WLTP Test Procedures for Chassis Dynamometer Testing

Chris Laroo - U.S. EPA

April 14, 2010

WLTP-DTP-01-13

Outline

- Overview of current US domestic test procedures, WHDC, and NRMM GTR
- Overview of proposed WLTP test procedures
- Conclusions

Current Test Procedures

- The United States currently regulates passenger cars utilizing 40 CFR Part 86.
- For engine testing, we regulate to 40 CFR Part 1065.
- Recently the NRMM GTR was finalized
  - The test procedures in this document closely resemble 1065.
  - WHDC GTR also closely resembles 1065.
- EPA believes that 40 CFR Part 1065 should be adapted to chassis testing to create a more robust test procedure.

Draft WLTP Test Procedure Organization

Section and Title	Intended Audience
100s Dynamometer Laboratory Equipment Specifications	Lab Facilities
200s Measurement Instruments	Instrument Procurement
300s Calibrations and Performance Checks	Instrument Operator
500s Dynamometer Laboratory Test Protocols	Test Operator
600s Calculations and Required Data for Certification	Reporting Engineer
700s Analytical Gases	Supply Procurement
800s Testing with Oxygenated Fuels	Specialized Technician
1000s Definitions and Other Reference Information	All

Highlights

- Uses International System of Units (SI) “metric”
- Measurement and control specifications scaled to
  - Emissions standards
  - Specified gas standard accuracy scaled as function of emissions standards

Highlights

- Molar based emission calculations
  - Uses chemical balance, iteratively solved, to determine
    - Removed water correction
    - Amount of dilution gas per mole of exhaust, $x_{dil/exh}$
    - Requires only total dilute exhaust flow measurement
  - Provides for a more robust emission calculation and background correction.
  - Note, chemical balance is not necessary if you directly measure two of the following flow rates:
    - Dilution air flow – Used directly for background mass emission calculation
    - Exhaust flow – Used to determine dilution air or CVS total flow
    - Dilute exhaust total flow – Used directly in vehicle mass emission calculation

100s: Equipment

- Dilution equipment
- Probes, sample lines: heated as necessary
- Sample-conditioning equipment
  - NO_2 to NO converter
  - Dryers
  - Pumps
  - PM preclassifiers
- PM sampling and stabilization conditions

200s and 300s

Measurement Parameter	200s: Instrument Specifications	300s: Calibrations Verifications
Update and Record	202	
Press, Temp, Dewpoint	215	315
Diluted Exh. Flow	240	340, 341
Sample Flow	245	.345
Gas Divider	248	307

EPA

Subparts C and D

Measurement Parameter	200s: Instrument Specifications	300s: Performance Checks
CO and CO_2	250	350, 355
NMHC	260, 265	360, 362, 365
NO_x	270, 272	370, 372, 376, 378
PM, gravimetric balance	290	390
PM, inertial balance	295	395

Highlighted Verifications

- 303: Verification frequency
  - Linearity, response, leaks, interference, penetration, quench, conversion efficiency…
- 307: Linearity
  - Verifies calibrations
  - Note 35-day gas analyzer linearity verifications
- 308 and 309: signal update, response, and alignment
  - For continuous gas analyzers

500s: Performing an Emission Test

- 510 Dynamometer procedure
- 515 Pre-test checks
- 520 Emission Test Sequence
- 525 Vehicle starting and restarting
- 550 Gas analyzer range validation, drift validation
- Validation of test driver power demand
- 590 PM sampling media (e.g., filters) preconditioning and tare weighing
- 595 PM sample post-conditioning and total weighing.

EPA

600s: Calculations

- Examples
  - General statistics
  - Molar based emissions calculations
  - Removed water correction
  - Drift validation and correction

600: Mass emission and background calculations

- Mass emission calculation

$$m = M \cdot \sum_{i=1}^{N} x_i \cdot \dot{n}_i \cdot \Delta t$$

  - Here ndot is the dilute exhaust flow rate
  - For background determination, ndot is the dilution air flow rate
- Background mass calculation using chemical balance

$$m_{\text{bkgnddexh}} = M \cdot \bar{x}_{\text{bkgnd}} \cdot n_{\text{dexh}}$$

$$m_{\text{bkgnd}} = \bar{x}_{\text{dil/exh}} \cdot m_{\text{bkgnddexh}}$$

Conclusions

- EPA believes that one set of improved test procedures for labs should improve repeatability
- One set of test procedures provides pathway for significant international harmonization across all testing platforms
- 40 CFR 1065 should be used as a basis for international harmonization across all certification platforms (chassis and engine).