

5 November 2018

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## **Agreement**

### **Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations\***

(Revision 3, including the amendments which entered into force on 14 September 2017)

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#### **Addendum 50 – UN Regulation No. 51**

#### **Revision 3 - Amendment 3**

Supplement 3 to the 03 series of amendments – Date of entry into force: 16 October 2018

#### **Uniform provisions concerning the approval of motor vehicles having at least four wheels with regard to their sound emissions**

This document is meant purely as documentation tool. The authentic and legal binding texts are: ECE/TRANS/WP.29/2018/7 and ECE/TRANS/WP.29/2018/7/Add.1.



**UNITED NATIONS**

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\* Former titles of the Agreement:

Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958 (original version); Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, done at Geneva on 5 October 1995 (Revision 2).

Paragraph 1., amend to read:

## "1. Scope

This Regulation contains provisions on the sound emitted by motor vehicles and applies to vehicles of categories M and N.<sup>1</sup>

The specifications in this Regulation are intended to reproduce the sound levels which are generated by vehicles during normal driving in urban traffic.

This regulation provides, as well, additional sound emission provisions for vehicles of categories M<sub>1</sub> and N<sub>1</sub> referring to driving conditions with extreme accelerations in an extended speed range representative for urban and suburban traffic."

Paragraph 2.8.1., amend to read:

"2.8.1. If two or more sources of propulsive power operate at the conditions of test specified in Annex 3 to this Regulation, the total engine power, P<sub>n</sub>, shall be the arithmetic sum of parallel propulsive engines on the vehicle.

Applicable parallel propulsive engines are those power sources, which provide forward motion to the vehicle in combination at the conditions of test, specified in Annex 3 to this Regulation.

The specified power for non-combustion engines shall be the power stated by the vehicle manufacturer."

Paragraph 2.24., table, amend to read and add new rows at the end:

"2.24. Table of symbols

| <i>Symbol</i>    | <i>Unit</i> | <i>Annex</i> | <i>Paragraph</i> | <i>Explanation</i>  |
|------------------|-------------|--------------|------------------|---|
| ...              | ...         | ...          | ...              | ...   |
| BB'              | —           | Annex 3      | 3.1.1.           | line perpendicular to vehicle travel which is 10.00 m behind line PP'   |
| ...              | ...         | ...          | ...              | ...   |
| v <sub>AA'</sub> | km/h        | Annex 3      | 3.1.2.1.2.       | vehicle velocity when the reference point passes line AA' (see paragraph 2.11. for definition of reference point); value to be reported and used for calculations to the first decimal place                        |
| v <sub>BB'</sub> | km/h        | Annex 3      | 3.1.2.1.2.       | vehicle velocity when the reference point or rear of the vehicle passes line BB' (see paragraph 2.11. for definition of reference point); value to be reported and used for calculations to the first decimal place |
| v <sub>PP'</sub> | km/h        | Annex 3      | 3.1.2.1.2.       | vehicle velocity when the reference point passes line PP' (see paragraph 2.11. for definition of reference point);  |

| <i>Symbol</i>                   | <i>Unit</i> | <i>Annex</i> | <i>Paragraph</i> | <i>Explanation</i>  |
|---------------------------------|-------------|--------------|------------------|---|
|                                 |             |              |                  | value to be reported and used for calculations to the first decimal place   |
| ...                             | ...         | ...          | ...              | ...   |
| $M_t$ (2 axles virtual)         | kg          | Annex 3      | 2.2.7.4.         | test mass of a virtual vehicle with two axles (4x2 or 4x4)  |
| $V_{rf}$                        | —           | Annex 3      | 2.2.7.4.         | vehicle with more than two axles representing the vehicle family  |
| $M_{unladen}$ (2 axles virtual) | kg          | Annex 3      | 2.2.7.4.         | unladen vehicle mass of the virtual vehicle with two axles  |
| $M_{xload}$ (2 axles virtual)   | kg          | Annex 3      | 2.2.7.4.         | extra loading for the virtual vehicle with two axles  |
| $M_{ac\ ra\ max}$ (chosen)      | kg          | Annex 3      | 2.2.7.4.         | Technically permissible maximum laden mass allowed for the chosen rear axle as defined in paragraph 2.2.7.4. in Annex 3 |

"

Add new paragraphs 2.27. and 2.28. to read:

- "2.27. "Kickdown" means a driver initiated automated gear shift to a test condition outside the specific target conditions for the vehicle as defined in Annex 3.
- 2.28. "Prevention of downshift" means a measure by the vehicle manufacturer to ensure that the vehicle is tested within its specific target conditions as defined in Annex 3 and Annex 7."

Paragraph 3.3., amend to read:

- "3.3. In the case of paragraph 2.2.2. the single vehicle, representative of the type in question, will be selected by the Technical Service conducting approval tests, in accordance with the vehicle manufacturer following the specification laid down in paragraph 3.1.2.2. in Annex 3."

Paragraph 6.2.3., amend to read:

- "6.2.3. Additional sound emission provisions
- The Additional Sound Emission Provisions (ASEP) apply only to vehicles of categories  $M_1$  and  $N_1$  equipped with an internal combustion engine.
- ...
- Any electric sound enhancement system for the purpose of the exterior sound emission shall be operational during the type-approval test."

Paragraph 11.6., amend to read:

- 11.6. Until 30 June 2022, vehicles with a serial hybrid drive train which have a combustion engine with no mechanical coupling to the power train are excluded from the requirements of paragraph 6.2.3. above.

Insert a new paragraph 11.9., to read:

"11.9. Until 18 months after the date of entry into force of the Supplement 3, it shall not apply to extensions of existing approvals, originally granted prior to the date of entry into force of Supplement 3."

Annex 1,

Appendix 1, paragraph 2.3.3., amend to read:

"2.3.3. If applicable, pre-acceleration length  $l_{PA}$  (Point of the accelerator depression in meter before line AA'). If the pre-acceleration length differs per gear, reporting per gear is required."

Appendix 2,

Add a new item 0.2. to read:

"0.2. Type: ....."

The existing items 0.2. to 0.6., renumber as 0.3. to 0.7. accordingly.

Add a new item 3.2.6. and subitems to read:

"3.2.6. Pressure charger(s)

3.2.6.1. Make(s): .....

3.2.6.2. Type(s): ....."

Annex 3,

Paragraph 2.1., amend to read:

"2.1. ...  
The meteorological instrumentation should be positioned adjacent to the test area at a height of  $1.20\text{ m} \pm 0.02\text{ m}$ . The measurements shall be made when the ambient air temperature is within the range from  $5\text{ }^{\circ}\text{C}$  to  $40\text{ }^{\circ}\text{C}$ .

Tests carried out on request of the manufacturer at temperatures below  $5\text{ }^{\circ}\text{C}$  shall be accepted as well.

..."

Paragraph 2.2.1., table, amend to read:

"2.2.1. ...

| Vehicle category                | Vehicle test mass  |
|---------------------------------|--|
| M <sub>1</sub>                  | The test mass $m_t$ of the vehicle shall be between<br>$0.9\ m_{ro} \leq m_t \leq 1.2\ m_{ro}$   |
| N <sub>1</sub>                  | The test mass $m_t$ of the vehicle shall be between<br>$0.9\ m_{ro} \leq m_t \leq 1.2\ m_{ro}$   |
| N <sub>2</sub> , N <sub>3</sub> | $m_{target} = 50\text{ [kg/kW]} \times P_n\text{ [kW]}$<br>Extra loading, $m_{xload}$ , to reach the target mass, $m_{target}$ , of the vehicle shall be placed above the rear axle(s).<br>If the test mass $m_t$ is equal to the target mass $m_{target}$ , the test mass $m_t$ shall be $0.95\ m_{target} \leq m_t \leq 1.05\ m_{target}$<br>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 |

| Vehicle category  | Vehicle test mass  |
|---|--|
|   | <p>permissible maximum laden mass allowed for the rear axle, <math>m_{ac\ ra\ max}</math>.</p> <p>If the test mass <math>m_t</math> is lower than the target mass <math>m_{target}</math>, the test mass <math>m_t</math> shall be achieved with a tolerance of <math>\pm 5</math> per cent.</p> <p>If the centre of gravity of the extra loading cannot be aligned with the centre of the rear axle, the test mass, <math>m_t</math>, of the vehicle shall not exceed the sum of the front axle in an unladen condition, <math>m_{fa\ load\ unladen}</math>, and the rear axle load in an unladen condition, <math>m_{ra\ load\ unladen}</math> plus the extra loading, <math>m_{xload}</math>, and the mass of the driver <math>m_d</math>.</p> <p>The test mass for vehicles with more than two axles shall be the same as for a two-axle vehicle.</p> <p>If the vehicle mass of a vehicle with more than two axles in an unladen condition, <math>m_{unladen}</math>, is greater than the test mass for the two-axle vehicle, then this vehicle shall be tested without extra loading.</p> <p>If the vehicle mass of a vehicle with two axles, <math>m_{unladen}</math>, is greater than the target mass, then this vehicle shall be tested without extra loading.</p> |
| M <sub>2</sub> (M ≤ 3,500 kg)                               | The test mass $m_t$ of the vehicle shall be between $0.9m_{ro} \leq m_t \leq 1.2m_{ro}$  |
| Complete<br>M <sub>2</sub> (M > 3,500 kg), M <sub>3</sub>   | <p>If the tests are carried out with a complete vehicle having a bodywork,</p> <p><math>m_{target} = 50 \text{ [kg/kW]} \times P_n \text{ [kW]}</math> is calculated either in compliance with conditions above (see N<sub>2</sub>, N<sub>3</sub> category)</p> <p>or</p> <p>the test mass <math>m_t</math> of the vehicle shall be <math>0.9 m_{ro} \leq m_t \leq 1.1 m_{ro}</math>.</p>  |
| Incomplete<br>M <sub>2</sub> (M > 3,500 kg), M <sub>3</sub> | <p>If the tests are carried with an incomplete vehicle not having a bodywork,</p> <p><math>m_{target} = 50 \text{ [kg/kW]} \times P_n \text{ [kW]}</math> is calculated either in compliance with conditions above (see N<sub>2</sub>, N<sub>3</sub> category),</p> <p>or</p> <p>the test mass <math>m_t</math> of the vehicle shall be <math>0.9 m_{ro} \leq m_t \leq 1.1 m_{ro}</math>.</p> <p>where</p> <p><math>m_{ro} = m_{chassisM2M3} + m_{xloadM2M3}</math>.</p>   |

Paragraph 2.2.6., amend to read:

"2.2.6. 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."

Paragraph 2.2.7.1., amend to read:

"2.2.7.1. Calculation of extra loading

...

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

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

The test mass,  $m_t$ , shall be achieved with a tolerance of  $\pm 5$  per cent."

*Add a new paragraph 2.2.7.4. to read:*

"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 ( $m_{\text{unladen (2 axles virtual)}}$ ), take from the vehicle with more than two axles (vrf) the measured unladen front axle load ( $m_{\text{fa (vrf) load unladen}}$ ) and the measured unladen rear axle load of that driven rear axle ( $m_{\text{ra (vrf) load unladen}}$ ) 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.

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

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

Due to the requirement that the sum of the extra loading ( $m_{\text{xload (2 axles virtual)}}$ ) and the unladen rear axle load,  $m_{\text{ra (vrf) load unladen}}$ , is limited to 75 per cent of the technically permissible maximum laden mass allowed for the rear axle,  $m_{\text{ac ra max (2 axles virtual)}}$ , this value,  $m_{\text{ac ra max (2 axles virtual)}}$ , 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 ( $m_{\text{ac ra max (chosen)}}$ ) for the vehicle family as declared by the manufacturer.

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

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

then

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

and

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

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

then

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

and

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

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

$$m_t \text{ (vrf)} = m_t \text{ (2 axles virtual)}$$

and the extra loading is calculated as

$$m_{\text{load (vrf)}} = m_t \text{ (2 axles virtual)} - m_d - m_{\text{unladen (vrf)}}$$

Paragraph 3.1.2.1., amend to read:

"3.1.2.1. Vehicles of category  $M_1$ ,  $N_1$  and  $M_2 \leq 3,500$  kg technically permissible maximum laden mass:

The path of the centreline of the vehicle shall follow line CC' as closely as possible throughout the entire test, from the approach to line AA' until the rear of the vehicle passes line BB' +20 m.

..."

Paragraph 3.1.2.1.4., amend to read:

"3.1.2.1.4. Gear ratio selection

...

Appendix 3, Figure 4a to Figure 4e, give gear selection criteria and test run criteria for categories  $M_1$  and  $M_2$  having a technically permissible maximum laden mass not exceeding 3,500 kg and for category  $N_1$ , in a flowchart form as an aid to test operation."

Paragraph 3.1.2.1.4.1., amend to read:

"3.1.2.1.4.1. Vehicles with manual transmission, automatic transmissions, adaptive transmissions or CVTs tested with locked gear ratios

The following conditions for selection of gear ratios are possible:

- (a) If one specific gear ratio gives an acceleration in a tolerance band of  $\pm 5$  per cent of the reference acceleration  $a_{\text{wot ref}}$ , not exceeding  $2.0 \text{ m/s}^2$ , test with that gear ratio.
- (b) If none of the gear ratios give the required acceleration, then choose a gear ratio  $i$ , with an acceleration higher and a gear ratio  $i+1$ , with an acceleration lower than the reference acceleration. If the acceleration value in gear ratio  $i$  does not exceed  $2.0 \text{ m/s}^2$ , use both gear ratios for the test. The weighting ratio in relation to the reference acceleration  $a_{\text{wot ref}}$  is calculated by:

$$k = (a_{\text{wot ref}} - a_{\text{wot (i+1)}}) / (a_{\text{wot (i)}} - a_{\text{wot (i+1)}})$$

- (c) If the acceleration value of gear ratio  $i$  exceeds  $2.0 \text{ m/s}^2$ , the first gear ratio shall be used that gives an acceleration below  $2.0 \text{ m/s}^2$  unless gear ratio  $i+1$  (or  $i+2$ , or  $i+3$  or ...) provides acceleration less than  $a_{\text{urban}}$ . In this case, two gears,  $i$  and  $i+1$  (or  $i+2$ , or  $i+3$  or ...) shall be used, including the gear  $i$  with acceleration exceeding  $2.0 \text{ m/s}^2$ . In other cases, no other gear shall be used. The achieved acceleration  $a_{\text{wot test}}$  during the test shall be used for the calculation of the part power factor  $k_p$  instead of  $a_{\text{wot,ref}}$ .
- (d) If rated engine speed is exceeded in a gear ratio  $i$  before the vehicle passes BB' the next higher gear  $i+1$  shall be used. If the next higher gear  $i+1$  results in an acceleration below  $a_{\text{urban}}$ , the vehicle test speed,  $v_{\text{test}}$ , in the gear ratio  $i$  shall be reduced by  $2.5 \text{ km/h}$  and the gear ratio selection shall proceed as specified by the options given in this paragraph. In no case shall the vehicle test speed be reduced below  $40 \text{ km/h}$ . If the rated engine speed is exceeded in gear ratio  $i$  before the vehicle passes BB' and the vehicle test speed is equal to  $40 \text{ km/h}$ , the higher gear ratio  $i+1$

is allowed even if  $a_{wot}$  test does not exceed  $a_{urban}$ . The vehicle test speed in the higher gear ratio  $i+1$  shall be 50 km/h.

In the case of a vehicle not exempted from ASEP according to paragraph 6.2.3., gear  $i$  shall be tested and values reported ( $L_{wot,i}$ ,  $n_{wot,BB i}$ ,  $v_{wot,BB i}$ ) in order to perform tests of Annex 7.

*Add a new paragraph 3.1.2.1.4.3. to read:*

"3.1.2.1.4.3. Vehicles with only one gear ratio, like but not limited to Battery Electric Vehicles (BEV) and Fuel Cell Vehicles (FCV)

The gear selector position for forward driving shall be used. The acceleration value  $a_{wot\ test}$  shall be calculated as defined in paragraph 3.1.2.1.2.1.

The achieved acceleration  $a_{wot\ test}$  shall be greater or equal to  $a_{urban}$ .

If possible, the manufacturer shall take measures to avoid an acceleration value  $a_{wot\ test}$  greater than 2.0 m/s<sup>2</sup>.

The achieved acceleration  $a_{wot\ test}$  is then used for the calculation of the partial power factor  $k_p$  (see paragraph 3.1.2.1.3.) instead  $a_{wot\ ref}$ ."

*Paragraphs 3.1.2.1.5. and 3.1.2.1.6., amend to read:*

"3.1.2.1.5. Acceleration test

The manufacturer shall define the position of the reference point in front of line AA' of fully depressing the accelerator. The accelerator shall be fully depressed (as rapidly as is practicable) when the reference point of the vehicle reaches the defined point. The accelerator shall be kept in this depressed condition until the rear of the vehicle reaches line BB'. The accelerator shall then be released as rapidly as possible. The measurement reading shall not end before the rear of the vehicle is 20 m behind the BB' line. The point of fully depressing the accelerator shall be reported in Addendum to the Communication form (Annex 1, Appendix 1). The Technical Service shall have the possibility of pretesting.

If the vehicle length was set according to the provisions of 3.1.2.1.2. the accelerator shall be kept in the depressed condition until the reference point reaches BB' + 5 m for front engine vehicles, and BB' + 2.5 m for mid-engine vehicles.

...

3.1.2.1.6. Constant speed test

The constant speed test shall be carried out with the same gear(s) specified for the acceleration test and a constant speed of 50 km/h with a tolerance of  $\pm 1$  km/h between AA' and BB', or if applicable at the speed determined for the acceleration test according 3.1.2.1.4.1. (d) with a tolerance of  $\pm 1$  km/h between AA' and BB'. ..."

*Paragraph 3.1.2.2.1., amend to read:*

"3.1.2.2.1. Gear ratio selection

...

Appendix 3, Figure 5a to Figure 5d, give gear selection criteria and test run criteria for categories  $M_2$  having a technically permissible maximum laden

mass exceeding 3,500 kg, and for category N<sub>2</sub>, M<sub>3</sub> and N<sub>3</sub>, in a flowchart as an aid to test operation."

*Appendix, flowcharts,*

*Figures 3a to 3e, renumber as 4a to 4e, respectively.*

*Figures 4a to 4d, renumber as 5a to 5d, respectively.*

*Figure 4a (renumbered),* replace "locked gears (3.1.2.1.4.1.) See Figures 3b, 3c and 3d" by "locked gears (3.1.2.1.4.1.) See Figures 4b, 4c and 4d".

*Figure 4a (renumbered),* replace "non-locked gears (3.1.2.1.4.2.) See Figure 3e" by "non-locked gears (3.1.2.1.4.2.) See Figure 4e".

*Figure 4b (renumbered),* replace "See Case 1 in Figure 3c" by "See Case 1 in Figure 4c".

*Figure 4b (renumbered),* replace "See Case 2 in Figure 3c" by "See Case 2 in Figure 4c".

*Figure 4c (renumbered),* replace "See Case 3 in Figure 3d" by "See Case 3 in Figure 4d".

*Annex 4,*

*Paragraph 1., amend to read:*

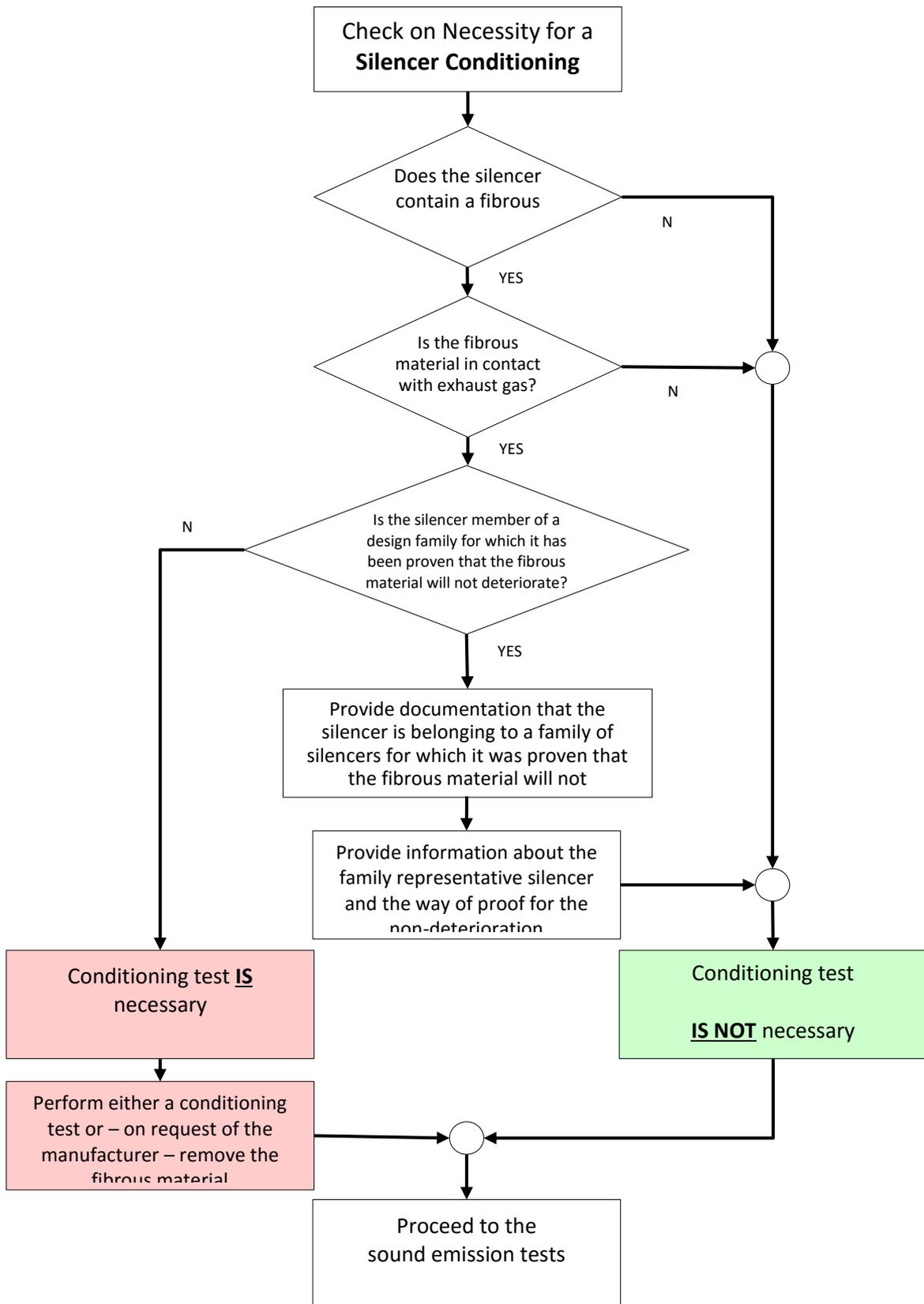
"1.           General

...

Unless one of these conditions is fulfilled, the complete silencing system or components thereof shall be submitted to a conventional conditioning using one of three installations and procedures described below, or - on request of the manufacturer - by removing the fibrous materials from the silencer."

*Appendix, add a new flowchart to read:*

**Figure 2: Flowchart for the check on the necessity for a silencer conditioning test**



*Annex 6,*

*Paragraph 2.1.,* amend to read:

"2.1. The vehicle(s) under test shall be subjected to the test for measurement of sound of vehicle in motion as described in paragraph 3.1. of Annex 3.

For vehicles of category M<sub>1</sub>, N<sub>1</sub> and M<sub>2</sub> ≤ 3,500 kg technically permissible maximum laden mass,

- the same mode, gear(s)/gear ratio(s), gear weighting factor k and partial power factor k<sub>p</sub> as determined during the type approval process.
- the test mass m<sub>t</sub> of the vehicle shall be between  $0.9m_{ro} \leq m_t \leq 1.2m_{ro}$  "

*Paragraph 3.,* amend to read:

"3. Sampling and evaluation of the results

One vehicle shall be chosen and subjected to the tests set out in point 2. If the sound level of the vehicle tested does not exceed by more than 1 dB(A) the limit value specified in paragraph 6.2.2. of this Regulation, and, where appropriate, paragraph 3. of Annex 5, the vehicle type shall be considered to conform to the requirements of this Regulation.

..."

*Annex 7,*

*Paragraph 3.1.,* amend to read:

"3.1. Determination of the anchor point

The anchor point is the same for each gear ratio  $\kappa$  falling under the control range according to paragraph 2.3. The parameters for the anchor point are taken from the acceleration test of Annex 3 as follows:

In the case the test has been carried out with two gear ratios:

L<sub>anchor</sub> is the higher sound pressure level of L<sub>wot,(i)</sub> of left and right side of gear ratio i;

n<sub>anchor</sub> is the average of n<sub>BB,wot,i</sub> of the 4 runs of gear ratio i reported from Annex 3;

In the case the test has been carried out in a single gear:

L<sub>anchor</sub> is the higher sound pressure level of L<sub>wot</sub> of left and right side of gear ratio selected for the test;

n<sub>anchor</sub> is the average of n<sub>BB,wot</sub> of the 4 runs of gear ratio selected for the test reported from Annex 3;"