Proposal for amendments to the working document ECE/TRANS/WP.29/GRBP/2024/10

This amendment is based on GRBP/2024/10.

The modifications to the current text of the 04 series of amendments to UN Regulation No. 117 are marked in bold for new or strikethrough for deleted characters.

The modifications to GRBP/2024/10 are in red and marked in bold for new or strikethrough for deleted characters.

Table of contents., **amend to read:**

"[…]

"

I. Proposal

Paragraph 1.1., amend to read:

"1.1.	This Regulation applies to new pneumatic tyres * of classes C1, C2 and C3 in new state with regard to their sound emissions, rolling resistance and to adhesion performance on wet surfaces (wet adhesion) and for class C1 tyres in worn state with regard to adhesion performance on wet surfaces (wet adhesion). **[It also applies to C1 tyres in new state with regards to their tyre abrasion as defined in paragraph 1.3. of this UN Regulation].** It does not, however, apply to:"

Insert a new paragraph 1.3., to read:

"**1.3.	In the case of class C1 tyres, except ice grip tyres and tyres having a nominal rim diameter code ≤ 13, approval shall be supplemented with information on the abrasion level according to paragraphs 5.7 to 5.9 of this Regulation.**"

Paragraph 2.7., amend to read:

"2.7.	"*Representative tyre size*" means the tyre size which is submitted to the test described in Annex 3 to this Regulation with regard to rolling sound emissions, or Annex 5 for adhesion on wet surfaces or Annex 6 for rolling resistance **or Annex 9 for adhesion on wet surfaces of tyres in worn state** to assess the conformity for the type approval of the type of tyre, or Annex 7 for measuring snow performance, or Annex 8 for measuring ice performance~~, or Annex 9 for adhesion on wet surfaces tyres in worn state~~."

Paragraph 2.18., amend to read:

"2.18	"*Standard Reference Test Tyre*" or "*SRTT*" means a tyre that is produced, controlled and stored in accordance with the standards of ASTM International:

(a)	E1136 – 17 for the size P195/75R14 and referred to as "SRTT14",

(b)	F2493 – 20 for the size P225/60R16 and referred to as "SRTT16",

(c)	F3611-22 for the size P225/60R16 in worn state and referred to as "moulded SRTT16 worn",

(d)	F2872 – 16 for the size 225/75R16C and referred to as "SRTT16C",

(e)	F2871 – 16 for the size 245/70R19.5 and referred to as "SRTT19.5",

(f)	F2870 – 16 for the size 315/70R22.5 and referred to as "SRTT22.5"

**[(g)	reserved,**

**(h)	reserved,**

**(i)	F3676 – 23 for the size 225/45R17 and referred to as "SRTT17S",**

**(j)	F3675 – 23 for the size 225/45R17 and referred to as "SRTT17W".]**"

Insert a new paragraph 2.21. and its subparagraphs, to read:

"**2.21.	Abrasion performance - Specific definitions**

**2.21.~~2.~~1.	"*Abrasion rate*" means the ratio of mass of material lost from the tyre due to the abrasion process per distance travelled, and expressed in mg/km.**

**2.21.~~1.~~2.	"*Abrasion level*" means the ~~ratio of mass of material lost from the tyre due to the abrasion process per distance travelled~~ abrasion rate normalized to the load on the tyre, and expressed in mg/km/t.**

**2.21.3.	"*Abrasion index*" (AICT) of candidate tyre means the dimensionless unit for expressing the tyre abrasion level of a tyre relative to that of the applicable Standardized Reference Test Tyre (SRTT).**"

Paragraph 3.1.1., amend to read:

"3.1.1.   The performance characteristics to be assessed for the type of tyre; "rolling sound emissions level" and/or "adhesion performance level on wet surfaces of a tyre in new state" and/or "adhesion performance level on wet surfaces of a tyre in worn state" and/or "rolling resistance level"; "snow performance level" in case of tyre for use in severe snow conditions and additionally "ice performance level" in case of ice grip tyre; ~~[and/or "tyre abrasion"];~~"

Insert a new paragraph 3.1.1.1., to read:

"**3.1.1.1.   In case of class C1 tyres, the information on the abrasion level, if reported, shall be communicated in the format according to the test report sheet of Appendix 2 or Appendix 6 of Annex 10;**"

Paragraph 3.2.1., amend to read:

"3.2.1.   Details of the major features, with respect to the effects on the performance (i.e. rolling sound emission level, adhesion on wet surfaces, rolling resistance, snow performance**,** ice performance, **and tyre abrasion**) of the tyres, including the tread pattern, included in the designated range of tyre sizes. This may be by means of descriptions supplemented by technical data, drawings, photographs or Computer Tomography (CT) scans, and must be sufficient to allow the Type Approval Authority or Technical Service to determine whether any subsequent changes to the major features will adversely affect the tyre performance. The effects of changes to minor details of tyre construction on tyre performances will be evident and determined during checks on conformity of production**.**"

Insert new paragraph 5.7 to 5.10~~9~~., to read:

"**5.7.   Until ~~[6 July 202~~6~~5]~~ and upon request of the applicant, during the approval of new type of class C1 tyres, it will be possible to determine the tyre abrasion level of** one tyre of **the tyre type in accordance with Annex 10 to this Regulation. The test results shall be communicated to the Type Approval Authority in the format according to the test report sheet of Appendix 2 or Appendix 6 of Annex 10.**

5.8.   ~~Starting from [7 July 2025], the manufacturer during the approval of new type of class C1 tyres, shall communicate the tyre abrasion level of the tyre type determined in accordance with Annex 10 to this Regulation.~~ Between 7 July 2026 and 31 December 2026 and upon request of the applicant, during the approval of new type of class C1 tyres, it will be possible to determine the tyre abrasion level of the tyre type determined in accordance with Annex 10 to this Regulation. The test results shall be communicated to the Type Approval Authority in the format according to the test report sheet of Appendix 2 or Appendix 6 of Annex 10.

5.9.   ~~Abrasion tests are not required for extensions of existing type approvals according to this Regulation first granted before [7 July 2025].~~ Starting from ~~[7 July 2025]~~ 1 January 2027, the manufacturer, during the approval of new type of class C1 tyres, shall communicate the tyre abrasion level of the tyre type determined in accordance with Annex 10 to this Regulation. The test results shall be communicated to the Type Approval Authority in the format according to the test report sheet of Appendix 2 or Appendix 6 of Annex 10.

5.10.   Abrasion tests are not required for extensions of existing type approvals according to this Regulation first granted before 1 January 2027."

Annex 1,

~~Introductory part,~~ amend to read:

"~~[...]~~

Concerning:[2] ~~Approval granted~~
~~Approval extended~~
~~Approval refused~~
~~Approval withdrawn~~
~~Production definitively discontinued~~

~~of a type of tyre with regard to "rolling sound emission level" and/or "adhesion performance on wet surfaces" and/or "rolling resistance"~~ **[and/or "tyre abrasion"]** ~~pursuant to UN Regulation No. 117~~

~~Approval No.[3]........ ....~~   ~~Suffix(es)[4]...................~~

~~1.   [...]"~~

Insert a new item 8.6., to read:

"**8.6.**   **Abrasion level available in the case of class C1 tyres (Yes/No)[2]**"

Insert a new item 8.6.1. to read:

"**8.6.1.**   **Use of the vehicle on public open roads method[2] or the indoor drum method[2]**"

Insert a new Annex 10, to read:

"**Annex 10**

Procedure for determining the abrasion performance of tyres of class C1

Introduction

For the calculation of the tyre abrasion index of a candidate tyre, the abrasion level of the candidate tyre is compared to the abrasion level of a standard reference test tyre. It is measured with one of the followings test methods:

(a)   vehicle test method on public open roads;

(b)   indoor drum test method.

1.   **Test method (a) using vehicle on public open roads**

1.1.   **Scope**

This method applies to C1 tyres in scope of this regulation except ice grip tyres and tyres having a nominal rim diameter code ≤ 13.

1.2.   **Definitions**

In addition to relevant definitions set at point 2 of this Regulation the following apply.

1.2.1.   *"Loop"* means the section of the circuit having the same starting and ending point. If the same loop is run clockwise and counterclockwise it shall be considered as 2 loops.

1.2.2.   *"Circuit"* identifies the roads which will be used for the abrasion test. The circuit may consist of one or several loops, which can be run in any order.

1.2.3.   *"Shift"* means the period of time required to run the circuit (including break time, rotation time between vehicle in convoy or drive in vehicle).

1.2.4.   *"Total distance"* is the total distance ran by a tyre during the test.

1.2.5. *"Electric machine"* identifies the energy converter transforming between electrical and mechanical energy.

1.2.6. *"Category of propulsion energy converter"* means **(i) an** ~~the~~ internal combustion engine, **(ii)** ~~or~~ an electric machine **or (iii) fuel cell**.

1.2.7. *"Hybrid electric vehicle (HEV)"* is a Hybrid vehicle where one of the propulsion energy converters is an electric machine.

1.2.8. *"Hybrid vehicle"* is a vehicle equipped with a powertrain containing at least two different categories of propulsion energy converters and at least two different categories of propulsion energy storage systems.

1.2.9. *"Not off-vehicle charging hybrid electric vehicle (NOVC-HEV)"* is a hybrid electric vehicle that cannot be charged from an external source.

1.2.10. *"Off-vehicle charging hybrid electric vehicle (OVC-HEV)"* is a Hybrid electric vehicle that can be charged from an external source.

1.2.11. *"Pure electric vehicle (PEV)"* is a vehicle equipped with a powertrain containing exclusively electric machines as propulsion energy converters and exclusively rechargeable electric energy storage systems (REESS) as propulsion energy storage systems.

1.2.12. *"Pure internal combustion engine (ICE) vehicle* ~~*(ICE)*~~*"* is a vehicle where all propulsion energy converters are internal combustion engines.

1.2.13. *"~~Rechargeable electric energy storage system –~~Traction REESS"* means an electric energy storage system that is rechargeable and that provides electric energy for electric propulsion.

1.2.14. *"FWD (Front Wheel Drive) vehicle"* means a vehicle where only the front axle delivers traction torque.

1.2.15. *"RWD (Rear Wheel Drive) vehicle"* means a vehicle where only the rear axle delivers traction torque.

1.2.16. *"4WD (4 Wheel Drive) vehicle"* means a vehicle where ~~**one of**~~ the axle traction torque **for one axle** can be switched off by the driver.

1.2.17. *"AWD (All Wheel Drive) vehicle"* means a vehicle with permanent or vehicle controlled 4 wheels drive.

1.2.18. *"Reference vehicle"* identifies the vehicle that will be fitted with the reference tyres.

1.2.19. *"Candidate vehicle"* identifies the vehicle that will be fitted with the candidate tyres.

1.2.20. *"Vehicle f2 coefficient"* (measured in $N/(km/h)^2$) is the second order road load coefficient according to UN Regulation No. 154. It is provided at reference conditions.

1.2.21. *"Longitudinal acceleration"* (measured in m/s^2) is the acceleration in the direction of vehicle movement. Longitudinal acceleration has a positive sign for speed increase and a negative sign for speed decrease (e.g. braking).

1.2.22. *"Lateral acceleration"* (measured in m/s^2) is the acceleration perpendicular to the direction of vehicle movement. Lateral acceleration has a positive sign when turning left in the direction of the vehicle movement. Lateral acceleration has a negative sign when turning right in the direction of the vehicle movement.

1.2.23. *"Test tyre"* indicates either candidate tyres or reference tyres.

1.2.24. *"Candidate tyre"* means a tyre whose abrasion performance is evaluated relative to that of a reference tyre.

1.2.25.   *"Reference tyre"* means the tyre which will be used in each convoy as a reference for the evaluation of the abrasion performance of the candidate tyre, according to the following table:

		Reference tyre	
Candidate tyre		*SRTT17S*	*SRTT17W*
Normal tyre		X	
Snow tyre			X
	Snow tyre that is classified as tyre for use in severe snow conditions		X
Special use tyre		[X]	
	"M+S" or "M.S" or "M&S"		X
	Special use tyre that is classified as tyre for use in severe snow conditions		X

1.3.   **Symbols and abbreviated terms**

Symbol	*Unit*	*Designation*
Q_{Ri}	kg	Test load for each reference tyre
Q_{Ti}	kg	Test load for each candidate tyre
$MRTS_i$	g	Reference tyre initial mass of tyre i
$MRTF_i$	g	Reference tyre final mass of tyre i
$MCTS_i$	g	Candidate tyre initial mass of tyre i
$MCTF_i$	g	Candidate tyre final mass of tyre i
S_S	mg/km/t/°C	Sensitivity of *SRTT17S* to temperature variation
S_W	mg/km/t/°C	Sensitivity of *SRTT17W* to temperature variation
S1	mg/km/t	Minimum abrasion rate @ 20°C of SRTT17S during test
S2	mg/km/t	Maximum abrasion rate @ 20°C of SRTT17S during test
W1	mg/km/t	Minimum abrasion rate @ 10°C of SRTT17W during test
W2	mg/km/t	Maximum abrasion rate @ 10°C of SRTT17W during test
D_{Ti}	km	Total distance run by each test tyre during test
ARR	mg/km	Abrasion rate of reference tyre at test conditions
ARC	mg/km	Abrasion rate of candidate tyre at test conditions
ARRT	mg/km/t	Abrasion rate of reference tyre, normalized to load in ton, at test conditions
ARCT	mg/km/t	Abrasion rate of candidate tyre, normalized to load in ton, at test conditions
AICT	No dimension	Abrasion index of the candidate tyre

Symbol	*Unit*	*Designation*
AICT	**No dimension**	**Abrasion index of the candidate tyre**
ALC	**mg/km/t**	**Abrasion level of candidate tyre at test conditions**
ALRT	**mg/km/t**	**Abrasion level of reference tyre at test conditions**
ARC	**mg/km**	**Abrasion rate of candidate tyre at test conditions**

ARR	mg/km	Abrasion rate of reference tyre at test conditions
D_{Ci}	km	Total distance run by candidate vehicle during the test
D_{Ri}	km	Total distance run by reference vehicle during the test
$MCTF_i$	g	Candidate tyre final mass of tyre i
$MCTS_i$	g	Candidate tyre initial mass of tyre i
$MRTF_i$	g	Reference tyre final mass of tyre i
$MRTS_i$	g	Reference tyre initial mass of tyre i
O_S	mg/km/t	Offset of the regression lines of the reference tyre abrasion level of SRTT17S
O_W	mg/km/t	Offset of the regression lines of the reference tyre abrasion level of SRTT17W
Q_{Ci}	kg	Test load for each candidate tyre
Q_{Ri}	kg	Test load for each reference tyre
S_S	mg/km/t/ºC	Sensitivity of *SRTT17S* to temperature variation
S_W	mg/km/t/ºC	Sensitivity of *SRTT17W* to temperature variation
T_i	ºC	Average temperature of the test
$\overline{T}$	ºC	Average temperature of the n tests

1.4. **Instrumentation.**

~~Calibration and check for weight scales shall be carried out according to Annex 10 Appendix 1.~~

1.4.1. **Instruments for tyre mass measurement.**

The weight scale shall be able to measure the tyre mass with an accuracy of ± 2 g.

1.4.2. **Instruments for alignment and camber measurement on vehicle**

The device shall have an accuracy of ~~± 0.033 degrees~~.

1.4.3. **Instruments for vehicle mass measurement per position.**

The weight scale shall be able to measure the load on each tyre with an accuracy of ± 0.1 per cent.

1.4.4. **Instruments for acceleration, distance, and speed measurements.**

During the test, a continuous evaluation of speed, lateral, and longitudinal acceleration shall be done, with a minimum and recommended sampling rate of 10 Hz. GNSS (Global Navigation Satellite System as defined by ISO 24245:2023) measurement associated with numerical treatment of the positions shall be used. See numerical treatment for GNSS (Global Navigation Satellite System) data in Appendix 1 of this Regulation.

The distance ran by the tyre shall equal the GNSS reported distance plus the distance ran without a GNSS signal, unless the latter is estimated by the GNSS system., unless this distance is estimated by the GNSS itself.

Accelerometers shall not be used.

1.4.5. **Tyre pressure measurement device.**

The device shall have an accuracy of ± 3 kPa.

1.4.6. **Instruments for weather (rain, snow, ice) measurement.**

For rain, test drivers shall report mileage with wipers in function (actually wiping the windshield) for each shift.

For snow/ice, test drivers shall report mileage driven with snow or ice on the road for each shift.

1.4.7.   **Instruments for temperature measurement.**

The vehicle external thermometer may be used. Data shall be recorded with time and location on paper or file. Any thermometer positioned to measure external air temperature is acceptable as well. The thermometer shall have a measurement accuracy of ± 1 °C. A continuous measurement device recording the temperature is acceptable as well provided it fulfils the measurement accuracy described above.

Initial and final measurement shall be done using a calibrated thermometer.

1.4.8.   **Instruments for tyre and wheel assembly mass measurement**

The weight scale shall be able to measure the tyre mass with an accuracy of ± 2 g.

1.5.   **Tyre, tyre and wheel assembly, and vehicle measurement procedure**

1.5.1.   **Tyre mass measurement**

The tyre shall be cleaned and dried before the mass measurement, with device or product not removing any rubber from the tyre (e.g. water based non-abrasive cleaner). Any visible stone shall be removed from the pattern before mass measurement. The measurement shall be repeated 3 times and averaged.

1.5.2.   **Tyre and wheel assembly mass measurement**

The tyre assembly shall be cleaned and dried before the mass measurement, with device or product not removing any rubber from the tyre (e.g. water based non-abrasive cleaner). Any visible stone shall be removed from the pattern before mass measurement, without air pressure, and without valve core.

The mass measurement shall be performed after checking that the balancing masses are all present on the assembly.

1.5.3.   **Vehicle mass measurement procedure**

The vehicle shall be cleaned and dried before measurement, with full fuel tank (ICE vehicle), test ballast **as described in paragraph 1.6. of this Annex**, equipped with the tyres to be tested, and wheels used for the test with drivers' average weight **(i.e. 75 kg).** Load Q on each wheel shall be measured.

1.5.4.   **Vehicle alignment measurement procedure**

The vehicle alignments shall be measured, with full fuel tank (ICE vehicle), test ballast **as described in paragraph 1.6. of this Annex**, equipped with the tyres to be tested, and wheels used for the test with drivers' average weight **(i.e. 75 kg).**

1.6.   **Vehicle requirements**

1.6.1.   **General requirements**

Alignments setting shall be performed as following:

(a)   Measure and record the alignment values with vehicles in loaded conditions as explained in 1.5.4.

(b)   The values measured with loaded conditions will be monitored during the test and will serve as the reference values to respect during the tests.

Alignments (TOE and camber) on both axles of reference vehicle and of each candidate vehicle shall be checked at least:

(c)   At the beginning of the test. The alignment shall take place maximum at 50 km of distance run before starting the test;

(d)   Optionally at half distance;

(e)   In case of an impact that may affect the alignment (e.g. curbstone contact, etc);

(f)   At the end of the test. The alignment shall take place maximum at 50 km of distance run after finishing the test;

(g)   Any additional distance to reach the geometry measurement facility shall not be driven with reference or candidate tyres.

At the end of the test, the alignments shall not vary by more than ± 0.15 degrees for toe and ± 0.3 degrees for camber from initial measurement under the same condition.

1.6.2.   Vehicles acceptable suspension and static tuning for FWD vehicles

1.6.2.1.   Vehicles used for candidate tyres, loaded condition as described in paragraph 1.5.4.:

(a)   Toe IN/OUT angle per wheel on the front axle set to 0 ± 0.1 degrees;

(b)   Camber angle per wheel on the front axle set between -1.2 degrees to 0 degrees;

(c)   Toe IN/OUT angle per wheel on the rear axle between 0.05 degrees and 0.15 degrees;

(d)   Camber angle per wheel on the rear axle between -1.9 degrees and -0.6 degrees.

1.6.2.2.   Vehicle used for reference tyres, loaded condition as described in paragraph 1.5.4:

(a)   Toe IN/OUT angle per wheel on the front axle set to 0 ± 0.05 degrees;

(b)   Camber angle per wheel on the front axle set between -1.2 degrees to 0 degree;

(c)   Toe IN/OUT angle per wheel on the rear axle between 0.05 degrees and 0.15 degrees;

(d)   Camber angle per wheel on the rear axle between -1.9 degrees and -0.6 degrees; ~~.~~

(e)   In addition, ~~for the reference vehicle,~~ the toe IN/OUT in absolute value shall be lower than or equal to the values used in the test vehicles for the front axle.

1.6.3.   Vehicles acceptable suspension and static tuning for RWD vehicles

1.6.3.1.   Vehicles used for candidate tyres, loaded condition as described in paragraph 1.5.4.:

(a)   Toe IN/OUT angle per wheel on the front axle set to 0 ± 0.1 degrees;

(b)   Camber angle on the front axle set to 0 ± 0.1 degrees;

(c)   Toe IN/OUT angle per wheel on the rear axle set to 0 ± 0.1 degrees;

(d)   Camber angle on the rear axle set to 0 ± 0.1 degrees.

1.6.3.2.   Vehicle used for reference tyres loaded condition as described in paragraph 1.5.4:

(a) Toe IN/OUT angle per wheel on the front axle set 0 ± 0.05 degrees;

(b) Camber angle on the front axle set to 0 ± 0.1 degrees;

(c) Toe IN/OUT angle per wheel on the rear axle set to 0 ± 0.1 degrees;

(d) Camber angle on the rear axle set to 0 ± 0.1 degrees; .

(e) In addition, for reference vehicle, toe IN/OUT in absolute value shall be lower than or equal to the values used for candidate vehicles for front axle.

1.6.4. Vehicle acceptable suspension and static tuning for 4WD vehicles

4WD vehicles may be used if only one axle is applied as drive axle. In this case, they are considered as FWD or RWD, depending on the configuration.

1.6.5. Vehicles acceptable suspension and static tuning for AWD vehicles

Vehicle with permanent 4WD shall respect the RWD vehicles settings described in paragraph 1.6.3. of this Annex.

1.6.6. In case no vehicle respecting conditions described in paragraph 1.6.2., 1.6.3., 1.6.4. or 1.6.5., the following process shall be used:

(a) Measurement with at least 4 different vehicles (if 4 vehicles available or all the available vehicles if less than 4) able to fit the candidate tyres must demonstrated that the settings limits cannot be achieved. The vehicles shall be aged of less than two years, and made by 4 different carmakers.

(b) Select vehicles (both reference and candidate vehicles) respecting following criteria:

(i) Front Toe shall respect the previously given tolerances (0° +/- tolerance);

(ii) Front camber angle shall not differ by more than 0.5° between Reference and Candidate vehicle. Reference vehicle shall have a Front Camber lower than or equal to the respective value of the candidate vehicle, in absolute value;

(iii) Rear camber angle shall not differ by more than 0.6° between reference and candidate vehicle. Reference vehicle shall have a rear camber lower than or equal to the respective value of the candidate vehicle, in absolute value;

(iiii)(iv) Rear Toe angle shall not differ by more than 0.1° between reference and candidate vehicle. Reference vehicle shall have a rear toe lower than or equal to the respective value of the candidate vehicle, in absolute value;

(iiii)(v) In addition, the following limit shall be respected for candidate vehicles with loaded condition as described in paragraph 1.5.3.:

(a) Toe IN/OUT angle per wheel on the front axle set to 0 ± 0.1 degrees;

(b) Camber angle on the front axle set between -1.7 degrees and 0 degree;

(c) Toe IN/OUT angle per wheel on the rear axle set between 0.05 degree and 0.3 degrees;

(d) Camber angle on the rear axle set between -2.7 degree and 0.3 degrees.

(iiiii)(vi)   In addition, the following limit shall be respected for candidate reference vehicles with loaded condition as described in paragraph 1.5.3.:

(a)   Toe IN/OUT angle per wheel on the front axle set to 0 ± 0.05 degrees;

(b)   Camber angle on the front axle set between -1.7 degrees and 0 degree;

(c)   Toe IN/OUT angle per wheel on the rear axle set between 0.05 degree and 0.3 degrees;

(d)   Camber angle on the rear axle set between -2.7 degree and 0.3 degrees.

1.6.7.   **Vehicle acceptable propulsion energy convertor**

All the propulsion energy convertor types are allowed, as long as they are homogeneous in the convoy. The convoy shall consist of vehicles that belong in the same vehicle type in terms of the vehicles' electrification grade (i.e. ICE or NOVC-HEV or OVC-HEV or PEV).

1.6.8.   **Vehicle acceptable transmission system**

A FWD vehicle shall be used for the tyre size to be tested when available.

If the tyre size can only be fitted on RWD vehicles, a RWD vehicle shall be used, and the reference tyres shall as well be fitted on RWD vehicle.

If the tyre size can only be fitted on all wheels drive vehicles, an all wheels drive vehicle shall be used, and the reference tyre shall as well be fitted on all wheels drive vehicle. If available, vehicle with similar torque distribution shall be used for both reference tyre and candidate tyre. If not available, the default mode shall be used for both reference vehicle and candidate vehicle.

Vehicles featuring automatic or manual transmission systems are allowed in the same convoy.

1.6.9.   **Vehicle driving mode**

If several driving modes are available, the default driving mode, if as it is defined by the vehicle manufacturer, shall be selected.

In the case that no default driving mode is defined by the vehicle manufacturer, the use of a representative driving mode shall be agreed with the responsible authority.

1.6.10.   **Regenerative braking**

The vehicles of the convoy shall have similar regenerative capabilities. This is fulfilled by selecting vehicles of the similar electrification grade (see 1.6.7). If the regenerative braking function of a vehicle can be deactivated, the driver is allowed to do so only if all vehicles in the convoy run under the same regenerative braking conditions.

1.6.11.   **Vehicle acceptable aerodynamic performances**

Aerodynamic performance of the vehicle fitted with reference tyres shall respect the following condition:

The f2 value of the vehicle with reference tyres shall be lower than or equal to 1.2 times the f2 value of the vehicles with candidate tyres.

The provision defined in this paragraph does not apply when the f2 value of the vehicles is not available to the testing facility.

1.6.12.   **Vehicle acceptable mass (depending on the tyre size and tyre load index)**

The total vehicle mass shall allow to load the tyre with a total load of (67 ± 7) per cent of the total nominal tyre load capacity for 4 tyres.

Example of calculation:

Assuming that the reference tyres load index is 94, which corresponds to a maximum load of 670 kg.

The total load nominal load of the 4 reference tyres would then be: 670*4 = 2680 kg.

The loaded vehicle mass shall then be 2680*67 % = 1796 kg with a tolerance of 2680*7 %, which corresponds to ± 188 kg.

Load distribution between front and rear axle shall be as following:

(a)   For FWD vehicles

Front axle load: (56 ± 7) per cent of total vehicle load.

Rear axle load: (44 ± 7) per cent of total vehicle load.

(b)   For AWD/RWD vehicles

Front axle load: (50 ± 7) per cent of total vehicle load.

Rear axle load: (50 ± 7) per cent of total vehicle load.

Ballasting allowing to reach above loads is authorized, as long as it does not exceed 85 per cent of the vehicle maximum payload. A minimum ballast of 1.5 passengers including driver shall be included.

1.6.13.   **Circuit, acceleration, and speed requirements**

The circuit shall be a closed loop. Vehicles shall return to the departure point without being transported on a car carrier.

1.6.13.1.   **Circuit minimum length**

Circuit shall be made of one or several closed loops. Vehicles shall return to the departure point. The minimum length shall be 300 km of different roads. Vehicle shall not be transported on a car carrier, except in case of vehicle/tyre failure.

~~When the circuit allows for running tests in both directions, the test shall be run to an equal distance for each direction when both directions are used.~~

1.6.13.2.   **Driving style distribution**

The circuit shall respect the following distribution of acceleration/distance for each one of the represented driving styles:

(a)   Roads representative of highway-like driving style:

(i)   more than 35 per cent of the total distance;

(ii)   The longitudinal acceleration standard deviation shall be in range from 0.10 ~~5~~ to 0.45 ~~5~~ m/s^2;

(iii)   The lateral acceleration standard deviation shall be in range from 0.15 to 1.00 ~~0.80~~ m/s^2.

(b)   ~~Roads representative of regional driving style:~~

~~(i)   more than 25 per cent of the total distance;~~

~~(ii)   The longitudinal acceleration standard deviation shall be in range from 0.20 to 0.75 m/s^2;~~

~~(iii)   The lateral acceleration standard deviation shall be in range from 0.70 to 1.80 m/s^2.~~

(b)(e) **Roads representative of urban-like driving style:**

    (i) more than 25 per cent of the total distance;

    (ii) The longitudinal acceleration standard deviation shall be in range from 0.45 0 to 0.90 m/s^2;

    (iii) The lateral acceleration standard deviation shall be in range from 0.40 to 1.20 m/s^2.

(c) **Roads representative of regional-like driving style corresponds to the data points not lying in one of the clusters defined in (a) and (b) of this paragraph;**

(d) **In addition, the speed distribution for the circuit shall respect the following conditions:**

    (i) **The speed shall be lower than 60 km/h for at least 10 per cent of the global distance;**

    (ii) **The speed shall be equal to or higher than 60 km/h and lower than 90 km/h for at least 25 per cent of the global distance;**

    (iii) **The speed shall be equal to or higher than 90 km/h for at least 35 per cent of the global distance.**

The calculation of the speed distribution shall be carried out using the 10 Hz data recorded on the global distance.

1.6.13.3. **Global accelerations level**

The following provisions regarding the deceleration standard deviation and maximum values shall apply:

1.6.13.3.1. **Standard deviation**

    (a) Longitudinal acceleration: 0.45 m/s^2 ± 10 per cent;

    (b) Lateral acceleration: 0.93 m/s^2 ± 10 per cent.

Longitudinal and lateral accelerations standard deviations during the test shall not deviate by more than 5 per cent from one vehicle to another vehicle of the same convoy.

1.6.13.3.2. **Maximum acceleration**

    (a) Longitudinal acceleration: ± 5 m/s^2 for a distance representing at least 99.98 per cent of the total distance;

    (b) Lateral acceleration: ± 5 m/s^2 for a distance representing at least 99.9 per cent of the total distance.

1.6.14. **Speed requirements**

Speed, with a measurement tolerance of 10 km/h, shall not exceed the applicable legal limits applying in the respective country where the circuit is located. Additionally, the speed shall not exceed the value of 140 km/h. The maximum tolerance in distance travelled (including measuring tolerance of 10 km/h) is 0.5 per cent (40 km in total for 8000 km driving distance).

1.6.15. **Acceleration and speed monitoring during the test**

Acceleration and speed shall be constantly monitored during the test for each car in the convoy.

Details regarding acceleration and speed calculation are provided in Appendix 1 of this Annex.

1.6.16. **Circuit abrasion level**

To be usable for test, the circuit shall respect the following abrasion level specifications for reference tyres:

(a)   SRTT17S: the circuit abrasion level at 20 °C shall be in the range from [s1 25 to 75 s2] mg/km/t;

(b)   SRTT17W: the circuit abrasion level at 10 °C shall be in the range from [s1 25 to 75 s2] mg/km/t.

If a circuit uses only one of the reference tyres (e.g. only the SRTT17S), only one of the conditions shall be respected, the one for the reference tyre which is used on the circuit.
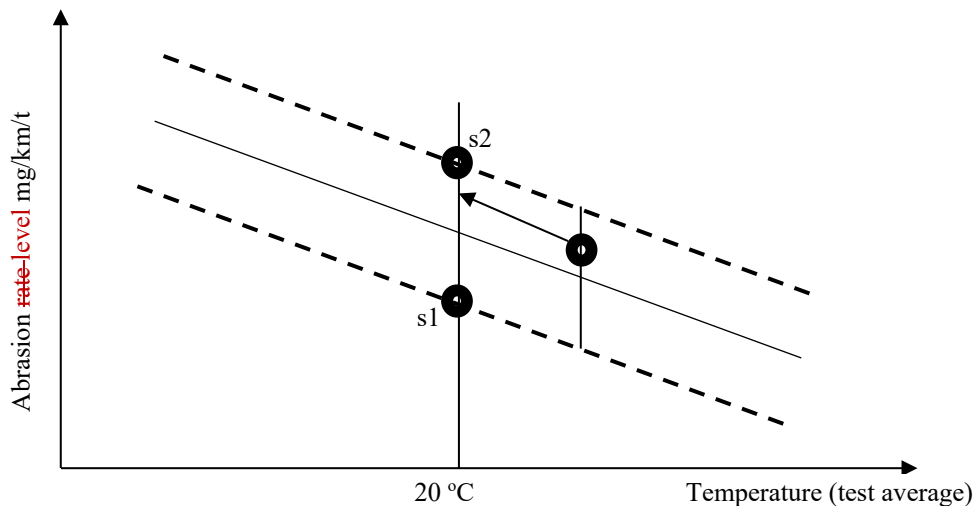
Figure 1: The normalised to 20°C abrasion ~~rate~~ level of the test shall be within s1 and s2.

The calculation of the circuit abrasion level shall be made according to paragraph 1.6.16.1. of this Annex.

1.6.16.1.   The following provisions apply for the measurement of the **abrasion level of the** reference tyre~~s' abrasion rate~~:

(a)   At least one reference tyre (SRTT17S or SRTT17W) shall be selected. The reference tyre shall be measured at least at 3 different temperatures differing **from each other** by more than 5 °C;

(b)   ~~A linear regression will give the~~ **The** value of abrasion ~~rate~~ **level** for references tyres at 20 °C (SRTT17S) or 10°C (SRTT17W) **shall be given by a linear regression;**

(c)   For SRTT17S, at least one measurement shall be done between 15 and 25 °C;

(d)   For SRTT17W, at least one measurement shall be done between 5 and 15 °C.

For each of the (at least) 3 sets of reference tyres tested, the *~~ARRTi~~ ALRTi* abrasion ~~rate~~ **level** in mg/km/t at a temperature ~~Ti~~ T_i is available.

Calculation shall be updated each quarter using the results of all performed tests from the previous 4 quarters, starting one year after the circuit's initial accreditation. Update of slopes and offset at origin may only be performed if the range of temperature covers the provisions of this paragraph.

The **sensitivity of SRTT17S and SRTT17W to temperature variation during the test ("S_S" and "S_W") (i.e. the** slope of the regression line of the reference tyre abrasion ~~rate~~ **level** to the average test temperature) ~~during the test (S)~~ is calculated by means of the following equation:

$$S = \frac{\sum_{i=1}^{n}\left(ARRT_i - \overline{ARRT}\right) \times \left(T_i - \overline{T}\right)}{\sum_{i=1}^{n}\left(T_i - \overline{T}\right)^2} \quad S_S = \frac{\sum_{i=1}^{n}\left(ALRT_i - \overline{ALRT}\right) \times \left(T_i - \overline{T}\right)}{\sum_{i=1}^{n}\left(T_i - \overline{T}\right)^2}$$

for SRTT17S

$$S_W = \frac{\sum_{i=1}^{n}\left(ALRT_i - \overline{ALRT}\right) \times \left(T_i - \overline{T}\right)}{\sum_{i=1}^{n}\left(T_i - \overline{T}\right)^2} \qquad \text{for SRTT17W}$$

The offsets of the regression lines of the reference tyre abrasion ~~rate~~ **level** to the average test temperature during the test are calculated by means of the following equations:

$$O_S = \overline{\text{~~ARRT~~}ALRT} - \text{~~M~~}S_S \cdot \overline{T} \qquad \text{for SRTT17S}$$

$$O_W = \overline{\text{~~ARRT~~}ALRT} - \text{~~M~~}S_W \cdot \overline{T} \qquad \text{for SRTT17W}$$

The circuit abrasion levels at the relevant temperatures are calculated by means of the following equations:

$$R_{ACS} = O_S + \text{~~M~~}S_S \cdot 20 \qquad \text{for SRTT17S}$$

$$R_{ACW} = O_W + \text{~~M~~}S_W \cdot 10 \qquad \text{for SRTT17W}$$

Where:

S is the slope of the regression line of the reference tyre abrasion ~~rate~~ **level** to the temperatures during the tests;

$\text{~~ARRT_i~~}ALRT_i$ is the abrasion ~~rate~~ **level** of reference tyre at test conditions in mg/kg/t;

$\overline{\text{~~ARRT~~}ALRT}$ is the average abrasion ~~rate~~ **level** of the n reference tyres at three temperatures in mg/kg/t;

T_i is the average temperature of the test in °C;

$\overline{T}$ is the average temperature of the n tests in °C.

n is the number of tests performed.

If the circuit is utilized **for both SRTT17S and SRTT17W**~~to test tyres of category of use normal, tyres of category of use snow or special use not classified as tyres for use in severe snow conditions and tyres for use in severe snow conditions~~, the S calculation shall be done for each reference tyre, giving S$_S$ and S$_W$ values.

1.7.   **Weather and climate conditions requirements**

1.7.1.   Tyres tested against SRTT17S according to table in paragraph 1.2.25. of this Annex shall respect the following weather and climate conditions:

(a)   The average temperature during the test shall be within the following range: from 7 °C to 35 °C;

(b)   The minimum and maximum temperature during the test shall be within the following range: from 2 °C to 40 °C for at least 90 per cent of test distance;

(c)   No driving under snow or ice conditions is allowed;

(d)   The maximum allowed percentage of the total distance driven under wet conditions is 20 per cent.

1.7.2.   Tyres tested against SRTT17W according to table in paragraph 1.2.25. of this Annex shall respect the following weather and climate conditions:

1.7.2.1.   **Tyres for use in severe snow conditions**

(a)   The average temperature during the test shall be within the following range: from -3 °C to 20 °C;

(b) The minimum and maximum temperature during the test shall be within the following range: from -7 °C to 25 °C for at least 90 per cent of test distance;

(c) No driving under snow or ice conditions is allowed for more than 5 per cent of the total distance driven;

(d) The maximum allowed percentage of the total distance driven under wet conditions is 20 per cent.

1.7.2.2. **Tyres not for use in severe snow conditions**

(a) **The average temperature during the test shall be within the following range: from -3 °C to 35 °C;**

(b) **The minimum and maximum temperature during the test shall be within the following range: from -7 °C to 40 °C for at least 90 per cent of test distance;**

(c) **No driving under snow or ice conditions is allowed for more than 5 per cent of the total distance driven;**

(d) **The maximum allowed percentage of the total distance driven under wet conditions is 20 per cent.**

1.7.3. Weather data recording

1.7.3.1 Wet distance measurement

The wet distance, expressed as a per cent of the distance travelled, corresponds to the distance travelled with wipers on. These can be manually collected on one vehicle of the convoy. Alternatively, data can be collected from vehicle information (e.g. CAN bus - Controller Area Network- **or OBD -** On-Board Diagnostics-**) when available.**

1.7.3.2. Average temperature

For the calculation of the average temperature, a minimum 5 of measurements per shift on the circuit shall be carried out. The measurements shall include starting and arrival point. Furthermore, the temperature at the highest altitude reached on the circuit shall be measured. Measurements shall be made on at least one vehicle of the convoy.

The average temperature of the circuit shall be calculated as the average of all the measured temperatures of all 5 points.

~~The temperature measuring devices shall be accurate within ±1 °C.~~ At least at starting and arrival point, the measurement shall be done with a fixed device respecting requested accuracy. The temperature sensor shall be positioned outside in an unobstructed location, exposed to the airflow, and protected from direct solar radiation. The latter may be achieved by any shading screen or similar device.

For measurements on the road, a weather station installed in the vehicle with external temperature sensor may be used. Continuous temperature measurement throughout the test is acceptable. In this case, average, minimum, and maximum measurement should be reported for the full test. The 10 first minutes after departure and after each driver's break shall be discarded from the minimum, maximum, and average calculation. ~~A~~ **Both** time-based **and distance-base** average for temperature ~~is~~ **are** acceptable.

1.8. Standard Reference Test Tyre requirements

Reference tyres SRTT17S and SRTT17W shall be stored in condition recommended **in F3676-23 and F3675-23 respectively** ~~by [ASTM].~~

SRTT17S shall be used for evaluating candidate tyres of category of use normal and for tyres of category of use snow or special use not classified as tyres for use in severe snow condition **and for tyres of category of use "special use" not declared "M+S"**.

SRTT17W shall be used for evaluating candidate tyres of category of use snow tyres ~~or~~ **and** special use tyres **declared as "M+S", either or not classified as tyres for severe snow conditions**.

1.9.   **Preparation and adjustments with respect to tyres**

1.9.1.   **Tyre fitment on rim and vehicle**

New candidate tyres shall be mounted and balanced on a rim permitted by the tyre manufacturer.

New Reference tyres for each test shall be fitted on a 7.5" rim width.

The rim width of **a** candidate tyre shall be reported in the test report. Tyres with special fitment requirements, such as asymmetric or directional design, shall also be mounted in accordance with these requirements: the direction of rotation shall be respected and the side of the tyre intended to face vehicle outside shall be positioned appropriately.

1.9.2.   **Tyre weight measurement (without rim)**

The tyre weight measurement shall be done following the procedure described in paragraph 1.5.1. of this Annex.

No rubber (e.g. mould vents) shall be removed from any tyre (test or reference).

Each tyre weight shall be measured:

(a)   Before being fitted on the wheel, to get the initial tyre mass~~es~~ (*MRTSi*) for reference tyres and (*MCTSi*) for candidate tyres;

(b)   After completing the test and dismounting the tyre from the tyre wheel assembly, to get the final tyre masses (*MRTFi*) for reference tyres and (*MCTFi*) for candidate tyres.

1.9.3.   **Tyre and wheel assembly mass measurement**

The tyre and wheel assembly mass measurement shall be done ~~the~~ following **the** procedure described in paragraph ~~1.5.1.~~**1.5.2.** of this Annex.

Intermediate measurements of tyre and wheel mass assembly are optional.

1.9.4.   **Tyre inflation pressure**

The ~~reference~~ inflation pressure of the **reference** tyres shall be 290 kPa.

Candidate tyres shall be inflated (cold) at their nominal pressure determined by the standard they belong to. More specifically:

(a)   For standard load tyres the pressure shall be 250 kPa;

(b)   For reinforced load tyres (XL) and high load capacity tyres (HL) the pressure shall be 290 kPa;

(c)   The nominal pressure for nominal load as determined by the relevant standard if different from (a) and (b).

1.10.   **Preparation and adjustments with respect to vehicles**

Vehicles for candidate and reference tyres shall be selected following the constraints of paragraph 1.6.

1.10.1.   **Vehicle mass measurement**

The vehicle mass measurement shall be done following the procedure described in paragraph 1.5.3. of this Annex. The vehicle shall be ballasted following the specifications described in paragraph 1.6.12. of this Annex.

Measurements of each ~~wheel~~ tyre load Q for reference and candidate vehicles are required.

1.10.2.   Vehicle tuning

Vehicle alignments to be tuned following the provisions specified in paragraphs 1.6.2. to 1.6.6. of this Annex.

1.11.   Test method and measurements

1.11.1.   General

The tyre abrasion test shall be run on open roads. A maximum of 4 vehicles are allowed in a convoy. The vehicles shall drive approximately 8000 km along selected circuits with a given driving severity with the aim of exposing each candidate tyre to the same conditions (e.g. severity, drivers, position in convoy, weather~~...~~).

The tyres are evaluated relatively to a reference tyre. The reference tyre shall be fitted on one convoy's vehicle in order to absorb mainly temperature variation, but other varying parameters as well.

A candidate vehicle shall be fitted with the same candidate tyres.

The measured performance shall be calculated according to paragraph 1.11.13. of this Annex. ~~the mass losses of new tyres for a given distance and/or carried load. The overall mass loss shall be averaged among the 4 tyres of the tyre set and shall be reported in [mg/km and/or mg/km/ton], giving an index relative to reference tyre.~~

1.11.2.   Test total distance

The total distance driven by each vehicle in the convoy shall be 8000 ± 300 km. Any total distance outside these boundaries shall invalidate the test.

1.11.3.   Convoy composition and management

The convoy shall be homogeneous regarding the following vehicle parameters:

(a)   Number and position of driven wheels (see paragraph 1.6. of this Annex)

   (i)   FWD only in the convoy;

   (ii)   RWD only in the convoy;

   (iii)   AWD (4 permanent driven wheels) only in the convoy.

(b)   Propulsion energy converters (e.g. Pure internal combustion engine vehicle" (ICE), NOVC-HEVCs only, OVC-HEVs only, or PEVs only) in the same convoy. For hybrid vehicles, the provisions described in paragraph ~~1.6.9.~~1.6.7. of this Annex shall apply.

The same model and same settings of vehicles shall be used for both reference tyre and candidate tyre provided that:

(c)   The candidate tyre size can be fitted on the same vehicle model as for the reference tyre;

(d)   Loading and alignment parameters are allowed for candidate tyre.

Regarding the maximal distance between vehicles in the convoy, each driver shall be able to have visual contact with the preceding and following vehicles.

Each vehicle shall drive on the right lane (or left lane for left driving countries) when free.

1.11.4. **Vehicle rotation in the convoy and driver rotation on vehicles**

Each candidate tyre, including tested and reference tyres, shall run equal parts of the test:

(a)   with all drivers;

(b)   in all positions in the convoy.

Changes in drivers and vehicle positions may occur within a tolerance of 10 per cent of the predefined distance in the circuit.

1.11.5. **Data measured before, during, and after the test**

1.11.5.1. **Before and after the test:**

Before and after the test, the following measurements shall be done:

(a)   **Mass of each tyre;**

(b)   **Load on each tyre;**

(c)   **Vehicle alignments (~~both unloaded and~~ loaded vehicle);**

(d)   **Tyre pressure after tyre fitment and before dismounting tyres.**

1.11.5.2. **During the test**

During the test, the following ~~measurements~~ recordings shall be performed:

(a)   **Continuous ~~measurements~~ recordings of parameters needed for the calculation of longitudinal and lateral accelerations on each vehicle;**

(b)   **Continuous speed measurement on each vehicle;**

(c)   **Temperature measurement (as specified in paragraph 1.7.3. of this Annex.);**

(d)   **Tyre pressure each day under cold conditions. By cold conditions it is meant at least 30 minutes after the last stop. Tyre shall never be deflated;**

(e)   **Vehicle alignment, in loaded condition, accompanied by correction to initial value if relevant for vehicle used for reference tyres. The vehicle alignment measurement shall be carried out 4 times during the test, each at roughly a quarter of the test distance.**

At intermediate stops, it is recommended but not compulsory to measure:

(f)   **Tyre and Wheel assembly mass;**

(g)   **Vehicle alignment, in loaded condition, accompanied by correction to initial value if relevant for vehicle used for candidate tyres.**

1.11.6. **Data processing for average temperature**

Temperature measurement during the test:

~~During each shift, temperature shall be measured and recorded at the beginning of test, at three intermediate points, and at the end of the test. At least one temperature measurement point shall be at the maximum altitude of the circuit. Additionally, one temperature measurement point shall be at the minimum altitude of the circuit.~~ Temperature shall be measured according to paragraph 1.7.3. ~~The average temperature of the circuit shall be calculated as the average of all the measured temperatures of all 5 points.~~

~~In case of continuous measurement, average temperature may be calculated either distance-based or time-based. Distance-based average for temperature is recommended.~~

1.11.7. **Data processing for test longitudinal and lateral accelerations standard deviation**

During each shift, a continuous evaluation of speed, lateral, and longitudinal acceleration shall be carried out. A minimum sampling rate of 10 Hz is recommended. Most common technology is GNSS (global Navigation Satellite System) measurement associated with numerical treatment of the positions.

Acceleration data processing is defined in Appendix 1 of this Annex.

1.11.8. **Test validation**

The test is considered valid when the following conditions are met:

(a) Temperatures: minimum, maximum, and average temperatures as calculated in paragraph 1.11.6. of this Annex shall respect specifications defined in paragraph 1.7. of this Annex;

(b) Accelerations: lateral and longitudinal acceleration shall respect maximum and standard deviation values as calculated in paragraph 1.11.7. of this Annex and shall the respect specifications defined in paragraph 1.6.13.3. of this Annex;

(c) If more than ~~[~~1500 km ~~]~~GNSS acceleration data are missing for the candidate tyre, the test for this candidate tyre is invalid;

(d) If more than ~~[~~1500 km~~]~~ GNSS acceleration data are missing for the reference tyre, the whole test is invalid;

(e) Vehicle alignments at the beginning and end of test shall respect the specifications defined in paragraph ~~6.1.~~1.6. of this Annex;

(f) For candidate tyres for use in severe snow conditions, the abrasion ~~rate~~ level of the SRTT17W normalized at 10 °C (~~ARRT20~~ALRT$_{10}$) shall be in the range defined in paragraph 1.6.16. of this Annex;

(g) For other candidate tyres, the abrasion ~~rate~~ level of the SRTT17S normalized at 20 °C (~~ARRT20~~ALRT$_{20}$) shall be in the range defined in paragraph 1.6.16. of this Annex;

(h) A visual inspection of the reference tyres shall show no damage. The tyre sidewall marking shall still be readable. If a reference tyre was losing more than 1 cm^2 of tread chunking area, the tyre shall be considered as destroyed, and tyre destroyed process ~~to be used~~ as described in paragraph 1.11.11. of this Annex shall apply.

1.11.9. **Deviation from nominal circuit**

The circuit is considered valid when the following provisions are met altogether:

(a) The circuit is modified by less than 10 km for the full test or if it is modified by more than 10 km and less than 30 km, for less than 8 shifts;

(b) The total driven distance remains in the 8000 ± 300 km;

(c) The abrasion ~~rate~~ level of reference tyre at 20°C is within the ranges specified in paragraph 1.6.16. of this Annex;

(d) The acceleration limits are within the ranges specified in paragraphs 1.6.13.2. and 1.6.13.3. of this Annex.

When all provisions are met the circuit is considered valid and the distance considered for calculation has to be corrected accordingly.

Accidental deviation(s) are acceptable if representing less than 20 per cent of circuit distance or less than 100 km (whichever is lower) under the condition that the reference tyre abrasion ~~rate~~ level at 20°C stays in authorized limits and acceleration standard deviations are respected.

In all other cases, the test is considered not valid and the circuit has to be revalidated.

1.11.10.   Vehicle trouble handling

The following provisions apply in case of vehicle damages in the convoy:

(a)   If a vehicle used in the convoy is damaged and cannot be used anymore (e.g. major mechanical failure or accident), it shall be replaced by an identical vehicle that shall be identically loaded and tuned. The replacement vehicle, equipped with the same tyres having started the test, shall run the distance lost due to vehicle failure on the lost segment of the circuit alone without the other vehicles of the convoy;

(b)   If a vehicle used in the convoy is broken down and can be repaired, the lost distance shall be ran without other convoy vehicles on the lost segment of the test circuit;

(c)   If the failure occurs on a candidate vehicle and not on the reference vehicle, the convoy may continue the test and the failing vehicle/tyre shall be withdrawn from the convoy. A new set of candidate tyres shall then be used for a new test, starting from scratch.

1.11.11.   Tyre trouble handling

The following provisions apply in case of tyre damages in the convoy:

(a)   If a tyre used during the test on the reference vehicle or one of the candidate vehicles is damaged by a reparable puncture and if the tyre can be repaired without running without pressure, the added repair mass shall be recorded and taken into account in the final calculation. The use of a spare tyre is permitted for a maximum distance of one loop 7.5 per cent of the test. The mileage ran with the spare tyre shall be recorded and taken into account for the tyre abrasion ~~rate~~ level;

(b)   If a tyre used during the test is destroyed (or non-repairable puncture or ran without pressure), the mass loss of the other tyre tested on the same axle is used twice to perform the final calculation. The spare tyre used to replace the destroyed tyre should have the same size and same pattern as the replaced tyre.

1.11.12.   GNSS trouble handling

If the speed and acceleration recording for one vehicle for one shift failed for more than [5%] per cent of the circuit distance (because of missing satellites signal or device failure), the missing data shall be replaced with one of the other vehicles (preferably the reference vehicle) of the same convoy of the same shift, if valid.

1.11.13.   Data processing for abrasion ~~rate~~ level calculation.

1.11.13.1.   Reference tyre abrasion ~~rate normalized to distance and load~~ level at average test temperature (mg/km/t)

The average abrasion ~~rate~~ level at test average temperature of the reference tyre during the test is calculated as following:

$$ARRT = \frac{1000 * \sum_{i=1}^{4}(MRTS_i - MRTF_i)/D_{Ti}}{\sum_{i=1}^{4} Q_{Ri}/1000}$$

$$ALRT = \frac{1000 * \sum_{i=1}^{n}(MRTS_i - MRTF_i)/D_{Ri}}{\sum_{i=1}^{n} Q_{Ri}/1000}$$

Where:

$~~ARRT~~ALRT$ is the abrasion ~~rate~~ level of the reference tyre at test average temperature in mg/~~kg~~km/t;

$MRTS_i$ is the mass of the reference tyre at the beginning of the test in g ~~mg~~;

$MRTF_i$ is the mass of the reference tyre at the end of the test in g ~~mg~~;

$~~D_{Ti}~~D_{Ri}$ is the total distance of the reference vehicle in km;

Q_{Ri} is the test load of the reference tyre in kg; ~~sum of the reference tyres load.~~

n is the number of tyres.

1.11.13.2. **SRTT17S abrasion ~~rate~~ level calculation at ~~20ºC~~ 20 ºC**

Apply the temperature correction determined in paragraph 1.6.16.1. of this Annex to the normal reference tyre abrasion ~~rate~~ level as follows:

$$ARTT_{20} = ARTT + S_S \cdot (T_m - 20)$$

$$ALTT_{20} = ALRT + S_S \cdot (20 - \overline{T}\,\overline{T})$$

where $\overline{T}$ ~~T_m~~ is the average temperature of the test

1.11.13.3. **SRTT17W abrasion ~~rate~~ level calculation at ~~10ºC~~ 10 ºC**

Apply the temperature correction determined in paragraph 1.6.16.1. of this Annex to the Winter reference tyre abrasion ~~rate~~ level as follows:

$$ARTT_{10} = ARTT + S_W \cdot (T_m - 10)$$

$$ALTT_{10} = ALRT + S_W \cdot \left(10 - \overline{T}\right)$$

where $\overline{T}$ ~~T_m~~ the average temperature of the test

1.11.13.4. **Candidate tyre abrasion ~~rate normalized to distance and load~~ level at average test temperature (mg/km/t)**

The average abrasion ~~rate~~ level at test average temperature of the candidate tyre during the test is calculated as following:

$$ARCT = \frac{1000 * \sum_{i=1}^{4}(MTTS_i - MTTF_i)/D_{Ci}}{\sum_{i=1}^{4} Q_{RCi}/1000}$$

$$ALCT = \frac{1000 * \sum_{i=1}^{n}(MCTS_i - MCTF_i)/D_{Ci}}{\sum_{i=1}^{n} Q_{Ci}/1000}$$

Where:

$~~ARCT~~ALCT$ is the abrasion ~~rate~~ level of the candidate tyre at test average temperature in mg/~~kg~~km/t;

$MCTS_i$ is the mass of the candidate tyre at the beginning of the test in g ~~mg~~;

$MCTF_i$ is the mass of the candidate tyre at the end of the test in g ~~mg~~;

D_{Ci} is the total distance of the candidate vehicle in km;

Q_{Ci} is the test load of the candidate tyre in kg; ~~he sum of the candidate tyres load~~

_n_   **is the number of tyres.**

1.11.13.5.   The abrasion index of the candidate tyre shall be independent from the average test temperature and is calculated from the following equation:

$$AICT = \frac{\cancel{ARCT}ALCT}{\cancel{ARRT}ALRT}$$

Where:

AICT   **is the abrasion index of the candidate tyre;**

~~ARCT~~ALCT   **is the abrasion ~~rate~~ level of the candidate tyre at test average temperature in mg/~~kg~~km/t;**

ALRT   **is the abrasion ~~rate~~ level of the reference tyre at test average temperature in mg/km/t.**

1.12.   **Test report**

1.12.1.   **The test report shall include the following information:**

(a)   **Average, minimum, and maximum temperature during the test;**

(b)   **Percentage of distance covered on wet roads;**

(c)   **Reference of the circuit used for the test, including the circuit length, driving style distribution, and location;**

(d)   **Total deviation distance to the nominal distance in km;**

(e)   **Start and end date of the test.**

1.12.2.   **For each reference tyre, the following information shall be reported:**

(a)   **Model of vehicle used for reference tyre;**

(b)   **Tyre data, including manufacturer, brand name, trade name, size, LI and load capacity, speed symbol, reference pressure, and serial number of the tyres;**

(c)   **Vehicle tuning at the beginning of the test (Front axle TOE and camber, rear axle TOE and camber), in ~~un~~loaded condition;**

(d)   **Vehicle tuning at the beginning of the test (Front axle TOE and camber, rear axle TOE and camber), in loaded condition;**

(e)   **Vehicle tuning at each intermediate measurement of the test (Front axle TOE and camber, rear axle TOE and camber), in loaded condition;**

(f)   **Vehicle tuning at the end of the test (Front axle TOE and camber, rear axle TOE and camber), in loaded condition;**

(g)   **Rim width (7.5”);**

(h)   **Cold inflation pressure at the fitment;**

(i)   **Cold inflation pressure at [50] per cent of the test;**

(j)   **Cold inflation pressure at the end to the test;**

(k)   **Balancing mass at the beginning of the test;**

(l)   **Balancing mass at the end of the test;**

(m)   **Initial tyre mass (_MRTSi_) for each reference tyre;**

(n)   **Final tyre mass (_MRTFi_) for each reference tyre;**

(o)   **Abrasion ~~rate~~ level in mg/km/t normalized at ~~20oC~~ 20 ºC**

(p)   **Distance ran for each reference tyre;**

(q)   **Standard deviation of longitudinal acceleration for the vehicle fitted with reference tyre;**

(r)   **Standard deviation of lateral acceleration for the vehicle fitted with reference tyre;**

(s)   **Percentage of distance covered over the maximum longitudinal acceleration for the vehicle fitted with reference tyre;**

(t)   **Percentage of distance covered over the maximum lateral acceleration for the vehicle fitted with reference tyre;**

(u)   **Percentage of time travelled over each speed range (i.e. urban-like, regional-like, and highway-like);**

(u̶v)   **Measured tyre load for each reference tyre;**

(v̶w)   **Reference tyres visual inspection report.**

1.12.3.   **For each candidate tyre, the following information shall be reported:**

(a)   **Model of vehicle used for candidate tyre;**

(b)   **Tyre data, including manufacturer, brand name, trade name, size, LI and load capacity, speed symbol, reference pressure, and serial number of the tyre;**

(c)   **Vehicle tuning at the beginning of the test (Front axle TOE and camber, rear axle TOE and camber) in u̶n̶loaded condition;**

(d)   **Vehicle tuning at the beginning of the test (Front axle TOE and camber, rear axle TOE and camber) in loaded condition;**

(e)   **Vehicle tuning at the end of the test (Front axle TOE and camber, rear axle TOE and camber) in loaded condition;**

(f)   **Rim width;**

(g)   **Cold inflation pressure at the fitment;**

(h)   **Cold inflation pressure at [̶50]̶ per cent of the test;**

(i)   **Cold inflation pressure at the end to the test;**

(j)   **Balancing mass at the beginning of the test;**

(k)   **Balancing mass at the end of the test;**

(l)   **Initial tyre mass ($MCTSi$) for each candidate tyre;**

(m)   **Final tyre mass ($MCTFi$) for each candidate tyre;**

(n)   **Measured tyre load for each candidate tyre;**

(o)   **Distance ̶r̶a̶n̶ run for each candidate tyre;**

(p)   **Standard deviation of longitudinal acceleration for the vehicle fitted with candidate tyre;**

(q)   **Standard deviation of lateral acceleration for the vehicle fitted with candidate tyre;**

(r)   **Percentage of distance covered under the maximum longitudinal acceleration for the vehicle fitted with candidate tyre;**

(s)   **Percentage of distance covered under the maximum lateral acceleration for the vehicle fitted with candidate tyre;**

(t)   **Percentage of time travelled over each speed range (i.e. urban-like, regional-like, and highway-like).**

(t)   **Measured tyre load for each candidate tyre.**

1.12.4.   **Final test results**

(a) The measured result of abrasion rate level ~~ARRT~~ ALRT for the reference tyre during the test at average test temperature as described in paragraph 1.11. of this Annex;

(b) The measured result of abrasion rate level ~~ARTT~~ ALCT for the candidate tyre during the test at average test temperature as described in paragraph 1.11. of this Annex;

(c) The final result tyre abrasion ~~rate~~ index ~~AITT~~ AICT as described in paragraph 11. of this Annex.

2. **Test method (b) using indoor drum**

2.1. **Scope**

2.1.1. This method applies to C1 tyres in scope of this regulation except ice grip tyres and tyres having a nominal rim diameter code ≤ 13.

2.2. **Definitions and Terms**

In addition to relevant definitions provided in Paragraph 2 of this Regulation the following definitions apply to the indoor drum method.

2.2.1. "Tyre abrasion" means tyre wear that is observed as the loss of tyre mass during usage.

2.2.2. "Mass loss" means amount of the mass lost due to tyre abrasion Note 1 to entry: It is expressed in grams.

~~2.2.3. "Abrasion rate" means mass loss per unit distance travelled normalized by tyre load. It is expressed in mg/km/t.~~

~~2.2.4. "Abrasion index" means index that is calculated as the abrasion rate of a candidate tyre compared to the abrasion rate of a reference tyre under the same test method and conditions specified in this document.~~

2.2.3. "Test tyre" means tyre that is used for an evaluation programme, either candidate tyres or reference tyres.

2.2.3.1. Candidate tyre

T   test tyre that is part of an evaluation programme and that is evaluated with the reference tyre using the same test method.

2.2.3.2. Reference tyre

R   special test tyre that is used as a benchmark in an evaluation programme.

2.2.3.2.1. "Standard Reference Test Tyre" or "SRTT" means a tyre that is produced, controlled and stored in accordance with the standards of ASTM International:

(a) F3676 - 23 for the size 225/45R17 and referred to as "SRTT17S";

(b) F3675 - 23 for the size 225/45R17 and referred to as "SRTT17W".

Normal reference tyre (225/45R17 94 XL ASTM F3676 - 23) shall be used for testing candidate tyres not for severe snow condition, means normal, snow and special tyres not bearing M+S nor 3PMSF marks.

Winter reference tyre (225/45R17 94 XL ASTM F3675 - 23) shall be used for testing candidate tyres for severe snow conditions (marked with 3PMSF symbol) and special use tyres bearing the marking M+S or 3PMSF.

2.2.4. "Mean profile depth" is used for the characterization of the surface roughness in macroscale and is described in ISO13473-1~~, for characterization of surface roughness in macroscale.~~

2.2.5. **"Micro-roughness" means the surface roughness characterized in microscale and is measured by altered filtering conditions as defined in ISO 13473-1.**

2.2.6. **"Tyre Coordination system" is tyre coordinate system specified in ISO 8855.**
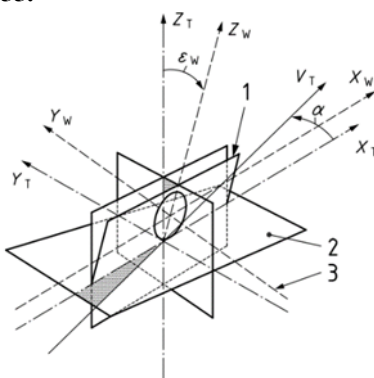
2.2.7. **"Vertical load" means the ~~Fz~~ tyre normal force of a tyre exerted on the road resulting from the mass supported by the tyre~~, as the~~. Tyre normal force is specified in ISO 8855. ~~It is expressed in Newtons.~~**

2.2.8. **"Lateral force" means the ~~Fy~~ force of a tyre generated in lateral direction during cornering. Tyre lateral force is specified in ISO 8855. ~~It is expressed in Newtons.~~ It takes a positive sign when turning left and a negative sign when turning right.**

2.2.9. **"Longitudinal force" means the force of a tyre generated in the longitudinal direction during acceleration or braking~~, as the~~. Tyre longitudinal force is specified in ISO 8855. ~~It is expressed in Newtons.~~ It takes a positive sign for speed increase and a negative sign for speed decrease (e.g. braking).**

2.2.10. **"Loaded radius" means the distance from the tyre axis to the drum outer surface under steady-state conditions at 0 speed and 0 camber as well while the test load and inflation pressure is applied at room temperature and refer to the thermal conditioning of ~~section~~ Paragraph 2.5.2~~., in meter.~~**

2.2.11. **"Tyre torque" means the moment on tyre rotation axle.**

2.2.12. **"Load index" means numerical code associated with the maximum load a tyre can carry at the speed indicated by its speed symbol under the service conditions specified by the tyre manufacturer.**

2.3. **Symbols and Abbreviated terms**

In addition to relevant symbols and abbreviated terms provided in Paragraph 1 of Annex 10 of this Regulation the following symbols and abbreviated terms apply to the indoor drum method.

Symbol	Unit	Designation
T	No dimension	Candidate tyre
R	No dimension	Reference tyre
Fz	N	Vertical load
Fy	N	Lateral force
Fx	N	Longitudinal force
r_L	m	Loaded radius
My	Nm	Tyre torque

LI	No dimension	Load Index
MPD	mm	Mean Profile Depth

2.4. **Test Method**

2.4.1. **General**

This test method evaluates the mass loss of the candidate tyre relative to the reference tyre.

In measuring tyre tread wear per distance travelled, it is necessary to control normal load, lateral force, and longitudinal force applied to a test tyre.

This test method uses a tread wear test equipment with a cylindrical flywheel (drum) with external surface of drum.

2.4.2. **Drum Specifications**

2.4.2.1. **Tyre Wear Test Equipment**

Tyre Tread wear test equipment shall consist of a drum, a tyre carriage device, a loading device, and adhesion prevention system. There can be one or two carriage devices.

2.4.2.2. **Drum Diameter**

The test dynamometer shall have a cylindrical flywheel (drum) with a diameter of at least [1.7]3 m.

2.4.2.3. **Test Surface**

The test surface shall be applied to external surface of the cylindrical drum. The test surface of drum shall meet the following minimum requirements:

(a) The test surface of the drum shall have a MPD measured at the start and the end of the drum test not exceeding applied from 0,22 mm to 2,10 mm, according to ISO 13473-1 except for sampling interval, resampling, and low pass filter;

(b) The test surface of the drum shall have a micro-roughness measured at the start and end of the drum test within the range from 0,07 mm to 0,4 mm. The measuring method of MPD described in ISO 13473-1 shall apply to the measurement of micro-roughness, except for sampling interval, resampling, high-pass and low-pass filtering, and segment length. The device for measurement of MPD must fulfil the specifications of ISO 13473-3. The sampling interval shall not be more than 0,033 mm, and samples shall be taken at a fixed interval in the horizontal direction. Re-sample the signal to either 0,017 mm (preferably) or 0,033 mm spacing; preferably 0,017mm. For high-pass and low-pass filtering, the filters shall be of the Butterworth type, 2nd order, and shall have a cut-off at 3,0 mm and 0,1 mm texture wavelength, respectively. The segment length shall be 3,33 mm ± 0,33 mm;

(c) The test surface of the drum shall be textured with sands, stones, or an alternative material, e.g., aluminium oxide resin;

(d) The drum surface shall be built with rigid and not deformable material;

(e) The test surface, including voids, shall be dry and clean during the entire measurement procedure and for all measurements;

(f)   The device for measurement of the MPD must fulfil the specifications of ISO 13473-3. The device for measurement of micro-roughness must fulfil the specifications of ISO 13473-3, except for horizontal resolution, which shall not be more than 0,033 mm and provide a resolution less than 0,1mm.

The abrasion rate level of the SRTT17S reference tyre for all types of surface shall be in the range between. In case of SRTT17S, the range is 50 mg/km/t and 190 mg/km/t.

The abrasion rate level of the In case of SRTT17W reference tyre for all types of surface shall be in the range between the range is 35 mg/km/t and 165 mg/km/t. The abrasion level rate shall be calculated according to the method in paragraph 2.8. of this Annex. In case of sand paper used for surface it shall be replaced as specified in Appendix 5.

When the drum surface no longer satisfies the conditions of the previous period, the surface shall be replaced. Intermediate inspection of the abrasion rate for the reference tyre is recommended.

2.4.2.4.   **Width**

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

2.4.3.   **Tyre Carriage and Drive System**

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.

.   Admitted The maximum allowed deviation from the nominal value of load (Fz), lateral force (Fy), longitudinal force (Fx), and tyre torque (My) during testing is defined as follows:

(c)   Fz: ±50N or 1 per cent whichever is greater;

(d)   Fy: ± 100N or 5 per cent whichever is greater, for the difference between input peaks and actually generated peaks;

(e)   Fx: ± 100N or 5 per cent whichever is greater, for the difference between input peaks and actually generated peaks;

(f)   My: ±40Nm or 5 per cent whichever is greater, for the difference between input peaks and actually generated peaks.

2.4.4.   **Adhesion Prevention System**

2.4.4.1.   **Powder Distribution**

The treadwear test equipment shall be equipped with the have a powder distribution system to spray a controlled volume of either talc or silica. Mixture of talc and silica is not allowed. The powder particle typical size can range from 0,1 μm to 100 μm. such material (e.g., talc) on the test surface near the test tyre contact patch so that abrasion fragments does not adhere to the tyre surface or the test drum surface. The material used for powder distribution shall be a mineral or clay, in the form of a powder. The powder particle size is generally around 0.1μm to 100μm.

The powder distribution system shall spray on the test surface near the test tyre contact patch so that abrasion fragments do not adhere to the tyre or test drum surface. Powder distribution system and materials shall be identical for both reference tyre and candidate tyre during a test and

shall remain constant during the entire test. The powder delivery rate (measured by mass or volume) applied to the reference and candidate tyres shall be the same, with a maximum ±10 per cent difference for each test.

2.4.4.2.   Nozzle Position

The nozzle position for powder distribution system shall follow at least one of the following specifications:

(a)   Blow-in type: In case of only one nozzle, centre of the nozzle ~~should~~ shall be positioned in symmetrical plane. The distance between nozzles and centre of contact patch shall be at less/lower than 35 cm from centre of contact patch.

In case of multiple nozzles, they shall be placed parallel to the Y axis and symmetrically distributed respective to the X axis. The distance between nozzles and centre of contact patch shall be lower than 35 cm. Nozzles ~~should~~ shall be oriented towards contact patch entrance.

~~or~~

(b)   Dispersion type: The tester shall be ~~is~~ covered with the enclosure coverings. Powder ~~should~~ shall be evenly dispersed within the enclosure. The nozzle/nozzles shall be placed parallel to the Y axis and symmetrically distributed respective to the X axis.

2.4.5   Load, Alignment, Control and Instrumental Accuracies

Measurement of these parameters shall be sufficiently accurate and precise to provide the required test data. The specific and respective values are provided ~~shown~~ in Appendix 4 of this Annex.

2.4.6   Mass Scale

The mass scale for test tyres shall have:

(a)   A mass capacity being able to weigh test tyre;

(b)   An accuracy within ±2 g.

The mass scale shall be duly calibrated following the requirements defined by the manufacturer.

2.5.   Test Conditions

2.5.1   General

The test consists of a measurement of tyre mass loss in which the tyre is inflated to the cold pressure as specified in Paragraph 2.5.3. of this Annex and the inflation pressure shall be allowed to build up (i.e. "capped inflation") and not be regulated by machine.

2.5.2   Test Load

The standard test load Fz on the tyre to be measured shall be calculated from its LI load, corresponding to the maximum mass associated with the LI of the tyre.

The standard test load shall be computed from the values shown in Table 1 and shall be kept within the tolerance specified in Appendix 4 of this Annex.

2.5.3   Tyre Inflation Pressure

The inflation pressure shall be set in accordance with that shown in Table 1 with the accuracy specified in Appendix 4 of this Annex and shall be capped.

Table 1

Test loads and inflation pressures

Tyre type	C1 [a]	
	Standard load or light load	Reinforced or extra load
Load -% of maximum load capacity	80	80
Inflation pressure [b] (kPa)	210	250
[a] For those C1 tyres belonging to categories which are not shown in ISO 4000-1:2015, Annex B, the inflation pressure shall be the inflation pressure recommended by the tyre manufacturer, corresponding to the maximum tyre load capacity, reduced by 30 kPa. [b] The inflation pressure shall be capped with the accuracy specified in Appendix 4.		

2.5.4   **Testing Conditions (Longitudinal force, lateral force, test speed, running distance)**

The following testing conditions shall be met for a test to be considered valid:

(a)   Longitudinal force and lateral force shall be computed from the values shown in Appendix 3 **of this Annex**. Speed shall be in accordance with that shown in Appendix 4 **of this Annex**;

(b)   **The total** running distance **of the test** shall be 5000 km. The total distance of an actual test shall not differ more than ± 5 per cent from the total input distance;

(c)   The reference tyre shall be mounted on **a** 7.5 **Rim** width **code** rim. New candidate tyres shall be mounted on any rim requested and approved by the tyre manufacturer;

(d)   The rim width of candidate tyre shall be recorded. Tyres with special fitment requirements, such as asymmetric or directional design, shall also be mounted in accordance with these requirements: direction of rotation shall be respected;

(e)   The test shall be performed at null camber ~~(0°)~~.

2.6.   **Test Procedure**

2.6.1.   **General**

The test procedure steps described below ~~are to~~ **shall** be followed in the **given** sequence:

(a)   Both reference and candidate tyres shall be new when starting the test;

(b)   Test tyres with specified direction of rotation shall be rolling in the forward direction;

(c)   **The** direction of rolling shall be kept ~~in~~ the same throughout the test;

(d)   The abrasion **level** ~~rate~~ calculation **shall use the** ~~uses~~ actual test run distance.

2.6.2.   **Thermal Conditioning**

~~Place~~ **The** inflated tyre **shall be placed** in the thermal environment of the test location for a minimum of 3 h.

2.6.3.   **Pressure Adjustment**

After thermal conditioning, the inflation pressure shall be adjusted to the test pressure.

2.6.4.   **Thermal Environment**

During the test, the ambient temperature **shall be kept at 25 °C ± 5 °C. The ambient temperature shall be measured** at a distance of not less than 0,15 m and not more than 1 m from the tyre, shall be kept at 25 °C ± 5 °C.

The average ambient temperature for reference and candidate tyres during testing shall not differ by more than 2 **°C** degrees.

2.6.5.   **Mass Measurement**

The mass of tyre shall be measured before and after 5,000 km of run **as defined** set out in paragraph 2.6.**6. of this Annex** for both reference and candidate tyres.

2.6.6.   **Test Cycle**

2.6.6.1.   **Input Condition**

Both reference tyre and candidate tyre shall be tested according to input condition of Appendix 4 of this Annex. The Appendix 4 test condition of 250 km is defined as one test cycle, and the test cycle shall be repeated 20 times until 5000 km is reached.

2.6.6.2.   **Default Test Program** Basic test program **(2 positions drum)**

Both reference tyre and candidate tyre shall be mounted **at** different positions of one drum. Testing of both reference tyre and candidate tyre shall be conducted at the same time.

Tyres mounted at the two positions shall be exchanged once after the completion of 2500 km. The direction of rotation shall remain constant throughout the test.

A visual inspection of **the** tyre**s** is recommended after the completion of 2500 km to ensure no tread chunking.

2.6.6.3.   **Alternative Test Program (1 position drum)**

In case testing of reference tyre and candidate tyre is not possible at the same time, the alternative test program is available **may be followed.** As **The following test order for the** Reference tyre (R) and Candidate tyre (T) shall be followed:

R (1000 km) – T (2000 km) – R (2000 km) – T (2000 km) – R (2000 km) – T (1000 km)

Repeat a set of Appendix 3 input conditions 4 times for 1000 km and 8 times for 2000 km.

A visual inspection of tyre is recommended around the completion of 2,500 km to ensure no tread chunking.

2.6.6.4.   **Test Starting Phase**

The tyres should **shall** touch the drum with speed **that** equals 0 km/h. Then the test load Fz should **shall** be applied at speed equal to 0 km/h or at very low speed. After load application, speed can be increased to the initial test value 60 km/h with a maximum longitudinal acceleration of 0.125 m/s^2 or maximum travelled distance of 3.5 km. During **This** starting phase shall be free rolling conditions. **The** distance run **during the** starting phase should **shall** not be counted.

2.6.7.   **Measurement and Recording**

Table 2 summarizes the items that shall be measured and recorded:

Table 2
Parameters to be measured and recorded over the drum test

Item	Requirements
a) Test speed	Sampling frequency ≥ 1Hz
b) Tyre normal force to the drum surface	Sampling frequency ≥ 1Hz
c) Test inflation pressure: initial and end of the test, as defined in 2.6.3	Shall measure ~~at the timing of~~: • Before starting the test; • 3 or more hours after end of the test. Interim measurement during test is optional
d) Ambient temperature measured in ~~degree~~ °C, t_{amb}	Sampling frequency ≥ 1Hz
e) Lateral force applied to the test tyre during the test	Sampling frequency ≥ 10 Hz
f) Longitudinal force or torque applied to the test tyre during the test	Sampling frequency ≥ 10 Hz
g) Mass of tyre	Shall measure ~~at the timing of~~: • Before starting the test; • 3 or more hours after end of the test. Interim measurement during test is optional
h) MPD and micro-roughness of the test surface;	Shall measure at the timings of : • Before starting the test; • 3 or more hours after end of the test. Interim measurement during test is optional
i) Photograph of tyres after test program	Photograph of tyres after test to record the surface as a proof of test completion in the right way.

During the measurement of the force or torque applied to the test tyre, a moving average over one-wheel revolution may be used to eliminate first and/or second harmonic of the tyre.

During the measurement of the force or torque applied to the test tyre, a low pass filter may be used to eliminate first and/or second harmonic of the tyre.

2.7.   **Validation**

When a tyre has been subjected to the test method specified in paragraph 2.5. of this Annex using a test rim and a valve that undergo no permanent deformation and allow no loss of air, there shall be no visual evidence of tread, sidewall, ply, cord, inner liner, belt or bead separation, chunking, open splices, cracking, broken cords, or rubber adhesion.

A visual inspection of reference tyres shall show no damage on reference tyres. If a reference tyre loses more than a total of 1 cm² of tread area (due to chunking or other mechanism), the tyre shall be considered as destroyed and the test as invalid.

The following values measured from each parameter shall be with their tolerances as specified in Table 3. Otherwise, the test results shall be rejected.

Table 3
Validation of Fx, Fy, Fz

Parameter	Measurement	Value to be verified	Tolerance
Fx	RMS (a) of G(x)	$RMS_{Gx} = 0,059$	±5 %
Fy	RMS (a) of G(y)	$RMS_{Gy} = 0,074$	±5 %
Fx and Fy	RMS (a) of G(x, y)	$RMS_{Gxy} = 0,095$	±5 %
Fz	RMS of Fz applied filter divided by Fz nominal	Average of Fz	±50 N or ±1 %, whichever is greater

Note 1 to entry:

(a) For the whole test of total 5000 km, calculate the Root Mean Square (RMS) of G(x) and G(y) using the equations below:

$$RMS_{Gx} = \sqrt{\frac{1}{N} \times \sum_{i=1}^{N} \left(\frac{Fx_i}{Fz_i}\right)^2}$$

$$RMS_{Gy} = \sqrt{\frac{1}{N} \times \sum_{i=1}^{N} \left(\frac{Fy_i}{Fz_i}\right)^2}$$

$$RMS_{Gxy} = \sqrt{\frac{1}{N} \times \sum_{i=1}^{N} \frac{(Fx_i)^2 + \left(Fy_i\right)^2}{(Average\ of\ Fz)^2}}$$

Where;

i is the number of data acquired at a sampling frequency of 10 Hz;
N is the total number of data acquired;
Fx, Fy and My may be filtered by a low pass filter to remove noise of the output;
Fz shall be filtered as the moving average per one second.

2.8.   **Processing of Measurement Results**

The calculation method for the abrasion index and the abrasion level ~~rate~~ shall follow the equations:

$MlT = MT_b - MT_a$

$MlR = MR_b - MR_a$

Where:

MlT   is Mass loss of candidate tyre, in grams

MlR   is Mass loss of reference tyre, in grams

MT_b is Mass of candidate tyre before test cycle, in grams

MT_a is Mass of candidate tyre after test cycle, in grams

MR_b is Mass of reference tyre before test cycle, in grams

MR_a is Mass of reference tyre after test cycle, in grams

The abrasion index (AICT) **shall be calculated according to the following equation:**

AICT = ArT/ArR

Where,

ArT   Normalized abrasion rate (mg/km/t) of candidate tyre,

ArT = MlT (g)/DT(km)/Fz,T(t) x 1000 (mg/kg)

ArR   Normalized abrasion rate (mg/km/t) of reference tyre,

ArR = MlR (g)/DR(km)/Fz,R(t) x 1000 (mg/kg)

DR   Testing mileage of candidate tyre (km)

DR   Testing mileage of reference tyre (km)

Fz,T   Test load (t) of candidate tyre

Fz,R   Test load (t) of reference tyre

The reference tyre used to calculate the abrasion index shall be one of the tyres described in 2.2.3.2.1. of this Annex.

2.9.   **Test report**

2.9.1.   The test report shall include the following information:

(a)   Test machine identification;

(b)   Drum circumference (m);

(c)   Test cycle (2 positions /1 position);

(d)   3rd body (Mineral / Clay);

(e)   MPD of test surface (mm): Beginning of test / End of test;

(f)   Tyre class;

(g)   Brand;

(h)   Pattern/trade description;

(i)   Tyre size designation;

(j)   Service description;

(k)   Test load (N);

(l)   Test inflation pressure (kPa);

(m)   Tyre identification;

(n)   3PMSF marking (Y/N);

(o)   Rim width (inch);

(p)   Inflation pressure (kPa): Beginning of test / End of test;

(q)   Mass of tyre (g): Before test / After test;

(r)   Test distance (km);

(s)   Abrasion rate (mg/km);

(t)   Normalized aAbrasion rate level (mg/km/t);

(u)   Abrasion index (only applicable for candidate tyre);

(v)   Average ambient temperature (°C);

(w)   RMS of G(x);

(x)   RMS of G(y);

(y)   **Average of Fz.**

Annex 10 – Appendix 1

Accelerations calculation

1.   **Input for calculation**

1.1.   **Required parameters**

The following parameters are required for the calculation of longitudinal and lateral acceleration:

(a)   The vehicle velocity (v), [m/s]

(b)   The longitudinal acceleration ($a_{longitudinal}$), [m/s²]

(c)   The lateral acceleration ($a_{lateral}$), [m/s²]

The accelerations are derived by evaluation of GNSS (GLOBAL NAVIGATION SATELLITE SYSTEM as defined by ISO 24245:2023) signals. The recommended sampling rate is 10 Hz or more. Otherwise, the below described filtering process is not working.

Filter for measured Values
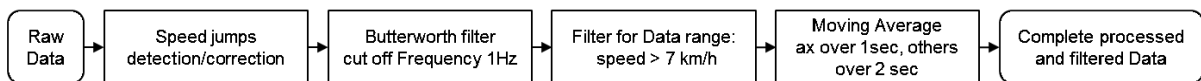
1.2.   **Speed jumps detection and correction**

Before starting the filtering process, all measured values are checked concerning speed jumps. Speed jumps refer to measurements which are not plausible. For identifying speed jumps, the velocity is filtered by using a Butterworth filter with a cut-off frequency of 1 Hz. A threshold of 9 m/s² for the maximum longitudinal acceleration is defined. That means, that a speed change of maximum 9 m/s² · $t_{sampling}$ is still plausible.

A speed jump will be detected if there is a speed difference of 2 · $\Delta speed_{possible}$. In case of a detected speed jump, the relevant raw speed values will be replaced by a linear interpolated value.

1.3.   **Butterworth Filter:**

For filtering the measurement, a Butterworth filter second order with a cut-off frequency of 1 Hz is used. After this filter the values are smoothed with a "moving average" over 1 second for longitudinal acceleration, all other values over 2 seconds.

All accelerations measured for a velocity less than 7 km/h are excluded.

~~[Matlab code:~~

~~fg = 1; % cut off frequency~~

~~order = 2; % filter order~~

~~fsample = 1/dt; % sample rate of measurement~~

~~[b,a] = butter(order,fcutoff/(0.5*fsample),'low');~~

~~out = filtfilt(b,a,double(datn)); % datn = relevant data]~~

Python code:

```python
from scipy.signal import butter, filtfilt
# Filter settings: n_order is the order of the filter,
#  A scalar or length-2 sequence giving the critical frequencies
N = 2
Wn = 1 / (0.5 * round(data_inp['freq_sample'].mean()))
```

```
[b,a] = butter(N, Wn, 'lowpass')
data_filt = filtfilt(b, a, data_inp, padtype = 'odd')
data_inp = data_inp[(data_inp.speed_filt > speed_min)]
```

1.4. ~~Filter for data range:~~

~~[Matlab code:~~

~~% define index based on data range~~

~~indx = find(speed > limits.vmin/3.6 & speed < limits.vmax/3.6 & abs(ax) < limits.ax & abs(ay) < limits.ay); % impossible accelerations are also eliminated~~

~~speed = speed(indx);~~

~~ax = ax(indx);~~

~~ay = ay(indx);]~~

1.~~4~~5. **Moving Average:**

~~[Matlab code:~~

~~winAx = filter.ax*fsample;~~

~~winOthers = filter.others*fsample;~~

~~ax = smooth(ax,winAx,'moving');~~

~~ay = smooth(ay,winOthers,'moving');~~

~~speed = smooth(speed,winOthers,'moving');]~~

Python code:

```
# averaging over 1 second window
# make sure window is odd
if round(data_inp['freq_sample'].mean()) % 2 != 0:
      win = int(round(data_inp['freq_sample'].mean()))
else:
      win = int(round(data_inp['freq_sample'].mean()) - 1)

data_inp['accx_filt_movg'] =
data_inp['accx_filt'].rolling(window=win,,
center=True, min_periods=1).mean()

# averaging over 2 second window
win = int(round(data_inp['freq_sample'].mean()) * 2 - 1)
data_inp['accy_filt_movg'] = data_inp['accy_filt'].rolling(window=win,
center=True, min_periods=1).mean()
      data_inp['speed_filt_movg'] =
data_inp['speed_filt'].rolling(window=win,
center=True, min_periods=1).mean()
```

1.~~5~~6. **Distance-based Standard Deviation**

~~Measured~~ **Calculated** accelerations (sampled with a constant frequency) are transferred in distance-based values: one value per meter. For this, a simple interpolation is used. With these accelerations, the standard deviation can be calculated with following well-known formulas:

$$S_{longitudinal} = \sqrt{\frac{1}{N-1} \cdot \sum_{i=1}^{N} \left(a_{longitudinal,i} - \mu_{longitudinal}\right)^2}$$

with $\mu_{longitudinal} = \frac{1}{N}\sum_{i=1}^{N} a_{longitudinal,i}$

$$S_{lateral} = \sqrt{\frac{1}{N-1} \cdot \sum_{i=1}^{N} \left(a_{lateral,i} - \mu_{lateral}\right)^2}$$

with $\mu_{lateral} = \frac{1}{N}\sum_{i=1}^{N} a_{lateral,i}$

~~[Matlab code:~~

~~distance = cumsum(speed/fsample);~~

~~axDB = interp1(distance,ax,distance(1):1:distance(end)); % one value per 1m~~

~~ayDB = interp1(distance,ay,distance(1):1:distance(end));~~

~~stdax = round(std(axDB)*1000)/1000;~~

~~stday = round(std(ayDB)*1000)/1000;]~~

Python code:

```python
from scipy import interpolate
import numpy as np
data_inp['distance'] = data_inp['speed']/data_inp['fsample']
data_inp['distance'] = data_inp['distance'].cumsum()

# interpolate function for acc
f_accx = interpolate.interp1d(data_inp['distance'], data_inp['accx'])
f_accy = interpolate.interp1d(data_inp['distance'], data_inp['accy'])

# generate array of distance every 1m
distance_1m = np.array(data_inp['distance'].iloc[0], data_inp['distanc
e'].iloc[-1], 1)

#
create an interpolation every 1m for the accelarations - numpy array r
esult
# len of the array same as len of distance_1m
accx_DB = f_accx(distance_1m)
accy_DB = f_accy(distance_1m)

# compute the stadx with ceiling accx_DB and accy_DB
stdax = np.std(accx_DB)
stday = np.std(accy_DB)
```

2.   **Calculation of distribution of driving styles**

The following steps shall be followed for the calculation of the distribution of driving styles:

(a)   **Cumulate 8 000 km of acceleration data on a vehicle at the circuit. The accelerations data obtained while qualifying the circuit for abrasiveness may be used. The provisions defined for vehicle speed in paragraph 1.6.13.2. (d) of this Annex shall be respected in every single convoy test;**

(b)   **Split the data in segments of 20 km;**

(c)   **Compute the longitudinal and lateral acceleration standard deviations ($S_{longitudinal}$; $S_{lateral}$ ~~σ_x ; σ_y~~) for each segment, following the method described in paragraph 1. of this appendix;**

(d)   **For each segment with ($S_{longitudinal}$; $S_{lateral}$ ~~σ_x ; σ_y~~) data, count which road driving style (as defined in paragraph 1.6.13.2.) it belongs to.**

This shall be done by attributing it to urban-like driving style if matching the corresponding criteria, to highway-like driving style if matching the corresponding criteria, or to regional-like driving style if not matching the urban-like or highway-like driving style;

(e) The share of points in one road driving style equals to the number of points in the road driving style divided by the total number of segments. This share shall respect the shares defined in paragraph 1.6.13.2.

Annex 10 – Appendix 2

Test report example for vehicle method

Tyre abrasion rate test report				
Test conditions				
Test Starting date		**Test end date**		
Test temperatures: (degree C)				
Average		**Minimum**		**Maximum**	
Percentage of distance covered on wet road:			**(add snow)**	
Circuit used for test:				
Reference:		**Location**		
Nominal circuit length		**Total distance covered**		
Highway-like driving distance:		**Regional-like style distance:**		
Urban-like driving style distance:		**Total deviation distance**		
Slope of reference tyre sensitivity to temperature:				

	Candidate ~~Reference~~ tyre/vehicle				Reference ~~Candidate~~ tyre/vehicle			
	Front Left	Front right	Rear left	Rear right	Front Left	Front right	Rear left	Rear right
Vehicle information								
Vehicle model								
Standard deviation X acceleration								
% of distance covered under the maximum longitudinal acceleration								
Standard deviation Y acceleration								
% of distance covered under the maximum lateral acceleration								
Toe at test start								
Camber at test start								
Toe at test end								
Camber at test end								
Load per position								
Tyre information								
Tyre brand								
Tyre pattern								
Tyre size designation								
Tyre load index								
Tyre speed index								
Serial number (if available)								
Cold inflation pressure (fitment)								
Cold inflation pressure 50% test								
Cold inflation pressure (test end)								
Balancing mass (test beginning)								
Balancing mass (test end)								
Rim width					7.5"	7.5"	7.5"	7.5"
Initial tyre mass								
Final tyre mass								
Distance run by each tyre								
Reference tyre abrasion ~~rate~~ level in mg/km/t normalized at 20°C (or 10°C)								
Tyres visual inspection report								
Test results								
Tyre Abrasion ~~rate~~ level in mg/km/t								
Tyre Abrasion ~~rate~~ index					N/A			

Annex 10 – Appendix 3

Input of test cycle

In order to calculate the input forces Fx and Fy, longitudinal and lateral acceleration indices, as G(x) and G(y) respectively, are introduced as below.

For torque control testing machine, tyre torque (My) is calculated with longitudinal force (Fx) and loaded radius (RL) **following the equations provided below:**

Fx ☐ Fz × G(x) or My = Test load(Fz) ×G(x) × RL

Fy ☐ Fz × G(y)

Fz is the test load defined in 2.2.8 and 2.**5**.2.

G(x) and G(y) represent the index compared to the standard acceleration due to earth gravity (g= 9.80665 m/s^2). **Alternatively**, the local earth gravity ~~can~~ **may** be defined.

Table A1 defines the time, G(x), G(y), and speed of test cycle. **In Table T1**, T represents the total test duration from the beginning of the test. 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.

T means the driving time from starting test.

The value of G(x) and G(y) at driving time T is mentioned in Table A1.

G(x) and G(y) between each point changes linearly through those two points.

Graph A.1
Example of Fx , with a test load of 5727N
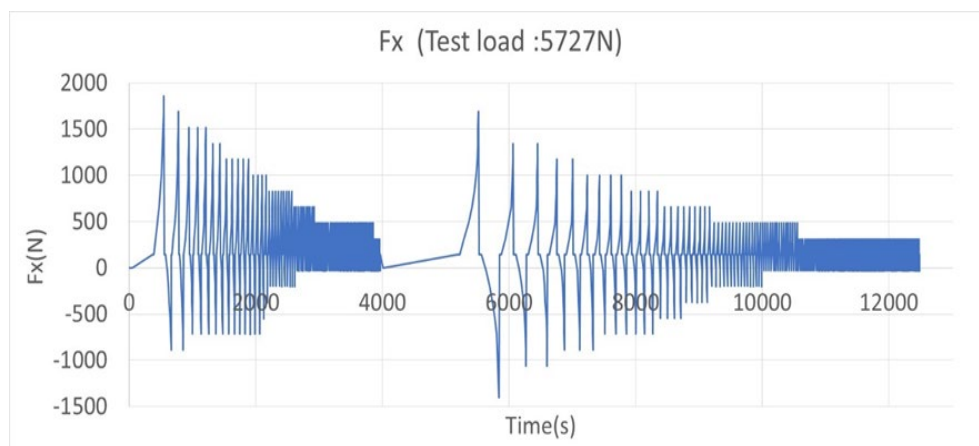
Graph A.2
Example of Fy , with a test load of 5727N

Fy (Test load :5727N)
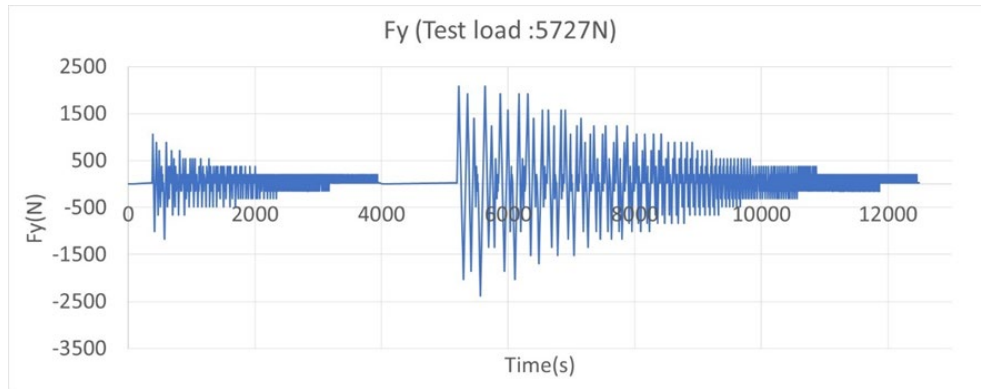
Table A1.
Input of test cycle

T	v	G(x)	G(y)
(s)	(kph)		
0	60	0.000	0
50	100	0.000	0.000
373.2	100	0.025	0.005
388.4	100	0.025	0.185
418.7	100	0.055	-0.175
446.5	100	0.085	0.155
471.7	100	0.115	-0.115
491.9	100	0.145	0.125
509.6	100	0.175	-0.085
522.3	100	0.205	0.065
532.4	100	0.235	-0.025
540.0	100	0.265	0.035
545.0	100	0.295	0.005
547.5	100	0.325	0.005
556.8	100	0.025	0.005
574.5	100	0.025	-0.205
602.3	100	-0.005	0.155
620.0	100	-0.035	-0.085
632.6	100	-0.065	0.065
645.2	100	-0.095	-0.055
657.9	100	-0.125	0.065
662.9	100	-0.155	0.005
668.8	100	0.025	0.005

T	v	G(x)	G(y)
678.9	100	0.025	0.125
699.1	100	0.055	-0.115
719.3	100	0.085	0.095
737.0	100	0.115	-0.085
747.1	100	0.145	0.065
757.2	100	0.175	-0.025
764.8	100	0.205	0.035
769.9	100	0.235	0.005
774.9	100	0.265	0.035
777.4	100	0.295	0.005
785.9	100	0.025	0.005
796.0	100	0.025	-0.115
816.2	100	-0.005	0.125
826.3	100	-0.035	-0.025
833.9	100	-0.065	0.035
841.4	100	-0.095	-0.025
849.0	100	-0.125	0.035
851.6	100	-0.155	0.005
857.4	100	0.025	0.005
865.0	100	0.025	0.095
885.2	100	0.055	-0.115
902.9	100	0.085	0.095
915.6	100	0.115	-0.055
923.1	100	0.145	0.035
930.7	100	0.175	-0.025

935.8	100	0.205	0.035	1216.2	100	0.025	0.005
940.8	100	0.235	0.005	1223.8	100	0.025	-0.085
945.9	100	0.265	0.035	1236.4	100	-0.005	0.065
953.5	100	0.025	0.005	1241.5	100	-0.035	0.005
961.0	100	0.025	-0.085	1246.5	100	-0.065	0.035
978.7	100	-0.005	0.095	1251.6	100	-0.095	0.005
986.3	100	-0.035	-0.025	1256.6	100	-0.125	0.035
991.3	100	-0.065	0.035	1261.7	100	0.025	0.005
996.4	100	-0.095	0.005	1269.3	100	0.025	0.095
1001.5	100	-0.125	0.035	1284.4	100	0.055	-0.085
1006.5	100	0.025	0.005	1299.6	100	0.085	0.065
1014.1	100	0.025	0.095	1307.2	100	0.115	-0.025
1031.8	100	0.055	-0.085	1312.2	100	0.145	0.035
1049.5	100	0.085	0.095	1317.3	100	0.175	0.005
1059.6	100	0.115	-0.025	1322.3	100	0.205	0.035
1067.1	100	0.145	0.035	1324.8	100	0.235	0.005
1072.2	100	0.175	0.005	1331.6	100	0.025	0.005
1077.2	100	0.205	0.035	1339.2	100	0.025	-0.085
1082.3	100	0.235	0.005	1351.8	100	-0.005	0.065
1084.8	100	0.265	0.005	1356.8	100	-0.035	0.005
1092.4	100	0.025	0.005	1361.9	100	-0.065	0.035
1100.0	100	0.025	-0.085	1366.9	100	-0.095	0.005
1112.6	100	-0.005	0.065	1372.0	100	-0.125	0.035
1120.2	100	-0.035	-0.025	1377.1	100	0.025	0.005
1125.3	100	-0.065	0.035	1382.1	100	0.025	0.065
1130.3	100	-0.095	0.005	1397.3	100	0.055	-0.085
1135.4	100	-0.125	0.035	1409.9	100	0.085	0.065
1140.4	100	0.025	0.005	1417.5	100	0.115	-0.025
1148.0	100	0.025	0.095	1422.5	100	0.145	0.035
1165.7	100	0.055	-0.085	1427.6	100	0.175	0.005
1180.8	100	0.085	0.065	1432.6	100	0.205	0.035
1188.4	100	0.115	-0.025	1435.2	100	0.235	0.005
1193.5	100	0.145	0.035	1441.9	100	0.025	0.005
1198.5	100	0.175	0.005	1447.0	100	0.025	-0.055
1203.6	100	0.205	0.035	1457.1	100	-0.005	0.065
1206.1	100	0.235	0.005	1462.1	100	-0.035	0.005
1208.6	100	0.265	0.005	1467.2	100	-0.065	0.035

1472.2	100	-0.095	0.005		1713.9	100	0.145	0.035
1477.3	100	-0.125	0.035		1719.0	100	0.175	0.005
1482.3	100	0.025	0.005		1721.5	100	0.205	0.005
1487.4	100	0.025	0.065		1727.4	100	0.025	0.005
1502.5	100	0.055	-0.085		1732.4	100	0.025	-0.055
1515.2	100	0.085	0.065		1740.0	100	-0.005	0.035
1522.7	100	0.115	-0.025		1745.1	100	-0.035	0.005
1527.8	100	0.145	0.035		1747.6	100	-0.065	0.005
1532.9	100	0.175	0.005		1750.1	100	-0.095	0.005
1535.4	100	0.205	0.005		1752.7	100	-0.125	0.005
1541.3	100	0.025	0.005		1757.7	100	0.025	0.005
1546.3	100	0.025	-0.055		1762.8	100	0.025	0.065
1556.4	100	-0.005	0.065		1775.4	100	0.055	-0.055
1561.5	100	-0.035	0.005		1788.0	100	0.085	0.065
1566.5	100	-0.065	0.035		1793.1	100	0.115	0.005
1571.6	100	-0.095	0.005		1798.1	100	0.145	0.035
1576.6	100	-0.125	0.035		1800.7	100	0.175	0.005
1581.7	100	0.025	0.005		1803.2	100	0.205	0.005
1586.8	100	0.025	0.065		1809.1	100	0.025	0.005
1601.9	100	0.055	-0.085		1814.1	100	0.025	-0.055
1614.5	100	0.085	0.065		1821.7	100	-0.005	0.035
1619.6	100	0.115	0.005		1826.8	100	-0.035	0.005
1624.6	100	0.145	0.035		1829.3	100	-0.065	0.005
1629.7	100	0.175	0.005		1831.8	100	-0.095	0.005
1632.2	100	0.205	0.005		1834.3	100	-0.125	0.005
1638.1	100	0.025	0.005		1839.4	100	0.025	0.005
1643.2	100	0.025	-0.055		1844.5	100	0.025	0.065
1650.8	100	-0.005	0.035		1857.1	100	0.055	-0.055
1655.8	100	-0.035	0.005		1867.2	100	0.085	0.035
1660.9	100	-0.065	0.035		1872.2	100	0.115	0.005
1663.4	100	-0.095	0.005		1877.3	100	0.145	0.035
1665.9	100	-0.125	0.005		1879.8	100	0.175	0.005
1671.0	100	0.025	0.005		1882.3	100	0.205	0.005
1676.0	100	0.025	0.065		1888.2	100	0.025	0.005
1691.2	100	0.055	-0.085		1893.3	100	0.025	-0.055
1703.8	100	0.085	0.065		1900.9	100	-0.005	0.035
1708.9	100	0.115	0.005		1905.9	100	-0.035	0.005

1908.5	100	-0.065	0.005		2100.5	100	0.175	0.005
1911.0	100	-0.095	0.005		2105.5	100	0.025	0.005
1913.5	100	-0.125	0.005		2108.0	100	0.025	-0.025
1918.6	100	0.025	0.005		2115.6	100	-0.005	0.035
1923.6	100	0.025	0.065		2120.7	100	-0.035	0.005
1936.2	100	0.055	-0.055		2123.2	100	-0.065	0.005
1946.4	100	0.085	0.035		2125.7	100	-0.095	0.005
1951.4	100	0.115	0.005		2129.9	100	0.025	0.005
1956.5	100	0.145	0.035		2132.5	100	0.025	0.035
1959.0	100	0.175	0.005		2142.6	100	0.055	-0.055
1964.0	100	0.025	0.005		2150.2	100	0.085	0.035
1969.1	100	0.025	-0.055		2155.2	100	0.115	0.005
1976.7	100	-0.005	0.035		2160.3	100	0.145	0.035
1981.7	100	-0.035	0.005		2162.8	100	0.175	0.005
1984.2	100	-0.065	0.005		2167.8	100	0.025	0.005
1986.8	100	-0.095	0.005		2170.4	100	0.025	-0.025
1989.3	100	-0.125	0.005		2177.9	100	-0.005	0.035
1994.4	100	0.025	0.005		2180.5	100	-0.035	0.005
1999.4	100	0.025	0.065		2183.0	100	-0.065	0.005
2009.5	100	0.055	-0.055		2186.4	100	0.025	0.005
2019.6	100	0.085	0.035		2188.9	100	0.025	0.035
2024.7	100	0.115	0.005		2199.0	100	0.055	-0.055
2029.7	100	0.145	0.035		2206.6	100	0.085	0.035
2032.3	100	0.175	0.005		2211.6	100	0.115	0.005
2037.3	100	0.025	0.005		2214.2	100	0.145	0.005
2042.4	100	0.025	-0.055		2218.4	100	0.025	0.005
2049.9	100	-0.005	0.035		2220.9	100	0.025	-0.025
2055.0	100	-0.035	0.005		2228.5	100	-0.005	0.035
2057.5	100	-0.065	0.005		2231.0	100	-0.035	0.005
2060.0	100	-0.095	0.005		2233.5	100	0.025	0.005
2062.6	100	-0.125	0.005		2236.1	100	0.025	0.035
2067.6	100	0.025	0.005		2246.2	100	0.055	-0.055
2070.1	100	0.025	0.035		2253.7	100	0.085	0.035
2080.3	100	0.055	-0.055		2258.8	100	0.115	0.005
2087.8	100	0.085	0.035		2261.3	100	0.145	0.005
2092.9	100	0.115	0.005		2265.5	100	0.025	0.005
2097.9	100	0.145	0.035		2268.1	100	0.025	-0.025

2275.6	100	-0.005	0.035		2442.4	100	0.145	0.005
2278.2	100	-0.035	0.005		2446.6	100	0.025	0.005
2280.7	100	0.025	0.005		2449.1	100	0.025	-0.025
2283.2	100	0.025	0.035		2454.2	100	-0.005	0.035
2293.3	100	0.055	-0.055		2456.7	100	-0.035	0.005
2300.9	100	0.085	0.035		2459.2	100	0.025	0.005
2306.0	100	0.115	0.005		2461.8	100	0.025	0.035
2308.5	100	0.145	0.005		2469.3	100	0.055	-0.025
2312.7	100	0.025	0.005		2476.9	100	0.085	0.035
2315.2	100	0.025	-0.025		2482.0	100	0.115	0.005
2322.8	100	-0.005	0.035		2484.5	100	0.145	0.005
2325.3	100	-0.035	0.005		2488.7	100	0.025	0.005
2327.8	100	0.025	0.005		2491.2	100	0.025	-0.025
2330.4	100	0.025	0.035		2496.3	100	-0.005	0.035
2340.5	100	0.055	-0.055		2498.8	100	-0.035	0.005
2348.1	100	0.085	0.035		2501.3	100	0.025	0.005
2353.1	100	0.115	0.005		2503.9	100	0.025	0.035
2355.6	100	0.145	0.005		2511.4	100	0.055	-0.025
2359.9	100	0.025	0.005		2519.0	100	0.085	0.035
2362.4	100	0.025	-0.025		2524.1	100	0.115	0.005
2370.0	100	-0.005	0.035		2526.6	100	0.145	0.005
2372.5	100	-0.035	0.005		2530.8	100	0.025	0.005
2375.0	100	0.025	0.005		2533.3	100	0.025	-0.025
2377.5	100	0.025	0.035		2538.4	100	-0.005	0.035
2385.1	100	0.055	-0.025		2540.9	100	-0.035	0.005
2392.7	100	0.085	0.035		2543.4	100	0.025	0.005
2397.7	100	0.115	0.005		2546.0	100	0.025	0.035
2400.3	100	0.145	0.005		2553.5	100	0.055	-0.025
2404.5	100	0.025	0.005		2561.1	100	0.085	0.035
2407.0	100	0.025	-0.025		2563.7	100	0.115	0.005
2412.1	100	-0.005	0.035		2566.2	100	0.145	0.005
2414.6	100	-0.035	0.005		2570.4	100	0.025	0.005
2417.1	100	0.025	0.005		2572.9	100	0.025	-0.025
2419.6	100	0.025	0.035		2578.0	100	-0.005	0.035
2427.2	100	0.055	-0.025		2580.5	100	-0.035	0.005
2434.8	100	0.085	0.035		2583.0	100	0.025	0.005
2439.9	100	0.115	0.005		2585.5	100	0.025	0.035

2593.1	100	0.055	-0.025		2743.9	100	0.025	-0.025
2600.7	100	0.085	0.035		2748.9	100	-0.005	0.035
2603.2	100	0.115	0.005		2750.6	100	0.025	0.005
2606.6	100	0.025	0.005		2753.1	100	0.025	0.035
2609.1	100	0.025	-0.025		2760.7	100	0.055	-0.025
2614.2	100	-0.005	0.035		2765.8	100	0.085	0.035
2616.7	100	-0.035	0.005		2768.3	100	0.115	0.005
2619.2	100	0.025	0.005		2771.7	100	0.025	0.005
2621.8	100	0.025	0.035		2774.2	100	0.025	-0.025
2629.3	100	0.055	-0.025		2779.2	100	-0.005	0.035
2636.9	100	0.085	0.035		2780.9	100	0.025	0.005
2639.4	100	0.115	0.005		2783.5	100	0.025	0.035
2642.8	100	0.025	0.005		2791.0	100	0.055	-0.025
2645.3	100	0.025	-0.025		2796.1	100	0.085	0.035
2650.4	100	-0.005	0.035		2798.6	100	0.115	0.005
2652.1	100	0.025	0.005		2802.0	100	0.025	0.005
2654.6	100	0.025	0.035		2804.5	100	0.025	-0.025
2662.2	100	0.055	-0.025		2809.6	100	-0.005	0.035
2669.8	100	0.085	0.035		2811.2	100	0.025	0.005
2672.3	100	0.115	0.005		2813.8	100	0.025	0.035
2675.7	100	0.025	0.005		2821.4	100	0.055	-0.025
2678.2	100	0.025	-0.025		2826.4	100	0.085	0.035
2683.2	100	-0.005	0.035		2828.9	100	0.115	0.005
2684.9	100	0.025	0.005		2832.3	100	0.025	0.005
2687.4	100	0.025	0.035		2834.8	100	0.025	-0.025
2695.0	100	0.055	-0.025		2839.9	100	-0.005	0.035
2702.6	100	0.085	0.035		2841.6	100	0.025	0.005
2705.1	100	0.115	0.005		2844.1	100	0.025	0.035
2708.5	100	0.025	0.005		2851.7	100	0.055	-0.025
2711.0	100	0.025	-0.025		2856.7	100	0.085	0.035
2716.1	100	-0.005	0.035		2859.2	100	0.115	0.005
2717.8	100	0.025	0.005		2862.6	100	0.025	0.005
2720.3	100	0.025	0.035		2865.1	100	0.025	-0.025
2727.9	100	0.055	-0.025		2870.2	100	-0.005	0.035
2735.5	100	0.085	0.035		2871.9	100	0.025	0.005
2738.0	100	0.115	0.005		2874.4	100	0.025	0.035
2741.3	100	0.025	0.005		2882.0	100	0.055	-0.025

2887.0	100	0.085	0.035		3028.5	100	0.085	0.035
2889.6	100	0.115	0.005		3031.0	100	0.025	0.005
2892.9	100	0.025	0.005		3036.1	100	0.025	0.005
2895.5	100	0.025	-0.025		3041.2	100	-0.005	0.035
2900.5	100	-0.005	0.035		3042.8	100	0.025	0.005
2902.2	100	0.025	0.005		3045.4	100	0.025	0.035
2904.7	100	0.025	0.035		3052.9	100	0.055	-0.025
2912.3	100	0.055	-0.025		3058.0	100	0.085	0.035
2917.4	100	0.085	0.035		3060.5	100	0.025	0.005
2919.9	100	0.115	0.005		3065.6	100	0.025	0.005
2923.3	100	0.025	0.005		3070.6	100	-0.005	0.035
2925.8	100	0.025	-0.025		3072.3	100	0.025	0.005
2930.8	100	-0.005	0.035		3074.8	100	0.025	0.035
2932.5	100	0.025	0.005		3082.4	100	0.055	-0.025
2935.0	100	0.025	0.035		3087.5	100	0.085	0.035
2942.6	100	0.055	-0.025		3090.0	100	0.025	0.005
2947.7	100	0.085	0.035		3095.1	100	0.025	0.005
2950.2	100	0.025	0.005		3100.1	100	-0.005	0.035
2952.7	100	0.025	-0.025		3101.8	100	0.025	0.005
2957.8	100	-0.005	0.035		3104.3	100	0.025	0.035
2959.5	100	0.025	0.005		3111.9	100	0.055	-0.025
2962.0	100	0.025	0.035		3116.9	100	0.085	0.035
2969.6	100	0.055	-0.025		3119.5	100	0.025	0.005
2974.6	100	0.085	0.035		3124.5	100	0.025	0.005
2977.2	100	0.025	0.005		3129.6	100	-0.005	0.035
2979.7	100	0.025	-0.025		3131.3	100	0.025	0.005
2984.7	100	-0.005	0.035		3133.8	100	0.025	0.035
2986.4	100	0.025	0.005		3141.4	100	0.055	-0.025
2988.9	100	0.025	0.035		3146.4	100	0.085	0.035
2996.5	100	0.055	-0.025		3149.0	100	0.025	0.005
3001.6	100	0.085	0.035		3154.0	100	0.025	0.005
3004.1	100	0.025	0.005		3159.1	100	-0.005	0.035
3006.6	100	0.025	-0.025		3160.7	100	0.025	0.005
3011.7	100	-0.005	0.035		3163.3	100	0.025	0.035
3013.4	100	0.025	0.005		3170.8	100	0.055	-0.025
3015.9	100	0.025	0.035		3175.9	100	0.085	0.035
3023.5	100	0.055	-0.025		3178.4	100	0.025	0.005

3183.5	100	0.025	0.005	3325.0	100	0.025	0.005
3188.5	100	-0.005	0.035	3327.5	100	0.025	0.035
3190.2	100	0.025	0.005	3332.5	100	0.055	0.005
3192.7	100	0.025	0.035	3335.1	100	0.085	0.005
3197.8	100	0.055	0.005	3337.6	100	0.025	0.005
3202.8	100	0.085	0.035	3342.6	100	0.025	0.005
3205.4	100	0.025	0.005	3347.7	100	-0.005	0.035
3210.4	100	0.025	0.005	3349.4	100	0.025	0.005
3215.5	100	-0.005	0.035	3351.9	100	0.025	0.035
3217.2	100	0.025	0.005	3357.0	100	0.055	0.005
3219.7	100	0.025	0.035	3359.5	100	0.085	0.005
3224.7	100	0.055	0.005	3362.0	100	0.025	0.005
3229.8	100	0.085	0.035	3367.1	100	0.025	0.005
3232.3	100	0.025	0.005	3372.1	100	-0.005	0.035
3237.4	100	0.025	0.005	3373.8	100	0.025	0.005
3242.4	100	-0.005	0.035	3376.3	100	0.025	0.035
3244.1	100	0.025	0.005	3381.4	100	0.055	0.005
3246.6	100	0.025	0.035	3383.9	100	0.085	0.005
3251.7	100	0.055	0.005	3386.4	100	0.025	0.005
3256.7	100	0.085	0.035	3391.5	100	0.025	0.005
3259.3	100	0.025	0.005	3394.0	100	-0.005	0.005
3264.3	100	0.025	0.005	3395.7	100	0.025	0.005
3269.4	100	-0.005	0.035	3398.2	100	0.025	0.035
3271.1	100	0.025	0.005	3403.3	100	0.055	0.005
3273.6	100	0.025	0.035	3405.8	100	0.085	0.005
3278.6	100	0.055	0.005	3408.3	100	0.025	0.005
3283.7	100	0.085	0.035	3413.4	100	0.025	0.005
3286.2	100	0.025	0.005	3415.9	100	-0.005	0.005
3291.3	100	0.025	0.005	3417.6	100	0.025	0.005
3296.3	100	-0.005	0.035	3420.1	100	0.025	0.035
3298.0	100	0.025	0.005	3425.2	100	0.055	0.005
3300.5	100	0.025	0.035	3427.7	100	0.085	0.005
3305.6	100	0.055	0.005	3430.2	100	0.025	0.005
3310.6	100	0.085	0.035	3435.3	100	0.025	0.005
3313.2	100	0.025	0.005	3437.8	100	-0.005	0.005
3318.2	100	0.025	0.005	3439.5	100	0.025	0.005
3323.3	100	-0.005	0.035	3442.0	100	0.025	0.035

3447.1	100	0.055	0.005		3561.6	100	0.025	0.005
3449.6	100	0.085	0.005		3566.7	100	0.025	0.005
3452.1	100	0.025	0.005		3569.2	100	-0.005	0.005
3457.2	100	0.025	0.005		3570.9	100	0.025	0.005
3459.7	100	-0.005	0.005		3573.4	100	0.025	0.035
3461.4	100	0.025	0.005		3578.5	100	0.055	0.005
3463.9	100	0.025	0.035		3581.0	100	0.085	0.005
3469.0	100	0.055	0.005		3583.5	100	0.025	0.005
3471.5	100	0.085	0.005		3588.6	100	0.025	0.005
3474.0	100	0.025	0.005		3591.1	100	-0.005	0.005
3479.1	100	0.025	0.005		3592.8	100	0.025	0.005
3481.6	100	-0.005	0.005		3595.3	100	0.025	0.035
3483.3	100	0.025	0.005		3600.3	100	0.055	0.005
3485.8	100	0.025	0.035		3602.9	100	0.085	0.005
3490.9	100	0.055	0.005		3605.4	100	0.025	0.005
3493.4	100	0.085	0.005		3610.5	100	0.025	0.005
3495.9	100	0.025	0.005		3613.0	100	-0.005	0.005
3501.0	100	0.025	0.005		3614.7	100	0.025	0.005
3503.5	100	-0.005	0.005		3617.2	100	0.025	0.035
3505.2	100	0.025	0.005		3619.7	100	0.055	0.005
3507.7	100	0.025	0.035		3622.2	100	0.085	0.005
3512.8	100	0.055	0.005		3624.8	100	0.025	0.005
3515.3	100	0.085	0.005		3629.8	100	0.025	0.005
3517.8	100	0.025	0.005		3632.3	100	-0.005	0.005
3522.9	100	0.025	0.005		3634.0	100	0.025	0.005
3525.4	100	-0.005	0.005		3636.6	100	0.025	0.035
3527.1	100	0.025	0.005		3639.1	100	0.055	0.005
3529.6	100	0.025	0.035		3641.6	100	0.085	0.005
3534.7	100	0.055	0.005		3644.1	100	0.025	0.005
3537.2	100	0.085	0.005		3649.2	100	0.025	0.005
3539.7	100	0.025	0.005		3651.7	100	-0.005	0.005
3544.8	100	0.025	0.005		3653.4	100	0.025	0.005
3547.3	100	-0.005	0.005		3655.9	100	0.025	0.035
3549.0	100	0.025	0.005		3658.5	100	0.055	0.005
3551.5	100	0.025	0.035		3661.0	100	0.085	0.005
3556.6	100	0.055	0.005		3663.5	100	0.025	0.005
3559.1	100	0.085	0.005		3668.6	100	0.025	0.005

3671.1	100	-0.005	0.005		3772.1	100	0.025	0.035
3672.8	100	0.025	0.005		3774.7	100	0.055	0.005
3675.3	100	0.025	0.035		3777.2	100	0.085	0.005
3677.8	100	0.055	0.005		3779.7	100	0.025	0.005
3680.4	100	0.085	0.005		3784.8	100	0.025	0.005
3682.9	100	0.025	0.005		3787.3	100	-0.005	0.005
3687.9	100	0.025	0.005		3789.0	100	0.025	0.005
3690.5	100	-0.005	0.005		3791.5	100	0.025	0.035
3692.1	100	0.025	0.005		3794.0	100	0.055	0.005
3694.7	100	0.025	0.035		3796.6	100	0.085	0.005
3697.2	100	0.055	0.005		3799.1	100	0.025	0.005
3699.7	100	0.085	0.005		3804.1	100	0.025	0.005
3702.2	100	0.025	0.005		3806.7	100	-0.005	0.005
3707.3	100	0.025	0.005		3808.4	100	0.025	0.005
3709.8	100	-0.005	0.005		3810.9	100	0.025	0.035
3711.5	100	0.025	0.005		3813.4	100	0.055	0.005
3714.0	100	0.025	0.035		3815.9	100	0.085	0.005
3716.6	100	0.055	0.005		3818.5	100	0.025	0.005
3719.1	100	0.085	0.005		3823.5	100	0.025	0.005
3721.6	100	0.025	0.005		3826.0	100	-0.005	0.005
3726.7	100	0.025	0.005		3827.7	100	0.025	0.005
3729.2	100	-0.005	0.005		3830.3	100	0.025	0.035
3730.9	100	0.025	0.005		3832.8	100	0.055	0.005
3733.4	100	0.025	0.035		3835.3	100	0.085	0.005
3735.9	100	0.055	0.005		3837.8	100	0.025	0.005
3738.5	100	0.085	0.005		3842.9	100	0.025	0.005
3741.0	100	0.025	0.005		3845.4	100	-0.005	0.005
3746.0	100	0.025	0.005		3847.1	100	0.025	0.005
3748.6	100	-0.005	0.005		3849.6	100	0.025	0.035
3750.3	100	0.025	0.005		3852.2	100	0.055	0.005
3752.8	100	0.025	0.035		3854.7	100	0.085	0.005
3755.3	100	0.055	0.005		3857.2	100	0.025	0.005
3757.8	100	0.085	0.005		3862.3	100	0.025	0.005
3760.4	100	0.025	0.005		3864.8	100	-0.005	0.005
3765.4	100	0.025	0.005		3866.5	100	0.025	0.005
3767.9	100	-0.005	0.005		3869.0	100	0.025	0.035
3769.6	100	0.025	0.005		3871.5	100	0.055	0.005

3873.2	100	0.025	0.005		5291.3	60	0.055	-0.355
3878.3	100	0.025	0.005		5358.1	60	0.085	0.335
3880.8	100	-0.005	0.005		5416.6	60	0.115	-0.325
3882.5	100	0.025	0.005		5458.3	60	0.145	0.245
3885.0	100	0.025	0.035		5486.2	60	0.175	-0.085
3887.5	100	0.055	0.005		5497.3	60	0.205	0.065
3889.2	100	0.025	0.005		5505.6	60	0.235	-0.025
3894.3	100	0.025	0.005		5511.2	60	0.265	0.035
3896.8	100	-0.005	0.005		5514.0	60	0.295	0.005
3898.5	100	0.025	0.005		5523.3	60	0.025	0.005
3901.0	100	0.025	0.035		5562.2	60	0.025	-0.415
3903.5	100	0.055	0.005		5637.4	60	-0.005	0.365
3905.2	100	0.025	0.005		5693.1	60	-0.035	-0.235
3910.3	100	0.025	0.005		5737.6	60	-0.065	0.215
3912.8	100	-0.005	0.005		5779.3	60	-0.095	-0.235
3914.5	100	0.025	0.005		5801.6	60	-0.125	0.095
3917.0	100	0.025	0.035		5818.3	60	-0.155	-0.055
3919.5	100	0.055	0.005		5826.7	60	-0.185	0.035
3921.2	100	0.025	0.005		5835.0	60	-0.215	-0.025
3926.3	100	0.025	0.005		5837.8	60	-0.245	0.005
3928.8	100	-0.005	0.005		5847.1	60	0.025	0.005
3930.5	100	0.025	0.005		5877.7	60	0.025	0.335
3933.0	100	0.025	0.035		5941.7	60	0.055	-0.325
3935.5	100	0.055	0.005		5991.8	60	0.085	0.275
3937.2	100	0.025	0.005		6033.6	60	0.115	-0.175
3942.3	100	0.025	0.005		6047.5	60	0.145	0.065
3944.8	100	-0.005	0.005		6055.8	60	0.175	-0.025
3946.5	100	0.025	0.005		6061.4	60	0.205	0.035
3951.5	100	0.025	0.005		6067.0	60	0.235	0.005
3954.1	100	0.055	0.005		6074.4	60	0.025	0.005
3955.7	100	0.025	0.005		6107.8	60	0.025	-0.355
3960.8	100	0.025	0.005		6169.0	60	-0.005	0.335
3963.3	100	-0.005	0.005		6202.4	60	-0.035	-0.175
3965.0	100	0.025	0.005		6227.5	60	-0.065	0.095
4015.0	60	0.000	0.000		6246.9	60	-0.095	-0.085
5188.3	60	0.025	0.005		6258.1	60	-0.125	0.065
5221.7	60	0.025	0.365		6266.4	60	-0.155	-0.025

6269.2	60	-0.185	0.005		6950.2	60	0.055	-0.205
6276.6	60	0.025	0.005		6983.6	60	0.085	0.185
6307.3	60	0.025	0.335		6994.7	60	0.115	-0.025
6360.1	60	0.055	-0.265		7000.3	60	0.145	0.035
6404.7	60	0.085	0.245		7005.9	60	0.175	0.005
6429.7	60	0.115	-0.085		7008.7	60	0.205	0.005
6440.9	60	0.145	0.035		7015.2	60	0.025	0.005
6446.4	60	0.175	0.005		7040.2	60	0.025	-0.265
6452.0	60	0.205	0.035		7082.0	60	-0.005	0.215
6454.8	60	0.235	0.005		7093.1	60	-0.035	-0.025
6462.2	60	0.025	0.005		7101.4	60	-0.065	0.035
6490.0	60	0.025	-0.295		7109.8	60	-0.095	-0.025
6542.9	60	-0.005	0.275		7115.4	60	-0.125	0.035
6562.4	60	-0.035	-0.085		7118.1	60	-0.155	0.005
6576.3	60	-0.065	0.065		7124.6	60	0.025	0.005
6587.4	60	-0.095	-0.055		7146.9	60	0.025	0.245
6595.8	60	-0.125	0.035		7185.9	60	0.055	-0.175
6601.4	60	-0.155	0.005		7213.7	60	0.085	0.155
6604.1	60	-0.185	0.005		7224.8	60	0.115	-0.025
6611.6	60	0.025	0.005		7230.4	60	0.145	0.035
6636.6	60	0.025	0.275		7233.2	60	0.175	0.005
6686.7	60	0.055	-0.235		7238.7	60	0.025	0.005
6725.7	60	0.085	0.215		7261.0	60	0.025	-0.235
6739.6	60	0.115	-0.055		7297.2	60	-0.005	0.185
6745.2	60	0.145	0.035		7305.5	60	-0.035	-0.025
6750.7	60	0.175	0.005		7313.9	60	-0.065	0.035
6753.5	60	0.205	0.005		7319.5	60	-0.095	0.005
6760.0	60	0.025	0.005		7325.0	60	-0.125	0.035
6785.1	60	0.025	-0.265		7327.8	60	-0.155	0.005
6835.2	60	-0.005	0.275		7334.3	60	0.025	0.005
6849.1	60	-0.035	-0.055		7353.8	60	0.025	0.215
6857.4	60	-0.065	0.035		7392.8	60	0.055	-0.175
6865.8	60	-0.095	-0.025		7412.2	60	0.085	0.095
6871.3	60	-0.125	0.035		7420.6	60	0.115	-0.025
6874.1	60	-0.155	0.005		7426.2	60	0.145	0.035
6880.6	60	0.025	0.005		7428.9	60	0.175	0.005
6905.7	60	0.025	0.275		7434.5	60	0.025	0.005

7454.0	60	0.025	-0.205	7924.4	60	0.085	0.065
7490.2	60	-0.005	0.185	7929.9	60	0.115	0.005
7498.5	60	-0.035	-0.025	7932.7	60	0.145	0.005
7506.9	60	-0.065	0.035	7937.4	60	0.025	0.005
7512.4	60	-0.095	0.005	7954.1	60	0.025	-0.175
7515.2	60	-0.125	0.005	7984.7	60	-0.005	0.155
7520.8	60	0.025	0.005	7993.0	60	-0.035	-0.025
7540.3	60	0.025	0.215	7998.6	60	-0.065	0.035
7576.5	60	0.055	-0.175	8001.4	60	-0.095	0.005
7595.9	60	0.085	0.095	8004.2	60	-0.125	0.005
7601.5	60	0.115	0.005	8009.7	60	0.025	0.005
7607.1	60	0.145	0.035	8026.4	60	0.025	0.185
7609.9	60	0.175	0.005	8057.1	60	0.055	-0.145
7615.4	60	0.025	0.005	8068.2	60	0.085	0.065
7634.9	60	0.025	-0.205	8073.8	60	0.115	0.005
7665.5	60	-0.005	0.155	8076.5	60	0.145	0.005
7673.9	60	-0.035	-0.025	8081.2	60	0.025	0.005
7679.4	60	-0.065	0.035	8097.9	60	0.025	-0.175
7685.0	60	-0.095	0.005	8122.9	60	-0.005	0.125
7687.8	60	-0.125	0.005	8128.5	60	-0.035	0.005
7693.4	60	0.025	0.005	8134.1	60	-0.065	0.035
7712.8	60	0.025	0.215	8136.8	60	-0.095	0.005
7749.0	60	0.055	-0.175	8139.6	60	-0.125	0.005
7765.7	60	0.085	0.095	8145.2	60	0.025	0.005
7771.3	60	0.115	0.005	8161.9	60	0.025	0.185
7774.1	60	0.145	0.005	8192.5	60	0.055	-0.145
7776.9	60	0.175	0.005	8203.6	60	0.085	0.065
7782.4	60	0.025	0.005	8209.2	60	0.115	0.005
7801.9	60	0.025	-0.205	8212.0	60	0.145	0.005
7832.5	60	-0.005	0.155	8216.6	60	0.025	0.005
7840.9	60	-0.035	-0.025	8233.3	60	0.025	-0.175
7846.4	60	-0.065	0.035	8255.6	60	-0.005	0.125
7849.2	60	-0.095	0.005	8261.2	60	-0.035	0.005
7852.0	60	-0.125	0.005	8266.7	60	-0.065	0.035
7857.6	60	0.025	0.005	8269.5	60	-0.095	0.005
7877.1	60	0.025	0.215	8272.3	60	-0.125	0.005
7910.5	60	0.055	-0.145	8277.9	60	0.025	0.005

8294.6	60	0.025	0.185		8665.7	60	0.115	0.005
8322.4	60	0.055	-0.115		8669.4	60	0.025	0.005
8333.5	60	0.085	0.065		8683.3	60	0.025	-0.145
8339.1	60	0.115	0.005		8702.8	60	-0.005	0.095
8341.9	60	0.145	0.005		8708.4	60	-0.035	0.005
8346.5	60	0.025	0.005		8711.1	60	-0.065	0.005
8360.4	60	0.025	-0.145		8713.9	60	-0.095	0.005
8382.7	60	-0.005	0.125		8718.6	60	0.025	0.005
8388.3	60	-0.035	0.005		8732.5	60	0.025	0.155
8391.1	60	-0.065	0.005		8752.0	60	0.055	-0.085
8393.8	60	-0.095	0.005		8760.3	60	0.085	0.035
8398.5	60	0.025	0.005		8763.1	60	0.115	0.005
8415.2	60	0.025	0.185		8766.8	60	0.025	0.005
8440.2	60	0.055	-0.115		8780.7	60	0.025	-0.145
8451.4	60	0.085	0.065		8797.4	60	-0.005	0.095
8456.9	60	0.115	0.005		8800.2	60	-0.035	0.005
8460.6	60	0.025	0.005		8803.0	60	-0.065	0.005
8474.6	60	0.025	-0.145		8806.7	60	0.025	0.005
8494.0	60	-0.005	0.095		8820.6	60	0.025	0.155
8499.6	60	-0.035	0.005		8840.1	60	0.055	-0.085
8502.4	60	-0.065	0.005		8848.5	60	0.085	0.035
8505.2	60	-0.095	0.005		8851.2	60	0.115	0.005
8509.8	60	0.025	0.005		8854.9	60	0.025	0.005
8523.7	60	0.025	0.155		8866.1	60	0.025	-0.115
8548.8	60	0.055	-0.115		8882.8	60	-0.005	0.095
8557.1	60	0.085	0.035		8885.6	60	-0.035	0.005
8562.7	60	0.115	0.005		8888.3	60	-0.065	0.005
8566.4	60	0.025	0.005		8892.1	60	0.025	0.005
8580.3	60	0.025	-0.145		8906.0	60	0.025	0.155
8599.8	60	-0.005	0.095		8925.5	60	0.055	-0.085
8605.4	60	-0.035	0.005		8933.8	60	0.085	0.035
8608.2	60	-0.065	0.005		8936.6	60	0.115	0.005
8610.9	60	-0.095	0.005		8940.3	60	0.025	0.005
8615.6	60	0.025	0.005		8951.4	60	0.025	-0.115
8629.5	60	0.025	0.155		8968.1	60	-0.005	0.095
8654.5	60	0.055	-0.115		8970.9	60	-0.035	0.005
8662.9	60	0.085	0.035		8973.7	60	-0.065	0.005

8977.4	60	0.025	0.005	9274.3	60	0.025	0.005
8988.5	60	0.025	0.125	9282.7	60	0.025	0.095
9008.0	60	0.055	-0.085	9299.4	60	0.055	-0.055
9013.6	60	0.085	0.035	9304.9	60	0.085	0.035
9016.4	60	0.115	0.005	9307.7	60	0.025	0.005
9020.1	60	0.025	0.005	9318.8	60	0.025	-0.115
9031.2	60	0.025	-0.115	9332.8	60	-0.005	0.065
9045.1	60	-0.005	0.065	9335.5	60	-0.035	0.005
9047.9	60	-0.035	0.005	9338.3	60	0.025	0.005
9050.7	60	-0.065	0.005	9346.7	60	0.025	0.095
9054.4	60	0.025	0.005	9363.4	60	0.055	-0.055
9065.6	60	0.025	0.125	9368.9	60	0.085	0.035
9085.0	60	0.055	-0.085	9371.7	60	0.025	0.005
9090.6	60	0.085	0.035	9380.1	60	0.025	-0.085
9093.4	60	0.115	0.005	9394.0	60	-0.005	0.065
9097.1	60	0.025	0.005	9396.8	60	-0.035	0.005
9108.2	60	0.025	-0.115	9399.6	60	0.025	0.005
9122.1	60	-0.005	0.065	9407.9	60	0.025	0.095
9124.9	60	-0.035	0.005	9421.8	60	0.055	-0.055
9127.7	60	-0.065	0.005	9427.4	60	0.085	0.035
9131.4	60	0.025	0.005	9430.2	60	0.025	0.005
9142.6	60	0.025	0.125	9438.5	60	0.025	-0.085
9162.0	60	0.055	-0.085	9449.7	60	-0.005	0.065
9167.6	60	0.085	0.035	9452.4	60	-0.035	0.005
9170.4	60	0.115	0.005	9455.2	60	0.025	0.005
9174.1	60	0.025	0.005	9463.6	60	0.025	0.095
9185.2	60	0.025	-0.115	9477.5	60	0.055	-0.055
9199.2	60	-0.005	0.065	9483.1	60	0.085	0.035
9201.9	60	-0.035	0.005	9485.8	60	0.025	0.005
9204.7	60	0.025	0.005	9494.2	60	0.025	-0.085
9215.9	60	0.025	0.125	9505.3	60	-0.005	0.065
9235.3	60	0.055	-0.085	9508.1	60	-0.035	0.005
9240.9	60	0.085	0.035	9510.9	60	0.025	0.005
9243.7	60	0.025	0.005	9519.2	60	0.025	0.095
9254.8	60	0.025	-0.115	9533.2	60	0.055	-0.055
9268.7	60	-0.005	0.065	9538.7	60	0.085	0.035
9271.5	60	-0.035	0.005	9541.5	60	0.025	0.005

9549.9	60	0.025	-0.085		9792.0	60	0.055	-0.055
9561.0	60	-0.005	0.065		9794.8	60	0.085	0.005
9563.8	60	-0.035	0.005		9797.6	60	0.025	0.005
9566.6	60	0.025	0.005		9803.1	60	0.025	-0.055
9574.9	60	0.025	0.095		9811.5	60	-0.005	0.035
9588.8	60	0.055	-0.055		9814.3	60	-0.035	0.005
9594.4	60	0.085	0.035		9817.1	60	0.025	0.005
9597.2	60	0.025	0.005		9825.4	60	0.025	0.095
9605.5	60	0.025	-0.085		9839.3	60	0.055	-0.055
9616.7	60	-0.005	0.065		9842.1	60	0.085	0.005
9619.4	60	-0.035	0.005		9844.9	60	0.025	0.005
9622.2	60	0.025	0.005		9850.5	60	0.025	-0.055
9630.6	60	0.025	0.095		9858.8	60	-0.005	0.035
9644.5	60	0.055	-0.055		9861.6	60	-0.035	0.005
9650.1	60	0.085	0.035		9864.4	60	0.025	0.005
9652.8	60	0.025	0.005		9869.9	60	0.025	0.065
9661.2	60	0.025	-0.085		9883.9	60	0.055	-0.055
9669.5	60	-0.005	0.035		9886.6	60	0.085	0.005
9672.3	60	-0.035	0.005		9889.4	60	0.025	0.005
9675.1	60	0.025	0.005		9895.0	60	0.025	-0.055
9683.5	60	0.025	0.095		9903.3	60	-0.005	0.035
9697.4	60	0.055	-0.055		9906.1	60	-0.035	0.005
9700.2	60	0.085	0.005		9908.9	60	0.025	0.005
9702.9	60	0.025	0.005		9914.5	60	0.025	0.065
9708.5	60	0.025	-0.055		9925.6	60	0.055	-0.025
9716.9	60	-0.005	0.035		9928.4	60	0.085	0.005
9719.6	60	-0.035	0.005		9931.2	60	0.025	0.005
9722.4	60	0.025	0.005		9936.7	60	0.025	-0.055
9730.8	60	0.025	0.095		9945.1	60	-0.005	0.035
9744.7	60	0.055	-0.055		9947.9	60	-0.035	0.005
9747.5	60	0.085	0.005		9950.7	60	0.025	0.005
9750.3	60	0.025	0.005		9956.2	60	0.025	0.065
9755.8	60	0.025	-0.055		9967.4	60	0.055	-0.025
9764.2	60	-0.005	0.035		9970.1	60	0.085	0.005
9767.0	60	-0.035	0.005		9972.9	60	0.025	0.005
9769.7	60	0.025	0.005		9978.5	60	0.025	-0.055
9778.1	60	0.025	0.095		9986.8	60	-0.005	0.035

9989.6	60	-0.035	0.005		10188.2	60	0.025	0.065
9992.4	60	0.025	0.005		10196.5	60	0.055	-0.025
9998.0	60	0.025	0.065		10199.3	60	0.085	0.005
10009.1	60	0.055	-0.025		10202.1	60	0.025	0.005
10011.9	60	0.085	0.005		10207.7	60	0.025	-0.055
10014.7	60	0.025	0.005		10216.0	60	-0.005	0.035
10020.2	60	0.025	-0.055		10217.9	60	0.025	0.005
10028.6	60	-0.005	0.035		10223.4	60	0.025	0.065
10030.4	60	0.025	0.005		10231.8	60	0.055	-0.025
10036.0	60	0.025	0.065		10234.6	60	0.085	0.005
10047.1	60	0.055	-0.025		10237.3	60	0.025	0.005
10049.9	60	0.085	0.005		10242.9	60	0.025	-0.055
10052.7	60	0.025	0.005		10251.3	60	-0.005	0.035
10058.3	60	0.025	-0.055		10253.1	60	0.025	0.005
10066.6	60	-0.005	0.035		10258.7	60	0.025	0.065
10068.5	60	0.025	0.005		10267.0	60	0.055	-0.025
10074.1	60	0.025	0.065		10269.8	60	0.085	0.005
10085.2	60	0.055	-0.025		10272.6	60	0.025	0.005
10088.0	60	0.085	0.005		10278.2	60	0.025	-0.055
10090.8	60	0.025	0.005		10286.5	60	-0.005	0.035
10096.3	60	0.025	-0.055		10288.4	60	0.025	0.005
10104.7	60	-0.005	0.035		10293.9	60	0.025	0.065
10106.5	60	0.025	0.005		10302.3	60	0.055	-0.025
10112.1	60	0.025	0.065		10305.1	60	0.085	0.005
10123.2	60	0.055	-0.025		10307.9	60	0.025	0.005
10126.0	60	0.085	0.005		10313.4	60	0.025	-0.055
10128.8	60	0.025	0.005		10321.8	60	-0.005	0.035
10134.4	60	0.025	-0.055		10323.6	60	0.025	0.005
10142.7	60	-0.005	0.035		10329.2	60	0.025	0.065
10144.6	60	0.025	0.005		10337.5	60	0.055	-0.025
10150.1	60	0.025	0.065		10340.3	60	0.085	0.005
10161.3	60	0.055	-0.025		10343.1	60	0.025	0.005
10164.0	60	0.085	0.005		10348.7	60	0.025	-0.055
10166.8	60	0.025	0.005		10357.0	60	-0.005	0.035
10172.4	60	0.025	-0.055		10358.9	60	0.025	0.005
10180.7	60	-0.005	0.035		10364.4	60	0.025	0.065
10182.6	60	0.025	0.005		10372.8	60	0.055	-0.025

10375.6	60	0.085	0.005		10560.2	60	0.025	-0.055
10378.4	60	0.025	0.005		10568.6	60	-0.005	0.035
10383.9	60	0.025	-0.055		10570.4	60	0.025	0.005
10392.3	60	-0.005	0.035		10576.0	60	0.025	0.065
10394.1	60	0.025	0.005		10584.3	60	0.055	-0.025
10399.7	60	0.025	0.065		10586.2	60	0.025	0.005
10408.1	60	0.055	-0.025		10589.0	60	0.025	-0.025
10410.8	60	0.085	0.005		10597.3	60	-0.005	0.035
10413.6	60	0.025	0.005		10599.2	60	0.025	0.005
10419.2	60	0.025	-0.055		10604.7	60	0.025	0.065
10427.5	60	-0.005	0.035		10613.1	60	0.055	-0.025
10429.4	60	0.025	0.005		10615.0	60	0.025	0.005
10435.0	60	0.025	0.065		10617.7	60	0.025	-0.025
10443.3	60	0.055	-0.025		10626.1	60	-0.005	0.035
10446.1	60	0.085	0.005		10627.9	60	0.025	0.005
10448.9	60	0.025	0.005		10633.5	60	0.025	0.065
10454.4	60	0.025	-0.055		10641.9	60	0.055	-0.025
10462.8	60	-0.005	0.035		10643.7	60	0.025	0.005
10464.6	60	0.025	0.005		10646.5	60	0.025	-0.025
10470.2	60	0.025	0.065		10654.8	60	-0.005	0.035
10478.6	60	0.055	-0.025		10656.7	60	0.025	0.005
10481.3	60	0.085	0.005		10662.3	60	0.025	0.065
10484.1	60	0.025	0.005		10670.6	60	0.055	-0.025
10489.7	60	0.025	-0.055		10672.5	60	0.025	0.005
10498.0	60	-0.005	0.035		10675.3	60	0.025	-0.025
10499.9	60	0.025	0.005		10683.6	60	-0.005	0.035
10505.5	60	0.025	0.065		10685.5	60	0.025	0.005
10513.8	60	0.055	-0.025		10691.0	60	0.025	0.065
10516.6	60	0.085	0.005		10699.4	60	0.055	-0.025
10519.4	60	0.025	0.005		10701.2	60	0.025	0.005
10525.0	60	0.025	-0.055		10704.0	60	0.025	-0.025
10533.3	60	-0.005	0.035		10712.4	60	-0.005	0.035
10535.2	60	0.025	0.005		10714.2	60	0.025	0.005
10540.7	60	0.025	0.065		10719.8	60	0.025	0.065
10549.1	60	0.055	-0.025		10728.1	60	0.055	-0.025
10551.9	60	0.085	0.005		10730.0	60	0.025	0.005
10554.6	60	0.025	0.005		10732.8	60	0.025	-0.025

10741.1	60	-0.005	0.035		10910.0	60	0.025	0.005
10743.0	60	0.025	0.005		10912.8	60	0.025	0.035
10748.6	60	0.025	0.065		10921.1	60	0.055	-0.025
10756.9	60	0.055	-0.025		10923.0	60	0.025	0.005
10758.8	60	0.025	0.005		10925.8	60	0.025	-0.025
10761.5	60	0.025	-0.025		10931.3	60	-0.005	0.035
10769.9	60	-0.005	0.035		10933.2	60	0.025	0.005
10771.7	60	0.025	0.005		10936.0	60	0.025	0.035
10777.3	60	0.025	0.065		10944.3	60	0.055	-0.025
10785.7	60	0.055	-0.025		10946.2	60	0.025	0.005
10787.5	60	0.025	0.005		10949.0	60	0.025	-0.025
10790.3	60	0.025	-0.025		10954.5	60	-0.005	0.035
10798.7	60	-0.005	0.035		10956.4	60	0.025	0.005
10800.5	60	0.025	0.005		10959.2	60	0.025	0.035
10806.1	60	0.025	0.065		10967.5	60	0.055	-0.025
10814.4	60	0.055	-0.025		10969.4	60	0.025	0.005
10816.3	60	0.025	0.005		10972.1	60	0.025	-0.025
10819.1	60	0.025	-0.025		10977.7	60	-0.005	0.035
10827.4	60	-0.005	0.035		10979.6	60	0.025	0.005
10829.3	60	0.025	0.005		10982.4	60	0.025	0.035
10834.8	60	0.025	0.065		10990.7	60	0.055	-0.025
10843.2	60	0.055	-0.025		10992.6	60	0.025	0.005
10845.0	60	0.025	0.005		10995.3	60	0.025	-0.025
10847.8	60	0.025	-0.025		11000.9	60	-0.005	0.035
10856.2	60	-0.005	0.035		11002.8	60	0.025	0.005
10858.0	60	0.025	0.005		11005.5	60	0.025	0.035
10863.6	60	0.025	0.065		11013.9	60	0.055	-0.025
10871.9	60	0.055	-0.025		11015.8	60	0.025	0.005
10873.8	60	0.025	0.005		11018.5	60	0.025	-0.025
10876.6	60	0.025	-0.025		11024.1	60	-0.005	0.035
10884.9	60	-0.005	0.035		11026.0	60	0.025	0.005
10886.8	60	0.025	0.005		11028.7	60	0.025	0.035
10889.6	60	0.025	0.035		11037.1	60	0.055	-0.025
10897.9	60	0.055	-0.025		11038.9	60	0.025	0.005
10899.8	60	0.025	0.005		11041.7	60	0.025	-0.025
10902.6	60	0.025	-0.025		11047.3	60	-0.005	0.035
10908.1	60	-0.005	0.035		11049.2	60	0.025	0.005

11051.9	60	0.025	0.035		11180.0	60	0.055	0.005
11057.5	60	0.055	0.005		11181.8	60	0.025	0.005
11059.4	60	0.025	0.005		11184.6	60	0.025	-0.025
11062.1	60	0.025	-0.025		11187.4	60	-0.005	0.005
11067.7	60	-0.005	0.035		11189.2	60	0.025	0.005
11069.6	60	0.025	0.005		11192.0	60	0.025	0.035
11072.3	60	0.025	0.035		11197.6	60	0.055	0.005
11077.9	60	0.055	0.005		11199.5	60	0.025	0.005
11079.8	60	0.025	0.005		11202.2	60	0.025	-0.025
11082.6	60	0.025	-0.025		11205.0	60	-0.005	0.005
11088.1	60	-0.005	0.035		11206.9	60	0.025	0.005
11090.0	60	0.025	0.005		11209.7	60	0.025	0.035
11092.8	60	0.025	0.035		11215.2	60	0.055	0.005
11098.3	60	0.055	0.005		11217.1	60	0.025	0.005
11100.2	60	0.025	0.005		11219.9	60	0.025	-0.025
11103.0	60	0.025	-0.025		11222.6	60	-0.005	0.005
11108.5	60	-0.005	0.035		11224.5	60	0.025	0.005
11110.4	60	0.025	0.005		11227.3	60	0.025	0.035
11113.2	60	0.025	0.035		11232.9	60	0.055	0.005
11118.7	60	0.055	0.005		11234.7	60	0.025	0.005
11120.6	60	0.025	0.005		11237.5	60	0.025	-0.025
11123.4	60	0.025	-0.025		11240.3	60	-0.005	0.005
11128.9	60	-0.005	0.035		11242.1	60	0.025	0.005
11130.8	60	0.025	0.005		11244.9	60	0.025	0.035
11133.6	60	0.025	0.035		11250.5	60	0.055	0.005
11139.1	60	0.055	0.005		11252.3	60	0.025	0.005
11141.0	60	0.025	0.005		11255.1	60	0.025	-0.025
11143.8	60	0.025	-0.025		11257.9	60	-0.005	0.005
11149.4	60	-0.005	0.035		11259.8	60	0.025	0.005
11151.2	60	0.025	0.005		11262.5	60	0.025	0.035
11154.0	60	0.025	0.035		11268.1	60	0.055	0.005
11159.6	60	0.055	0.005		11270.0	60	0.025	0.005
11161.4	60	0.025	0.005		11272.7	60	0.025	-0.025
11164.2	60	0.025	-0.025		11275.5	60	-0.005	0.005
11169.8	60	-0.005	0.035		11277.4	60	0.025	0.005
11171.6	60	0.025	0.005		11280.2	60	0.025	0.035
11174.4	60	0.025	0.035		11285.7	60	0.055	0.005

11287.6	60	0.025	0.005		11390.6	60	0.025	-0.025
11290.4	60	0.025	-0.025		11393.4	60	-0.005	0.005
11293.2	60	-0.005	0.005		11395.2	60	0.025	0.005
11295.0	60	0.025	0.005		11398.0	60	0.025	0.035
11297.8	60	0.025	0.035		11400.8	60	0.055	0.005
11303.4	60	0.055	0.005		11402.6	60	0.025	0.005
11305.2	60	0.025	0.005		11405.4	60	0.025	-0.025
11308.0	60	0.025	-0.025		11408.2	60	-0.005	0.005
11310.8	60	-0.005	0.005		11410.1	60	0.025	0.005
11312.6	60	0.025	0.005		11412.8	60	0.025	0.035
11315.4	60	0.025	0.035		11415.6	60	0.055	0.005
11321.0	60	0.055	0.005		11417.5	60	0.025	0.005
11322.8	60	0.025	0.005		11420.3	60	0.025	-0.025
11325.6	60	0.025	-0.025		11423.0	60	-0.005	0.005
11328.4	60	-0.005	0.005		11424.9	60	0.025	0.005
11330.3	60	0.025	0.005		11427.7	60	0.025	0.035
11333.1	60	0.025	0.035		11430.5	60	0.055	0.005
11338.6	60	0.055	0.005		11432.3	60	0.025	0.005
11340.5	60	0.025	0.005		11435.1	60	0.025	-0.025
11343.3	60	0.025	-0.025		11437.9	60	-0.005	0.005
11346.0	60	-0.005	0.005		11439.7	60	0.025	0.005
11347.9	60	0.025	0.005		11442.5	60	0.025	0.035
11350.7	60	0.025	0.035		11445.3	60	0.055	0.005
11356.2	60	0.055	0.005		11447.2	60	0.025	0.005
11358.1	60	0.025	0.005		11450.0	60	0.025	-0.025
11360.9	60	0.025	-0.025		11452.7	60	-0.005	0.005
11363.7	60	-0.005	0.005		11454.6	60	0.025	0.005
11365.5	60	0.025	0.005		11457.4	60	0.025	0.035
11368.3	60	0.025	0.035		11460.2	60	0.055	0.005
11371.1	60	0.055	0.005		11462.0	60	0.025	0.005
11372.9	60	0.025	0.005		11464.8	60	0.025	-0.025
11375.7	60	0.025	-0.025		11467.6	60	-0.005	0.005
11378.5	60	-0.005	0.005		11469.4	60	0.025	0.005
11380.4	60	0.025	0.005		11472.2	60	0.025	0.035
11383.2	60	0.025	0.035		11475.0	60	0.055	0.005
11385.9	60	0.055	0.005		11476.9	60	0.025	0.005
11387.8	60	0.025	0.005		11479.6	60	0.025	-0.025

11482.4	60	-0.005	0.005		11573.4	60	0.025	0.005
11484.3	60	0.025	0.005		11576.1	60	0.025	0.035
11487.1	60	0.025	0.035		11578.9	60	0.055	0.005
11489.8	60	0.055	0.005		11580.8	60	0.025	0.005
11491.7	60	0.025	0.005		11583.6	60	0.025	-0.025
11494.5	60	0.025	-0.025		11586.3	60	-0.005	0.005
11497.3	60	-0.005	0.005		11588.2	60	0.025	0.005
11499.1	60	0.025	0.005		11591.0	60	0.025	0.035
11501.9	60	0.025	0.035		11593.8	60	0.055	0.005
11504.7	60	0.055	0.005		11595.6	60	0.025	0.005
11506.6	60	0.025	0.005		11598.4	60	0.025	-0.025
11509.3	60	0.025	-0.025		11601.2	60	-0.005	0.005
11512.1	60	-0.005	0.005		11603.0	60	0.025	0.005
11514.0	60	0.025	0.005		11605.8	60	0.025	0.035
11516.8	60	0.025	0.035		11608.6	60	0.055	0.005
11519.5	60	0.055	0.005		11610.5	60	0.025	0.005
11521.4	60	0.025	0.005		11613.2	60	0.025	-0.025
11524.2	60	0.025	-0.025		11616.0	60	-0.005	0.005
11527.0	60	-0.005	0.005		11617.9	60	0.025	0.005
11528.8	60	0.025	0.005		11620.7	60	0.025	0.035
11531.6	60	0.025	0.035		11623.5	60	0.055	0.005
11534.4	60	0.055	0.005		11625.3	60	0.025	0.005
11536.2	60	0.025	0.005		11628.1	60	0.025	-0.025
11539.0	60	0.025	-0.025		11630.9	60	-0.005	0.005
11541.8	60	-0.005	0.005		11632.7	60	0.025	0.005
11543.7	60	0.025	0.005		11635.5	60	0.025	0.035
11546.4	60	0.025	0.035		11638.3	60	0.055	0.005
11549.2	60	0.055	0.005		11640.2	60	0.025	0.005
11551.1	60	0.025	0.005		11642.9	60	0.025	-0.025
11553.9	60	0.025	-0.025		11645.7	60	-0.005	0.005
11556.7	60	-0.005	0.005		11647.6	60	0.025	0.005
11558.5	60	0.025	0.005		11650.4	60	0.025	0.035
11561.3	60	0.025	0.035		11653.1	60	0.055	0.005
11564.1	60	0.055	0.005		11655.0	60	0.025	0.005
11565.9	60	0.025	0.005		11657.8	60	0.025	-0.025
11568.7	60	0.025	-0.025		11660.6	60	-0.005	0.005
11571.5	60	-0.005	0.005		11662.4	60	0.025	0.005

11665.2	60	0.025	0.035		11757.1	60	0.055	0.005
11668.0	60	0.055	0.005		11758.9	60	0.025	0.005
11669.8	60	0.025	0.005		11761.7	60	0.025	-0.025
11672.6	60	0.025	-0.025		11764.5	60	-0.005	0.005
11675.4	60	-0.005	0.005		11766.3	60	0.025	0.005
11677.3	60	0.025	0.005		11769.1	60	0.025	0.035
11680.0	60	0.025	0.035		11771.9	60	0.055	0.005
11682.8	60	0.055	0.005		11773.8	60	0.025	0.005
11684.7	60	0.025	0.005		11776.5	60	0.025	-0.025
11687.5	60	0.025	-0.025		11779.3	60	-0.005	0.005
11690.3	60	-0.005	0.005		11781.2	60	0.025	0.005
11692.1	60	0.025	0.005		11784.0	60	0.025	0.035
11694.9	60	0.025	0.035		11786.7	60	0.055	0.005
11697.7	60	0.055	0.005		11788.6	60	0.025	0.005
11699.5	60	0.025	0.005		11791.4	60	0.025	-0.025
11702.3	60	0.025	-0.025		11794.2	60	-0.005	0.005
11705.1	60	-0.005	0.005		11796.0	60	0.025	0.005
11707.0	60	0.025	0.005		11798.8	60	0.025	0.035
11709.7	60	0.025	0.035		11801.6	60	0.055	0.005
11712.5	60	0.055	0.005		11803.4	60	0.025	0.005
11714.4	60	0.025	0.005		11806.2	60	0.025	-0.025
11717.2	60	0.025	-0.025		11809.0	60	-0.005	0.005
11719.9	60	-0.005	0.005		11810.9	60	0.025	0.005
11721.8	60	0.025	0.005		11813.6	60	0.025	0.035
11724.6	60	0.025	0.035		11816.4	60	0.055	0.005
11727.4	60	0.055	0.005		11818.3	60	0.025	0.005
11729.2	60	0.025	0.005		11821.1	60	0.025	-0.025
11732.0	60	0.025	-0.025		11823.9	60	-0.005	0.005
11734.8	60	-0.005	0.005		11825.7	60	0.025	0.005
11736.6	60	0.025	0.005		11828.5	60	0.025	0.035
11739.4	60	0.025	0.035		11831.3	60	0.055	0.005
11742.2	60	0.055	0.005		11833.1	60	0.025	0.005
11744.1	60	0.025	0.005		11835.9	60	0.025	-0.025
11746.8	60	0.025	-0.025		11838.7	60	-0.005	0.005
11749.6	60	-0.005	0.005		11840.6	60	0.025	0.005
11751.5	60	0.025	0.005		11843.3	60	0.025	0.035
11754.3	60	0.025	0.035		11846.1	60	0.055	0.005

11848.0	60	0.025	0.005	11953.7	60	0.025	0.005
11850.8	60	0.025	-0.025	11956.5	60	-0.005	0.005
11853.5	60	-0.005	0.005	11958.4	60	0.025	0.005
11855.4	60	0.025	0.005	11961.2	60	0.025	0.035
11858.2	60	0.025	0.035	11963.9	60	0.055	0.005
11861.0	60	0.055	0.005	11965.8	60	0.025	0.005
11862.8	60	0.025	0.005	11971.4	60	0.025	0.005
11865.6	60	0.025	-0.025	11974.2	60	-0.005	0.005
11868.4	60	-0.005	0.005	11976.0	60	0.025	0.005
11870.2	60	0.025	0.005	11978.8	60	0.025	0.035
11873.0	60	0.025	0.035	11981.6	60	0.055	0.005
11875.8	60	0.055	0.005	11983.4	60	0.025	0.005
11877.7	60	0.025	0.005	11989.0	60	0.025	0.005
11883.2	60	0.025	0.005	11991.8	60	-0.005	0.005
11886.0	60	-0.005	0.005	11993.6	60	0.025	0.005
11887.9	60	0.025	0.005	11996.4	60	0.025	0.035
11890.7	60	0.025	0.035	11999.2	60	0.055	0.005
11893.4	60	0.055	0.005	12001.1	60	0.025	0.005
11895.3	60	0.025	0.005	12006.6	60	0.025	0.005
11900.9	60	0.025	0.005	12009.4	60	-0.005	0.005
11903.6	60	-0.005	0.005	12011.3	60	0.025	0.005
11905.5	60	0.025	0.005	12014.0	60	0.025	0.035
11908.3	60	0.025	0.035	12016.8	60	0.055	0.005
11911.1	60	0.055	0.005	12018.7	60	0.025	0.005
11912.9	60	0.025	0.005	12024.3	60	0.025	0.005
11918.5	60	0.025	0.005	12027.0	60	-0.005	0.005
11921.3	60	-0.005	0.005	12028.9	60	0.025	0.005
11923.1	60	0.025	0.005	12031.7	60	0.025	0.035
11925.9	60	0.025	0.035	12034.5	60	0.055	0.005
11928.7	60	0.055	0.005	12036.3	60	0.025	0.005
11930.5	60	0.025	0.005	12041.9	60	0.025	0.005
11936.1	60	0.025	0.005	12044.7	60	-0.005	0.005
11938.9	60	-0.005	0.005	12046.5	60	0.025	0.005
11940.8	60	0.025	0.005	12049.3	60	0.025	0.035
11943.5	60	0.025	0.035	12052.1	60	0.055	0.005
11946.3	60	0.055	0.005	12053.9	60	0.025	0.005
11948.2	60	0.025	0.005	12059.5	60	0.025	0.005

12062.3	60	-0.005	0.005		12169.9	60	0.025	0.005
12064.1	60	0.025	0.005		12172.7	60	0.025	0.035
12066.9	60	0.025	0.035		12175.5	60	0.055	0.005
12069.7	60	0.055	0.005		12177.3	60	0.025	0.005
12071.6	60	0.025	0.005		12182.9	60	0.025	0.005
12077.1	60	0.025	0.005		12185.7	60	-0.005	0.005
12079.9	60	-0.005	0.005		12187.5	60	0.025	0.005
12081.8	60	0.025	0.005		12190.3	60	0.025	0.035
12084.6	60	0.025	0.035		12193.1	60	0.055	0.005
12087.3	60	0.055	0.005		12195.0	60	0.025	0.005
12089.2	60	0.025	0.005		12200.5	60	0.025	0.005
12094.8	60	0.025	0.005		12203.3	60	-0.005	0.005
12097.5	60	-0.005	0.005		12205.2	60	0.025	0.005
12099.4	60	0.025	0.005		12208.0	60	0.025	0.035
12102.2	60	0.025	0.035		12210.7	60	0.055	0.005
12105.0	60	0.055	0.005		12212.6	60	0.025	0.005
12106.8	60	0.025	0.005		12218.2	60	0.025	0.005
12112.4	60	0.025	0.005		12220.9	60	-0.005	0.005
12115.2	60	-0.005	0.005		12222.8	60	0.025	0.005
12117.0	60	0.025	0.005		12225.6	60	0.025	0.035
12119.8	60	0.025	0.035		12228.4	60	0.055	0.005
12122.6	60	0.055	0.005		12230.2	60	0.025	0.005
12124.5	60	0.025	0.005		12235.8	60	0.025	0.005
12130.0	60	0.025	0.005		12238.6	60	-0.005	0.005
12132.8	60	-0.005	0.005		12240.4	60	0.025	0.005
12134.7	60	0.025	0.005		12243.2	60	0.025	0.035
12137.4	60	0.025	0.035		12246.0	60	0.055	0.005
12140.2	60	0.055	0.005		12247.8	60	0.025	0.005
12142.1	60	0.025	0.005		12253.4	60	0.025	0.005
12147.6	60	0.025	0.005		12256.2	60	-0.005	0.005
12150.4	60	-0.005	0.005		12258.1	60	0.025	0.005
12152.3	60	0.025	0.005		12260.8	60	0.025	0.035
12155.1	60	0.025	0.035		12263.6	60	0.055	0.005
12157.9	60	0.055	0.005		12265.5	60	0.025	0.005
12159.7	60	0.025	0.005		12271.0	60	0.025	0.005
12165.3	60	0.025	0.005		12273.8	60	-0.005	0.005
12168.1	60	-0.005	0.005		12275.7	60	0.025	0.005

12278.5	60	0.025	0.035		12384.2	60	0.025	0.035
12281.2	60	0.055	0.005		12387.0	60	0.055	0.005
12283.1	60	0.025	0.005		12388.9	60	0.025	0.005
12288.7	60	0.025	0.005		12394.4	60	0.025	0.005
12291.5	60	-0.005	0.005		12397.2	60	-0.005	0.005
12293.3	60	0.025	0.005		12399.1	60	0.025	0.005
12296.1	60	0.025	0.035		12401.9	60	0.025	0.035
12298.9	60	0.055	0.005		12404.6	60	0.055	0.005
12300.7	60	0.025	0.005		12406.5	60	0.025	0.005
12306.3	60	0.025	0.005		12412.1	60	0.025	0.005
12309.1	60	-0.005	0.005		12414.8	60	-0.005	0.005
12310.9	60	0.025	0.005		12416.7	60	0.025	0.005
12313.7	60	0.025	0.035		12419.5	60	0.025	0.035
12316.5	60	0.055	0.005		12422.3	60	0.055	0.005
12318.4	60	0.025	0.005		12424.1	60	0.025	0.005
12323.9	60	0.025	0.005		12429.7	60	0.025	0.005
12326.7	60	-0.005	0.005		12432.5	60	-0.005	0.005
12328.6	60	0.025	0.005		12434.3	60	0.025	0.005
12331.3	60	0.025	0.035		12437.1	60	0.025	0.035
12334.1	60	0.055	0.005		12439.9	60	0.055	0.005
12336.0	60	0.025	0.005		12441.8	60	0.025	0.005
12341.6	60	0.025	0.005		12447.3	60	0.025	0.005
12344.3	60	-0.005	0.005		12450.1	60	-0.005	0.005
12346.2	60	0.025	0.005		12452.0	60	0.025	0.005
12349.0	60	0.025	0.035		12454.7	60	0.025	0.035
12351.8	60	0.055	0.005		12457.5	60	0.055	0.005
12353.6	60	0.025	0.005		12459.4	60	0.025	0.005
12359.2	60	0.025	0.005		12464.9	60	0.025	0.005
12362.0	60	-0.005	0.005		12467.7	60	-0.005	0.005
12363.8	60	0.025	0.005		12469.6	60	0.025	0.005
12366.6	60	0.025	0.035		12475.2	60	0.025	0.005
12369.4	60	0.055	0.005		12477.9	60	0.055	0.005
12371.2	60	0.025	0.005		12479.8	60	0.025	0.005
12376.8	60	0.025	0.005		12485.4	60	0.025	0.005
12379.6	60	-0.005	0.005		12488.1	60	-0.005	0.005
12381.4	60	0.025	0.005		12490.0	60	0.025	0.005

Annex 10 – Appendix 4

Test equipment tolerances

Table B.1
Instrumentation accuracy

Parameter	*Control accuracy*	*Instrumentation accuracy at full scale*
Tyre forces ~~**and torque**~~	**Fz: ±50 N or 1% using filtered values whichever is greater.** **Fy: ±100 N or 5% using filtered values whichever is greater, for the difference between input peaks and actually generated peaks.** **Fx: ± 100 N or 5% using filtered values whichever is greater, for the difference between input peaks and actually generated peaks.** **My: ± 40 Nm or 5% using filtered values whichever is greater, for the difference between input peaks and actually generated peaks.**	**Fz: ±1%** **Fy: ±1%** **Fx: ±1%** **My: ±1%**
Inflation pressure	**± 3 kPa**	**± 3 kPa**
Mass scale	~~**± 2 g**~~ **not applicable**	**± 2 g**
Test duration	**For the test time durations, the total time of an actual test shall not differ more than ±5% from the total input time, 68.83h (247,800s). The interval of measurement shall be** ~~**minimum**~~ **more than 1Hz.**	**±0.02 s for the time increments**
Camber angle	**0 +/- 0.1 degrees**	**0 +/-0.1 degrees**
Thermometer	**±5 °C**	**±0.5 °C**
Speed	**±2 km/h**	**±0.1%**

Annex 10 – Appendix 5

Replacement of sandpaper surface

Sandpaper surface shall be replaced ~~either~~ when~~:~~ it ~~could~~ does not meet the specifications described in 2.3.2.3.; ~~or~~

Sandpaper surface should be replaced either when:

Running distance reached 20,000 km for 2 positions drum in case of 3m, 40,000 km for 1 position drum in case of 3 m,

In case of drum diameter is not 3 m, the following formula applies:

Road surface replacement distance (km) = Road surface replacement distance (standard value) x Drum diameter owned by each testing institution (m) / Standard drum diameter (m)

Where:

Road surface replacement distance (~~reference~~ standard value) = 20000 km;

Standard drum diameter = 3 m.

Annex 10 – Appendix 6

Example of a test report for indoor drum test method

The test report shall include the following information.

Test report number:		Test date:	~	
Test machine identification:				
Drum circumference (m),			**Beginning of test**	**End of test**
Test cycle (2 positions /1 position)		MPD of test surface (mm):		
3<s>rd body</s>Powder	<s>Mineral or Clay</s> **Talc or Silica**	**Micro roughness of test surface (mm)**		

Type of test tyre		*Reference tyre*	*Candidate tyre*
Tyre class			
Brand			
Pattern/trade description		SRTT…	
Tyre size designation			
Service description			
Test load (N)			
Test inflation pressure (kPa)			
Tyre identification			
3PMSF marking (Y/N)			
Rim width			
Inflation pressure (kPa)	**Beginning of test**		
	End of test		
Mass of tyre (g)	**Before test**		
	After test		
Test distance (km)			
Abrasion rate (mg/km)			
<s>Normalized a</s>**A**brasion <s>level rate</s> (mg/km/t)			
Abrasion index		✕	
Average ambient temp. (°C)			
RMS of G(x)			
RMS of G(y)			
RMS of G(x,y)			
Average of Fz			
Amount of powder sprayed relative to reference tyre		✕	
Remarks			

"

II. Justification

1.   In line with the work ongoing in the Task Force on Tyre Abrasion (TFTA) as presented in document GRBP-78-26, TFTA is proposing to introduce a new methodology to measure tyre abrasion of C1 tyres in UN Regulation No. 117. For this reason, two methods are proposed: a vehicle test method on public open roads and an indoor drum test method. ~~The investigation of a possible correlation between the two methods is still ongoing in TFTA, which explain the […] in some parts of the proposed amendmen~~t. No limit for tyre abrasion is proposed in the current text as a market assessment is required to define any performance level.

2.   The scope is enlarged in paragraph 1.1. ~~but the additions remain in […] as~~ **even if**, on one hand, there is a requirement for measuring the tyre abrasion of C1 tyres; however, on the other hand, there is still no requirement for compliance with any threshold.

3.   Nevertheless, paragraph 1.3. specify the applicable C1 tyres under the scope of tyre abrasion measurement: it covers all C1 tyres except for tyres with nominal rim ~~>~~ ≤ 13 and ice grip tyres. The latter are expected to have different use and behaviour and thus are not considered in the current proposal.

4.   Paragraph 2.7. was missing, following the introduction of the previous amendments to the UN Regulation concerning adhesion on wet surfaces of tyres in worn state.

5.   As tyre abrasion is expressed as an index of a candidate tyre compared to a reference tyre, dedicated to the abrasion, then the reference to the American Society for Testing and Materials (ASTM) standards needs to be included for both "summer" (SRTT17S) and "winter" (SRTT17W) reference tyres.

6.   The abrasion performance is evaluated in three units: mass loss per distance normalised to the load index of the tyre (mg/km/t), mass loss per distance (mg/km), and index of abrasion of the candidate tyre compared to the reference tyre (-).

7.   Several references to tyre abrasion shall be introduced in the Regulation in paragraph 3.2.1. and when limits will be defined in paragraphs 3.1.1. and 3.1.1.1.

8.   As explained, the introduction of the tyre abrasion in the Regulation is a two steps approach: implementation of the test methods for C1 tyres to introduce, at a later stage, limits to comply with (ongoing work of TFTA). In any case, the proposal is to introduce the tyre abrasion measurement with a phase-in period in voluntary basis till ~~[~~6 July 202**6** ~~5]~~, and as mandatory from ~~[~~7 July 202**6** ~~5]~~, **for one tyre of the type** for new types of tyres approved according to this Regulation (paragraphs 5.7 to 5.9).

9.   The abrasion results **and method applied** shall then be included in the certificate template.

10.   Proposal to introduce new Annex 10 with description of the measurement (test conditions and methods and test report): for vehicle test method on public open roads method in appendices 1 and 2 and for indoor drum test method in appendices 3 to 6, as previously described in GRBP-78-26 with conclusions of open items ~~except for remaining square brackets~~.

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