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**Working Party on Noise and Tyres**

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Item 5 (b) of the provisional agenda
**Tyres: Tyre Abrasion**

# Proposal for a new UN Regulation on the uniform provisions concerning the approval of tyres with regard to abrasion performance

**Submitted by the Task Force Tyre Abrasion (TF TA)\***

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# UN Regulation No. [XXX] on uniform provisions concerning the approval of tyres with regard to abrasion performance

# Contents

# 1. Scope

1.1. This Regulation applies to new pneumatic tyres[*] of class C1 with regard to their abrasion performance.

This Regulation applies only to tyres that conform to Regulation No. 117.

1.2. This Regulation does not apply (and approvals to this Regulation shall not be granted) to the following tyres:

1.2.1. Tyres designed as temporary-use spare tyres and marked "Temporary use only";

1.2.2. Tyres having a nominal rim diameter code $\leq 13$ (or $\leq 330$ mm) or $\geq 25$ (or $\geq 635$ mm);

1.2.3. Tyres designed for competition;

1.2.4. Tyres intended to be fitted to road vehicles of categories other than M, N and O;[1]

1.2.5. Ice grip tyres;

1.2.6. Tyres fitted with additional devices to improve traction properties (e.g. studded tyres);

1.2.7. Tyres with a speed category less than 120 km/h (speed category symbol L);

1.2.8. Tyres designed only to be fitted to vehicles registered for the first time before 1 October 2000;

1.2.9. Professional off-road tyres;

1.2.10. [Road legal race tyres;]

1.2.11. [Tyres for use in severe snow conditions with a speed category less than or equal to 160 km/h (speed category symbol Q).]

# 2. Definitions

For the purpose of this Regulation, in addition to the definitions contained in UN Regulation No. 30, the following definitions apply:

2.1. "*Type of tyre*" means tyres which do not differ in such essential characteristics as:

(a) The manufacturer's name;

(b) The tyre class (see paragraph 2.5. below);

(c) The tyre structure;

(d) The category of use: normal tyre, snow tyre and special use tyre;

[(e) Whether tyre for use in severe snow conditions or not;]

(f) The tread pattern (see paragraph 3.2.1. of this Regulation).

2.2. "*Manufacturer*" means the person or body who is responsible to the Type Approval Authority (TAA) for all aspects of the type-approval and for ensuring the conformity of production.

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[*] For the purpose of this Regulation "tyres" means "pneumatic tyres".
[1] As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3).

2.3.  "*Brand name/trademark*" means the identification of the brand or trademark as defined by the tyre manufacturer and marked on the sidewall(s) of the tyre. The brand name/trademark may be the same as that of the manufacturer.

2.4.  "*Trade description/commercial name*" means an identification of a range of tyres as given by the tyre manufacturer. It may coincide with the brand name/trademark.

2.5.  "*Tyre class*" means one of the following groupings:

2.5.1.  "*Class C1 tyres*" means tyres conforming to Regulation No. 30;

2.6.  "*Representative tyre size*" means the tyre size which is submitted to the test described in Annex 3 to this Regulation to assess the conformity for the type approval of the type of tyre.

2.7.  "*Temporary-use spare tyre*" means a tyre different from a tyre intended to be fitted to any vehicle for normal driving conditions; but intended only for temporary use under restricted driving conditions.

2.8.  "*Tyre designed for competition*" means a tyre intended to be fitted to vehicles involved in motor sport competition and not intended for non-competitive on-road use.

2.9.  ["*Road legal race tyre*" means a tyre approved for use on public roads but primarily designed for track use and/or competition.]

2.10.  "*Normal tyre*" means a tyre intended for normal on-road use.

2.11.  "*Snow tyre*" means a tyre whose tread pattern, tread compound or construction is primarily designed to achieve in mud and/or snow conditions a performance better than that of a normal tyre with regard to its ability to initiate and control vehicle motion.

2.11.1.  "*Tyre for use in severe snow conditions*" means a snow tyre or a special use tyre whose tread pattern, tread compound or construction is specifically designed to be used in severe snow conditions and that conforms to Regulation No. 117.

2.11.1.1.  "*Ice grip tyre*" means a class C1 snow tyre that is classified as tyre for use in severe snow conditions additionally designed to be used on road surfaces covered with ice and conforming to Regulation No. 117.

2.12.  "*Special use tyre*" means a tyre intended for mixed use both on- and off-road or for other special duty. These tyres are primarily designed to initiate and maintain the vehicle in motion in off-road conditions.

2.12.1.  "*Professional off-road tyre*" means a special use tyre primarily used for service in severe off-road conditions.

2.13.  "*Reinforced tyre*" or "*extra load tyre*" of class C1 means a tyre designed to carry more load at a higher inflation pressure than the load carried by the corresponding standard version tyre at the standard inflation pressure as specified in ISO 4000-1:2024.[2]

2.14.  "*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 – 24 for the size 225/45R17 94V and referred to as "SRTT17S";

(b)  F3675 – 24 for the size 225/45R17 94H and referred to as "SRTT17W".

2.15.  "*Candidate tyre*" means a tyre, representative of the type that is submitted for approval in accordance with this Regulation and whose performance is evaluated relative to that of a reference tyre.

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[2]  Class C1 tyres correspond to "passenger car tyres" in ISO 4000-1:2024.

2.16.   "*Reference tyre*" means a Standard Reference Test Tyre that is used as a reference in an evaluation programme.

2.17.   "*Test tyre*" means a candidate tyre or a reference tyre.

2.18.   "*Test cycle*" means a driving programme of a test tyre on the drum defined by the application of a series of longitudinal and lateral forces.

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

2.20.   "*Abrasion level*" means the abrasion rate normalized to the load on the tyre, and expressed in mg/(km·t).

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

2.22.   "*Approval reference number*" means a six- to eight-digit number concatenating:
- the two digits (with a leading zero where applicable, "00" indicating that the approval was granted in accordance with original version of a regulation) that indicate the series of amendments applied to the approval pursuant to Schedule 4, paragraph 3, Section 2(a) of the 1958 Agreement and
- the four to six-digit sequential number (with leading zeros in case the sequential number is less than 1000) pursuant to Schedule 4, paragraph 3, Section 3 of the 1958 Agreement, both as contained within the approval number assigned by the Contracting Party pursuant to paragraph 5.2.

# 3.   Application for approval

3.1.   The application for approval of a type of tyre with regard to this Regulation shall be submitted by the tyre manufacturer or by its duly accredited representative. It shall specify:

3.1.1.   Manufacturer's name and address;

3.1.2.   If applicable, name and address of manufacturer's representative;

3.1.3.   Tyre class (see paragraph 2.5. of this Regulation);

3.1.4.   Category of use (normal, snow, or special use);

[3.1.4.1.   Whether or not the tyre is for use in severe snow conditions.]

3.1.5.   Tyre structure;

3.1.6.   Brand name(s)/trademark(s), trade description(s)/commercial name(s);

3.1.7.   A list of tyre size designations covered by this application and specifying for each brand name/trademark and/or each trade description/commercial name the applicable tyre size designations and service descriptions [, adding whether "reinforced" (or "extra load") or not, and whether or not the tyre is for use in severe snow conditions].

3.2.   The application for approval shall be accompanied by:

3.2.1.   Details of the major features, with respect to the effects on the abrasion performance 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;

3.2.2. Drawings or photographs of the tyre sidewall, showing the approval marks referred to in paragraph 4., shall be submitted once the production has been established, but no later than one year after the date of granting of type approval;

3.3. At the request of the Type Approval Authority, the applicant shall submit samples of tyres for test or copies of test reports from the Technical Services, communicated as given in paragraph 11. of this Regulation.

3.4. With regard to the application, testing may be confined to a representative tyre size of the type of tyre, at the discretion of the Type Approval Authority.

# 4.      Markings

4.1. All tyres constituting the type of tyre shall be marked as prescribed by Regulations No. 30 and No. 117.

4.2. In particular, tyres shall bear:[3]

4.2.1. The manufacturer's name or the brand name/trademark;

4.2.2. The trade description/commercial name (see paragraph 2.4. of this Regulation). However, the trade description is not required when it coincides with the brand name/trademark;

4.2.3. The tyre size designation;

4.2.4 The inscription "REINFORCED" (or alternatively "EXTRA LOAD") if the tyre is classified as reinforced;

4.2.5. The "Alpine Symbol" ("3-peak-mountain with snowflake" conforming to the pictogram described in Annex 7, Appendix 1 to Regulation No. 117 from now on referred to as "3PMSF") if the snow tyre or the special use tyre is classified as tyre for use in severe snow conditions;

4.2.6. The inscription "ET" and/or "POR" if the tyre is classified in the category of use "special". In addition, they may also bear the inscription "M+S" or "M.S" or "M&S".

ET means Extra Tread, and POR means Professional Off-Road.

[4.2.7. The inscription "[RLR]" if the tyre is classified as a road legal race tyre.]

4.3. Every tyre conforming to the type of tyre approved under this Regulation shall be marked on at least one of its sidewalls conspicuously with an international approval mark.

4.3.1. The approval mark shall be situated in the lower area of the tyre on at least one of its sidewalls. However, in the case of tyres identified by the tyre to rim fitment configuration symbol "A" or "U", the marking may be located anywhere on the outside sidewall of the tyre.

4.3.2. The international approval mark shall consist of the following:

4.3.2.1. A circle surrounding the letter "E" followed by the distinguishing number[4] of the country which has granted approval and

4.3.2.2. The approval reference number and

4.3.2.3. One of the suffixes listed below:

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[3] Some of these requirements may be specified separately in Regulation No. 30.

[4] The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3).

| A1 | Stage 1 |
|----|---------|
| A2 | Stage 2 |

4.3.3.  The approval reference number and the suffix shall be placed close to the circle prescribed in paragraph 4.3.2.1. and with respect to the letter "E" either above or below or to the left or to the right of that circle and shall face in the same direction as the "E".

4.3.4.  If the tyre conforms to type approvals under one or more other Regulations annexed to the Agreement in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.3.2.1. does not need to be repeated. In such a case the additional numbers and symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed adjacent to the symbol prescribed in paragraph 4.3.2.1.

4.3.5.  Notwithstanding paragraph 4.3.2., in case the approval of a tyre pursuant to this Regulation has been granted by the same Type Approval Authority than that granting the approval pursuant to Regulation No. 30, the approval mark pursuant to Regulation No. 30 can be combined with an indication of the applicable series of amendments to which the tyre was approved pursuant to Regulation No. [XXX] in the form of 2 digits (for example "00" indicating that the Regulation No. [XXX] approval was granted following the original version) and the suffixes "A1" or "A2" using the addition sign "+", as described in Annex 2 - Appendix 3 to this Regulation, for example "0236378 + 00A1".

4.3.6.  Notwithstanding paragraph 4.3.2., in case the approval of a tyre pursuant to this Regulation has been granted by the same Type Approval Authority than that granting the approval pursuant to Regulation No. 117, the approval mark pursuant to Regulation No. 117 can be combined with an indication of the applicable series of amendments to which the tyre was approved pursuant to Regulation No. [XXX] in the form of 2 digits (for example "00" indicating that the Regulation No. [XXX] approval was granted following the original version) and the suffixes "A1" or "A2" using the addition sign "+", as described in Annex 2 - Appendix 3 to this Regulation, for example "0401523 S2W2R3B + 00A2".

4.3.7.  Annex 2 to this Regulation gives examples of arrangements of approval marks.

4.4.  The markings specified in paragraph 4.2. and the approval mark specified in paragraph 4.3. of this Regulation shall be clearly legible, indelible and raised above or sunk below the tyre surface.

# 5.     Approval

5.1.  If the candidate tyre submitted for approval pursuant to this Regulation meets the requirements of paragraphs 6. and 7. below, approval of that type of tyre shall be granted.

5.2.  An approval number according to Schedule 4 to the Revision 3 of the 1958 Agreement shall be assigned to the type of tyre approved. The same Contracting Party may not assign the same number to another type of tyre.

5.3.  Notice of approval or extension of approval or refusal of approval of a type of tyre pursuant to this Regulation shall be communicated to the Parties to the Agreement which apply this Regulation by means of a form conforming to the model in Annex 1 to the Regulation.

5.4.  Contracting Parties applying this Regulation shall continue to accept test reports that were issued in accordance with Annex 10 to Regulation No. 117, before the entry into force of Supplement [4] to the 04 Series of Amendments to Regulation No. 117.

## 6. Requirements

6.1.    Abrasion performance limits, as measured by [one of] the method[s] described in Annex 3 to this Regulation.

6.1.1.    The abrasion index of the candidate tyre shall not exceed the values given below:

| Category of use | Abrasion index (AICT) |
|---|---|
| Normal tyre | [1.00] |
| Snow tyre | [1.00] |
| Special use tyre | [Not defined] |

## 7. Modifications of the type of tyre and extension of approval

7.1.    Every modification of the type of tyre, which may influence the performance characteristics approved in accordance with this Regulation, shall be notified to the Type Approval Authority which approved the type of tyre. That Authority may either:

7.1.1.    Consider that the modifications are unlikely to have any appreciable adverse effect on the performance characteristics approved and that the tyre will comply with the requirements of this Regulation; or

7.1.2.    Require further samples to be submitted for test or further test reports from the designated Technical Service.

7.2.    Confirmation or refusal of approval, specifying the modifications, shall be communicated by the procedure given in paragraph 5.3. of this Regulation to the Parties to the Agreement which apply this Regulation.

7.3.    The Type Approval Authority granting the extension of approval shall assign a series number for such an extension which shall be shown on the communication form.

## 8. Conformity of production

The conformity of production procedures shall comply with those set out in the 1958 Agreement, Schedule 1 (E/ECE/324-E/ECE/TRANS/505/Rev.3) with the following requirements:

8.1.    Any tyre approved under this Regulation shall be so manufactured as to conform to the performance characteristics of the type of tyre approved and satisfy the requirements of paragraph 6. above;

8.2.    The authority which has granted type approval may at any time verify the conformity control methods applied by the manufacturer. In general, the conformity control methods should take into consideration the production volumes of the type of tyre at each manufacturing facility. The normal frequency of these verifications shall be at least once every two years.

8.3.    Verification tests shall be carried out on random samples of tyres bearing the approval mark required by this Regulation taken from the series production. Because the test procedure involves testing a number of tyres at the same time, the set shall be considered as being one unit for the purposes of calculating the number of tyres to be tested. The Type Approval Authority shall satisfy itself that all tyres falling within an approved type comply with the approval requirement.

8.3.1. The verification tests shall be carried out using the same testing method as that adopted for original approval.

[8.3.2. Verification tests shall apply the same abrasion margin ($A_{margin}$) value as that applied for the original approval.]

8.4. Production shall be deemed to conform to the requirements of this Regulation if the abrasion index complies with the limits prescribed in paragraph 6.1. of this Regulation, with an additional allowance of [0.20] for considering possible mass production variations.

## 9.     Penalties for non-conformity of production

9.1. The approval granted in respect of a type of tyre pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8. above are not complied with, or if any tyre of the type of tyre exceeds the limits given in paragraph 8.4.

9.2. If a Party to the Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith notify the other Contracting Parties applying this Regulation by means of a copy of the approval form conforming to the model in Annex 1 to this Regulation.

## 10.     Production definitively discontinued

If the holder of an approval completely ceases to manufacture a type of tyre approved in accordance with this Regulation, it shall so inform the Type Approval Authority, which granted the approval. Upon receiving the relevant communication that Authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

## 11.     Names and addresses of Technical Services responsible for conducting approval tests of Type Approval Authorities

11.1. The Contracting Parties to the 1958 Agreement which apply this Regulation shall communicate to the United Nations Secretariat, the names and addresses of the Technical Services responsible for conducting approval tests and, where applicable, of the approved test laboratories and of the Type Approval Authorities which grant approval and to which forms certifying approval or extension of approval or refusal of approval or withdrawal of approval, or production definitively discontinued, issued in other countries, are to be sent.

11.2. The Contracting Parties to the 1958 Agreement which apply this Regulation may designate laboratories of tyre manufacturers as approved test laboratories.

11.3. Where a Contracting Party to the 1958 Agreement applies paragraph 11.2. above, it may, if it so desires, be represented at the tests by one or more persons of its choice.

## 12.     Introductory provisions

12.1. As from the official date of entry into force of this Regulation, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type approvals pursuant to this Regulation.

12.2. As from [1 January 2033], Contracting Parties applying this Regulation shall not be obliged to accept type approvals of tyres, first issued after [31 December 2032], pursuant to this Regulation if the requirements Stage 2 are not complied with.

12.3. Until [31 December 2034], Contracting Parties applying this Regulation shall continue to grant extensions to type approvals, first issued before [1 January 2033], pursuant to this Regulation, if the requirements of Stage 2 are not complied with.

12.4. Until the dates given below, no Contracting Parties applying this Regulation shall mandatorily require the approval pursuant to this Regulation of new types of class C1 tyres.

| Stage 1 | [30 June 2028] |
|---------|----------------|
| Stage 2 | [31 December 2032] |

12.5. Until the dates given below, no Contracting Parties applying this Regulation shall mandatorily require the approval pursuant to this Regulation of all types of class C1 tyres.

| Stage 1 | [30 June 2030] |
|---------|----------------|
| Stage 2 | [31 December 2034] |

12.6. Until [30 June 2032], Contracting Parties applying this Regulation and mandatorily requiring the approval pursuant to this Regulation of all types of class C1 tyres shall continue to allow fitting on a vehicle in use of new class C1 tyres manufactured prior to [30 June 2030] and not type approved pursuant to this Regulation.

## Annex 1

## Communication

(Maximum format: A4 (210 x 297 mm))

E 1 ...[1]    Issued by:    Name of administration:

.....................................

.....................................

.....................................

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

of a type of tyre pursuant to Regulation No. [XXX]

Approval No.[3]...... ............................................................ Suffix[4]: . ..................................

1.    Manufacturer's name and address: ................................................................

2.    If applicable, name and address of manufacturer's representative: .............................

3.    "Tyre class" of the type of tyre: ..................................................................

4.    "Category of use" of the type of tyre: ...........................................................

[4.1.    Tyre for use in severe snow conditions (Yes/No)[2]]

5.    Tyre structure: ......................................................................................

6.    Type of tyre designation:

6.1.    Brand name(s)/trademark(s) of the type of tyre

6.2.    Trade description(s)/commercial name(s) of the type of tyre:

7.    Technical Service and, where applicable, test laboratory approved for purposes of approval or of verification of conformity tests: ...........................................................

8.    Tyre abrasion index of the representative tyre size, paragraph 2.6. of this Regulation, as per the test report in Appendix 2 or 6 to Annex 3: …………… using the vehicle test method on public open roads [2] or the indoor drum method[2]

9.    Number of report issued by the Technical Service: ...............................................

10.    Date of report issued by that Service: ...........................................................

11.    Reason(s) of extension (if applicable): ...........................................................

12.    Any remarks:........................................................................................

13.    Place: ................................................................................................

14.    Date: .................................................................................................

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[1]  Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

[2]  Strike out what does not apply.

[3]  According to Schedule 4 to Revision 3 of the 1958 Agreement.

[4]  According to paragraph 4.3.2.3. of this Regulation

15.     Signature: ..............................................................................................

16.     Annexed to this communication are: ..............................................................

16.1.   A list of documents in the approval file deposited at the Type Approval Authorities having delivered the approval and which can be obtained upon request.

16.2.   A list of tyre size designations: Specify for each brand name/trademark and/or each trade description/commercial name the list of tyre size designations and service descriptions [, adding whether "reinforced" (or "extra load") or not, and whether or not tyre for use in severe snow conditions].

# Annex 2

## Arrangements of approval marks

### Example of a separate Regulation No. [XXX] approval mark

**Example 1**
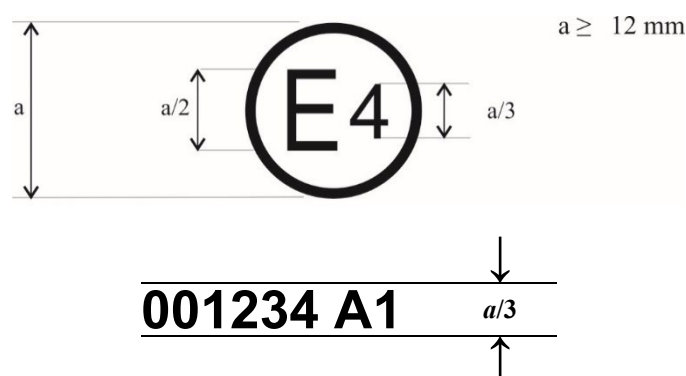


The above approval mark, affixed to a tyre shows that the tyre concerned has been approved in the Netherlands (E4) pursuant to Regulation No. [XXX] (marked by the suffix "A1" (abrasion at stage 1)), under the original version of this regulation (indicated by the first two digits "00") and the serial number 1234.

### Approval pursuant to Regulation No. [XXX] coincident with approval pursuant to other regulations

**Example 1**



The above approval mark shows that the tyre concerned has been approved in the Netherlands (E4) pursuant to Regulation No. [XXX] (marked by the suffix "A1" (abrasion at stage 1)) with approval reference number 001234 and Regulation No. 30 with approval reference number 0236454. The first two digits of the approval numbers ("00" and "02") indicate that the approval pursuant to Regulation No. [XXX] was granted according to the original version and the approval pursuant to Regulation No. 30 according to the 02 series of amendments.

**Example 2**
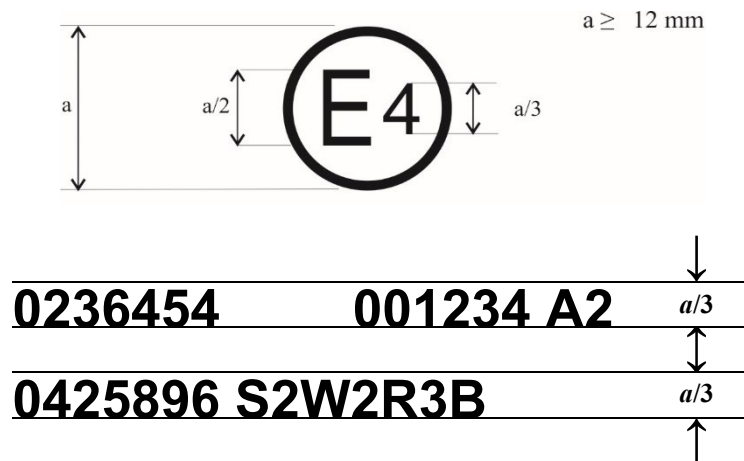


The above approval mark shows that the tyre concerned has been approved in the Netherlands (E4) pursuant to Regulation No. [XXX] (marked by the suffix "A2" (abrasion at stage 2)) with approval reference number 001234, pursuant to Regulation No. 30 with approval reference number 0236454 and pursuant to Regulation No. 117 with approval reference number 0425896 for rolling sound emission at stage 2, wet adhesion of tyres in new state at stage 2, rolling resistance at stage 3 and wet adhesion of tyres in worn state (indicated by "S2W2R3B"). The first two digits of the approval numbers ("00", "02", and "04", respectively) indicate that the approval pursuant to UN Regulation No. [XXX] was granted according to the original version, the approval pursuant to UN Regulation No. 30 according to the 02 series of amendments, and the approval pursuant to UN Regulation No. 117 according to the 04 series of amendments.

**Combinations of markings of approvals issued pursuant to Regulations Nos. [XXX], 30 and/or 117**

**Example 1**
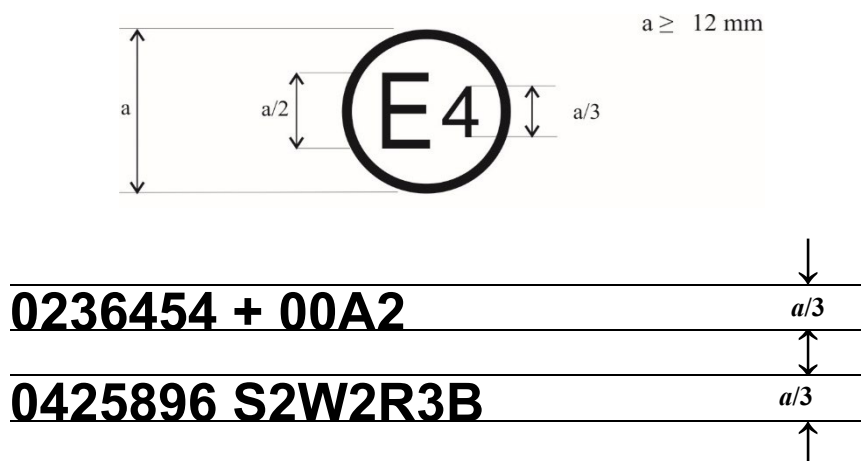


The above approval mark shows that the tyre concerned has been approved in the Netherlands (E4) pursuant to Regulation No. [XXX] (marked by the "+ 00A2" (abrasion at stage 2)) according to the original version of this regulation, pursuant to Regulation No. 30 with approval reference number 0236454 and pursuant to Regulation No. 117 with approval reference number 0425896 for rolling sound emission at stage 2, wet adhesion of tyres in new state at stage 2, rolling resistance at stage 3 and wet adhesion of tyres in worn state (indicated by "S2W2R3B").

**Example 2**
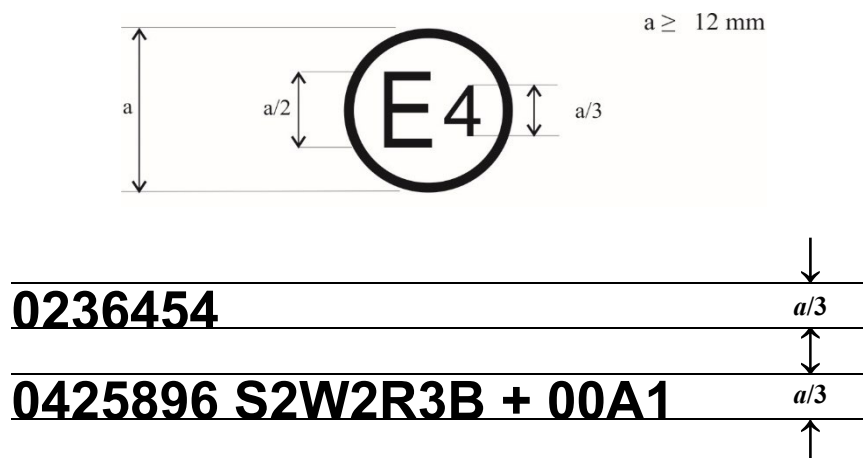


The above approval mark shows that the tyre concerned has been approved in the Netherlands (E4) pursuant to Regulation No. [XXX] (marked by the "+ 00A1" (abrasion at stage 1)) according to the original version of this regulation, pursuant to Regulation No. 30 with approval reference number 0236454 and pursuant to Regulation No. 117 with approval reference number 0425896 for rolling sound emission at stage 2, wet adhesion of tyres in new state at stage 2, rolling resistance at stage 3 and wet adhesion of tyres in worn state (indicated by "S2W2R3B").
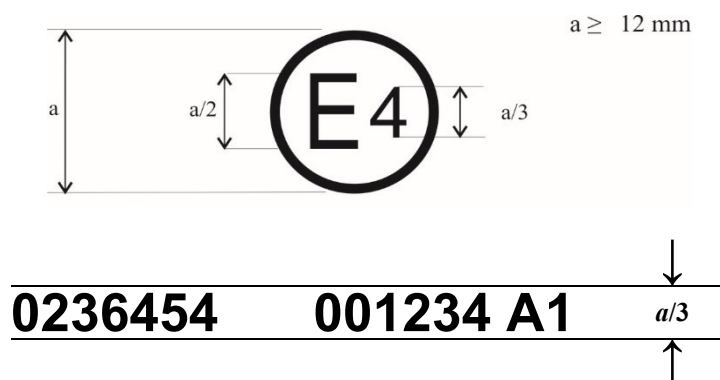
**Example 3**
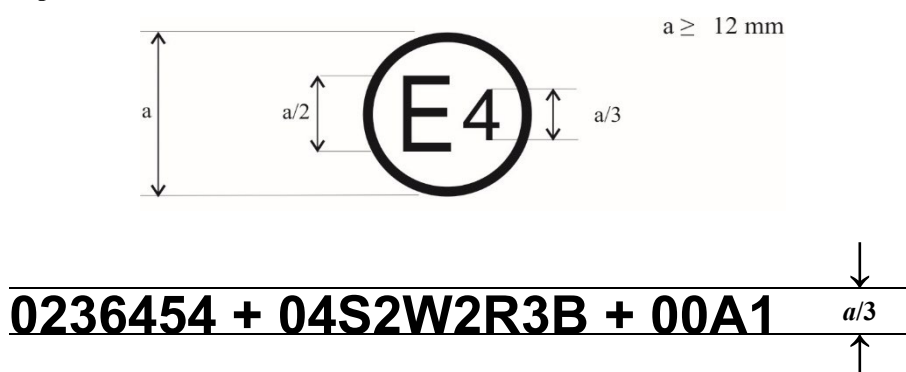


The above approval mark shows that the tyre concerned has been approved in the Netherlands (E4) pursuant to Regulation No. [XXX] (marked by the "+ 00A1" (abrasion at stage 1)) according to the original version of this regulation, pursuant to Regulation No. 30 with approval reference number 0236454 and pursuant to Regulation No. 117 according to the 04 series of amendments for rolling sound emission at stage 2, wet adhesion of tyres in new state at stage 2, rolling resistance at stage 3 and wet adhesion of tyres in worn state (indicated by "+ 04S2W2R3B").

# Annex 3

## 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 following test methods:

(a)     vehicle test method on public open roads;

(b)     indoor drum test method.

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

1.1.     This method applies to class C1 tyres in scope of this regulation.

1.2.     Definitions

In addition to relevant definitions set out in paragraph 2 of this Regulation the following apply.

1.2.1.     "*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.

1.2.2.     "*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.

1.2.3.     "*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 run 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 internal combustion engine, (ii) an electric machine or (iii) fuel cell.

1.2.7.     "*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.

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

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*" is a vehicle where all propulsion energy converters are internal combustion engines.

1.2.13.     "*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 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.

1.3. Symbols and abbreviated terms

| Symbol | Unit | Designation |
|---|---|---|
| AICT | No dimension | Abrasion index of the candidate tyre |
| ALCT | $\frac{mg}{km \cdot t}$ | Abrasion level of candidate tyre at test conditions |
| ALRT | $\frac{mg}{km \cdot t}$ | Abrasion level of reference tyre at test conditions |
| $A_{margin}$ | No dimension | Abrasion margin |
| $D_{Ci}$ | 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 $i$ |
| $O_S$ | $\frac{mg}{km \cdot t}$ | Offset of the regression lines of the reference tyre abrasion level of SRTT17S |
| $O_W$ | $\frac{mg}{km \cdot t}$ | 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 |
| $S_S$ | $\frac{mg}{km \cdot t \cdot °C}$ | Sensitivity of *SRTT17S* to temperature variation |
| $S_W$ | $\frac{mg}{km \cdot t \cdot °C}$ | Sensitivity of *SRTT17W* to temperature variation |
| $T_i$ | °C | Average temperature of the test |

| Symbol | Unit | Designation |
|--------|------|-------------|
| $\overline{T}$ | °C | Average temperature of the n tests |

1.4.        Instrumentation

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 run by the tyre shall equal the GNSS reported distance plus the distance run without a GNSS signal, 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 that it fulfils the measurement accuracy described above.

Initial and final measurements 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 and wheel assembly 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 and circuit 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 $0 \pm 0.05$ 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, the toe IN/OUT angle in absolute value shall be lower than or equal to the values used in the candidate 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 $0 \pm 0.1$ degrees;

(b)    Camber angle on the front axle set to $0 \pm 0.1$ degrees;

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

(d)    Camber angle on the rear axle set to $0 \pm 0.1$ 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 $0 \pm 0.05$ degrees;

(b)    Camber angle on the front axle set to $0 \pm 0.1$ degrees;

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

(d)    Camber angle on the rear axle set to $0 \pm 0.1$ degrees;

(e)    In addition, 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 demonstrate that the settings limits cannot be achieved. The vehicles shall be less than two years old and made by 4 different carmakers.

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

(i)    Front Toe IN/OUT angle 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;

(iv)   Rear Toe IN/OUT 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;

(v)    In addition, the following limits shall be respected for candidate vehicles with 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 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 degrees and 0.3 degrees.

(vi)   In addition, the following limits shall be respected for reference vehicles with 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 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 degrees and 0.3 degrees.

1.6.7.   Vehicle acceptable propulsion energy converter

All the propulsion energy converter 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 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 $(67 \pm 7)$ 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 axles shall be as following:

(a)    For FWD vehicles

Front axle load: $(56 \pm 7)$ per cent of total vehicle load.

Rear axle load: $(44 \pm 7)$ per cent of total vehicle load.

(b)    For AWD/RWD vehicles

Front axle load: $(50 \pm 7)$ per cent of total vehicle load.

Rear axle load: $(50 \pm 7)$ 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.

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 to 0.45 $m/s^2$;

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

(b) 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 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 25 to 75 mg/(km·t);

(b) SRTT17W: the circuit abrasion level at 10 °C shall be in the range from 25 to 75 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.
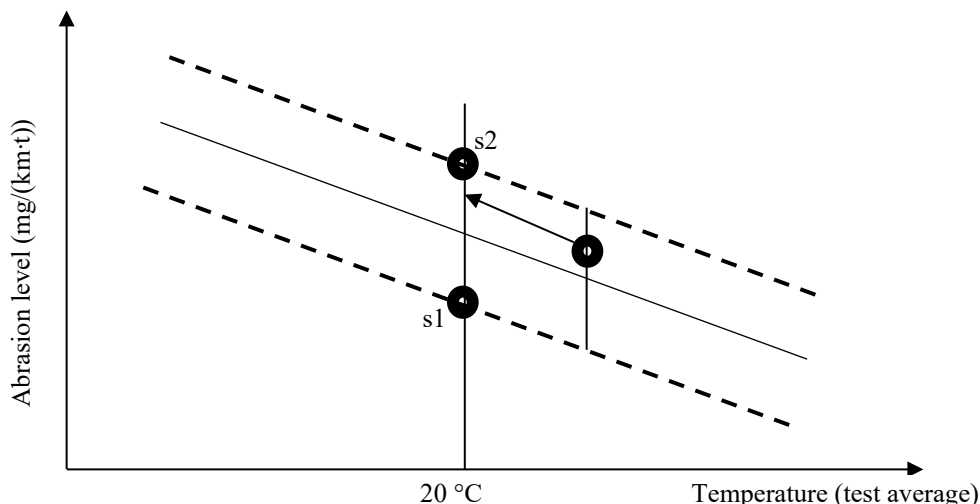


**Figure 1:** The normalised to 20°C abrasion level of the test shall be within s1 and s2.

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:

(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) The value of abrasion 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 $ALRT_i$ abrasion level in $mg/(km \cdot t)$ at a temperature $T_i$ 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 level to the average test temperature) is calculated by means of the following equation:

$$S_S = \frac{\sum_{i=1}^{n}(ALRT_i - \overline{ALRT}) \times (T_i - \overline{T})}{\sum_{i=1}^{n}(T_i - \overline{T})^2} \qquad \text{for SRTT17S}$$

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

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

$$O_S = \overline{ALRT} - S_S \cdot \overline{T} \text{ for SRTT17S}$$

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

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

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

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

Where:

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

$ALRT_i$      is the abrasion level of reference tyre at test conditions in mg/(km·t);

$\overline{ALRT}$      is the average abrasion level of the *n* reference tyre tests at three temperatures in mg/(km·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, 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.      When testing tyres against SRTT17S according to the table in paragraph 1.8. of this Annex, the following weather and climate conditions shall be respected:

(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.      When testing tyres against SRTT17W according to the table in paragraph 1.8. of this Annex, the following weather and climate conditions shall be respected:

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.

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. Both time-based and distance-based average for temperature are acceptable.

1.8.     Standard Reference Test Tyre requirements

For the evaluation of the abrasion performance of the candidate tyre using the vehicle test method on public open roads, the reference tyre shall be selected according to the following table:

| | | Reference tyre | |
|---|---|---|---|
| Category of use of the 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 | |
| | Marked with "M+S" or "M.S" or "M&S" | | X |
| | Special use tyre that is classified as tyre for use in severe snow conditions | | X |

Reference tyres SRTT17S and SRTT17W shall be stored in condition recommended in ASTM F3676-23 and ASTM F3675-23 respectively.

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 code rim.

The rim width code 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 ($MRTSi$) 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 following the procedure described in paragraph 1.5.2. of this Annex.

Intermediate measurements of tyre and wheel mass assembly are optional.

1.9.4. Tyre inflation pressure

The 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 tyres or extra load tyres 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 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.

1.11.2.     Test total distance

The total distance driven by each vehicle in the convoy shall be $8000 \pm 300$ 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 1.6.7. 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 (loaded vehicle);

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

1.11.5.2.    During the test

During the test, the following recordings shall be performed:

(a)    Continuous 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:

Temperature shall be measured according to paragraph 1.7.3.

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

During each shift, a continuous evaluation of speed, lateral, and longitudinal accelerations 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 respect the 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 1.6. of this Annex;

(f) For candidate tyres of category of use snow tyres and special use tyres marked "M+S", either or not classified as tyres for use in severe snow conditions, the abrasion level of the SRTT17W normalized at 10 °C ($ALRT_{10}$) shall be in the range defined in paragraph 1.6.16. of this Annex;

(g) For other candidate tyres, the abrasion level of the SRTT17S normalized at 20 °C ($ALRT_{20}$) 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 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 level of reference tyre at 20 °C or 10 °C as applicable 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 level at 20 °C or 10 °C as applicable 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 run 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 or maximum 7.5 per cent of the test distance. The mileage run with the spare tyre shall be recorded and taken into account for the tyre abrasion level;

(b)     If a tyre used during the test is destroyed (or non-repairable puncture or run 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 level calculation.

1.11.13.1.    Reference tyre abrasion level at average test temperature $(mg/(km \cdot t))$

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

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

Where:

$ALRT$     is the abrasion level of the reference tyre at test average temperature in mg/(km·t);

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

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

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

$Q_{Ri}$ is the test load of the reference tyre in kg;

$N$            is the number of tyres.

1.11.13.2.    SRTT17S abrasion level calculation at 20 °C

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

$$ALRT_{20} = ALRT + S_S \cdot (20 - \bar{T})$$

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

1.11.13.3. SRTT17W abrasion level calculation at 10 °C

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

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

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

1.11.13.4. Candidate tyre abrasion level at average test temperature in mg/(km·t)

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

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

Where:

$ALCT$      is the abrasion level of the candidate tyre at test average temperature in mg/(km·t);

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

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

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

$Q_{Ci}$      is the test load of the candidate tyre in kg;

$n$      is the number of tyres.

1.11.13.5. The abrasion index of the candidate tyre shall be calculated from the following equation:

$$AICT = \frac{ALCT}{ALRT} - A_{margin}$$

Where:

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

$ALCT$      is the abrasion level of the candidate tyre, in mg/(km·t);

$ALRT$      is the abrasion level of the reference tyre, in mg/(km·t);

$A_{margin}$      is the dimensionless abrasion margin, which accounts for the complexities of the abrasion level measurement methods and the special abrasion characteristics of specific tyre groups as indicated below. $A_{margin}$ is defined in two steps that account for the evolution of abrasion level measurement methods and tyre technology, as given in the following table:

| | Stage 1 | Stage 2 |
|---|---|---|
| $A_{margin}$ *by tyre category of use* | | |
| Normal | [0.20] | [0.15] |
| Snow | [0.20] | [0.15] |
| Special use | [Not defined] | [Not defined] |
| $A_{margin}$ *allowances for specific tyre groups (to be incorporated into $A_{margin}$)* | | |
| Tyre for use in severe snow conditions (3PMSF) | [+0.10] | [+0.10] |
| Reinforced or extra load tyre (XL) | [+0.10] | [-] |

| Tyres with a nominal aspect ratio ≤ 40 and suitable for speeds ≥ 300 km/h | [+0.10] | [-] |
|---|---|---|
| [Tyres with low load index (LI < 77)] | [+0.10] | [-] |

Note: $A_{margin}$ allowances for specific tyre groups are cumulative. E.g., if a candidate tyre is a reinforced snow tyre for use in severe snow conditions, the applicable $A_{margin}$ shall be 0.2 + 0.1 + 0.1 = 0.4.

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 dates of the test;

(f)    $A_{margin}$ applied, with indication of any allowances incorporated therein.

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 loaded condition;

(d)    Vehicle tuning at each intermediate measurement 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 code (7.5);

(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 ($MRTSi$) for each reference tyre;

(m)    Final tyre mass ($MRTFi$) for each reference tyre;

(n)    Abrasion level in mg/(km·t) normalized at 20 °C or 10 °C as applicable;

(o)    Distance run for each reference tyre;

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

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

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

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

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

(u)     Measured tyre load for each reference tyre;

(v)     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 loaded condition;

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

(e)     Rim width code;

(f)     Cold inflation pressure at the fitment;

(g)     Cold inflation pressure at 50 per cent of the test;

(h)     Cold inflation pressure at the end to the test;

(i)     Balancing mass at the beginning of the test;

(j)     Balancing mass at the end of the test;

(k)     Initial tyre mass ($MCTSi$) for each candidate tyre;

(l)     Final tyre mass ($MCTFi$) for each candidate tyre;

(m)     Measured tyre load for each candidate tyre;

(n)     Distance run for each candidate tyre;

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

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

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

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

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

1.12.4.     Final test results

(a)     The measured result of abrasion level 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 level 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 index AICT as described in paragraph 11. of this Annex.

| | |
|---|---|
| 2. | Test method (b) using indoor drum |
| 2.1. | This method applies to class C1 tyres in scope of this regulation. |
| 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 the amount of the mass, expressed in grams, lost due to tyre abrasion. |
| 2.2.3. | "*Mean profile depth*" is used for the characterization of the surface roughness in macroscale and is described in ISO 13473-1. |
| 2.2.4. | "*Micro-roughness*" means the surface roughness characterized in microscale and is measured by altered filtering conditions as defined in ISO 13473-1. |
| 2.2.5. | "*Tyre coordinate system*" is tyre coordinate system specified in ISO 8855. |



| | |
|---|---|
| 2.2.6. | "*Vertical load*" means the tyre normal force of a tyre exerted on the road resulting from the mass supported by the tyre. Tyre normal force is specified in ISO 8855. |
| 2.2.7. | "*Lateral force*" means the force of a tyre generated in lateral direction during cornering. Tyre lateral force is specified in ISO 8855. It takes a positive sign when turning left and a negative sign when turning right. |
| 2.2.8. | "*Longitudinal force*" means the force of a tyre generated in the longitudinal direction during acceleration or braking. Tyre longitudinal force is specified in ISO 8855. It takes a positive sign for speed increase and a negative sign for speed decrease (e.g. braking). |
| 2.2.9. | "*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 Paragraph 2.6.2. of this Annex. |
| 2.2.10. | "*Tyre torque*" means the moment on tyre rotation axle. |
| 2.2.11. | "*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 1.3. of Annex 3 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 abrasion 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 tyre abrasion test equipment with a cylindrical flywheel (drum) with external surface of drum.

2.4.2.      Drum Specifications

2.4.2.1.    Tyre Abrasion Test Equipment

Tyre abrasion 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 tyre abrasion test machine shall have a cylindrical flywheel (drum) with an external diameter of at least 3 m. [The drum circumference shall be measured over test surface segments.]

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 2,0 mm, according to ISO 13473-1;

(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 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. 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.

The abrasion level of the SRTT17S reference tyre for all types of surface shall be in the range between 50 mg/(km·t) and 190 mg/(km·t).

The abrasion level of the SRTT17W reference tyre for all types of surface shall be in the range between 35 mg/(km·t) and 165 mg/(km·t). The abrasion level shall be calculated according to the method in paragraph 2.8. of this Annex. In case of sandpaper 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 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.

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 tread abrasion test equipment shall 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.

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 per time) applied to the reference and candidate tyres shall be the same, with a maximum ±[2]

per cent difference for each test [and be in the range of 40 g/h to 200 g/h for each test tyre].

[The powder delivery rate for each test cycle shall be controlled within ± 5 per cent of the average powder delivery rate for each test. This applies to both reference tyre and candidate tyre.]

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 a blow-in type system, powder is blown directly to the contact patch through nozzles. In case of only one nozzle, centre of the nozzle shall be positioned in symmetrical plane (X = 0). The distance from the nozzles to the centre of the contact patch shall not exceed 35 cm.

In case of multiple nozzles, they shall be placed parallel to the Y axis and symmetrically distributed respective to the X axis. The distance from the centre of the nozzle array to the centre of the contact patch shall not exceed 35 cm. Nozzles shall be oriented towards contact patch entrance.

(b)    Dispersion type: [In a dispersion-type system, powder is dispersed in the space around the tyre and the drum, but not blown directly onto the contact patch. The contact patch and the tyre are covered with the enclosure coverings, where powder should be evenly dispersed within the enclosure, so that the powder could be distributed to the contact patch. The nozzle(s) should 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 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.

2.4.7.    Reference tyre

For the evaluation of the abrasion performance of the candidate tyre using the indoor drum method, the reference tyre shall be selected according to the following table:

| | | Reference tyre | |
|---|---|---|---|
| Category of use of the 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 |

Reference tyres SRTT17S and SRTT17W shall be stored in condition recommended in ASTM F3676-23 and ASTM F3675-23 respectively.

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 $F_z$ 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 class C1 tyres belonging to categories which are not shown in ISO 4000-1:2024, 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 3 of this Annex;

(b) The total running distance of the test shall be 5044 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 code 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 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 the same throughout the test;

(d)    The abrasion level calculation shall use the actual test run distance.

2.6.2.    Thermal Conditioning

Inflate the tyre to not lower than the test pressure and place it in the thermal environment of the test location [between 17°C and 28°C] 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 ± 3 °C for normal tyre and 20 °C ± 3 °C for snow tyre. ]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.

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

2.6.5.    Mass Measurement

The mass of tyre shall be measured before and after 5044 km of run as defined 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 3 of this Annex. The Appendix 3 test condition of 250 km is defined as one test cycle, and the test cycle shall be repeated 20 times until 5044 km is reached.

2.6.6.2.    Default 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 tyres 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 may be followed. 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 shall touch the drum with speed that equals 0 km/h. Then the test load Fz 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. This starting phase shall be free rolling conditions. The distance run during the starting phase 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 | Shall measure: <br> • Before starting the test; <br> • 3 or more hours after end of the test. <br><br> Interim measurement during test is optional |
| (d) Ambient temperature measured in °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: <br> • Before starting the test; <br> • after end of the test. <br><br> Interim measurement during test is optional |
| (h) MPD and micro-roughness of the test surface; | Shall measure at the timings of: <br> • Before starting the test; <br> • after end of the test. <br><br> 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

After a tyre has been subjected to the test procedure specified in paragraph 2.6. 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 cm$^2$ 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 | Prescribed test load R$_{Fz}$ | ±50 N or ±1 %, whichever is greater |

Note 1 to entry:

(a) For the whole test of total 5044 km, calculate the Root Mean Square (RMS) of $G$(x), $G$(y) and F$_z$ using the equations below:

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

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

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

$$RMS_{Fz} = \sqrt{\frac{1}{N} \times \sum_{i=1}^{N} (Fz_i)^2}$$

Where;

$i$ is the number of data acquired at a sampling frequency of 10 Hz;
N is the total number of data acquired;
$F$x, $F$y and $M$y may be filtered by a low pass filter to remove noise of the output;
$F$z 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 shall follow the equations:

MlT = MT$_b$ – MT$_a$

MlR = MR$_b$ - MR$_a$

Where:

MlT    is the mass loss of the candidate tyre, in grams

MlR    is the mass loss of the reference tyre, in grams

MT$_b$    is the mass of the candidate tyre before test cycle, in grams

MT$_a$    is the mass of the candidate tyre after test cycle, in grams

MR$_b$    is the mass of the reference tyre before test cycle, in grams

MR$_a$    is the mass of the reference tyre after test cycle, in grams

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

$$AICT = \frac{ALCT}{ALRT} - A_{margin}$$

Where:

[ALCT    is the abrasion level (mg/(km·t)) of the candidate tyre,

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

ALRT  is the abrasion level (mg/(km·t)) of the reference tyre,

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

DT    is the testing mileage of candidate tyre (km)

DR    is the testing mileage of the reference tyre (km)

Fz,T    is the test load of the candidate tyre (t)

Fz,R    is the test load of the reference tyre (t)

$A_{margin}$ is the dimensionless abrasion margin, which accounts for the complexities of the abrasion level measurement methods and the special abrasion characteristics of specific tyre groups as indicated below. $A_{margin}$ is defined in two steps that account for the evolution of abrasion level measurement methods and tyre technology, as given in the following table:

| | Stage 1 | Stage 2 |
|---|---|---|
| $A_{margin}$ *by tyre category of use* | | |
| Normal | [0.20] | [0.10] |
| Snow | [0.20] | [0.10] |
| Special use | [Not defined] | [Not defined] |
| $A_{margin}$ *allowances for specific tyre groups (to be incorporated into $A_{margin}$)* | | |
| Tyre for use in severe snow conditions (3PMSF) | [+0.10] | [+0.10] |
| Reinforced or extra load tyre (XL) | [+0.10] | [-] |
| Tyres with a nominal aspect ratio ≤ 40 and suitable for speeds ≥ 300 km/h | [+0.10] | [-] |
| Tyres with low load index (LI < 77) | [+0.10] | [-] |

Note: $A_{margin}$ allowances for specific tyre groups are cumulative. E.g., if a candidate tyre is a reinforced snow tyre for use in severe snow conditions, the applicable` $A_{margin}$ shall be 0.2 + 0.1 + 0.1 = 0.4.The reference tyre used to calculate the abrasion index shall be one of the tyres described in 2.4.7. of this Annex.

2.9.      Test report

2.9.1.      The test report shall include the following information:

(a)    Test machine identification;

(b)    Drum diameter (m);

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

(d)     3rd body (talc / silica);

(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)     M+S marking (Y/N);

(p)     Rim width code;

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

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

(s)     Test distance (km);

(t)     Abrasion rate (mg/km);

(u)     Abrasion level (mg/(km·t));

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

(w)     Average ambient temperature (°C);

(x)     RMS of G(x);

(y)     RMS of G(y);

(z)     Average of Fz;

(aa)    $A_{margin}$ applied, with indication of any allowances incorporated therein.

## Annex 3 – 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
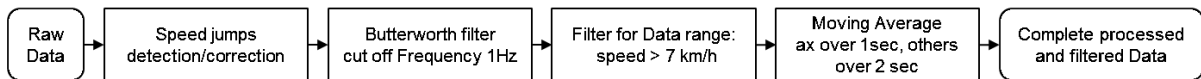


1.2. Speed jumps detection and correction

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.

Python code:

```
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. Moving Average:

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.        Distance-based Standard Deviation

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

Python code:

```
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['distance'].iloc[-1], 1)

# create an interpolation every 1m for the accelarations - numpy array result
# 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 ($S_{longitudinal}$ ; $S_{lateral}$) for each segment, following the method described in paragraph 1. of this appendix;

(d)    For each segment with ($S_{longitudinal}$ ; $S_{lateral}$) 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 3 – Appendix 2

### Test report example for vehicle test method on public open roads

1. Type Approval Authority or Technical Service: ..........................................................

2. Name and address of manufacturer: ..........................................................

   ..........................................................

3. Test report No.: ..........................................................

4. Brand name and trade description: ..........................................................

5. Tyre Class: C1

6. Category of use: ..........................................................

6.1. M+S marking in the case of special use tyres (Yes/No)[8]

6.2. 3PMSF marking (Yes/No)[8]

6.3. XL marking (Yes/No)[8]

6.4. Tyres with a nominal aspect ratio ≤ 40 and suitable for speeds ≥ 300 km/h (Yes/No)[8]

6.5. [Tyres with low load index (LI < 77) (Yes/No)[8]]

7. Comments (if any): ..........................................................

   ..........................................................

8. Date: ..........................................................

9. Signature: ..........................................................

| 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 tyre/vehicle | | | | Reference 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 | | | | | | | | |

---

[8] strike out what does not apply.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| % 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 code | | | | | 7.5 | 7.5 | 7.5 | 7.5 |
| Initial tyre mass | | | | | | | | |
| Final tyre mass | | | | | | | | |
| Distance run by each tyre | | | | | | | | |
| Reference tyre abrasion level in mg/(km·t) normalized at 20°C (or 10°C) | | | | | | | | |
| Tyres visual inspection report | | | | | | | | |
| Test results | | | | | | | | |
| Tyre Abrasion level in mg/(km·t) | | | | | | | | |
| $A_{margin}$ applied | | | | | | | | |
| Tyre Abrasion index (AICT) | | | | | N/A | | | |

**Annex 3 – 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:

$Fx = Fz \times G(x)$ or $My = Test load(Fz) \times G(x) \times RL$

$Fy = Fz \times G(y)$

Fz is the test load defined in paragraphs 2.2.6. and 2.5.2. of this Annex.

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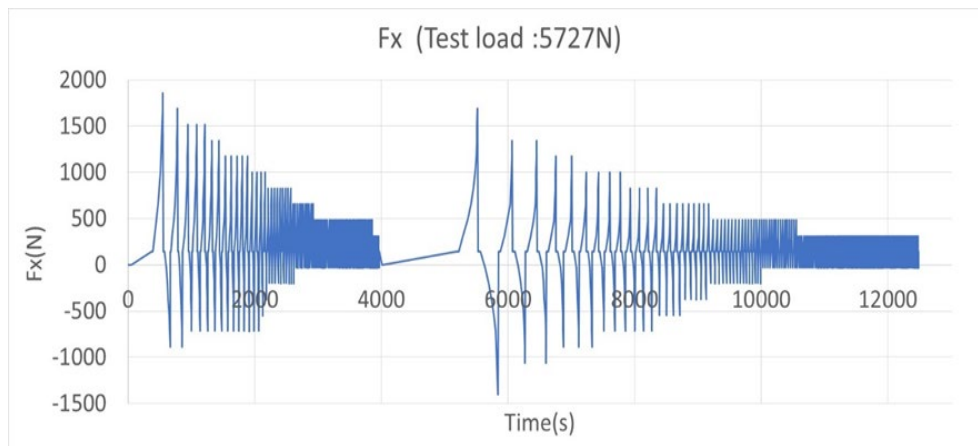
**Graph A.2**
Example of Fy, with a test load of 5727N
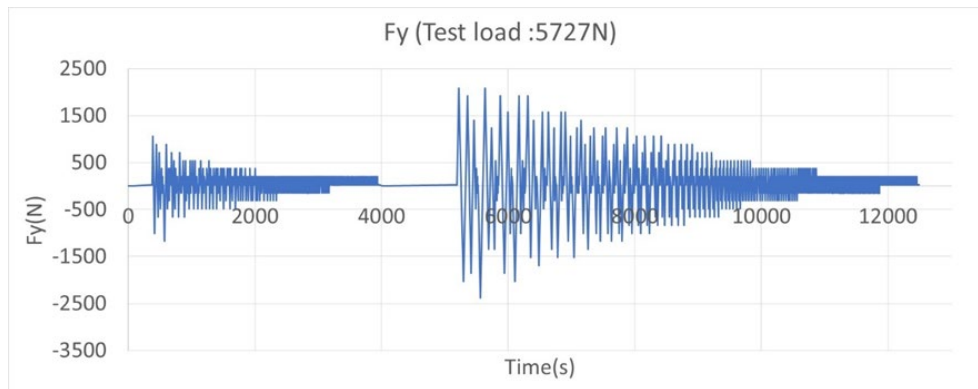


**Table A1.**
Input of test cycle

| T | v | G(x) | G(y) | | 678.9 | 100 | 0.025 | 0.125 |
|---|---|---|---|---|---|---|---|---|
| (s) | (kph) | | | | 699.1 | 100 | 0.055 | -0.115 |
| 0 | 60 | 0.000 | 0 | | 719.3 | 100 | 0.085 | 0.095 |
| 50 | 100 | 0.000 | 0.000 | | 737.0 | 100 | 0.115 | -0.085 |
| 373.2 | 100 | 0.025 | 0.005 | | 747.1 | 100 | 0.145 | 0.065 |
| 388.4 | 100 | 0.025 | 0.185 | | 757.2 | 100 | 0.175 | -0.025 |
| 418.7 | 100 | 0.055 | -0.175 | | 764.8 | 100 | 0.205 | 0.035 |
| 446.5 | 100 | 0.085 | 0.155 | | 769.9 | 100 | 0.235 | 0.005 |
| 471.7 | 100 | 0.115 | -0.115 | | 774.9 | 100 | 0.265 | 0.035 |
| 491.9 | 100 | 0.145 | 0.125 | | 777.4 | 100 | 0.295 | 0.005 |
| 509.6 | 100 | 0.175 | -0.085 | | 785.9 | 100 | 0.025 | 0.005 |
| 522.3 | 100 | 0.205 | 0.065 | | 796.0 | 100 | 0.025 | -0.115 |
| 532.4 | 100 | 0.235 | -0.025 | | 816.2 | 100 | -0.005 | 0.125 |
| 540.0 | 100 | 0.265 | 0.035 | | 826.3 | 100 | -0.035 | -0.025 |
| 545.0 | 100 | 0.295 | 0.005 | | 833.9 | 100 | -0.065 | 0.035 |
| 547.5 | 100 | 0.325 | 0.005 | | 841.4 | 100 | -0.095 | -0.025 |
| 556.8 | 100 | 0.025 | 0.005 | | 849.0 | 100 | -0.125 | 0.035 |
| 574.5 | 100 | 0.025 | -0.205 | | 851.6 | 100 | -0.155 | 0.005 |
| 602.3 | 100 | -0.005 | 0.155 | | 857.4 | 100 | 0.025 | 0.005 |
| 620.0 | 100 | -0.035 | -0.085 | | 865.0 | 100 | 0.025 | 0.095 |
| 632.6 | 100 | -0.065 | 0.065 | | 885.2 | 100 | 0.055 | -0.115 |
| 645.2 | 100 | -0.095 | -0.055 | | 902.9 | 100 | 0.085 | 0.095 |
| 657.9 | 100 | -0.125 | 0.065 | | 915.6 | 100 | 0.115 | -0.055 |
| 662.9 | 100 | -0.155 | 0.005 | | 923.1 | 100 | 0.145 | 0.035 |
| 668.8 | 100 | 0.025 | 0.005 | | 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|
| 2275.6 | 100 | -0.005 | 0.035 |
| 2278.2 | 100 | -0.035 | 0.005 |
| 2280.7 | 100 | 0.025 | 0.005 |
| 2283.2 | 100 | 0.025 | 0.035 |
| 2293.3 | 100 | 0.055 | -0.055 |
| 2300.9 | 100 | 0.085 | 0.035 |
| 2306.0 | 100 | 0.115 | 0.005 |
| 2308.5 | 100 | 0.145 | 0.005 |
| 2312.7 | 100 | 0.025 | 0.005 |
| 2315.2 | 100 | 0.025 | -0.025 |
| 2322.8 | 100 | -0.005 | 0.035 |
| 2325.3 | 100 | -0.035 | 0.005 |
| 2327.8 | 100 | 0.025 | 0.005 |
| 2330.4 | 100 | 0.025 | 0.035 |
| 2340.5 | 100 | 0.055 | -0.055 |
| 2348.1 | 100 | 0.085 | 0.035 |
| 2353.1 | 100 | 0.115 | 0.005 |
| 2355.6 | 100 | 0.145 | 0.005 |
| 2359.9 | 100 | 0.025 | 0.005 |
| 2362.4 | 100 | 0.025 | -0.025 |
| 2370.0 | 100 | -0.005 | 0.035 |
| 2372.5 | 100 | -0.035 | 0.005 |
| 2375.0 | 100 | 0.025 | 0.005 |
| 2377.5 | 100 | 0.025 | 0.035 |
| 2385.1 | 100 | 0.055 | -0.025 |
| 2392.7 | 100 | 0.085 | 0.035 |
| 2397.7 | 100 | 0.115 | 0.005 |
| 2400.3 | 100 | 0.145 | 0.005 |
| 2404.5 | 100 | 0.025 | 0.005 |
| 2407.0 | 100 | 0.025 | -0.025 |
| 2412.1 | 100 | -0.005 | 0.035 |
| 2414.6 | 100 | -0.035 | 0.005 |
| 2417.1 | 100 | 0.025 | 0.005 |
| 2419.6 | 100 | 0.025 | 0.035 |
| 2427.2 | 100 | 0.055 | -0.025 |
| 2434.8 | 100 | 0.085 | 0.035 |
| 2439.9 | 100 | 0.115 | 0.005 |

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|---|---|---|---|
| 2442.4 | 100 | 0.145 | 0.005 |
| 2446.6 | 100 | 0.025 | 0.005 |
| 2449.1 | 100 | 0.025 | -0.025 |
| 2454.2 | 100 | -0.005 | 0.035 |
| 2456.7 | 100 | -0.035 | 0.005 |
| 2459.2 | 100 | 0.025 | 0.005 |
| 2461.8 | 100 | 0.025 | 0.035 |
| 2469.3 | 100 | 0.055 | -0.025 |
| 2476.9 | 100 | 0.085 | 0.035 |
| 2482.0 | 100 | 0.115 | 0.005 |
| 2484.5 | 100 | 0.145 | 0.005 |
| 2488.7 | 100 | 0.025 | 0.005 |
| 2491.2 | 100 | 0.025 | -0.025 |
| 2496.3 | 100 | -0.005 | 0.035 |
| 2498.8 | 100 | -0.035 | 0.005 |
| 2501.3 | 100 | 0.025 | 0.005 |
| 2503.9 | 100 | 0.025 | 0.035 |
| 2511.4 | 100 | 0.055 | -0.025 |
| 2519.0 | 100 | 0.085 | 0.035 |
| 2524.1 | 100 | 0.115 | 0.005 |
| 2526.6 | 100 | 0.145 | 0.005 |
| 2530.8 | 100 | 0.025 | 0.005 |
| 2533.3 | 100 | 0.025 | -0.025 |
| 2538.4 | 100 | -0.005 | 0.035 |
| 2540.9 | 100 | -0.035 | 0.005 |
| 2543.4 | 100 | 0.025 | 0.005 |
| 2546.0 | 100 | 0.025 | 0.035 |
| 2553.5 | 100 | 0.055 | -0.025 |
| 2561.1 | 100 | 0.085 | 0.035 |
| 2563.7 | 100 | 0.115 | 0.005 |
| 2566.2 | 100 | 0.145 | 0.005 |
| 2570.4 | 100 | 0.025 | 0.005 |
| 2572.9 | 100 | 0.025 | -0.025 |
| 2578.0 | 100 | -0.005 | 0.035 |
| 2580.5 | 100 | -0.035 | 0.005 |
| 2583.0 | 100 | 0.025 | 0.005 |
| 2585.5 | 100 | 0.025 | 0.035 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|
| 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 |

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|--------|----|--------|--------|---|--------|----|--------|--------|
| 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 |

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|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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|---|---|---|---|---|---|---|---|---|
| 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 |

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

## Annex 3 – Appendix 4

## Test equipment tolerances

**Table B.1**
Instrumentation accuracy

| Parameter | Control accuracy | Instrumentation accuracy |
|---|---|---|
| Tyre forces (using filtered values) | Fz: ± 50 N or 1% using filtered values whichever is greater. | at full scale: Fz: ± 1% |
| | Fy: ± 100 N or 5% using filtered values whichever is greater, for the difference between input peaks and actually generated peaks. | at full scale: Fy: ± 1% |
| | Fx: ± 100 N or 5% using filtered values whichever is greater, for the difference between input peaks and actually generated peaks. | at full scale: Fx: ± 1% |
| Tyre torque | My: ± 40 Nm or 5% using filtered values whichever is greater, for the difference between input peaks and actually generated peaks. | at full scale: My: ± 1% |
| Inflation pressure | Not applicable | ± 3 kPa |
| Mass scale | 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, 69.39h (249800s). The interval of measurement shall be more than 1Hz. | The accuracy of measuring one second is within ± 0.02 s |
| Camber angle | 0 +/- 0.1 degrees | 0 +/-0.1 degrees |
| Temperature | ±3 °C | ±0.5 °C |
| Speed | ±2 km/h | ± 0.1% at full scale or ± 0.3 km / h, whichever is greater |
| Loaded radius | Not applicable | ±1 mm |

## Annex 3 – Appendix 5

### Replacement of sandpaper surface

Sandpaper surface shall be replaced when it does not meet the specifications described in paragraph 2.4.2.3. of this Annex;

Sandpaper surface should be replaced either when:

Running distance reached 20000 km for 2 positions drum in case of 3 m, 40000 km for 1 position drum in case of 3 m, [or partial replacement is also allowed]

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 (standard value) = 20000 km;

Standard drum diameter = 3 m.

## Annex 3 – Appendix 6

## Example of a test report for indoor drum test method

The test report shall include the following information.

| Test report number: | |
|---|---|
| Test machine identification: | |
| Drum circumference (m), | |
| Test cycle (2 positions /1 position) | |
| | Talc or Silica |

| | Test date: | ~ |
|---|---|---|

| | Beginning of test | End of test |
|---|---|---|
| MPD of test surface (mm): | | |
| 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 (Yes/No)[7] | | | |
| M+S marking (Yes/No) [7] | | | |
| XL marking (Yes/No)[7] | | ✕ | |
| Tyres with a nominal aspect ratio ≤ 40 and suitable for speeds ≥ 300 km/h (Yes/No)[7] | | ✕ | |
| [Tyres with low load index (LI < 77) (Yes/No)[7]] | | ✕ | |
| Rim width code | | 7.5 | |
| Inflation pressure (kPa) | Beginning of test | | |
| | End of test | | |
| Mass of tyre (g) | Before test | | |
| | After test | | |
| Test distance (km) | | | |
| Abrasion rate (mg/km) | | | |
| Abrasion level (mg/(km·t)) | | | |
| $A_{margin}$ applied | | ✕ | |
| Abrasion index (AICT) | | ✕ | |
| 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 | | |

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