In-Use Emissions Testing in the New and Future European Motor Vehicle Emissions Regulations

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End 90s until 2003: US-EPA first rules and preliminary instrumentation developments

In Europe:

- 2004-2005: Feasibility of PEMS to check the conformity of heavy-duty engines
- 2007 to 2008: Heavy-Duty PEMS Pilot program
- 2010: Publication of the PEMS based In-Service Conformity provisions for the future EURO VI standards, (also applicable for EURO V engines)
- 2010(-2012): Non-Road Mobile Machinery PEMS Pilot program
Regulation 715/2007 (LDV):
• Recital (15) requests the Commission to investigate the use of PEMS and ‘not-to-exceed’ regulatory concepts in the context of the revision of the New European Drive Cycle (NEDC) and the need to bring on-road off-cycle emissions in line with those measured at type approval.
• Article 4(2) requires the manufacturer to ensure that emissions are effectively limited throughout the normal life of the vehicles under normal conditions of use.

Regulation COM(2007) 851 (HDV)
• Article 15 – In order to better control actual in-use emissions including OCE and to facilitate the in-service conformity process, a testing methodology and performance requirements based on the use of portable emission measuring systems (PEMS) should be adopted.
• Article 12 – The Commission should adopt world-wide harmonised driving cycles in the test procedure that provides the basis of EC type-approval emissions regulations. The application of portable emissions measurement systems for verifying the actual in use emissions and the introduction of procedures to control Off Cycle Emissions (OCE) should also be considered.
Environmental performance (for criteria pollutants THC, CO, NOx, PM) requirements of vehicle/engines:

1. On standard cycles (fixed set of conditions)

2. During the real-world operation (in-use):
   - EURO6-LDV (“Real driving emissions”)
   - EURO VI-HDV (“Off-Cycle emissions”)

To be demonstrated both for the certification and during the useful life: EU Concept of In-Service Conformity (ISC), Equivalent to the US In-Use Compliance (IUC).
To assess the in-use emissions performance:

**In the laboratory, using conventional facilities** (chassis dynamometer or engine test cell): **spots checks** can be conducted on cycles addressing specific situations or random cycles.

**During the real-world operation with PEMS** (in-use), provided that:

1) The experiments provide accurate data **(Instrumentation)**

2) The data evaluation method has the ability to properly assess the performance.
1. Performance evaluation is to be conducted both on:

- Standard certification cycles
- Complementary procedure addressing real-world emissions

2. As the real-world operation cannot be fully “captured”:

- It is the purpose of any real-world emission test procedure that its performance evaluation schemes can not be addressed by procedure-specific design.
- The manufacturer has to ensure the real-world emissions performance by proper vehicle design.
- Design criteria should include elements to ensure that the technologies to control emissions and energy consumption are functional in normal use.
- Exclusion of data outside the applicable conditions
- Averaging process (on sub-sets or ‘windows’)
- Exclusions of windows on the averaged data set
- Not To Exceed principle (A given percentage of the averaging window emissions cannot exceed a defined value)
First averaging window
Duration determined by the reference quantity

First average emissions value
Average power of the first window
Engine In-Service Conformity (ISC) evaluation:

- Exclusion of data outside the applicable conditions
  - Cold engine (based on coolant temperature)
  - Altitude (based on barometric pressure)
  - Ambient temperature

- Moving Averaging Window
  - Reference quantity: Engine Work or CO2 mass emissions transient certification cycle
  - EURO V: European Transient Cycle (ETC)
  - EURO VI: World Harmonized Transient Cycle (WHTC)

- Exclusions of windows below the power threshold
  - 20% of the maximum engine power
  - If less than 50% of the windows are valid, the threshold is decreased by steps of 1%

- 90% the windows must have a conformity factor lower than or equal to 1.5
Comparison of EU and US data evaluation: Case 1
NRMM Engines Data Evaluation

- Comparison of EU and US data evaluation: Case 2 (Same machine as case 1 on a different duty cycle)
On the agenda (1)

- Heavy-Duty
  - **Engine Testing on Vehicle** to complement engine laboratory testing for certification
  - Review of EURO VI ISC-PEMS procedures to be completed by 2013
  - Development of PM provisions, including the instrumentation requirements and the development of on-vehicle test protocol
  - Adaptation of methods/rules to hybrids

- Non-Road Mobile machinery
  - Pilot Program
  - Preparation of amendments for the Stage IV standards
On the agenda (2)

- Control of LDV Real-Driving Emissions
- Validation of HDV CO2 emissions for labelling
- Validation of HDV hybrid certification results
- Standards harmonisation (e.g. EU & US data evaluation rules)

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