



## Hydraulic and electrical parts combine to reduce the time to drill 250,000 holes in Crossrail tunnels

Eaton supplies electrical and hydraulic part content for innovative automated Crossrail drilling rigs

**Location:**

London, UK/ Küssnacht, Switzerland

**Challenge:**

Automation of drilling rig

**Solution:**

SmartWire-DT with hydraulic and electrical parts

**Results:**

Enormous reduction in drilling time and improved operator welfare

*“The mechatronic approach taken, which includes Eaton’s hydraulic and electrical parts, has resulted in a fantastic technical achievement in record time - the automated drilling rig, which can be defined as a robot, is the first of its kind,”*

*Michael Fabianek, CTO, ATP Hydraulik AG.*

ATP Hydraulik AG (referred to as ATP) designs and produces hydraulic systems and mechatronic solutions combined with automation. The company was awarded a contract to design and provide all the cylinders, hydraulic power units, complete piping, electrical and hydraulic engineering and software on two bespoke drilling rigs for the London Crossrail program. In addition to the complete piping and cabling, ATP supplied the greasing circuits, together with the fire detection and extinguishing systems.

For the mechatronic system, which integrated electrical and hydraulic components, ATP chose to work with Eaton; this allowed ATP to liaise with just one manufacturer for optimum development time. At the

moment they are the only official Solution Partner of Eaton working globally that integrates technologies from both its electrical and hydraulic businesses.

**Background**

Crossrail, Europe’s largest construction project, will transform rail transport in London and the south east of England, increasing central London rail capacity by 10%, supporting regeneration and cutting journey times across the city. Currently nearly 20 km of track has been laid on what will be known as the Elizabeth line. The total funding envelope available to deliver Crossrail is £14.8 bn (approx. €18 bn).

The objective for Crossrail is to bring an extra 1.5 million people to within 45 minutes of central London and link London’s



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key employment, leisure and business districts – Heathrow Airport, West End, the City, Docklands – to enable further economic development. The first Crossrail services through central London will start in late 2018 with an estimated 200 million annual passengers.

## Challenge

### Reduce the time to drill 250,000 holes and improve worker health and safety

Multiple hole patterns are required to be drilled every 6.4 meters in the concrete tunnel lining to secure the rail infrastructure. This includes brackets for the emergency escape walkways, cable management systems, fire mains and the 25 kV overhead line system that powers the Crossrail trains.

In previous tunneling projects this task was carried out manually, when surveyors would be employed to physically mark each position and then the holes would be drilled by other workers using hand-held hammer drills. For the 42 km of tunneling involved in the project, this would have taken 2 to 3 years to complete (depending upon the number of construction workers employed).

The vibration and noise from drilling 250,000 holes could have caused health & safety issues for the workforce. Even with suitable personal protection equipment (PPE), over an extended period of time, hand-arm vibration (HAV) exposure may be serious and disabling. Besides being a known contributing factor to carpal tunnel syndrome and other ergonomic-related injuries, HAV exposure may cause direct injury to the

fingers and hand, affecting feeling, dexterity, and grip. For these reasons, a solution was required to speed up the drilling operation and improve operator welfare.

## Solution

### Providing a new solution to meet Crossrail's program schedule

ATC (a joint venture consisting of Alstom, TSO and Costain) was tasked with deploying two brand new, state-of-the-art precision automated drilling rigs. The Crossrail drilling rigs were manufactured by Rowa Tunnelling Logistics in Switzerland and were completed by November 2015.

For the mechatronic system, which integrates electrical and hydraulic components as well as the complete software and interface, ATP Hydraulik worked with Eaton; this allowed ATP to liaise with one main supplier for optimum development time.

The electrical components included Eaton's SmartWire-DT contactors and fuses for the drilling machines and pumps for the dust suppression system, which is controlled via a Profinet/SmartWire-DT gateway. The SmartWire-DT intelligent wiring and communication technology consolidates complex circuit wiring into a single, durable cable that can be connected to a standard network.

Eaton's Heavy Duty Series of axial piston pumps supply the hydraulic oil for the hydraulic systems that manipulate the arms and control the 36 drills, along with Eaton's proportional valves, cartridge valves, directional control valves, and tube fittings.

The first phase was to perform a 3D scan along the tunnel taking measurements in small increments. This data was laid out in a co-ordinate form into a computer program and segment templates for the drilling positions were overlaid. Every 6.4 meters, the drilling rigs are positioned automatically via laser. They receive the drilling data via a USB stick. All the holes are drilled simultaneously, fully automatically and accurately to within  $\pm 2$  mm.

## Results

### An elegant solution to a complex problem

"The mechatronic approach taken, which includes Eaton's hydraulic and electrical parts, has resulted in a fantastic technical achievement in record time - the automated drilling rig, which can be defined as a robot, is the first of its kind," says Michael Fabianek, CTO, ATP Hydraulik AG. "By integrating Eaton's Intelligent Wiring and Communication technology, we estimate a time saving of 80 hours of labor was achieved to build the two switch cabinets for the two drilling vehicles." The saving was achieved by reducing wiring time, as well as time for I/O testing and commissioning.

For ATP to realize the project until factory acceptance test (FAT), it took four months. After extensive regulation and safety testing and an FAT in Switzerland, commissioning was completed in the UK with real, modified data.

Actual tunnel wall drilling started in April 2016. It is anticipated that type of drilling rig will be used for other future tunneling programs.



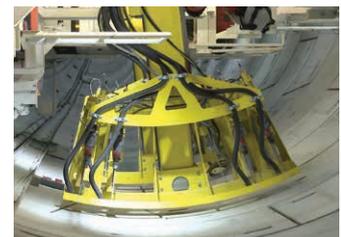
Eaton's SmartWire-DT intelligent wiring and communication system saved about 80 hours of labor to build the two switch cabinets for the two drilling vehicles – this time includes wiring, I/O testing and commissioning.



A remarkable feat of engineering – the Crossrail drilling rig, comprising two machine components, moves through the tunnels drilling more than 250,000 holes in the tunnel lining.



A perfect fit – the first drilling rig drills all the holes that will accommodate brackets for cabling, walkways and fire mains. The second machine focusses on the holes for the overhead electricity line, which will power the Crossrail trains.



Crossrail drilling rig working in the Thames Tunnel, which stretches for almost two miles beneath the city of London. Eaton's Heavy Duty Series of axial piston pumps supply the hydraulic oil for the hydraulic systems that manipulate the arms and control the 36 drills.

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