Choose the right track and help eliminate railway 'sudden death'

Saft's Holger Schuh discusses the importance of battery power for the railway industry and introduces a new technology with the potential for condition-based monitoring

Uptime of railway control and communication equipment is vital for safety. Level crossing signals, barrier controls and points need continuous power in the case of a mains outage. Level crossing safety is a top safety priority for rail operators. One example that highlights the vital role of signalling systems is a fatal train crash in the Chinese city of Wenzhou in July 2011, when two trains collided due to a faulty trackside signalling installation.

According to operator Network Rail, there are around 6,000 pedestrian and vehicle level crossings and 20,000 sets of points in the UK. Uninterruptible power is critical for public safety at such sites and is typically provided by rechargeable batteries in trackside cabinets.

The challenge to operators is how to optimise their trackside infrastructure. Choice of battery is an important aspect of this as it sets the maintenance requirements for the life of the installation.

Engineers typically have a choice between two types of battery. Lead-acid batteries are relatively inexpensive but require regular testing and can suffer a failure mode called 'sudden death'. This phenomenon describes the potential for lead-acid battereries to stop working overnight.

Nickel-cadmium (Ni-Cd) batteries such as Saft's Tel.X or Uptimax batteries embed high technology designs that prevent sudden death and, in addition, they require little or no maintenance.

Fear factor

The factor of sudden death is a major advantage for nickel technology in critical applications. It can happen at any time during the life of a lead-acid battery system and is caused by softening and eventual failure of the lead electrodes inside the battery. It does not affect nickel batteries as they rely on a rigid steel structure to guarantee mechanical strength in spite of the potential for trackside vibration or mechanical knocks.

Some operators manage the risk of sudden death by installing a fully redundant second back-up battery. Other operators carry out capacity testing of batteries every six months – a gruelling task that requires either a constant round of site visits for maintenance engineers or significant cabling for remote testing.

For those who prefer to minimise total cost of ownership (TCO), nickel-based batteries have a clear advantage. Nickel batteries become less expensive after the first seven to eight years, which is helpful considering the operating life of a typical trackside installation is in excess of 20 years. However, this includes only the initial price, maintenance cost and replacement of the battery.

> The factor of sudden death is a major advantage for nickel technology in critical applications

As no operator has the same approach to battery testing, the price of capacity testing has not been included in our TCO calculation, so some operators may find a faster payback on nickel batteries.

Another area that may narrow the difference is where air conditioning and ventilation systems are needed inside cabinets. High temperatures cause premature ageing for all battery chemistries. However, nickel is better at handling hot conditions.

At a constant 20˚C, nickel batteries have a potential to last 20 to 30 years and lead-acid five to 10 years. However, as the thermometer nudges higher, the life expectancy of lead-acid drops away. At 30˚C, lead-acid will last five years, compared with 16 years for Ni-Cd and the gap grows wider as it gets hotter.

Nickel batteries age more slowly at higher temperatures and more predictably, with no risk of sudden death.

Operating conditions inside the cabinets can be tough for battery systems. Temperatures vary between winter chill and summer heat. Some sites can experience anything from -20˚C to 40˚C or even higher.

Although such conditions may only last a few days or weeks, they can reduce the life or require additional testing, either of which impacts the lifetime cost. So by selecting nickel batteries, an operator gains more control over ageing and also eliminates air conditioning and ventilation inside cabinets.

Low temperature extremes can also impact battery performance. Nickel batteries have the edge over lead-acid in the cold. As the temperature drops, batteries' internal resistance rises, reducing the power output. Engineers overcome this by oversizing the battery so that it will deliver the power needed even on the coldest night of the year.

However, because nickel batteries have a smaller derating factor at lower operating temperatures, they require less oversizing. This allows for a smaller cabinet and fewer batteries to maintain (and avoid the need for a heater) – advantages which help to keep costs under control.

Operators SŽDC and ŽSR's modernisation programme includes a slimline trackside cabinet

Recognising the advantages of nickel-cadmium, railway infrastructure operators in the Czech Republic and neighbouring Slovakia have both switched back to nickel technology for their trackside installations after trials with lead-acid batteries.

Since 2000, operators SŽDC and ŽSR have delivered major programmes of modernisation, including the introduction of a new crossing design concept with a slimline trackside cabinet. However, the operators experienced maintenance issues with the original valve regulated lead-acid (VRLA) batteries. In 2016, they switched to Saft's nickel-based Tel.X batteries after a trial. The Tel.X battery is a reliable, maintenance-free 'drop-in' replacement for the original batteries and is expected to deliver more than 16 years' service compared with only five years for VRLA batteries.

Even though nickel batteries are reliable by design, Saft recognises the fast-growing trend towards digital railways. Therefore, the company is now developing a digital monitoring system for batteries used in trackside applications. The new system will monitor the state of health of batteries and send updates to operators in control centres.

While nickel batteries have exceptionally high reliability, the system will prove popular with operators that want to achieve enhanced online visibility of all their assets. It will open up the potential for condition-based maintenance of battery installations, reducing maintenance cost, increasing fleet availability and ensuring that maintenance is only carried out when it is needed. The new tool is planned for launch in 2018.