

## TRACTION Portugal

# Sintra tests confirm potential of low-cost repowering



The trial operation of an IGBT gate unit on a suburban EMU in Lisboa has confirmed the potential for increasing reliability and saving energy at a fraction of the cost of replacing an entire traction unit.

**Nick Kingsley** reports from Amadora.

On January 27 the traction equipment compartment for a Series 2300/2400 EMU used by CP on the Lisboa – Sintra line was delivered to a depot in Amadora in the suburbs of Lisboa. The compartment contained a traction converter and control equipment, but an empty shelf where the operator had already removed the GTO drive units. This will be the second traction unit to enter commercial service as part of the ‘Lusogate’ repowering trial to equip the Sintra line fleet with IGBT traction technology at around a third of the cost of a conventional repowering approach.

The Amadora facility is the headquarters of national operator CP’s maintenance business EMEF, but much of the site is the former Sorefame factory which assembled rolling stock for Portugal and various international markets until 2005 and is now occupied by various non-railway companies.

The EMEF site is also home to NT Power, a traction equipment business which is part of EMEF’s Nomad Tech joint venture with Nomad Digital; Nomad Tech also offers reliability-centred maintenance services and remote online condition monitoring tools under the NT Maintain brand (RG 2.14 p60) and energy management as NT Eco. At the heart of NT Power’s business model is

Fitted with Siemens traction equipment, CP’s Series 2300/2400 EMUs operate on routes linking Sintra with both Rossio and Oriente stations in Lisboa.

the replacement of GTO-based electric power drives with IGBT components, taking a lower-cost approach which it believes could significantly undercut the prices of the major systems integrators.

‘This is disruptive innovation in action’, insists Costa Franco, General Manager of Nomad Tech. ‘The business case is clear. We can offer an operator an immediate return on investment.’ NT Power has been working on the design of its refurbished traction converter since 2010, after CP asked EMEF to find a cheaper alternative to renewing the entire converter pack for the Sintra line fleet. Costa outlines how the initial work on an IGBT-based unit was undertaken by EMEF in partnership with CP and the Faculty of Engineering at the University of Porto, before CP chose a Class 2300/2400 EMU on which to test the Lusogate equipment.

### Don’t change everything

Given that both GTOs (gate turn-off thyristors) and the more modern IGBTs (insulated gate bipolar transistors) are readily available on the power electronics market, the challenge facing NT Power was how to incorporate the IGBT assembly into the gate unit while minimising the need to adapt existing switchgear and control software. Similarly, NT Power was determined to ensure

that electromagnetic compatibility and harmonic interference patterns did not change as a result of the modifications.

Tweaking the methodology for the repowering has taken time — almost five years passed from the outset of the project until the test train entered revenue service on the Sintra line. Yet Costa argues that this has been time well spent, as it has enabled NT Power to undertake extensive tests to demonstrate the approach’s most compelling feature: no re-authorisation of the vehicle or its traction system is required.

‘Normally when an OEM approaches an operator, they offer a complete renewal of the drive system. By definition, this requires re-authorisation by the relevant infrastructure manager and safety authority’, Costa says. ‘We have developed a non-intrusive option.’

Nomad Tech’s General Manager for Rolling Stock & Maintenance Engineering Nuno Freitas adds that ‘we had to convince REFER [now Infraestruturas de Portugal] that the key parameters for authorisation had not changed. They told us, “we believe you, but we still have to check!”.’

### Energy saving

On March 1, the Series 2400 test train was due to complete a year of revenue operations; the four-car 25 kV 50 Hz EMU

**12.5**  
%

ENERGY SAVING  
ACHIEVED BY IGBT  
UNIT OVER GTO  
DRIVE DURING  
IN-SERVICE TRIALS

**COST REDUCTION**

## Two stages to energy saving

The Nomad Tech joint venture has also been exploring energy saving techniques on CP's electrified routes north of Porto. As with the telemaintenance and remote diagnostics methods developed with strong input from depot staff, Nomad Tech says it has put CP's drivers at the forefront of its energy management initiative.

EMEF began examining ways to reduce CP's energy costs in 2009 at the height of the country's financial crisis. Since then, EMEF and latterly Nomad Tech have developed a two-stage methodology which is driven by influencing drivers' behaviour, not by the imposition of novel technology. 'One-third of a train's energy consumption is driven by the auxiliaries', explains Hélder Ribeiro, Head of Department for Software Engineering & Power Systems at Nomad Tech. 'The first stage of our work with CP focused on getting the drivers to respect certain key behaviours in the working day, such as leaving trains in low-power mode overnight.' Other issues addressed include the use of lighting and

air-conditioning during train cleaning. 'We showed the impact of having HVAC equipment running in every vehicle of a train when it is being cleaned by one person. That's not energy-efficient.'

The use of real data from Nomad Tech's onboard metering and diagnostic equipment means that the impact of different driver actions can be illustrated in training sessions; Ribeiro reports that CP has recorded energy savings of 9-3% in the live environment.

The first stage of the NT Eco policy is now used daily by CP at its São Bento depot; the second stage has been under development since 2013. 'This is a driver advisory system', Ribeiro explains, 'but it is human-centred DAS.' Nomad Tech has initially developed a static tool, rather than dynamic or 'connected DAS', which the driver manages via a portable tablet rather than a cab-mounted DMI.

The speed and traction profiles used to guide the driver are based on the working timetable, but considerable staff input is used to finalise the

interface. 'About half the design came directly from the drivers', Ribeiro says. In addition, CP was able to request additional functions, such as more location data to reassure drivers when they encounter foggy conditions, a common occurrence around Porto. Drivers can intervene to reset the DAS where external factors intervene, to reflect omitted station calls for example. Nomad Tech's onboard unit records traction, friction and regenerative braking data, which is then used to inform driver training.

Nomad Tech believes the second stage could deliver energy savings of between 7% and 15%, and a four-month trial with four EMUs in the summer of 2015 has verified these findings. 'We are ideally looking for a very rapid return on investment', says Nomad Tech General Manager Costa Franco. He reiterates that the NT Eco tools have been developed 'bottom-up', working with the drivers themselves, and says that CP staff will accompany Nomad Tech when they demonstrate the product to potential customers. ■

has a married pair of traction drives, of which one is the modified IGBT unit and one a GTO thyristor. 'CP and REFER wanted a year of operations through the summer heat to ensure they could do a meaningful comparison between two drive units on a single train', Freitas explains.

The in-service trials are already generating tangible benefits, including a 12.5% energy saving for the IGBT unit over the GTO drive running in identical conditions. Nomad Tech was able to install real-time diagnostic equipment as part of the repowering, meaning the drive system could be migrated to a condition-based maintenance regime.

Because the control equipment has not been altered, the IGBT is operating in the same low-frequency range as a GTO drive. Freitas accepts that this means the full capability of the IGBT technology is not being exploited. While this limits the performance benefits for the train itself, it should mean that the life span of the traction drive can be significantly extended, while the IGBT pack is also lighter and less electrically-complex than the GTO it replaces.

Costa believes that, as well as offering the potential for repowering a fleet

at around a third of the upfront cost often quoted by an OEM, NT Power can deliver 'immediate' return on investment by giving the operator a reusable pool of GTOs to reduce maintenance costs and downtime for vehicles not being refurbished.

'There is no competition in the OEM market, so consequently no price pressure', he adds. 'The big suppliers like to prepare the ground for a mid-life refurbishment by raising the price of components — even obsolete ones — and insisting that the operator must procure entirely new converters.' Nomad Tech believes that the Sintra line trial has shown that a cheaper and faster option is available. The joint venture is aiming to

**Right:** At the EMEF headquarters in Amadora, Nomad Tech has created a test bench from second-hand components. A universal traction motor is fed from a single-phase inverter to replicate the traction control commands given to the power modules.

**Below right:** Technicians work on the Lusogate products in the Nomad Tech laboratory at Amadora.

**Below:** A second Lusogate IGBT power module was due to be fitted to the trial EMU by the end of February; it will use only a small proportion of the equipment modules where the GTO drive used to sit. Nomad Tech says the rest of the switchgear and control equipment is reliable and can be left unaltered.

hone the procedure so that a 'first in class' installation would take no more than six months from design to revenue service. Subsequent fitment would be accomplished using a 'plug-and-play' approach during routine vehicle maintenance slots.

'It has been a steep learning curve to get this far', Costa accepts. 'But in the future it should take less than a year to get from concept design to commercial service.' And the market is potentially huge — one upcoming opportunity that the joint venture is studying is a tender to overhaul 475 locomotives with IGBT drives where the operator has already stipulated that any refurbishment must not require the locomotives to be recertified. ■

