Transmitted by the expert from France

Informal Document No. **GRB-51-14**
(67th GRB, 15 – 17 February 2010,
agenda item 7)

Regulation No. 117 (Tyres rolling noise and wet grip adhesion)

Proposal for amendments to ECE/TRANS/WP.29/GRB/2010/3

This document supersedes informal document No GRRF-67-16 transmitted by France and presented at GRRF of February 2010. The text reproduced below was prepared by the expert from France to introduce some corrections in the document ECE/TRANS/WP.29/GRB/2010/3 and to adjust some values remained between brackets. An explanation of the choice of these new values is provided in the appendix. It also includes additional results from experimental values to illustrate the influence of the tyre type number to be used for the alignment process. The modifications to the document ECE/TRANS/WP.29/GRB/2010/3 are marked in bold or strikethrough characters and supersedes GRRF-67-16.

A. PROPOSAL

Annex 6 paragraph 2.2 (a), 3.4 table 2 note (a) and annex 6 appendix 1 paragraph 2.1:
Replace ISO 4000-1:[2009] **by ISO 4000-1:2007**

Annex 6 paragraph 3.2 table 1: correct to read

Tyre ~~Type~~ **Class**	C1	C2 **and C3**	C3	
Load Index	All	~~LI=121 and below~~ **LI ≤ 121**	~~LI=122 and above~~ **LI > 121**	
Speed Symbol	All	All	J 100 km/h and lower or tyres not marked with speed symbol	K 110 km/h and higher
Speed	80	80	60	80

Annex 6 paragraph 4.4 table 3: correct to read

Tyre ~~Type~~ **Class**	~~Class~~ C1	~~Class~~ C2 **and C3** LI ≤ 121	~~Class~~ C3 LI > 121	
Nominal Rim Diameter	All	All	< 22.5	≥ 22.5
Warm up duration	30 min.	50 min.	~~550~~ **150** min.	180 min.

Annex 6 paragraph 6.5 correct the formula

~~$n = (\sigma_{m,i} / x)^2$~~ **$n = (\sigma_{m,i} / x)^2$**

Annex 8: Title**:** ~~Annex 8 [(informative)]~~ amend to read **"Annex 8 (informative)"**

Annex 8 paragraph 1: correct to read

.1. This clause describes the procedure to be followed to perform inter-laboratory comparison. It can be used for determination of assigned values (see paragraph ~~3~~. **1.3** below) for a set of reference tyres**.**

Annex 8 Add new paragraphs 2, 3 and 4

2. Any additional technical service wishing to refer to assigned values shall perform the same set of measurements than those participating to the inter laboratory comparison.

3. Any new measurements will not affect the current assigned values

4 The inter laboratory shall be repeated periodically (e.g. at every two years).

Annex 8 §1.2, Annex 9 § 1.1, §2.2, §4.1: Delete the word "predetermined"

Annex 9: Title**:** ~~Annex 9 [(informative)]~~ amend to read **"Annex 9 (informative)"**

Annex 9 paragraph 1.1: correct to read:

1.1. Alignment tyres

Set of ~~[1-5]~~ **[at least 5]** ~~predetermined~~ tyres measured by both the candidate and Technical Service machines to perform machine alignment.

Annex 9 paragraph 2.2: correct to read:

2.2. The machine alignment procedure requires ~~[1-5]~~ **[at least 5]** ~~predetermined~~ alignment tyres used by the candidate laboratory operating the machine. These tyres are used to align candidate machine(s) by comparing the measured Cr results to the ones obtained by a Technical Service eligible in the inter-laboratory comparison. An alignment formula is then established and shall be used to translate the results obtained on the candidate machine into aligned results.

Annexe 9 paragraph 4.1: correct to read:

4.1. The ~~predetermined~~ alignment tyres used to conduct the alignment procedure shall be identified to cover the needed usage range in terms of ~~load index, Cr and Fr~~ **Cr, dimensions, Fr and load index** as follows:

(a) Cr values shall have a ~~minimum~~ ~~range~~ **gap between two alignment tyres** of:
~~[3 N/kN]~~ **[1.5 +/- 0.5 N/kN]** for Class C1 and C2 tyres, and
~~[2 N/kN]~~ **[1.0 +/- 0.5 N/kN]** for Class C3 tyres.

(b), (c), (d) are inchanged

The number of alignment tyres shall be ~~equal to [1-5]~~ **[at least 5]**, i.e. there shall be**:**
~~[1-5]~~ **[at least 5]** alignment tyres for Class C1 and C2 tyres, and
~~[1-5]~~ **[at least 5]** alignment tyres for Class C3 tyres.

Annex 9 paragraph 5.1, 5.2, 5.3 replace "paragraph 4" by "**paragraph 4 of annex 6**" and "paragraph 3" by "**paragraph 3 of annex 6"**

Annex 9 paragraph 5.3 (a) and (b), correct to read:

(a) not greater than ~~[0.05]~~ **[0,075** N/kN**]** for Class C1 and C2 tyres, and

(b) not greater than ~~[0.05]~~ **[0,06** N/kN**]** for Class C3 tyres.

B. JUSTIFICATIONS

Annex 6:
- The current standard ISO 4000-1 is dated 2007 and not 2009. It exist a new draft for this standard but it is not yet voted.

- Table 1and Table 3:
  -The replacement of "Tyre Type" by "Tyre Class" is in accordance with the definition (see § 2.4).
  -C3 has been added in the second column because some of current tyres of this class have a load index <= 121
  - LI = 121 and below and LI=122 and above replaced respectively by LI<=121 and LI>121 is to be in coherence between the different tables.
  -Table 3: 150 min instead 550 min to be in coherence with ISO 28580

-§6.5: Index in the formula has to be in small letter and not in capital letter

Annex 8:
- Title: This annex shall be informative.

- §1: Error in the number of paragraph referred in the parenthesis.

- §2: This added paragraph is needed to include the case where a technical service wants to perform tests after the inter laboratory comparison is finished. It has to use the same set of samples in order to be compared with the other laboratories.

-§3: This paragraph means that the assigned values are not modified if a technical service performs tests after the inter laboratory comparison.

Annex 8 §1.2, Annex 9 § 1.1, §2.2, 4.1: The word “predetermined” can be deleted because the manner to choose the tyres are well defined trough the range to be covered and the distribution of the tyres within the range (see the new paragraph 4.1).

Annex 9 - Title – this annex shall be informative

Annex 9 § 1.1, 2.2 and 4.1: During the different meetings of the STD informal group no consensus was obtained among the participants on the number of tyres to be used for the alignment process.
For that reason, we try to show theoretically in the appendix of this informal document why a number of at least 5 tyres is needed to have a good precision in the alignment process.

Annex 9 § 4.1 (a):
- Taking into account both the number of tyres used .in the alignment process (at least 5) and the total usage range of the coefficients (e.g. 5.5 to 12 for C1 Tyre Class), we need to limit the gap between each alignment tyre in order to have a homogeneous distribution.

Annex 9 paragraphs 5.1, 5.2, 5.3: The number of the annex has been added.

Annex 9 paragraph 5.3 (a) and (b): The values into brackets have been changed to be in coherence with the other parts of the document.

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Appendix

According to the § 5.4 of the annex 9, the alignment process consists to establish a linear regression between two variables based on a regression model similar to:
$y_i = a + bx_i + \varepsilon_i$ from which we are able to estimate the parameters "a" and "b" by "$\hat{a}$" and "$\hat{b}$".

The standard deviation for a new predicted value $\hat{y}_0 = \hat{a} + \hat{b}x_0$ is given by the formula:

$$\pm t\hat{\sigma}\sqrt{1 + \frac{1}{n} + \frac{(x_0 - \bar{x})^2}{\sum_i^n (x_i - \bar{x})^2}} \quad (1)$$

$\hat{\sigma}$ being an estimation of the repeatability standard deviation such as defined in § 5.3, the above quantity can be only reduced in increasing:

-"n" and

- the sum of square $\sum_i^n (x_i - \bar{x})^2$.

"n" represents in our case the number of alignment tyres and the sum of square represents the **variation** ~~range~~ of the data x_i that is to say the needed usage range .

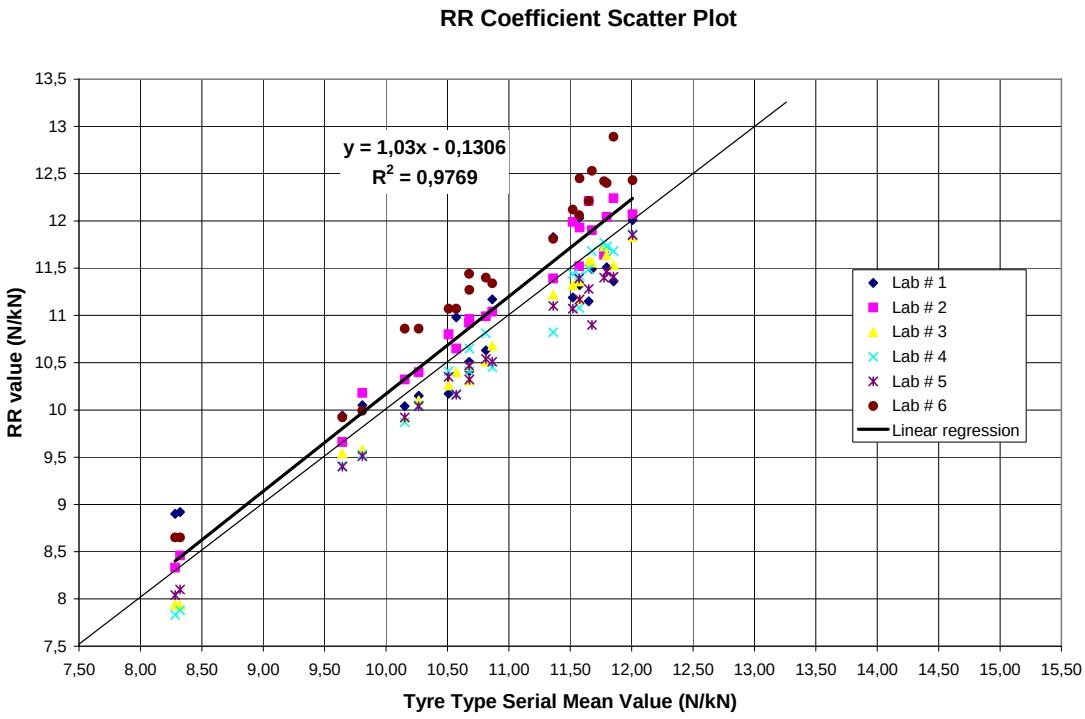
By increasing "n" both quantity $\frac{1}{n}$ and "t" value coming from the Student's **distribution** ~~test~~, according to the table below, are decreasing.

n value	Number of degrees of freedom	"t" such $P(\lvert T_{n-2} \rvert > t) = 5\%$
3	1	12.7
4	2	4.3
5	3	3.2
8	6	2.4
10	8	2.3
15	13	2,2

Considering that the impact of "t" is important in the relation (1) and looking at its variation versus the "n" values (see table above) there is a big interest to have the most important number of **tyre types** ~~samples~~ "n" to reduce the standard deviation of the predicted values

An example based on experimental measurement values obtained for 11different tyre types in six different labs, is given hereafter, at figure 1. Two measurements were performed for each tyre in each lab. RR measured coefficients are plotted versus the calculated average of the RR obtained for the six labs, for each tyres type.

Figure 1



The evolution of standard deviation (SD) for the predicted value versus tyre types number is plotted in figure 2.

The standard deviation according to paragraph 5.3 of annex 9 is fixed to 0,075 N/kN.

A range of tyre type in between : 8,30 and 10,21 for 3 tyre types; 8,30 and 10,72 for 5 tyre types; 8,30 and 11,47 for 7 tyre types; 8,30 and 11,59 for 9 tyre types were considered.

1) predicted value is performed from a given value x0 =12N/kN located out of the range;

2) predicted value is performed from a given value x0 equal to the mean of the xi

3) predicted value is performed from a given value x0 =9N/kN located within range

Conclusions:

These results confirm that the SD for predicted values decreases with the number of tyre types, whatever the case. It also confirms the need to measure at least more than five tyre types to obtain a good SD for predicted value. The worst case, in this example, is obtained when the SD for predicted value is evaluated, for a given value x0 located out of the range, especially for a reduced number of tyres. The SD for predicted value evaluated for a given value x0, equal to the mean of the xi or located within the range, is lower. Therefore, more than 5 tyre types are still necessary.

Figure 2

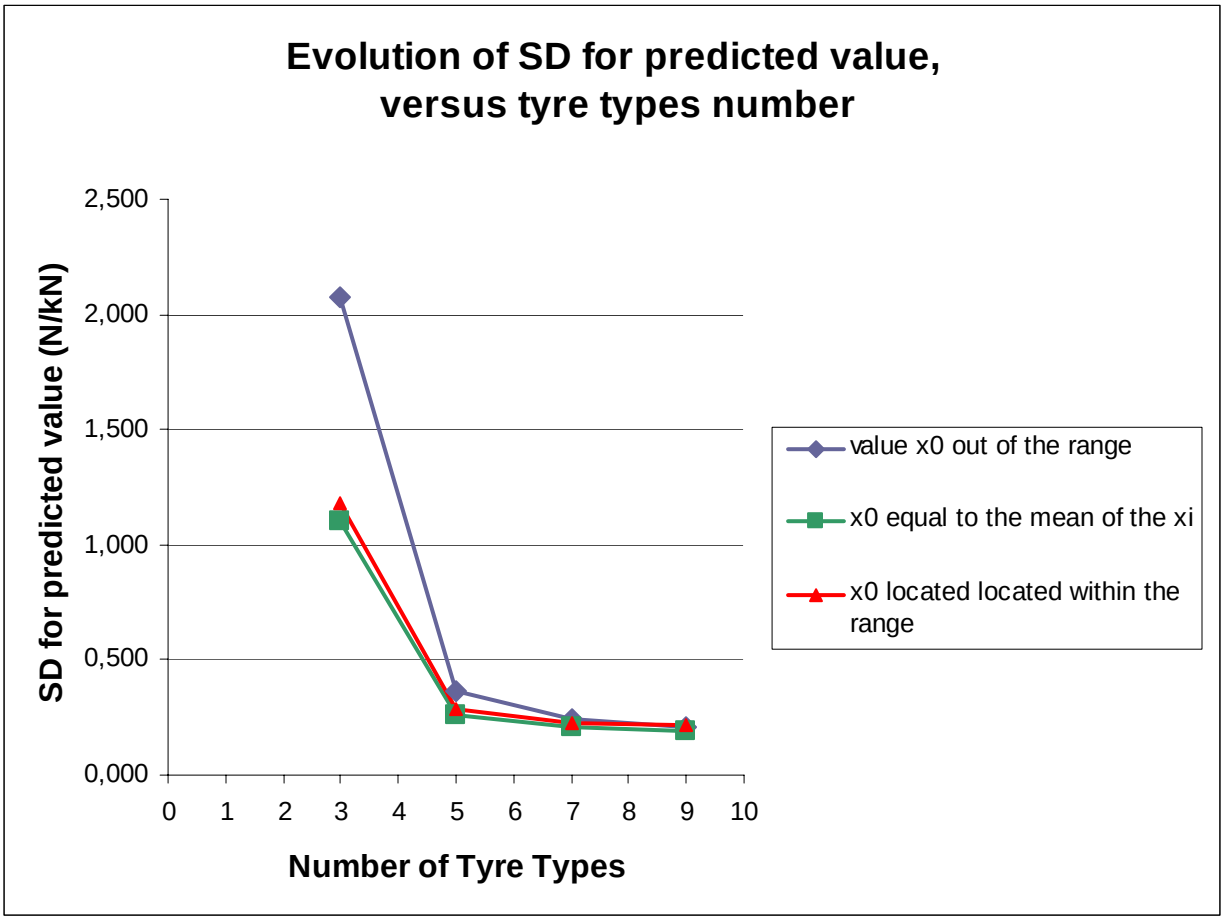


Table 1: calculation

x0	12	12	12	12
Average	9,41	9,91	10,25	10,56
Residual STD	0,075	0,075	0,075	0,075
t(n-2)	12,706	3,182	2,571	2,447
n	**3**	**5**	**7**	**9**
RR	10,21	10,72	11,47	11,47
	9,73	10,59	10,72	10,72
	8,30	10,21	10,75	10,75
		9,73	10,21	11,71
		8,30	10,59	11,59
			9,73	10,21
			8,30	10,59
				9,73
				8,30
STD predicted value	2,07	0,37	0,25	0,21

x0	average	average	average	average
Average	9,41	9,91	10,25	10,56
Residual STD	0,075	0,075	0,075	0,075
t(n-2)	12,706	3,182	2,571	2,447
n	**3**	**5**	**7**	**9**
	10,21	10,72	11,47	11,47
	9,73	10,21	10,72	10,72
	8,30	10,59	10,75	10,75
		9,73	10,21	11,71
		8,30	10,59	11,59
			9,73	10,21
			8,30	10,59
				9,73
				8,30
STD predicted value	1,10	0,26	0,21	0,19

x0	9	9	9	9
Average	10,13	10,18	10,31	10,58
Residual STD	0,075	0,075	0,075	0,075
t(n-2)	12,706	3,182	2,571	2,447
n	**3**	**5**	**7**	**9**
RR	11,89	11,89	11,89	11,89
	10,21	10,75	10,75	11,59
	8,30	10,21	10,72	11,47
		9,73	10,59	10,75
		8,30	10,21	10,72
			9,73	10,59
			8,30	10,21
				9,73
				8,30
STD predicted value	1,18	0,28	0,23	0,21