Leica Geosystems TruStory
Safety on the High Seas

Government awareness of the need for increased safety on offshore works is increasing worldwide. Russia has a strong interest in offshore safety and is in the process of preparing a bill concerning "protecting the seas of the Russian Federation against oil pollution". There are currently two oil-drilling rigs in operation, both belonging to "Lukoil" Ltd. The bill is not yet ready or obligatory, but Lukoil's directors have already initiated geodynamic monitoring systems on a maritime, ice-resistant platform over the Yuri Korchagin oil deposit to ensure safe operation and to protect workers from unexpected occurrences on the high seas.

The Yuri Korchagin oil deposit was discovered in 2000 and is located 180 km (110 mi) from Astrakhan in the northern part of the Caspian sea, at an average sea depth of 11– 13 m (36 – 43 ft). The rig began working in spring 2010 and consists of two blocks: the production and the accommodation facility.

Preliminary Evaluation

The owner and operator "Lukoil-Nizhnevolzhskneft" Ltd. put on a competition for the monitoring project, which was won by the Perm State Technical University (PSTU). The Mining GIS and Surveying department of PSTU had already had successes with projects in the area of deposit extraction and considered professional, quality equipment and software a crucial part of successful project completion. The scientists chose Leica Geosystems GNSS equipment to monitor the vertical and horizontal displacements of the oil rig.

The Caspian rig is permanently fixed to the seabed on six carriers. During the extraction process, the deoiled rock is repacked so the terrain generally settles down. However, if irregularities occur in the process, the rig might lurch. Therefore platform position monitoring is crucial to prevent dangers.

If subsidence processes develop gradually, production- related subsidence should not impact the facilities.However, local irregular seabed displacements can occur, which may pose a threat to the oilfield infrastructure. Natural seismic activity in the region can aggravate the risk of man-made seismic events, which is further proof that geodynamic monitoring of facilities is essential.

Mathematical deformation modeling of the rock mass and the earth surface during oil production at the Yuri Korchagin field performed by experts from the Perm State Technical University have shown that maximum seabed subsidence is 100 mm (4 in). Preliminary evaluation of the general rock stress level during commingled oil and gas production indicates that maximum pay zone compaction reaches 890 mm (35 in). This means the development of gas reserves at the field is the main driving force behind seabed subsidence.

The Right Monitoring Approach

The PSTU scientists proposed a two-segment monitoring system: the first segment is an automated monitoring

system using Leica GNSS Spider software and the second is control monitoring performed upon control reference points onshore. Both segments involve sea and onshore works.

The shore reference network uses a reference station installed on the roof of a Lukoil-Nizhnevolzhskneft Ltd. office and connected to a server running Leica GNSS Spider, which is regularly checked by the chief surveyor. In addition, raw measurements of the four constantly operating sensors are saved on this computer. The sea segment of the monitoring system consists of three sets of GNSS equipment with antennas set up permanently on the three edges of the rig's main deck.

A geodynamic polygon of ten control sites has been created for the shore segment monitoring. Baseline solutions to the rig are computed from a single master site. All other sites are used to control the stability of the master site. If the master is moved or lost for any reason, its role transfers to another site.

The combination of sea and onshore segments results in a collection of raw measurements of all GNSS sensors combined on the computer of Lukoil-Nizhnevolzhskneft's chief surveyor. Leica GNSS Spider allows gathering and archiving data automatically. The system is configured to compute sensor coordinates (points on the edges of the main deck) in real-time every second, as well as with hourly and twelve hour intervals in post processing. The results of coordinate calculations are presented in a movement diagram and are used to make a conclusion about sensor stability – and therefore rig stability.

Section two of the system is controlling the monitoring results by making long-term GNSS observations on permanent onshore base stations. To ensure the stability of the control network, first-order leveling was performed before starting GNSS observations.

A Stable Oil Platform

Since the installation of the monitoring system, the results show that control measurements and automated monitoring data correlate: the nature of subsidence and rises is completely identical, concluding that the real-time monitoring gives correct results. The sensor displacements are of non permanent nature; their values are small and for the most part do not exceed measurement accuracy, which indicates that their location is permanent and stable.

Comparing the control monitoring results with a drilling map leads PSTU to believe that smaller movements of 20 mm (0.8 in) are mainly caused by engine lowering and lifting. The Leica Geosystems monitoring installation remains essential to keeping all relevant parties informed.

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