Transmitted by the expert
from the Russian Federation

Informal Document **GRB-58-13**
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agenda item 6)

Proposal for Supplement 6 to the 02 series of amendments to Regulation No. 117 amending proposal by ETRTO in GRB-58-02 and ECE/TRANS/WP.29/GRRF/2013/30

The text reproduced below was prepared by the experts from the Russian Federation in response to the proposal by ETRTO presented in GRB-58-02 and ECE/TRANS/WP.29/GRRF/2013/30. The text reproduced below modifies the text drafted by ETRTO. The modifications to the existing text of the Regulation are shown in bold for new characters.

I. Proposal

Annex 6, Appendix 1

Paragraph 4, amend to read:

"4. Control accuracy

…

(d) Time ±**0.02 s for the force, torque and power method and ±0.2% from time increment value chosen by a user for deceleration method in approximate Δω/Δt or exact dω/dt form.**

…"

Paragraph 5, amend to read:

"5. Instrumentation accuracy

The instrumentation used for readout and recording of test data shall be accurate within the tolerances stated below:

Parameter	*Load Index ≤ 121*	*Load Index > 121*
Tyre load	±10 N or ±0.5 % (a)	±30 N or ±0.5 % (a)
Inflation pressure	±1 kPa	±1.5 kPa
Spindle force	±0.5 N or +0.5 % (a)	±1.0 N or +0.5 % (a)
Torque input	±0.5 Nm or +0.5 % (a)	±1.0 Nm or +0.5 % (a)
Distance	±1 mm	±1 mm
Electrical power	±10 W	±20 W
Temperature	±0.2 °C	
Surface speed	±0.1 km/h	
Time	±0.01 s **(b)**	
Angular velocity	±0.1 %	

(a) Whichever is greater.

(b) **For the force, torque and power method; +/-0.1% from time increment value chosen for deceleration method in approximate Δω/Δt or exact dω/dt form.**"

II. Justification

1. Having considered the proposal by ETRTO presented in GRB-58-02 and ECE/TRANS/WP.29/GRRF/2013/30 the Russian Federation experts agree with the proposed time measurement accuracies ±0.02 s for force, torque and power methods. Really, according to formulae in paragraphs 5.1.2., 5.1.3. and 5.1.4. of Annex 6 to UN Regulation No. 117 time is not involved in calculation of rolling resistance for force, torque and power method, therefore exact time measurement is not needed for those three methods.

2. For deceleration method independently on approximate $\Delta\omega/\Delta t$ or exact $d\omega/dt$ form of calculations, the required accuracy follows from equality:

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{zt_z}, \qquad (1)$$

where: ω – angular speed in radians per second,

T – time period of one turn,

z – number of sensor pulses per one revolution,

t_z – time increment.

The equality of angular speed and time relative error follows from dependency (1):

$$\delta\omega = \delta t$$

According to ISO 18164, paragraph C.4.1., $\delta\omega = \pm 0.2\%$. UN Regulation No. 117 confirms in Annex 6, paragraph 5 the angular velocity instrumentation accuracy ±0.1%.

Therefore the maximum allowed value of time relative error also should equal to ± 0.2%. This value is the proposed parameter for Annex 6, paragraph 4. For paragraph 5 this value is divided by 2, i.e. ± 0.1%. This proposal applies to the both exact and approximate forms of rolling resistance calculations in the deceleration method and also covers usage of encoders.

3. For absolute time permissible error it cannot be presented by a constant and shall be calculated for each separate case by formula:

$$\varepsilon t = t_z \delta t = 2 \cdot 10^{-3} t_z \text{ (s)}$$

The examples for the case of the test drum radius R = 0.85 m and peripheral speed V = 80 km/h had been calculated applying formula:

$$zt_z = \frac{2\pi R}{V}$$

Thus:

- for the exact form of calculations, where $z = 1$, $t_z = 0.24$ s, $\varepsilon t = 0.5$ ms;

- for the approximate form of calculations, where $z = 5$, $t_z = 0.048$ s , $\varepsilon t = 96$ µs;

- for encoder usage, where $z = 10^3$, $t_z = 0.24$ ms, $\varepsilon t = 0.48$ µs.

This is much less than the value εt = 0.02 s.

4. UN Regulation No. 117 in paragraph 6.3. sets the values of rolling resistance with the accuracy up to the first digit after the decimal point, which requires measuring of rolling resistance with the accuracy of ±0.05 N/kN.

Consequently, the permissible relative error for the highest rolling resistance value in the table of paragraph 6.3.1.:

$$\delta C_{\gamma} = \pm \frac{0.05}{12.0} = \pm 0.4\% \, .$$

For the basic deceleration method the rule for calculating relative error of fraction

$$j = \frac{\Delta\omega}{\Delta t} \, , \quad (2)$$

where j – deceleration,

yields the sum of angular speed and time errors:

$$\delta j = \delta\omega + \delta t \quad (3)$$

In supposition, that moments of inertia are determined without error and neglecting the error from distance and speed linearization, the following equality shall be applied:

$$\delta j = \delta C_{\gamma} = \pm 0.4\% .$$

As soon as $\delta\omega = 0.2\%$ (see above), the maximum allowed value of time relative error equals to:

$$\delta t = \delta j - \delta\omega = 0.4 - 0.2 = \pm 0.2\%$$

5. If the previous value $\varepsilon t = \pm 0.02$ s had been kept, then:

- if there were one pulse for one revolution of a drum with R = 0.85 m at the peripheral speed of 80 km/h, then $\Delta t = 0.24$ s and the relative time error would equal to:

$$\delta t = \frac{0.02}{0.24} = \pm 8.3\%,$$

(Compare that with $\delta C_{\gamma} = \pm 0.4\%$ as per UN Regulation No. 117, paragraph 6.3.1.);

- if there were 2, 3, etc. pulses per one revolution and $\varepsilon t = 0.02$ s, then the relative error consequently would equal to:

$$\delta t = \frac{0.02}{0.12} = \pm 16.7\%, \qquad \delta t = \frac{0.02}{0.08} = \pm 25\%, \qquad \text{etc.,}$$

which would discredit the accuracy of the deceleration method.