SAE-770136

A Treatise on Exhaust Emission Test Variability

Wiplove K. Juneja
David D. Horchler
Harold M. Haskew
Vehicle Emission Laboratories
Engineering Staff – Current Product Engineering
General Motors Corporation

International Automotive Engineering
Congress and Exposition
Cobo Hall, Detroit, Michigan
February 28-March 4, 1977

ABSTRACT:

The major sources of variability of an exhaust emission test on the 1975 Federal Test Procedure (FTP) are discussed. Vehicle, driver and the ambient conditions affect hydrocarbon (HC) and carbon monoxide (CO) variability significantly. On the other hand, oxides of nitrogen (NOx) and carbon dioxide (CO_2) are influenced more by the differences in vehicle loading. However, the importance of any other source of variability cannot be ignored, especially when a comparison is made between two tests. Various diagnostic aids such as the “Total Torque Tester,” a “Driver Evaluator,” an “Exhaust Bag Cross-Check,” and a “Repeatable Car,” which are used for the purpose of a better correlation between measurement systems on a different test sites, are described.

Designed experiments were conducted on vehicles whose emission levels were at or near the standards of 0.41 grams per mile HC, 3.4 grams per mile CO and 2.0 grams per mile NOx. A computer simulation of emissions was also employed to determine relative contributions from different sources to overall variability. Variability due to measurement error and within-vehicle variability observed in this work is +/- 19% of the mean for HC, +/- 33% of the mean for CO, +/- 9% of the mean for NOx and +/- 5% for the mean for CO_2. Variability as used here is defined as 1.96 times the coefficient of variation. The magnitude of variability is variable depending on differences in the overall system which includes the vehicle, the measurement system and test operating conditions.