Electric

As increasing numbers of LCVs and PSVs are equipped with hybrid and electric powertrains, engineers and technicians need updating not only on the technologies, but also the maintenance and safety issues. John Challen and Brian Tinham report

Hybrid and electric vehicles (EVs) are fast becoming more familiar sights, so it's obvious that fleet and workshop managers, as well as their technicians, need a good grounding in safe practices and procedures. Less obvious, perhaps, is the point that workers in the emergency services and even drivers also need to be made aware of the risks these machines can present to the unwary.

Eliot Smith, an independent training provider at Pro-Moto Automotive, is good value here. Formerly a technical training co-ordinator with Honda (home to a wealth of experience on alternative drives for passenger cars), Smith more recently headed the team writing national training qualifications for technicians working on electric and hybrid vehicles. He now develops and runs courses for manufacturers, colleges and associations, aimed at everything from full technician certification to raising risk awareness for people using or coming into contact with these vehicles.

"There are several grades of qualifications for IMI [Institute of the Motor Industry] members," explains Smith. "The first is an awareness qualification for those who use electric and hybrid vehicles in their line of work – such as drivers." Courses cover likely hazards in the event of an accident or a system fault, and delegates get a Level One certificate.

"The second qualification is hazard management – developed for the emergency services," continues Smith. "If a hybrid or electric car, or LCV is involved in an accident, the ambulance, police and fire crews – but also vehicle recovery operators – need to be aware of the hazards in handling and moving these vehicles." This course is about explaining the types of hazards and identifying potential risks. It leads to a Level Two qualification.

Then there are two further certification grades, designed for technicians and covering respectively routine maintenance or repair of hybrids and EVs – the latter necessarily including removal and replacement of high-voltage components. Both of these are Level Three qualifications.

"If something goes wrong, technicians need an in-depth understanding of the technologies. They also need to know how to establish where the fault might lie, bearing in mind that there are engine management units, but also HV [high voltage] systems and different diagnostic equipment. Most importantly, they need to be apprised of the risks," states Smith.

Left: Delphi inverter, converting dc from the battery into ac for the traction motor – must be treated with extreme caution

Above: Mercedes-Benz new Hybrid Fuso Canter truck power pack (page 23)

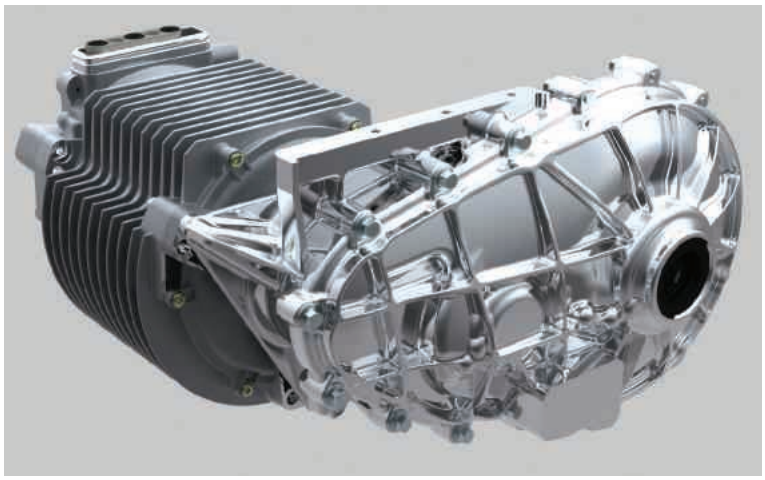
Hidden dangers

"So for Level Two and Three qualifications, we essentially identify how hybrid and electric vehicles work, and the kinds of voltages they operate at," he continues. "Beyond that, we also explain some of the less obvious risks – not just the electrical hazards, but also mechanical and the possibility of combustion."

Smith gives the example of a potential for damaged or ageing batteries to become unstable. At the most basic level, he also warns that batteries are likely to be fully charged and hence dangerous, even if a vehicle is switched off. "Most manufacturers follow standard shutdown procedures, but capacitors can retain very high charges for some time and batteries always have significant potential across them – so there are very real and present dangers," he warns.

"If technicians are working on the HV side of a vehicle, it's because there's a fault," he observes. "And, unlike with internal combustion engines, you can't hear, smell or see a problem with the electrics until it's too late... Remember, these batteries deal in dc [direct current], and capacitors can discharge very quickly and at very high voltages. It only takes 50 milli Farads to kill you."

As a result, in large part, EV certified training



Above: The latest Vocis-Zytek electric powertrain: a combined single speed gearbox and traction motor

engineering

relates in large part to taking common sense precautions – using the correct PPE (personal protective equipment) and ensuring that operatives are protected throughout repair and maintenance operations. However, they also cover the importance of checking that no HV hazards are left on a vehicle that might cause a problem for its users.

Most important, says Smith, the courses look at risks associated with electric motors themselves. "All hybrids, even fuel cell types, use electric motors and these are very powerful. They can accelerate very quickly and deliver very high torque, even at low speeds. They also use powerful rare earth magnets. So, for example, if a technician has a pace maker, they can seriously affect him or her."

But perfectly healthy people can get hurt, too. "I know of one guy who lost the tops of his fingers... And bear in mind that electric motors can also become HV generators, if they're turned over. There won't be any warning."

Smith adds that similar caution is required around stop-start systems. "If an engine is switched on, but not running, it can spring back to life very fast. So when technicians are working on vehicles with these systems, they need to be aware and restrict access. That's especially the case, if they're testing and running up an engine."

What's more, there are fire hazards around EV batteries. "Li-Ion cells can be dangerous. They get very hot and produce hydrogen. It's very easy to be blasé around engines – until something goes wrong. The fact is that, with EVs, if something goes wrong, the risks go up exponentially... It's like anything: if you're aware, then you can minimise the dangers. If you're not, then you have no idea of the risks you're exposing yourself and others to." TE

Good vibrations?

Potentially groundbreaking work on electric and hybrid batteries is being carried out at Millbrook Proving Ground, aimed at improving their vibration resistance, and so reducing repair and warranty issues for operators and manufacturers alike.

"We were asked by a customer for some consultancy on how best to test EV batteries for vibration durability," explains Jim Hooper, senior engineer in Millbrook's component test laboratory. "We did some background research and found little published data for electric vehicles."

Closer inspection uncovered some standards and an ECE regulation on the horizon that will make vibration testing a legal requirement for EVs. "But the data was derived from ICE [internal combustion engine] products, which have very different vibration characteristics," states Hooper. He also reveals that, in some cases, data had been taken from consumer electronics studies, aimed at abuse testing. Using this as a baseline might well lead to over-engineered batteries, he says, with all that means, in terms of cost and weight.

Millbrook's solution has been to borrow some electric vehicles and evaluate the battery packs, comparing their behaviour against ICE-powered vehicle equivalents. "We found that, even in an EV battery pack, there is some powertrain-induced vibration," he says. "We also found some high energy vibration spikes above 300Hz on some of the vehicles' batteries.

"This is an area we are still researching, but we believe it is associated with the different battery cooling strategies." Other possibilities include the power electronics and electric motors.

The next step will be to determine the most effective vibration isolation methods. And it's not just about the motor and battery mountings. "The cooling strategy also has an effect on the vibration durability of the [battery] pack," explains Hooper, who says that results will be made public in due course.