Comparative study of US and EU vehicle emissions legislation

EMIS Committee meeting

5 December 2016
Outline

1. Current legislation on emissions limits and its development over time
   - EU
   - US
   - Technology Response

2. Defeat device legislation

3. How do approval systems work
   - EU
   - US

4. Enforcement systems
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   - US

5. Conclusions and Recommendations
1. Current legislation on emissions limits, and how it developed over time

<table>
<thead>
<tr>
<th>Emissions standards for pollutants (g/km)</th>
<th>US</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen oxides (NOx)</td>
<td>0.04</td>
<td>0.06/0.08*</td>
</tr>
<tr>
<td>Non-methane organic gases (NMOG)</td>
<td>0.06</td>
<td>0.07/na*</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>2.61</td>
<td>1.0/0.5*</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂, in 2016)</td>
<td>155</td>
<td>130</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂, in 2020)</td>
<td>132</td>
<td>95</td>
</tr>
<tr>
<td>Form of vehicle emission testing</td>
<td>FTP</td>
<td>NEDC</td>
</tr>
</tbody>
</table>

*Petrol / diesel standards
Federal Test Procedure (FTP)
New European Driving Cycle (NEDC)

<table>
<thead>
<tr>
<th>US</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-certification for safety regulations</td>
<td>X</td>
</tr>
<tr>
<td>Type-approval for safety regulations</td>
<td>X</td>
</tr>
<tr>
<td>Government or government-approved labs used for all testing</td>
<td>X</td>
</tr>
<tr>
<td>Type-approval for emissions</td>
<td>X</td>
</tr>
<tr>
<td>Mutual recognition of regulations by other countries</td>
<td>X</td>
</tr>
<tr>
<td>Government sets fleet fuel economy standards</td>
<td>X</td>
</tr>
<tr>
<td>Government sets fleet CO₂ standards</td>
<td>X</td>
</tr>
<tr>
<td>Fuel economy standard (miles/ gallon)</td>
<td>34.1</td>
</tr>
<tr>
<td>- in 2016</td>
<td>n/a</td>
</tr>
<tr>
<td>- in 2020</td>
<td>n/a</td>
</tr>
<tr>
<td>Government sets emissions standards</td>
<td>X</td>
</tr>
</tbody>
</table>

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Current EU limits

- Regulated by:
  - “Euro emission standards” as set out in the EU framework for the type approval of cars, vans, trucks, buses and coaches (Directive 2007/46/EC)
  - Regulation 715/2007 (EC) on emissions from light passenger and commercial vehicles, and subsequent amendments. Regulation (EC) 715/2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information

- For light duty vehicles (cars and vans), the current standards are Euro 6. These standards, which were established in 2014, set the emission limits for cars for regulated pollutants, in particular nitrogen oxides (NOx, i.e. the combined emissions of NO and NO₂) of 80mg/km for diesel, and 60mg/km for petrol.

<table>
<thead>
<tr>
<th></th>
<th>CO</th>
<th>HC</th>
<th>HC + NOx</th>
<th>NOx</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compression Ignition (Diesel)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>-</td>
<td>0.17</td>
<td></td>
<td>0.08</td>
<td>0.005c</td>
</tr>
<tr>
<td><strong>Positive Ignition (Petrol)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>0.10a</td>
<td>-</td>
<td></td>
<td>0.06</td>
<td>0.005b,c</td>
</tr>
</tbody>
</table>

a. and NMHC = 0.068 g/km
b. applicable only to vehicles using DI engines
c. 0.0045 g/km using the PMP measurement procedure

- The stringency in practice of the emissions standards set out in EU legislation is significantly dependent on the process and test regime for type approval
Development of EU emissions limits

1980s
• Public pressure in some MSs required greater action tackling acidification and other air quality issues, although this was opposed by other MSs
• A Commission proposal for a strengthening of standards was tabled in 1984.
• Follow-up legislation on second-stage reductions for small cars was adopted in 1989 in Directive 89/458/EEC which included more stringent standards for CO, HC and NOx
• Initial regulations implemented in response to Germany & France adopting legislation inspired by US standards.
• Introduced to ensure that MS measures relating to the safety and local environmental impacts of vehicles did not disrupt the internal market
• Non-compliant vehicles continued to be manufactured for use in individual MSs

1990s
• Timing of new standards’ implementation became compulsory from 1992
• All new-model cars were required to meet Euro 1 standards from 1992 (Directive 91/441/EEC)
• Further improvements in legislative standards in the following years focused in particular on cleaner fuels (Directive 98/69/EC) which introduced standards for cold starts and the use of on-board diagnostics

2000s
• Establishment of Clean Air for Europe (CAFE) programme
• Adoption of the Commissions thematic strategy on air pollution in 2005, which concluded that further emissions reductions were required.
• Work started on the development of Euro 5 and 6 standards for cars and vans

1970
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1992
Euro 1

1996
Euro 2

2005
Euro 4

2009
Euro 5

2014
Euro 6
Development of EU emissions limits (2)

Legislation on GHG emissions

• A voluntary agreement was reached in 1998 in efforts to reduce CO$_2$ from passenger cars. The industry committed to reduce average CO$_2$ emissions from all new cars to 140 g/km by 2008. While some progress was being made, manufacturers collectively were failing to meet their commitments.

• In 2009, mandatory CO$_2$ standards for all new passenger cars were introduced (Regulation 443/2009/EC), which established a 2015 target of 130 g/km for the fleet average of all manufacturers combined. Individual manufacturers were allowed a higher or lower CO$_2$ emission value depending on the average vehicle weight of their fleet i.e. the heavier the average weight of a manufacture’s cars, the higher their CO$_2$ allowance.

• Legislation was also developed to provide buyers with information on the fuel economy and CO$_2$ emissions of new cars at the point of sale. The EU Car Labelling Directive (Directive 1999/94/EC) requires each Member State to ensure that a label on fuel economy and vehicle emissions is easily available and accessible to consumers when buying a new car.

• At the end of 2013, the European Parliament and EU Council agreed on further proposals for mandatory CO$_2$ 2020 emissions targets whereby passenger cars are set at 95g/km and light commercial vehicles are 147g/km. 100% implementation is required by 2021.

• Beyond 2020, an initial target range of vehicle CO$_2$ emissions was recommended at 68-78 g/km for 2025.
Current US limits

- US legislation on air quality and vehicle emissions is a combination of federal law, and stricter Californian standards, which may also be voluntarily applied by other states.
- Regulations were introduced and developed in order to limit the emissions of certain air pollutants from stationary and mobile sources in order to protect human health and wellbeing as well as the environment.
- US and Californian standards applied equally to diesel and petrol vehicles
- Standardised testing procedures using the Federal Test Procedure (FTP) with additional supplemental testing to test various driving scenarios.
- There are a set of standards of varying stringency against which manufacturers can choose to certify their vehicles. A manufacturer’s fleet must steadily increase the proportion of their marketed vehicles which comply with the more rigorous categories throughout the phase-in period.

Current Emissions Standards in the US (g/km)

<table>
<thead>
<tr>
<th>Standard</th>
<th>Date of Adoption</th>
<th>Implementation Period</th>
<th>NMOG + NOx</th>
<th>PM</th>
<th>CO</th>
<th>HCHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>California LEV III (LEV 160)</td>
<td>2012</td>
<td>2015-2025</td>
<td>0.099</td>
<td>0.006</td>
<td>2.61</td>
<td>0.003</td>
</tr>
<tr>
<td>Federal Tier 3 (Bin 160)</td>
<td>2014</td>
<td>2017-2025</td>
<td>0.099</td>
<td>0.002</td>
<td>2.61</td>
<td>0.003</td>
</tr>
</tbody>
</table>
Development of US emissions limits

Throughout the development process of auto emissions legislation in the US, California has been a driver of innovation and change, typically producing more stringent standards at an earlier period in time than the EPA.

1950s
- In an effort to curb air quality related health issues, California developed auto emissions legislation in 1950.
- In 1955 the Air Pollution Control Act was passed at the federal level.
- In 1959 the Motor Vehicle Pollution Control Act was passed in California.

1960s
- In 1963 the Clean Air Act (CAA) was passed at the federal level.
- In 1965 California implemented vehicle emissions standards.
- In 1968 Congress adopted California’s 1965 standards at a federal level.

1970s
- In 1970 amendments to the CAA that introduced regulatory control for air pollution and stricter federal enforcement
- The Environment Protect Agency (EPA) was established
- More amendments to the CAA were made in 1977 which placed a greater emphasis on long-term maintenance of emission standards

1990s
- Further amendments were made to the CAA in 1990 that led to the introduction of the federal ‘Tier 1’ standards which applied to all new light-duty vehicles weighing less than 8,500lbs.
- 1999 saw the adoption of federal ‘Tier 2’ standards which were more stringent than preceding standards and included standards for medium-duty passenger vehicles.

2014
- Tier 3

2012
- LEV III

1990
- LEV
- Tier 1
- LEV II & Tier 2
Development of US emissions limits (2)

Legislation on GHG emissions

- Focus on CO$_2$ emissions standards didn’t begin until 2007 when the US Supreme Court ruled that it was a pollutant covered by the CAA and therefore falling under the jurisdiction of the EPA due to their management of vehicle emissions.

- By 2010 standards for CO$_2$ emissions were introduced by the EPA and the National Highway Traffic Safety Administration that would apply to fleets of vehicles manufactured from 2012. Emissions standards for CO$_2$ are dependent on the size of the vehicle i.e. the larger the vehicle, the larger the permitted emission level.

- By 2016, fleet averages of CO$_2$ emissions must not exceed 155g/km (with standards getting increasingly more stringent, starting at an upper limit of 183g/km CO$_2$ in 2012).

- Projected fleet wide CO$_2$ emission standards for 2017-2025 range from 151g/km in 2017 to 101g/km in 2025.

- Flexibility is allowed regarding averaging, banking and trading of GHG emission credits and deficits.
Technology responses to emissions limits

Increasing stringency of emissions standards has gradually forced manufacturers to apply more sophisticated engine control systems, calibration strategies and after treatment technologies. One downside of many emission-reduction technologies is the trade-off with fuel efficiency. This trade-off leads to an incentive for manufacturers to calibrate their engines towards low emissions during the test cycle but not in real driving conditions so as to improve fuel economy.

- **Diesel engine management** - changing the timing of the fuel injection to influence NOx emissions i.e. late injection reduces the engine-out NOx emissions
- **Exhaust Gas Recirculation (EGR)** - recirculating some of the exhaust gas back into the engine → less oxygen available in the cylinder for combustion, → leading to a lower combustion temperature → less NOx production.
- **Lean NOx Trap (LNT)** - a catalytic converter that combines an oxidation catalyst and a reduction catalyst...NOx is desorbed and reduced to nitrogen. Reportedly capable of reducing NOx by 70 to 90%.
- **Selective Catalytic Reduction (SCR)** - a catalytic converter reduces NOx to nitrogen that can achieve conversion rates of up to 80-95%. Unfortunately, the catalyst operates at a high temperature so it does not work until the engine is warmed up or potentially during short trips with low engine loads and frequent stops.
- **Diesel Particulate Filter (DPF)** – a filter that physically traps solid particulate matter from the exhaust gas, including fine particles. The particulate reduction rates of DPFs are high, reportedly at least 90-95%.
- **LNT + SCR** - Increasingly, SCR and LNT technologies are combined in high-spec diesel cars to take advantage of the best operating characteristics of both.
2. Rules on defeat devices

• Defeat devices forbidden in both US and EU, with almost identical definitions of:
  – Defeat device
  – Permitted derogations

• US legislation: “Defeat device means an auxiliary emission control device (AECD) that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use”

• EU legislation: “any element of design which senses temperature, vehicle speed, engine speed (RPM), transmission gear, manifold vacuum or any other parameter for the purpose of activating, modulating, delaying or deactivating the operation of any part of the emission control system, that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use”
Rules on defeat devices (2)

- Exceptions to the ban on defeat devices
- Both the EU and US legislation allow for the use of defeat devices where “the need for the device is justified in terms of protecting the engine against damage or accident and for safe operation of the vehicle” (US legislation)
- Also allowed where it “does not function beyond the requirements of engine starting”
- Also allowed where the conditions are included in the test procedures.
- US legislation also provides exemptions for emergency vehicles
3. Legislation on approvals systems: EU

- Type approval is applied by Member State authorities to certify that a model of a certain vehicle (or a vehicle type) meets all EU safety, environmental and production requirements before authorising it to be placed on the EU market. It focuses on pre-market compliance checks, on the basis of testing a sample vehicle.
- The type-approval process consists of various types of approval, including approval for individual components, system approvals, and then finally Whole Vehicle Type-Approval (WVTA). 
- Type approval process:
  - Manufacturer application for type approval & initial Conformity of Production (CoP) assessment
  - Testing process
  - Submission of documents
  - Granting of the EC WVTA & concluding CoP arrangements
  - Vehicle registration & continued CoP verification
  - In-service conformity (ISC).
- There are a number of concerns about the effectiveness of the system, including weaknesses in the identification and follow-up of discrepancies between emissions assessed at type approval and the subsequent performance of vehicles in use.
- Observers have pointed out that there is significant flexibility for a manufacturer to choose a regulator to suit its needs best.
- Each EU Member State has its own designated type-approval authority; the way in which the authorities are structured, including their funding, vary significantly between Member States.
- For a manufacturer to obtain and maintain the CoP certificate throughout the production phase of a vehicle, it must demonstrate that each vehicle is manufactured in accordance with the approved specifications.
- Although defeat devices are banned in the EU, applicable regulations do not explicitly define any procedure that require manufacturers to disclose the use of defeat devices.
Legislation on vehicle approvals: US

- US system does not have a direct equivalent for type approval, but its approach to certification of vehicles has a similar effect.
- EPA specifies a set of standards, categorised according to vehicle type/weight or by manufacturer selection, which must be adhered to in order for vehicles to reach the marketplace.
- The EPA administers a certification programme, through various stages of testing (pre and post production), to ensure that every vehicle introduced to market complies with emission standards.
- To gain a CoP certificate, a manufacturer’s application must include:
  1. A description of the vehicle or engine that is to be approved with specifics about the engine itself, the emission control systems and fuel components;
  2. A detailed description of any Auxiliary Emission Control Devices (AECD); and
  3. A detailed explanation as to why each AECD, if any, is present that might reduce the efficacy of the vehicle’s emission control systems.
4. Enforcement systems in the EU and US

EU

• In practice, there has been limited EU-level oversight of the work of TAAs to ensure approvals are issued correctly, in accordance with EU law and to a consistently high standard
• As there is no independent EU-wide authority which validates in-use performance, the EU system relies on Member States’ willingness to introduce systems for surveillance
• High level of conflict of interest
• Enforcement of CO₂ legislation is more straightforward, with a system of fines on a sliding scale based on vehicle performance and sales. This is soon to change to a flat fine of €95 per vehicle per g/km exceeded.

Example of Enforcement

Following the initial investigation into Volkswagen in the US in 2015, and inquiry was launched into the manufacture in the EU. Measurements conducted on VW Group vehicles were able to show the effect of the unlawful defeat device on NOx emissions. Whilst the manufacture has justified the lawfulness of the device, the Commission of Inquiry of the BMVI has doubts regarding these claims.
Enforcement systems in the EU and US (2)

US

- US system is relatively extensive, with rules on in-use testing that is to be conducted by both manufacturers and the EPA at various stages
- Relatively extensive “inspection and maintenance” programmes, based on random sampling of vehicles meeting a specified mileage
- Inspections of manufacturing facilities, emissions laboratories, dealerships and suppliers of vehicle and engine parts
- The EPA can issue administrative and civil penalties in cases of non-compliance, such as up to $37,500 per non-compliant vehicle.

Example of Enforcement

A recent example of enforcement of the standards used to regulate automotive emissions is the 2016 complaint against Volkswagen who sold around 600,000 diesel vehicles that did not meet the standards, therefore invalidating their Certificate of Conformity. A partial settlement has been reached requiring the recall of at least 85% of these vehicles from the market by mid-2019, the payment of $2.7 billion to mitigate any issues caused by the additional NOₓ emissions and allocation of $2 billion to the promotion of ‘zero emission vehicles’. In contrast, enforcement in the EU, by the German TAA, has yet to impose any penalties.
Conclusions and recommendations (1)

Conclusions

• The **US system** for **implementation and enforcement of emissions standards** for new vehicles, and for the **ban on defeat devices** is significantly **more stringent, coherent and comprehensive** than that of the EU system.

• This is partly due to existence of the EPA as a **single federal regulator**, whose **primary purpose** is the **protection of the environment and human health**;

• Also linked to **significant uncertainty in practice** about both the reach and the enforcement of the **EU legislative ban on defeat devices**.

• **EU legislation** is more adapted to **ensuring that Member States do not discriminate against manufacturers from other MS**, than to **ensuring that emissions reductions are achieved**.

• **Type approval authorities** have either been **insufficiently interested in pursuing discrepancies**, or **hesitant about entering into legal cases** with often well-funded and influential businesses.

Recommendations (1)

• Ensure **oversight by organisations that have environmental protection as a priority** (alongside other tasks such as the implementation of standards and vehicle safety)

• A **significant enhancement in the transparency** of the type approval system ensuring that test results and other information is made publicly available
Conclusions and recommendations (2)

Recommendations (2)

• Introduce a system of allocation of type approval decisions to type approval authorities to minimise bias and conflict of interest i.e. based on an assessment of the most effective and appropriate allocation, rather than on the preference of the manufacturer.

• Current flexibilities for manufacturers to choose which vehicles are tested should be reviewed, and curtailed where possible.

• Require manufacturers to declare the full list of the auxiliary emissions control devices used together with the rationale and explanation for each, in line with the US system.

• Implement clear rules obliging competent authorities to investigate any cases that come to their attention of discrepancies between test data and real-world performance.

• Clarify that any type approval authority may initiate action against a manufacturer it suspects of transgressing the ban on defeat devices.

• The Commission should be given enhanced powers to monitor performance of Type Approval Authorities, and withdraw authority to issue TA in cases of poor performance.

• Implementation of random sampling and testing of vehicles on the market by TAAs or other environmental bodies and pursuing any discrepancies.

• Require the reporting of direct real-time emissions data from on-board systems on a sample of vehicles, throughout their lifetime, to provide further evidence of any discrepancies.