Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Offshore Condition Based Maintenance (CBM)

Smart Offshore Maintenance

Transport, fishing, oil and gas extraction and more recently wind farms; the North Sea is increasingly being used for many purposes. In order to adequately serve this great diversity of stakeholders, the Ministry of Economic Affairs and Climate (EAC/EZK) has commissioned the Ministry of Infrastructure and Water Management, in particular Rijkswaterstaat (RWS), to act as data broker for the North Sea.

A wide range of sensors are currently being installed in the North Sea. Including nautical radars to monitor shipping and radars to monitor bird migration. Corrosion by salt and water and continuous vibration driven by wind, make the North Sea a harsh environment for sensitive equipment. Nevertheless, the proper functioning of all sensors must be guaranteed over a period of up to 30 years.


Foto: Tommy Kleyn

Offshore maintenance, especially in remote locations, can be extremely expensive and requires careful planning ahead of time. After all, when a sensor fails, it takes time to organize a crew, spare parts and transport. And to board, the weather and sea conditions must be favorable. It is therefore crucial to ensure the uninterrupted operation of offshore sensors and to reduce costs.

The drivers for Smart Offshore Maintenance are Condition Based Maintenance (CBM), Remote Assistance (RA) and Augmented Reality (AR).

CBM PROTECTS SENSORS

It goes without saying that in order to save the lifespan (costs), maintenance is ideally carried out just in time (preventive maintenance). This is to prevent calamities with higher costs and downtime. Therefore, it is highly preferable to detect degradation of sensors before failure occurs.

Continuous monitoring of change factors such as vibration, temperature, power consumption or ultrasound produced by degrading bearings can provide insight into when a critical situation occurs. By modeling critical system components (digital twins), including expected loads (e.g. vibrations), predictions can be made about the likelihood of future failures.

SCOPE FOR OFFSHORE CBM

Approximately 20-30 nautical radars will be installed offshore. Their rotating antennas make them relatively vulnerable. As they are essential for monitoring the perimeter of wind farms, the offshore CBM program will prioritize them. In the future, CBM will also be eligible for other sensors.

CBM MEASUREMENT CAMPAIGN FOR NAUTICAL RADARS

The program consists of two phases of measuring and simulating vibrations and loads. Fatigue can be calculated accordingly.

Phase 1: ***Perform measurements and simulations at the Offshore Expertise Center (OEC).***
A nautical radar at the OEC will be equipped with sensors to measure vibrations and stresses caused by wind load. These measurement data will be compared to a Finite Elements digital simulation of mast, radar and wind load.

Phase 2: ***Perform measurements and simulations Offshore:***

A) A nautical radar atop the mast of an offshore substation will be equipped with sensors to measure vibrations and stresses caused by wind loads.

B) A nautical radar on a platform attached to an offshore wind turbine will be equipped with sensors to measure vibrations and stresses caused by wind loads.

We use the measured data to fit the simulation model. We also monitor data that may be related to mechanical deterioration, such as temperature, gearbox ultrasonic levels, motor power consumption and excessive vibration due to antenna imbalance.

The application of mitigating measures, such as installing dampers to prevent predicted fatigue, can be considered.

BUILDING THE CBM-DASHBOARD

By applying *AI* and statistical software to the Condition Monitoring data, we can simulate wear and tear over longer periods. In this way we get a general prediction of future fatigue build-up on the nautical radar. This allows us to apply Predictive Maintenance (pre-planning corrective maintenance).

The CBM dashboard will:

- Present metrics that track changes in both equipment signature and equipment behavior.
- Include extrapolation over time to show the probability of future failures.

After building and testing a demonstrator, an operational CBM dashboard is installed.

REMOTE MAINTENANCE THROUGH VIRTUAL REALITY

Virtual Reality technology makes offshore maintenance at sea easier. Specialists can stay ashore while supporting offshore workers at sea. Specific manuals can be uploaded based on GPS asset locations and viewed through augmented reality. This will allow faster operation. This is expected to lead to a further reduction in costs and loss of our assets. The applicability of remote maintenance is first explored in the Offshore Expertise Center and later exploited offshore.

IMPLEMENTING MAINTENANCE AND MANAGEMENT

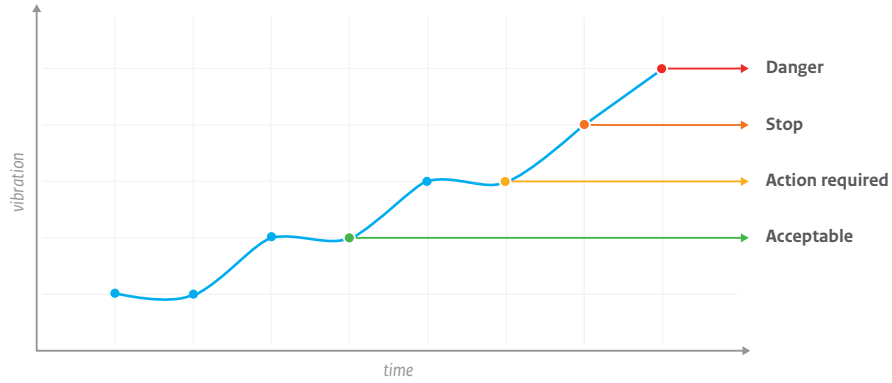
Maintenance and management of nautical radars are developed on the basis of CBM measurement data. Remote maintenance is implemented and made operational. Operational procedures are developed, set up and optimized in collaboration with operational maintenance teams. With CBM, maintenance intervals can be greatly extended, leading to significant cost savings.

OFFSHORE CBM SPIN OUT

While we try to share our findings, we aim to:

- Apply experience to other offshore sensors such as bird detection radar.
- Disseminate knowledge to inland radar applications and to other areas within Rijkswaterstaat.

Interpreting vibration levels:



THE OFFSHORE EXPERTISE CENTER

The OEC is located in Stellendam (NL), a stone's throw from the North Sea. With two full size sensor masts (OEC Alpha and OEC Beta) and sea conditions in combination with the benefits of land accessibility, this is an ideal test location. At the OEC, tests are performed on a wide variety of sensors and in real time.

The OEC is also an ideal location for developing innovations with applications for the global energy transition. The OEC therefore welcomes collaborations with research institutes, universities and other parties.

OUR PARTNERS

Rijkswaterstaat CIV cooperates with external partners, from both industry and academia (e.g. TU Delft, Ørsted, Terma and Zephyros).

Rijkswaterstaat

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