

Status report to 78th GRBP (August-September 2023)

Task Force on Tyre Abrasion

On behalf of GRBP and GRPE

Task Force on Tyre Abrasion

Targets	<ul style="list-style-type: none">• Develop a procedure for measuring the abrasion of tyres: test conditions and methods• Rate the abrasion performance of a wide range of tyres available in the market• Define abrasion limits for tyres in order to limit the emission of microplastics to the environment• Assess potential correlation between abrasion performance and durability (mileage) of tyres.• Develop a UN Regulation (or addition to UN Regulation No 117) for the type approval of tyres in respect to their abrasion
Roles	<ul style="list-style-type: none">• Co-chairs: France and European Commission• Secretariat: ETRTO (European Tyre and Rim Technical Organisation)
Reporting	To both working parties: GRPE and GRBP Adoption: GRBP
Web page	Task Force on Tyre Abrasion (TF TA) - Transport - Vehicle Regulations - UNECE Wiki

Task Force on Tyre Abrasion: facts and figures



- Meetings

- 8th hybrid meeting: 30th-31st Jan 2023
- 9th web-meeting: 10th Feb 2023
- 10th web-meeting: 10th March 2023
- 11th web-meeting: 30th March 2023
- 12th web-meeting: 28th April 2023
- 13th web-meeting: 11th May 2023
- 14th web-meeting: 5th June 2023
- 15th hybrid-meeting: 20th July 2023



- Attendees ~80

- CPs:
European Commission, France, China, Germany, India, Japan, Norway, Netherlands, South Korea, Spain, Switzerland, UK, USA, Canada
- NGOs:
ADAC, AVL, ETRMA, ETRTO, HORIBA, IDIADA, ITMA, JAMA, JATMA, LINK, OICA, SMMT, TRAC, TÜV Nord, UniBW., USTMA, UTAC, VTI

Testing methods developed by TFTA



©UTAC

LABORATORY
(Indoor drum method)



©ADAC / Test und Technik

IN-VEHICLE REAL LIFE
(On-road method)

Task Force on Tyre Abrasion: work progress

Work on the 2023 test campaign

- Validation and correlation test campaign for 2023: ongoing **for C1**
 - Test conditions and methods: first drafts (to finalise after ongoing test campaign)
On-road method: GRBP-78-17
Indoor drum method: GRBP-78-18
 - Tyres selections (candidate and “reference” tyres) for correlation: done
 - Tyres selections for alignment: done
 - Validation test campaign on 3 on-road test centres and 4 drum test centres: done
 - Alignment test campaign on 7 on-road test centres and 4 drum test centres: starting
 - Post processing: to start (21st September)

Drafting Scope

- Applicable to C1 tyres as defined in R117. Excluded:
 - Tyre not homologated for on road permanent usage (e.g. competition tyres)
 - Free rolling tyres (trailers, caravan...) **to be checked**
 - Temporary tyres (marked “temporary” only)
 - Tyres designed for competitions;
 - Tyres fitted with additional devices to improve traction properties (e.g. studded tyres);
 - Tyres designed only to be fitted to vehicles registered for the first time before 1 October 2000;
 - Professional off-road tyres.

On-road method - Drafting Group

- Objective
 - Develop text on on-road test method
- Roles
 - Chair: EC
 - Secretary: ETRTO
- Participants:
 - CP: Japan, European Commission, France
 - NGOs: JATMA, ETRTO, ITMA, USTMA, OICA
 - Companies: AVL, EDAG
- Meetings
 - 1st Web meeting 21st March 2023
 - 2nd Web meeting 20th April 2023
 - 3rd Web meeting 9th May 2023
 - 4th Web meeting 16th May 2023
 - 5th Web meeting 25th May 2023
 - 6th Web meeting 30th May 2023
 - 7th Web meeting 15th June 2023
 - 8th Web meeting 27th June 2023
 - 9th Web meeting 17th July 2023

On-Road method - Table of Contents

- Scope [1]
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- Annex A: Calculations
- Annex B: Calibration
- Annex C: Abrasion rate

Brackets and numbers: chapters in document

Red: under discussion

On-Road method - Reference tyres

- Reference tyres shall be stored in condition recommended by ASTM.

Normal: 225/45R17 94 XL



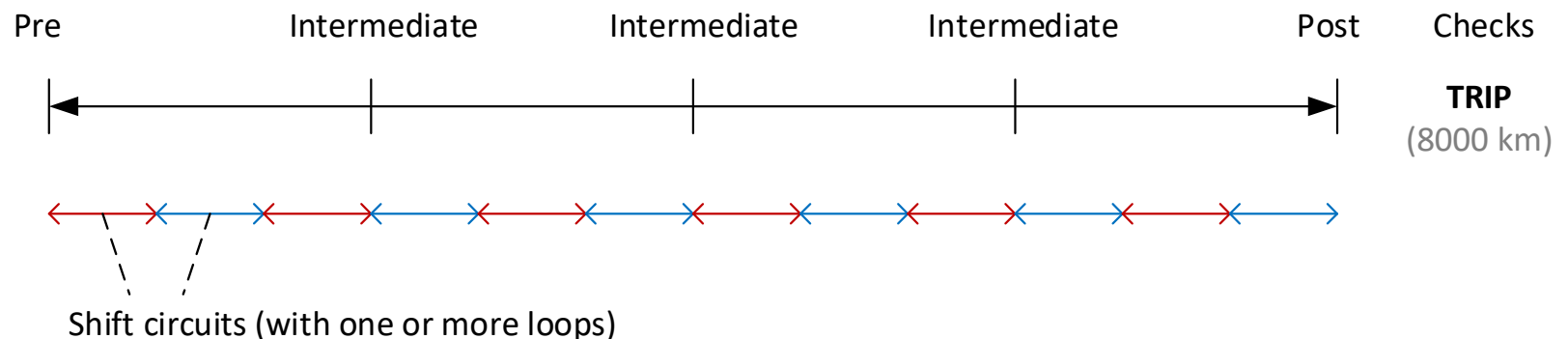
Reference tyre to be used →	"Normal" reference tyre	"3PMSF" reference tyre
Candidate tyres ↓		
Normal tyre	X	
Snow tyre	X	
<div style="border: 1px solid black; padding: 2px;"> Snow tyre that is classified as tyre for use in severe snow conditions </div>		X
Special use tyre	X	
<div style="border: 1px solid black; padding: 2px;"> Special use tyre that is classified as tyre for use in severe snow conditions </div>		X

3PMSF: 225/45R17 94 XL

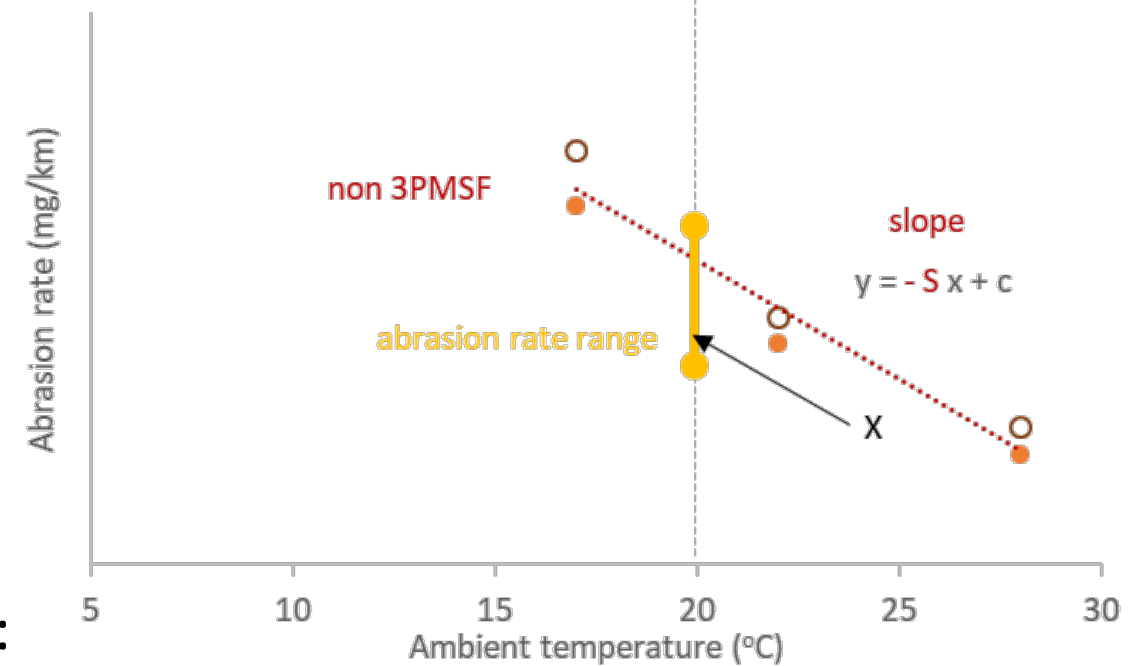


On-Road method - Circuit [3 and 8.1]

- Test distance: 8 000 km (-300 km to +1200 km) driven by repeating circuits on open public roads
- Circuit consists of one or more loops, with cars returning to the departure point without being transported.
- Circuit min distance 300 km of different roads.
- Loop: section of circuit having the same start and end point. Loop driven opposite way is considered different loop. The loops of a circuit can be run in any order.



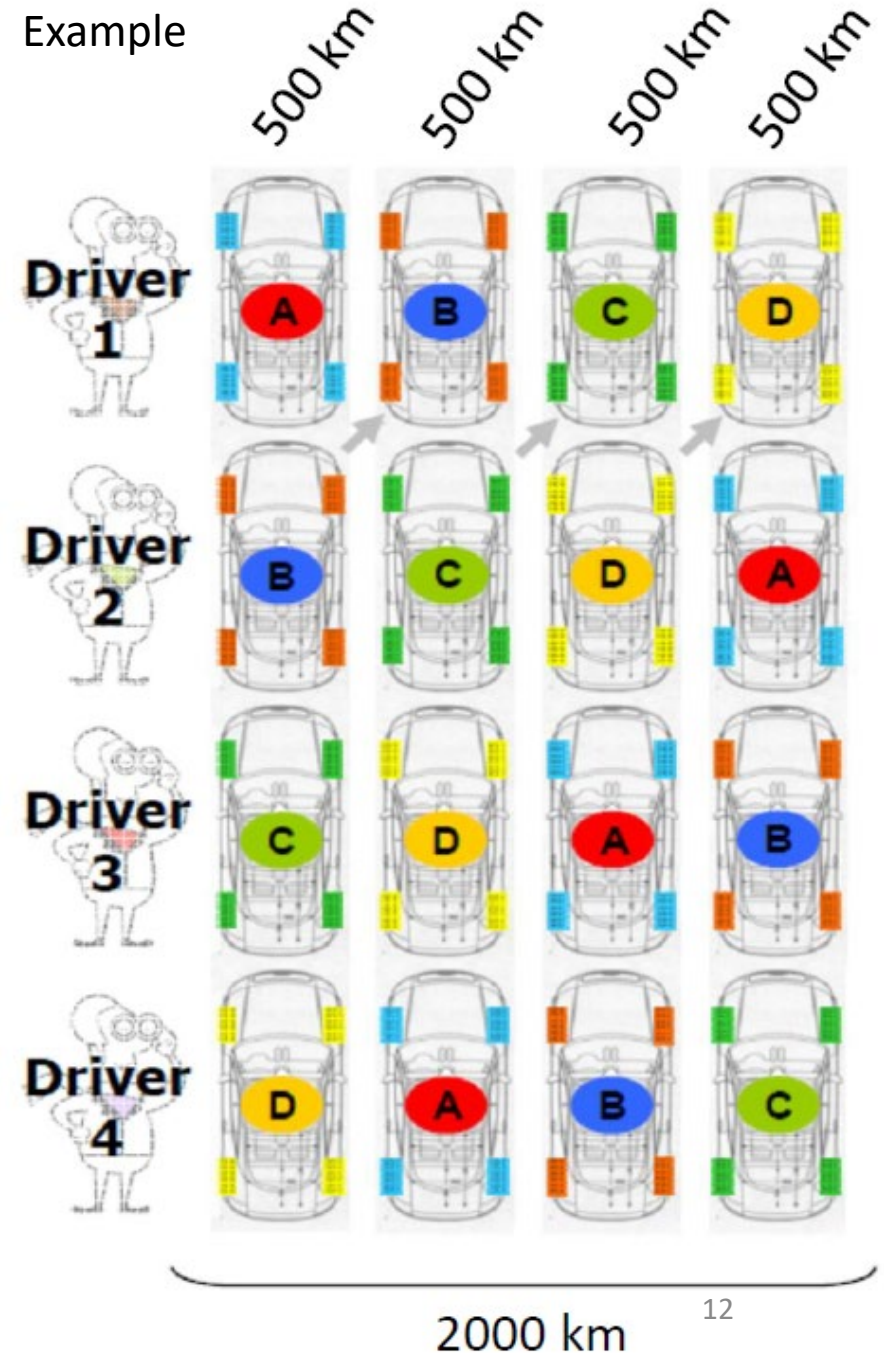
On-Road method - Circuit [8.6]



- The circuit abrasion rate shall be determined:
 - Convoy of at least 2 vehicles having the reference tyres (Normal or 3PMSF)
 - At three ambient temperatures: one at least 15-25°C (Normal) or 5-15°C (3PMSF)
- The circuit abrasion rate shall be (one needs to be checked)
 - @20°C (Normal reference tyres) needs to be in the range [range] mg/km/ton
 - @10°C (3PMSF reference tyres) needs to be in the range [range] mg/km/ton
- 13.9: If the circuit is modified by ≤ 10 km, or 10-30 km for ≤ 8 shifts or < 100 km (or 20% of circuit, whichever is smaller), it is still valid

On-Road method - Preparation

- Convoy
 - 13.1 General. Up to 4 vehicles. One is fitted with reference tyres
 - 13.3 Convoy composition. Homogeneous for:
 - Number and position of driven wheels [7.1]
 - FWD or RWD or AWD only in the convoy
 - Same propulsion energy converters (e.g. ICE, or NOVC-HEV etc.)
 - F2 vehicle ref. tyres $\leq 1.2 \times$ F2 vehicle candidate tyres [7.1.9]
 - 13.4 Vehicles and drivers rotation
 - Each tyre shall be exposed to the same distance ($\pm 10\%$) to all drivers and positions in convoy



On-Road method - Preparation

- Tyres preparation [11]
 - 11.2 Tyre mass measurement (without rim) [6.1]
 - 11.1 Tyre fitment on rim (*and vehicle*)
 - 11.3 Tyre and wheel assembly mass measurement [6.2] (**optional**)
 - 11.4 Tyre inflation pressure: Ref. tyres: 290 kPa, candidate tyres: 250 kPa for standard load tyres or 290 kPa for reinforced load and high load capacity tyres(XL, HL)
- Vehicles preparation [12]
 - Vehicle balasting [7.1.10]
 - Tyre load 67% ($\pm 7\%$) of tyre load capacity (and not exceeding 85% vehicle max payload)
 - Load distribution: FWD: 56% ($\pm 7\%$) to 44% ($\pm 7\%$); RWD/AWD: 50% ($\pm 7\%$) to 50% ($\pm 7\%$);
 - 12.2 Vehicle tuning (alignment) [7.1.1 to 7.1.4 and 6.4]
 - 12.1 Vehicle mass measurement and load at each wheel [6.3]

On-Road method – Acceleration and Speed

Circuit approval End of test

	Urban	Regional	Highway	Global
Share (% distance)	30 (±5)	30 (±5)	40 (±5)	-
Long. acc. stdev (m/s ²)	0.42-0.80	0.34-0.78	0.18-0.53	0.35-0.55
Lat. acc. stdev (m/s ²)	0.54-1.27	0.52-1.46	0.32-0.78	0.83-1.03

- Instrumentation [5, Ann.B]
- Circuit [8]

- 13.2 Total distance 8000 km (-300 to +1200 km) along selected circuit
- 8.1 Circuit of at least 300 km consisting of one or more loops
- 8.2 Driving style distribution (see table)
- 8.6 Abrasion level for reference tyres at 20°C (normal) and/or 10°C (severe snow) [range] mg/km/t

To be checked at the end of the test (*monitored* continuously):

- 8.3 Global (test) acceleration levels
- 8.4 Speed requirements (<140 km/h)

On-Road method - Measurements

13.5.1 Before and after test

- Tyre mass [6.1]
- Load on each tyre [6.3]
- Vehicle alignments
 - (unloaded and loaded vehicle) [6.4 and 7.1]
- Tyre pressure
 - Before test and after tyre fitment
 - After test and before dismounting



Brackets and numbers: chapters in document

Red: under discussion

On-Road method - Measurements

13.5.2 During test

- Long. and lat. acc. of each vehicle with frequency ≥ 10 Hz (e.g.constant monitoring) [8.5]
- Speed of each vehicle (constant monitoring)
- Tyre pressure each day (cold condition)
- Average of five temperatures of at least start, end, at lower and higher altitude points [9.3.2 and 13.6]
- Wet distance measurement [9.3.1], ice on road measurement [5.6]

At intermediate stops

- Vehicle alignment of reference vehicle every 2 000 km [6.4 and 7.1]
- Tyre and wheel assembly mass [6.2] (**optional** but compulsory during the test campaign)
- Vehicle alignment of test vehicles [6.4 and 7.1] (**optional** at half distance but compulsory during the test campaign)

On-Road method - Troubleshooting

- 13.10 Vehicle:
 - Repair is possible: The repaired vehicle shall run the distance lost (without other vehicles of the convoy)
 - Major failure or accident: The replacement vehicle equipped with the same (new) tyres shall run the distance lost (without other vehicles of the convoy)
 - If failure happens to a test vehicle and not reference vehicle, the failed vehicle (and tyres) can be withdrawn.
- 13.11 Tyres:
 - Tyre is destroyed: Spare part with same size and pattern is used. The mass loss of the other tyre is multiplied by two for the calculations
 - Tyre is reparable: The added repair mass is taken into account in the calculations. Spare tyre can be used for max one loop. Distance will be considered in the calculations

On-Road method - Validation [13.8]

- Weather and Climate [9.1, 9.2]
- Accelerations [processing in Annex A]
 - 8.3.1 see table beside
 - 8.3.2 Long. and lat. acc. stdev within 5% of ref. vehicle values
- Vehicle alignments [7.1]
 - End-Start: $\pm 0.15^\circ$ toe, $\pm 0.3^\circ$ camber
- Visual inspection
 - Sidewall marking readable
 - Tyre loss $< 1\text{cm}^2$ of tread chunking area (for Ref tyre: all results invalid)
- Ref. tyres abrasion rate value @20°C or @10°C within abrasion rate range

	Normal	3PMSF
Average T (°C)	7 to 35	-3 to 20
Min/max for 90% of dist. (°C)	2 / 40	-7 / 25
Wet mileage	<20%	<20%
Ice or snow mileage	0%	<5%

	Global
Max speed (km/h)	140
Long. acc. stdev (m/s ²)	0.35-0.55
Max long. acc. (m/s ²)	± 5 (for $\geq 99.8\%$ distance)
Lat. acc. stdev (m/s ²)	0.83-1.03
Max lat. acc. (m/s ²)	± 5 (for $\geq 99.6\%$ distance)

On-Road method - Calculations [13.12]

- ARRT = **A**brasion **R**ate of **R**eference **T**yres normalized to load

$$= (\Sigma(\text{MRTS}_i - \text{MRTF}_i) / D_{Ti}) / \Sigma(Q_{R,i}) \quad @T_{\text{average}}$$

MRTS_i = **M**ass of **R**eference **T**yre **S**tart (wheel i)

MRTF_i = **M**ass of **R**eference **T**yre **F**inal (wheel i)

D_{Ti} = **D**istance of tire i

$Q_{R,i}$ = Test load of each reference tyre i

- ARCT = **A**brasion **R**ate of **C**andidate **T**yres normalized to load @ T_{average}
- AICT = **A**brasion **I**ndex of **C**andidate **T**yre (independent on T_{ave})
= ARCT / ARRT

On-Road method - Test report [15]

Calibration [Annex B]

Instrument	Interval	Criterion
Scale for tyres	Yearly and at major maintenance	± 2 g
Instrument for toe and camber	Yearly	+/- 0.033°
Acceleration/Speed sensor	Yearly	
Scale for vehicle	Yearly and at major maintenance	+/- 0.1%
Temperature sensor	Yearly	± 1 °C
Tyre pressure sensor	Yearly	± 3 kPa
Scale for tyre and wheel assembly	Yearly and at major maintenance	± 2 g

On-Road method - Measurement Uncertainty [14]

- To be discussed when first data is available

Tyre category	Run-to-run (same circuit, same vehicle, similar temperatures, consecutive tests)	Month to month (same circuit, different vehicles, different temperatures, longer period)	Site-to-site (different circuits, different vehicles, different temperatures)
C1 abrasion index	[X]	[Y]	[Z]

Indoor drum method - Drafting Group

- Objective
 - Develop text on indoor drum test methods
- Roles
 - Chair: JASIC
 - Secretary: JATMA
- Meetings
 - 1st Web meeting 22nd March, 2023
 - 2nd Web meeting 18th April, 2023
 - 3rd Web meeting 1st June, 2023
 - 4th Web meeting 20th June, 2023
- Participants:
 - CP: Japan, European Commission, France
 - NGOs: JATMA, ETRTO, ITMA, USTMA, OICA
 - Companies: Twms Consulting, AVL

Indoor drum method - Table of Contents

- Scope [1]
- Definitions and Terms [2]
- Test method [3]
- Test Conditions [4]
- Test procedure [5]
- Validation [6]
- Processing of measurement results [7]
- Input of test cycle [Annex XX – Appendix 1]
- Test equipment tolerances [Annex XX – Appendix 2]
- Replacement of sandpaper surface [Annex XX – Appendix 3]
- Example of a test report [Annex XX – Appendix 4]

Brackets and numbers: chapters in document

Red: under discussion

Indoor drum method - Reference tyres [2.5.2.1]

- Possible options of reference tyre are SRTT16 and SRTT17 (Summer & Winter).
 - [(a) F2493 for the size P225/60R16 and referred to as "SRTT16"]
 - [(b) Fxxxx for the size 225/45R17 and referred to as "SRTT17S"]
 - [(c) Fyyyy for the size 225/45R17 and referred to as "SRTT17W"]
- Comparative tests between the SRTT17 and SRTT16 are ongoing at JASIC, and **if there are no problems**, the SRTT17 will be adopted, which is the same as the vehicle method.

Indoor drum method - Drum specification [3.2]

- Tyre Wear Test Equipment

A drum, a tyre mounting device, a loading device and an adhesion prevention system

- Drum diameter

The test dynamometer shall have a cylindrical flywheel (drum) with a diameter of at least [1,7] m.

The roller diameter shall be defined and reported considering the thickness of test surface, to compute test speed and running distance correctly.

- Width

The width of the test surface shall always exceed the width of the test tyre contact patch throughout entire test duration.

Indoor drum method - Drum specification [3.2]

- Surface

The test surface shall be applied to external surface of the cylindrical drum.

The test surface of drum shall:

- (a) have MPD measured at the start and the end of the drum test, according to [ISO 13473-1] except for low pass filter, applied from [0,2] mm to [2,0] mm.
 - (b) low pass filter cut-off shall be [0,1]mm for MPD data processing procedure.
 - (c) be textured with sands, stone or an alternative material, e.g., aluminum oxide resin
 - (d) The drum surface shall be built with rigid and not deformable material.
- Check surface by reference tyre abrasion rate.
 - The abrasion rate of the reference tyre for all surface shall be in the range [30] mg/km to [100] mg/km

Indoor drum method - Tyre carriage and drive system [3.3]

- The tyre carriage and drive system shall be able to provide dynamic control of:
 - (a) tyre lateral force developed by the drag force produced by tyre slip angle during running
 - (b) Longitudinal tyre force or torque developed by tractive force by the tyre during braking and accelerating
- Adhesion prevention system
 - Tread wear test equipment shall be equipped with the powder delivery system to spray a controlled volume of such material (e.g., talc) on the test surface near the test tyre contact patch so that a test tyre does not adhere to and change the test surface.

Indoor drum method - Test Conditions [4]

- Test load
 - Test load Fz is 80% of maximum load capacity
- Tyre inflation pressure
 - Standard load : 210 kPa
 - Extra load : 250 kPa
- Testing condition
 - Longitudinal force, lateral force and speed : Appendix 1
 - Running distance is 5 000km.

Test equipment tolerances

Table B.1 - Instrumentation accuracy

Parameter	Control accuracy	Instrumentation accuracy
Tyre forces and torque	Fz: $\pm 150\text{N}$ or 3% whichever is greater, for semi-static input. Fy: $\pm 100\text{N}$ or 5% whichever is greater, for the difference between input peaks and actually generated peaks. Fx: $\pm 100\text{N}$ or 5% whichever is greater, for the difference between input peaks and actually generated peaks. My: $\pm 40\text{Nm}$ or 5% whichever is greater, for the difference between input peaks and actually generated peaks.	Fz: $\pm 1\%$ Fy: $\pm 1\%$ Fx: $\pm 1\%$ My: $\pm 1\%$
Inflation pressure	$\pm 3\text{ kPa}$	$\pm 3\text{ kPa}$
Mass scale	$\pm 2\text{ g}$	$\pm 2\text{ g}$
Test duration	For the test time durations, the total time of an actual test shall not differ more than $\pm 5\%$ from the total input time, 68.83h (247,800s). The interval of measurement shall be minimum 1Hz.	$\pm 0.02\text{s}$ for the time increments
Speed	$\pm 2\text{ km/h}$	$\pm 0.1\%$

Indoor drum method - Input of test cycle [Appendix 1]

- Fx (or My) and Fy calculation

- Longitudinal force : $F_x = \text{Test load } F_z \times \text{Longitudinal acceleration } G(x)$

or Tyre torque : $My = F_z \times G(x) \times \text{Loaded Radius } RL$

- Lateral force : $F_y = F_z \times \text{Lateral acceleration } G(y)$

At a point of test duration T, the values of G(x) and G(y) shall be equal to those listed in Table A1;

G(x) and G(y) shall change linearly between two adjacent points.

Therefore, the values of Fx and Fy will also change linearly from one point to another.

The following graphs show samples of linear change for Fx or Fy with respect to T.

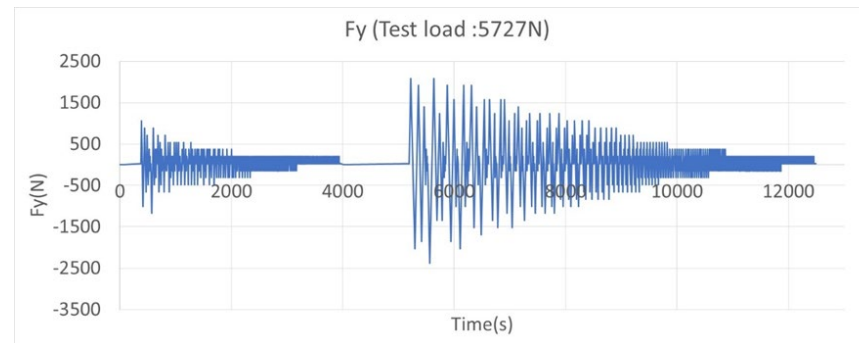
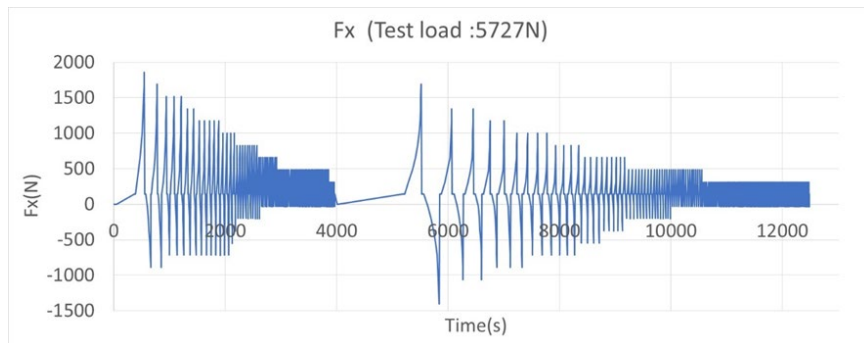


Table A1. – Input of test cycle¹

1 cycle : 250 km

T ²	v ²	G(x) ²	G(y) ²
[s] ²	[kph] ²		
0 ²	100 ²	0.000 ²	0 ²
50 ²	100 ²	0.000 ²	0.000 ²
373.2 ²	100 ²	0.025 ²	0.005 ²
388.4 ²	100 ²	0.025 ²	0.185 ²
418.7 ²	100 ²	0.055 ²	-0.175 ²
446.5 ²	100 ²	0.085 ²	0.155 ²
471.7 ²	100 ²	0.115 ²	-0.115 ²
491.9 ²	100 ²	0.145 ²	0.125 ²
509.6 ²	100 ²	0.175 ²	-0.085 ²
522.3 ²	100 ²	0.205 ²	0.065 ²
532.4 ²	100 ²	0.235 ²	-0.025 ²
540.0 ²	100 ²	0.265 ²	0.035 ²
545.0 ²	100 ²	0.295 ²	0.005 ²
547.5 ²	100 ²	0.325 ²	0.005 ²
556.8 ²	100 ²	0.025 ²	0.005 ²
574.5 ²	100 ²	0.025 ²	-0.205 ²
602.3 ²	100 ²	-0.005 ²	0.155 ²
620.0 ²	100 ²	-0.035 ²	-0.085 ²
632.6 ²	100 ²	-0.065 ²	0.065 ²
645.2 ²	100 ²	-0.095 ²	-0.055 ²
657.9 ²	100 ²	-0.125 ²	0.065 ²
662.9 ²	100 ²	-0.155 ²	0.005 ²
668.8 ²	100 ²	0.025 ²	0.005 ²
678.9 ²	100 ²	0.025 ²	0.125 ²
699.1 ²	100 ²	0.055 ²	-0.115 ²
719.3 ²	100 ²	0.085 ²	0.095 ²
737.0 ²	100 ²	0.115 ²	-0.085 ²
	100 ²		0.065 ²

Indoor drum method - Test procedure [5]

- **Thermal conditioning**
Place the inflated tyre in the thermal environment of the test location for a minimum of 3 h.
- **Pressure adjustment**
After thermal conditioning, the inflation pressure shall be adjusted to the test pressure.
- **Thermal environment**
During the test, the ambient temperature, at a distance of not less than 0,15m and not more than 1 m from the tyre, shall be $25\text{ °C} \pm 5\text{ °C}$
Average temperature for reference and candidate tyre during test within 2 degrees
- **Mass measurement**
The mass of tyre shall be measured before and after 5 000km of run set out in paragraph 5.6 for both reference and candidate tyres.

Indoor drum method - Test cycle [5]

- Input condition
 - Both reference tyre and candidate tyre shall be tested according to input condition of Appendix 1.
 - The Appendix 1 test condition of 250 km is set as one set, and the test cycle shall be repeated 20 times until 5 000 km is reached.

Indoor drum method - Test cycle [5]

- Basic test cycle (2 positions)
 - Both reference tyre and candidate tyre shall be mounted different position of one drum. Test of both reference tyre and candidate tyre shall be conducted at the same time.
 - Tyre positions shall be exchanged once after the completion of 2 500km.
 - Direction of rotation shall remain constant throughout the test.
- Alternative test cycle (1 position)
 - In case test of reference tyre and candidate tyre is not possible at the same time, the alternative test cycle is available. As Reference tyre (R) and Candidate tyre (T), test order is following:

R(1000km) - T(2000km) - R(2000km) - T(2000km) - R(2000km) - T(1000km)

Repeat a set of Appendix 1 input conditions 4 times for 1 000 km and 8 times for 2 000 km.

Indoor drum method - Measurement and recording [5.6.4]

The following shall be measured and recorded:

- (a) Test speed;
- (b) Load on the tyre normal to the drum surface, F_z ;
- (c) Test inflation pressure: initial and middle of the test, as defined in 5.3;
- (d) Ambient temperature measured in degree °C;
- (e) Force or torque applied to the test tyre and testing duration, with a maximum time interval of 1s;
- (f) Test rim size;
- (g) Mass of tyre; at the beginning and the end of the test
- (h) MPD of the test surface; at the beginning and the end of the test
- (i) Photograph of tyre after test run;

Indoor drum method - Validation [6]

- Test operate undergo with NO...
Permanent deformation
Loss of air
- Visual inspection to check there are NO...
Visual evidence of tread, sidewall, ply, cord, inner liner, belt
Bead separation
Chunking
Open splices
Cracking
Broken cords
Rubber adhesion

Indoor drum method - Calculations [7]

- **Abrasion Index ; $Ari = ArT (g) / ArR (g)$**

ArT : Abrasion rate(mg/km) of candidate tyre

$$ArT = MIT (g) / DT(km) \times 1000(mg/g)$$

ArR : Abrasion rate(mg/km) of reference tyre

$$ArR = MIR (g) / DR(km) \times 1000(mg/g)$$

MIT : Mass loss of candidate tyre, in grams

MIR : Mass loss of reference tyre, in grams

DT : Testing mileage of candidate tyre

DR : Testing mileage of reference tyre

Open points on both test methods

- Tread depth is included in the test campaign (mileage).
- Ice tyres special requirements (e.g. average ambient temperature $<5^{\circ}\text{C}$)
- Units mg/km or mg/km/t

Task Force on Tyre Abrasion: next

Next steps

- Start the post processing of the validation and correlation test campaign
- Draft the final proposal of method(s) for GRPE review (January 24) and GRBP adoption (February 24)
- Once the method(s) is validated and finalised
 - Perform the market review (2024 TBC)
 - Define and introduce reference tyre(s) for abrasion test in ASTM standard
- Set the limits for abrasion
- Work on the feasibility of rating and definition of the mileage of tyres
- Evaluate and adapt or propose method(s) and rating to C2 and C3 tyres

Back up

On-Road method - Open points

- **Tyre and wheel assembly mass measurements**: To be decided after test campaign
- **Reference tyres abrasion rate range**: To be decided after test campaign
- Data (worst case) of abrasion and impact on result with **distance** 7700 km and 9200 km

Indoor drum method - Open points

- **Reference tyre**: needed?
- **Reference tyres abrasion rate range**: To be decided after test campaign
- **Tolerances of test equipment**: To be decided after test campaign