Proposal for a new Supplement to the Original Version and the 01, 02 and 03 Series of Amendments to UN Regulation No. 154

This document aims to revise the requirements of UN Regulation No. 154 with regards to the calculation of run-in factors. The modifications to the current text of the Regulation are marked in bold for new or strikethrough for deleted characters. The red text shows the differences between this document and the first version GRPE-85-20.

I. Introduction

In Appendix 3, Paragraph 1.9., amend to read:

"1.9.   For the determination of the run-in factor for CO2 emissions of the 4 phase WLTP test, the coefficients CRI and Cconst in the following equation shall be calculated by a least squares regression analysis to four significant digits on all valid tests before and after the run-in:

$$\cancel{M_{CO2,i} = -C_{RI} \cdot ln(D_i - D_s) + C_{const}}$$

$$M_{CO2,i} = C_{RI} \cdot ln(D_i - D_s) + C_{const}$$

where:

$M_{CO2,i}$ is the measured CO_2 emission for test i, g/km

C_{RI} is the slope of the logarithmic regression line

C_{const} is the constant value of the logarithmic regression line

In the case that multiple vehicles have been tested, the C_{RI} shall be calculated for each vehicle, and the resulting values shall be averaged. The manufacturer will provide statistical evidence to the responsible authority that the fit is sufficiently statistically justified."

In Appendix 3, Paragraph 1.9.1., amend to read:

"1.9.1.   Based on the deviation of the measurements from the fit, the slope CRI should be corrected downward with the standard ~~deviation of the~~ errors ~~in~~ **of** the ~~fit~~**slope**:

$$\sigma_{fit} = \sqrt{\frac{\Sigma\left(M_{CO2,i} - M_{CO2,i-fit}\right)^2}{N - 2}}$$

and

$$SE(C_{RI}) = \frac{\sigma_{fit}}{\sqrt{\Sigma(x_i - \bar{x})^2}}$$

where:

$M_{CO2,i-fit}$ is the result of the applying the equation for each of the distances Di.

$$x_i = \ln (D_i - D_s)$$
$$\bar{x} = mean\ value\ \ln(D_i - D_s)$$

The slope C_{RI} shall be corrected for the uncertainty in the fit by:

~~$CRI \rightarrow CRI - \sigma_{fit}$~~

$$C_{RI-fit} = C_{RI} + SE(C_{RI})"$$

In Appendix 3, Paragraph 1.10., amend to read:

"1.10.   The run-in factor $RI_{CO2}(j)$ for CO_2 emissions after 4 phases of CoP test vehicle j shall be determined by the following equation:

$$\require{cancel}\cancel{RI_{CO2}(j) = 1 - C_{RI} \cdot \left(\frac{\ln(D_k) - \ln(D_j)}{M_{CO2,j}} \right)}$$

$$RI_{CO2}(j) = 1 + C_{RI-fit} \cdot \left(\frac{\ln(D_k) - \ln(D_j)}{M_{CO2,j}} \right)$$

where:

D_k is the average distance of the valid tests after the run-in, km

D_j is the system odometer setting of the CoP test vehicle, km

$M_{CO2,j}$ is the mass CO_2 emission measured on the CoP test vehicle, g/km

In the case that D_j is lower than the minimum D_i, D_j shall be replaced by the minimum D_i."

II. Justification

1.   Paragraph 1.9. intends to fit a curve to the measurement data from the run-in factor procedure by using least squares regression analysis based on a logarithmic scale (ln(mileage)).

2.   The literature on least squares regression analysis for linear regression refer to a conventional formula syntax, i.e. $y = \beta_1 \cdot x + \beta_0$

3.   The sign (positive/negative) of the slope β_1 is given by the measurement points and the least squares regression. In the example of CO_2 run-in factor, the sign is negative by nature:
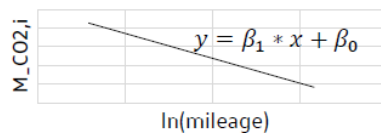
4.   Removing the first negative sign in paragraph 1.9 aligns to conventional formula syntax.

5.   Subsequently, the first negative sign in paragraph 1.10 needs to switch to a positive sign.

6.   This would:

- prevent interpretation uncertainties regarding the sign (positive/negative) of the slope in paragraph 1.9. and in following steps of the calculation (paragraph 1.10.), and

- align the spelling of the formula in the Regulation to literature on linear regression

7.   Paragraph 1.9.1. intends to take the deviation of the measurements into account by correcting the slope of the fit.

8.   Referring to literature on linear regression:
To take the deviation of the measurements into account by correcting the slope, it is needed to calculate the standard error of the slope itself ($SE(C_{RI})$) instead of the deviation of the fit as a whole (σ_{fit}).

9.   This would:

- align the syntax of the formulae in the Regulation to literature on linear regression, and

- represent mathematically correct calculations and prevent interpretation uncertainties as well as misleading calculation results

————————