Procedure on laboratory alignment for the measurement of tyre rolling resistance

Market Surveillance on tyres labelling

Pierre CASTAING on behalf of the Expert Group on laboratory alignment for the measurement of tyre rolling resistance (E02519)

To provide advice and expertise to the Commission in relation to the implementation of Regulation (EC) No 2009/1222, in particular perform the laboratory alignment necessary for the measurement of tyre rolling resistance. Implementing measures : Regulation(EC)2011/1235.

RRC in regulations

- Regulation on CO^2
- Global Safety Regulation under framework directive 2007/46
- Regulation on Labelling of tyres

Why an alignment of RR machines is necessary

- European Regulation 1222/2009 is based upon absolute rolling resistance coefficient (RRC) values.

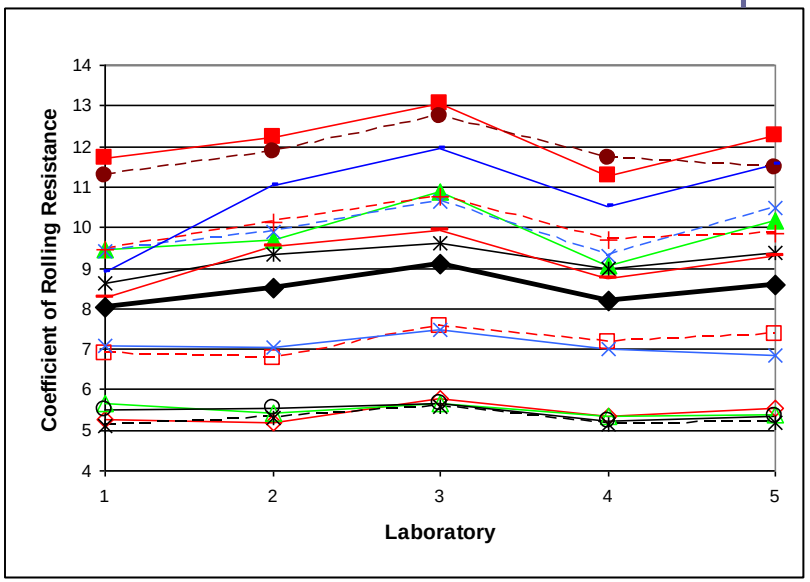
- Due to observed dispersion between measurement machines, an alignment procedure is mandatory to get comparative RRC values and give an appropriate competitive playground for the declaration of RRC labeling values.

Consequently, a Network of Laboratories workgroup was created by the Committee on the Labelling of Tyres under Regulation 1222/2009.

The procedure was based upon the generation of assigned RRC values as described in Annex IVa of European Regulation 1222/2009

Input from previous inter-laboratories comparison

Example of a Round-Robin Test performed by 5 ETRTO Members in 2004:



Average of 14 tyres

- Each line represents 1 tyre measured at all 5 Laboratories.
- For example, Laboratory #3 gives higher values than the others, Laboratories #1 and #4 give lower values.
- If we consider the average values of the 14 tyres measured by each laboratory as shown in above chart, the difference is more than 1 N/kN between the extremes.

(For comparison, the RR labelling class B has a width of 1.2 N/kN).

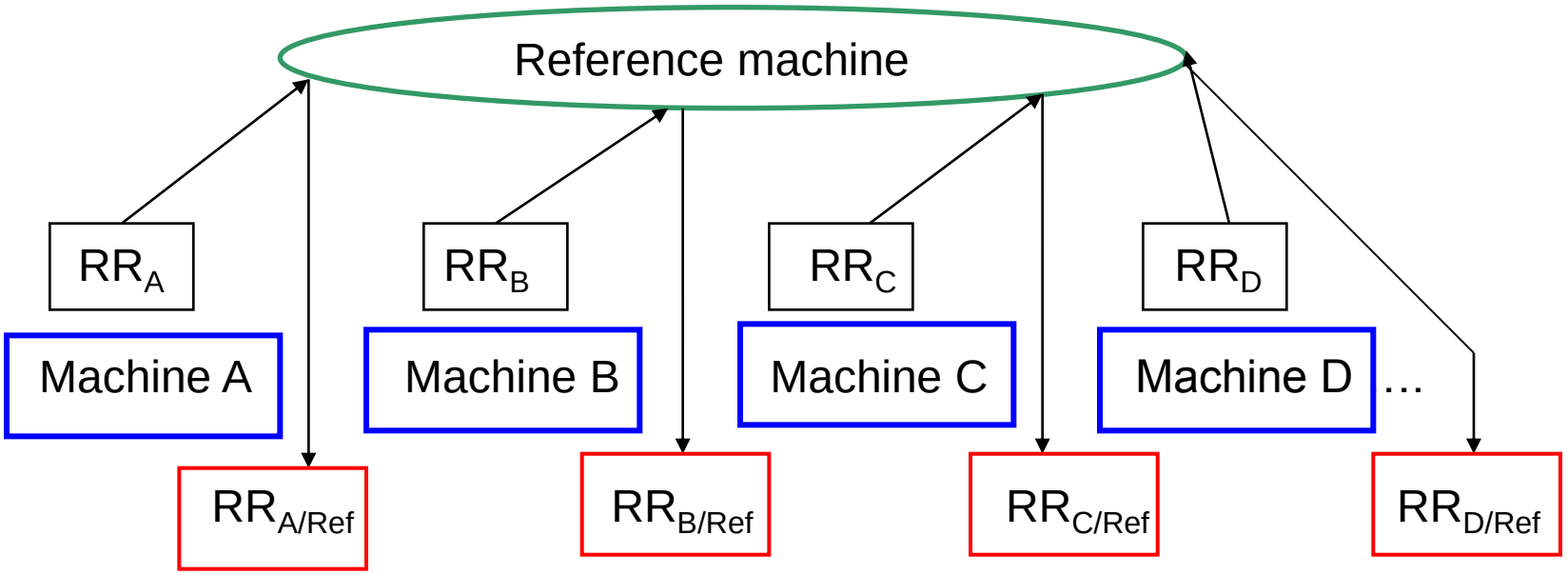
A Laboratory Alignment is necessary

Why an alignment of RR machines is necessary

- Rolling resistance is not a direct measurement (i.e. not linked to any international yardstick)
- ISO 28580 request a reference laboratory for alignment due to the uncertainty of the measurement methods (4)
- Not important for type approval (uncertainty is included in the value of the regulation limit)
- Important for ranking products with the goal of labelling (gaps between grades are smaller than uncertainty of measurement)

Alignment procedure ISO28580

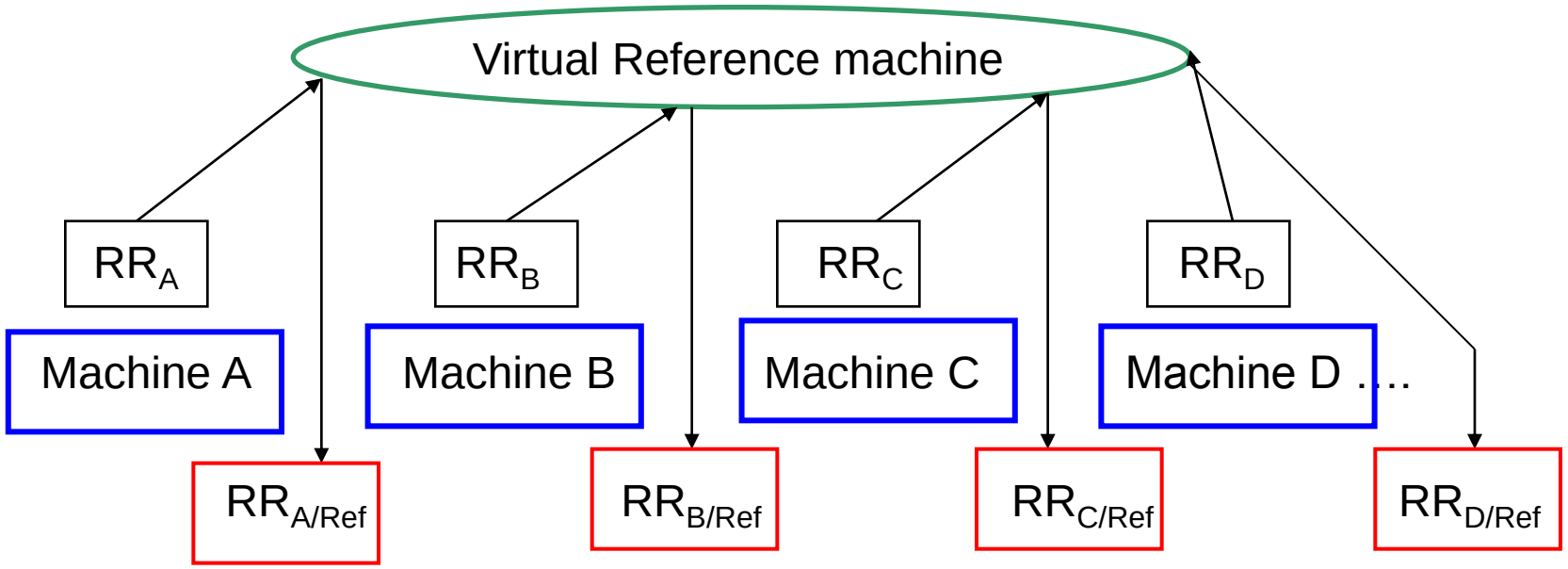
The aim is to align measurement results to a given reference machine, to reduce dispersion and allow direct inter-machines comparisons.



The aligned results are expressed in the referential of reference machine, Obtained from an initial linear regression and are directly comparable.

Alignment procedure 1222/2009

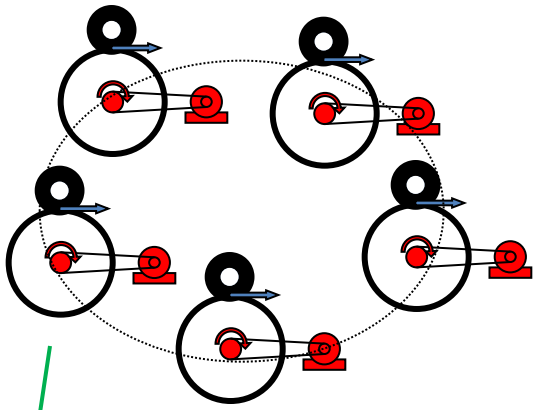
The aim is to align measurement results to a virtual reference machine, to reduce dispersion and allow direct inter-machines comparisons.



The aligned results are expressed in the referential of the virtual reference machine, Obtained from an initial linear regression and are also directly comparable.

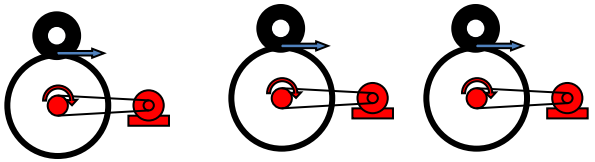
Process to organize the Laboratory Alignment

Network Laboratories



First Step:
Create a Network of Laboratories for the definition of assigned values.
Based on the assigned values, correlate and align the Laboratories in the Network.

Candidate Laboratories



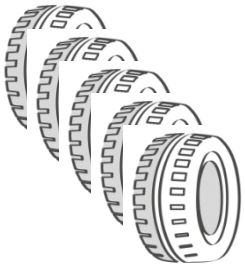
Second Step:
Any Candidate Laboratory to align with any of the Network Laboratories.

First Step:

Tests done within the Network of Laboratories

Reference Laboratory 1 | Reference Laboratory 2 | Reference Laboratory n

Measuring similar sets of alignment tyres.



Determination of assigned values for the Alignment Tyres

Alignment → Reference Laboratory 1
Corrected with aligned values

Alignment → Reference Laboratory 2
Corrected with aligned values

Alignment → Reference Laboratory n
Corrected with aligned values

History

- The Network of Laboratories working group was created Sept 3, 2010 by the Committee on the Labelling of Tyres under Regulation 1222/2009.(Call Expert Group on laboratory alignment for the measurement of tyre rolling resistance)
- Test Laboratories were invited to join the workgroup.
- 10 Laboratories was participating to the Network of Laboratories.
- Main activities dedicated to the creation of an alignment method for laboratories having to measure tyre RRC in accordance with Regulation (EC) 1222/2009.
- Met several times in 2010/2011 for the alignment of **reference laboratories** for the measurement of tyre RRC under the Regulation.
- Re-activated in 2013/2014 for the first assessment of the stability and validity of the **assigned values** of the initial alignment according to Annex IVa, point 3 of the Regulation.
- Next re-assessment of the assigned values of the reference laboratories alignment is foreseen in 2015/2016.

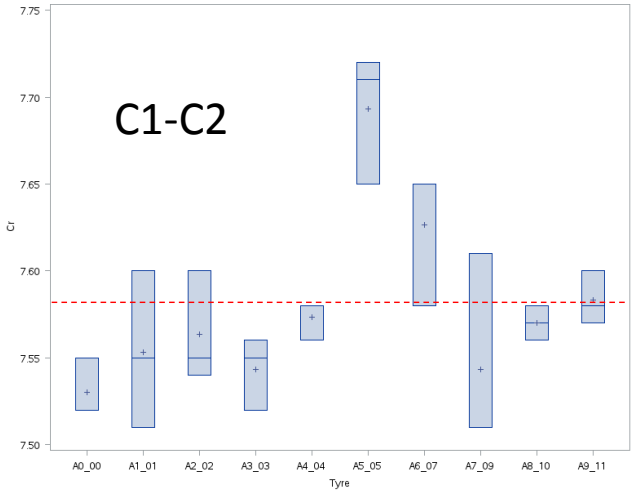
Members of the group (as today)

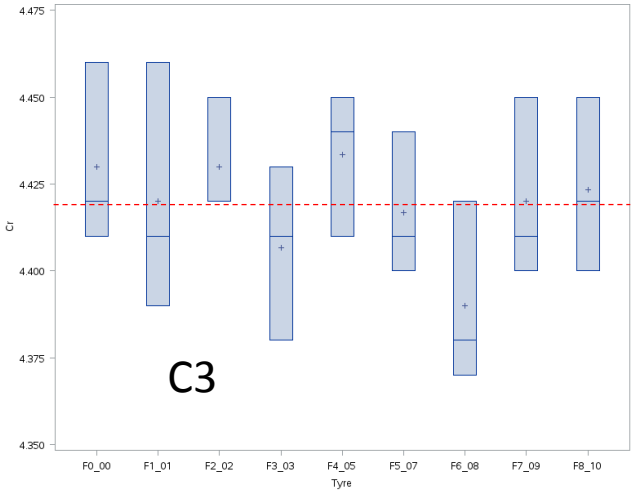
Name of Organisation	Category	Countries/Areas represented	Membership Status
APOLLO VREDESTEIN	Corporate	European	Member
BRIDGESTONE	Corporate	European	Member
CONTINENTAL	Corporate	European	Member
ETRTO	International organization	European	Member
GOOYEAR Luxembourg	Corporate	European	Member
IDIADA	Corporate	Spain	Member
MICHELIN	Corporate	European	Member
PIRELLI	Corporate	European	Member
TÜV SÜD Automotive GmbH	Association	Germany	Member
UTAC	Association	France	Member
ETRMA	Corporate	European	Observer
JASIC	Association	Japan	Observer
NOKIAN	Corporate	European	Observer
RDW	Association	Netherlands	Observer
Swedish Energy Agency	Association	Sweden	Observer
VCA	Association	United Kingdom	Observer

First inter-laboratories results

Pre-test results

- The repeatability of the pre-test data include the variation of the RRC measurement process as well as the evolution of the tyres during the pre-tests.
- The goal of the pre-tests was to analyse the variation within a batch of tyres and to use the results to apply a correction factor if needed.
- The first test is generally not in line with the following
- The maximum variation of the measured RRC coefficient for a set of 10 or 8 carefully selected tyres is:
  - For C1-C2 = -1.42% / +2.12%
  - For C3 = -1.92% / +2.51%





Even if we could consider that these results are not so bad for manufactured products, a correction factor was used to normalize the values for future computerization of regression function for each machine.

This correction makes no change for assigned values calculation.

First inter-laboratories results

Alignment tests results

- The group has decided to run in the alignment tests four tests instead of three and to use only the three last measurements to calculate the average value (Included now in the amendment of Annex IVa of Regulation(EC) No 1222/2009).
- Each tyre has been tested on one machine four times and the average of three last measurements has been recorded.
- From the statistical analysis, the maximum deviation of the assigned values is 1% in the worst case.
- As a conclusion, the risk of laboratory effect is low and it was agreed to keep all the laboratories in the Network.

First inter-laboratories results

Conclusion

- **A pre-test is needed** to monitor the dispersion of the batch of tyres and improve the accuracy of alignment equation for each machine.
- Independently from the variation from one laboratory to another (if they are compliant with the requirement of Annex IVa of Regulation (EC) No 1222/2009) **the system is robust**.
- The pre-test shows that **a first test in the same conditions is necessary** before starting the series of measurements.
- The statistical analysis confirms that the **correlation is very high**.
- **Data formats** to be used for the computations and results need to be defined in Annex IVa of Regulation 1222/2009.
- The accuracy of measured value is improved by this alignment procedure:
  - Maximum deviation from assigned values before alignment
    - **For C1-C2 = -5.10% / +6.35%**
    - **For C3 = -3.65% / ++4.45%**
  - Maximum deviation from assigned values after alignment
    - **For C1-C2 = -2.10% / +2.22%**
    - **For C3 = -1.63% / +1.86%**

First amendment of Annex IVa

- Commission Regulation (EU) No 1235/2011 of 29 November 2011 amending Regulation (EC) No 1222/2009 of the European Parliament and of the Council requires that laboratories testing tyres for the purpose of their labelling shall be aligned to a reference laboratory in compliance with its Annex IVa.

Second inter-laboratories results

Pre-test results

- The repeatability of the pre-test data include the variation of the RRC measurement process as well as the evolution of the tyres during the pre-tests.
- The goal of the pre-tests was to analyse the variation within a batch of tyres and to use the results to apply a correction factor if needed.
- The first test out of four is generally not in line with the three following;
- The maximum variation of the measured RRC coefficient for a set of 10 or 8 carefully selected tyres is:
  - **For C1-C2 = -2.13%, +1.87%**
  - **For C3 = -3.23%, +2.71%**

Second inter-laboratories results

Alignment tests results

- Each tyre has been tested on one machine four times and the average of three last measurements has been recorded.
- From the statistical analysis, the maximum deviation of the assigned values is 1% in the worst case.
- As a conclusion, the risk of laboratory effect is low and it was agreed to keep all the laboratories in the Network.

Second inter-laboratories results

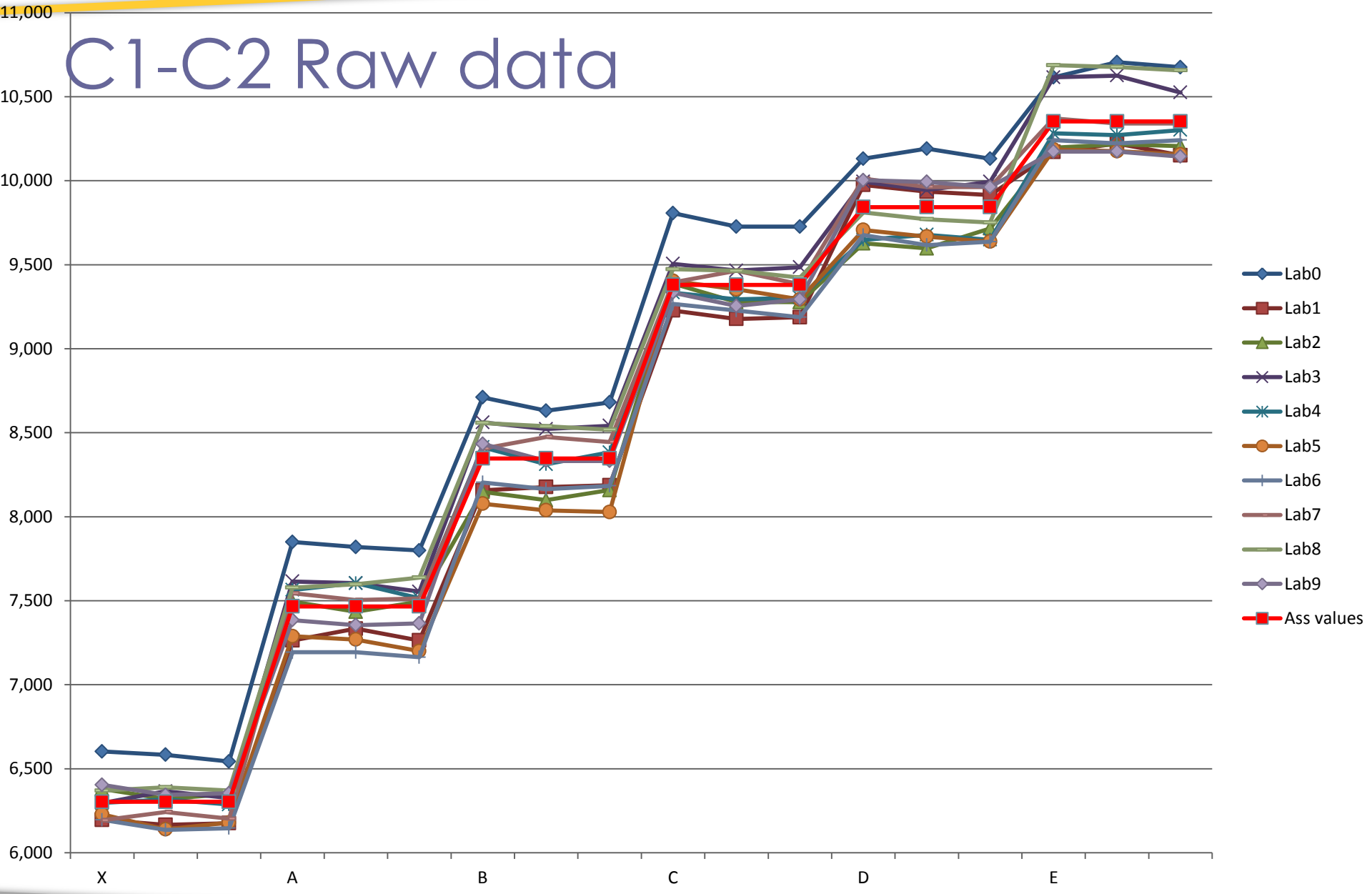
Conclusion

- **A pre-test is needed** to monitor the dispersion of the batch of tyres and improve the accuracy of alignment equation for each machine.
- Independently from the variation from one laboratory to another (if they are compliant with the requirement of Annex IVa of Regulation (EC) No 1222/2009) **the system is robust**.
- The pre-test shows that **a first test in the same conditions is necessary** before starting the series of measurements.
- The statistical analysis confirms that the **correlation is very high**.
- The accuracy of measured value is improved by this alignment procedure:
  - Maximum deviation from assigned values before alignment
    - **For C1-C2 = -3.79% / +4.77%**
    - **For C3 = -3.21% / +5.13%**
  - Maximum deviation from assigned values after alignment
    - **For C1-C2 = -2.11% / +3.24%**
    - **For C3 = -2.17% / +2.21%**

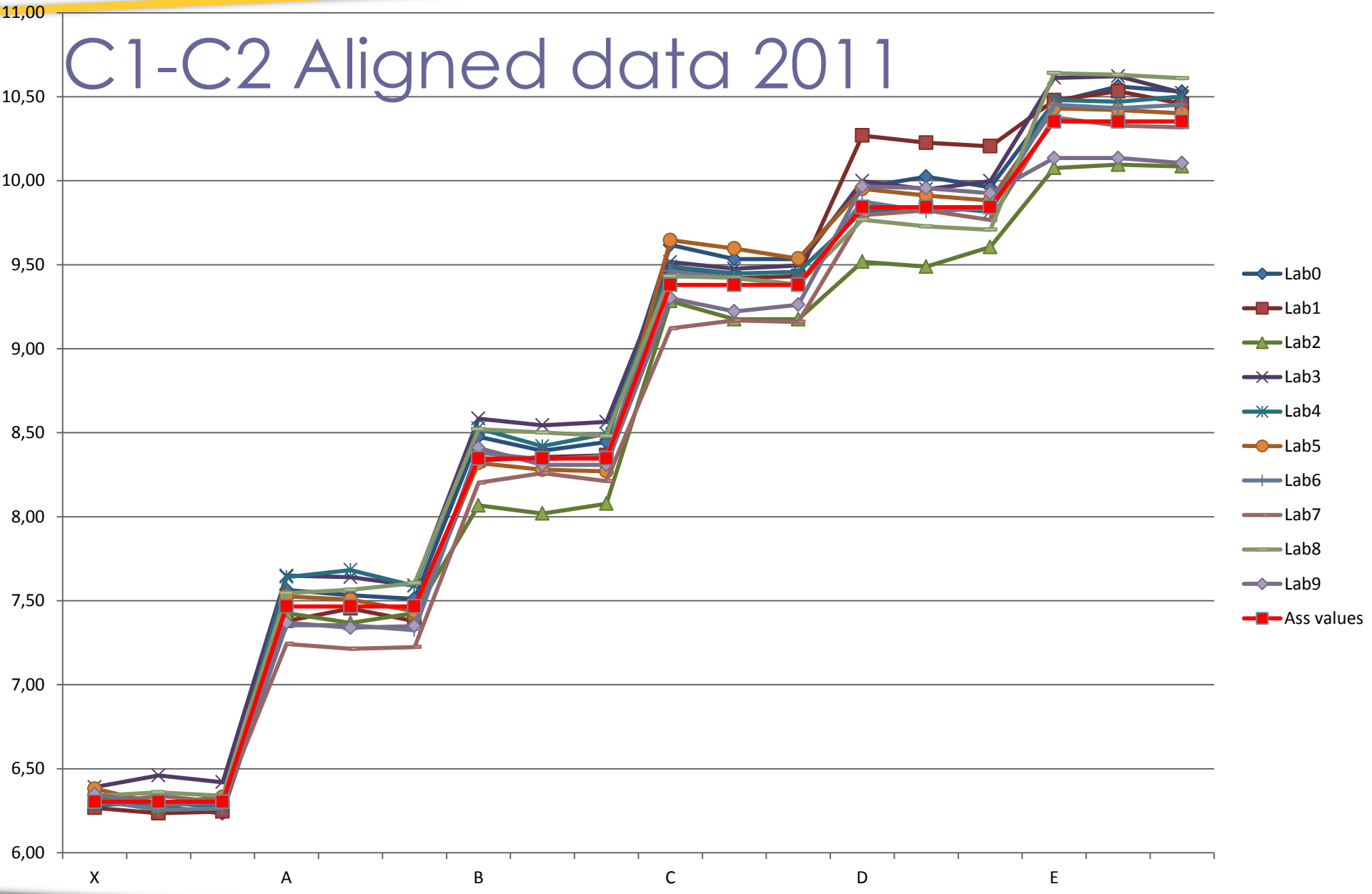
Second amendment of Annex IVa

- Rephrasing needed for seek of clarification.
  - Reference laboratory is linked to reference machine
  - One batch of tyres for each candidate machine
  - Clarification needed in case e.g. the same machine features two measurement spindles.
  - Suppression of the constraints on tyre width and outer diameter, to allow more flexibility in the choice of alignment tyres.
- Introduction of the "ratio of the RR Forces", as a criteria for alignment tyres set selection. It is based on the experience gained during the last alignment, where for C1/C2 tyres, the ratio of the lowest/highest RR force is 2.8, for the C3 tyre set the ratio is 2.4. Fixed values in [N] may create issues in the future with RR forces further decreasing, preventing to get a suitable tyre set complying with the requirement set.
- The review of the assigned values shall be kept iterative every second year in order to monitor the stability and validity of the assigned value.
- Clarification needed to manage possible impacts due to machine's components change or possible machine's drift.
- The candidate machines must be re-aligned every second year.
- Measurement order criteria needed to specify the Candidate Laboratory shall perform the tests before the Reference Laboratory selected.
- Four measurements are needed, the first one in order to stabilise the tyre.
- Introduction of a criterion on the Coefficient of Determination R^2. To limit scatter along the linear regression line and improve the uncertainty of prediction.

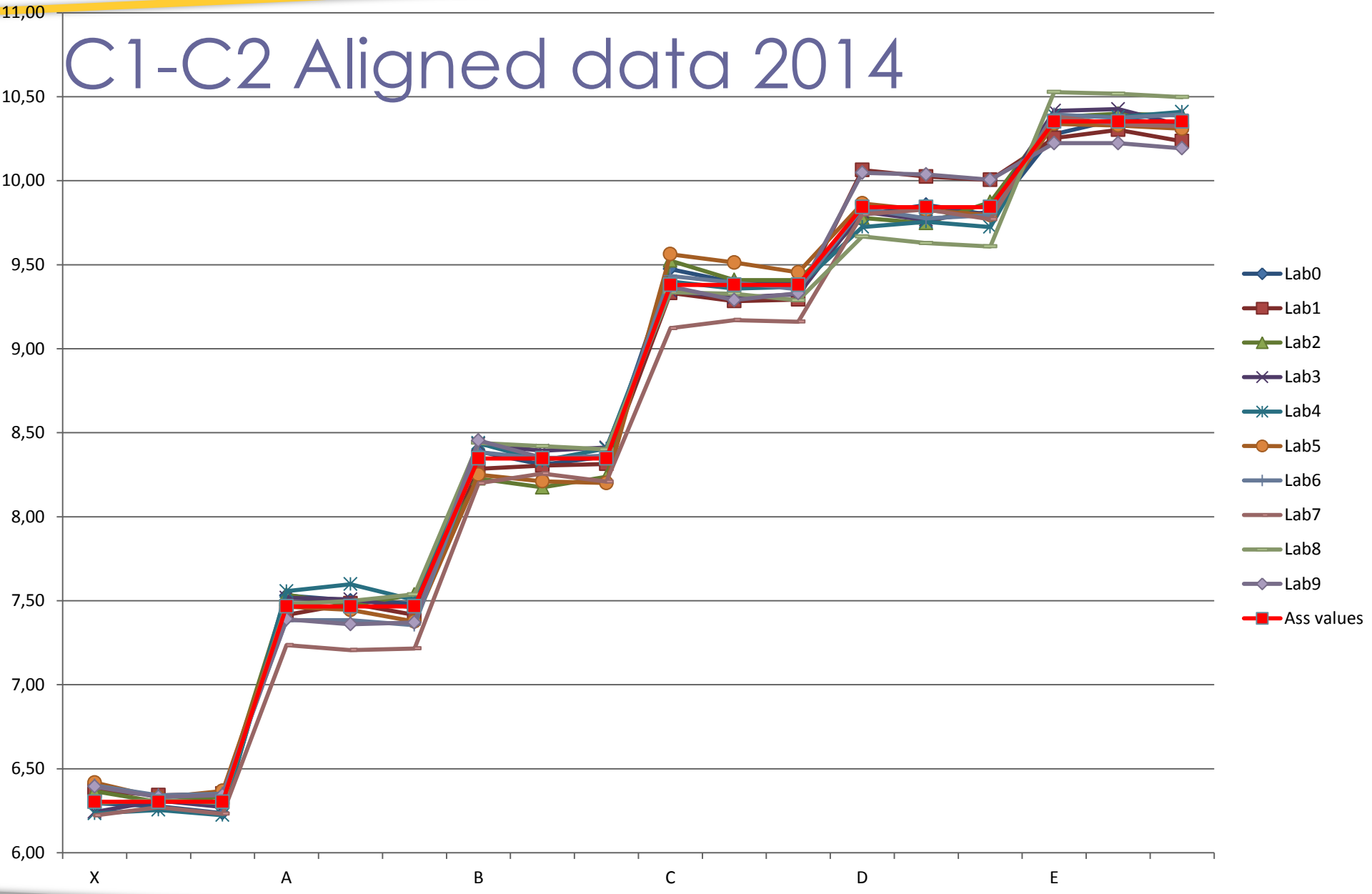
C1-C2 Raw data



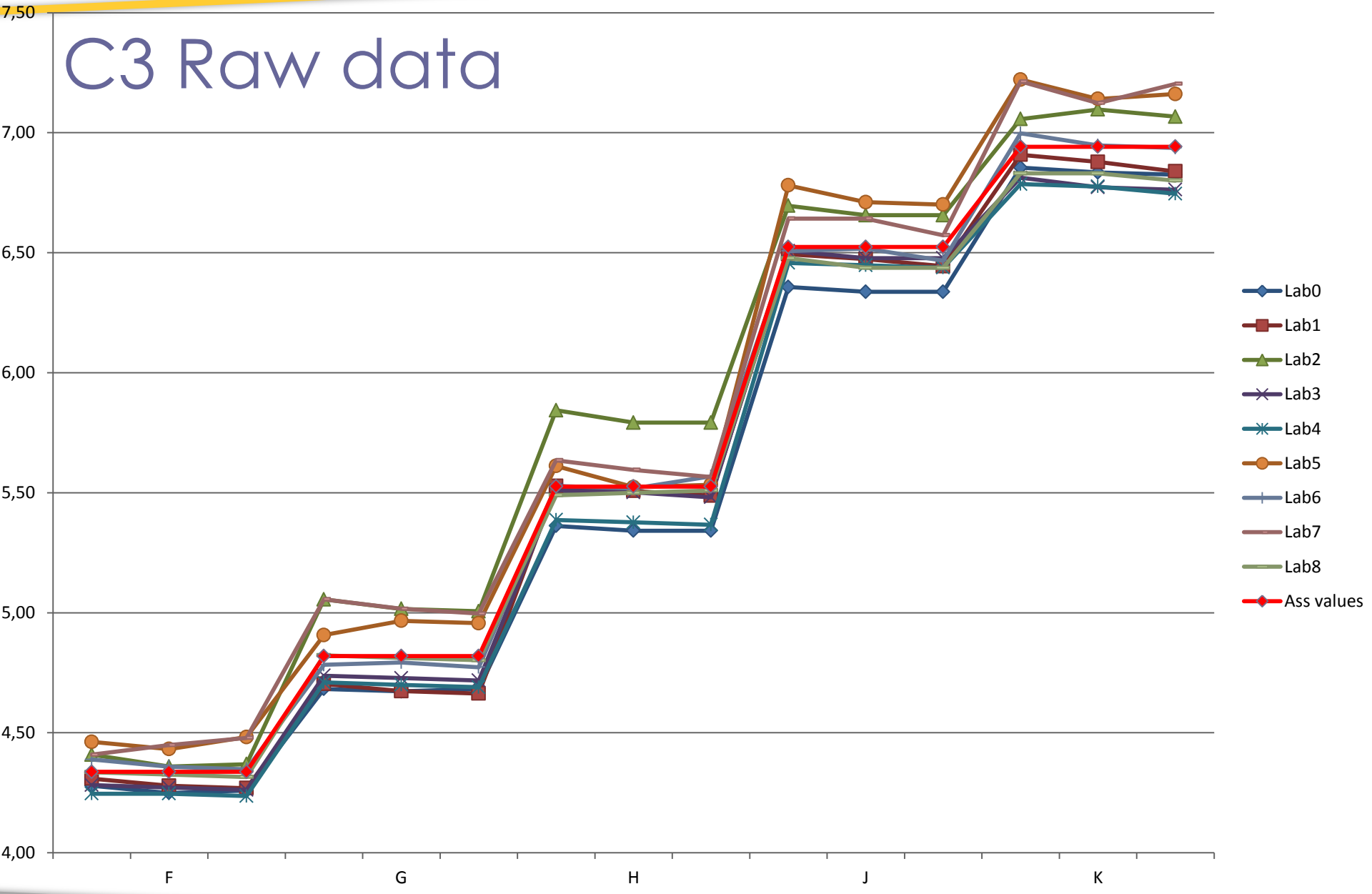
C1-C2 Aligned data 2011



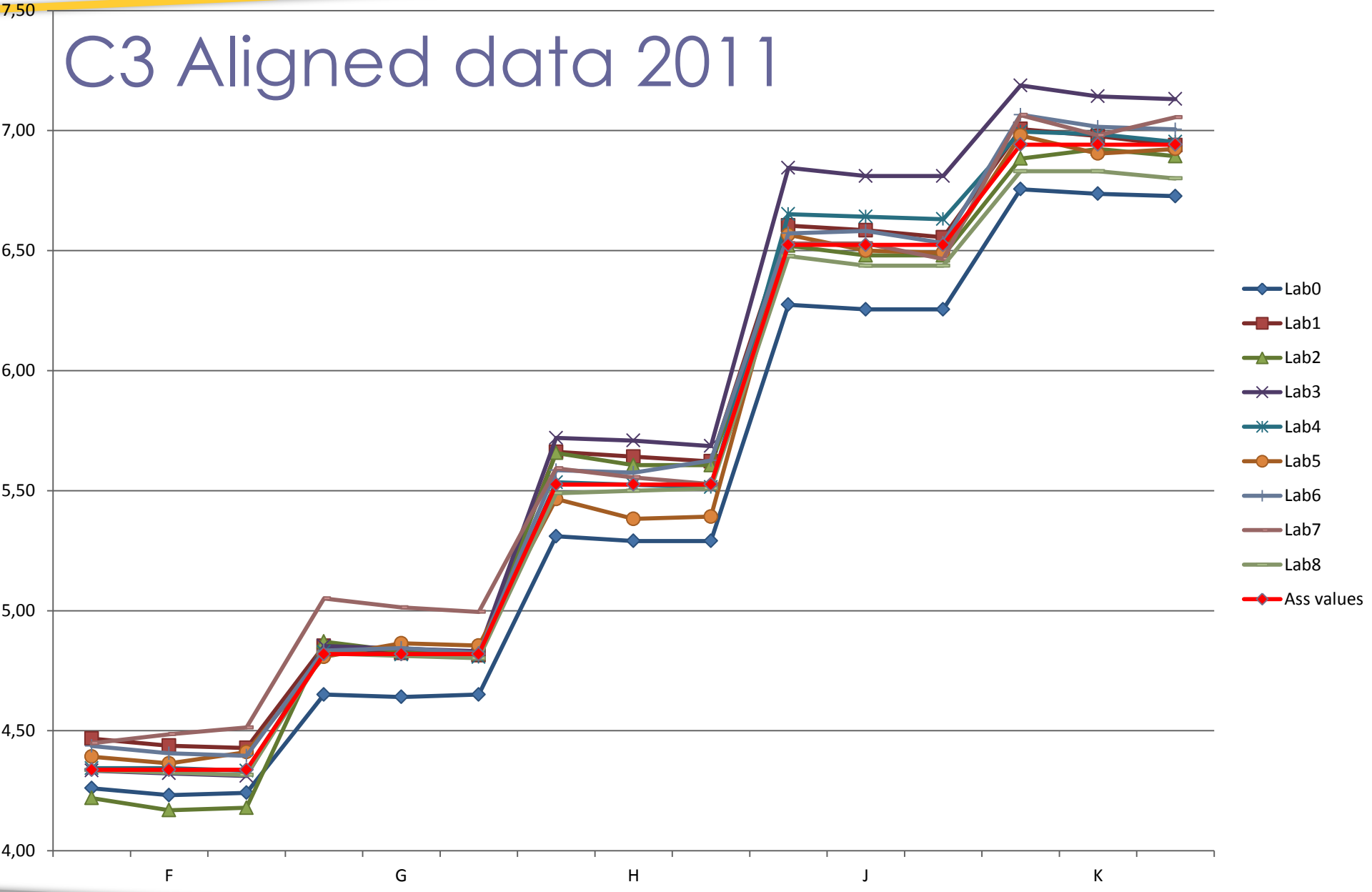
C1-C2 Aligned data 2014



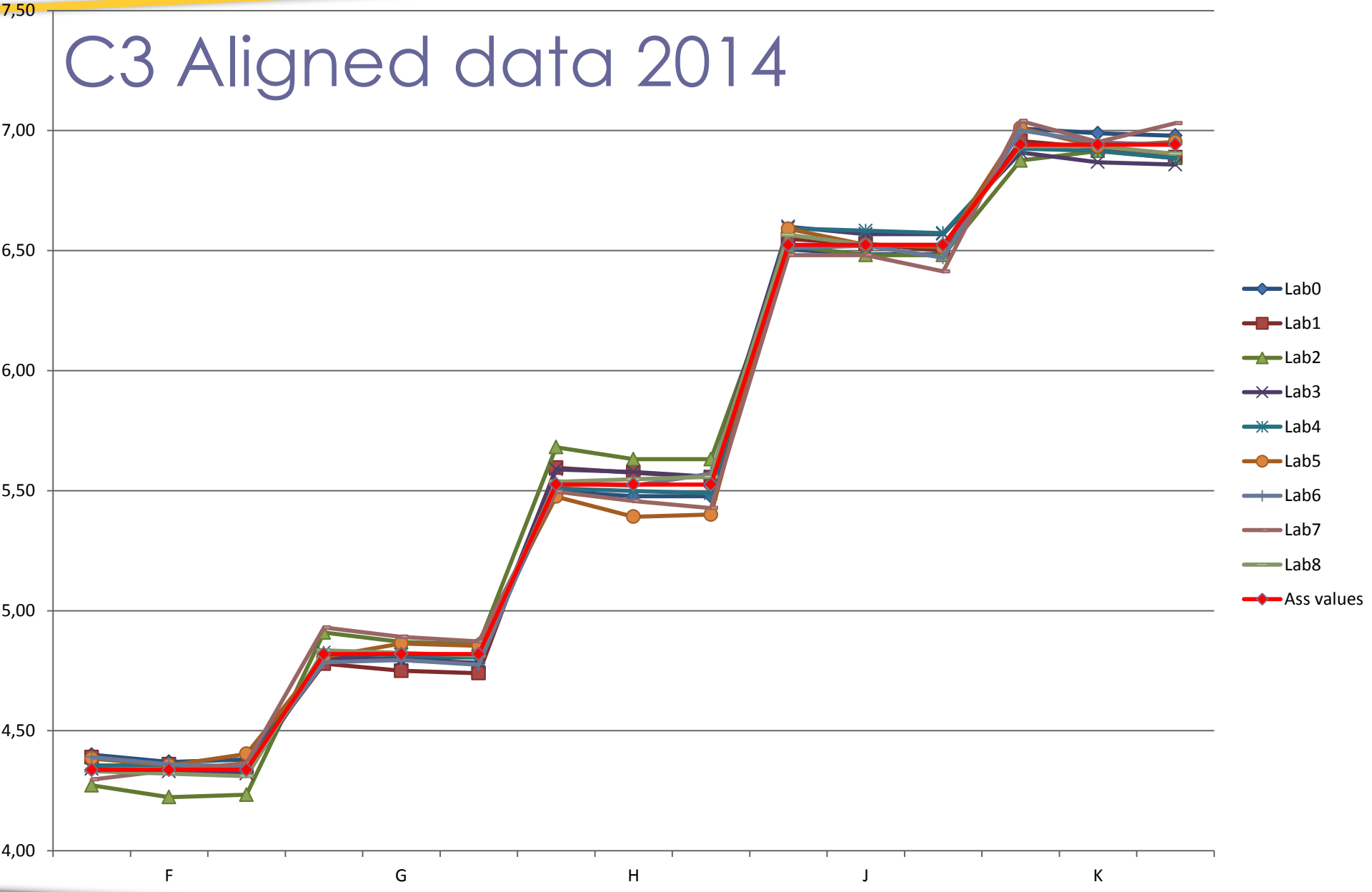
C3 Raw data


7,50
7,00
6,50
6,00
5,50
5,00
4,50
4,00
F
G
H
J
K
Lab0
Lab1
Lab2
Lab3
Lab4
Lab5
Lab6
Lab7
Lab8
Ass values

C3 Aligned data 2011



C3 Aligned data 2014



List of reference laboratories

Reference laboratory	Name/Address
Apollo Vredestein	Vredestein Banden BV Ir. E.L.C. Schiffstraat 370 7547 RD Enschede NEDERLAND
Bridgestone	Bridgestone Technical Center Europe SpA Via del Fosso del Salceto 13/15 00128 Roma RM ITALIA
Continental	Continental Reifen Deutschland GmbH Jaedekamp 30 30419 Hannover DEUTSCHLAND
Goodyear	Goodyear Innovation Center Luxembourg Avenue Gordon Smith 7750 Colmar-Berg LUXEMBOURG
IDIADA	IDIADA Automotive Technology, SA Pol Ind L'Albornar 43710 Santa Oliva ESPAÑA
Michelin	CERL Michelin Zone Industrielle de Ladoux 63040 Clermont-Ferrand FRANCE
Pirelli	Pirelli Tyre SpA Viale Sarca 222 20126 Milano MI ITALIA
TÜV SÜD	TÜV SÜD Automotive GmbH Daimlerstrasse 15 85748 Garching/München DEUTSCHLAND
UTAC	L'Union Technique de l'Automobile du motocycle et du Cycle (UTAC) Autodrome de Linas-Montlhéry avenue Georges Boillot 91310 Montlhéry Cedex FRANCE

Proposal of guidance on how to handle the process of changing alignment equations, both for Reference and Candidate Laboratories

1. **The applicable alignment equation is determined based on the measurement date:**
   A RR test result generated before Jan. 1st, 2015 will be aligned with the old equation and a test result generated from Jan. 1st, 2015 will be aligned with the new equation.

2. **For any candidate machine, current alignment equation are still valid during 2 years following its alignment report issue date**

3. **If from 1st January 2015 a validation check is done on a tyre Label grade, it can be done according to the following multi-steps approach:**

   a. For validation test result generated from 1st January 2015
   => Apply the alignment equation applicable from 1st January 2015

   After this first step (a) if the results confirm the level of the Label grade, the tyre is declared conform.
   If the results do not confirm the level of the Label grade the second step (b) shall be applied.

   b. If Label grade was originally based on an alignment report generated after 1st January 2015, the tyre is declared non-conform and the procedure defined in annex IVa of Regulation (EC) N° 1222/2009 shall be applied.
   If Label grade was originally based on an alignment report generated before 1st January 2015
   => Alignment equation applicable before 1st January 2015 will be applied to these 2015 validation results.

   After this second step (b) if these new results confirm the level of the Label grade, the tyre is declared conform.

   If these new results do not confirm the level of the Label grade, the tyre is declared non-conform and the procedure defined in annex IVa of Regulation (EC) N° 1222/2009 shall be applied.

Thanks for your attention

Full reports under:

http://ec.europa.eu/energy/en/topics/energy-efficient-products-and-labels/tyres