

ENABLING EARLY AUTOMATIC HYDROCARBON DETECTION

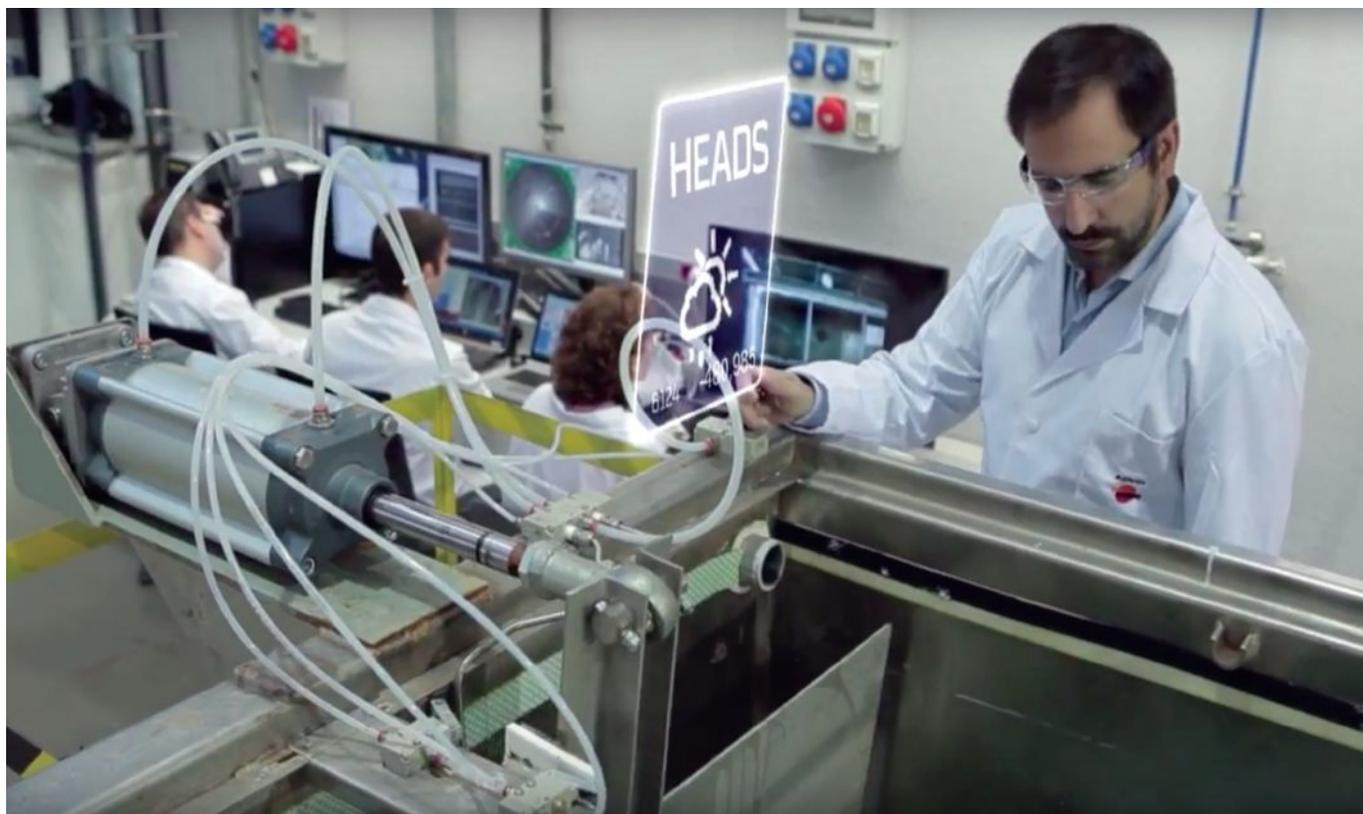
Innovative Environmental Technology Can Prevent Oil Spills

By Jose Vicente Solano Fernandez, HEADS Project Leader, Repsol



The importance of marine environmental surveillance has dramatically increased over recent years, and many companies, including those working in the oil and gas sector, have made great efforts to minimize the number of incidents that release oil or other hazardous substances into the water.

Early detection of oil spills is the key to environmental protection and disaster management. The use of correct safety measures is crucial to quickly and accurately identify problems remotely or in an automated fashion. That said, existing technology has so far been insufficient and most of the time focused on containment rather than early detection.



The HEADS project was formally initiated in 2011 and consisted of four stages of rigorous testing. During the first stage, which was carried out at Repsol's Technology Centre in Madrid, technical-economic viability was tested. Phases Two to Four were carried out through the use of two pilot studies at Repsol's Tarragona Industrial Complex and the Casablanca platform.

Collaboration between Repsol and Indra

Repsol and Indra, two leading companies in the fields of energy and advanced technology, joined forces to develop a pioneering technology known as HEADS (Hydrocarbon Early and Automatic Detection System), which is designed for the early detection of oil spills.

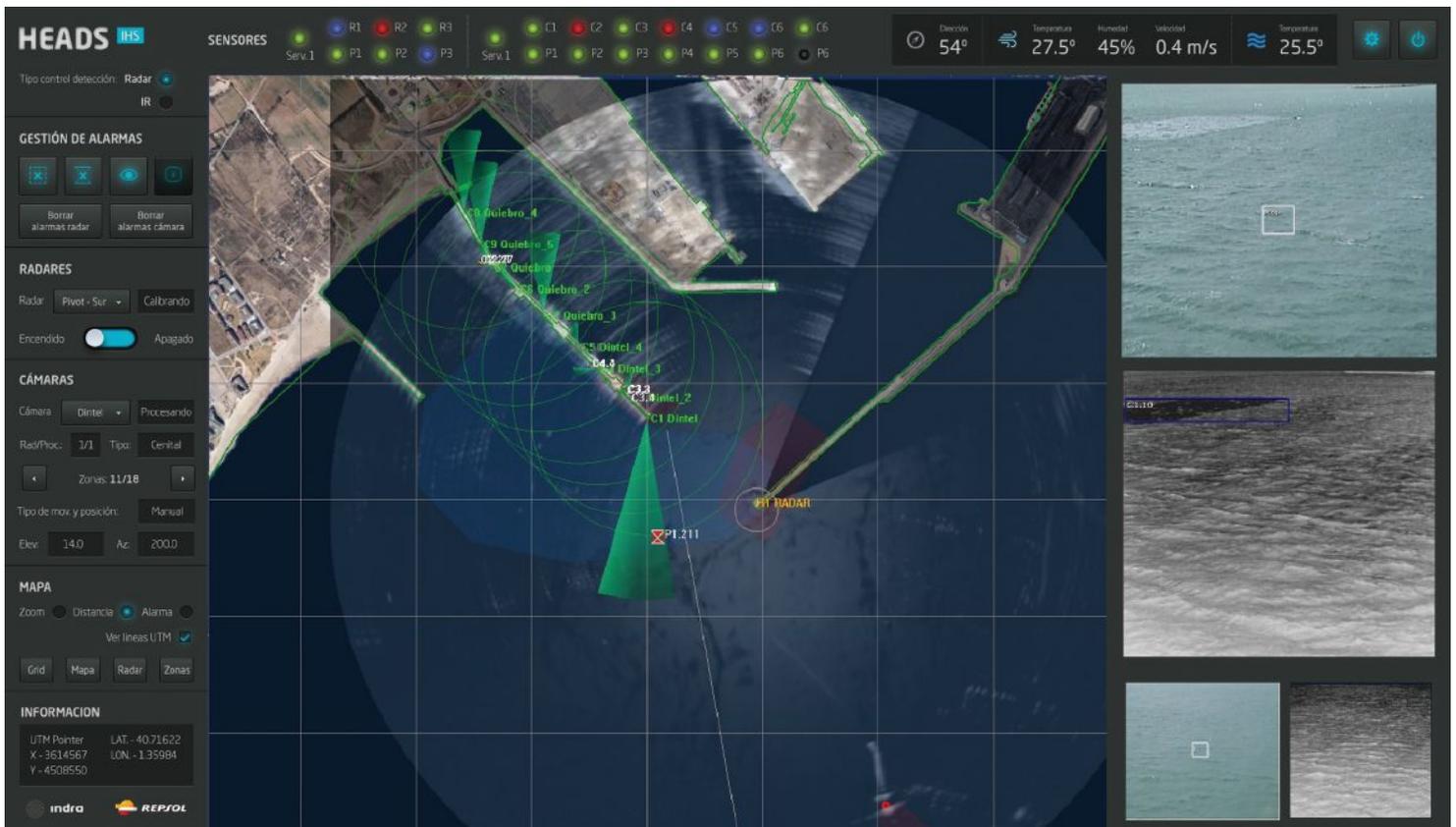
HEADS is based on highly advanced infrared sensors, radars and algorithms that maximize the probability of detection and minimize the likelihood of false alarms. The system is operational 24/7, ensuring that no oil spill remains undetected. Furthermore, through the use of intelligent algorithms, HEADS' computer is also able to achieve an unprecedented level of oil spill detection.

HEADS is not only an upstream application, but can also be used at ports, harbors and any other installation where large volumes of hydrocarbons are stored or managed. Because the system detects even the smallest oil spill, it can also be a useful tool to identify accidental oil releases caused by shipping.

Repsol contributed to HEADS with its extensive knowledge of physical processes related to hydrocarbons and

the marine environment as well as its experience in offshore crude oil exploration and production. The company has also provided all the technology developed at the Repsol Technology Centre, which includes a laboratory to reproduce weather conditions at sea. Indra contributed its expertise on image interpretation and algorithms as well as its experience in the development of real-time data processing and the construction and use of infrared cameras and radars.

The project was formally initiated in 2011 and consisted of four stages of rigorous testing. During the first stage, which was carried out at Repsol's Technology Centre in Madrid, technical-economic viability was tested. Phases Two to Four were carried out through the use of two pilot studies at Repsol's Tarragona Industrial Complex and the Casablanca platform. The project included a multidisciplinary team of over 20 highly qualified experts and researchers specialized in a variety of areas such as oil and gas, physics, chemistry, software programming, radar technology and algorithms. After 21 months, HEADS was put into commercial use in July 2013 and underwent further fine tuning until the end of 2013.



HEADS is based on highly advanced infrared sensors, radars and algorithms that maximize the probability of detection and minimize the likelihood of false alarms. The system is operational 24/7, ensuring that no oil spill remains undetected. Furthermore, through the use of intelligent algorithms, HEADS' computer is also able to achieve an unprecedented level of oil spill detection.

HEADS: «Hydrocarbon Early Automatic Detection System».



HEADS consists of oil-detecting infrared cameras, oil spill detection radar, and two control algorithms. The first algorithm detects the oil spill and sets off an alarm through the infrared sensors. The second integrates the signals of both sensors and—based on these signals and the weather conditions—decides whether to set off the alarm to signal an oil spill.

How does HEADS work?

HEADS consists of three main elements. The first is a system of infrared cameras that scan the sea areas continuously for 20 to 60 seconds. The technology is able to detect variations in temperature and heat emissions of different substances (e.g., oil over water).

The second element is the oil spill detection radar that scans the water for anomalies in its echo, with each scan revolution only taking three seconds. The radar is used in conjunction with the infrared sensors improving HEADS' efficiency as the radar is capable of operating at full capacity even in adverse weather conditions and can reach distances of up to 5 km.

The third element of HEADS is its two control algorithms. The first algorithm detects the oil spill and sets off an alarm through the infrared sensors. The second algorithm integrates the signals of both sensors and—based on these signals and the weather conditions—decides whether to set off the alarm to signal an oil spill.

This system is modular and scalable and could be adapted to any topology through the use of the appropriate combination of thermal and radar sensors. The combined use of different technologies maximizes the probability of detection and minimizes the probability of false alarms. The system can operate in complete darkness and can detect spillages of as little as 10 L, meaning that it is effective wherever and whenever it is

deployed. In addition, HEADS is coupled with a system that can automatically identify vessels that are in the vicinity of the sensors, helping to avoid collisions as well as identifying ships correctly in the case of an oil spill with the backtracking tool.

Tackling new challenges

The development of new technologies to tackle challenging issues for the oil and gas sector has always been at the forefront of Repsol's activities. As oil and gas companies continue to explore areas deeper and further offshore, tackling the associated risks will become ever more challenging. The environmental impact of oil and gas spills has never been under as close scrutiny as it has in recent years, and energy companies need to demonstrate they are equipped to deal with these potential scenarios and continue to invest in the technology necessary to mitigate these risks.

Repsol specializes in hydrocarbon exploration and, in recent years, has made some of the biggest discoveries worldwide. Repsol operates in the most demanding areas on the planet with the toughest technological requirements, many inaccessible to the industry until just a few years ago. HEADS forms part of Repsol's commitment to supply smart energy and joins success stories such as the Kaleidoscope Project, in collaboration with the BSC and Stanford University, or the Sherlock project, which made the Repsol Technology Centre a global benchmark for innovation and technology. For more information, visit www.repsol.com.