Introduction

This document has been constructed by the ETRTO Working Group on GTR. The aim is to analyse current worldwide regulations concerning the determination of the physical dimensions of passenger car tyres and to harmonize these into a single test method and single set of requirements and tolerances. This document presents both the analysis, the conclusions of that analysis and a proposal with justifications for a new harmonized method and requirements.

On pages 2 and 3 is a table containing pertinent information about all of the physical dimensions tests that are required in the various regulations for passenger car tires around the world.

For the analysis we chose the 2 identical regulations from UN ECE Regulation 30 and the European Union Directive 92/23 as a reference. All other regulations were compared to these 2. Any other choice could have been made for the reference regulations, and the analysis and conclusions would have been identical.

We chose 8 other regulations for passenger car tyres in use throughout the world. Some are from countries that are Contracting Parties to the 1998 Agreement, while others are not.

The list of regulations, listed in the order from the table below, is the following:

1. UN ECE Regulation 30 for passenger car tyres
2. European Directive 92/23 for tyres for motor vehicles
3. USA FMVSS 139: New pneumatic radial tires for light vehicles
4. Australian Design Rule (ADR) 23/01 for Passenger Car Tyres
5. Chinese Standard GB/T 521/2003 for passenger car tyres (and related documents)
6. Gulf Countries, Gulf Standard 53/1986 (and related documents)
7. Indonesian Standard SNI-06-0098-2002
8. Philippines Standard PNS 25-(1994)
9. Indian Standard AIS-044 (2004)
10. Brazilian Standard RTQ-41 (1996) (and related documents)

Table Comparing Different Regulations With Test Method for Physical Dimensions

PHYSICAL DIMENSIONS - COMPARISON OF DIFFERENT REGULATIONS										
Regulation	**Conditioning at test temperature**	**Temperature**	**Rim width**	**Pressure Standard Load**	**Pressure Extra Load**	**Section width, number of points**	**Section width, calculation method**	**Overall Diameter, method**	**Others?**	**Comments**
1958 Agreement CPs, UN/ECE R30	24 hours	ambient room temperature	specified by manufacturer	180 kPa	230 kPa	6, equally spaced	largest measured value of the 6	circumference divided by π (3.1416)	TWI height required, but specified in another section of R30.	These 2 test methods are strictly identical. For the purposes of this comparison, they are taken as the Reference method.
European Union 25 Countries, Dir 92/23	24 hours	ambient room temperature	specified by manufacturer	180 kPa	230 kPa	6, equally spaced	largest measured value of the 6	circumference divided by π (3.1416)	TWI height required, but specified in another section of Directive.	
USA, FMVSS 139	24 hours	20°C to 30°C	specified by manufacturer	180 kPa	220 kPa	6, approximately equally spaced; section width AND overall width	average of 6 values	circumference divided by π (3.14)	Yes, overall width (includes markings, etc.)	Different temperature, different pressure for Extra Load tires. Tolerances for section width and overall width are Standard values (ETRTO, etc.) plus 7% or 10 mm, whichever is greater. There is no tolerance given for overall diameter.
Australia, ADR 23/01	24 hours	ambient room temperature	specified by manufacturer	Measurement pressure specified in "Nominated Standard"; for ETRTO, 180 kPa	Measurement pressure specified in "Nominated Standard"; for ETRTO, 220 kPa	6, approximately equally spaced	average of 6 values	circumference divided by π	Yes, overall width (includes markings, etc.)	Different pressure for Extra Load, different calculation for overall width (average instead of largest value). Tolerances have to comply with nominated standard (ETRTO, etc.). In ETRTO we can take the max SW in service and max OD in service.
China, GB/T 521-2003	3 hours uninflated, 24 hours inflated	18 - 36°C	Standard rim	Pressure given in GB 9743 - 1997 tables; 180 kPa	Pressure given in GB 9743 - 1997 tables; 230 kPa	4, approximately equally spaced	average of 4 values	circumference divided by π	Yes, tread depth and TWI height	Initial certification measurements are performed by Chinese lab, but COP is done by manufacturer. Temperature, pressures are different from Reference method. Tolerance section width = +-3.5%; overall diameter = +-1%

Gulf Countries, Gulf Standard 53/1986	24 hours	23±2°C	a measuring rim	170 kPa	200 kPa	6, approximately equally spaced	average of 6 values	circumference divided by π (3.1416)	No	Different pressures. Tolerances for section width and diameter given in separate tables of GS51, not same as Standards (ETRTO, etc.)
Indonesia SNI-06-0098-2002	24 hours	20 - 30°C	from Tables included in Standard, similar to ETRTO	180 kPa	220 kPa	Overall width, not section width 4, approximately equally spaced	average of 4 values	circumference divided by π (3.1416)	Yes, TWI height.	Only overall width measured (not section width). Tolerances given in tables per size, but not same as Standards (ETRTO, etc.)
Philippines PNS 25-(1994)	24 hours	ambient room temperature	from Tables included in Standard	180 kPa	220 kPa	Overall width, not section width 4, equally around	average of 4 values	circumference divided by π (3.1416)	Yes, TWI	Tolerances for section width and outside diameter are given in tables.
India AIS-044 (2004)	24 hours	ambient room temperature	specified by the manufacturer	180 kPa	230 kPa	Overall width 6, equally spaced	Highest measurement	circumference divided by π (3.1416)	Yes, TWI height.	Tolerances for overall width and diameter given in tables, but not same as Standards (ETRTO, etc.). For sizes not in list, use existing tyre Standards.
Brazil RTQ-41 (1996)	24 hours	ambient room temperature	specified by the manufacturer	180 kPa	230 kPa	Overall width, 6, equally spaced	Highest measurement	circumference divided by π (3.1416)	Yes, TWI height.	Overall width only takes into account lettering, etc. on ONE sidewall. Tolerances given in tables in separate document, but not same as Standard (ETRTO, etc.)

Conclusions of the Comparison

1. Conditioning requirements are slightly different for one regulation.
2. Two different methods are required for the differing pressures of Standard Load tires (170 kPa and 180 kPa).
3. Three different test methods are required for Extra Load tires to cover the pressure differences (200 kPa, 220 kPa and 230 kPa)
4. Although the same test method and conditions can be used to determine section width and overall width, each tire has to be measured at 8 different points to comply with the 2 requirements (6 points or 4 points). In addition, some requirements call for the maximum value, some call for an average of the 4 or 6 measures.
5. The only difference in overall diameter is that the constant pi (π) is sometimes cited as 3.14, sometimes as 3.1416. The difference is negligible.
6. TWI measurements are not always cited in the same part of the regulations, but in general it is required to measure their height. One regulation requires TWI, but doesn't specify how many and how high. Another regulation requires that tread depth (needed to determine TWI height) must also be reported.

Discussion and Justifications of Proposed Measurement Method

- **Overall objectives of the test**
  This test is used to determine the physical dimensions of a tyre. The dimensions are necessary to insure interchangeability between different brands or makes of tyre. The values to be measured are reported at the level of millimetres (except tread wear indicators, reported at the level of 0.1 mm). Modern measurement technologies easily allow for such precision, and extraordinary precautions during the conduct of the method are not required.

- **Conditioning**
  Only one regulation uses different conditioning requirements than the others. It therefore seems logical to accept the conditions required by the majority, which specifies 24 hours of conditioning at the test temperature and pressure.

- **Temperature**
  This test is a manual operation. Most regulations specify ambient room temperature as adequate. In order to avoid the additional cost of measurement rooms with climate control systems, and the constraints of requiring workers to do these measurements in very hot conditions, the measurements can be done at ambient temperature without significantly affecting the outcome or the reproducibility. In order to avoid unusual or extreme conditions, we propose to define ambient temperature as between 18°C and 36°C.

- **Rim width**
  All regulations currently allow the test rim width to be specified by the manufacturer. We propose to continue this practice.

- **Pressure**
  All countries specify a pressure for standard load tyres, and a higher one for extra load (also known as "reinforced") tyres. For standard load tyres, one regulation requires 170 kPa (100 kPa = 1 bar), whereas all the others require 180 kPa. Since the tyre can only increase in dimensions with increasing pressure, it was decided to request 180 kPa as the pressure for standard load tyres, knowing that if a tyre passes at 180 kPa it will automatically pass at 170 kPa. The ETRTO, JATMA and T&RA standards also recommend 180 kPa for these types of tyres.
  For extra load tyres, there are 3 different requirements: 200 kPa, 220 kPa and 230 kPa. It was felt that the best compromise was the value of 220 kPa, which corresponds to the recommended value in the ETRTO and T&RA standards and FMVSS 139.
  For bias ply and bias-belted tyres we recommend using the pressures given in UNECE Regulation 30. T-type temporary spares are inflated to 420 kPa, and we recommend this as the test pressure.

- **Section width**
  In general the section width is determined at 6 approximately equally spaced points around the tyre. Three regulations only require measurements at 4 points around the tyre. It is

certainly true that 4 points are sufficient to measure a modern tyre; it was decided then, also in the interest of efficiency, to require measurement at 4 points. The reported value should be the average of these 4 measurements.

- **Overall width**
  As with section width, the most efficient and logical choice is to require 4 measurement points spaced approximately equally around the tyre, and report the average of these measurements.

- **Outside diameter**
  The only difference in the studied regulations was the numerical value of the physical constant pi. In some cases it was given as 3.14, and in others as 3.1416. We have decided that the overall diameter should be the measured circumference of the tyre divided by 3.1416 and rounding to the nearest integer.

- **TWI**
  The number and placement of the tread wear indicators is not part of this section of the gtr, but for the purposes of this proposal we have assumed that current practice applies. In other words, we assume there are at least 6 rows of TWIs approximately equally spaced around the tyre, except for tyres with rim diameters smaller than 12 inches, where there are at least 4 rows. For the determination of the height of these TWIs, the different regulations treat the subject very differently. A compromise solution is proposed here. We think it is reasonable to measure one indicator chosen at random in 6 rows of indicators (only 4 rows for tyres with less than 12 inch rim diameter) and to take the average of the 6 (or 4) measured indicators as the reported value for tread wear indicator height. We do not propose to report tread depth, as required by one regulation.

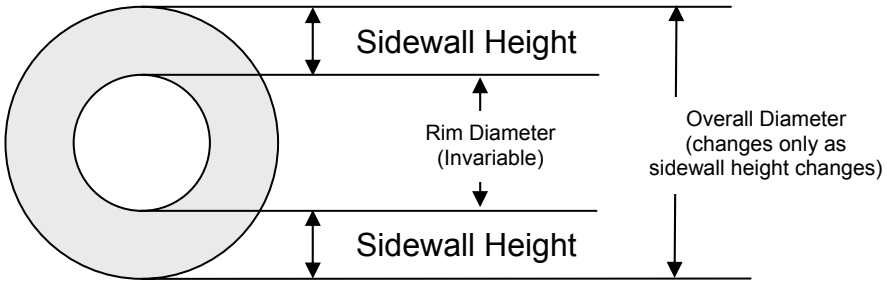
Discussion and Justifications of Proposed Tolerances

- **General Discussion**
  The tolerances for section width, overall width and overall diameter can vary from one regulation to another. In the gtr for tyres, we must propose a harmonized set of tolerances for all the physical dimensions. In general, it seemed most logical to propose the tolerances already in use by the majority of the regulations. A spreadsheet was created which allows the numerical values of the different tolerances for 5 commonly used tyre sizes to be compared.

- **Section width (See examples of the tolerances applied for 5 different tyre sizes in Annex 1)**
  Based on calculations for some commonly occurring tyre sizes, the UN ECE Regulation 30 and EU Directive 92/23 tolerances are more severe than any other regulation studied in this analysis except those from the Gulf Coast Countries, where a narrower rim width is specified than the one given by the ETRTO standard. If the Gulf Coast Countries tolerances were expressed for the same rim width as the other regulations, they would be larger than those in UN ECE Regulation 30. We therefore propose to use the same formula as the one in Regulation 30 and Directive 92/23 for the calculation of tolerances for section width.

- **Overall width (See examples of the tolerances applied for 5 different tyre sizes in Annex 2)**
  Most of the studied regulations do not differentiate in a clear manner between the tolerances for section width and those for overall width.

- **Outside diameter (See examples of the tolerances applied for 5 different tyre sizes in Annex 3)**
  In theory, the tolerances for the overall diameter should be based on the sidewall height, since the rim diameter is considered invariable (see drawing below). Since any variability in sidewall height affects the overall diameter twice, the tolerances for overall diameter should be expressed as 2 times the tolerance for sidewall height.



From least severe (largest tolerance) to most severe, the outside diameter tolerances in the regulations can be classified as follows:

- FMVSS 139 has no tolerances
- Regulation 30, Australia, the Gulf Coast Countries and the Philippines use 2 times 4% of the sidewall height (since there are 2 sidewalls included in the overall diameter).
- Indonesia, Brazil and India use 2 times 3% of the sidewall height
- China uses 1% of the design overall diameter

It would seem logical to exclude FMVSS 139, which does not specify tolerances on overall diameter.

The Chinese tolerances are based on the design overall diameter instead of the sidewall height. The rim is not part of the dimensional tolerances of the tyre, so it seems scientifically unjustified to use a tolerance that takes into account a part of the assembly that does not change with the tyre diameter. We propose to exclude this definition.

Of the remaining regulations, four use 2 times 4% (i.e. 8%) of sidewall height, and three use 2 times 3% (i.e. 6%) of sidewall height.

We therefore propose to use the definition adopted by the majority, i.e. ± 2 times 4% (i.e. ± 8%) of sidewall height.

- **TWI**

  Australia gives a tolerance for tread wear indicators that would allow, in theory, their height to be less than 1.6 mm (minimum 1.35 mm in ADR 23/01). In the USA, the tolerances are given in another regulation, which specifies that they can not be less than 1.6 mm. All the other regulations give tolerances for tread wear indicators that allow for a range of values from 1.6 to 2.2 mm (1.6 mm -0, +0.6). We propose to use these last tolerances.

Annex 1: Calculation of maximum allowed Section Width for several sizes, according to the different regulations

									Section Width								
									Tolerances for Maximum Section Width								
Size	Nominal Section Width, SN in mm	Nominal rim diam (d, in mm)	Sidewall Height (H = 0.5 (D-d))	Aspect ratio (fraction)	Measurement Rim (A) from ETRTO	Theoretical Rim Width (A1= SN * R)	Theoretical Section Width (R30)(S = S1 + K(A-A1)	Design ETRTO	R30/ Dir 92/23	FMVSS 139	ADR 23/01	China, GB/T 521-2003	Gulf Countries, Gulf Standard 53/1986	Indonesia SNI-06-0098-2002	Philippine PNS 25-(1994)	India AIS-044 (2004)	Brazil RTQ-41 (1996)
175/70 R 13	175	13	122,9	0,70	5,0	4,8	175,1	177	182,1	189,4	184,0	183,2	183,0	184,0	186,0	184,0	184,1
185/65 R 14	185	14	120,2	0,65	5,5	5,1	185,2	189	192,6	202,2	197,0	195,6	191,0	197,0	195,0	???	196,6
195/65 R 15	195	15	107,5	0,65	6,0	5,4	195,3	201	203,1	215,1	209,0	208,0	204,0	209,0	204,0	209,0	209,0
205/55 R 16	205	16	94,8	0,55	6,5	5,6	205,3	214	213,6	229,0	223,0	???	211,0	223,0	215,0	223,0	222,6
225/45 R 17	225	17	82,1	0,45	7,5	6,2	225,5	225	234,5	240,8	234,0	???	???	???	???	???	234,0

* The rim width for these tolerances is ½ inch less than the usual measurement rim width. If the wider rim is used, these tolerances would be greater than those from UN ECE Regulation 30.

Annex 2: Calculation of maximum allowed Overall Width for several sizes, according to the different regulations

									Overall Width								
									Tolerances for Maximum Overall Width								
Size	Nominal Section Width, SN in mm	Nominal rim diam (d, in mm)	Sidewall Height (H = 0.5 (D-d))	Aspect ratio (fraction)	Measurement Rim (A) from ETRTO	Theoretical Rim Width (A1= SN * R)	Theoretical Section Width (R30)(S = S1 + K(A-A1)	Design ETRTO	R30/ Dir 92/23	FMVSS 139	ADR 23/01	China, GB/T 521-2003	Gulf Countries, Gulf Standard 53/1986	Indonesia SNI-06-0098-2002	Philippine PNS 25-(1994)	India AIS-044 (2004)	Brazil RTQ-41 (1996)
175/70 R 13	175	13	122,9	0,70	5,0	4,8	175,1	177	190,1	189,4	184,0	183,2	183,0	184,0	186,0	184,0	184,1
185/65 R 14	185	14	120,2	0,65	5,5	5,1	185,2	189	200,6	202,2	197,0	195,6	191,0	197,0	195,0	???	196,6
195/65 R 15	195	15	107,5	0,65	6,0	5,4	195,3	201	211,1	215,1	209,0	208,0	204,0	209,0	204,0	209,0	209,0
205/55 R 16	205	16	94,8	0,55	6,5	5,6	205,3	214	221,6	229,0	223,0	???	211,0	223,0	215,0	223,0	222,6
225/45 R 17	225	17	82,1	0,45	7,5	6,2	225,5	225	242,5	240,8	234,0	???	???	???	???	???	234,0

Annex 3: Calculation of maximum allowed Overall Diameter for several sizes, according to the different regulations

									Overall Diameter								
									Tolerances for Maximum OD								
Size	Nominal Section Width, S_N in mm	Nominal rim diam (d, in mm)	Sidewall Height (H in mm)	Aspect ratio (fraction)	Measurement Rim (A) from ETRTO	Theoretical Rim Width (A1= S_N * R)	Theoretical Outer Diameter (R30) (D = d+2H)	Design ETRTO	R30/ Dir 92/23	FMVSS 139	ADR 23/01	China, GB/T 521-2003	Gulf Countries, Gulf Standard 53/1986	Indonesia SNI-06-0098-2002	Philippines PNS 25-(1994)	India AIS-044 (2004)	Brazil RTQ-41 (1996)
175/70 R 13	175	13	122,9	0,70	5,0	4,8	576	576	586	NA	586	582	590	583	588	583	583
185/65 R 14	185	14	120,2	0,65	5,5	5,1	596	596	606	NA	606	602	606	603	606	???	603
195/65 R 15	195	15	127,0	0,65	6,0	5,4	635	635	645	NA	645	641	645	643	645	643	643
205/55 R 16	205	16	112,8	0,55	6,5	5,6	632	632	641	NA	642	???	641	639	641	639	639
225/45 R 17	225	17	101,1	0,45	7,5	6,2	634	634	642	NA	642	???	???	???	???	???	640
Comments ---->									R30 uses a tolerance of 4% of the sidewall height	FMVSS 139 has no tolerances on OD	ADR uses the tolerances of the "nominated standard", in this case ETRTO, + R30	China has a fixed tolerance of 1% of the design OD (column I)	SASO uses 4% of sidewall height	Indonesia uses 3% of sidewall height	Philippines uses 4% of sidewall height, the same as R30	India uses 3% of sidewall height	Brazil uses 3% of sidewall height