United Nations ECE/TRANS/WP.29/GRBP/2021/22

Economic and Social Council

Distr.: General
1 July 2021

Original: English

Economic Commission for Europe

Inland Transport Committee

World Forum for Harmonization of Vehicle Regulations

Working Party on Noise and Tyres

Seventy-fourth session
Geneva, 15–17 September 2021
Item 3 of the provisional agenda
UN Regulation No. 51 (Noise of M and N categories of vehicles)

Proposal for supplement 7 to 03 series of amendments to UN Regulation No. 51

Submitted by the Informal Working Group on Measurement Uncertainties*

The text below has been prepared by the experts of the Informal Working Group on Measurement Uncertainties (IWG MU) in order to introduce measures to reduce variability. The modifications to the existing text of the UN Regulation are marked in bold for new or strikethrough for deleted characters. Some modifications include moving existing provisions to other places.

* In accordance with the programme of work of the Inland Transport Committee for 2021 as outlined in proposed programme budget for 2021 (A/75/6 (Sect.20), para 20.51), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

Please recycle

I. Proposal

Annex 3,

Paragraph 1.4., amend to read:

"1.4. Instrumentation for speed measurements

The engine speed shall be measured with instrumentation having an accuracy of ±2 per cent or better at the engine speeds required for the measurements being performed.

The road speed of the vehicle shall be measured with **a continuous speed measuring device** ~~instrumentation~~ having an accuracy of at least ±0.5 km/h~~, when using continuous measurement devices~~.

~~If testing uses independent measurements of speed, this instrumentation shall meet specification limits of at least ±0.2 km/h.~~"

Paragraph 1.5., amend to read:

"1.5. Meteorological instrumentation

The meteorological instrumentation used to monitor the environmental conditions during the test shall include the following devices, which meet at least the given accuracy:

(a) Temperature measuring device, ±1 °C;

(b) Wind speed-measuring device, ±1.0 m/s;

(c) Barometric pressure measuring device, ±5 hPa;

(d) A relative humidity measuring device, ±5 per cent.

A monitoring of the wind speed is not mandated, when tests are carried out in an indoor facility."

Paragraph 2.1.3., amend to read:

"2.1.3. Ambient conditions

2.1.3.1. Ambient condition indoor

2.1.3.1.1. General

Meteorological conditions are specified to provide a range of normal operating temperatures and to prevent abnormal readings due to extreme environmental conditions.

The meteorological instrumentation shall deliver data representative for the test site and values of temperature, relative humidity, and barometric pressure shall be recorded during the measurement interval.

2.1.3.1.2. Temperature

The measurements shall be made when the ambient air temperature is within the range from 5 °C to 40 °C.

The ambient temperature may of necessity be restricted to a narrower temperature range such that all key vehicle functionalities (e.g. start/stop, hybrid propulsion, battery propulsion, fuel-cell stack operation) are enabled according to manufacturer's specifications.

2.1.3.1.3. Wind

n.a.

2.1.3.1.4. Background noise

For indoor testing, background noise shall take into account noise emissions produced by the dynamometer rollers, ventilation systems, and facility exhaust gas systems.

2.1.3.2. Ambient condition outdoor

2.1.3.2.1. General

The surface of the site shall be free of powdery snow, tall grass, loose soil or cinders. There shall be no obstacle which could affect the sound field within the vicinity of the microphone and the sound source. The observer carrying out the measurements shall so position themself as not to affect the readings of the measuring instrument.

Measurements shall not be made under adverse weather conditions. It shall be ensured that the results are not affected by gusts of wind.

The meteorological instrumentation should be positioned adjacent to the test area at a height of 1.2 m ± 0.02 m. ~~The measurements shall be made when the ambient air temperature is within the range from 5 °C to 40 °C.~~

~~Tests carried out on request of the manufacturer at temperatures below 5° C shall be accepted as well.~~

~~The tests shall not be carried out if the wind speed, including gusts, at microphone height exceeds 5 m/s, during the sound measurement interval.~~

A value representative of **air and road surface** temperature, wind speed and direction, relative humidity, and barometric pressure shall be recorded during the sound measurement interval.

2.1.3.2.2. Temperature

The measurements shall be made when the ambient air temperature is within the range from 5 °C to 40 °C and the test surface temperature within the range from 5 °C to 60 °C.

Tests carried out on request of the manufacturer at temperatures below 5° C shall be accepted as well.

The ambient temperature may of necessity be restricted to a narrower temperature range such that all key vehicle functionalities (e.g. start/stop, hybrid propulsion, battery propulsion, fuel-cell stack operation) are enabled according to manufacturer's specifications.

2.1.3.2.3. Wind

The tests shall not be carried out if the wind speed, including gusts, at microphone height exceeds 5 m/s, during the sound measurement interval.

2.1.3.2.4. Background noise

Any sound peak which appears to be unrelated to the characteristics of the general sound level of the vehicle shall be ignored in taking the readings.

The background noise shall be measured for duration of 10 seconds immediately before and after a series of vehicle tests. The measurements shall be made with the same microphones and microphone locations used during the test. The A-weighted maximum sound pressure level shall be reported.

The background noise (including any wind noise) shall be at least 10 dB(A) below the A-weighted sound pressure level produced by the vehicle under test. If the difference between the ambient noise and the measured sound is between 10 and 15 dB(A), in order to calculate the test results the appropriate correction shall be subtracted from the readings on the sound-level meter, as in the following table:

Difference between ambient noise and sound to be measured dB(A)	*10*	*11*	*12*	*13*	*14*	*15*
Correction dB(A)	0.5	0.4	0.3	0.2	0.1	0.0

~~For indoor testing, background noise shall take into account noise emissions produced by the dynamometer rollers, ventilation systems, and facility exhaust gas systems.~~**"**

Paragraph 2.2., amend to read:

"2.2. Vehicle

2.2.1. **Vehicle Selection**

The vehicle shall be representative of vehicles to be put on the market as specified by the manufacturer in agreement with the Technical Service to fulfil the requirements of this Regulation.

Measurements shall be made without any trailer, except in the case of non-separable vehicles. At the request of the manufacturer, measurements may be made on vehicles with lift axle(s) in a raised position.

2.2.2. Vehicle test mass m_t and vehicle target mass m_{target}

2.2.2.1. Measurements shall be made on vehicles at the test mass m_t specified according to the ~~following table~~ **Table 2 below.**

When testing indoors, the test mass, m_t shall be utilized by the control system of the dyno roller. Actual mass of the vehicle has no effect on results and it is permitted to load the vehicle as necessary to prevent slip between the tyres and the dyno rolls. To detect excessive slip, it is recommended to control the ratio of engine rotational speed and vehicle speed between the acceleration phase and the constant-speed status. To avoid slip, it is possible to increase the axle load.

2.2.2.2. Target mass, m_{target}, is used to denote the mass that N_2 and N_3 vehicles should be tested at. The actual test mass of the vehicle can be less due to limitations on vehicle and axle loading.

Vehicle category	*Vehicle test mass*
M_1	The test mass m_t of the vehicle shall be between $0.9\ m_{ro} \leq m_t \leq 1.2\ m_{ro}$
N_1	The test mass m_t of the vehicle shall be between $0.9\ m_{ro} \leq m_t \leq 1.2\ m_{ro}$
N_2, N_3	$m_{target} = 50$ [kg/kW] x P_n [kW] Extra loading, m_{xload}, to reach the target mass, m_{target}, of the vehicle shall be placed above the rear axle(s). If the test mass m_t is equal to the target mass m_{target}, the test mass m_t shall be $0.95\ m_{target} \leq mt \leq 1.05\ m_{target}$ The sum of the extra loading and the rear axle load in an unladen condition, $m_{ra\ load\ unladen}$, is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle, $m_{ac\ ra\ max}$. If the test mass m_t is lower than the target mass m_{target}, the test mass mt shall be achieved with a tolerance of ±5 per cent. If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, the test mass, m_t, of the vehicle shall not exceed the sum of the front axle in an unladen condition, $m_{fa\ load\ unladen}$, and the rear axle load in an unladen condition, $m_{ra\ load\ unladen}$ plus the extra loading, m_{xload}, and the mass of the driver m_d.

Vehicle category	*Vehicle test mass*
	The test mass for vehicles with more than two axles shall be the same as for a two-axle vehicle. If the vehicle mass of a vehicle with more than two axles in an unladen condition, $m_{unladen}$, is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading. If the vehicle mass of a vehicle with two axles, $m_{unladen}$, is greater than the target mass, then this vehicle shall be tested without extra loading.
M_2 (M ≤ 3,500 kg)	The test mass m_t of the vehicle shall be between $0.9m_{ro} \leq mt \leq 1.2m_{ro}$
Complete M_2 (M > 3,500 kg), M_3	If the tests are carried out with a complete vehicle having a bodywork, m_{target} = 50 [kg/kW] x P_n [kW] is calculated either in compliance with conditions above (see N_2, N_3 category) or the test mass m_t of the vehicle shall be $0.9\ m_{ro} \leq mt \leq 1.1\ m_{ro}$.
Incomplete M_2 (M > 3,500 kg), M_3	If the tests are carried with an incomplete vehicle not having a bodywork, m_{target} = 50 [kg/kW] x P_n [kW] is calculated either in compliance with conditions above (see N_2, N_3 category), or the test mass m_t of the vehicle shall be $0.9\ m_{ro} \leq mt \leq 1.1\ m_{ro}$. where $m_{ro} = m_{chassisM2M3} + m_{xloadM2M3}$.

Table 2: Specification of test mass for the various vehicle categories

2.2.2.3. Calculation procedure to determine extra loading of N_2 and N_3 vehicles only

2.2.2.3.1. Calculation of extra loading

The target mass, m_{target}, (per kW rated power) for two-axle vehicles of category N_2 and N_3 is specified in the Table in paragraph 2.2.1: above.

$$m_{target} = 50\ [kg / kW] \times Pn\ [kW] \quad (1)$$

To reach the required target mass, m_{target}, for a vehicle being tested, the unladen vehicle, including the mass of the driver, m_d, shall be loaded with an extra mass, m_{xload}, which shall be placed above the rear axle as given in Formula (8):

$$m_{target} = m_{unladen} + m_d + m_{xload} \quad (2)$$

The target mass, m_{target}, shall be achieved with a tolerance of ±5 per cent.

The vehicle mass of the test vehicle in the unladen condition, $m_{unladen}$, is calculated by measuring on a scale the unladen front axle load, $m_{fa\ load\ unladen}$, and the unladen rear axle load, $m_{ra\ load\ unladen}$, as given in Formula (3):

$$m_{unladen} = m_{fa\ load\ unladen} + m_{ra\ load\ unladen} \quad (3)$$

By using Formulae (2) and (3), the extra loading, m_{xload}, is calculated as given in Formulae (4) and (5):

$$m_{xload} = m_{target} - (m_d + m_{unladen}) \quad (4)$$

$$m_{xload} = m_{target} - (m_d + m_{fa\ load\ unladen} + m_{ra\ load\ unladen}) \quad (5)$$

The sum of the extra loading, m_{xload}, and the unladen rear axle load, $m_{ra\ load\ unladen}$, is limited to 75 per cent of the technically permissible maximum laden mass for the rear axle, $m_{ac\ ra\ max}$, as given in Formula (6):

$$0{,}75\ m_{ac\ ra\ max} \geq m_{xload} + m_{ra\ load\ unladen} \quad (6)$$

The m_{xload} is limited according to Formula (7):

$$m_{xload} \leq 0{,}75\ m_{ac\ ra\ max} - m_{ra\ load\ unladen} \quad (7)$$

If the calculated extra loading, m_{xload}, in Formula (5) fulfils Formula (7), then the extra loading is equal to Formula (5). The test mass, m_t, of the vehicle is as calculated from Formula (8):

$$m_t = m_{xload} + m_d + m_{fa\ load\ unladen} + m_{ra\ load\ unladen} \quad (8)$$

In this case, the test mass of the vehicle is equal to the target mass

$$m_t = m_{target} \quad (9)$$

If the calculated extra loading, m_{xload}, in Formula (5) does not fulfil Formula (7), but rather fulfils Formula (10)

$$m_{xload} > 0{,}75\ m_{ac\ ra\ max} - m_{ra\ load\ unladen} \quad (10)$$

then, the extra loading, m_{xload}, shall be as given by Formula (11):

$$m_{xload} = 0{,}75\ m_{ac\ ra\ max} - m_{ra\ load\ unladen} \quad (11)$$

and the test mass, m_t, of the vehicle shall be as given by Formula (12):

$$m_t = 0{,}75\ m_{ac\ ra\ max} + m_d + m_{fa\ load\ unladen} \quad (12)$$

In this case, the test mass of the vehicle is lower than the target mass

$$m_t < m_{target} \quad (13)$$

The test mass, m_t, shall be achieved with a tolerance of ± 5 per cent.

2.2.2.3.2. Loading considerations if load cannot be aligned with the centre of rear axle

If the centre of gravity of the extra loading, m_{xload}, cannot be aligned with the centre of the rear axle, the test mass of the vehicle, m_t, shall not exceed the sum of the unladen front axle load, $m_{fa\ load\ unladen}$, and the unladen rear axle load, $m_{ra\ load\ unladen}$, plus the extra loading, m_{xload}, and the mass of the driver, m_d.

This means that if the actual front and rear axle loads are measured on a scale when the extra loading, m_{xload}, is placed onto the vehicle and it is aligned with the centre of the rear axle, the test mass of the vehicle minus the mass of the driver is as given by Formula (14):

$$m_t - m_d = m_{fa\ load\ laden} + m_{ra\ load\ laden} \quad (14)$$

Where:

$$m_{fa\ load\ laden} = m_{fa\ load\ unladen} \quad (15)$$

If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, Formula (14) is still fulfilled, but

$$m_{fa\ load\ laden} > m_{fa\ load\ unladen} \quad (16)$$

because the extra loading has partly distributed its mass to the front axle. In that case, it is not allowed to add more mass onto the rear axle to compensate for the mass moved to the front axle.

2.2.2.3.3. Test mass for vehicles with more than two axles

If a vehicle with more than two axles is tested, then the test mass of this vehicle shall be the same as the test mass for the two-axle vehicle.

If the unladen vehicle mass of a vehicle with more than two axles is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading.

2.2.2.3.4. **Calculation of the test mass of a virtual vehicle with two axles:**

When a vehicle family is not represented by a two-axle vehicle because it is physically not available, the vehicle family can be represented by a vehicle with more than two axles (vrf). In that case the test mass of a virtual two-axle vehicle ($m_{t\ (2\ axles\ virtual)}$) can be calculated in the following way:

For the calculation of the unladen vehicle mass of the virtual two-axle vehicle ($m_{unladen\ (2\ axles\ virtual)}$), take from the vehicle with more than two axles (vrf) the measured unladen front axle load ($m_{fa\ (vrf)\ load\ unladen}$) and the measured unladen rear axle load of that driven rear axle ($m_{ra\ (vrf)\ load\ unladen}$) which has the highest unladen load.

If the vehicle (vrf) has more than one front axle, take the one with the highest unladen front axle load.

➔ $m_{unladen\ (2\ axles\ virtual)} = m_{fa\ (vrf)\ load\ unladen} + m_{ra\ (vrf)\ load\ unladen}$

➔ $m_{xload\ (2\ axles\ virtual)} = m_{target} - (m_d + m_{unladen\ (2\ axles\ virtual)})$

Due to the requirement that the sum of the extra loading ($m_{xload\ (2\ axles\ virtual)}$) and the unladen rear axle load, $m_{ra\ (vrf)\ load\ unladen}$, is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle, $m_{ac\ ra\ max\ (2\ axles\ virtual)}$, this value, $m_{ac\ ra\ max\ (2\ axles\ virtual)}$, has to be chosen in such a way that it represents the rear axle of the forecasted highest production-volume in the manufacturer's variation with a technically permissible maximum laden mass allowed for the rear axle ($m_{ac\ ra\ max\ (chosen)}$) for the vehicle family as declared by the manufacturer.

➔ $m_{ac\ ra\ max\ (4x2\ virtual)} = m_{ac\ ra\ max\ (chosen)}$

If $m_{xload\ (2\ axles\ virtual)} \leq 0{,}75\ m_{ac\ ra\ max\ (chosen)} - m_{ra\ (vrf)\ load\ unladen}$

then

$m_{t\ (2\ axles\ virtual)} = m_{xload\ (2\ axles\ virtual)} + m_d + m_{fa\ (vrf)\ load\ unladen} + m_{ra\ (vrf)\ load\ unladen}$

and

$m_{t\ (2\ axles\ virtual)} = m_{target}$

If $m_{xload\ (2\ axles\ virtual)} > 0{,}75\ m_{ac\ ra\ max\ (chosen)} - m_{ra\ (vrf)\ load\ unladen}$

then

$m_{t\ (2\ axles\ virtual)} = 0{,}75\ m_{ac\ ra\ max\ (chosen)} + m_d + m_{fa\ (vrf)\ load\ unladen}$

and

$m_{t\ (2\ axles\ virtual)} < m_{target}$

The test mass of the vehicle with more than two axles representing the vehicle family is defined as followed:

$m_{t\ (vrf)} = m_{t\ (2\ axles\ virtual)}$

and the extra loading is calculated as

$m_{xload\ (vrf)} = m_{t\ (2\ axles\ virtual)} - m_d - m_{unladen\ (vrf)}$

2.2.2.**4.** At the applicant's request the vehicle of a category M_2, M_3, N_2 or N_3 is deemed representative of its completed type if the tests are carried out to an incomplete vehicle not having a bodywork. In the test of an incomplete vehicle all relevant soundproofing materials, panels and noise reduction components and systems shall be fitted on the vehicle as designed by the manufacturer except a part of bodywork which is built in a later stage.

No new test shall be required due to fitting of a supplement fuel tank or re-location of the original fuel tank on condition that other parts or structures of the vehicle apparently affecting sound emissions have not been altered.

~~The tyres and rims to be used for the test shall be representative for the vehicle and shall be selected by the vehicle manufacturer and recorded in Addendum to the Communication form (Annex 1, Appendix 1). They shall correspond to one of the tyre sizes designated for the vehicle as original equipment. The tyre is or will be commercially available on the market at the same time as the vehicle.[1] The tyres shall be inflated to the pressure recommended by the vehicle manufacturer for the test mass of the vehicle. The tyres shall have at least 1.6 mm tread depth.~~

~~When performing indoor testing, tyre/road sound is evaluated independently on the test track with the tyres to be used, according to this paragraph. Propulsion sound is independently evaluated on the dynamometer using tyres and other sound control measures to produce tyre/road sound which does not influence the measurement result.~~

2.2.3. **Preparation of the vehicle before testing**

~~Before the measurements are started, the engine shall be brought to its normal operating conditions.~~

2.2.3.1. General

The vehicle shall be equipped as specified by the vehicle manufacturer. Before the measurements are started, the vehicle shall be brought to its normal operating conditions, which means that essential components for the operation of the vehicle are at their nominal temperatures as specified by the manufacturer. This applies especially, but is not limited to

- **the cooling water (if applicable);**
- **oil temperature (if applicable).**

2.2.3.2. Battery state of charge

If so equipped, propulsion batteries shall have a state-of-charge sufficiently high to enable all key functionalities according to the specifications of the vehicle manufacturer. Propulsion batteries shall be within their component temperature window to enable all key functionalities. Any other type of rechargeable energy storage system shall be ready to operate during the test.

2.2.3.3. Active Sound Systems

Any active sound devices, either for noise control, or sound enhancement, shall operate as foreseen by the vehicle manufacturer and not be interfered with during the measurements.

2.2.3.4. Tyres

2.2.3.4.1. Tyre Selection

The tyres and rims to be used for the test shall be representative for the vehicle and shall be selected by the vehicle manufacturer and recorded in Addendum to the Communication form (Annex 1, Appendix 1). They shall correspond to one of the tyre sizes designated for the vehicle as original equipment. The tyre is or will be commercially available on the market at the same time as the

[1] ~~Given that the tyre contribution for overall sound emission is significant, regard shall be given for existing regulatory provisions concerning tyre/road sound emissions. Traction tyres, snow tyres and special use tyres as defined in paragraph 2. of Regulation No. 117 shall be excluded during type-approval and conformity of production measurements at the request of the manufacturer in accordance with Regulation No. 117.~~

vehicle.[2] The tyres shall be inflated to the pressure recommended by the vehicle manufacturer for the test mass of the vehicle. The tyres shall have at least 1.6 mm tread depth.

When performing indoor testing, tyre/road sound is evaluated independently on the test track with the tyres to be used, according to this paragraph. Propulsion sound is independently evaluated on the dynamometer using tyres and other sound control measures to produce tyre/road sound which does not influence the measurement result.

2.2.3.4.2. Tyre conditioning

Tyres with special fitment requirements, such as asymmetric or directional design, shall also be mounted in accordance with these requirements.

Before testing, tyres shall be conditioned (broken-in). Tyre break-in shall be representative to about 100 km of normal on-road operation. Tyres with special fitment requirements shall be broken-in in accordance with these requirements. The tyres fitted to the test vehicle shall rotate in the same direction as when they were broken-in.

Test tyres shall be warmed-up immediately prior to testing for at least 10min in the range of the test speed, with moderate lateral & longitudinal acceleration. The lateral acceleration shall be selected in a way to avoid excessive tire tread wear effects.

~~2.2.4.~~**2.2.3.5.** If the vehicle is fitted with more than two-wheel drive, it shall be tested in the drive which is intended for normal road use.

~~2.2.5.~~**2.2.3.6.** If the vehicle is fitted with fan(s) having an automatic actuating mechanism, this system shall not be interfered with during the measurements.

~~2.2.6.~~**2.2.3.7.** If the vehicle is equipped with an exhaust system containing fibrous materials, it might be necessary to carry out a conditioning test prior to testing. The provisions of Annex 4, paragraph 1. in conjunction with the flowchart (Figure 2) of the appendix to Annex 4 shall be followed.

2.2.3.8. Suspension Trim Level

If fitted, the trim level of a height adjustable suspension shall be set to its normal level for on-road operation as specified by the vehicle manufacturer.

~~2.2.7. Calculation procedure to determine extra loading of N_2 and N_3 vehicles only~~

~~2.2.7.1. Calculation of extra loading~~

~~The target mass, m_{target}, (per kW rated power) for two-axle vehicles of category N_2 and N_3 is specified in the Table in paragraph 2.2.1: above.~~

~~m_{target} = 50 [kg / kW] × Pn [kW] (1)~~

~~To reach the required target mass, m_{target}, for a vehicle being tested, the unladen vehicle, including the mass of the driver, m_d, shall be loaded with an extra mass, m_{xload}, which shall be placed above the rear axle as given in Formula (8):~~

~~$m_{target} = m_{unladen} + m_d + m_{xload}$ (2)~~

~~The target mass, m_{target}, shall be achieved with a tolerance of ±5 per cent.~~

[2] **Given that the tyre contribution for overall sound emission is significant, regard shall be given for existing regulatory provisions concerning tyre/road sound emissions. Traction tyres, snow tyres and special-use tyres as defined in paragraph 2. of Regulation No. 117 shall be excluded during type-approval and conformity of production measurements at the request of the manufacturer in accordance with Regulation No. 117.**

The vehicle mass of the test vehicle in the unladen condition, $m_{unladen}$, is calculated by measuring on a scale the unladen front axle load, $m_{fa\ load\ unladen}$, and the unladen rear axle load, $m_{ra\ load\ unladen}$, as given in Formula (3):

$$m_{unladen} = m_{fa\ load\ unladen} + m_{ra\ load\ unladen} \qquad (3)$$

By using Formulae (2) and (3), the extra loading, m_{xload}, is calculated as given in Formulae (4) and (5):

$$m_{xload} = m_{target} - (m_d + m_{unladen}) \qquad (4)$$

$$m_{xload} = m_{target} - (m_d + m_{fa\ load\ unladen} + m_{ra\ load\ unladen}) \qquad (5)$$

The sum of the extra loading, m_{xload}, and the unladen rear axle load, $m_{ra\ load\ unladen}$, is limited to 75 per cent of the technically permissible maximum laden mass for the rear axle, $m_{ac\ ra\ max}$, as given in Formula (6):

$$0{,}75\ m_{ac\ ra\ max} \geq m_{xload} + m_{ra\ load\ unladen} \qquad (6)$$

The m_{xload} is limited according to Formula (7):

$$m_{xload} \leq 0{,}75\ m_{ac\ ra\ max} - m_{ra\ load\ unladen} \qquad (7)$$

If the calculated extra loading, m_{xload}, in Formula (5) fulfils Formula (7), then the extra loading is equal to Formula (5). The test mass, m_t, of the vehicle is as calculated from Formula (8):

$$m_t = m_{xload} + m_d + m_{fa\ load\ unladen} + m_{ra\ load\ unladen} \qquad (8)$$

In this case, the test mass of the vehicle is equal to the target mass

$$m_t = m_{target} \qquad (9)$$

If the calculated extra loading, m_{xload}, in Formula (5) does not fulfil Formula (7), but rather fulfils Formula (10)

$$m_{xload} > 0{,}75\ m_{ac\ ra\ max} - m_{ra\ load\ unladen} \qquad (10)$$

then, the extra loading, m_{xload}, shall be as given by Formula (11):

$$m_{xload} = 0{,}75\ m_{ac\ ra\ max} - m_{ra\ load\ unladen} \qquad (11)$$

and the test mass, m_t, of the vehicle shall be as given by Formula (12):

$$m_t = 0{,}75\ m_{ac\ ra\ max} + m_d + m_{fa\ load\ unladen} \qquad (12)$$

In this case, the test mass of the vehicle is lower than the target mass

$$m_t < m_{target} \qquad (13)$$

The test mass, m_t, shall be achieved with a tolerance of ± 5 per cent.

2.2.7.2. Loading considerations if load cannot be aligned with the centre of rear axle

If the centre of gravity of the extra loading, m_{xload}, cannot be aligned with the centre of the rear axle, the test mass of the vehicle, m_t, shall not exceed the sum of the unladen front axle load, $m_{fa\ load\ unladen}$, and the unladen rear axle load, $m_{ra\ load\ unladen}$, plus the extra loading, m_{xload}, and the mass of the driver, m_d.

This means that if the actual front and rear axle loads are measured on a scale when the extra loading, m_{xload}, is placed onto the vehicle and it is aligned with the centre of the rear axle, the test mass of the vehicle minus the mass of the driver is as given by Formula (14):

$$m_t - m_d = m_{fa\ load\ laden} + m_{ra\ load\ laden} \qquad (14)$$

Where:

$$m_{fa\ load\ laden} = m_{fa\ load\ unladen} \qquad (15)$$

If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, Formula (14) is still fulfilled, but

$$m_{fa\ load\ laden} > m_{fa\ load\ unladen} \qquad (16)$$

because the extra loading has partly distributed its mass to the front axle. In that case, it is not allowed to add more mass onto the rear axle to compensate for the mass moved to the front axle.

2.2.7.3. Test mass for vehicles with more than two axles

If a vehicle with more than two axles is tested, then the test mass of this vehicle shall be the same as the test mass for the two-axle vehicle.

If the unladen vehicle mass of a vehicle with more than two axles is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading.

2.2.7.4. Calculation of the test mass of a virtual vehicle with two axles:

When a vehicle family is not represented by a two-axle vehicle because it is physically not available, the vehicle family can be represented by a vehicle with more than two axles (vrf). In that case the test mass of a virtual two-axle vehicle ($m_{t\ (2\ axles\ virtual)}$) can be calculated in the following way:

For the calculation of the unladen vehicle mass of the virtual two-axle vehicle ($m_{unladen\ (2\ axles\ virtual)}$), take from the vehicle with more than two axles (vrf) the measured unladen front axle load ($m_{fa\ (vrf)\ load\ unladen}$) and the measured unladen rear axle load of that driven rear axle ($m_{ra\ (vrf)\ load\ unladen}$) which has the highest unladen load.

If the vehicle (vrf) has more than one front axle, take the one with the highest unladen front axle load.

➔ $m_{unladen\ (2\ axles\ virtual)} = m_{fa\ (vrf)\ load\ unladen} + m_{ra\ (vrf)\ load\ unladen}$

➔ $m_{xload\ (2\ axles\ virtual)} = m_{target} - (m_d + m_{unladen\ (2\ axles\ virtual)})$

Due to the requirement that the sum of the extra loading ($m_{xload\ (2\ axles\ virtual)}$) and the unladen rear axle load, $m_{ra\ (vrf)\ load\ unladen}$, is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle, $m_{ac\ ra\ max\ (2\ axles\ virtual)}$, this value, $m_{ac\ ra\ max\ (2\ axles\ virtual)}$, has to be chosen in such a way that it represents the rear axle of the forecasted highest production-volume in the manufacturer's variation with a technically permissible maximum laden mass allowed for the rear axle ($m_{ac\ ra\ max\ (chosen)}$) for the vehicle family as declared by the manufacturer.

➔ $m_{ac\ ra\ max\ (4x2\ virtual)} = m_{ac\ ra\ max\ (chosen)}$

If $m_{xload\ (2\ axles\ virtual)} \leq 0,75\ m_{ac\ ra\ max\ (chosen)} - m_{ra\ (vrf)\ load\ unladen}$

then

$m_{t\ (2\ axles\ virtual)} = m_{xload\ (2\ axles\ virtual)} + m_d + m_{fa\ (vrf)\ load\ unladen} + m_{ra\ (vrf)\ load\ unladen}$

and

$m_{t\ (2\ axles\ virtual)} = m_{target}$

If $m_{xload\ (2\ axles\ virtual)} > 0,75\ m_{ac\ ra\ max\ (chosen)} - m_{ra\ (vrf)\ load\ unladen}$

then

$m_{t\ (2\ axles\ virtual)} = 0,75\ m_{ac\ ra\ max\ (chosen)} + m_d + m_{fa\ (vrf)\ load\ unladen}$

and

$m_{t\ (2\ axles\ virtual)} < m_{target}$

The test mass of the vehicle with more than two axles representing the vehicle family is defined as followed:

$m_{t\ (vrf)} = m_{t\ (2\ axles\ virtual)}$

and the extra loading is calculated as

$m_{xload\ (vrf)} = m_{t\ (2\ axles\ virtual)} - m_d - m_{unladen\ (vrf)}$"

II. Justification

General

1. The accuracy in determination of speed and acceleration (which is calculated out of the speed measurements and thus more sensitive to variation) has been improved.

2. Chapter 2.1.3. for ambient conditions has been completely restructured for more clarity and to differentiate between indoor and outdoor testing.

3. A new requirement for road surface temperature recording has been introduced to limit the variability of the road surface temperature within the range from 5 °C to 60 °C.

4. Chapter 2.2.2 for vehicle selection has been completely restructured for more clarity.

5. A restructured and updated chapter 2.2.3. for preparation of the vehicle before test has been introduced for clarity and improved variability.

6. Proper tyre conditioning has been introduced, because this is necessary for achieving representative, repeatable and reproducible test results

Annex 3, paragraph 1.4.

7. The determination of the vehicle speed by independent speed measuring devices has been deleted to improve the accuracy in determination of speed and acceleration (which is calculated out of the speed measurements and thus more sensitive to variation).

Annex 3, paragraph 1.5.

8. A sentence was added to clarify that no determination of the wind speed is needed for indoor testing.

Annex 3, paragraph 2.1.3.1.2.

9. This paragraph clarifies the temperature range for indoor facilities. There is no need to require more narrow temperature conditions for air temperature compared to outdoor testing, as outdoor testing will stay the reference for all tests.

10. New text was added to clarify, that especially with new technologies the manufacturer may determine more narrow temperature conditions, if otherwise the key functionalities – (e.g. start/stop, hybrid propulsion, battery propulsion, fuel-cell stack operation) cannot be ensured.

Annex 3, paragraph 2.1.3.2.2.

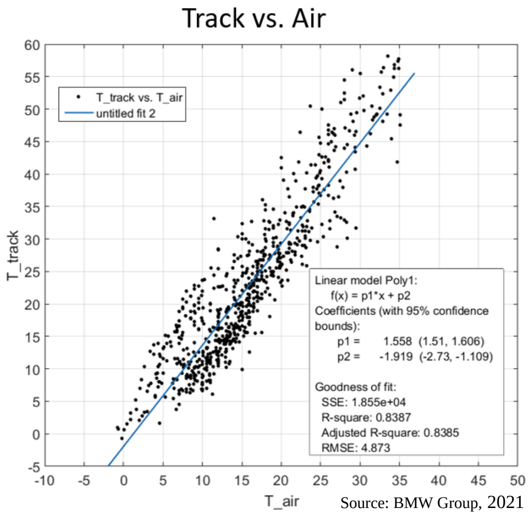
11. This provision clarifies the temperature range for outdoor facilities. New requirements for road surface temperature has been introduced. The maximum temperature is under discussion to be either aligned with UN Regulation No. 117 to 50°C or the be expanded for practical reasons to 60°C. There is evidence that 60 °C surface temperature correlates for with the actual mandated 40°C air temperature.

12. The tyre rolling sound component will be corrected to a reference temperature (pending work package). Thus, the temperature range is less critical as today.

Figure

Measurements of air and track surface temperature (about 700)
measurement points under various ambient conditions (summer, winter, cloudy, sunny, etc…)

$$T_{Track} = 1.558*T_{air} – 1.919$$



Source: BMW Group, 2021

13. New text was added here as well to clarify, that especially with new technologies the manufacturer may determine more narrow temperature conditions, if otherwise the key functionalities – (e.g. start/stop, hybrid propulsion, battery propulsion, fuel-cell stack operation) cannot be ensured.

Annex 3, paragraph 2.2.2.1.

14. Clarification of where to find the specifications on test mass and target mass.

Annex 3, paragraph 2.2.2.2.

15. Relocation of specific section for target mass to clarify use and importance of this term for N_2 and N_3 vehicles for better structure.

Annex 3, paragraph 2.2.2.3.

16. Addition of new paragraph heading to clarify intent and organization of extra loading and test mass sections. The restructuring of paragraph numbering is designed to assist users of the regulation to come to a correct load and test mass result.

Annex 3, paragraph 2.2.2.3.1.

17. Addition of new paragraph heading to clarify intent and organization of extra loading sections. This subsection contains all of the calculations necessary for the general loading calculation and is no longer mixed with other loading or mass provisions.

Annex 3, paragraph 2.2.2.3.2.

18. Addition of new paragraph heading to clarify intent and organization of extra loading sections. This subsection contains all of the calculations necessary for the loading calculation for the case, where load cannot be aligned with the rear axle. These calculations are no longer mixed with other loading or mass provisions.

Annex 3, paragraph 2.2.2.3.3.

19. Addition of new paragraph heading to clarify intent and organization of test mass for vehicles with more than two axles. These specifications are no longer mixed with other loading or mass provisions.

Annex 3, paragraph 2.2.2.3.4.

20. Addition of new paragraph heading to clarify intent and organization of test mass for "virtual" vehicles with two axles. These specifications are no longer mixed with other loading or mass provisions.

Annex 3, paragraph 2.2.2.4.

21. Addition of new paragraph heading to clarify intent and use of an incomplete vehicle. These specifications are no longer mixed with other loading or mass provisions.

Annex 3, paragraph 2.2.3.

22. Addition of new paragraph heading to clarify intent and procedures for vehicle preparation. Specific sub-paragraphs are added for each vehicle preparation action.

Annex 3, paragraph 2.2.3.1.

23. Addition of new paragraph and wording to clarify intent and procedures for general vehicle preparation. Explanation of "normal operating conditions" provided to assist the user of this regulation correctly "warm up" the vehicle power train.

Annex 3, paragraph 2.2.3.2.

24. Addition of new paragraph to clarify intent and procedures for battery state of charge. Battery state of charge is a key vehicle parameter for electric or hybrid electric vehicles to enable correct vehicle operation. These provisions are the same language as in UN Regulation No. 138, standards ISO 362-1 and ISO 16254.

Annex 3, paragraph 2.2.3.3.

25. Addition of new paragraph to include any sort of exterior sound generation system as part of the test conditions for this regulation. These provisions prevent the condition where the test result according to this regulation may not be representative of on road and in-use vehicle operation.

Annex 3, paragraph 2.2.3.4.

26. Addition of new paragraph heading to clarify and organize all provisions relating to tyres.

Annex 3, paragraph 2.2.3.4.1.

27. Addition of new paragraph to clarify provisions relating to tyre selection. Rims (wheels) are added to indicate both parts of a tyre/wheel assembly work together to provide the correct result.

Annex 3, paragraph 2.2.3.4.2.

28. Addition of new paragraph to clarify provisions relating to tyre conditioning. Proper tyre conditioning is necessary to achieve representative, repeatable and reproducible test results.

Annex 3, paragraph 2.2.3.5.

29. Addition of new paragraph to clarify provisions relating to drive mode when a vehicle has more than two-wheel drive. Drive mode provisions are no longer mixed with other vehicle preparation provisions

Annex 3, paragraph 2.2.3.6.

30. Addition of new paragraph to clarify provisions relating to automatic cooling fans. Cooling fan provisions are no longer mixed with other vehicle preparation provisions.

Annex 3, paragraph 2.2.3.7.

31. Addition of new paragraph to clarify provisions relating to fibrous materiel in exhaust systems. Fibrous materiel provisions are no longer mixed with other vehicle preparation provisions

Annex 3, paragraph 2.2.3.8.

32. Addition of new paragraph to clarify provisions relating to the possible inclusion of a height adjustable suspension.

33. All text in this proposal is produced by IWG MU by amending the 03 series of amendments to UN Regulation No. 51.