PRACTICE REPORT
PROCESS ANALYSIS
WATER QUALITY MONITORING
EUROTUNNEL

Photo © Eurotunnel

Water Quality Monitoring 40 Metres Below the Sea bed

Natural groundwater collected around the tunnels operated by Eurotunnel is continuously monitored before being pumped to the coast and discharged into the sea. Six multiparameter ➔*water quality monitoring systems* have been custom-designed by HACH LANGE to ensure that there is no potential for harmful water to enter the pipelines.

Each monitoring system is connected to a sophisticated data collection and ➔*alarm system* that is able to divert water into vast underground sumps if alarm conditions occur. To-date, no such emergency has taken place.

Commenting on the new monitoring system, Eurotunnel Senior Technician / Project Manager Michael Edwards, says “The two major benefits are ➔*improved reliability* and a ➔*lower maintenance* requirement.”

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The longest undersea tunnel in the world

Background

The Channel Tunnel is 50km long, with the 39km undersea section making it the longest undersea tunnel in the world. The Eurotunnel system actually consists of three separate tunnels: two rail tunnels through which the trains travel, and a central service tunnel. This “safe haven” is used for maintenance and evacuation, and is linked to the rail tunnels every 375 metres. On average, the tunnels lie 40 metres below the seabed of the English Channel.

The service tunnel is maintained at a higher air pressure and thus remains free from smoke and fumes in the event of an incident. It provides access to a wide range of assets that ensure safe and efficient operation of the tunnel. This includes the water monitoring systems, the pumps and pipelines.

One of the world’s most significant construction projects

The excavation of the tunnels was one of the world’s most significant construction projects. Work began in the UK during December 1987 and in France during February 1988 and over the entire construction period sufficient soil was removed to fill Wembley stadium 13 times.

The water that seeps down to the tunnels is a mixture of groundwater and seawater. It is collected at six drainage stations and is continuously monitored. The main purpose of the monitoring system is to protect the enormous pumps (capable of almost 1,000m^3/hr) and pipes from corrosive attack. It also serves to ensure that water discharged to the sea is not harmful to the environment.

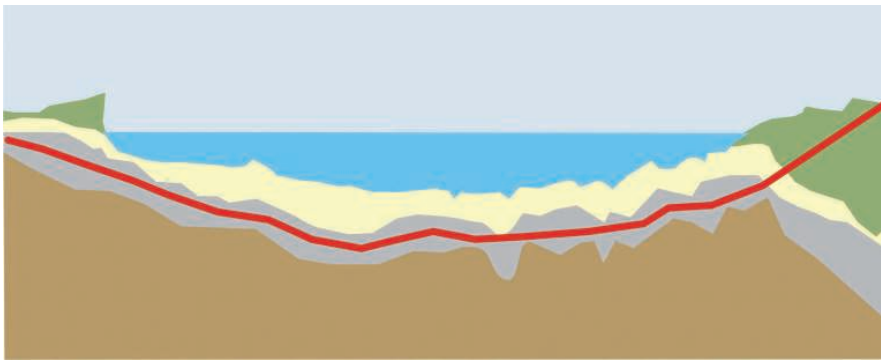

Fig. 1: Geological profile of the Eurotunnel

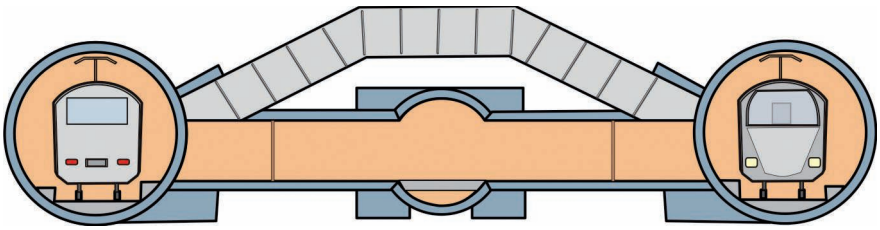

Fig. 2: Cross section of the tunnels with train tunnels on the left and right and side, service tunnel in the middle

The early monitoring system suffered from a number of problems that largely resulted from blockages in the small pipes that passed water to the sensors and HACH LANGE was tasked with the development of a more reliable, less labour-intensive system.

Water Quality Monitoring

The HACH LANGE and Eurotunnel engineers decided that a flow-though holding tank would resolve potential problems with blockages; large bore pipes could be employed and sediment could be removed easily. In addition, the latest sensor technology meant that the requirement for recalibration was much lower.

Environmental protection system

Each of the six flow-through tanks contains sensors for conductivity, turbidity, dissolved oxygen, pH, Redox and temperature and data is transferred to a PLC that is programmed to raise alarms when pre-specified conditions occur. If an alarm is raised all water is immediately passed to an underground storage sump and remains in quarantine until tested and passed as fit to be allowed into the pipeline. The monitoring system returns to normal once water quality levels leave the alarm condition. Any quarantined water can then be removed by bowsers.

In the early years, water was passed though a wastewater treatment works near Dover, however, the water quality was found to be consistently of good quality so the treatment works was decommissioned and water is now passed directly to the sea under a discharge consent from the Environment Agency. Naturally, the monitoring system prevents the discharge of any water outside the consent conditions.

“The new system is far superior”
Kevin Rivers, Senior M&E technician at Eurotunnel was responsible for the configuration of the monitoring and control system. Comparing the HACH LANGE system with its predecessor, he reflects “The new system is far superior because it is more reliable, it requires less maintenance and is easier to operate. The water quality monitoring sensors are connected to SC 100 controllers which are ‘plug and play’ – all you have to do is tap the serial number into the controller and it starts to monitor correctly automatically. The reliability of the new system means that we no longer experience false alarms, which is a major benefit; there are strict procedures in place before an M&E team can enter the sumps to investigate an alarm and coupled with the amount of time it takes to drive to the drainage stations, false alarms are very costly. We estimate that the new system requires about one quarter of the maintenance that was previously necessary, which saves a great deal of time and money.

One of the reasons for this is the new dissolved oxygen sensor, the LDO (Luminescent Dissolved Oxygen), which employs an optical monitoring technology that does not require recalibration – we simply change the sensor cap every year. In order to prevent sensor fouling, we have fitted a compressed air system that automatically cleans the sensor heads.”

Following installation of the monitoring systems, HACH LANGE ran short training courses on both the UK and French sides of the tunnel and Eurotunnel staff are now responsible for operation and maintenance. HACH LANGE simply provides a yearly service and calibration check.

Commenting on behalf of HACH LANGE, Project Manager Clive Murren said “These installations have been successful because the technological requirements identified by the Eurotunnel team coincided with the development of new monitoring equipment. As a result, the instrumentation has been deployed in a customised monitoring system, designed specifically to overcome the problems that had been previously experienced. It was a pleasure for us to be involved in such an unusual application, however, plug-and-play technology coupled with advanced low

Fig. 4: pH and Redox sensors with automatic cleaning system

Fig. 5: Water quality monitoring station with digital controllers and sensor mounting

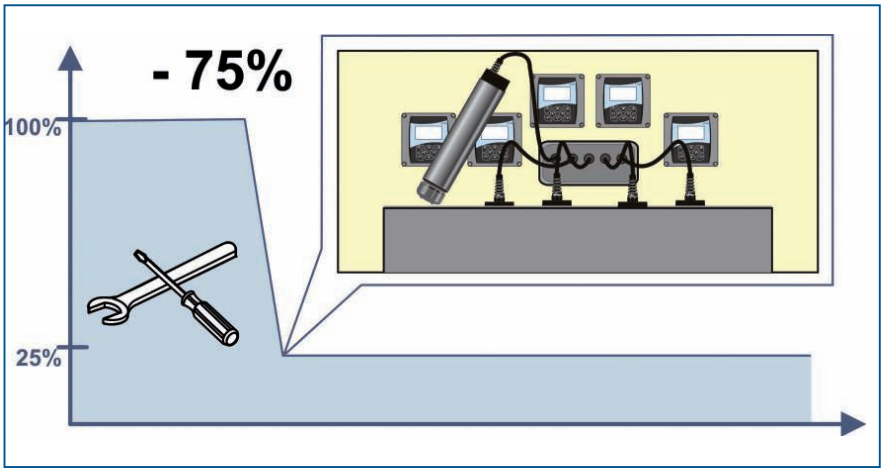

Fig. 3: Maintenance was reduced by 75%

Fig. 6: The service tunnel
Photo © Eurotunnel

Process instruments used

Fig. 7: Members of the Eurotunnel Maintenance Team

maintenance sensors enable us to help develop and supply customer-specific solutions very easily."

Eurotunnel is a unique and highly important project

Michael Edwards says that "The tunnel systems were extremely well designed. The water seepage levels have been significantly lower than was originally estimated and the collection sumps have enormous capacity so the whole drainage system is running significantly under capacity. However, this provides the reassurance that we would be more than capable of handling any emergency. Furthermore, the system that we have developed with HACH LANGE has helped to radically reduce the running costs whilst significantly improving reliability, which is good news for everyone."

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Process instruments used

SC 100 Controller	For two digital probes or electrodes, all parameters easily configurable. Three potential-free changeover switches, 5A 115/230V AC, 5A 30V DC, programmable as limiting value, status, P controller, or alarm.
LDO	Flow-through probe, optical (luminescence) measuring method, calibration-free, drift-free, maintenance-free, with PT 100 temperature sensor
SOLITAX sc	Process immersion or inline probes with a combined infrared absorption scattered light photometer for measuring lowest turbidity levels in accordance with DIN ISO EN 27027 as well as high sludge levels (up to 150g/l), colour independent method, probe housing available in SS316 (V4A) or plastic material, automatic self-cleaning wiper system.
pHD-S sc	Rugged digital differential pH-probe or ORP-sensor, closed design, no contact between reference system and the fluid that is being measured, no electrode poisoning and no damage by H_2S; the unique salt bridge reduces cleaning requirements and avoids dilution of the electrolyte.
3798-S sc	Rugged digital non-contacting, inductive conductivity sensor, wide measuring range, particularly suitable for heavily soiled media such as municipal and industrial wastewater, polluted surface water and drinking water; PEEK housing for lasting resistance, factory precalibrated for immediate use, safe and interference free communication between probe and controller.

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