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1958 Agreement:
Consideration of draft amendments to existing UN Regulations submitted by GRBP

Proposal for Supplement 7 to 03 series of amendments to UN Regulation No. 51 (Noise of M and N categories of vehicles)

Submitted by the Working Party on Noise and Tyres*

The text reproduced below was adopted by the Working Party on Noise and Tyres (GRBP) at its seventy-fourth session (ECE/TRANS/WP.29/GRBP/72, para. 5). It is based on ECE/TRANS/WP.29/GRBP/2021/22 and para. 5 of the report. It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Administrative Committee (AC.1) for consideration at their March 2022 sessions.

* In accordance with the programme of work of the Inland Transport Committee for 2022 as outlined in proposed programme budget for 2022 (A/76/6 (part V sect. 20) para 20.76), 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.

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 having an accuracy of at least ±0.5 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.

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 air 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

"

Paragraph 2.2. and its subparagraphs, 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 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.

Table 2
Specification of test mass for the various vehicle categories

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. 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 ($M \leq 3{,}500$ 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

Vehicle category	*Vehicle test mass*
	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 $m_{ro} = m_{chassisM2M3} + m_{xloadM2M3}$.

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.

2.2.3. Preparation of the vehicle before testing

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 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.

2.2.3.4.2. 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.

2.2.3.5. 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.

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

2.2.3.7. 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."

[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 UN Regulation No. 117 shall be excluded during type-approval and conformity of production measurements at the request of the manufacturer in accordance with UN Regulation No. 117.