MORE THAN 50 YEARS OF STANDARDISATION

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INDEX

ETRTO – MORE THAN 50 YEARS OF STANDARDISATION
(How - When - Why)

1. ETRTO

1.1 Before 1964

In June 1952 the Economic Commission for Europe of the United Nations (UN-ECE) established Working Party 29 (WP.29) as "Working Party of Experts on Technical Requirement of Vehicles" with the task to establish uniform rules for the construction of vehicles and their components.

An Agreement was signed in Rome in 1956 in the form of an exchange of letters (indirectly sponsored by WP.29) between the governments of the Federal Republic of Germany, France, Italy and the Netherlands, on the subject of adoption of uniform and harmonized requirements for headlamps emitting an asymmetrical passing beam.

Promoted by Dr. Sergio Vittorelli, (Technical Director of the tyre division in Industry Pirelli SpA) through CUNA, and under his active chairmanship the major European National Organisations active on tyre standardisation:

- CUNA - (Commissione per l'Unificazione Ne 11' Automobile) -Italy
- WdK - (Wirtschaftsverband der Deutschen Kautschukindustrie) - Germany
- SMMT - (Society of Motor Manufacturers & Traders)- United Kingdom
- BNA - (Bureau National de l' Automobile) - France
- TNB - (Travaux de Normalisation du Benelux) - BeNeLux
- SIS - (Swedish Institute for Standardisation) - Scandinavia

met in Torino on 30 April 1956 with the aim to *'align national standards in order to achieve interchangeability of tyres, wheels and valves'* and eventually establish a common organisation, thus originating the European Tyre and Wheel Technical Conference (ETWTC). ETWTC established an Executive Committee and some Working Groups (PC, CV, AGR, INP) to try and harmonise the national standards for these tyres and the relative rims.

The TRANSPORT division of UNECE on 20 March 1958 agreed on the proposal made by WP29: "*Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts*" (1958 Geneva Agreement), that entered into force on 20 June 1959 with attached Regulation N.1 "*Uniform provisions concerning the approval of motor vehicle headlamps emitting an asymmetrical passing beam and/or a driving beam and equipped with filament lamps of categories R2 and/or HS1*".
To fulfil with the requirements of the 1958 Agreement, WP29 created amongst others a "Group de Rapporteurs sur les Pneumatiques (GRPN)" with the scope to prepare Regulations aimed at the type approval of tyres. Later on GRPN was merged with the "Group de

Rapporteurs sur le Freinage", thus creating the new "Groupe de Rapporteurs sur le Roulement et Freinage (GRRF)".
At the beginning of the 60s some USA eastern states published the first tyre safety standard (the" V-1" standard).

In order to offer WP.29 a unique representation of the European Tyre Manufacturers from 1956 to 1964, ETWTC held 8 General Meetings, hosted by the national organisations (plus Austria and Switzerland), and the Executive Committee prepared a draft Constitution for the new official Organisation.

At their meeting on 15 October 1964 in Montreux (CH) the General Meeting of ETWTC completed its task and approved the creation of the new organisation named European Tyre and Rim Technical Organisation (ETRTO), the relevant Constitution and the Rules of Procedure. The European Tyre and Wheel Technical Conference (ETWTC) was disbanded.

1.2 The new Organisation

The new organisation nominated a General Secretary (L. J. Lambourn) based in Birmingham (UK).
The Organisation was constituted by Full Members (Tyre, Rim and Valve manufacturers having production facilities in Western Europe), Corresponding Members and Associate Members (the original national organisations, where in the meantime SMMT had been replaced by BRMA and SIS by STRO. Later on, BNA was replaced by TNPF).

An Executive Committee formed by 11 members (nominated by the Associate Members: 2 each from France, Italy, Germany, Great Britain and 1 each from Scandinavia, Benelux, Austria/Switzerland) was established.

Mr. Sergio Vittorelli was nominated Honorary President.

Similarly, as in the Tire and Rim Association Inc., technical Sub-Committees were created to deal with Passenger Car tyres, Commercial Vehicle tyres, Agricultural tyres, Motorcycle and Cycle tyres, Earthmoving tyres, Industrial pneumatic tyres and Valves. Rim contours were under the responsibility of each tyre Sub-Committee.

A special Sub-Committee (Road Safety) was also created with ad-hoc assignments to deal with the '*Recommendations on tyre use and maintenance*' as well as to interact with governmental agencies (mainly WP29-GRPN and NHTSA because of the '*National Traffic and Motor Vehicle Safety Act*' issued by the USA in 1966) on the subject of tyre Regulations.

Members of the Committees were nominated by the Associate Members (two each) and also manufacturers of other countries (i.e. Spain, Austria, Switzerland and Turkey), where no Associate Member was active, could nominate one delegate.

The first General Meeting of ETRTO took place in Roma on 30 September 1965 and the Organisation did count 67 Full Members (50 Tyre, 13 Rim and 4 Valve) from 17 eastern European countries, inclusive Turkey, and two Corresponding Members (SATMC-South African Tyre Manufacturers' Conference and JATMA- Japan Automobile Tyre Manufacturers' Association).

Meetings of the Technical Sub-Committees were organised and managed by the Associate Members and were conducted and reported in the three official languages (English, French and German); only the Executive Committee was organised and managed by the Secretary General.
Only in 1969 the first ETRTO Data Book was published under the responsibility of the new Secretary General, Mr. R. Debesson, based in Montluçon (France).

The first ETRTO premises were installed in Bruxelles, Avenue Brugmann, 32 only in 1973.

The Rim Sub-Committee started as a Working Group in 1973, organised by the Secretary General (their technical data were then transferred to the relevant tyre Sub-Committees for approval) and became an independent Sub-Committee only in 1976.

The Solid Tyre group, originally created by WdK and whose standards were hosted in the ETRTO Data Book, became officially an ETRTO Sub-Committee in 1989 and a new category "Affiliated Members" was created to include their manufacturers.

Starting in 1976, with the new Secretary General Mr. J. Trimble, the Secretariat and management of the various Sub-Committees was gradually transferred to ETRTO and meetings convened in Bruxelles.
From 1982 the Secretariat of all Sub-Committees was managed by the Secretary General and from 1991 all Sub-Committee meetings were convened in Bruxelles.

From the edition 1987, the "Data Book" was renamed "Standards Manual".

2. LOAD INDEX AND SPEED SYMBOL

2.1 Preamble

Since 1969, FMVSS109 did require that the maximum load (lbs) and corresponding maximum pressures (psi) be marked in clear on the tyre sidewalls of Passenger Car tyres. No speed requirement was specified due to the national speed limit.

At the origin of the service description (load index and speed symbol) marking was the necessity to define (as requested by UNECE-GRPN) a marking, to be placed on the tyres in order to clearly identify the actual tyre load capacity as well as the tyre speed capability, initially for Passenger Car tyres only, as a requirement of the new Regulation under development (known as ECE Regulation N.30, issued in 1975).

At that time, the tyre versions were identified only by the marking of the traditional Ply Rating (PR), but that indication had no direct relation to the actual load value.

Moreover, as in Europe, differently from the USA where an interstate speed limit of 50 mph (80 km/h) was in force, there was a specific attribution of maximum speed capability depending on tyre size and structure, as follows:

Type	Max speed (km/h)	Radial tyres	Diagonal tyres
Passenger Car	120		Rim diam =10”
	140		Rim diam =12”
	150	M+S Reinforced marked “SR” and marked “R”	Rim diam >= 13”; Rim diam =10” marked “S”
	160	M+S marked “SR”	Rim diam =12” marked “S”
	170	Reinforced marked “SR”	
	180	Marked “SR”	Rim diam >=13” marked “S” Rim diam =10” marked “H”
	190	M+S marked “HR”	Rim diam =12” marked “H”
	200		Rim diam >=13” marked “H”
	210	Marked “HR”	
	>210	Marked “VR”	Rim diam >=13” marked “V”
Commercial Vehicles	80	SW >12.00	SW >12.00
	100	Truck	Truck
	120	Light Truck (C type)	Light Truck (C type)
Motorcycles	50		Mopeds
	80		Some small c.c
	100		Small cubic capacity and standard rim diam <=12”
	130		Standard code designated
	150		Standard metric designation
	180		Marked “S”

Speed Category Marking (S, H or V) used to be part of the size designation (e.g. 5.60-13, 5.60 S 13, 185 R 16, 185 SR 16; 185 VR 16) where “S” meant “Speed”, “H” meant “High speed” and “V” meant “Very high speed”.
“C” (“Camionnette”) suffix was intended as a speed category marking for light truck tyres.

2.2 Load index

The first attempt to identify the load capacity of the tyre was to mark it in clear (kg) on tyre sidewalls. But there were some reactions from UK and USA (in ISO/TC31) because they wanted also the marking in pounds (lbs), though that was out of acceptable units in ISO. Moreover the indication of one load in clear would create problems with the load/speed table of bonuses already applied for CV tyres.

Therefore the ETRTO PC Sub-Committee (after a first proposal made by Michelin, during four meetings held in 1973 and with agreement of ISO/TC31/SC3) proposed to adopt an index to identify the reference tyre load carrying capacity. The Renard “series of preferred numbers” (as per ISO standards N.3, N.17 and N.497 published in 1973) was identified as suitable for the scope.

To allow enough differentiation between load capacities, the Renard 80 series was selected. Moreover in agreement with T&RA it was decided to start with the value of 45 kg (100 lbs) assigned to load index (LI) “0”.
Thus: *Load (kg) = $45*10^{LI/80}$ rounded as per the ISO series*.

ECE Regulation N.30 was then first issued on April 1975 with the requirement to mark the load index on the tyre sidewalls for the identification of the tyre load capacity.
ETRTO, in 1974 Data Book, first published load indices aside some tyre sizes starting with Passenger Car tyres (only in the 1977 edition all PC sizes were associated with a load index). Then, the other Sub-Committees also followed this practice.
In the case of LT and CV tyres, since there was no fixed ratio between loads in single and in dual formation, it was agreed to adopt a double marking of the load index, single fitment/dual fitment (e.g. 154/146).

2.3 Speed symbol

Because of the confused situation in the identification of the tyre maximum speed, as shown in the table above, and with the aim to identify it with a unique symbol, it was decided to assign a letter to each existing speed value (possibly in alphabetical sequence) with the exception of letters "I" and "O" to avoid possible confusions with "1" and "0".
In order to maintain continuity with the consolidated practice and the market customary acceptance, the PC Sub-Committee (in agreement with ISO/TC31/SC3) in 1973 decided to assign the letter "S" to 180 km/h and the letter "H" to 210 km/h.
Other speed symbols were assigned consequently with steps of 10 km/h.

ECE Regulation N.30 was therefore first issued on April 1975 with the requirement to mark the speed symbol aside the load index on the tyre sidewalls to identify the maximum tyre speed capability.
The following table was then published, accepting that "H" was the last value and exceptionally out of the alphabetical sequence.

Speed Symbol	Maximum speed (km/h)
L	120
M	130
N	140
P	150
Q	160
R	170
S	180
T	190
U	200
H	210

At that time "V" speed category tyres were very few and tailor made only for some very special fast cars (Ferrari, Aston Martin, Bugatti, etc) and therefore out of the scope of ECE Regulation N.30.

For some time it was accepted to have on the tyre sidewalls both the 'speed category marking' and the 'speed symbol' (e.g. 185/70.SR 13 86S), but gradually, for the new lines of tyres the 'speed category marking' disappeared from the size designation.
When, later on, ECE Regulation N.54 was published in 1983, also speed symbols corresponding to commercial vehicle tyre standards were added in agreement with ISO/TC31/SC4.

Speed Symbol	Maximum speed (km/h)
F	80
G	90
J	100
K	110

Subsequently ISO/TC31 decided to extend the concept of speed symbols also to other categories of tyres maintaining in principle the 10 km/h stepping, with the exception of 65 km/h originally requested by the Earthmoving Sub-Committee. Thus adding:

Speed Symbol	Maximum speed (km/h)
B	50
C	60
D	65
E	70

In order to include also maximum speeds required by Agricultural and Industrial tyres, ISO/TC31 decided to adopt, for speeds below 50 km/h, steps of 5 km/h adding numerical suffixes to letter “A”. Thus:

Speed Symbol	Maximum speed (km/h)
A1	5
A2	10
A3	15
A4	20
A5	25
A6	30
A7	35
A8	40
A9	45

Only in 1987 ECE Regulation N.30 extended the scope to include tyres up to 240 km/h and added speed symbol “V” corresponding to 240 km/h, since it was decided to have steps of 30 km/h over 210 km/h.
However under pressure of some UK tyre manufacturers (mainly interested in diagonal tyres) the PC Sub-Committee accepted to maintain the current practice to reduce the load capacity over 210 km/h, thus the load at 240 km/h was fixed to 91% of the load corresponding to the load index (that applied up to 210 km/h) marked on the tyre.

In 1988 ECE Regulation N.75 (tyres for motorcycles) was published including speed symbols “B” and from “F” to “H”.

EU Directive 92/23 (issued in March 1992 and specifying requirements for tyres equipping passenger cars and commercial vehicles) did include speed symbols from “F” up to “V” and identified tyres for speeds over 240 km/h with the speed category marking “ZR”, placed inside the tyre size designation (e.g. 235/50 ZR 16), exempting them from the marking of load index and speed symbol.

In 1994, on request of ETRTO, ECE Regulation N.30 extended the scope to include tyres up to 270 km/h and added speed symbol “W” corresponding to 270 km/h, keeping the principle already accepted for “V” speed symbol. The load at 240 km/h was fixed to 100% (corresponding to the load index) and the load at 270 km/h was fixed to 85% of the load corresponding to the load index marked on the tyre. Thus overlapping with the “ZR” requirement of directive 92/23 for tyres with speeds over 240 km/h, but retaining the possibility of the ZR optional marking.
Also ECE Regulation N.75 was extended to 240 km/h and speed symbol “V” was added with the same structure as in ECE Regulation N.30. Speed category marking ‘ZR’ was recognised for tyres with a speed capability over 240 km/h.

In 1995 the scope of ECE Regulation N.75 was then extended to tyres without any speed restriction and speed symbol “W” was added with the same structure as in ECE Regulation N.30.
Tyres with speed symbol ‘V’ were authorised, with specific load reductions, up to 270 km/h if authorised by the tyre manufacturer and if additionally marked with the speed category marking “V”, or “VR” or “VB” inside the tyre size designation.
Moreover in case of speeds in excess of 270 km/h the letters “ZR” or “ZB” had to be marked inside the tyre size designation and the service description corresponding to W speed marked on the tyres within brackets, hence (58W).
The load capacity for the maximum speed had to be specified by the tyre manufacturer and subjected to test.

In 1995, on request of ETRTO, ECE Regulation N.30 extended the scope to include tyres up to 300 km/h and added speed symbol “Y” corresponding to 300 km/h, keeping the principle already accepted for “W” speed symbol.
The load at 270 km/h was fixed to 100% (corresponding to the load index) and the load at 300 km/h was fixed to 85% of the load corresponding to the load index marked on the tyre and the possibility of retaining the ZR optional marking was confirmed.

Note: Speed Symbol “X” was excluded from any considerations due to strong resistance from one tyre manufacturer

In 1998 ECE Regulation N.106 (tyres for agricultural vehicles) was published and included speed symbols A2, A4, A6, A8, B and D.

In 2000, on request of ETRTO, ECE Regulation N.30 extended the scope to include tyres without any max speed restriction. Similarly as already defined in ECE Regulation N.75, in case of speeds in excess of 300 km/h the letter “Z” had to be marked in front of the symbol of the structure (i.e. ZR) and the service description for Y speed marked on the tyres within brackets, hence (91Y). Thus tyres without any service description were no more allowed to conform to ECE Regulations.
Therefore to conform to both ECE Regulation 30 and EU Directive 92/23, tyres for speeds over 240 km/h may be marked “ZR”, whilst tyres for speeds higher than 300 km /h must be marked “ZR”.

3. METRIC MARKING AND ASPECT RATIO

At the beginning of the ETRTO standardisation, the tyre size designations were expressed in inches (codes) following the T&RA practice and the various series, especially in case of Passenger Car tyres where the technical evolution versus squatter tyres was more evident, were identified by selecting appropriate sequences of nominal section widths (roughly related to the tyre section width on the measuring rim) rather than by the h/s ratio.

For example:

- Super Balloon tyres (h/s ≅ 95): 4.80, 5.20, 5.60, 5.90, 6.40, 6.70, 7.10, 7.60, etc.
- Low Section tyres (h/s ≅ 88): 5.00, 5.50, 6.00, 6.50. 7.00, 7.50, etc.
- Super Low Section tyres (h/s ≅ 82): 5.35, 5.65, 5.95, 6.15, 6.35, 6.85, 7.15, 7.35, etc.
- Ultra Low Section tyres (h/s ≅ 77): 5.3, 5.9, 6.2, 6.5, 6.9, 7.2, 7.7

Super Low Section tyres (especially in case of radial tyres) were then also identified by a converted value in mm: 125, 135, 145, 155, 165… 235 (in some cases the double marking inch and metric was used)
Low Section tyres, in case of radials, were also marked in mm: 120, 130, 140, 150, 160, 170, 180

When tyre h/s ratio started to be further reduced ,T&RA first considered marking the h/s in the size designation, but they selected to identify the sizes first with the tyre load capacity expressed by a letter (e.g. E70-14 or for radials ER70-14), the so called 'alphanumeric' designation.
Dimensions were then derived from the reference load through the T&RA load formula.

The first sizes listed in the ETRTO Data Book in 1969 did therefore follow that set of rules, with the exceptions of 70 series tyres showing the metric designation (some, however, complemented the 'alphanumeric' designation with the corresponding metric designation e.g. FR70-14 –> 215/70R14), as already previously defined by the PC Sub-Committee.

Due to the fact that radial and diagonal tyres had the same size marking but could not be mixed on the same axle it was also agreed to identify radial tyres with the letter "R" inside the tyre designation in place of the dash ("-") traditionally used for diagonal tyres. Regulations also requested the additional marking "Radial" in clear.

In order to avoid publishing tyre dimensional tables in ECE Regulation N.30 (that would have requested a continuous update of the relevant tables to permit tyre type approvals), ETRTO agreed (with the consensus of ISO/TC31/SC3) to identify tyre dimensions through the metric tyre size designation including the h/s ratio (the aspect ratio) and just add into the Regulation the formula for the calculation of the design tyre dimensions starting from the tyre size designation.
Old size designations with the relevant dimensions had to be attached to Annex 5 of the Regulation.
Gradually the metric size designation, inclusive of the aspect ratio, was adopted also by the other tyre Sub-Committees.

To prevent misfittings it was also agreed to have PC, LT and CV (i.e. long distance road vehicles) tyre sizes expressed with a nominal section width ending in 5s, whilst MC and AGRI

tyres had a nominal section width ending in 0s. LT tyres retained the suffix "C" in order to be distinguished from PC and CV sizes.
Exception to that rule are the "ultra-light" CV tyres that have a nominal section width ending in 0s; the reason being that they were originally standardised as 'scooter derivatives' by the MC Sub-Committee.

Note: 'scooter derivative' tyres were first standardised by the MC Sub-Committee in 1970 because of their dimensional similarity with scooter tyres (nominal rim diameter <=12"), but then were transferred to the responsibility of the CV Sub-Committee in 1995 because of their 'C' suffix and higher pressures due to their primary fitment on tricycles and quadricycles and also because their tread was prevalently flat compared to the round tread of other motorcycle tyres.

With the introduction of metric 70 series tyres the AGRI Sub-Committee decided to have steps of 20 mm in nominal section widths starting from 300.
Later on in ISO/TC31/SC5 it was agreed to have the following steps after 620: 650, 680, 710, 750 followed by steps of 50 mm.

Note: the first 70 series tyres for agricultural tractor drive wheels were developed by Pirelli in 1986 (sizes 480/70R28-34-38 and 520/70R34-38).
Their overall diameter was designed to conform to previous code designated tyres (i.e. 16.9R24-34-38 and 18.4R34-38 respectively), therefore they did not follow exactly the calculation of dimensions for 70 series tyres.
However to overcome that, at the beginning and taking into account that the lugs were deeper than those of current tyres, it was agreed to standardise the exact OD as per the calculations, but to accept a coefficient FhG = 1.08 (instead of 1.05) and identify the tyres with the marking "DEEP".
Subsequently other sizes were approved in 1988 (320/70R24-28, 360/70R24-28, 380/70R24-28, 420/70R24-28 and 580/70R38) conforming to OD of tyre sizes 11.2R24-28, 12.4R24-28, 13.6R24-28, 14.9R24-28 and 20.8R38 respectively.
Load capacities, however, were based on original 70 series dimensions.
When other manufacturers in the mid '90s started developing the same sizes and also expanding the range, with the agreement also in ISO, it was decided to modify the OD of those 70 series tyres to reflect the actual market situation, thus deviating from the exact calculations and reverting back the coefficient FhG to 1.05.
Therefore, when ECE Regulation N.106 was published in 1998, a special table was added in Annex 5 to reflect those out of line dimensions and a special note was added to the dimensional table of the ETRTO Standards Manual referring the exceptions to ECE106.
Also T&RA in 2005 did follow a similar approach.

Later on also the EM Sub-Committee selected the ending in 5s for their metric tyres.

At the beginning, some manufacturers would have preferred that for PC tyres there would be steps of 10 not only in nominal section width but also in aspect ratios, but then, after the acceptance of TR tyres in 1977, it was agreed to have steps of 5 in aspect ratios.

In the PC section of the Data Book, following the same principle of 70 series, 60 series tyres, were first published in 1972, 50 series in 1977, 65 series in 1978 down to 20 series in 2006.

In the MC section of the Data Book the first metric sizes were 90 diagonal series in 1975 down to 30 series in 2005.

In the CV section of the Data Book the first metric sizes were 70 series in 1978 down to 45 series in 1998.

In the AGRI section of the Data Book the first metric sizes were 70 series in 1986 down to 35 series in 2013.

4. THEORETICAL AND MEASURING RIM FACTORS

Following the practice established by T&RA, it was agreed in ETRTO PC Sub-Committee to adopt a coefficient of 0,70 (ratio between the width of the design rim and the nominal section width) initially for 70 series metric tyres.
Notwithstanding some technical objections from Pirelli, the same coefficient was then extended to all new metric series down to 50 and ISO/TC31/SC3 confirmed that coefficient.

Only later on in 1984 the ETRTO PC Sub-Committee, under new pressures also from the German tyre manufacturers, recognised that lower aspect ratio tyres were better fitted on larger rims and decided to modify the coefficient s for the 'measuring rim width', though leaving unchanged the coefficient for the theoretical/design rim width, and at the same time modify the coefficient of the theoretical rim for series 45 and below.

That is why the design section widths of PC metric tyres in series 70 to 50 do not correspond to the 'nominal section widths' and the relevant measuring rim does not correspond to the theoretical rim width, e.g.:

- 205/80 design section width 203 on rim code 5.5
- 205/70 design section width 209 on rim code 6
- 205/60 design section width 209 on rim code 6
- 205/50 design section width 214 on rim code 6.5
- 205/40 design section width 212 on rim code 7.5

The CV Sub-Committee, for consistency, followed the same principle for light truck tyres.
On the contrary heavy CV, MC and AGRI tyres maintained the same value for both the theoretical and the measuring rim width coefficients.

5. RIM TYPES

Since the first Data Book, there are four traditional types of rim contours adopted by all tyre types:

- 5° tapered Drop Centre Rims (still used by PC, MC, LT and AGRI tyres)
- 15° tapered Drop Centre Rims (still used by CV and AGRI tyres)
- 5° tapered Flat base demountable Rims (still used by CV, EM and IND tyres)
- 5° tapered divided rims (still used by small rim diameter MC, AGRI and IND tyres)

All of them have the nominal width and nominal rim diameter expressed with the traditional inch/code designation.
Some other tyre to rim technical configurations was proposed and standardised for Passenger Car tyres, but did not encounter the favour of the market and disappeared:

	Typical size designation	Typical rim designation	Proposed by	Standardised first in	Moved to obsolete
(Denovo) tyres (**)	205/65R375	325-90 DD (divided rims)	Dunlop	1974	1983
DL tyres (Denloc) (**)	200/65R345 DL	320x95 DL	Dunlop	1979	1984
TR tyres	220/55R415 TR	390x165TR FH	Michelin	1977	1999
TD tyres (**)	220/55R415 TD	365x190TD (*)	Dunlop	1983	1999
CT tyres (**)	CT225/40R475	CT450x150	Continental	1988	2005
Asymmetric "A" tyres (**)	205-650R440A	185x420A	Michelin	1997	??

(*) TD rims were dimensionally equal to TR rims except from a grove in the bead area to retain tyre beads as in the case of DL rims (this was intended to permit fitting of TR tyres on TD rims).
(**) tyres had features for run flat operations
All of them were identified by a nominal width and nominal rim diameter expressed in mm. Asymmetric 'A' tyres do show in the size designation the nominal overall diameter in place of the h/s ratio.

6. SPECIFIED RIM DIAMETERS

Originally in T&RA, where all rim types had cylindrical bead seats or were flat base, the specified rim diameter did correspond to the value of the nominal rim diameter expressed in inches.
Then T&RA, before the 2nd World War, for 5° tapered bead seat rims, established a fixed correlation between the nominal rim diameter and the specified rim diameter differentiating them in relation to the group of rim diameters and types :

- 5° tapered drop centre rims up to 16": specified rim diameter= nominal rim diameter – 0.032"
- 5° tapered drop centre rims 17" and above: specified rim diameter= nominal rim diameter + 0.188"

Flat base rims and 5° tapered multi piece rims 15" to 24": specified rim diameter= nominal rim diameter + 0.25"

Full tapered bead seat rims for earthmovers (25" and above) as well as 15° drop centre rims, developed later on, kept the exact correlation between nominal and specified rim diameters.

ETRTO, since the first issue of the Data Book, accepted that state of the art as already adopted by the various European National Standards.

Motorcycle M/C , 5° tapered bead seat rims 13" and above were first developed in 1979.

In order to allow, for tyres, interchangeability with previously used cylindrical bead seat rims, the specified rim diameter was agreed by ISO/TC31/SC10 to be equal to the nominal rim diameter + 0.80" with the exception of 16" (where it is – 0.013") as it already existed in T&RA.
That is why the nominal rim diameter is suffixed with "M/C" to differentiate from other 5° tapered drop centre rims previously standardised and used by other categories of tyres (PC, LT and AGRI).

However, independently from the actual value of the specified rim diameter, by convention it was agreed in ISO/TC31 that the calculation of the overall diameter for metric designated tyres be based on the nominal rim diameter converted to a full value of millimetres.
The same convention was adopted also by all UNECE Regulations.

7. LOAD CAPACITY VERSIONS AND INFLATION PRESSURES

The first ETRTO Data Book did identify load capacity versions by the marking of the PR (ply rating) as already historically fixed by T&RA.

> *Note: the ply rating number originally, in T&RA, identified the number of cotton plies necessary to withstand the tyre inflation pressure of bias tyres (that is why it is always an even number) according to the Bernoulli formula.*
> *Then conventionally was extended also to other types of cords and structures.*

In particular for diagonal PC: 4PR identified tyres with a reference inflation pressure of 2.10 kg/cm^2

- 6PR identified tyres with a reference inflation pressure of 2.50 kg/cm^2
- 8PR identified tyres with a reference inflation pressure of 2.80 kg/cm^2

For radial PC tyres, only two load versions were standardised by ETRTO: a "normal load" with a reference pressure of 2.20 or 2.30 kg/cm^2 and a "Reinforced" version with an extra 0.50 to 0.70 kg/cm^2 depending on the tyre size.

In 1983 PC Sub-Committee agreed to unify the reference inflation pressures for all metric tyres (at the exception of 80 series tyres) to 2.50 bar for the normal version and 2.90 bar for the reinforced version (to equate exactly 36 and 42 psi).

Also "C" tyres were originally standardised in three load versions identified by 6PR, 8PR and 10PR with reference pressures 3.50 or 3.75, 4.50 and 5.25 kg/cm^2.

CV tyres started with load versions identified by PR, then when tyres for 15°DC rims were standardised (in the meantime T&RA had replaced PRs with Load Ranges), there was an attempt to identify the three load versions as NL, ML and HL (meaning normal, medium and high load) versions. That identification, never adopted in practice, was then superseded by the adoption of the load indices.

MC tyres started with two load versions: normal with a reference pressure of 2.25 kg/cm^2 and reinforced with 2.80 kg/cm^2 (2.50 and 3.25 kg/cm^2 respectively for scooter tyres with nominal rim diameter <=12").

In 1981 the reference inflation pressure for normal load tyres was modified from 2.25 to 2.30 bar.

AGRI diagonal and radial tractor drive wheel tyre load versions were originally identified by the PR marking as in T&RA.
Then, for code designated radial tyres, an attempt to rationalise the reference inflation pressures was defined by ISO/TC31/SC5 by selecting three steps (1.20, 1.60 and 2.10 bar or the equivalent 18, 24 and 30 psi) identified by 1, 2 or 3 stars respectively.
This type of identification was adopted also by T&RA until recently. ETRTO in 1984 (followed in 1986 also by the first 70 series metric tyres) only retained the load version at 1.60 bar identifying them just with the load index.
Only in 1992/1994 the first load versions at 3.20 and 2.40 bar respectively were standardised for tractor drive wheel radial tyres.

Originally AGRI implement tyres were standardised separately in two versions (garden tractors/drive wheels, with the possibility of extra diameters for traction tyres, and free rolling tyres) with different load capacities and pressures.
Then, when more and more sizes were designed for mixed applications (both drive wheels and free rolling wheels), Implement sizes were unified adopting a 70% ratio between load capacities for drive wheels compared to free rolling wheels (later on when load indices were adopted and the difference in load capacities was fixed to 12 LIs).

When Regulation ECE regulation N°106 was first developed in 1997, there appeared the necessity to identify properly the type of use appropriate for the load index marked on implement tyres, hence the application symbol was defined in ETRTO and adopted by GRRF.

Earthmover tyres originally started with a PR marking. Then when in 1972 load capacities of radial tyres were revised the marking with stars replaced, for them, the PR marking.

In the 1973/74 Data Book, inflation pressures were expressed in bar and kPa, rather than in $kg/cm^{2,}$ with a conversion factor 1 kg/cm^{2} = 1 bar, following ISO/TC31 recommendations.
In the 2004 Standards Manual, inflation pressures were expressed in kPa only, with a conversion factor 100 kPa = 1 bar.

Until 1976 Sub-Committees published in the Data Book load/pressure scales for each tyre version, as it is still done today in T&RA. Since then only the reference pressure related to the load version was published.

To conform with the requirements of FMVSS109, and of the Federal Trade Commission (16CFR ch 1 – part 228) '*Tire advertising and labelling guides*' paragraph 228.1.3 (ii), when NHTSA decided to drop the load pressure tables from FMVSS109 and just refer to relevant standards organisations, ETRTO, separately from the Data Book, published load/pressure scales in lbs/psi for PC tyres until it was decided to publish in the Standards Manual 1994 the load/pressure scales related to the Load Index.

Inflation pressures for intermediate loads were given, as in case of CV and LT tyres, by publishing a formula in the Standards Manual or, as in case of AGRI tyres in the EDI, a set of percentages to be applied to the reference load corresponding to the load index.

ETRTO started publishing again in the Standards Manual load/pressure scales related to load index for PC (1994) and MC (2000) tyres, where only two versions ("normal" and "reinforced/extra load") were standardised with fixed reference pressures.
In the Engineering Design Information of 2005 first the AGRI published load percentages at the various intermediate inflation pressures.

8. LOAD/SPEED BONUS LOADS AND LOAD FORMULA

The AGM in Nice (1967) approved the study performed by Pirelli on the influence of speed on the load capacity of CV tyres and hence the first load/speed table for tyres having a nominal maximum speed up to respectively 80 km/h, 100 km/h and 120 km/h (C-type tyres).

In the early '70 with the increasing number of new radial metric tyres, ETRTO found that the traditional T&RA formula developed in the '30s for diagonal balloon tyres did no more satisfy the technical evolution especially for radial low section tyres.
A Working Group was established by the ETRTO PC Sub-Committee in order to define a formula appropriate to the radial structures.

There were proposals submitted by Pirelli, Goodyear and Michelin. After long discussions in 1972 the PC Sub-Committee adopted the formula, experimentally developed by Mr. P.G. Malinverni (Pirelli); load capacities were a function of the tyre volume, the inflation pressure and the tyre deflection. To interpolate the loads already assigned to existing radial tyres the PC Sub-Committee decided for an exponent of the volume 0,8 instead of 2/3 as it would be dimensionally correct and originally proposed. The influence of the deflection was consolidated into a K-factor and the influence of inflation pressure being linear with a coefficient P0 to simulate the load capacity of the structure at zero pressure (tyre stiffness).

The MC Sub-Committee in 1975 adopted the original load formula, initially for the 90 series diagonal and then for all new metric tyre sizes.
Also the CV Sub-Committee in 1975 adopted the original load formula, initially for the code designated radial tyres on 15° DC rims.
The AGRI Sub-Committee in 1984 started adopting the load formula for radial code designated tractor drive wheel tyres and then in 1986 for the 70 series metric radial tyres. Then in 1998 the Sub-Committee defined a complete set of K-factors for all metric tyre types and versions. In 2005 IF and VF tyre types for tractor drive wheels were standardised with higher K-factors.

The CV Sub-Committee in 2009 decided, for heavy truck tyres, to revert back the K-factors to the original concept of tyre percent deflection.

The PC Sub-Committee, after a compromise agreed in ISO/TC31/SC3 with T&RA and JATMA, decided in 2005 to adopt for new tyre sizes developed in series 50 and above (where the load index was higher than 100) a new formula (derived from T&RA traditional formula) and a new exponent of the pressure (0.625 instead of 0.8). Those tyres are identified in the Standards Manual with an asterisk (*) added after the load index.

9. BICYCLE TYRES

Until the end of the 60s in Europe, and in the world, existed various standards on bicycle tyres (UK, France, Netherland, Germany, Scandinavia, Italy, etc.), all of them being based on the theoretical overall diameter, but incompatible one to the other.

Cycle tyre marking/identification was formed by one or two or three and even four numbers, some expressed in inches and others in mm:

- The first number generically identified the nominal overall diameter (e.g. 16 or 28 or 550)
- The second number (or a letter in case of marking in mm) could identify either the tyre width or the nominal tyre section height (e.g. 20 x 1½, 550 A)
- The third number (a letter in case of marking in mm), when applicable, could identify either the tyre width or the nominal tyre section height (e.g. 26 x 1⅜ x 1½, 550x32A)
- The fourth number (when present) did identify the rim width (e.g. 28 x 1⅜ x 1¼ x 1⅛)

The specified diameter of the rim, the most important parameter that could permit the interchangeability of the tyres, was defined as:

> *Specified rim diameter = 'nominal overall diameter' minus twice the 'nominal section height'.*

Due to double meaning of the second and third numbers in the marking, it was very frequent to have tyres with the same marking but referred to a different rim diameter (e.g. the same size 28 x 1⅜x 1½ could mean a specified rim diameter of 622 mm or 635 mm, or size 550 x 32 A could mean a specified rim diameter of 489 mm or 501 mm) depending on the reference standard applied in a given country.

That ambiguity created a lot of confusion when tyres were exchanged amongst the different countries.
Moreover tyres with inch marking and tyres with metric marking, even if corresponding in dimensions could not be interchanged (e.g. 650 x 35 B and 26 x 1½).

The first attempt in ETRTO was carried out by the MC Sub-Committee with a complete enquiry and comparison of all existing standards in Europe. At first it appeared the fact that some sizes with the same designation did have different dimensions and it was decided to identify them as 'NL' since they were mainly manufactured in the Netherlands. However that interim solution did not solve the case where nominal section height and nominal section width were exchanged in the marking.

Therefore in 1969 the MC Sub-Committee agreed to revise the criteria on how to identify uniquely the tyre size designation of bicycle tyres. The major dimensions for proper tyre identification were selected as the 'specified rim diameter' and the 'nominal section width' (assuming that bicycle tyres had an approximate round shape) expressed in millimetres.
The new metric marking appeared as : 37-584.

Thus one unique and self-explaining marking did replace several previous markings, from then on identified as 'old markings' that could, eventually, be additionally marked within brackets on the tyre sidewall. Here below are some examples:

Old marking	ETRTO marking
16 x 1⅜ NL	**37-340**
400 A Confort	
400 A Demi Ballon	
400 x 35 A	
400 x 42 A	
26 x 1¾ x 2	**54-571**
26 x 2	
26 x 2 x 1¾	
650 x 50 C	

Old marking	ETRTO marking
26 x 1½ x 1⅜	**44-584**
26 x 1⅜ x 1½	
26 x 1¾ x 1½	
650 B Demi Ballon	
650 B semi Confort	
650 x 42 B	
28 x 1⅜ x 1⅛	**28-622**
28 x 1⅜ x 1¼ x 1⅛	
700 C Carrera	
700 x 28 C	

Old marking	ETRTO marking
28 x 1.75	**47-622**
28 x 1⅜ x 1¾	
28 x 1¾	
700 x 45 C	
28 x 1½	**40-635**
28 x 1½ x 1⅜	
700 B Standard	
700 x 35 B	
700 x 38 B	

Also the rims were identified with the nominal rim width and the nominal rim diameter specified in millimetres.

ISO then, in the early 80s with agreement of USA and Japan, adopted the same principles and published standards ISO 5775-1 and ISO 5775-2.
