasing weather conditions comes increased risk to the crew, even if workboat operation limits are defined for safe operations. From the experience gained with ROST during commercial projects in 2018 the workboat exposures related to barnacle cleaning was reduced by 70-80%, still increasing with experience and improved ability to launch SCUs with the ROST as close to the front as the first active.

A number of client audits have been conducted since the system was deployed. Together with own continuous improvement process, the audits have contributed to improvements in procedures and solutions.

Conclusion

A method for efficiently cleaning the streamer spread while acquiring seismic data and without human interaction with the streamer has been demonstrated using a remotely operated streamer tool (ROST). During its first season the system prevented full streamer recovery for cleaning and reduced the barnacle-related workboat exposure by 70-80%. Operability in 3.5 m seas, in extreme currents, and also in darkness has been safely and reliably demonstrated.

Acknowledgements

The engineering project is partly funded through the Norwegian Research Council's SkatteFunn grant. We acknowledge GALP, PGS MultiClient and BP for their cooperation during the surveys, and PGS for permission to publish this material.

References

Tønnessen, R. and Skadberg T. [2016] Focus on operational efficiency and crew safety – Introducing advanced ROV technology in marine towed streamer seismic. *78th EAGE Conference & Exhibition,* Extended Abstracts, Th SBT1 09.

Widmaier, M., Fromyr, E. and Dirks, V. [2015] Dual-sensor towed streamer: From concept to fleet-wide technology platform. *First Break*, 33, no.11, 83-89.