Brazil Campos Case Study: Improved Operation Efficiency and Reduced Risks by Introducing State of the Art Barnacle Mitigation Tools

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Summary

We describe a series of barnacle mitigation measures applied during a five-month towed-streamer seismic survey by the Ramform Titan in the Campos Basin, Brazil. The 14 x 10000m streamer spread was an industry record and occurred during the period of the year recognized as the high season for barnacles in the area, and was frequently affected by challenging weather too.

The high-capacity seismic vessel was equipped with a pilot system for coating streamers with a proprietary anti-barnacle coating, deployed the self-propelled streamer cleaning units common to all PGS operations, and was also supported by the Thor Frigg; a large support vessel (Figure 1) equipped with a proprietary fast-going underwater drone capable of deploying the self-propelled streamer cleaners without workboat operations. Collectively, these barnacle-mitigation efforts present a unique insight into the complementary solutions necessary for remote operations in the most challenging settings.

Our experiences demonstrated the usefulness of those tools. The prototype anti-barnacle coating required no attention for eight weeks on the streamer fronts where barnacle growth can become problematic during periods of no workboat activity being possible. The underwater drone removed the weather factor that correspondingly limits barnacle cleaning with traditional workboat-based tools, and thereby prevented a full spread recovery. The collective anti-barnacle mitigations enabled the survey to be completed ahead of schedule, despite particularly challenging conditions. Workboat-related HSE exposure was also greatly reduced.

Introduction

It is well-known in the offshore seismic industry that seismic streamer operations in offshore Brazil are associated with particularly high operational risks. High barnacle growth in combination with high sea swells coming in from the Atlantic, topped with wind driven waves and challenging sea currents, creates a mixture of survey risks that makes every project planner nervous. For long periods of time, bad weather prevents workboat launches, and in combination with high barnacle growth, this has led to many critical situations in the past that necessitated costly full spread recoveries, or even full spread collapse and tangles, with the ultimate worst-case outcome of losing the streamer inventory.

Figure 1: Support vessel positioned over the streamer front while the underwater drone is deployed.

With this in mind, the seismic vessel was supplied with all the state-of-the-art anti barnacle tools the company could provide. This included a streamer coating system still in development, as well as a proprietary underwater drone system for deploying autonomous barnacle cleaners independent of weather.

The survey was mobilized at short notice, and a collection of operational challenges related to the Covid-19 pandemic challenges of 2020 impacted our ability to deploy key personnel to oversee the activities. Nevertheless, the value of the collective barnacle-mitigations was robustly demonstrated.

The anti-barnacle strategy

Barnacle and other marine growth on seismic streamers is an industry-wide problem, increasing drag and streamer tension, increasing mechanical noise, and creating operational risks related to equipment failure and reduced vessel speed.

Barnacle mitigation can be divided into two main groups:

1) **Preventive cleaning:** applying coating to the streamer, or mechanical removal of marine slime before barnacles can grow

2) **Reactive cleaning:** Mechanical removal of full-grown barnacles by knives, rope, scrapers, or a motorized cleaning unit

Traditionally, barnacles are removed with simple tools by the workboat crew. These operations are regarded as high-risk operations, particularly as the weather and sea state become too dangerous to continue workboat operations. Manual streamer cleaning involves rising the streamer to the surface and letting the streamer rest on a skid mounted at the side of the workboat. The weight of the streamer lead-in exaggerates the downward force from the front of each streamer, which adds another risk dimension to the operation in terms of the risk of capsizing the workboat—particularly in combination with high sea swell and wind waves.

The company's strategy has been to stepwise remove the human involvement in barnacle mitigation; first by introducing so-called streamer cleaner units (SCUs), then by introducing an underwater drone capable of deploying the SCUs without involving workboats, and now also by developing a barnacle-repellent streamer coating and a system to apply it.

Streamer Cleaning Units

The streamer cleaning unit (SCU) shown in Figure 2 is an autonomous, self-propelled, preventive cleaning tool, adapted for streamers equipped with three lateral-steering and depth-control wings. It is used proactively for the mechanical removal of slime and barnacle larvae and was described in detail by Tønnessen *et al*. (2016). As it is most effective for early-stage small barnacle larvae, the SCU will not remove fully grown barnacles, and should be applied as a continuous preventive action before growth develops. Until recently, SCUs have been deployed from workboats only, and have proven to be a very effective barnacle mitigation tool across the fleet since 2012. The introduction of SCU significantly reduced the crew workboat exposures compared to traditional manual cleaning as the human interaction with the streamer is now limited to launch and recovery of the SCU. A series of enhancements have been developed in the decade since (Skadberg et al., 2019), and several SCUs can be deployed in tandem even during data acquisition when the conditions allow workboat activity. Associated mechanical noise is temporarily restricted to local streamer positions and can be robustly removed during data processing.

Figure 2: SCU passing a three-winged bird used for streamer depth and lateral control

Remote Operated Streamer Tool

With the challenges experienced in streamer cleaning from workboat, either manually or by the launching of the SCUs, a solution to overcoming these hinders was needed. The main function of the remote operated streamer tool (ROST) is to deploy SCUs onto the streamer (Figure 3), which has been demonstrated to improve crew safety by reducing workboat exposure. The system is operational in sea conditions up to 3.5m waves/swell and winds up to 25 knots. The ROST is deployed at seismic speed from a support vessel operating over the streamer spread. Such operations can be safely facilitated because the multisensor streamers are naturally towed deep. (Tønnessen *et al.,* 2016, and Skadberg *et al*., 2019.) Global experience demonstrates that in any of the most demanding seismic barnacle areas, weather conditions more severe than the thresholds above typically last for only a few days. A tool operational in these conditions can therefore significantly increase the operational weather window as it enables continuous streamer cleaning. However, the ROST system is primarily a tool for deploying streamer cleaning units, so the cleaning effectiveness depends on the ability of these devices to remove growth. It is correspondingly beneficial to begin preventive streamer cleaning from the first day of deployment in any survey.

In addition to deploying SCUs, the ROST can carry a motorized cleaner unit for heavy-duty barnacle cleaning.

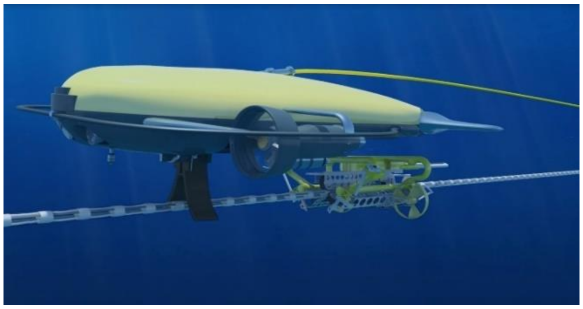

Figure 3: The ROST vehicle pictured just after releasing a cleaning device on to a streamer.

Streamer Coating System

A new streamer coating system (SCS) is still under development (Figure 4) and is designed to clean and coat streamers during deployment. The coating is biodegradable and has a foul-release effect, which prevents barnacles from adhering to the streamers. The coating can be removed by mechanical scraping, where required, and both the cleaning and coating processes are designed to automatically adjust to deployment speed variations.

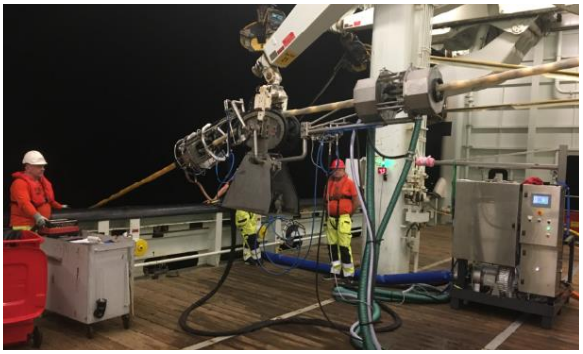

Figure 4: Streamer coating during deployment.

The coating slows barnacle growth but does not completely prevent it. Some experiences from testing and development are as follows:

- Coated steamer sections require about 90% less cleaning during the first 1-2 months of operations. The conditions of each survey are unique, so the time until the first required manual scraping is dependent upon the intensity of the barnacle growth.
- The coated streamers still have a foul-release effect after the first manual scraping, but the protection diminishes gradually each time the coated area is scraped.
- Barnacles are observed to be loosely attached to coated areas; meaning they are easier to remove.

Current developments are focused upon adapting the existing mechanical scraping tools to remove the barnacles while retaining the coating.

Key results from field operations

Streamer coating was applied during deployment on the first 1 km of each streamer; however, on streamer 7 the first 3 km was coated. This area of streamers is more difficult to access by workboat than the remaining streamer length, and correspondingly is most dependent upon favorable weather conditions to enable safe workboat operations.

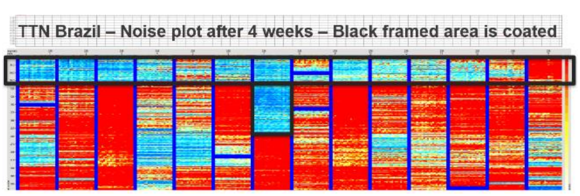

Figure 5: QC noise plots of the first 5km of the spread. Coated areas inside the black frames. (Red = high noise, Blue = low noise. Color levels are adjustable and displayed levels should not be regarded as acceptance criteria.)

Noise RMS QC plots (Figure 5) were used as indicator for barnacle growth. The QC plots showed significantly reduced barnacle growth on the coated areas still after 4 weeks, except from streamer 14 that was not properly coated. The same effect was observed for up to 2 months on the coated sections. During the same period, uncoated streamer sections were cleaned 8-9 times on average, which is consistent with previous experiences. It should be noted that unfavorable weather at the start of the survey prevented regular SCU launches, hence some manual scraping had to be carried out.

The ROST was unavailable for the first 5 weeks of the survey, during which the barnacle growth accelerated, and poor weather hindered traditional workboat-based barnacle cleaning. When the ROST became available and started deploying the cleaning units on to the uncoated parts of the streamers, the crew was on the verge of recovering the entire spread as barnacle growth escalated. A full recovery, onboard cleaning and deployment would typically add 1-2 weeks to the survey time.

Figure 6: Underwater photo from the ROST showing advanced barnacle growth on a streamer with a three-wing steering and depth control device in the background.

Benefits

The barnacle mitigation solutions described have proven to provide benefits in many areas.

<u>Prevention of full spread recovery and streamer tangle</u>
For this survey the most obvious benefit is that a full streamer recovery was prevented. This is attributed primarily to the ROST's ability to operate independently of the weather conditions. Furthermore, the ROST deploys streamer cleaners at the streamer towing depth without interrupting vessel operations. This eliminates the high risk involved in raising streamers to the surface when in areas of high current, adverse weather, or in particular when the speed is so low that streamer steering is less efficient.

Less standby time for barnacle cleaning
When comparing two projects acquired over the same Campos Basin area at the same time of year with similar spread configurations, there is a significant reduction in standby time when a vessel is equipped with advanced barnacle mitigation tools. Even though the ROST was unavailable during the first weeks, the reduction in standby time was 32%.

Improved HSE by reduced workboat hours
One of the main objectives for the mitigation tools was to minimize crew workboat exposure. This has been clearly demonstrated. In particular, the coating of the streamer fronts was well received by the offshore crew.

ROST supported operations during a survey in 2018 showed that workboat exposures related to barnacle cleaning was reduced by 70-80%.

Vessel speed and turnaround
Vessel speed is controlled by integrated management of data analytics measured in real time; including tension measurements on towed equipment and seismic data quality. Moderate barnacle growth can result in reduced vessel speed. A 'minor' speed reduction of 0.1- 0.2 knots can have a substantial impact on project costs.

Introduction of the ROST on the Campos Basin project came at a stage where cleaning attempts from the workboat did not keep up with the growth, and had an immediately positive impact on the vessel speed. The continuous deployments of SCUs by the ROST, streamer by streamer, slowly got the vessel back to nominal speed. With additional scraping efforts from workboats (when they resumed activity), production was stabilized and even a bit increased

Had the ROST been available from survey start, or had the streamers been fully coated, the barnacles would not have been allowed to develop. It is feasible that improved operational performance and even less workboat exposure in the presence of barnacles are well within sight.

Conclusion

In areas of offshore Brazil such as the Campos Basin, marine growth on streamers poses a significant risk to the project; including catastrophic events such as full spread collapse, increased project execution time, and reduced crew safety. We have shown that by introducing a suite of state-of-the-art barnacle mitigation tools, these risks can be well managed. Despite a challenging start to the project, the tools prevented a full streamer recovery. Advanced barnacle mitigation methods clearly have significant potential to further reduce operational risk and improve efficiency as the technologies mature.

Acknowledgments

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