Saft Ni-Cd batteries help keep tram-trains running in Karlsruhe

**Saft nickel-cadmium (Ni-Cd) batteries help ensure non-stop tram-train service in the German city of Karlsruhe, with a balance of reliability, performance and low maintenance.**

The city of Karlsruhe was the first in Germany to link its street tramway and mainline railway by running urban trams on both networks. These tram-trains have dual equipment that enables them to run on both tram and train networks, using multiple supply voltages.

Changing between the 750 V DC tram track power supply and the 15 kV AC main line supply, requires the tram-train to pass a cut-off section of up to 250 metres where no external power is available.

The onboard battery system – with a nominal voltage of 24 V – must provide a minimum of 20 V for 20-25 seconds to support all the electrical loads. This means battery reliability is vital to ensuring the Stadtbahn Karlsruhe services run continuously and on time.

**Battery challenges**

Previously, most of the Karlsruhe tram-trains were fitted with flooded lead-acid batteries, which had a number of reliability, maintenance and service-life issues.

For example, ideally the battery should have a capacity of at least 300 Ah. But in practice this is limited to 230 Ah with lead-acid batteries due to the need to fit them in the space offered by the under-floor battery box. This meant there was a risk of the tram-train running out of power, and stopping before it could pass across the cut-off section.

Further battery problems were experienced during the winter months, when low temperatures adversely affected battery performance. There had also been at least one case of ‘sudden death’ – in which the open circuit failure of one or more cells caused the whole battery to fail. Overall service-life of the lead-acid batteries was limited to only two to three years.

**Ni-Cd advantages**

Ni-Cd batteries offer a number of advantages in tram-train applications. They can provide a larger capacity within the same footprint; resistance to deep discharges; high performance at extreme temperatures; long, predictable service-life (at least 15 years), with no risk of sudden death; simplified maintenance and extended service intervals.

Saft worked with Stadtbahn Karlsruhe to carry out a Total Cost of Ownership (TCO) analysis. This showed that, while the initial cost of acquisition of the Ni-Cd battery system would be higher than for lead-acid, when operation, maintenance and replacement costs over a 12-year period were considered, the Ni-Cd battery would actually cost less.

**Successful trial**

After proving the case for Ni-Cd batteries in principle, Stadtbahn Karlsruhe decided to carry out a practical evaluation through all the seasons of the year and asked Saft to provide a trial battery system. This comprised 19 MATRICS MRX 200 batteries that fitted within the existing battery box, with a nominal capacity of 200 Ah.

The Ni-Cd battery’s high current performance is crucial in supporting the passage of the tram-train through the cut-off section. Even though the Saft Ni-Cd battery had a lower rated capacity than the 230 Ah lead-acid battery it replaced, in practice it delivered superior performance, especially at low temperatures.

“Saft’s Ni-Cd battery performed very well during the field test,” says Rainer Supper, deputy workshop manager responsible for electrics at Stadtbahn Karlsruhe. “There were no problems or outages, which is more important than anything else – including cost – since fewer outages mean more passenger availability.

“We didn’t need to touch the Saft battery for a whole year and it only needed topping up with three litres of water,” Supper continues. “And, thanks to the centralized water filling system incorporated into the MRX design, topping up only took 15 minutes. With our lead-acid batteries, each cell had to be opened individually for refilling, and this had to be done three times. With three major maintenance sessions during the year, at least one hour of time could be saved per tram-train.”

The success of the first field test prompted Stadtbahn Karlsruhe to order two further test Ni-Cd test batteries, and the first of these was installed in December 2008.