



**Andrew Nicol:**  
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# Emissions engineering

The thorny issue of Euro 6 was addressed by Andrew Nicol, technical specialist for heavy-duty engines at Ricardo, who led a panel of experts from Cummins, Delphi Diesel, Iveco and Scania. Ian Norwell reports

Anyone who imagined that the operational issues around the impending Euro 6 emissions regulations for heavy-duty vehicles were a done deal would be wrong. While the pollutant limits themselves are well known, the IRTE 2012 Conference heard that the working realities for operators, their workshops and the manufacturers can vary considerably, according to factors that include each truck's duty cycle.

Indeed, it appears that Euro 6 engine designs, and the implications of the new legislation, will introduce yet more variables – quite apart from choosing which trucks to buy – making a transport engineer's task even more akin to playing three-dimensional snooker. That's why the Euro 6 session expert panel was populated by a pair of truck makers, a loose engine manufacturer and a fuel systems developer, led by Andrew Nicol (left), technical specialist on engine performance and calibration for Ricardo.

Nicol set the scene, reminding delegates of the upcoming strictures of Euro 6 (64/2012, 582/2011 and 595/2009). The reductions from existing Euro 5 levels amount to a further 80% cut in NOx and a 50% reduction in particulates, he explained. A new NH<sub>3</sub> (ammonia) limit also comes in and particulates get screened for number, as well as mass.

This latter requirement has made a DPF (diesel particulate filter) inescapable for all truck makers, and the addition of these devices alone means increased manufacturing costs. Add to that a technical requirement for SCR (selective catalytic reduction) and, in most cases, EGR (exhaust gas recirculation), and it's not difficult to see why heavy-duty truck purchase prices will have to rise considerably.

However, these are just the starting points. There are other forces, too – such as taking into account the impact of duty cycles on in-service monitoring for emissions compliance. As part of this, manufacturers will have to shoulder a new responsibility – to prove their technologies' effectiveness in-situ. That means: centralised auditing of service records for emissions system failures, and PEMS (portable emissions measurement systems) to check engines in-service.

## **Wear and tear**

Often forgotten in the hunt for fuel economy is engine longevity. As more and cleaner energy is squeezed out of smaller engines, operating at ever-higher injection and combustion pressures, are we asking too much? Evidence from the truck makers would seem to say 'no'. Cylinder heads cast from CGI (compacted graphite iron), capable of handling the 200 bar cylinder pressure, and lighter composite camshafts that cut rotating mass, are just two innovations, they say, designed to help.

That said, the Euro 6 regulations will require manufacturers to determine 'deterioration factors' to ensure that engines stay compliant within a certified tolerance over their 'useful lives' – with N2 and M2



Mark Graham

class vehicles given a six-year and 300,000km lifespan, and N3 and M3 classes seven years and 700,000km. Many OEMs' unofficial estimates go beyond these limits and component suppliers in the firing line are working hard, too.

Mark Graham, chief designer for Delphi Powertrain Systems, said that, despite truck makers only recently declaring their technology preferences for Euro 6, his company has developed fuel equipment that will work at injection pressures of 2,700 bar, with a 3,000 bar headroom to make them future-proof. Delphi has also made every effort to provide 'plug and play' capability, with its systems designed to be bolted onto existing cylinder head variants, to avoid engine makers going back to the drawing board.

Meanwhile, loose engine suppliers – which have to do rather more than design their powerplants simply to slip between several sets of OEMs' chassis rails – have also been hard at work. Jonathan Atkinson, chief engineer for product development at Cummins, said that most of his organisation's problems come from system integration issues that have to do with transmission, on the one hand, but duty cycles on the other. And Euro 6 has been challenging.



Jonathan Atkinson

### EGR versus SCR

As for the unseemly spats between truck makers over which of the apparently competing technologies they were espousing for Euro 5, well they are now yesterday's fish-and-chip wrappings. Conference was told that the industry has all but come together with a 'standard' approach that now combines SCR and EGR to meet Euro 6 emissions requirements – although specifications and designs are anything but standard. That said, the single exception is Iveco, which is ploughing its own furrow with a refined and highly-tuned package that depends on SCR alone.

Iveco's UK product director Martin Flach defended his company's position by pointing to its truck markets and duty cycles, which, he insisted, favour the SCR-only approach. "Duty cycles are critically important," he stated. "Not all operators will have the luxury of being able to keep temperatures down, for example, with low-stressed motorway work."

Transport engineers need to understand the impact of their proposed duty cycles, he asserted, if they want to determine optimal engine technologies at Euro 6. His point: it's not just about deviations from the maker's quoted usage of AdBlue – which will also vary according to duty. Yes, Iveco will pay a penalty on AdBlue, but the OEM expects to more than win that cost back on fuel – although only tens of thousands of km in service will confirm its hopes.

And it's worth noting that duty cycles will also have an impact on DPFs, with soot forcing regeneration more frequently on vehicles running in urban operations than the motorway cruisers. Further, all OEMs confirm that thermal management will be crucial to making SCRs and DPFs operate efficiently.



Martin Flach



Martin Jonsson

The good news, however, for fleet engineers is that the hard work has been done by the truck and engine manufacturers – so workshops will not need to change significantly. That's in part because of the array of sensing and control equipment designed both to keep emissions optimal and to provide diagnostics, if it doesn't. In Scania's Euro 6 R-series, for example, there's an upstream NOx sensor, DOC (diesel oxidation catalyst), full-flow DPF, AdBlue mixer, twin parallel SCR catalysts, ASC (ammonium slip catalyst) and a downstream NOx sensor. Temperature is measured all the way up to the catalysts and the pressure drop across the DPF is monitored to assess filter status.

Here lies a potential niggle for fleet engineers, though. As mentioned above, the particulate filter will need to be cleaned at intervals corresponding to the truck's duty cycle. As has been found in some PSV (passenger service vehicle) applications, a stop-start regime – or any departure from long-haul work – stresses the system. So care may be needed to avoid a build-up of ash that could overtake the capacity of the regeneration process.

Nevertheless, in response to a question from the floor on whether Euro 6 will impact technicians in this respect, Scania's head of engine optimisation Martin Jonsson said simply: "Not really." This is broadly true, but the issue of DPFs will need addressing and it is expected that a service exchange network will develop, as DPF cleaning is not a swift affair – although low ash oils will make a difference.

### Bio hazard

What about biodiesel? Its use with Euro 6 engines certainly found little support among the expert panel. Iveco's Flach was particularly disparaging, referring to "cooking oils brewed up in garages". It appears that the complexity and refinement of Euro 6 equipment and its myriad sensors have left anything cruder than current major biodiesel grades behind.

Few manufacturers are now happy to venture beyond a 7% bio blend with Euro 6, even if they had been happy with higher concentrations at Euro 5. Daimler has already declared that up to a "100% blend" could have been used at Euro 5, but with the very strong caveat that service intervals and oil change frequency would be dramatically, and adversely, affected.

As a parting shot, the issue of 'what after Euro 6?' was raised, with the consensus being that the EU's guns will soon be turned on carbon dioxide. That said, the panel was unanimous in condemning the current approach taken to carbon emissions with vans – which essentially mimics that used for passenger cars. Given the key variability of payload (which makes the existing measure meaningless), the experts indicated that a new CO<sub>2</sub> protocol for commercial vehicles that recognises actual work done per km must be introduced.