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Tyres: Regulation No. 117 (Tyre rolling resistance, rolling noise and wet grip)

Proposal for a Supplement to the 03 series of amendments to UN Regulation No. 117

Submitted by the Informal Working Group on Wet Grip Performance for Tyres in a Worn State*

The text reproduced below was prepared by the expert from the Informal Working Group on Wet Grip Performance for Tyres in a Worn State (IWG WGWT) with the aim to amend UN Regulation No. 117. The modifications to the existing text of the Regulation are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2022 as outlined in proposed programme budget for 2022 (A/76/6 (Sect.20), para 20.76), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.



I. Proposal

Paragraph 2.18., amend to read:

- "2.18. "Standard Reference Test Tyre" or "SRTT" means a tyre that is produced, controlled and stored in accordance with the standards of ASTM International:
- (a) E1136 – 17 for the size P195/75R14 and referred to as "SRTT14",
 - (b) F2493 – 20 for the size P225/60R16 and referred to as "SRTT16",
 - (c) **[F####-##] for the size P225/60R16 in worn state and referred to as "moulded SRTT16 worn"**
 - (ed) F2872 – 16 for the size 225/75R16C and referred to as "SRTT16C",
 - (~~e~~) F2871 – 16 for the size 245/70R19.5 and referred to as "SRTT19.5",
 - (ef) F2870 – 16 for the size 315/70R22.5 and referred to as "SRTT22.5"."

Insert a new paragraph 12.9., to read:

- "12.9. [Until 6 July 2024], Contracting Parties applying this Regulation may continue to grant type approvals according to the 03 series of amendments to this Regulation, based on the test procedures for measuring the wet adhesion of tyres in worn state as described in Annex 9 to this Regulation using buffed SRTT16 in worn state as reference tyre."**

Annex 5, part (B), paragraph 2.1.2.1., amend to read:

- "2.1.2.1. Fit the test tyres on rims specified by a recognized tyre and rim standards organization as listed in Appendix 4 to Annex 6 to this Regulation. Ensure proper bead seating by the use of a suitable lubricant. Excessive use of lubricant should be avoided to prevent slipping of the tyre on the wheel rim.
- Check the test tyres for the specified inflation pressure at ambient temperature (cold), just prior to testing. For the purpose of this standard the testing tyre cold inflation pressure P_t shall be calculated as follows:

$$\cancel{P_t = P_r \left(\frac{Q_t}{Q_r} \right)^{1.25}} \quad P_t = P_r \cdot \left(\frac{Q_t}{Q_r} \right)^{1.25}$$

Where:

P_r = Inflation pressure corresponding to the ~~the~~ indication of the inflation pressure marked on the sidewall as required by paragraph 4.1. of this Regulation.

Q_t = The static test load of the tyre

Q_r = The maximum mass associated with the load capacity index of the tyre"

Annex 7, paragraph 3.1.4.2., amend to read:

- "3.1.4.2. For class C2 tyres, the vehicle load shall be such that the resulting loads on the tyres are between 60 per cent and 100 per cent of the load corresponding to the tyre load **capacity** index.

The static tyre load on the same axle should not differ by more than 10 per cent.

The inflation pressure is calculated to run at constant deflection:

For a vertical load higher or equal to 75 per cent of the load capacity of the tyre, a constant deflection is applied, hence the test inflation pressure ~~" P_t "~~ P_t shall be calculated as follows:

$$P_t = P_r \left(\frac{Q_t}{Q_r} \right)^{1.25} \quad P_t = P_r \cdot \left(\frac{Q_t}{Q_r} \right)^{1.25}$$

~~Q_r~~ Q_r is the maximum load associated to the load capacity index of the tyre written on the sidewall

~~P_r~~ P_r is the reference pressure corresponding to the maximum load capacity ~~Q_r~~

P_r is the inflation pressure corresponding to the indication of the inflation pressure marked on the sidewall as required by paragraph 4.1. of this Regulation.

~~Q_t~~ Q_t is the static test load of the tyre

For a vertical load lower than 75 per cent of the load capacity of the tyre, a constant inflation pressure is applied, hence the test inflation pressure ~~P_t~~ P_t shall be calculated as follows:

$$P_t = P_r (0.75)^{1.25} = (0.7) P_r \quad P_t = P_r \times (0.75)^{1.25} = 0.7 P_r$$

~~P_r~~ P_r is the reference pressure corresponding to the maximum load capacity ~~Q_r~~ Q_r .

Check the tyre pressure just prior to testing at ambient temperature."

Annex 8,

Paragraph 2.4.2.2., amend to read:

"2.4.2.2. This adjusted mean fully developed deceleration $d_{m,adj}(R)$ of the reference tyre is calculated in accordance with Table 3, where $d_{m,ave}(R_i)$ and $d_{m,ave}(R_f)$ are the arithmetic means of the mean fully developed decelerations in the initial and in the final braking test of the reference tyre within a braking test cycle.

Table 3

Calculation of the adjusted mean fully developed deceleration $d_{m,adj}(R)$ of the reference tyre

If the number and the sequence of candidate tyres within one braking test cycle is	and the candidate tyre to be qualified is	the corresponding adjusted mean fully developed deceleration $d_{m,adj}(R)$ of the reference tyre is calculated as follows
1 R1 – T1 – R2 – Ri – T1 – Rf	T1 – T1	$d_{m,adj}(R) = 1/2 \cdot [d_{m,ave}(R_i) + d_{m,ave}(R_f)]$
2 R1 – T1 – T2 – R2 – Ri – T1 – T2 – Rf	T1 – T1	$d_{m,adj}(R) = 2/3 \cdot d_{m,ave}(R_i) + 1/3 \cdot d_{m,ave}(R_f)$
	T2 – T2	$d_{m,adj}(R) = 1/3 \cdot d_{m,ave}(R_i) + 2/3 \cdot d_{m,ave}(R_f)$

Second occurrence of paragraph 2.4.2.2., renumber as 2.4.2.3.

Second occurrence of paragraph 2.4.4.4., renumber as 2.4.4.5.

Paragraph 2.4.4.5. (former), renumber as 2.4.4.6.

Paragraph 2.4.5.2.1., amend to read:

"2.4.5.2.1. In a first series of three non-consecutive braking test cycles, using the procedure described in paragraph 2.1.3.2. to ~~2.4.4.5.~~ **2.4.4.6.** of this Annex in which the control tyre shall be treated as a candidate tyre, the ice grip index $G_{I,1}(C)$ of the control tyre relative to the reference tyre shall be established. In a second series of three non-consecutive braking test cycles, in which the control tyre serves as reference tyre, the ice grip index $G_{I,2}(T)$ of the candidate tyre relative to the control tyre shall be established."

Annex 9,

Paragraph 2.1.1., amend to read:

"2.1.1. "Tyre in worn state" or "worn tyre" means, for the purpose of this Regulation, a new tyre artificially worn by reducing the tread depth **or, with respect to the reference tyre in worn state, moulded** at the height **defined in paragraph 2.2.1.2.4.1. of this Annex.** ~~of the tread wear indicator as defined in the UN Regulation No. 30 (1.6 +0.6 / -0.0 mm).~~"

Paragraph 2.1.13., amend to read:

"2.1.13. "Reference tyre in worn state" or "Reference tyre set in worn state" means a tyre or a tyre set of Standard Reference Test Tyres ~~SRTT16 in worn state~~ **moulded SRTT16 worn.** "

Paragraph 2.3.2.2., amend to read:

"2.3.2.2. Using the procedure described in paragraph 2.4.2. of this Annex, perform in the same area where the average macro texture depth was measured one braking test of the reference tyre, consisting of at least six (6) test runs in the same direction.

Evaluate the braking test as described in paragraphs 2.4.2.1.1. and 2.4.2.1.2. of this Annex. If the coefficient of variation CV_{μ} exceeds 4 per cent, dismiss the results and repeat the braking test.

The arithmetic mean ($\overline{\mu_{\text{peak}}}$) of the measured peak braking force coefficients shall be corrected for effects of temperature as follows:

$$\mu_{\text{peak,corr}} = \overline{\mu_{\text{peak}}} + a \cdot (\vartheta - \vartheta_0)$$

Where

ϑ is the wetted road surface temperature in degrees Celsius

$a = 0.002 \text{ } ^\circ\text{C}^{-1}$ and $\vartheta_0 = 20 \text{ } ^\circ\text{C}$.

The temperature corrected average peak braking force coefficient ($\mu_{\text{peak,corr}}$) shall be not less than **[0.45 and not greater than 0.80]**."

Paragraph 2.4.1.1.4., amend to read:

" 2.4.1.1.4. Calculation of the wet grip index of the candidate tyre

The wet grip index $G_B(T_n)$ of the candidate tyre T_n ($n = 1, 2$ or 3) is calculated as follows:

$$G_B(T_n) = K_{\text{vehicle}} \cdot \{\overline{BFC_{\text{ave}}}(T_n) - [a \cdot \Delta BFC(R) + b \cdot \Delta\vartheta + c \cdot (\Delta\vartheta)^2 + d \cdot \Delta MTD]\}$$

where:

$\overline{BFC_{\text{ave}}}(T_n)$ is the arithmetic mean of the average braking force coefficients of the candidate tyre T_n within a braking test;

$$\Delta BFC(R) = BFC_{\text{adj}}(R) - BFC(R_0)$$

$BFC_{\text{adj}}(R)$ is the adjusted average braking force coefficient in accordance with Table 1 of **Annex 5**;

$BFC(R_0) = 0.52$ is fixed as the braking force coefficient for the reference tyre in the reference conditions;

$$\Delta\vartheta = \vartheta - \vartheta_0$$

ϑ is the measured wet surface temperature in degrees Celsius when the candidate tyre T_n is tested;

ϑ_0 is the wetted surface reference temperature for the candidate tyre according to its category of use as listed in Table 2;

$$\Delta MTD = MTD - MTD_0$$

MTD is the measured macro texture depth in mm of the track (see paragraph 3.1.4. of this Annex);

$MTD_0 = 0.8$ mm is the macro texture depth of the reference track;

$K_{\text{vehicle}} = [1.95]$ is a factor to grant consistency between previous calculation of the wet grip index and this one, and to ensure convergence between vehicle and trailer method and

coefficients a , b , c and d are given in Table 2.

Table 2

Category of use	ϑ_0 (°C)	a	b (°C ⁻¹)	c (°C ⁻²)	d (mm ⁻¹)
Normal tyre	20	+0.90996	-0.00179	-0.00013	-0.10313
Snow tyre	15	+0.81045	-0.00004	-0.00019	-0.05093
Snow tyre for use in severe snow conditions	10	+0.71094	+0.00172	-0.00025	+0.00127
Special use tyre	not defined				

"

Paragraph 2.4.1.1.2., amend to read:

"2.4.1.1.2. Validation of results

The coefficient of variation CV_{BFC} is calculated as follows:

$$CV_{BFC} = 100\% \cdot \frac{\sigma_{BFC}}{\overline{BFC}_{ave}}$$

where

$\sigma_{BFC} = \sqrt{\frac{1}{N-1} \sum_{j=1}^N (BFC_{ave,j} - \overline{BFC}_{ave})^2}$ denotes the corrected sample standard deviation and

\overline{BFC}_{ave} the arithmetic mean of the average braking force coefficients $BFC_{ave,j}$ of N test runs.

For the reference tyre:

- The coefficient of variation CV_{BFC} of the initial and the final braking test of the reference tyre within one test cycle shall be less than or equal to 4 per cent.
- The arithmetic means of the average braking force coefficients of the initial and the final braking test shall not differ by more than 5 per cent of the average of the two values:

$$CV_{\text{val}}(BFC_{ave}) = 100\% \cdot 2 \cdot \frac{|\overline{BFC}_{ave}(R_i) - \overline{BFC}_{ave}(R_f)|}{\overline{BFC}_{ave}(R_i) + \overline{BFC}_{ave}(R_f)} \leq 5\%$$

where

$\overline{BFC}_{ave}(R_i)$ and $\overline{BFC}_{ave}(R_f)$ are the arithmetic means of the average braking force coefficients respectively in the initial and final braking tests of the reference tyre within a test cycle.

- The temperature-corrected average braking force coefficients ($BFC_{ave,corr}$, see paragraph 3.2.1. of this Annex) as calculated from the initial and from the final braking tests of the reference tyre within a test cycle shall be not less than **[0.40 and not greater than 0.65]**. "

Paragraph 2.4.2.1.4., amend to read:

"2.4.2.1.4. Calculation of the wet grip index of the candidate tyre

The wet grip index $G_B(T_n)$ of the candidate tyre T_n ($n = 1, 2, 3$) is calculated as follows:

$$G_B(T_n) = K_{\text{trailer}} \cdot \{ \overline{\mu_{\text{peak}}}(T_n) - [a \cdot \Delta\mu_{\text{peak}}(R) + b \cdot \Delta\vartheta + c \cdot (\Delta\vartheta)^2 + d \cdot \Delta MTD] \}$$

where:

$\overline{\mu_{\text{peak}}}(T_n)$ is the arithmetic mean of the peak braking force coefficients of the candidate tyre T_n within a braking test;

$$\Delta\mu_{\text{peak}}(R) = \mu_{\text{peak,adj}}(R) - \mu_{\text{peak}}(R_0)$$

$\mu_{\text{peak,adj}}(R)$ is the adjusted peak braking force coefficient in accordance with Table 3 of Annex 5;

$\mu_{\text{peak}}(R_0) = 0.71$ is fixed as the peak braking force coefficient for the reference tyre in the reference conditions;

$$\Delta\vartheta = \vartheta - \vartheta_0$$

ϑ is the measured wet surface temperature in degrees Celsius when the candidate tyre T_n is tested;

ϑ_0 is the wetted surface reference temperature for the candidate tyre according to its sidewall marking as listed in Table 4;

$$\Delta MTD = MTD - MTD_0$$

MTD is the measured macro texture depth of the track

$MTD_0 = 0.8 \text{ mm}$ is fixed as the macro texture depth of the reference track;

$K_{\text{trailer}} = [1.50]$ is a factor to grant consistency between previous calculation of the wet grip index and this one, and to ensure convergence between vehicle and trailer method and

coefficients a , b , c and d are given in Table 4.

Table 4

Category of use	ϑ_0 (°C)	a	b (°C ⁻¹)	c (°C ⁻²)	d (mm ⁻¹)
Normal tyre	20	+0.99655	-0.00124	+0.00041	+0.06876
Snow tyre	15	+0.94572	-0.00032	-0.00020	+0.08047
	Snow tyre for use in severe snow conditions	10	+0.89488	+0.00061	-0.00080
Special use tyre	not defined				

Paragraph 2.3.1.5., amend to read:

"2.3.1.5. The wetted frictional properties of the surface shall be measured using the Standard Reference Test Tyre ~~SRTT16 in worn state~~ **moulded SRTT16 worn** either with the method described in paragraph 2.3.2.1 of this Annex in case the vehicle method (according to paragraph 2.4.1. below) is used, or with the method described in paragraph 2.3.2.2 in this Annex in case the trailer (or tyre test vehicle) method is used."

Insert a new paragraph 2.2.1.2.4.1.1., to read:

"2.2.1.2.4.1.1. The rim width shall be one specified by a recognized tyre and rim standards organization as listed in Appendix 4 to Annex 6 to this Regulation. The rim

width code shall not differ by more than 0.5 from the measuring rim width code. "

Insert a new paragraph 2.2.1.2.4.1.2., to read:

"2.2.1.2.4.1.2. The inflation pressure for the tread depth measurement shall be between 180 kPa and 220 kPa. "

II. Justification

1. To improve precision of the test procedures for measuring the wet adhesion of tyres in worn state as described in Annex 9, a moulded standard reference test tyre SRTT16 worn is developed instead of buffed SRTT16 in worn state. The moulded SRTT worn is expected to be more stable than the buffed SRTT in worn state and much more suitable to be used as a reference tyre.
 2. The requested transitional provisions in paragraph 12.9. are necessary to allow the technical services a smooth transition to moulded SRTT16 worn from buffed SRTT16 in worn state.
 3. This proposal also includes in the 03 series of amendments to UN Regulation No. 117 the corrections proposed with Supplement 15 to the 02 series of amendments:
 - In Annex 5, part (B), paragraph 2.1.2.1. a typo is corrected.
 - In Annex 7, the wording related to the test inflation pressure for C2 braking on snow is clarified.
 - In document ECE/TRANS/WP.29/GRBP/2021/17, paragraph numbers 2.4.2.2. and 2.4.4.4. were used twice. These errors were not corrected by informal document GRBP-74-31-Rev.1. It is done here by renumbering the relevant and subsequent paragraphs, as well as by correcting a reference to one of the renumbered paragraphs.
 4. The following editorial corrections are also proposed:
 - In Annex 9, paragraph 2.4.1.1.4., the reference Annex of Table 1 is Annex 5.
 - In Annex 9, paragraph 2.4.2.1.4., the reference Annex of Table 3 is Annex 5.
 5. Tread depth measurement can be affected by the rim size and inflation pressure, so it makes sense to define a range to reduce the measurement uncertainty. The proposed inflation range covers both trailer and vehicle test conditions.
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