

AUTOMOTIVE & DEFENCE

ELECTRIC DRIVE

New propulsion system under test for army's fighting vehicles

Keith Campbell | Senior Contributing Editor

South Africa's defence acquisition, disposals and research and development (R&D) agency, Armscor, will next year start a combat vehicle electric-drive technology test programme for the South African National Defence Force (SANDF), using a modified Rooikat armoured fighting vehicle, as the demonstrating vehicle for this technology.

Electric drive, once perfected, will revolutionise the design and significantly improve the capabilities of especially, but not exclusively, armoured vehicles, and is a technology being actively pursued in a number of major countries.

"Electric-drive vehicles have electrical motors in each wheel hub; they consequently have no axles, drive shafts, transmissions, or gearboxes," explains Armscor e-drive technology manager **Wynand Avenant**.

"This gives design flexibility that mechanical drives don't have – gearboxes and transmissions must be in certain places, but with electric drive you just have cables that can be routed anywhere," he highlights.

The elimination of mechanical drives will also reduce the combat vulnerability of armoured vehicles.

"This is a technology development and evaluation tool – the SANDF needs answers on electric drive: what is its reliability? Fuel consumption? Life cycle costs? Maintainability? This project will answer these questions," he affirms.

The Rooikat is the latest stage in a project that started 12 years ago.

"Conversion of this Rooikat was completed a couple of weeks before Africa Aerospace and Defence 2006, in September, and it was shown there," he states.

"Optimisation of the vehicle is now under way, and the test pro-



WYNAND AVENANT
Electric drive gives design flexibility

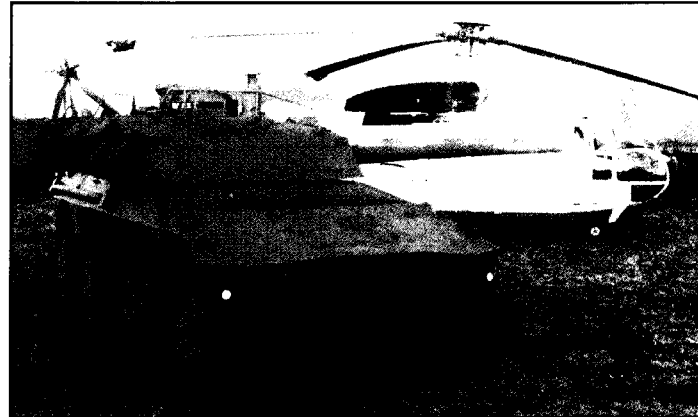
gramme will start next year," he adds.

The Rooikat is the South African Army's standard armoured fighting vehicle – to the uninitiated, it looks like a wheeled tank – and in its standard production form is a well-armoured, 28-t, 8 x 8, diesel-powered vehicle.

"We originally started by developing an electric-drive truck, to use as a demonstrator for the SANDF – trucks are very easy to convert to electric drive as they have very simple chassis and bodies – and the conversion was completed in 1996; we then ran lots of tests from then until 2001: we tested it in the mountains of Mpumalanga; we tested it in the desert; we tested it in the snow in Germany; we tested it towing Ratel infantry fighting vehicles; we proved its practicality, so the SANDF approved the fitting of a Rooikat chassis with electric drive," he reports.

This has been done, and various initial tests executed.

"We adapted a standard Mercedes-Benz diesel engine, which was upgraded by MTU, increasing the power output from 315 kW to 450 kW, but reduced the torque – as required by the electric alternator – and changed the fuel management system so that the best consumption is not at maximum torque but at the optimal operation point for the elec-



ELECTRIFYING
The electric-drive Rooikat at AAD 2006, with an Oryx helicopter behind

trical drive system," he recounts.

An electric motor is fitted in each wheel, each motor having a diameter of less than 50 cm. These are permanent magnet motors, and the Armscor edrive team has also developed the electronics to drive the motors – each electronic unit can handle up to 1 MW.

"In braking mode, each electric motor can deliver up to 400 kW; in traction mode, each can provide a constant power of up to 80 kW; each can deliver 2 200 N/m torque at zero speed – a motor needs torque to go over steep (70°) inclines and obstacles – but we are using a reduction gear to increase torque to up to 21 000 N/m a wheel," says Avenant.

Although not essential for an electric-drive vehicle, the team has also been looking at different energy storage systems – flywheels, induction storage systems, capacitors, and various types of heavy storage batteries.

"Using electrical braking – which does not cause wear and tear – when you brake you can dump energy into a storage system for later use.

"Induction storage systems really need practical superconductors, while a bullet hit on a capacitor could cause it to explode, so neither is currently practical," he stresses.

The advantage of flywheels is that they can both take up and release energy very rapidly; their disadvantage is that they have to be on the same plane at all times.

"So in a manoeuvrable vehicle like the Rooikat, a flywheel needs to be in a gimble, which makes it heavy and takes up a lot of volume," he cites. That left batteries – the team looked at lithium-iron batter-

ies, but these were too expensive; they also examined the locally developed Zebra battery, but that needs to be heated up to achieve optimal performance, which is simply not practical on a military vehicle.

"So we selected nickel metal hydride batteries, from Varta in Germany – the same sort of batteries used in the Toyota Prius petrol/electric hybrid drive car," he reveals.

The fitting of batteries allows the vehicle to use its communications and electronic systems and to move limited distances at low speeds without having to start its diesel-driven generator, thus giving it a "stealth mode" ability.

The replacement of the mechanical drive system by the electric-drive system, including the storage batteries, has reduced the weight of the vehicle by just under 2 t and freed up 1,5 m³ of internal volume – weight and space which could be used to mount more armour or carry more ammunition, or fuel, or a combination of these.

"Although this vehicle is a technology demonstrator, it will be evaluated under operational conditions," he highlights.

If proven practical, it will be possible to fit electric-drive technology to all wheeled armoured vehicles, whether 8 x 8, 6 x 6, or 4 x 4; it will be equally applicable to all types of military truck.

"An electric-drive military truck could also be used as a generator set, to provide power to field HQs, field hospitals, without the need to deploy specialist generator trucks," points out Avenant.

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