TRAKKER TRANSFORMATION

Preparing defence-standard trucks for delivery on active service – from amphibious vehicles and/or to operate in the arctic – takes some special measures. Brian Tinham talks to the converters

Ever wondered how converters might go about making trucks capable of wading through deep water and surviving? Even sea water, and let's say up to one and a half metres, with a two-metre contingency for breaking waves (compared to the standard 0.75 metres)? And what about protecting them from extremes of temperature, too, so they can continue to operate down at, say, -40°C?

One company that recently achieved both – on three Iveco Trakker defence-specification 6x6 SLDTs (self-loading dump trucks) for the MoD (Ministry of Defence) – was bespoke custom car (yes, car) conversions specialist Arden Automotive. What's more, its engineers did so without the benefit of CAD cab geometry and production line interventions on new vehicles – instead reverse engineering units requisitioned by the MoD that had already seen military action in the Middle East.

Taking it from the top, these triple drive axle Trakkers, each of which has a skip body and an Atlas crane behind the cab, were required for use initially on Royal Marines Commando training in northern Norway. They were to form part of an amphibious assault group, so had to be capable of deployment from beachhead landing craft but, separately, also of operating in the cold arctic climate, which sees night-time temperatures plummet to -46°C.

Arden Automotive director John Pick sets the scene. "Although these are regular Trakker chassis, they're fairly sophisticated. They have 13 onboard ECUs and four CANbus networks, so the prospect of deep sea water is a bit scary. But, basically, you have two choices. First, you can move equipment above the line likely to be impacted by water. You can do that, for example, with air filters and some of the hydraulic pipes and control gear, although most of these are designed for extreme conditions anyway. Or secondly, for equipment that can't be moved – such as the electrical harnesses and ECUs – you just have to exclude water either by protecting them or sealing them in containers."

Sounds simple enough? Well, no. Taking the mechanical aspects first, Pick points out that these trucks were not designed for waterproofing, so Arden's technicians had to go round the cabs, sealing every screw hole, trim hole, tooling hole, the box sections, etc. "You need to think of a truck cab as a cheese grater – there's a phenomenal number of holes," he says. "We spoke to 3M and they came up with an adhesive material that would seal the holes and stay in place, despite the likely water pressure. But we also used silicone grease in some of the box sections and enclosures."

Breathe easy

What about the breathers? "There are lots of actuators on vehicles like this," agrees Pick. "We chose to manifold the breathers and collect them in a nest of tubes that we took up to a central stack so that everything would be able to function normally underwater." And that meant piping off everything from the AMT (automated manual transmission) to the axles, transfer case, diff locks and the turbo, using coloured cable ties for later identification.

"The brakes were a special case: we used a bell jar principle. Because we're only interested in being able to exhaust the air under pressure, we checked the seals on the brake exhaust systems and piped them up to a chamber that would sit underwater and bubble compressed air out through a non-return valve. That avoided running even more and larger breather pipes above the water line."

Winterisation measures

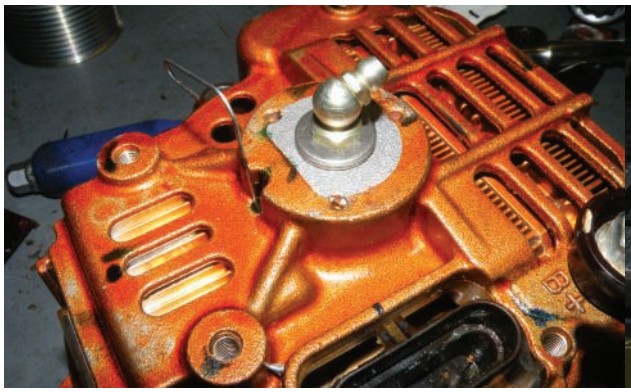
- Change all lubricants and fluids to grades and specifications appropriate to extreme low temperature
- Shielding and thermal installation of batteries
- Fitment of supplementary batteries
- Additional combustion heater
- Frost protection measures

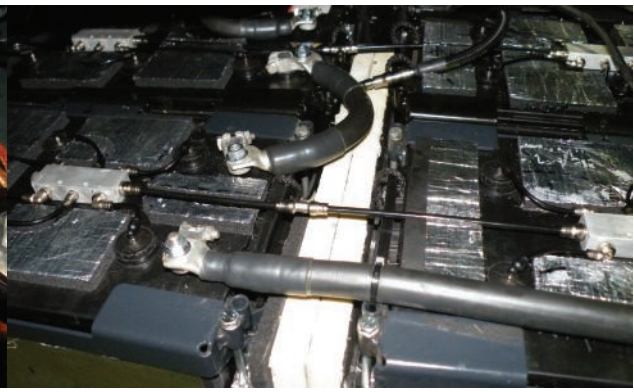
Waterproofing measures

- Sealing or repositioning of all chassis- and bulkhead-mounted ECUs, and replacement or sealing of electrical harness connectors
- Sealing of clutch actuator and gearbox bell housing
- Preparation and sealing of starter motor, alternator and auxiliary belt drive components
- Sealing of all cab structural voids and openings against water ingress – including cab bulkhead, floor, A-pillars, door shells, etc
- Relocation of air intake and filters
- Sealing of intake ducting
- Relocation above water level of breathers for engine, transmission, transfer case and axles
- Sealing or replacing of lamps against water ingress
- Sealing of fuel and AdBlue fillers
- Provision of an escape hatch in the cab roof

Right: The vehicle's alternator has an additional grease nipple and is covered with a protective coating

Far right: The team built in extra battery capacity, before shielding and insulating them





Then there were the door seals – "We smoke tested those"; the engine exhaust – "They were high enough but we remade the flanges to get tighter seals"; and the axle seals – "We sorted those out just by making sure the standard double seal arrangement, with its sacrificial ring, was in good condition". For much of the rest, Pick says coatings of grease and VP90 (a spray used by gunsmiths to preserve firearms in storage) proved the best solution. "VP90 provides a protective skin that self-levels and creeps, if there's any damage," he explains. "So it works very well in this kind of application."

Last but not least, the engineering team had to fabricate an escape hatch – using the optional civilian sunroof moulding mark in the cab as their guide, and expanding to the required MoD dimension with a frame insert.

What about the electronics? Pick reiterates that this aspect was more of a worry, the risk being error codes and limp-home mode being triggered as rising water levels were sensed as unusual conditions. "We tackled that by introducing a gateway ECU to massage signals likely to cause a problem." And he cites signals from the transmission, parking brake and the technician's start-stop button on the side of the engine. "It was all about minimum intervention: you don't want to meddle with a truck's CANbus system too much, if you can help it."

Winterisation

As for the winterisation aspect, the goal in any military vehicle extreme cold conversion project is meeting Def Stan 23-8, which requires vehicles to pass a standardised cold-start test from -40°C, with all systems then operating as they should. Making that possible requires several interventions, explains Pick, including changing all the hydraulics to aircraft hydraulic oil, swapping to aviation fuel on the engine and changing the coolant for almost pure antifreeze. Similarly, the engine and transmission oils need to be upgraded to much lower temperature grades.

That may sound onerous, but he makes the point that this is not about reconfiguring a vehicle to withstand 10 years or 100,000 miles at -40°C. It's about starting at that temperature and then getting

Wading test in action

John Pick, director of Arden Automotive, says that early trials were conducted at the 11th Amphibious Trials and Training Squadron, the Assault Group Royal Marines base at Instow, near Barnstaple in Devon. "We worked up from the standard issue Trakker wading depth of 0.75 metres to 1.5 metres. It's not the same as coming off a landing craft nose-in or catching waves, but it passed after sorting out a few niggles with, for example, the clutch actuator, which turned out to have a broken wire due to a faulty assembly."

However, with confidence in the dip tank rising, the team then had to move on to beach trials. "That was a different ball game," recalls Pick. "We didn't know what the effect would be from other variables, such as waves crashing into the vehicle and sand swirling round the drive seals." But with the beach surveyed and the backup in place, the Trakker was duly driven off the landing craft, front first and into the sea. "It's a really weird feeling, doing that. It's not a nice, gentle slope and every fibre in your body is telling you not to drive that vehicle into the sea."

on with the job as the systems warm through. "For example, although lead-acid batteries die at -46°C, we took the view that it's worth keeping things simple. So our solution was to provide thermal shielding and build in extra battery capacity to make sure the vehicle starts," he explains.

The team also fitted an auxiliary Webasto fuel-burning engine pre-heater, to warm the engine coolant. "The Def Stan allows one hour of preparation before start, so you get the auxiliary heater going to warm the engine and start the cab heater [Eberspächer], too, so that's nice and cosy – well, up to -10°C," he explains. That unit (which also has to survive underwater, albeit with inlet and exhaust caps) sits on the chassis next to the engine block, with its exhaust bathing the starter motor to provide additional heating for this key component, as well as secondary heating for the block and its engine oil.

It's a similar story with the auxiliary equipment hydraulics, although in this case a simple restrictor was enough to generate energy equivalent to 3kW of heating effect. "Even though we are using aircraft-grade hydraulic fluid, you still need to be sure that the pump will run and the viscosity will not be so high that the fluid won't return." Making that work across the anticipated temperature range was about installing a temperature-actuated bypass valve to the restrictor.

Sounds like a lot of intervention? Well it is, but Phil Armes, who owns Semratec and also worked on the Trakker project, makes another powerful point. "Nothing we did changed the standard Trakker tool kits. The cylinder head lifting gear, Iveco Easy diagnostic testing equipment, the Atlas crane diagnostic kit, even the torque wrenches. It's all still standard issue, as used by the armed forces."

But he did, and there the vehicle sat for the mandatory six minutes of punishment (in accordance with Def Stan 00-6), before duly driving out of the sea and up on to the beach. "That was the longest six minutes of my life, but when the time was up, off we drove and on to dry land. No water had come in; the sand hadn't been a problem; and the vehicle systems all worked." Pick admits that one of the Trakkers did go into limp-home mode on its third drive into the sea, but says on that occasion waves were breaking over the tipper body at 2.5 metres.

However, even that didn't quite deliver the final tick in the box. These vehicles might be deployed anywhere in the world and when the time comes for them to go, they might well have to leave by landing craft and ship – with no facilities for washdown. So the rest of the test entails sitting for 28 days with the sand and salt still on them – and then testing for any seized components. "We did have one issue with axle seals after that test," reveals Pick. "But we repeated the test after a rebuild and then we were fine."

Preparing trucks for driving into the sea may not be on everyone's must-do project list, but, with the increasing risk of extreme weather alongside global warming, the market may yet grow – and beyond meeting MOD requirements.

In fact, these Trakkers were on standby earlier this year to help with flood rescue in the south west. So it may not be long before similar trucks are requested by the emergency services around the UK and elsewhere to meet flood response situations. TE

Testing time: cold comfort

There aren't many cold testing facilities capable of taking something a s big as a truck down to -40°C. Arden took its Trakkers to the MoD's former huge Boscombe Down facility, now operated by Qinetiq. This is impressive: the site can test anything from helicopters to trains and trucks from +60°C to -72°C. For cold tests, it pumps liquid nitrogen in vast quantities, keeping going with two tanker deliveries per day – and test pricing reflects that scale of investment.

"You have to 'soak' the vehicle for 24 hours at -40°C, to make sure everything is right down to temperature, before the test can begin. The first time, we had a sticky starter motor, because it was still soaked from the water wading test. But once that was sorted, the Trakker just fired up on the first turn of the key." Note: the Trakkers converted are Euro 4 vehicles, equipped with EGR (exhaust gas recirculation) and SCR (selective catalytic reduction) – so, yes, the AdBlue tank is drained prior to testing.

As for the hydraulics, Phil Armes – former project manager with ALC Vehicles, but contracted to Arden for the Trakker conversion – says that although the correct hydraulic oil didn't arrive at Boscombe Down until just after minimum temperature had been reached, the vehicle still passed. "Containers with standard oil and the cold temperature oil were placed in with the truck to prove that the correct oil would flow. Then the hydraulic system was operated with standard oil to prove that the components withstood the temperature. It worked but, as you would expect, very slowly."