Annex 4 [new]

Procedure for Demonstrating Equivalence of Vehicle Test and Indoor Drum Test Facilities for Tyre Abrasion and Determining the Transfer Function for Indoor Drum Test Facilities

1. Scope and Purpose

1.1 This Annex sets out a procedure to demonstrate that the results of a tyre abrasion test carried out at a facility are equivalent to those obtained with other facilities. The aim is to ensure that, facilities yield equivalent abrasion performance results, so that approvals based on any facility or method remain comparable and mutually recognised.

1.2 The procedure provides a structured approach for selecting test tyres and facilities, establishing a baseline and evaluating facilities. It applies to both indoor drum and vehicle test facilities.

1.3 Furthermore, this procedure establishes the methodology for determining the transfer function, which mathematically relates the results obtained from the indoor drum test method to those of the vehicle test method. The procedure allows for the establishment of either a generic transfer function applicable to any indoor drum test facility or a specific transfer function applicable to a single indoor drum test facility.

2. Definitions

For the purposes of this Annex, the following definitions apply.

2.1 "Facility" means a testing centre, carrying out either vehicle tests at a circuit or indoor drum tests.

2.2 "Circuit" means the specific test route on public roads selected for the execution of the vehicle test method in accordance with Annex 3.

2.3 "Indoor Drum" means the test machine and associated equipment used for the execution of the indoor drum test method in accordance with Annex 3.

2.4 "Inter-facility equivalence exercise" means the coordinated testing campaign described in this Annex, involving the testing of a common set of exercise tyres by the facility under assessment and participating facilities, used to demonstrate equivalence and, where applicable, to determine the transfer function coefficient.

2.5 "Coordinating body" means the technical service, Technical Approval Authority, the facility under assessment, an Equivalent facility or other entity responsible for organising the inter-facility equivalence exercise, collecting the test data, and issuing the final equivalence report.

2.6 "Equivalent Drum (ED)" means an indoor drum test facility that proved equivalence to a Type Approval Authority in a previous inter-facility equivalence exercise.

2.7 "Equivalent Circuit (EC)" means a circuit that proved equivalence to a Type Approval Authority in a previous inter-facilities exercise. The circuits that provided the data for the definition of the abrasion limits are deemed Equivalent Circuits (EC).

2.8 "Assessed Drum (AD)" means a drum facility undergoing evaluation in the current inter-facility equivalence exercise to prove equivalence.

2.9 "Assessed Circuit (AC)" means a circuit undergoing evaluation in the current inter-facility equivalence exercise to prove equivalence.

2.10 "Facility under assessment" means the Assessed Drum (AD) or Assessed Circuit (AC) participating in the inter-facility equivalence exercise for the purpose of demonstrating equivalence.

2.11 "Participating facilities" means the designated facilities, other than the facility under assessment, selected to test the exercise tyres for the purpose of establishing the baseline values according to paragraph 4.1.2.1.

2.12 "Reference tyre" means the Standard Reference Test Tyre (SRTT) specified in the vehicle test method or indoor drum test method of Annex 3, used to normalize the abrasion level of the exercise tyres.

2.13 "Exercise Tyres (ET)" are the candidate tyres used for the equivalence assessments. These tyres shall be tested by the participating facilities and the facility under assessment and fulfil the requirements of paragraph 4.1.1.

2.14 "Baseline value" of an exercise tyre is the average Abrasion Level Index (ALI) obtained from all participating facilities as defined in paragraph 2.11. It represents the value against which under assessment facilities are compared to demonstrate equivalence.

2.15 "Abrasion Level Index (ALI)" means the abrasion performance of a tyre, expressed as the ratio of the Exercise tyre's abrasion level (ALCT) to that of a reference tyre (ALRT), without subtraction of any test-specific abrasion margin and without applying regulatory limits. For indoor drum tests, the ALI shall be adjusted using the relevant transfer function.

2.16 "Equivalence" means that a facility produces ALI results for the exercise tyres that are statistically consistent with the baseline values fulfilling the requirements of paragraph 4.3.2.

2.17 "Transfer function" means a linear relationship used to relate drum test results to vehicle test results. The transfer function is expressed as:

$$ALI_{vehicle} \approx ALI_{drumTF} = a\,(ALI_{drum} - 1) + 1,$$

where the coefficient a takes a value between [1 and 2] which shall be determined during the inter-facility equivalence exercise or using a generic transfer function, as applicable, $ALI_{vehicle}$ is the Abrasion Level Index of the candidate tyre that would be obtained using the vehicle test method in accordance with Annex 3, ALI_{drum} is the Abrasion Level Index obtained using the indoor drum test method, and ALI_{drumTF} is the approximation of $ALI_{vehicle}$ obtained through the applications of the transfer function;

2.18 "Generic transfer function" means a transfer function where the coefficient a is a fixed value established by a statistical analysis of multiple facilities, intended for use by any drum facility.

2.19 "Specific transfer function" means a transfer function where the coefficient *a* is determined individually by a specific drum facility through a dedicated equivalence exercise, valid only for that specific facility and its operational conditions.

3. Organisation of an inter-facility equivalence exercise

3.1 The equivalence exercise shall be organised by a coordinating body as defined in paragraph 2.5.

3.2 Upon completion of the tests, each participating facility shall submit the data resulting from the application of the procedure described in paragraph 4.3 to the coordinating body. The abrasion levels of the reference tyres shall also be reported; for circuit facilities, the abrasion level normalised to the relevant reference temperature shall be included.

3.3 The coordinating body shall compile the results, calculate the baseline values according to paragraph 4.2, determine the specific transfer function for the drum under assessment, if applicable, and issue an Equivalence Report for the facility under assessment.

4. Equivalence procedure outline

The equivalence procedure consists of three main steps.

4.1 Step 1: Selection of exercise tyres and facilities

4.1.1 Exercise tyres selection (Step 1a)

4.1.1.1 At least [six] tyres shall be selected so that

(i) they cover an ALI range of at least [0.5] units, with an even distribution across the range and

(ii) they are a mix of normal and 3PMSF tyres with a ratio between 1:2 and 2:1.

4.1.1.2 If a facility under assessment is designed for testing only normal or 3PMSF tyres, the equivalence of the facility shall be restricted to the corresponding tyre category and the requirement under paragraph 4.1.1.1 (ii) shall not apply.

4.1.2 Selection of participating facilities (Step 1b)

4.1.2.1 The participating facilities shall be selected according to the type of assessment being performed:

(a) Assessment of a Circuit: In addition to the AC, the participating facilities shall include either:

(i) At least [one] Equivalent Circuit (EC), with any number of additional equivalent circuits or equivalent drums, as long as the number of equivalent circuits is higher than the number of equivalent drums; or

(ii) At least [three] circuits (regardless of equivalence status), with no participating drums.

(b) Assessment of a Drum using a Specific Transfer Function: If the AD intends to determine a specific transfer function coefficient *a*, the participating facilities shall include either:

(i) At least [two] Equivalent Circuits (EC), with any number of additional equivalent circuits or equivalent drums, as long as the number of equivalent circuits is higher than the number of equivalent drums; or

(ii) At least [three] circuits (regardless of equivalence status), with no participating drums.

(c) Assessment of a Drum using a Generic Transfer Function: If the AD intends to use a Generic Transfer Function (as defined in paragraph 2.18) the participating facilities shall include either:

(i) At least [one] Equivalent Circuit (EC), with any number of additional equivalent circuits or equivalent drums, as long as the number of equivalent circuits is higher than the number of equivalent drums; or

(ii) At least [one] Equivalent Drum (ED), with any number of additional equivalent circuits or equivalent drums, provided that all equivalent drums use the same Generic Transfer Function.

4.2 Step 2: Establishment of baseline values

4.2.1 All facilities shall carry out the tests according to Annex 3 of this Regulation. Each participating facility shall test each exercise tyre once.

4.2.2 The results of each equivalent drum facility shall be adjusted using the transfer function defined in paragraph 2.17.

4.2.3 For each exercise tyre, if more than one test result is available, the baseline value shall be the arithmetic mean of the ALI results reported by the participating facilities as defined in paragraph 2.11. The calculation of the baseline requires a minimum of two data points, if at least two participating facilities are required according to paragraph 4.1.2.

4.2.4 Any result whose absolute difference from the mean exceeds [0.25] shall be excluded and a new mean shall be calculated with the remaining results. Such exclusions shall be applied iteratively until all remaining results lie within ±[0.25] of their mean. If fewer than two valid data points remain after exclusion, data from an additional facility shall be added or an additional tyre shall be tested.

4.3 Step 3: Demonstration of equivalence of a facility

4.3.1 The facility under assessment (AC or AD) shall compare its measurements with the baseline values.

4.3.2 The facility under assessment shall demonstrate equivalence by fulfilling the following criteria:

(i) For each exercise tyre, the candidate's ALI result of the facility under assessment (adjusted by the transfer function, if applicable) differs from the baseline value by no more than ±[0.25]; and

(ii) For all exercise tyres, the correlation coefficient (R^2) between the results of the facility under assessment and the baselines shall be greater than [0.85]. The correlation coefficient shall be calculated using the Ordinary Least Squares (OLS) method between the candidate facility's results and the baseline values, according to the following formula:

$$R^2 = 1 - \frac{\sum_i \left(\frac{ALCT_{drumTF,i}}{ALRT_{drumTF,i}} - \frac{ALCT_{vehicle,i}}{ALRT_{vehicle,i}}\right)^2}{\sum_i \left(\frac{ALCT_{drumTF,i}}{ALRT_{drumTF,i}} - \frac{\sum_j \frac{ALCT_{drumTF,j}}{ALRT_{drumTF,j}}}{n}\right)^2}$$

Where *i* is the exercise tyre index and *n* the total number of exercise tyres tested

4.3.3 Before comparing to the baseline values according to paragraph 4.3.2, the results of a drum facility under assessment shall be adjusted using the transfer function defined in paragraph 2.17.

4.3.4 Drum facilities under assessment using a generic transfer function shall apply the value of the generic coefficient *a*.

4.3.5 For drum facilities under assessment determining a specific transfer function, the value of the coefficient *a* shall be calculated based on the results of the inter-facility equivalence exercise.

The calculation method is the Least Squares regression on the shifted coordinates.

Let:

$x' = ALI_{drum} - 1$

$y' = ALI_{vehicle} - 1$

The coefficient *a* is calculated as:

$$a = \frac{\sum_i (x'_i \cdot y'_i)}{\sum_i (x'_i)^2}$$

4.3.6 Indoor drum test facilities that prove equivalence under this procedure for the specific or generic transfer function are recognised for the specific test parameters used during the exercise.

The following parameters shall be recorded in the equivalence test report and shall remain fixed for all subsequent Type Approval or Conformity of Production testing: (i) The surface texture (e.g., specific sandpaper grit or surface reference); (ii) The third body type and specification; (iii) The third body flow rate [g/km]); (iv) The method of third body distribution (e.g., nozzle type, position, and pulse frequency); (v) the transfer function applied.

Any change to the constructive characteristics (such as the powder distribution system) or significant deviation in the operational parameters shall require a new demonstration of equivalence.

4.3.7 The test reports and analysis shall be made available to the Type Approval Authority.

NOTES FOR TADG: Necessary changes to working document ECE/TRANS/WP.29/GRBP/2025/27 to integrate the 'equivalence' Annex:

Draft Proposal for Paragraph 6.1: "The abrasion level of the tyre, determined in accordance with the test method specified in Annex 3, shall be measured using a test facility (circuit or indoor drum) that has **demonstrated equivalence according to the procedure described in Annex 4**."

Draft Proposal for Annex 3, Paragraph [X]: "Prior to conducting any testing for Type Approval, the test facility (whether indoor drum or circuit) shall have successfully completed the equivalence assessment specified in Annex 4 and established its status as an Equivalent Circuit (EC) or Equivalent Drum (ED)."

§2.8 of Annex 3 (calculations of drum method): Add an equation applying the correction of the transfer function of Annex 4.

§2.2 of Annex 3 (definitions of drum method): Add transfer function referring to Annex 4.

Text to Insert into the Test Report Annex

[X]. Facility Equivalence Status

[X].1. Has the test facility demonstrated equivalence according to Annex 4? .....
Yes / No

(If No, the test results are not valid for Type Approval)

[X].2. Reference to the Equivalence Test Report (Unique ID/Date):

Transfer function applied (Drum Method Only): .....

[X].3. Abrasion levels of reference tyres:

Average temperature of test:

Abrasion levels of reference tyres:

Abrasion levels of reference tyres normalized at reference temperature (only for vehicle method):

[X].4. Verification of Test Parameters (Drum Method Only):

Parameter	Value in Equivalence Report	Value in Current Test	Compliant ?
Surface Texture *(e.g. specific sandpaper grit)*	....	....	Yes / No
Third Body Type *(e.g. Silica)*	....	....	Yes / No
Average Flow Rate *(g/km)*	....	....	Yes / No
Distribution System *(e.g. Nozzle type)*	....	....	Yes / No

Digest of changes from previous version (Document TFTA 41-4)

Feature	Previous Draft (v3b)	This draft (v4c – 29-01-2026)
Start-up / Reference	**Placeholder:** Section 3 was empty ("To be completed"). No legal mechanism to define who is the "reference".	**Grandfathering Clause:** Section 3.2 explicitly designates the limit-setting circuits as the initial "Equivalent Circuits" to solve the start-up deadlock (chicken-and-egg). NB: Testing against three circuits (regardless of equivalence status) can also establish equivalence.
Tyre selection	At least 6 that cover a range of 0.4 units	At least 6 with mix of normal and 3PMSF tyres that cover a range of 0.5 units
Facility Selection	**A**t least 3 Equivalent Facilities Did not distinguish between generic and specific transfer functions.	**Tiered Approach:** Split into 3 paths: 1. **Circuit:** Needs 1 Eq. Circuit. 2. **Drum (Generic *a*):** Needs 1 Eq. Facility (Lower burden). 3. **Drum (Specific *a*):** Needs 2 Circuits (Higher burden).
Transfer Function (*a*)	**Undefined:** "Specify... formula to calculate *a* was left as a note.	**Strict Definition (Guidance):** Defined in Guidance Sec 2.1 as Linear Regression forced through (1,1) using shifted coordinates.
Statistical Check of R^2	**Open:** Asked to "Specify whether" to use OLS or forced intercept.	**Standardized (Guidance):** Guidance Sec 9.1 mandates **Ordinary Least Squares (OLS)** to ensure statistical comparability independent of the transfer function.

Feature	Previous Draft (v3b)	This draft (v4c – 29-01-2026)
Parameter Stability	**Passive:** "Recognised for specific test parameters".	**Active "Freeze":** Annex 4 Sec 4.3.3 mandates parameters (surface, Flow, Nozzle) be **recorded and fixed**. Guidance Sec 10 adds 5% tolerance for flow rate.
Periodicity	**Optional** if requested by the TAA	Removed – recommended in the Guidance