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**EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT  
COUNCIL OF MINISTERS**

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**Council of Ministers**

**TRANSPORT AND ENVIRONMENT**

**NO<sub>x</sub> EMISSIONS: ENSURING FUTURE EXHAUST EMISSIONS REGULATIONS DELIVER AIR  
QUALITY STANDARDS**

**Conclusions and Recommendations**

*This document was examined under item 4.2 "Sustainable Transport Policies - Specific Topics: Transport and Environment" of the Agenda for the Dublin Council of Ministers.*

*Ministers noted the conclusions and recommendations and requested that the Secretariat transmit the report to the UN/ECE with a request to expedite deliberations on improved vehicle certification tests for NO<sub>x</sub> emissions for adoption world-wide.*

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## **NO<sub>x</sub> EMISSIONS: ENSURING FUTURE EXHAUST EMISSION LIMITS DELIVER AIR QUALITY STANDARDS**

### **CONCLUSIONS AND RECOMMENDATIONS**

- Paper limits* In order to improve air quality, the pollutant exhaust emissions of road vehicles are limited by regulation. Regulatory limits apply to exhaust emission measurements during vehicle type approval procedures<sup>1</sup>. Over the last two decades limit values were lowered in steps from EURO 0 to EURO 4. Further steps have already been defined for the coming years (EURO 5) or are under discussion (EURO 6).
- Polluted air* Air quality, however, has not improved as much as predicted with the tightening of emissions standards, especially in respect of nitrogen oxides (NO<sub>x</sub>). One reason for this is the gap between the performance of emission control measures during type approval tests and their effectiveness under real operating conditions.
- Passing tests* The gap between the exhaust emissions during type approval and during in-use operation arises in three ways:
- Cycle by-pass measures used by the manufacturer in order to pass the type approval tests but achieve better fuel efficiency or other performance enhancement at the cost of higher emissions during in-use operation;
  - On-board diagnostic systems (OBD) related gaps;
  - Driver behaviour related gaps.
- Cycle by-pass measures are not so much an abuse of the regulations as a weakness of the testing system and the design of regulations. The main avenue open for improving regulations is to modify test cycles to mirror real world driving more closely. Whilst tests can only ever be a rough approximation of the real world, improved test cycles that do not entail unreasonable costs have been developed. These should now be deployed.
- Cars* For cars, introduction of an in-use compliance test using real world driving cycles in addition to the current test<sup>2</sup> is recommended. The common Artemis driving cycle (CADC), developed under a European Union research programme, could be used for this. In the long term, the main test should be replaced by a more realistic driving cycle that better reflects real world driving.

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1. Type-approval certification is obligatory for any vehicle to be sold in or imported into the EU.  
2. The current test is known as the New European Driving Cycle (NEDC).

- Vans* For light duty commercial vehicles the same results apply with an additional dimension. There are currently two routes for type approval, with some vans following a vehicle testing procedure as for cars, and others following an engine testing procedure, as used for trucks. In simulated real world driving conditions, those certified following the second approach perform worst, especially in urban driving conditions. It might be appropriate therefore that in the future all light duty commercial vehicles follow vehicle rather than engine testing procedures<sup>3</sup>.
- Trucks* For heavy duty vehicles the main gap with respect to cycle by-pass measures is the ability to design the power-train of a vehicle in such a way that the most frequently used engine speed range lies outside the range currently tested for type approval. This particularly concerns the performance of engines under high load at low speed – typical of acceleration in stop-go traffic. Excess emissions are therefore to be expected in urban areas. Better tests, which cover a more representative range of engine operating conditions, have been developed<sup>4</sup>. A political decision to substitute these for the existing tests is now required.
- Non-exceedence testing* In the longer term, the most promising answer to deficiencies in emissions tests is to switch to a “non-exceedence” approach to testing, rather than modifying test cycles repeatedly. This would provide for emissions to be tested at any feasible engine operating point (any combination of engine speed and power) against a threshold for emissions that must never be exceeded. This would mark a break in the progressive tightening of the limits specified under conventional emissions regulations. A working group has been established by the Working Party on Pollution and Energy of the World Forum for Harmonization of Vehicle Regulations (WP29) at the UN ECE to establish guidelines for heavy duty vehicle regulations following a non-exceedence approach. Europe, Japan and the USA are represented in this group. Work on passenger cars may follow at a later date.
- AdBlue* Some approaches to limiting emissions are more vulnerable to by-pass, and more dependent on on-board diagnostic systems than others. Different approaches are available to meet EURO 4 and 5 NO<sub>x</sub> standards for heavy duty vehicles. Some rely on a combination of modifications to engine design and a passive catalyst in the exhaust system. Others rely instead on injection of an ammonia solution (marketed in Europe under the name AdBlue) into the exhaust gasses<sup>5</sup>. The tank for this catalyst solution needs to be filled at regular intervals. Running out of additive has no impact on

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3. Under the procedures of Directive 70/220/EEC.

4. WHSC (worldwide heavy duty diesel engine stationary test cycle) and WHTC (worldwide heavy duty diesel engine transient test cycle), developed under the umbrella of the GRPE (Working Party on Pollution and Energy of the United Nations Economic Commission for Europe) and its WHDC (worldwide heavy duty diesel engine certification procedure) subgroup.

5. An emission control approach known as selective catalytic reduction (SCR).

driving performance but a disastrous effect on NOx emissions, which can exceed EURO 1 levels. A sophisticated diagnostic and vehicle immobilisation system therefore has to be developed to ensure this does not happen on the road. Such systems are currently under development in Europe, but not yet proven. Regulators in the USA appear unlikely to permit this approach to controlling emissions while the uncertainty over guaranteeing on-road performance remains.

*Political decision*

To conclude, there are a number of factors that may explain why air quality, particularly in urban areas, has not improved as predicted with the tightening of emissions limits. Pollutants may travel further and disperse in more complicated patterns than was believed. Air quality monitoring equipment measures NO<sub>2</sub>, with total NOx levels interpolated from the results. Recent NOx oxidation catalyst exhaust treatment systems convert some NO into NO<sub>2</sub> and this may somewhat inflate ambient NOx level estimates compared the actual overall level of NOx in the air. Whilst more research into the part each of these factors plays would be useful, the fundamental reason for the gap between regulatory standards and air quality appears to lie in the design of NOx emissions regulations and in particular in the failure of vehicle type-approval tests to cover the range of engine operating conditions most frequently encountered in real world driving conditions. This applies especially to the conditions prevalent in urban areas. This is precisely where air quality is most critical and the costs of air pollution highest. Improved tests have been developed by the UN ECE and under EC research. Industry faces costs to adapt to new tests, even if these costs are likely to be modest, and can not therefore be expected to drive the process of improving emissions regulations without political direction. A political initiative is now required to make the change to the improved tests already available and to signal a switch in the longer term to a better, non-exceedence approach to regulation. Above all industry requires predictability in the way regulations will develop.

*Costs and Benefits*

Cost benefit assessments for new regulatory standards ought to include consideration of the impacts of moving to an alternative non-exceedence approach for NOx emissions control.

*Risks*

Ministers need to be aware of the risks that arise from the shortcomings of current emissions tests and uncertainty over the on-road performance of some new NOx emissions control systems for trucks. These risks have a bearing on the use of incentives for the purchase of new "clean" vehicles. NGO's and environment agencies have questioned the legality of incentives created through differentiated rates of circulation taxes and road charges, to promote "clean" Euro 2 and 3 vehicles. Similar challenges could arise over Euro 4 and 5 vehicles and particularly those that require exhaust after-treatment involving injection of a catalyst solution into the exhaust.